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ROYAL GOVERNMENT OF BHUTAN

MINISTRY OF INFRASTRUCTURE AND TRANSPORT

DEPARTMENT OF INFRASTRUCTURE DEVELOPMENT

"Towards quality,cost effective, green and sustainable infrastructure"

# SPECIFICATIONS FOR BUILDING AND ROAD WORKS - 2026

## FOREWORD

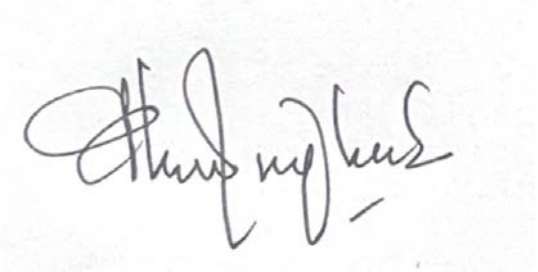
The Department of Infrastructure Development, Ministry of Infrastructure and Transport, is pleased to publish the Specifications for Building and Road Works - 2026. This document has been prepared as a technical guide for engineers, architects, contractors, consultants and other stakeholders involved in the planning, design, estimation, execution and supervision of building and road construction works.

The Specifications define the standards for materials, workmanship, construction methods, testing requirements, quality control procedures, mode of measurement and applicability of rates for items of work included in the Bhutan Schedule of Rates - 2026 (BSR - 2026) and the Labour and Material Coefficients - 2026 (LMC - 2026). Accordingly, this document shall be read in conjunction with the BSR - 2026 and LMC - 2026 for the preparation of estimates, tender documents, rate analysis and execution of works.

Relevant codes, standards and good engineering practices have been referenced wherever applicable. In preparing this publication, the Department has made every effort to update the specifications in line with current construction practices, technological developments and quality requirements.

The Department expects this document to serve as a useful reference for promoting consistency, quality, transparency and efficiency in building and road works.

Comments and suggestions related to this publication may be submitted to the Department for consideration in future revisions and improvements.



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# SECTION - 1: GENERAL

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**1.0 Interpretation:** - The Director General of the Department of Infrastructure Development shall be the sole deciding authority as to the meaning, interpretation, and implication of the various provisions of the specifications. His decision in writing shall be final and binding on all concerned.

**1.1 Materials:** - All materials shall be in accordance with the specifications given under "Specification of Materials" and shall be approved by the Engineer before use in the works. Samples of materials, fittings, etc. shall be submitted by the contractor for the approval of the Engineer before bulk supplies are brought to the site of works. The samples so approved shall be kept in the custody of the Engineer till the completion of works. When required by the Engineer, the contractor shall supply for the purpose of testing samples of any materials proposed to be used in the works.

**1.2 Testing of materials**: - Samples, whether submitted to govern bulk supplies or required for testing before use, shall be provided free of charge by the contractor. Suitable packages to contain the samples shall also be supplied free of charge. Testing charges, if any, shall be borne by the Department. All other expenditure required to be incurred for taking the samples, conveyance, packaging, etc. shall be borne by the contractor himself.

**1.3 Safety on works**: -Safety precautions pertaining to construction works such as excavation trenching, blasting, demolition, provision of scaffolds, ladder, working platforms, gang ways, mixing of asphalt materials, electric arc and gas welding, use of hoisting and construction machinery shall be taken as directed by the Engineer.

**1.4 Antiquities and useful materials**: - Any finds at the time of excavation such as relics of antiquity, coins, fossils or other articles of value shall be delivered by the contractor to the Engineer and shall be the property of the Government. Any materials obtained from the excavation which in the opinion of the engineer is useful, shall be stacked separately in regular stacks as directed by the engineer and shall be the property of the Government.

**1.5 Bench marks**: - Temporary site bench mark shall be constructed at the construction site, where so required by the Engineer.

**1.6 Reference to I.S**: - Wherever I.S (Indian Standard) issued by the Bureau of Indian Standards is referred to, it shall be taken as reference to the latest edition with all amendments issued thereto. However, in the event of any variation between the DOID Specification and that in the I.S., the DOID Specification shall take precedence over the I.S.

**1.7 Abbreviations**: - The following abbreviations, wherever they appear in the specifications, shall have the meaning or implication hereby assigned to them.

| | | |
|---|---|---|
| °C | : | Degree Celsius (Centigrade) |
| cc (C.C) | : | Cubic Centimetre |
| C.I (CI) | : | Cast Iron |
| C.G.S | : | Corrugated Galvanised Steel |
| cm | : | Centimetre |
| CPVC | : | Chlorinated Polyvinyl Chloride |

| | | |
|---|---|---|
| cu.m | : | Cubic metre |
| Deg. C | : | Degree Celsius (Centigrade) |
| Dia (dia) | : | Diameter |
| D.I | : | Ductile Iron |
| Fig (fig) | : | Figure |
| FPS (fps) | : | Foot, Pound, Second system of units |
| FRP | : | Fiber Reinforced Plastic |
| G.I (GI) | : | Galvanised Iron |
| G.L | : | Ground Level |
| Gr. | : | Grade |
| GRC | : | Glass Fiber Reinforced Concrete |
| gm | : | gram |
| HDPE | : | High Density Polyethylene |
| H.C.I. | : | Heavy Cast Iron |
| I.S. (IS) | : | Indian Standard |
| Kg (kg) | : | Kilogram |
| Kgf | : | Kilogramforce |
| KL | : | Kilolitre |
| l | : | litre |
| m | : | metre |
| M.I. | : | Malleable iron |
| M.K.S. | : | Metre, Kilogram and Second system of units |
| ml | : | milliliter |
| mm (MM) | : | millimetre |
| M.S. (MS) | : | Mild Steel |
| No. (no) | : | Number |
| Pt. (pt.) | : | Part |
| P.V.C. | : | Poly Vinyl Chloride |
| P.P.G.I | : | Pre-painted Galvanized Iron |
| P.P.G.L | : | Pre-painted Galvalume |
| q | : | quintal |
| RB | : | Reinforced Brickwork |
| RCC | : | Reinforced Cement Concrete |
| RSJ | : | Rolled Steel Joist |
| S.C.I | : | Sand Cast Iron |
| sq. | : | square |
| sq.cm | : | Square Centimetre |
| sq.dm | : | Square decimetre |
| sq.m | : | Square metre |
| S.W. | : | Stone Ware |
| Swg | : | Standard wire gauge |
| t | : | Tonne |
| UPVC | : | Unplasticized Poly Vinyl Chloride |
| WC | : | Water Closet |
| WPC | : | Wood Plastic Composite |

**Road Works:**

| | | |
|---|---|---|
| AASHTO | : | American Association of State Highway and Transportation Officials |
| ACV | : | Aggregate Crushing Value |
| AIV | | Aggregate Impact Value |
| ALD | : | Average Least Dimension |
| ASTM | : | American Society of Testing and Materials |
| BA | : | Bitumen Affinity |
| BS | : | British Standards |
| BSCP | : | British Standards Code of Practice |
| BSR | : | Bhutan Schedule of Rates |
| CBR | : | California Bearing Ratio |
| C/c | : | Centre to centre |
| CR | : | Crushing Ratio |
| dia | : | diameter |
| DCP | : | Dynamic Cone Penetrometer |
| DoFS | : | Department of Forestry Services |
| DoR | : | Department of Roads |
| ECP | : | Environment Code of Practice |
| FI | : | Flakiness Index |
| hr | : | hour |
| IRC | : | Indian Road Congress Recommended Code of Practice |
| IS | : | Indian Standards |
| ISO | : | International Organisation for Standardization |
| LAA | : | Los Angeles Abrasion Value |
| LS | : | Linear Shrinkage |
| MC | : | Moisture Content |
| MDD | : | Maximum Dry Density |
| min | : | minute |
| ml | : | Meter length |
| BSB | : | Bhutan Standard Bureau |
| DES | : | Department of Engineering Services |
| no | : | Number |
| No | : | Number (order) as in No 6 |
| OMC | : | Optimum Moisture Content |
| OPC | : | Ordinary Portland Cement |
| PI | : | Plasticity Index |
| PL | : | Plastic Limit |
| PM | : | Plasticity Modulus (PI x % passing 0.425 mm sieve) |
| SE | : | Sand Equivalent |
| sec | : | second |
| SG | : | Specific Gravity |
| SI | : | International Standard Units of Measurements |
| SSS | : | Sodium Sulphate Soundness test, loss on 5 cycles |
| STV | : | Standard Tar Viscosity |
| TS | : | Tensile Strength |
| UC | : | Uniformity Coefficient |

| | | |
|---|---|---|
| UCS | : | Unconfined Compressive Strength |
| VIM | : | Voids in Mix |
| w/c | : | Water cement ration |
| wt | : | Weight |
| % | : | Percent |
| QA | : | Quality Assurance |
| QC | : | Quality Control |

# SECTION - 2: DEFINITIONS

# SECTION 2: DEFINITIONS

The definitions given below shall be applicable to all sections unless otherwise indicated.

## 2.0 GENERAL

2.0.1 **Contractor**: - An individual or legal entity which enters into a contract to execute works.

2.0.2 **Engineer**: **-** Engineer shall mean a person with a degree or diploma in engineering from any recognized Institute or University of Engineering who shall supervise and be in charge of the work, and act on behalf of the Employer.

2.0.3 **Employer/Client/Owner**: - The Government Agency that enters into a contract with the successful contractor for the execution of works.

2.0.4 **Foundations: -** The work in foundation shall include:

a) For Building: - All works below floor 1 level or up to 1.2 metres above average ground level, whichever is lower.
b) For abutments, piers, walls of reservoirs (other than overhead reservoirs)- The floor level or where the floor is not determinate, up to 1.2 metres above bed level.
c) For retaining walls, wing walls, and compound walls – up to 1.2 metres above average ground level.
d) For basement reservoirs etc: All works below floor 1 level or up to 1.2 meters above bed level.

2.0.5 **Floor level**: - Floor level means top level of the structural slab, except for floor 1, which shall be the top of the finished floor. Floor 1 level is the level of the lowest floor above G.L. in the building unless otherwise specified in a particular case.

2.0.6 **Plinth level**: **-** First floor level (Floor 1) or 1.2 m above average ground level whichever is lower.

2.0.7 **Identification of floors**: **-** The floors above the floor 1 shall be numbered in sequence as 2nd floor (Floor 2), 3rd Floor (Floor 3) etc. The number shall increase upward. In case of structures like retaining walls etc. height of 3.5 metres above ground level will be reckoned as floor two level. The other floors above the floor two level shall be numbered in sequence is 3rd floor (Floor 3), 4th floor (Floor 4) etc. after every subsequent 3.5 metres height.

2.0.8 **Site**: **-** The land(s) and/or other places on, in, into or through which work is to be executed under the contract, or any adjacent land, path or street which may be allotted or used for the purpose of carrying out the contract.

2.0.9 **Diameter**: **-**

- For P.V.C. pipes, brass tubes, steel, conduits - the external diameter.
- In cases other than mentioned above, the nominal diameter of the bore.

## 2.1 EARTHWORK

2.1.1 **Deadman or Tell Tales**: - Mounds of earth left undisturbed in pits dug out for borrowing earth.

2.1.2 **Formation**: - Final shape or profile of the ground after excavation or filling up.

2.1.3 **Foul position**: - The excavation under foul position means under filthy and unhygienic conditions such as soil mixed with sewerage or night soil (excavation in conditions where physical movements are hampered).

2.1.4 **Lead**: - Carriage by manual labour shall be reckoned in units of 50 m. The distance for removal measured over the shortest practicable route and not necessarily the route actually taken is known as lead.

2.1.5 **Liquid mud**: - Mud in liquid form or in a highly plastic state.

2.1.6 **Lift**: - The lift shall be measured from ground level. The excavation upto 1.5 metres depth below ground level and depositing the excavated material upto 1.5 metres above ground level is included in the rate of earth work for various kinds of soil. Extra lifts shall be paid in units of 1.5 metres or part thereof. Lifts inherent in the lead due to ground slope shall not be paid for.

2.1.7 **Profile**: - The pattern to which the earth is to be cut or made up and dressed.

2.1.8 **Safety rules**: - Safety rules as laid down by the statutory authority.

2.1.9 **All Kinds of Soil**: Generally any strata, such as sand, gravel, loam, clay, mud, black cotton soil, moorum, shingle, river or nallah bed boulders, soiling of roads, paths etc. and hard core macadam surface of any description (water bound, grouted tarmac etc.), lime concrete, mud concrete and their mixtures which for excavation yields to the application of picks, shovels, jumpers, scarifiers, ripper and other manual digging implements.

2.1.10 **Ordinary Rock**: Generally any rock which can be excavated by splitting with crow bars or picks and does not require blasting, wedging or similar means of excavation such as lime stone, sand stone, hard laterite, hard conglomerate and un-reinforced cement concrete below ground level. If required light blasting may be resorted to, for loosening the materials but this will not in any way entitle the material to be classified as “Hard Rock”

2.1.11 **Hard Rock** : Generally any rock or boulder for the excavation of which blasting is required such as quartzite, granite, basalt, reinforced cement concrete ( reinforcement to be cut through but not separated from concrete) below ground level and the like.

2.1.12 **Hard Rock (blasting prohibited)** : Hard rock requiring blasting as described under 2.1.11 but where the blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging or any other agreed method

2.1.13 **Marshy Soil**: This shall include soils like soft clays and peat excavated below the original ground level of marshes and swamps and soils excavated from other areas requiring continuous pumping or bailing out of water.

2.1.14 **Pillar**: - Pillar means a detached masonry support. This can be rectangular, circular or elliptical etc. In case of rectangular pillars, the breadth shall not exceed three times the thickness and thickness itself shall not exceed more than three bricks or 75 cm.

2.1.15 **Retaining wall**: - A wall built to support earth at a higher level on the one side than on the other.

**2.2 STONEWORK**

2.2.1 **Blasting: -** The operation of breaking rock by boring a hole in it, filling it with explosive charge and firing.

2.2.2 **Bed Joint**: - The joint where one stone presses on another, for example, a horizontal joint in a wall or a radiating joint between the voussoirs of an arch.

2.2.3 **Bond**: - An interlocking arrangement of structural units in a wall to ensure stability.

2.2.4 **Bond Stone (Through Stone)**: - Selected long stones used to hold a wall together transversely.

2.2.5 **Corbel**: - Stone bonded well into the wall with part of it projecting out of the face of the wall to form a bearing surface.

2.2.6 **Cornice**: - A horizontal moulded projection which crowns or finishes either a wall, any horizontal division of wall, or any architectural feature.

2.2.7 **Course**: - A layer of stones or bricks in a wall including the bed mortar.

2.2.8 **Cramp**: - A small piece of metal or the hardest or toughest stone procurable, sunk in mortices and fixed across joints as additional ties. The ends of metal cramps are bent at right angles and stone cramps are dovetailed.

2.2.9 **Crushing**: - The further operation on the rock after blasting, namely, breaking and reducing the rock to required sizes in mechanical crushers.

2.2.10 **Dowels**: - Dowels are small sections of metal, stone or pebbles bedded with mortar in corresponding mortice in bed or side joint of adjacent stones.

2.2.11 **Hammer Dressing**: - Rough surfacing to a stone by means of a spall hammer.

2.2.12 **Jamb**: - The part of the wall at the side of an opening.

2.2.13 **Joggle**: - A key between the stones by providing a groove in one stone to take a corresponding concealed projection in the edges on the other stone.

2.2.14 **Natural Bed**: - The plane of stratification that occurs in sedimentary rocks.

2.2.15 **Parapet**: - A solid or pierced guard wall for flat terrace or a balcony (or a bridge) or a curb wall at the lower part of a pitched roof, which is exposed to atmosphere on face, back and top.

2.2.16 **Quoin**: - A quoin is the external angle of a wall or building. The term is also applied to a stone specially selected and neatly dressed for forming such angles.

2.2.17 **Random**: - Sizes and shapes irregular in nature.

2.2.18 **Reveal**: - The part of the jamb between the frame and the arris.

2.2.19 **Rubble Masonry**: - Masonry built of stones either irregular in shape as quarried or squared and only hammer dressed and having comparatively thick joints. Stones for rubble masonry shall be, as far as possible, angular.

2.2.20 **Scaffolding**: - A temporary erection of timber or steel work used in the construction, alteration, demolition, or repairs of a building to support or to allow of the hoisting or lowering of workmen, their tools, and materials.

2.2.21 **String Course**: - A horizontal band, plain or moulded, usually projecting slightly from the face of a wall.

2.2.22 **Template or bed block**: - A block of stone or concrete bedded in a wall to distribute the pressure from concentrated load.

2.2.23 **Riprap**: - An erosion protection system provided to safeguard embankment surfaces against deterioration caused by wave action, flowing water velocity, rainfall runoff, wind forces, and similar hydraulic or environmental effects. The protection consists of a layer of durable rock fragments or engineered materials placed over the embankment surface to enhance stability and prevent soil erosion.

## 2.3 STEELWORK

2.3.1 **Bead**: - A single run of weld metal deposited on a surface.

2.3.2 **Butt weld**: - A weld in which the weld metal lies substantially within the extension of the planes of the surfaces of the parts joined or within the extension of the planes of the smaller of the two parts of differing sizes. The edges of the metal pieces shall be levelled or chiselled to the required shape at the throat, for which no extra payment shall be made.

2.3.3 **Crater:** - A depression left in weld metal where the arc was broken or the flame was removed.

2.3.4 **End crater**: - A crater at the end of a weld or at the end of a joint.

2.3.5 **Fillet Weld**: - A weld of approximately triangular cross section joining two surfaces approximately at right angles to each other in a lap joint, tee joint or corner joint. It is of two types (1) Continuous, (2) Intermittent.

2.3.6 **Fusion Welding**: - Any welding process in which the weld is made between metals in a state of fusion without hammering or pressure.
Fusion Penetration:

a) In fusion welding - the depth to which the parent metal has been fused.

b) In spot, seam or projecting welding: - the distance from the interface to the edge of the weld nugget, measured in each case on a cross section through the centre of the weld and normal to the surface.

2.3.7 **Non-Fusion Welding**: - A term applied to the deposition, by the Oxy-Acetylene process, of filler metal on parent metal without fusion of the latter.

2.3.8 **Oxy-Acetylene Pressure Welding**: - Pressure welding in which an Oxy-Acetylene flame is used to make plastic the surface to be united. No filler metal is used.

2.3.9 **Run**: - The metal deposited during one passage of the electrode or blow pipe in the making of joint.

2.3.10 **Throat**: - In a resistance welding machine, the distance from the centre line of the electrodes or platens to be nearest point of interference for flat work or sheets. In

the case of a seam-welding machine with a universal head, the throat depth is measured with the machine arranged for transverse welding.

2.3.11 **Throat thickness**: - the minimum thickness of weld metal in a fusion weld measured as under: -

a) For a fillet weld or a bevel butt weld: - Along a line passing through the root.

b) For a close square-butt weld: - in the plane of the abutting faces.

c) For an open square-butt weld: - at the centre of the original gap in a plane parallel to the fusion faces.

## 2.4 ROOFING

2.4.1 **Accessories**: - Purpose made fittings, such as apron flashing pieces, barge boards, bottom glazing flashing, corner piece (corner flashing), eaves filler pieces, expansion joints, hip capping, hip tile or cap, ridge capping, ridge finials, roof lights, ventilators, with which the roof is furnished.

2.4.2 **Eaves**: - The lower edge of the inclined roof.

2.4.3 **Finial**: - A decorative fitting used at the junction or ridges and hips and at the top of conical, pyramidal, or dome roofs.

2.4.4 **Flashing**: - A strip of impervious material, usually metal used to exclude water from the junction between a roof covering and another part of the structure.

2.4.5 **Gable**: - The triangular upper part of a wall at the end of the ridge.

2.4.6 **Gutter**: - Any form of roof water channel.

2.4.7 **Hip**: - The outer angle (more than 180 degree) formed by the inclined ridge between two intersecting roof slopes.

2.4.8 **Pitch**: -

a) The angle of inclination with the horizontal of the rafters or substructure surface on which the roof coverings are laid.

b) In patent glazing, the angle at which the plane of a stretch of glazing is inclined to the horizontal.

2.4.9 **Pitched Roof**: - A roof of a pitch of which is greater than 10 degree to the horizontal.

2.4.10 **Ridge**: - The horizontal intersection at the apex of the two rising roof surfaces inclined in opposite directions.

2.4.11 **Valley**: - The re-entrant angle formed by the intersection of two inclined roof surfaces.

2.4.12 **Bitumen**: - A non-crystalline solid or viscous material having adhesive properties, derived from petroleum either by natural or refinery process, and substantially soluble in carbon disulfide.

2.4.12 **Bitumen emulsion**: - A liquid product in which a substantial amount of bitumen is suspended in a finely divided condition in an aqueous medium.

2.4.13 **Bitumen straight run**: - Bitumen which has been distilled (vacuum or steam refined) to a definite viscosity of penetration without further treatment.

2.4.14 **Tack-coat**: - It shall consist of application of a single coat of low viscosity liquid bituminous material to an existing surface preparatory to further bituminous construction.

2.4.15 **PUF(Polyurethane Foam) Panel: -** A factory-manufactured composite sandwich panel consisting of rigid polyurethane foam insulation core bonded between two outer facing sheets, typically made of pre-coated galvanized steel, aluminum, stainless steel, or other metallic/non-metallic materials.

**2.5 WOODWORK**

2.5.1 **Air-Seasoning**: - Seasoning done in open air, usually protected from sun and rain.

2.5.2 **Ballies**: - Thin round poles usually without bark.

2.5.3 **Batten**: – A piece of sawn timber whose cross-sectional dimensions do not exceed 5cm in either direction.

2.5.4 **Batten Board**: –A board having a core made up of strips of wood usually 8cm wide, each laid separately or glued or otherwise joined to form a slab which is glued between two or more outer veneers with the direction of the grain of the core battens running at right angles to that of the adjacent outer veneer.

2.5.5 **Beam**: - A structural timber, generally long in proportion to its width and thickness and used for supporting load primarily by its internal resistance to bending.

2.5.6 **Binder**: **-** Organic-binding material used for adhesion of timber.

2.5.7 **Blemish**: **-** Anything that mars the appearance of wood but is not serious enough to be classed as a defect.

2.5.8 **Blister**: **-** A bulge on the surface due to a separation of the constituent plies or veneers, usually at a glue line.

2.5.9 **Block Board**: - A board having a core made up of strips of wood, each not exceeding 25 mm in width, laid separately or glued or otherwise joined to form a slab which is glued between two or more outer veneers with the direction of the grain of the core blocks running at right angles to that of the adjacent outer veneers.

2.5.10 **Bow**: **-** A curvature in a piece of timber along its face in the direction of its length.

2.5.11 **Braces**: - Diagonal members in framework.

2.5.12 **Burr**: **-** A large bulge or excrescence that is formed on the trunk or the branch of a tree.

2.5.13 **Clear Timber**: **-** Timber, which is free from defects and blemishes.

2.5.14 **Common Rafter**: **-** A roof member, which supports roof battens and roof covering, such as boarding and sheeting.

2.5.15 **Conditioning**: - The process designed to suit the moisture content of timbers to the conditions and purposes for which it is to be used.

2.5.16 **Conversion**: - The process of sawing timber.

2.5.17 **Core**: - The inner layer or layers of a composite wood product.

2.5.18 **Core Board**: – A general term for block board, laminated board and batten board.

2.5.19 **Cross Band**: - A general term indicating a transverse layer of veneer or veneers in composite wood products.

2.5.20 **Cross Cutting**: **-** Sawing timber across the grain

2.5.21 **Cup**: - A curvature in a piece of timber across the grain or width of the piece

2.5.22 **Decorative Veneers**: - Veneers having attractive appearance due to figure, colour, grain, lustre, etc.

2.5.23 **Diagonal Brace**: - A frame member affixed to crate face at an angle of usually between $30^{o}$ and $60^{o}$ to the edge members of that face.

2.5.24 **Dressed Timber** - Timber, which has been sawn, planed and worked to the exact required condition.

2.5.25 **Edging -** Straightening the edges of a board with plane or machine.

2.5.26 **End Coating** – Coating applied to the ends of timber to retard end-drying and subsequent splitting.

2.5.27 **Face** – The better side of the plywood panel in any grade calling for a face and a back; also, either side of a panel where the grading rules draw no distinction between faces.

2.5.28 **Fence posts**: – Pieces of timber of specified length, circular or rectangular in cross section and which may be suitably connected to each other in vertical position to form a protective barricade to a place or building so as to prevent intruders.

2.5.29 **Frame Work**: – The frame work is the structure consisting of the edge members, diagonal braces and struts that contribute primarily to the strength and rigidity of crate.

2.5.30 **Grain**: – A term used rather loosely to refer to many different characteristics of wood like the general direction of the fiber or wood elements relative to the main axis of the piece, for example, cross, diagonal, dip, interlocked, spiral, straight and wild, etc.

2.5.31 **Hardwood**: - A conventional term used to denote the wood of broad-leaved trees. It has no relationship with the physical properties of hardness or strength.

2.5.32 **Honeycombing**: – Internal cracks (separation of fibers) in timber due to drying stresses.

2.5.33 **Joint**: - A prepared connection for joining adjacent pieces of wood, veneer, etc.

a) *Dovetail Joint*: - A joint at the corner of two pieces in such a way that the notches made on one are fitted exactly into projections of corresponding size and shape made in the other. There are various kinds of dovetail joints for instance, lapped dovetail joints, wedge shaped dovetail joints, etc, joined in a way which will resist withdrawal except in the direction in which it was assembled.

b) *Mitered Joint*: - A joint, between two members at an angle in which the joining surface is cut to corresponding edges at the intersection.

c) *Mortise and Tenon Joint*: - A joint in which the reduced end (tenon) of one member fits into the corresponding slot (mortise) in another member.

d) *Tongue and Groove Joint*: - A joint in which a tongue is provided on edge of one member to fit into a corresponding groove on the other.

e) *Dowel joint*: – A joint in which dowels or pegs are placed in corresponding holes made on the two joining faces.

2.5.34 **Joist**: – A beam directly supporting the floor, ceiling or roof of a structure.

2.5.35 **Kiln**: – A chamber in which temperature, humidity and circulation of air may be controlled for seasoning timber.

2.5.36 **Knot**: - A branch base or limb embedded in the tree or timber by natural growth.

*Diameter of a Knot* - The maximum distance between two points farthest apart on the periphery of a round knot, on the face of which it becomes visible. In the case of a spike or splay knot, the maximum width of the knot visible on the face on which it appears shall be taken as its diameter.

2.5.37 **Laminated Wood**: – An assembled product made up of layers of wood and adhesive in which the grains of adjacent layers are parallel.

2.5.38 **Lamin Board**: – A board having a core of strips, each not exceeding 7 mm in thickness, glued together face to face to form a slab which in turn is glued between two or more outer veneers, with the direction of the grain of the core strips running at right angles to that of the adjacent outer veneers.

2.5.39 **Log**: – the stem of a tree that is felled and prepared for conversion.

2.5.40 **Lumber**: – Converted timber.

2.5.41 **Moisture content**: – The mass of water present in wood or other material expressed as a percentage of its oven-dry mass.

2.5.42 **Multi-layer Particle Board**: – A board made of several layers of like material in which particles of different shapes and sizes may be used in different layers.

2.5.43 **Multiply**: – Plywood board made of more than three layers of veneer.

2.5.44 **Particle Board**: - A board manufactured from particles of wood or other lignocellulose material, for example, flakes, granules, shavings, slivers, splinters agglomerated, formed and pressed together by use of an organic binder together with one or more of the agents, such as heat, pressure, moisture and a catalyst.

2.5.45 **Particle**: - Distinct particle or fraction of wood, or other lignocellulose material produced mechanically for use as the aggregate for a particle board. This may be in the form of flake, granule, shaving, splinter and sliver.

*Flake* - Specially made thin flat particle, with the grain of the wood essentially parallel to the surface of the flake, prepared with the cutting action of the knife in a plane parallel to the grain but an angle to the axis of the fibre.

*Shaving* - A thin slice or strip of wood pared off with knife, plane or other cutting instruments, the knife action being approximately along the axis of the fibre, such as the shavings produced in planning the surface of wood.

*Granule* - A particle in which the length, width and thickness are approximately equal, such as particles of saw-dust.

*Splinter or sliver* - Particle of nearly square or rectangular cross-section with a length parallel to the grain of the wood of at least four times the thickness.

2.5.46 **Plank**: – A piece of sawn timber whose thickness does not exceed 5 cm but the width exceeds 5 cm.

2.5.47 **Pleat**: – A defect due to veneer being folded parallel to the grain forming three thickness locally.

2.5.48 **Plies**: – Individual veneers in plywood.

2.5.49 **Plywood**: - A board formed of three or more layers of veneer cemented or glued together, usually with the grain of adjacent veneers running at right angles to each other.

2.5.50 **Pole**: – A long solid, straight trunk of a tree 10 to 30 cm in diameter at breast height and tapering gradually to the top to a diameter of about 10 cm or more.

2.5.51 **Post**: – A general term for timber used in an upright position in building, fencing or other structural work.

2.5.52 **Preservation**: – Treatment of timber with chemicals so as to enhance its durability.

2.5.53 **Primer**: – An undercoat given to the surface for subsequent painting where required.

2.5.54 **Principal rafter**: – A roof member which supports purlins.

2.5.55 **Rails**: – Horizontal members of shutters of doors, windows, panels or fencing.

2.5.56 **Rebate**: - A recess along the edge of a piece of timber to receive another piece or a door, sash or a frame.

2.5.57 **Sapwood**: - The outer layers of the log, which in growing trees contain living cells and food material. The sapwood is usually lighter in colour and is readily attacked by insects and fungi.

2.5.58 **Seasoning**: - A process involving the reduction of moisture content in timber under more or less controlled conditions towards or to an amount suitable for the purpose for which it is to be used.

2.5.59 **Seasoned Timber**: - Timber whose moisture content has been reduced to the specified minimum, under more or less controlled processes of drying.

2.5.60 **Shake**: – A partial or complete separation between adjoining layers of tissues as seen in end surfaces.

2.5.61 **Shingle**: – A short, thin, rectangular piece of timber, usually tapering in thickness along the grain, used in the same way as tiles for covering the roofs and sides of buildings.

2.5.62 **Softwood**: - A conventional term used to denote the timber from conifers and has no relationship with the physical properties of hardness or strength.

2.5.63 **Spread of adhesive**: – The area of surface covered by 0.5 kg of adhesive mix prepared in accordance with manufacturer's instructions.

2.5.64 **Stile**: – A vertical member of the shutter frame.

2.5.65 **Structural Timber**: - Timber used in framing and load bearing structures or timber used or intended for use in buildings where strength is the primary consideration.

2.5.66 **Tenon**: – A tongue-like projection on the end of a piece of timber to fit into a corresponding mortise.

2.5.67 **Texture**: – Term to indicate relative size and distribution of wood elements.

2.5.68 **Timber**: – A commercial wood, often in converted form.

2.5.69 **Veneer**: – A thin sheet of wood of uniform thickness obtained by slicing, rotary cutting or sawing.

2.5.70 **Warp**: – A deviation in sawn timber from a true plane surface, or distortion due to stresses causing departure from a true plane.

2.5.71 **Wood-Wool**: – Long, narrow, curling wood shavings used as packing material

2.5.72 **Soffit Ceiling: -** A secondary ceiling or enclosed underside construction provided beneath structural elements such as slabs, beams, staircases, roofs, ducts, or projections to conceal services, improve aesthetics, and enhance acoustic or thermal performance.

## 2.6 HYDRAULIC CEMENTS

2.6.1 **Hydraulic properties**: - Hydraulic properties are the ability of a material to set and harden in the presence of water, with formation of stable compounds.

2.6.2 **Pozzolanic properties**: - The ability of a material to combine chemically with calcium hydroxide in the presence of water under ambient temperature forming compounds having cementitious properties.

2.6.3 **Portland Clinker**: - Clinker, consisting mostly of calcium silicates, obtained by heating to incipient fusion a predetermined and homogenous mixture of materials principally containing lime (CaO) and Silica ($SiO_2$) with smaller proportion of alumina ($Al_2O_3$) and Iron oxide ($Fe_2O_3$).

2.6.4 **Granulated Blast furnace Slag**: - Blast furnace slag in granulated form is used for the manufacture of hydraulic cement. Blast furnace slag is a non-metallic product consisting essentially of glass containing silicates and aluminum-silicates of lime and other bases, which is developed simultaneously with iron in blast furnace or electric pig iron furnace. Granulated slag is obtained by further processing the molten slag by rapidly chilling or quenching it with water or steam and air.

2.6.5 **Portland Cement**: - Portland cement is the cement obtained by grinding Portland clinker with possible addition of a small quantity of Gypsum, water or both, and not more than one percent of air entraining agents or other agents which proved not to be harmful.

2.6.6 **Portland Blast furnace Slag Cement**: - An intimately inter-ground mixture of Portland clinker and granulated slag with addition of gypsum and permitted additives or an intimate and uniform blend of Portland cement and finely ground granulated blast furnace slag.

2.6.7 **High Alumina Cement**: - High alumina cement is the cement obtained by grinding high alumina clinker.

2.6.8 **Portland Pozzolana Cement**: - An intimately inter-ground mixture of Portland clinker and pozzolana with the possible addition of gypsum or an intimate and uniform blend of Portland cement and fine pozzolana.

## 2.7 AGGREGATES FOR CEMENT CONCRETE

2.7.1 **Aggregate**: - Granular material, generally inert, such as natural sand, manufactured sand, gravel, crushed stone, and air-cooled iron blast furnace slag which when bound together into a conglomerated mass by a matrix forms concrete or mortar.

2.7.2 **Aggregate, Coarse**: - Aggregate most of which is retained on 4.75 mm IS Sieve and containing only as much of finer materials as is permitted by the specification.

2.7.3 **Aggregate, Fine**: - Aggregates most of which passes 4.75mm IS Sieve and contains only so much coarser material permitted for various grading zones in the specification.

2.7.4 **Ballast**: - Stone or gravel mixture of irregular unscreened sizes which may also contain smaller material and sand.

2.7.5 **Bulking**: - Increase in the bulk volume of a quantity of sand in a moist condition over the volume of the same quantity dry or completely inundated.

2.7.6 **Chips**: - Broken fragments of marble or other mineral aggregate screened to specified sizes.

2.7.7 **Cinder**: - Well burnt furnace residue which has been fused or sintered into lumps of varying sizes. The same material in a finely powdered form is found to possess some pozzolanic activity.

2.7.8 **Shingle**: - Rounded or waterworn stone of irregular size occurring in river beds or opened beaches.

## 2.8 MATERIALS (OTHER THAN CEMENT AND AGGREGATES)

2.8.1 **Accelerator**: - A substance which, when added to concrete, mortar, or grout, increases the rate of hydration of hydraulic cement, shortens the time of set, or increases the rate of hardening or strength development.

2.8.2 **Admixture**: - A material other than water, aggregates, and hydraulic cement. Used as an ingredient of concrete or mortar, and added to the batch immediately before or during its mixing to modify one or more of the properties of concrete.

2.8.3 **Air-Entraining**: - The capability of a material or process to develop a system of minute bubbles of air in cement paste, mortar, or concrete.

2.8.4 **Fly Ash**: - A finely divided residue that results from the combustion of ground or pulverized coal.

2.8.5 **Plasticizer**: - A material that increases plasticity of a cement paste, mortar, or concrete mixture.

2.8.6 **Retarder**: **-** An admixture which delays the setting of cement paste, and hence of mixtures, such as mortar or concrete containing cement.

2.8.7 **Waterproof Cement**: - Cement inter-ground with a water repellent material such as calcium stearate.

2.8.8 **Water proofing Compound**: - Material used to impart water repellency to a structure or a construction unit.

2.8.9 **Cementatious Waterproofing Polymer: -** A composite waterproofing system comprising cement-based materials modified with polymer additives or liquid polymers to improve adhesion, flexibility, impermeability, and crack-bridging properties.

## 2.9 SANITARY INSTALLATION, WATER SUPPLY AND DRAINAGE

2.9.1 **Air Gap**: - The unobstructed distance between the lowest point of a water inlet or feed pipe to an appliance and the spill-over level (or the overflowing level) of the appliance.

2.9.2 **Air Valve**: - A valve that releases air from a pipe line automatically without loss of water or introduces air into a pipe line automatically if the internal pressure becomes less than that of the atmosphere.

2.9.3 **Antisiphon Pipe**: - Ventilating pipes connected to or close to the outlet side of a trap seal.

2.9.4 **Automatic Flushing Cistern**: - A flushing cistern arranged to discharge its content by siphonage at regular intervals, determined by the rate at which water is fed into the cistern.

2.9.5 **Available Head**: - The head of water available at the point of consideration due to mains pressure or overhead tank or any other source of pressure.

2.9.6 **Back flow**: - The flow of water or other liquids, mixtures or substances into the distributing pipes of a potable supply of water system from any sources other than its intended source.

2.9.7 **Back Siphonage**: - The flowing back of used, contaminated or polluted water from a plumbing fixture or vessel into a water supply pipe due to lowering of pressure in such pipe.

2.9.8 **Ball Cock**: - A faucet opened or closed by the fall or rise of a ball floating on the surface of water.

2.9.9 **Barrel Nipple**: - A very short piece of steel, brass or copper tube, having an external taper thread at each end.

2.9.10 **Bath**: - Any of a wide range of sanitary appliances used for ablution or treatment purposes.

2.9.11 **Bell Mouth**: - An expanded rounded entrance to a pipe or orifice.

2.9.12 **Benching**: - Sloping surfaces constructed on either side of channels at the base of a manhole or inspection chamber for the purpose of confining the flow of sewage, avoiding the accumulation of deposits and providing a safe working platform.

2.9.13 **Bend**: - A curved fitting for a piece of pipe or channel, or a curve made in a pipe, for changing the direction of the run.

2.9.14 **Bib Tap**: - A tap with a horizontal inlet and a nozzle bent to discharge in a downward direction.

2.9.15 **Bidet**: - A sanitary appliance, for which the user sits, for washing the excretory organs.

2.9.16 **Boiler**: - An enclosed vessel in which water is heated by the direct application of heat.

2.9.17 **Bore**: - The water way through a pipe, tap, valve or other fitting.

2.9.18 **Bowl Urinal**: - A urinal consisting of a bowl-shaped receiver, which is fixed at a convenient height above the floor.

2.9.19 **Box Union**: - A device for jointing two threaded pipes.

2.9.20 **Branch**: -

a) A special form of vitrified sewer and cast-iron pipe used for making connections to a sewer or water main. The various types are called T, Y, T-Y, double Y, and V branches, according to their respective shapes.

b) Any part of a piping system other than a Main.

2.9.21 **Buffer Clip**: - A pipe clip for a WC flush pipe incorporating a rubber buffer to prevent the WC seat from damaging the pipe.

2.9.22 **Capacity (Actual Capacity)**: - The volume of a storage cistern measured up to the maximum water line.

2.9.23 **Caulking**: -

a) The process of driving, pouring, or forcing lead, oakum, plastic, or other material into a joint to make it leak-proof.

b) The material used in the caulking process.

2.9.24 **Caulked Joint**: - A spigot and socket joint in which the jointing material is compacted using a caulking tool and hammer.

2.9.25 **Channel**: - A perceptible natural or artificial waterway which periodically or continuously contains moving water or which forms a connecting link between two bodies of water. It has definite bed and banks which confine the water.

2.9.26 **Chase**: - A continuous recess in a wall, floor or ceiling to hold pipes and conduits.

2.9.27 **Check Valve**: - A device provided with a disc hinged on one edge so that it opens in the direction of normal flow and closes with reversal of flow.

2.9.28 **Cistern**: - A fixed container for water in which the water is at atmospheric pressure. The water is usually supplied through a float-operated valve.

2.9.29 **Cleaning Eye**: - An access opening in a pipe or pipe fitting arranged to facilitate the clearing or obstructions and fitted with a removable cover.

2.9.30 **Closed Coupled WC Suite**: - A WC suite which does not require a flush pipe, the flushing cistern being directly connected to the pan.

2.9.31 **Cock**: - A device for controlling the flow of water, comprising a body having a parallel or taper seating into which is fitted a rotatable plug with a waterway which can be displaced relative to the waterway through the body.

2.9.32 **Collar**: - A pipe fitting in the form of a sleeve for jointing the spigot ends of two pipes in the same alignment.

2.9.33 **Combination Tap Assembly (Combined fitting)**: - A hot water tap and a cold water tap coupled together with a nozzle, which may be either fixed or swiveling, to discharge hot, cold or mixed hot and cold water.

2.9.34 **Conduit**: - A pipe or channel for the conveyance of a fluid.

2.9.35 **Connection**: - A boss, flange or socket, on a fitting or appliance, to which a pipe or fitting may be connected.

2.9.36 **Coupling**: - A pipe fitting used for connecting pipes, or fittings.

2.9.37 **Cowl**: - A hood on the top of a vent pipe or soil stack.

2.9.38 **Cross**: - A pipe fitting used for connecting four pipes at right angles.

2.9.39 **Curb**: - The stone margin of a sidewalk.

2.9.40 **Depth of Manhole**: - The vertical distance from the top of the manhole cover to the outgoing invert of the main drain channel.

2.9.41 **Depth of Water seal**: - The depth of water that would have to be removed from a fully charged trap before air could pass freely through the trap.

2.9.42 **Discharge pipe**: - A pipe that conveys the discharge from sanitary appliances. It may also convey rainwater.

2.9.43 **Dispersion Trench**: - A trench in which open jointed pipes, surrounded by coarse aggregate media and overlaid by fine aggregate, are laid. The effluent from septic tanks gets dispersed through the open joints and is absorbed in the neighboring soil.

2.9.44 **Down take Tap**: - A tap connected to a system of piping not subject to water pressure from the water main.

2.9.45 **Drain**: - A conduit or channel for the carriage of storm water, sewage or other used water.

2.9.46 **Drainer: -** An impervious surface adjacent to, and having a fall towards, a sanitary appliance such as sink. It may be integral with the appliance or separate, and its surface is often fluted to improve drainage.

2.9.47 **Drainage**: - The removal of any liquid by a system constructed for the purpose.

2.9.48 **Drop Connection**: - A length of conduit installed vertically immediately before its connection to a sewer or to another drain.

2.9.49 **Drop Manhole**: - A manhole installed in a sewer where the elevation of the incoming sewer considerably exceeds that of the outgoing sewer; a vertical waterway outside the manhole is provided to divert the waste water from the upper to the lower level so that it does not fall freely into the manhole except at peak rate of flow.

2.9.50 **Effluents**: -

a) Tank effluent: - The supernatant liquid discharge from a septic tank.

b) Filter effluent: - The liquid discharged from a biological filter.

2.9.51 **Elbow**: - A pipe fitting for providing a sharp change of direction in a pipeline.

2.9.52 **Faucet**: - A valve on a water pipe using which water can be drawn from or held within the pipe. The valve is placed on the end of the pipe.

2.9.53 **Feed cistern**: - Any storage cistern used for supplying cold water to a hot water apparatus, cylinder or tank.

2.9.54 **Female**: - That part of a two-part coupling within which the male part is enclosed.

2.9.55 **Ferrule**: - A pipe fitting for connecting a service pipe to a water main.

2.9.56 **Ferrule Key**: - A key for operating the valve of a screw down ferrule.

2.9.57 **Fire Hydrant**: - A device, connected to a water main and provided with necessary valves and outlets, to which a fire hose may be attached for discharging water at a high rate for the purpose of extinguishing fires, washing down streets, or flushing out the water main.

2.9.58 **Fittings** : - Coupling, flange, branch, bend, tees, elbows, unions, waste with plug, P or S trap with vent, stop ferrule, stop tap, bib tap, pillar tap, globe tap, ball valve, cistern, storage tank, baths, water-closets, boiler, geyser, pumping set, with motor and accessories, meter, hydrant, valve and any other article used in connection with water supply, drainage and sanitation.

2.9.59 **Flange**: - A projecting flat rim at the end of a valve, pipe etc.

2.9.60 **Flanged joint**: - A joint made by the connection of two flanges by bolts or studs and nuts and gaskets of suitable material are generally used in between flanges.

2.9.61 **Flanged Pipe**: - A pipe provided with flanges so that the ends can be joined together by means of bolts.

2.9.62 **Float**: - A body lighter than water riding on a water surface and actuating a mechanism by its response to rise or fall of the water level.

2.9.63 **Float Operated Valve (Ball valve)**: - A valve, for controlling the flow of water into a vessel, the valve being operated by the vertical movement of a float riding on the surface of the water in the vessel automatically.

2.9.64 **Flush Bend**: - A bend located at the bottom of low level flushing cistern for the purpose of flushing pedestal type water closet and similar fixture.

2.9.65 **Flushing Cistern**: - A cistern provided with a device for rapidly discharging the contained water and used in connection with a sanitary appliance for the purpose of cleaning the appliance and carrying away its contents into a drain.

2.9.66 **Flush pipe**: - A pipe for conveyance of flushing water from a flushing cistern or flushing valve to a WC pan or slop-hopper.

2.9.67 **Flush pipe connector**: - A joining device used to make a water-tight seal between the flush pipe and the water inlet to a WC pan or slop-hopper.

2.9.68 **Flush Valve (Flushing valve)**: - A valve, for controlling the flushing water supply to a WC pan, or similar appliance, opened by hand and closed automatically after use.

2.9.69 **Foot Valve**: - A non-return valve fitted at the bottom of a pump suction pipe in order to retain the water in the suction pipe.

2.9.70 **Gasket**: - A piece of compressible materials, often perforated, used to make a joint between two flat surfaces.

2.9.71 **Gate Valve**: - A valve which affords a straight-through flow and in which a sliding gate is moved in its own plane at right angles to the flow.

2.9.72 **Gland**: - A device for preventing the escape of water from a valve or pumps along the surface of the spindle or shaft.

2.9.73 **Globe tap**: - A tap with a horizontal inlet, for fitting through the upright end of a bath, having a partially spherical body with a vertical nozzle.

2.9.74 **Globe valve**: - A screwdown valve having a partially spherical body with a horizontal inlet and horizontal or vertical outlet.

2.9.75 **Gully Chamber**: - The chamber built of masonry around a gully trap, for housing the same.

2.9.76 **Gully Trap**: - A trap provided in a drainage system with a water seal fixed in a suitable position to collect waste water from the scullery, kitchen sink, wash basins, baths and rain water pipes.

2.9.77 **Gutter**: - A channel for collecting and carrying surface water.

2.9.78 **Haunching**: - Outward sloping concrete support to the sides of a pipe or channel.

2.9.79 **Holder bat**: - A bracket, for fixing to a structure and supporting a pipe and holding it clear of the surface.

2.9.80 **Isolating Valve**: - Any valve fitted for the purpose of shutting off part of a water installation from the remainder.

2.9.81 **Inspection Chamber**: - A water-tight chamber constructed in any house - drainage system which takes wastes from gully traps and disposes off to manholes with access for inspection and maintenance.

2.9.82 **Intercepter Manhole (Intercepter Chamber)**: - A manhole incorporating an intercepting trap and providing means of access thereto.

2.9.83 **Invert**: - The lowest point of the interior or a sewer or drain at any cross-section.

2.9.84 **Interceptor Manhole (Interceptor Chamber)**: - A manhole incorporating an intercepting trap, and providing means of access thereto and equipped with a fresh air inlet on the up- stream side of the trap.

2.9.85 **Junction Pipe**: - A pipe incorporating one or more branches.

2.9.86 **Laboratory Sink**: - A sink of acid-resisting material, with a top edge so shaped as to facilitate bench top fixing.

2.9.87 **Main (Water Main)**: - A pipe laid by the water undertakers for the purpose of giving a general supply of water as distinct from a supply to individual consumers and includes any apparatus used in connection with such a pipe.

2.9.88 **Male**: - That part of a two-part coupling which is enclosed within the female part.

2.9.89 **Manhole** or **Manhole Chamber**: - A chamber constructed on a drain or sewer so as to provide access thereto for inspection, testing or the clearance of obstruction.

2.9.90 **Manhole Cover**: - A removable cover of a manhole.

2.9.91 **Meter: -** An apparatus for measuring the quantity of water passing through a pipeline.

2.9.92 **Meter Pit**: - A chamber for housing a meter, constructed in the ground and surmounted by a surface box or cover.

2.9.93 **Mixing Valve**: - A valve in which separate supplies of hot water and cold water mix together, the outlet temperature in some mixing valves being regulated thermostatically and in others manually.

2.9.94 **Oakum**: - Hemp or old hemp rope soaked in oil to make it waterproof.

2.9.95 **Offset:** - A pipe fitting used to connect two pipes whose axes are parallel but not in line.

2.9.96 **One pipe System**: - The plumbing system in which the waste connections from sinks, baths and wash basins and the soil pipe branches are all collected into the main pipe connected directly to the drainage system. Gully traps and waste pipes are completely dispensed with but all the traps of water closets, basins, etc, are completely ventilated to preserve the water seal.

2.9.97 **Overflow Pipe**: - A pipe connected to a vessel, sanitary appliance, sewer or chamber to discharge overflow.

2.9.98 **Pedestal Wash Basin**: - A wash basin supported from the floor by a column shaped base.

2.9.99 **Pedestal WC Pan**: - A WC pan which has an integral supporting base.

2.9.100 **Pillar Tap**: - A tap, suitable for mounting on a horizontal surface, having a vertical inlet and a nozzle arranged to discharge in a downward direction.

2.9.101 **Pipe (Tube)**: - A closed conduit for fluid, usually of circular cross section.

2.9.102 **Pipe Clip (Saddle Clip)**: - A piece of metal or other suitable material made to fit over a pipe and having ears for securing to a wall or other structure.

2.9.103 **Pipe Ear**: - Two wings cast integrally with the pipe socket provided with holes to fixing nails or screws.

2.9.104 **Pipe Fitting**: - Anything fitted to a pipe for jointing, connecting or changing the direction or bore of a pipe.

2.9.105 **Pipe Union**: - A union for connecting together two pipes. It is made in three parts, two of which are for fixing to the pipe ends, the third being a coupling nut.

2.9.106 **Pipe Work**: - An installation of piping and pipe fittings.

2.9.107 **Plug**: - A pipe fitting for stopping up the socket end of a pipe or pipe fitting

2.9.108 **Plug cock**: - A taper seated cock in which the plug is retained in the body by means of a washer, screw and nut at the smaller end of the plug.

2.9.109 **Plug waste**: - A waste fitted with a removable waste plug.

2.9.110 **Plumbing**: -

a) The pipes, fixtures and other apparatus inside a building for bringing in the water supply and removing the liquid and water borne wastes.

b) The installation of the foregoing pipes, fixtures and other apparatus.

2.9.111 **Pop-Up Waste**: - A waste fitted with a captive plug which is seated in, or lifted clear of, the waste by means of a remote manually operated device.

2.9.112 **Potable Water**: - Water which is satisfactory for drinking, culinary and domestic purposes and meets the requirements of the Authority.

2.9.113 **P-Trap**: - A trap with inlet vertical and outlet inclined slightly below the horizontal.

2.9.114 **Pump**: - A mechanical device for causing a fluid to flow.

2.9.115 **Rainwater Pipe (Down-comer), (Down Pipe), (Fall Pipe), (Rainwater Conductor)**: - A pipe for conveying rainwater from a roof or other parts of a building.

2.9.116 **Reducer**: - A pipe fitting with inside threads, larger at one end than at the other. All such fittings having more than one size are reducers because of the custom of stating the larger size first.

2.9.117 **Reflux Valve (Non-return Valve)**: - An automatic for preventing reversal of flow, being opened by the flow and closed by gravity when the flow stops.

2.9.118 **Rest Bend (Duck Foot Bend)**: - A bend, having a foot formed integrally in its base, used to receive a vertical pipe.

2.9.119 **Saddle**: -

a) A boss, secured to a pipe by a ring-shaped clamp, used to reinforce the thickness of the pipe where a screwed ferrule is inserted.

b) A short spigot and socket pipe fitting having a flange moulded on near the spigot end, the flange being curved to fit the outside of a larger pipe into the barrel of which the spigot is connected; it is used for connecting a branch pipe to a drain or sewer.

2.9.120 **Safety valve**: - A pressure relief valve fitted on or close to a boiler.

2.9.121 **Sanitary Appliance**: - A fixed appliance in which water is used either for cleaning, culinary or drinking purposes before passing to waste, or for the flushing away of foul or waste matter.

2.9.122 **Scum**: -

a) The layer or film of extraneous or foreign matter that rises to the surface of a liquid and is formed there.

b) A residue deposited on a container or channel at the water surface.

c) A mass of solid matter that floats on the surface.

2.9.123 **Seat and Cover**: - A WC seat provided with a hinged cover.

2.9.124 **Self-Closing Tap**: - A tap which is opened by pressure on, or by twisting, the top of the operating spindle and which, when the pressure is released, closes under the action of a spring or of water pressure.

2.9.125 **Septic Tank**: - A water tight single storey settling tank in which the settled sludge is in immediate contact with the sewage flowing through the tank, while organic solids are decomposed by anaerobic bacterial action.

2.9.126 **Service Main**: - A water main to which service pipes are connected.

2.9.127 **Service Pipe**: - Pipe that runs between the distribution main in the street and the riser in the case of a multi-storeyed building or the water in the case of an individual house and is subjected to water pressure from such main.

2.9.128 **Sewer**: -A pipe or conduit, generally closed, but normally not flowing full for carrying sewage or other waste liquids.

2.9.129 **Shower**: - A sanitary appliance consisting of a shower head, and a shower tray.

2.9.130 **Shower Head**: - A water fitting, for use in a shower, from which water issues as a film or spray.

2.9.131 **Shower Rose**: - A shower head in which water is caused to flow through a perforated plate and issues a spray.

2.9.132 **Shower Tray (Shower Receiver)**: - A receptacle, which may be prefabricated or formed in situ, for catching water from a shower head.

2.9.133 **Single Outlet Combination Tap Assembly**: - A combination tap assembly in which hot and cold water mix before they emerge from the nozzle and which requires the hot and cold water to be at balanced pressures.

2.9.134 **Single Stack System**: - One pipe system without trap ventilation pipe work.

2.9.135 **Sink**: - A sanitary appliance used for receiving domestic, culinary, laboratory or industrial process liquids.

2.9.136 **Siphonage**: - A suction, created by the flow of liquid in pipes by a pressure less than atmospheric.

2.9.137 **Siphonic WC Pan: -** A WC pan in which the excrement falls into the water in the trap and is subsequently removed by siphonic action induced by the flushing water.

2.9.138 **Sludge**: - The settled solid matter in semi-solid condition.

2.9.139 **Sluice Valve**: - A gate valve for use in water supply for pipes of 50 mm nominal diameter and greater.

2.9.140 **Soakaway**: - A pit, dug into permeable ground lined to form a covered perforated chamber or filled with hard-core, to which liquid is led, and from which it may soak away into the ground.

2.9.141 **Socket**: -

a) The end of a pipe, or a pipe fitting, having an enlarged bore for the reception of the plain or spigot end of another pipe, or pipe fitting, for the formation of a spigot and socket joint.

b) A pipe fitting in the form of a short cylindrical pipe, threaded on its inner surface, used for jointing together two pipes with externally threaded ends.

2.9.142 **Soffit (Crown)**: - The highest portion of the interior of a sewer or drain at any cross-section.

2.9.143 **Soil waste:** - The discharges from water closets, urinals, slop hoppers, stable yards or cowshed gullies and similar appliances.

2.9.144 **Soil Pipe**: - In plumbing, a pipe that conveys the discharge of water closets or fixtures having similar functions, with or without the discharges from other fixtures.

2.9.145 **Spigot**: - The plain, or locally thickened, end of a pipe for insertion in a socket for the formation of a spigot and socket joint.

2.9.146 **Spigot and Socket Joint**: - A joint for pipes and channels in which the plain end, or spigot, of one section is inserted into the enlarged end, or socket, formed on the next section. The space between the spigot and socket is filled with jointing material or is sealed with a joint ring.

2.9.147 **Squatting Plate**: - A raised tread for a squatting WC pan.

2.9.148 **Squatting WC Pan**: - A WC pan with an elongated bowl for installation with its top edge at or near floor level so that the user has to adopt a squatting position.

2.9.149 **Stack**: - A main vertical discharge or ventilating pipe.

2.9.150 **Stall Urinal**: - A urinal having a back curved on plan to form a stall for the user. It has an integral floor channel. When stall urinals are fixed in ranges, cloaking pieces are provided between each stall.

2.9.151 **Stop Cock**: - A cock fitted in a pipe line for controlling the flow of water.

2.9.152 **Stop-Valve (Stop Tap)**: - A valve, other than a servicing valve, fitted in a pipeline for controlling the flow of water. Contrast with stop cock.

2.9.153 **Storage Water Heater**: -

a) A gas or electric self-contained water heating appliance in which a volume of water is heated under thermostatic control and stored for use until required. With an electric heater the feed cistern may not be integral with the heater.

b) A thermally insulated vessel in which water is heated and held for subsequent use.

2.9.154 **Strainer**: - A device for separating solid matter from liquid to prevent it from entering a pump, valve, tap, meter or pipework.

2.9.155 **'S' Trap**: - A trap in which the outlet leg is parallel with the inlet leg.

2.9.156 **Storage Tank**: - A tank or a cistern for storage of water which is connected to the water main by means of supply pipe.

2.9.157 **Sub-soil Water**: - Water occurring naturally in the subsoil.

2.9.158 **Supply Pipe**: - The pipe which extends from the stop cock upto the ball cock of the storage tank, if any, and any consumer's pipe subject to water pressure from the water main.

2.9.159 **Surface Water Drain**: - A drain conveying surface water including storm water.

2.9.160 **Surface Water**: - Natural water from the ground surface, paved areas and roofs.

2.9.161 **Tap**: -

a) A tool used for cutting inside threads. Also to bore a hole into a pipe, tank or other device.

b) A valve with a free outlet used as a draw-off or delivery point.

2.9.162 **Tee: -** A branch fitting used to connect to a main pipe a branch pipe which is at an angle of $90^{o}$ to the main pipe.

2.9.163 **Toilet**: - A room in which are installed WC suite and/or urinals with or without wash basins.

2.9.164 **Trap**: - A fitting or device so designed and constructed as to provide, when properly vented, a liquid seal which will prevent the back passage of air without materially affecting the flow of sewage or waste water through it.

2.9.165 **Two Pipe System**: - A discharge pipe system comprising two independent discharge pipes one of which conveys soil directly to the drain the other conveying waste water to the drain through a trapped gully. The system may also require a ventilating pipe.

2.9.166 **Union**: - A pipe fitting used for joining the ends of two pipes neither of which can be turned.

2.9.167 **Valve**: - A device used for regulating the flow of a fluid, having an aperture which can be wholly or partially closed by the movement relative to a seating of a component in the form of a plate or disc, a diaphragm, a door or gate, a piston, a plug or a ball.

2.9.168 **Ventilating Pipe**: - A pipe in a sanitary pipework system that facilitates the circulation of air within the system and protects trap seals from excessive pressure fluctuation.

2.9.169 **Vent Pipe**: - An open-ended pipe, in a hot apparatus, for the escape of air and for the safe discharge of any steam generated.

2.9.170 **Vertical Pipe**: - Any pipe which is installed in a vertical position or which makes an angle of not more than 45 degrees with the vertical.

2.9.171 **Wall Hung WC Pan**: - A WC pan suspended clear of the floor and commonly supported by a chair or concealed brackets.

2.9.172 **Wash Basin (Lavatory Basin)**: - A sanitary appliance primarily intended for washing the upper parts of the body. It has a waste connection and a pipe water supply.

2.9.173 **Wash Down WC Pan**: - A WC pan in which the excrement falls into the water in the trap and is subsequently removed by the momentum of the flushing water.

2.9.174 **Waste**: -

a) A liquid that is discharged by the waste pipe.

b) A fitting that is intended to couple together in a water-tight manner a waste appliance or a urinal and the waste or soil pipe which conducts from the appliance.

2.9.175 **Waste pipe**: - In plumbing, any pipe that receives the discharge of any fixture, except water closets or similar fixtures and conveys the same to the house drain or soil or waste stack. When such a pipe does not connect directly with a house drain or soil stack, it is called an indirect waste pipe.

2.9.176 **Waste Plug (Plug): -** A tapered stopper which, when in position, prevents the flow of water through the waste. Its upper surface may have a suitable loose shackle for securing a plug chain.

2.9.177 **Waste stack**: - A vertical pipe used to convey liquid waste not containing human excreta.

2.9.178 **Waste Water/ Sullage Waste Water**: - Spent water from baths, wash basins, sinks, and similar appliances, which does not contain human or animal excreta.

2.9.179 **Water Closet**: - A water flushed plumbing fixture designed to receive human excrement directly from the user of the fixture. The term is used sometimes to designate the room or compartment in which the fixture is placed.

2.9.180 **Water Seal**: - The water in a trap which acts as a barrier to the passage of air through the trap.

2.9.181 **Water Works**: - Water works for public water supply include a lake, river, spring, well, pump with or without motor and accessories, reservoir, cistern tank, duct whether covered or open sluice, water main, pipe, culvert, engine and any machinery, land, building or anything for supply or used for storing, treating and supplying water.

2.9.182 **WC Pan (WC Bowl)**: - A sanitary appliance, for the reception and flushing away of human solid and liquid excrement, consisting of a bowl with an inlet for flushing water and a trapped outlet.

2.9.183 **WC Seat**: - A seat of impervious material made to fit the top of the WC pan.

2.9.184 **Y Branch (Y Junction)**: - A branch fitting in the shape of a letter Y.

2.9.185 **Double Wall Corrugated (DWC) pipe: -** A dual-layer thermoplastic piping system comprising an outer corrugated wall and an inner smooth wall, typically manufactured from High-Density Polyethylene (HDPE) or Polypropylene (PP).

# SECTION - 3: SPECIFICATIONS OF MATERIALS

# SECTION 3: SPECIFICATION OF MATERIALS

## I. Building and Road Items

3.0 **Water: -** Water used for mixing mortars and concrete shall be clean and reasonably free from injurious quantities of deleterious materials such as oils, acids, alkalis, salts and vegetable growth. Generally potable water shall be used. Where water can be shown to contain any sugar or an excess of acid, alkali or salt, the Engineer may refuse to permit its use. As a guide, the following concentrations may be taken to represent the maximum permissible limits of deleterious materials in water.

(a) Limits of acidity: - To neutralize a 200 ml sample of water, it should not require more than 2 ml of 0.1 N caustic soda solution.

(b) Limits of Alkalinity: - To neutralize a 200 ml sample of water it should not require more than 0.1 ml of 0.1 N hydrochloric acid.

(c) Percentage of solids should not exceed: -

| | |
|---|---|
| Organic | 200 ppm (0.02%) |
| Inorganic | 3000 ppm (0.30%) |
| Sulphates | 500 ppm (0.05%) |
| Alkali chlorides | 1000 ppm (0.1%) |

Water found satisfactory for mixing is suitable for curing concrete. However, the water used for curing should not produce any objectionable stain or deposit on the concrete surface.

3.1 **Stone boulder: -** It shall be hard, sound, free from decay, weathering and defects like cavities, cracks, flaws, sand holes, veins, patches of soft or loose materials etc. It shall be obtained from an approved quarry. Where required by the Engineer the stone shall be tested for water absorption determined as per IS: 1124. Stone boulders shall not have round surfaces.

3.1.1 *Stone aggregates 100 mm and down gauge*

3.1.2 *Stone aggregates 75 mm and down gauge.*

3.1.3 *Stone aggregates 50 mm and down gauge.*

3.1.4 *Stone aggregates 40 mm and down gauge.*

3.1.5 *Stone aggregates 25 mm and down gauge.*

3.1.6 *Stone aggregates 20 mm and down gauge.*

3.1.7 *Stone aggregates 12 mm to 6 mm gauge.*

These shall be crushed or broken from hard stones. It shall be hard, strong, dense and durable, clean and free from soft, friable, thin, flat, elongated or laminated, flaky pieces and shall be roughly cubical in shape. It shall be clean and free from dirt and any other foreign matter. However, the total amount of deleterious substances such as coal, lignite, clay lumps, soft fragments, foreign materials in the stone aggregate shall not exceed 5% of its weight.

The aggregate shall be stacked separately according to the size in regular stacks of height not exceeding 1.5 m. While stock-piling, the aggregate shall not form pyramids resulting in segregation of different sized materials. Tests must be carried out for the stone aggregates to check their conformance to the requirements of this specification. The aggregate shall conform to one of the gradings given in Table 3.1.

**Table 3.1** AGGREGATE GRADINGS

| IS Sieve designation | PERCENTAGE PASSING FOR | | | | |
|---|---|---|---|---|---|
| | **50 mm** | **40 mm** | **25 mm** | **20 mm** | **12 to 6 mm** |
| 80 | - | - | - | - | - |
| 63 | 100 | - | - | - | - |
| 50 | 95 - 100 | 100 | - | - | - |
| 40 | 35 - 70 | 95 - 100 | 100 | - | - |
| 25 | - | - | 95 - 100 | 100 | - |
| 20 | 0 - 10 | 30 – 70 | - | 95 - 100 | 100 |
| 12.5 | - | - | 30 - 70 | - | 90 - 100 |
| 10 | 0 - 5 | 10 - 35 | 20 - 50 | 25 - 55 | 40 – 85 |
| 4.75 | - | 0 - 5 | 0 - 7 | 0 - 10 | 0 – 10 |
| 2.36 | - | - | - | - | - |

3.2 **Boundary Stones**: - These shall be of hard stones of sound and durable quality in blocks of size 150 x 150 x 900 mm unless directed otherwise by Engineer. A tolerance of 10 mm shall be permitted in the specified size. The top 300 mm shall be chisel dressed on all the four sides and the top.

3.3 **Kilometer Stones**: - These shall be of specified design. The stones shall be hard, even, sound and durable. They shall be chisel dressed on the exposed surfaces above ground so that the dressed face shall not be more than 3 mm from a straight edge placed on it. The thickness of the slab shall be uniform and as specified with a tolerance of 1.5 mm. The thickness shall be measured correct to 3 mm.

3.4 **Marble: -** The marble chips shall be white or pink Makrana, black Bhainslana, Baroda green, or as specified. It shall be hard, sound, dense, homogeneous in texture with crystalline and coarse grains. It shall be uniform in colour and free from stains, cracks, decay and weathering.

The maximum thickness of the top layer for various sizes of chips shall be as under.

**Table 3.2** MAXIMUM THICKNESS OF THE TOP LAYER FOR VARIOUS SIZES OF CHIPS

| Grade No. | Size of chips in (mm) | Max. thickness of top layer (mm) |
|---|---|---|
| 00 | 1 – 2 | 6 |
| 0 | 2 – 4 | 9 |
| 1 | 4 – 7 | 9 |
| 2 | 7 - 10 | 12 |

Where chips of size larger than 10 mm are used the minimum thickness of the topping shall not be less than 11/3 times the maximum size of the chips. Where large size chips such as 20 mm or 25 mm are used, they shall be used only with a flat shape and bedded on the flat face so as to keep the minimum thickness of the wearing layer. Before starting the work, the contractor shall get the sample of marble chips approved by the Engineer.

The physical properties shall be as given below:

**Table 3.3** PHYSICAL PROPERTIES OF MARBLE CHIPS

| Sl. No | Characteristic | Physical properties requirements | Method of test |
|---|---|---|---|
| 1 | Moisture absorption after 24 hours immersion in cold water | Max. 0.4% by weight | IS1124 |
| 2 | Hardness | Min. 3 | Mho's scale |
| 3 | Specific gravity | Min. 2.5 | IS1122 |

3.5 **Structural Granite**: - Granite shall be free from flaws, injurious veins, cavities and similar imperfections that would impair its structural integrity and adversely affect its strength and appearance. The compressive strength shall not be less than 1000 kg/cm$^2$. The specific gravity shall not be less than 2.6. The water absorption shall not be more than 0.50 percent. Structural Granite shall conform to IS 3316. Granite slabs shall be rectangular or square and of specified dimensions. The tolerance in length and breadth shall be ± 2 mm and thickness ± 1 mm. The bottom face may be rough but the top surface shall be finely dressed and joint faces shall be dressed back square with the top surface for at least 50 mm, without hollowness or spalling off. The dimensions of the blocks shall be as specified. The tolerances shall be allowed ± 5 mm for facing blocks. The edges of the blocks shall be dressed according to IS: 1129.

3.6 **Gravel or shingle**: - Gravel/Shingle can be from the river beds or pits. It shall be sound, hard, clean, suitably graded in size with or without some broken fragments. It shall be free from flat particles of shale, powdered clay, silt, loam and other impurities. However, pit gravel shall have to be washed if it contains soil materials adhering to it. The grading shall conform to the gradings given below:

a) Ballast 50 mm and down gauge.

b) Ballast 40 mm and down gauge.

c) Ballast 25 mm and down gauge.

d) Ballast 20 mm and down gauge.

e) Chips 12 mm to 6 mm gauge.

3.7 **Sand: -** Not more than 10% shall be retained on 4.75 mm IS Sieve. The sum of the percentage of all deleterious materials shall not exceed 5%. It shall not contain harmful organic impurities in such form or quantities as to adversely affect the strength and durability of concrete or mortar. It shall not contain any acidic material, which is likely to attack steel reinforcement. The fineness modulus of sand to be used in plaster shall be between 1.0 and 1.5. The fineness modulus of sand to be used in concrete and for mortar required for masonry shall be between 2.0 and 3.1. The maximum quantity of silt shall not exceed 8%. Quantity passing through 150 microns IS Sieve shall not be more than 10%. Tests as required under the section 5 "Mandatory Tests" shall be carried out.

3.8 **Bricks 2nd class: -** The bricks shall be hand or machine molded confirming to IS: 1077. They shall be free from cracks and flaws and nodules of free lime. Frog shall be 1 to 2 cm in depth; 10 cm in length and 4 cm in width. The brick shall have a minimum crushing strength of 75 kg/cm$^2$. The tolerance of ± 8% shall be permitted over the average size of the bricks specified by the Engineer for the work. The bricks shall not absorb more than 20% of water by weight when immersed in water for 24 hours. Mandatory tests as required shall be done.

3.8.1 *Brick aggregate of various sizes***: -** It shall be obtained by breaking well burnt or over burnt dense brick bats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other deleterious material. The grading shall conform to one of the gradings given below:

a) Brick ballast 50 mm and down gauge.

b) Brick ballast 40 mm and down gauge.

c) Brick ballast 25 mm and down gauge.

d) Brick ballast 20 mm and down gauge.

e) Brick chips 12 mm to 6 mm gauge.

3.9 **Surkhi: -** Surkhi shall be made by grading well burnt (but not under or over burnt) broken bricks. It shall not contain any harmful impurities, such as iron pyrites, salts, coal, mica, shale or similar laminated or other materials which are likely to adversely affect hardening, strength or durability. The maximum quantities of clay, fine silt, fine dust and organic impurities (all taken together) shall not exceed 5% by weight.

3.10 **Lime: -** Lime used shall be as per IS: 712. Locally available fat lime shall be used. Lime shall be stored in weatherproof sheds. Lime, which has been damaged by rain, moisture or air slaking, shall not be used. All damaged and rejected lime shall be removed from the site of work forthwith.

Lime shall be classified as follows:

Class A - Eminently hydraulic lime used for structural purposes.

Class B - Semi-hydraulic lime used for masonry mortars, lime concrete and plaster undercoat.

Class C - Fat lime is used for finishing coat in plastering, whitewashing, composite mortars, etc., and with addition of pozzolanic materials for masonry mortar.

Class D - Magnesium/dolomitic lime used for finishing coats in plastering, white washing, etc.

The hydrated lime shall be supplied, in suitable containers, such as jute bags lined with polythene or high density polythene woven bags lined with polythene or craft paper bags, preferably containing 50 kg of lime. The quicklime shall be supplied in a container like metal container or similar suitable containers preferably containing 50 kg of lime. The lime packages shall bear the type and class of lime, the brand name of manufacturer; date of manufacture and net weight; in case of quicklime the slaking temperature shall be indicated.

3.11 **Silent blaster**: - These are non-explosive environment friendly blasting material used for breaking rocks and concrete. The material shall come in powder or cartridge form. The dimensions of cartridges shall be as follows:

| | | |
|---|---|---|
| Diameter | : | 30 mm max |
| Length | : | 200 mm max |

The silent blaster functions due to the expansive forces generated when it combines with water. The quantity of material required for breaking shall vary with the type of rock or boulder, its shape and the presence or absence of inherent cleavages in the rock. Plain and reinforced concrete can also be cracked using the silent blaster. The material shall be mixed with water before use to form an easy flowing slurry which shall be filled in the holes drilled in the rock or concrete. The effects of the silent blaster shall begin to manifest normally in ten to twelve hours by way of appearance of cracks linking the holes or otherwise. It may take 24 to 48 hours for the full effect to materialize, after pouring the slurry, depending upon the ambient temperature, the characteristics of the material to be demolished and the quantity of material used in a particular case.

3.12 **Concrete blocks**:

**General**

All concrete masonry units shall be sound and free of cracks or other defects which affect the proper laying of the units or impair the strength or permanence of the construction. Where units are to be used in exposed wall construction, the face or faces that are to be exposed shall be free of chips, cracks, or other imperfections.

**Dimensions**

Concrete masonry units shall be made in sizes and shapes to fit different construction needs. They include stretcher, corner, double corner or pier, jamb, header, bull nose, and partition block, and concrete floor units. Concrete masonry units, hollow (open or closed cavity) or solid shall be referred to by its nominal dimensions.

The nominal dimensions of concrete blocks shall be as follows:

| | |
|---|---|
| Length: | 400,500 or 600 mm |
| Height: | 200 or 100 mm |
| Width: | 50,75,100,150, 200, 250 or 300 mm |

In addition, blocks shall be manufactured in half lengths of 200, 250 or 300 mm to correspond to the full lengths. Full length and half-length U-blocks may also be manufactured for the purposes of band and lintels. The variation in the length of the

units shall not be more than ±5mm and variation in height and width of units shall not be more than ±3mm.

**Block Density**

The density calculated by dividing the mass of a block by overall volume. The average block density of three blocks shall be as per Table 3.4.

**Compressive Strength**

The minimum compressive strength of individual units when determined at 28 days shall be as per Table:3.4.

**Table: 3.4** PHYSICAL REQUIREMENTS

| Type | Grade | Density of Block ($Kg/m^2$) | Minimum Average Compressive strength of Units ($N/mm^2$) | Minimum Compressive strength of Individual Units ($N/mm^2$) |
|---|---|---|---|---|
| Hollow (open and closed cavity) load bearing unit | A (3.5) | Not less than 1500 | 3.5 | 2.8 |
| | A (4.5) | | 4.5 | 3.6 |
| | A (5.5) | | 5.5 | 4.4 |
| | A (7.0) | | 7.0 | 5.6 |
| | A (8.5) | | 8.5 | 7.0 |
| | A(10.0) | | 10.0 | 8.0 |
| | A(12.5) | | 12.5 | 10.0 |
| | A(15.0) | | 15.0 | 12.0 |
| | B (3.5) | Less than 1500 but not less than 1100 | 3.5 | 2.8 |
| | B (5.0) | | 5.0 | 4.0 |
| Solid load bearing unit | C (5.0) | Not less than 1800 | 5.0 | 5.0 |
| | C (4.0) | | 4.0 | 4.0 |

**Water Absorption**

Water absorption, being the average of three units, shall not be more than 10 percent by mass.

**Drying Shrinkage**

The difference between the length of concrete masonry unit which has been immersed in water and then subsequently dried to constant length, all under specified conditions. When determined as an average of three units, drying shrinkage shall not exceed 0.06 percent.

**Moisture Movement**

The difference between the lengths of concrete masonry units when dried to constant length and when subsequently immersed in water, all under specified conditions. When determined as an average of three units, moisture movement shall not exceed 0.09 percent.

3.13 **Soil based blocks: -** Soil based blocks used in general building construction shall conform to IS: 1725. It shall be manufactured from a mixture of suitable soil and ordinary Portland cement or lime pozzolana mixture thoroughly mixed together, preferably in a mechanical mixer. The mixture is moulded and cast into blocks. The blocks shall be of two classes, Class 20 and class 30.

Class 20 - min. average compressive strength of not less than 20kgf/cm$^2$.

Class 30 - min. average compressive strength of not less than 30kgf/cm$^2$.

There shall be three sizes of soil-cement blocks, the dimensions of which shall be as follows:

**Table 3.5** SIZES OF SOIL-CEMENT BLOCKS

| Length (cm) | Breadth (cm) | Height (cm) |
|---|---|---|
| 19 | 9 | 9 |
| 19 | 9 | 4 |
| 29 | 19 | 9 |

The dimensions shall be within the following limits per twenty blocks.

| Block size (cm) | Length (cm) | Breadth (cm) | Height (cm) |
|---|---|---|---|
| 19 x 9 x 9 | 372 to 388 | 174 to 186 | 174 to 186 |
| 19 x 9 x 4 | 372 to 388 | 174 to 186 | 74 to 86 |
| 29 x 19 x 9 | 570 to 590 | 372 to 388 | 174 to 186 |

20 (more according to the size of stack) whole blocks shall be selected at random from the sample selected. All blisters, loose particles of clay and small projections shall be removed. They shall then be arranged upon a level surface successively in contact with each other and in a straight line. The overall length of the assembled blocks shall be measured with a steel tape or other suitable inextensible measures sufficiently long to measure the whole row at one stretch. Measurement by repeated application of short rule or measure shall not be permitted. If, for any reason, it is found to measure blocks in one row, the sample may be divided into rows of 10 blocks each, which shall be measured separately to the nearest millimeters. All these dimensions shall be added together. Each bock shall also have a frog one centimeter deep and 10 x 4 cm on one of its flat sides.

3.14 **Gypsum partition blocks**: - These are used in non-load bearing construction in the interior of buildings and for the protection of columns, elevator shafts, etc, against fire. Blocks shall consist of set gypsum plaster complying with IS: 2547 (Part1), with or without aggregates. The mass of combustible materials shall not exceed 15 percent of the mass of the dry block. The block may be solid type or hollow type and shall be truly rectangular in shape with straight and square edges and true surfaces. The blocks shall conform to IS: 2849 and shall be of the dimension as given in the Table 3.6.

**Table 3.6** DIMENSIONS OF GYPSUM PARTITION BLOCKS

| Length L (1) | Height H (2) | Breadth B (3) | Hollow Blocks side and edge thickness , Min | |
|---|---|---|---|---|
| | | | Circular Holes t (4) | Elliptical or Rectangular Holes t (5) |
| 700 Max in multiples of 100 | 300 Max in multiples of 100 | 75 | 15 | 20 |
| | | 100 | 20 | 20 |
| | | 125 | 25 | 30 |
| | | 150 | 15 | 20 |

The tolerance on L, H and B shall be as below:

| | |
|---|---|
| Length | ± 3.0 mm |
| Height and Breadth | ± 1.5 mm |

In hollow blocks, the hollow spaces shall be symmetrically spaced. The sum of the thickness of the two side shells plus the thickness of the central vertical web of 150 mm wide blocks shall not be less than 50 mm for blocks having circular holes and not less than 70 mm for blocks having elliptical or rectangular holes.

When the surfaces of the block are scored, the scoring shall not reduce materially the thickness of the shell. Surfaces of the block shall be such that they afford a suitable bond with plaster. When tested in accordance with IS: 2542 (Part 2), the compressive strength of the block shall not be less than 0.5 N/mm$^2$ (5.0 kgf/cm$^2$) based on gross area. All blocks shall be sound and free from cracks, broken-edges and other imperfections that would render them unfit for use.

3.15 **Mud dry: -** Soil for making mud mortar shall have suitable plasticity. The soil shall be free from vegetable roots, stone gravel (of particle size greater than 2 mm) kankar, coarse sand and harmful and efflorescent salts. Soil shall not be collected from locality affected by white ants. The plasticity index of soil shall be between 6 and 10. The sulphate content shall not exceed 0.1 percent. Coarse materials shall not exceed 10 percent by weight.

3.16 **Cement: -** One of the types of the cements, specified below shall be used.

a) Ordinary Portland cement conforming to IS: 269

b) Rapid hardening Portland cement conforming to IS: 269

c) Low heat Portland cement conforming to IS: 269

d) Portland blast furnace slag cement conforming to IS: 455

e) Portland pozzolana cement conforming to IS: 1489

3.16.1 *Supply*: -The cement shall be packed in bags (of gunny, multiply paper or cloth). Alternatively it may also be supplied at site in silos installed for the purpose of supply.

3.16.2 *Stacking and Storage*: - Cement shall be stored and stacked in bags in dry and water proof sheds. The typical arrangement is shown in fig. below. The bags shall be stacked at

least 10 to 20 cm clear above the floor. A space of 60 cm all around should be kept between the exterior walls and the stacks. Cement bags should be placed close together in the stock to reduce circulation of air as much as possible. Cement bags shall not be stacked more than 10 bags high to avoid lumping under pressure. If the stack is more than 7 bags high, arrange the bags in header and stretcher fashion that is alternatively lengthwise and crosswise so as to tie them together and lessen the danger of toppling over. For extra safety during the monsoon or when it is expected to store the cement for an unusually long period, enclose the stock completely in 700 gauge polythene sheet or any other suitable water proofing material. The flap will close on the top of the stack. Care should be taken that the polythene sheet is not damaged any time during use. When removing bags from storage some bags should be removed from two or three tiers back rather than all from one tier. If the rows are thus stepped back, there is less chance of over turning them. When removing cement bags for use apply the "first in, first out"rule, that is, take the oldest cement out first. Each consignment of cement shall be stacked separately therein to permit easy access for inspection and facilitate removal.

Storage of cement at the site of work shall be at contractor's expense and risk. In the event of any damage occurring to cement due to faulty storage in contractor's sheds or on account of negligence on his part such damages shall be the liability of the contractor.

3.17 **White cement: -** This shall be as per IS: 8042. The following chemicals, as specified, shall be used in water emulsion.

| | |
|---|---|
| Aldrin Emulsifiable concentrate | 30% |
| Chlordane Emulsifiable concentrate | 20% |
| Heptachlor Emulsifiable concentrate | 30% |

To achieve the required concentration for use (0.5% or 1% as specified) the above chemical concentrates should be diluted with water in required quantity using graduated containers.

*Example: -*

To dilute a chemical of 30% concentration 59 parts of water are added to one part of the chemical to achieve 0.5% concentration. Chemicals shall be brought to site of work in sealed original containers, and shall be kept in the joint custody of the contractor and the Engineer. The chemicals are poisonous and all suitable precautions are to be observed and then used.

3.18 **Concrete Admixtures: -** These shall conform to IS: 9103**.** Admixture is a material other than water, aggregate, and hydraulic cement and additives like pozzolana or slag and fibre reinforcement used as an ingredient of concrete or mortar and added to the batch immediately before or during its mixing to modify one or more of the properties of concrete in the plastic or hardened state. The different types of admixture are as follows:

a) Accelerating admixtures,
b) Retarding admixtures
c) Water-reducing admixtures
d) Air entraining admixtures, and
e) Superplasticizing admixtures.

The chloride content in the admixture shall be declared by the manufacturer. Super plasticizers are expected to be chloride free. Admixtures that contain relatively large amounts of chloride may accelerate corrosion of prestressing steel. Where corrosion of such steel is of major concern, compliance with requirement of the specification of IS 9103 does not constitute assurance of acceptability of the admixture for use in prestressed concrete. In case of reinforced concrete, to minimize the chances of deterioration of concrete, the total chloride content in the concrete should be limited as specified in IS 456: 2000.

3.19 **Water proofing compound: -** It shall be of approved brand. The material shall not contain any harmful constituents, which are likely to impair the strength of cement. It shall conform to the specification of IS 2645.

3.19.1 **Polymer Modified Cementitious Waterproofing**

The waterproofing material shall be a two-component polymer modified cementitious coating system consisting of cement, graded fillers and acrylic/polymer emulsion suitable for waterproofing and damp-proofing applications on concrete and masonry surfaces.

The material shall be suitable for application on damp substrates and shall provide durable waterproofing protection against moisture ingress and moderate hydrostatic pressure.

The waterproofing coating shall conform to relevant ASTM, EN and IS standards as applicable. Equivalent approved products such as SikaTop®-107 Seal AE or approved equivalent may be used.

The material shall be supplied in original sealed containers with manufacturer's identification and batch details. The following tables present the Technical Specification of the material.

**Table 3.7:** Applicable Standards

| Sl. No. | Standard / Code | Description |
|---|---|---|
| **1** | EN 1504 | Products and systems for repair and protection of concrete |
| **2** | ASTM C836 | Liquid applied waterproofing membrane |
| **3** | IS 2645 | Integral cement waterproofing compounds |
| **4** | IS 456 | Plain and reinforced concrete |

**Table 3.8:** Technical Properties of Polymer Modified Cementitious Waterproofing

| Sl. No. | Description | Requirement |
|---|---|---|
| **1** | Type | Two-component polymer modified cementitious coating |
| **2** | Application | Brush / Roller / Trowel / Spray |
| **3** | Number of coats | Minimum 2 coats |
| **4** | Total thickness | 1.5 – 3.0 mm |
| **5** | Surface condition | SSD before application |
| **6** | Mixing | Mechanical mixing only |
| **7** | Pot life | As per manufacturer |
| **8** | Waterproofing performance | Resistant to moisture and moderate hydrostatic pressure |
| **9** | Reinforcement | Reinforcement mesh throughout the waterproofed area and at cracks/joints where required. |
| **10** | Protection screed | Required in trafficable areas |

3.20 **Bitumen felts for water-proofing and damp-proofing**: - Bitumen felt shall be of the approved brand and manufacture. It shall conform to IS 1322 and shall be classified as given below depending upon the type of base (used in their manufacture) and the uses to which the felts are suited.

Fibre Base

Type 1 – Saturated felt for underlay

Type 2 – Self finished felt (for water proofing)

Hessian Base

Type 3 – Self-finished felt (for water proofing) – Grade 1 or Self-finished felt (for damp proofing) – Grade 2

The weights of the ingredients used in the manufacture of bitumen felts per 10 $m^2$ shall be not less than those specified in Table 3.7.

The base fabric, fibre or hessian, after the removal of the major portion of the inherent moisture, shall be saturated by immersion in the bitumen maintained in a molted condition and the surplus saturant shall be removed. The manufacture of the underlay, that is, Type 1 felt, is complete at this stage. The base fabric shall be thoroughly and uniformly saturated. For the manufacture of self-finished felts, the saturated felt shall be

treated by passing through the bituminous coatant material. The coatant shall be uniformly applied. The resultant coated felts shall be given a superficial application of fine mineral powder. Unless otherwise specified, bitumen felts shall be supplied in width of 90 cm or 100 cm and in lengths of 10 m or 20 m.

3.20.1 *Sampling*: - All the rolls of the same type and grade and from the same batch of manufacture, in one consignment shall constitute a lot. The conformity of the lot to the requirements of the standard shall be determined on the basis of inspection and tests carried out on the samples selected from the lot. The number of rolls to be taken from the lot shall depend upon the size of the lot and shall be in accordance with Table 3.8. These rolls shall be taken at random from the lot, and in order to ensure randomness of selection, random number tables may be used. In case random number tables are not available, the following procedure may be adopted for the selection of the rolls. Starting from any roll in the lot count them as 1, 2, 3....r and so on, in one order. Every $r^{th}$ roll thus counted may be selected till the requisite number of rolls for the sample is obtained, or being the integral part of N/n, where N is the number of rolls in the lot, and n the number of rolls to be selected in the sample. From each of the rolls one piece 3m long and the full width of the felt shall be cut out for preparing test specimens. The first 2m of the roll shall not be selected for this purpose. The lengths of felts selected shall be free from abnormal defects and shall be truly representative of the whole consignment. The selected pieces of felts shall be dispatched without breakage or distortion, wrapped up in water proof paper or other similar materials so as to cause no damage to the material during transit. In case the material has stuck together, no heat shall be applied to separate the layer but the whole roll shall be sent for testing and the fact shall be reported.

**Table 3.9** THE WEIGHTS OF INGREDIENTS USED IN THE MANUFACTURE OF BITUMEN FELTS PER 10 Sq.m

| **Sl. No** | **Types of felt** | **For 10 sq.m** | | | | |
|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| | | *Untreated Base (see Note 1)* | *Coatant* | *Saturant* | *Bitumen* | *Total Weight of the finished Bitumen felt in Dry Condition with Mica Dusting Powder, in (see Notes 2 and 3)* |
| (a) | *Fibre Base* | | | | | |
| (i) | Type 1 Underlay | 4.0 | 3.6 | - | 3.6 | 7.6 |
| (ii) | Type 2 Self finished felt | 5.0 | 4.5 | 12.9 | 12 | 22.6 |
| *(b)* | *Hessian Base* | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| (i) | Type 3 self-finished felt Grade 1 | 2.3 | 1.8 | 17.7 | 12.1 | 23.0 |
| (ii) | Type 3 self finished felt Grade 2 | 2.3 | 1.8 | 31.8 | 20.2 | 37.1 |

***Notes:***

1. The weight of the untreated base shall be taken as in dry condition for fibre base felts. In the case of hessian base the weight of untreated base shall conform to IS: 2818 (Part 2):1971.
2. Include allowance for 1.2 kg minimum mica dusting powder in dry condition except for Type 1
3. When other type of mineral powders is used, the weights shown in the last column shall be changed on the basis as given below:

The weight of the dusting powder incorporated shall be as follows:

a) Mica powder – 1.2 to 2 kg/10 $m^2$
b) Talc powder – 1.5 kg to 2.25 kg/10 $m^2$
c) Slate powder – 1.5 kg to 2.25 kg/10 $m^2$

**Table 3.10** SAMPLE SIZE

| No. of rolls in the lot | No. of rolls to be selected in the sample | Permissible No. of defective rolls | Sub-sample sizes, No. of rolls to be selected |
|---|---|---|---|
| Up to 100 | 5 | 0 | 2 |
| 101 to 150 | 8 | 0 | 3 |
| 151 to 300 | 13 | 0 | 4 |
| 500 to 1000 | 32 | 2 | 6 |
| 1001 to 3000 | 50 | 3 | 8 |
| 3001 to above | 80 | 5 | 10 |

*Note 1*: - All the rolls taken as per columns 2 shall be inspected for width, length and visible external defects.
*Note 2*: - The rolls taken as per column 4 shall be tested for breaking strength, pliability, storage sticking, heat resistance, water absorption and pressure head.

3.20.2 *Tests*: - The samples, when tested as per IS: 1322 shall conform to the requirements given below: -

*Requirements of Bitumen felts*: -

- *Breaking strength*: Warp way - 135; Weft way – 90
- *Pliability test*: i) The roll shall not show any cracks on unrolling; ii) Consider any surface rupture exceeding 5mm in length as failure.
- *Storage sticking test*: i) The test piece shall be examined after cooling; ii) After release of the load, the layers of felt shall be capable of being separated without damaging the coatant in any way.

- *Heat resistance test*: The test piece shall show no sign of melting of the bitumen compound.
- *Pressure head test*: The test pieces shall show no sign of leakage.
  *Water absorption test (maximum)*: 2%

3.20.3 *Criteria for Conformity*: The lot shall be considered to conform with the equipment of the standard if the following conditions are satisfied:

(a) The number of rolls found defective concerning width, length and visible external defects, does not exceed the corresponding number given above.

(b) From the observed values of breaking strength, the average X and the range R are calculated for each direction (that is, warp way and weft way) separately, and the value of the expression X-0.6 R is found to be greater than or equal to the applicable specified value.

Note 1: - Average X is the value obtained by dividing the sum of the observed values by the number of observed values.

Note 2: - Range R is the difference between the maximum and minimum in a set of observed values.

(c) For all the other characteristics (except breaking strength), all the test pieces satisfy all the requirements of the characteristics individually.

3.20.4 *Bitumen Impregnated Fibre Board*: - This shall be equivalent to IS 1838 and shall be of an approved make.

3.21 **MS Angle, Tee, Channels, Flats/Plates/ Anchor Plates: -** All finished steel shall be well and cleanly rolled to the dimensions and weight specified subject to permissible tolerances as per IS 1852. The finished material shall be reasonably free from cracks, surface flaws, laminations, rough and imperfect edges, and all other harmful defects.

Steel sections shall be free from excessive rust, scaling and pitting and shall be well protected. The decision of the Engineer regarding acceptability of any steel section shall be final and binding on the contractor. The mechanical and chemical properties of the structural steel shall be as per Tables 3.11 and 3.12 respectively. The following varieties of steel shall be used for structural purposes: -

(a) S.T. 42-S: - The standard quality steel designated as S.T.42-S, conforming to IS: 226 shall be used for all the types of structure (riveted or bolted) including these subject to dynamic loading and where fatigue, wide fluctuation of stresses, reversal of stresses and great restraint are involved as for example crane gantry girders, road and rail bridges etc. It is also suitable for welded structures provided that the thickness of materials does not exceed 20 mm.

(b) S.T.42-W: - The fusion welding quality steel designated as S.T. 42-W, conforming to IS: 2062; shall be used for structures subject to dynamic loading (Wind load is not to be considered as dynamic for this purpose) where welding employed for fabrication and where fatigue, wide fluctuation of stress, reversal and great restraint are involved as for example, crane gantry girders and road bridges.

(c) S.T.42-O: - The ordinary quality steel designated as S.T. 42-O, conforming to IS: 1977 shall be used for structures not subjected to dynamic loading other than

wind loads where welding is not employed or/and structures not situated in earthquake zones or/and design has not been based on plastic theory.

(d) S.T.32-O: - The ordinary quality steel designated as S.T.32- O, conforming to IS: 1977 shall be used for doors, windows bars, grills, steel gates, hand railing, builders hardware, fencing post, tie bars etc.

**Table 3.11** MECHANICAL COMPOSITION OF STEEL

| **Steel Desig-nation** | **Class of steel product** | **Nominal thickness/dia** | **Tensile strength** | **Yield stress Min.** | **% Elongation Min. Gauge length. 5.65 x sqr.root (So)** |
|---|---|---|---|---|---|
| | | mm | Kgf/sq.mm | Kgf/sq.mm | |
| ST-42-W & ST-42-S | Plate sections (for example, angles, tees, beams, channels etc) and flats. | Below 6mm Bend test only shall be required. | | | |
| | | 6 upto 20 & i/c | 42-54 | 26 | 23 |
| | | Over 20 Upto & i/c 40 | 42-54 | 24 | 23 |
| | | Over 40 | 42-54 | 23 | 23 |
| | Bars (round, square and hexagonal) | Below 10 Bend tests only shall be required. | | | |
| | | 10 upto 20 & i/c | 42-54 | 26 | 23 |
| | | Over 20 | 42-54 | 24 | 23 |
| ST-42-0 | Plate sections (for example, angles, tees, beams, channels etc) and flats. | Below 6mm Bend test only shall be required. | | | |
| | | 6 & over | 42-54 | 26 | 23 |
| | Bars (round, square and hexagonal) | Below 10 Bend tests only shall be required. | | | |
| | | 0 & above | 42-54 | 26 | 23 |
| ST-32-0 | Plate sections (for example, angles, tees, beams, channels etc) and flats. | Below 6 Bend tests only shall be required. | | | |
| | | 6 & above | 32-44 | - | 26 |
| | Bars (round, square and hexagonal) | Below 10 Bend tests only shall be required. | | | |
| | | 0 & above | 32-44 | - | 26 |

**Table 3.12** CHEMICAL COMPOSITION OF STEEL

| Steel Designation | Maximum percentage | | |
|---|---|---|---|
| | Carbon | Sulphur | Phosphorous |
| ST-42-W | 0.23 | 0.06 | 0.06 |
| ST-42-S | 0.25/0.28 | 0.06 | 0.06 |
| ST-42-O | - | 0.07 | 0.07 |
| ST-32-O | - | 0.07 | 0.07 |

Note: - 0.25 for thickness or dia 20 mm & below. 0.28 for thickness or dia over 20 mm.

3.22 **Thermo Mechanically Treated bars –** TMT bars have higher strength and more ductility as a result of lower carbon content. The physical requirements of the TMT bars shall be at least equivalent to or better than for Fe 415 as specified in IS 1786 as given below:

Yield Strength - 415 MPa

Tensile Strength - 485 MPa

Elongation in % - 14.5

However there are limitations to using steel of strengths higher than 415 MPa in earthquake prone areas. IS 13920 forbids using reinforcement steels with strengths higher than 415 MPa under the following situations.

1. The structure is located in Seismic Zone IV and Zone V ( as per IS 1893 : 2002)
2. The structure is located in Zone III and has importance factor > 1.0 ( as per IS 1893 : 2002)
3. The structure is located in Zone III and is an industrial structure ( as per IS 1893 : 2002)
4. The structure is located in Zone III and is more than 5 storey high ( as per IS 1893 : 2002)

The TMT bars used shall satisfy the various tests and properties as per IS 1786.

Other types of reinforcement like Mild steel bars, Hot rolled deformed bars etc can be used as reinforcement provided they conform to respective IS standards. Care must be taken not to mix different types and grades of reinforcement bars in the same structural element as main reinforcement.

3.24 **Other Steel Items: -**

3.24.1 *Expanded metal*: -This shall be in the form of rhombus with its opening diagonals 20 x 60 mm and strands 3.25 mm wide and 1.6 mm thick weighing 4.078 kg/$m^2$. It shall be free from rust and other defects.

3.24.2 *Welded mesh*: - Welded mesh shall be a rectangular mesh of the size specified. 4 mm diameter wire shall be used for making the mesh.

**3***.24.3 Steel Doors, Windows, Ventilators and Fixed-lights:* - These shall be manufactured using rolled steel sections of the weights specified in IS 1038.The sizes for door, window and ventilator or fixed-light frames shall not vary by more than ± 1.5 mm.

They shall be designated by symbols denoting their width, type and height in succession in the following manner:

(a) Width – It shall be indicated by the number of modules in the width of opening.

(b) Type - It shall be indicated by the following letters of alphabet:

C = Centre hung shutter,

F = Fixed glass panes,

H = With horizontal glazing bars,

N = Without horizontal glazing bars,

S = Side hung shutters, and

T = Top hung shutters.

(c) Height - It shall be indicated by the number of modules in the height of opening.

Composite doors, windows, ventilators or fixed-lights shall be designated in the following manner:

(a) A 12 module wide and 21 module high horizontally glazed side hung door coupled on its two sides hung horizontally glazed windows, 6 module wide and 12 module high is designated by 6HS12/6HS12.

(b) Two 10 module wide and 12 module high horizontally glazed side hung windows coupled side by side with two fixed-lights at top, each 10 module wide and 6 module high, is designated by

10HF6/10HF6
10HS12/10HS12

Rolled steel sections used for the fabrication of steel doors, windows, ventilators and fixed-lights shall conform to IS 7452. Steel used in the manufacture of these sections shall conform to IS 7452. Glass panes for steel doors, windows, etc. shall be at least 3 mm thick and shall conform to IS 2835. All glass panes shall have properly squared corners and straight edges. Both the fixed and opening frames shall be constructed of section, which have been cut to length and mitred. The corners of fixed and opening frames shall be welded to form a solid fused welded joint. All frames shall be square and flat. The process of welding adopted may be flash butt welding or any other suitable method, which gives the desired requirements.

All the steel surfaces shall be thoroughly cleaned free of rust, mill-scale, dirt, oil, etc, either by mechanical means, for example, sand or shot blasting or by chemical means, for example, pickling and then finished either with painting only or phosphating and painting; or by hot dip galvanizing as may be agreed to between the purchaser and the manufacturer. Glazing shall be provided on the outside of the frames. Glazing clips for putty glazing shall be provided as standard fittings.

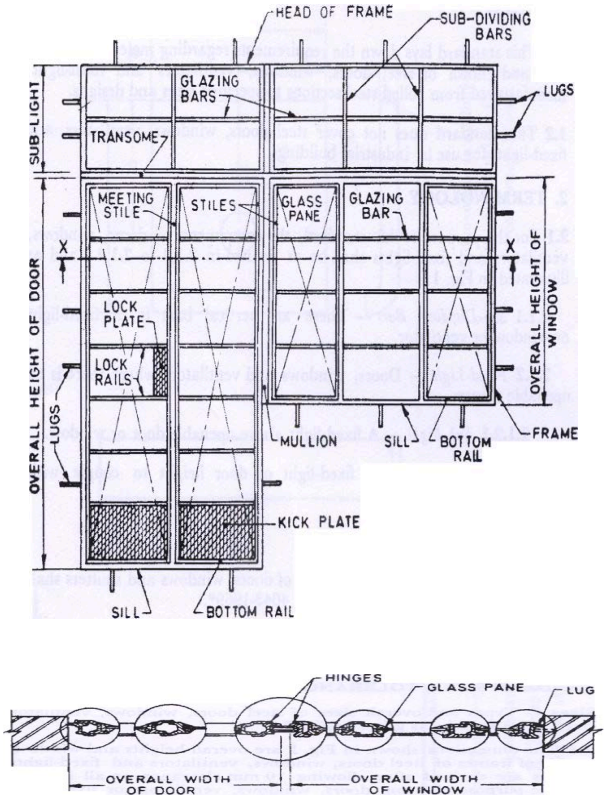



**Figure 3.1** TERMINOLOGY FOR STEEL DOORS, WINDOWS AND SUB-LIGHT

3.24.4 *Steel moulds for Precast Masonry Block manufacture*: - Moulds shall be made of 4 mm thick MS sheets, welded from outside to leave internal edge sharp true to line and shape required. The mould shall be made of a size to yield blocks of specified shape and contours. The single or gang moulds shall be approved by the Engineer before commencing of casting.

3.24.5 Hot finished weld tube: - This shall conform to IS 1161. The steel tubes when analyzed in accordance with the method specified in IS 226 shall show not more than 0.06 percent sulphur, no more than 0.06 percent phosphorus. Tubes shall be designated by their nominal bore. These shall be cleanly finished and reasonably free from scale. They shall be free from cracks, surface flaws, laminations and other defects. The ends shall be cut cleanly and square with the axis of the tube. The standard sizes and weights shall be as shown below.

**Table 3.13** STANDARD SIZES AND WEIGHTS OF HOT FINISHED WELD TUBE

| Nominal bore (mm) | Outside diameter (mm) | Wall thickness (mm) | Weight (kg/m) |
|---|---|---|---|
| 50 | 60.3 | 3.65 | 5.1 |
| 40 | 48.3 | 3.25 | 3.61 |

3.24.5 *Fly proof wire mesh*: - This shall be of galvanized M.S. wire and IS gauze designation 85 G. with wire of diameter 0.56 mm.

3.24.6 *Rolling Shutters*: - Rolling shutters shall be obtained from a reputed manufacturer. These shall include necessary locking arrangements and handles etc. These shall be

suitable for fixing in the position as specified i.e. outside or inside on or below lintel or between jambs of the opening. The door shall be either push and pull type or operated with chain and crank device supplied by the firm. Shutters up to 10 square metre shall be of push and pull type and shutters with an area of over 10 square metre shall generally be provided with reduction gear operated by mechanical device with chain or handle, if bearings are specified for each of operation, these shall be paid for separately.

3.24.7 Shutters: - These shall consist of MS laths 1.25 mm thick and 80 mm wide laths or as specified. The laths shall be machine rolled and straightened with an effective bridge depth of 16 mm and shall be interlocked together throughout their entire length and jointed together at the end with end locks. These shall be mounted on a specially designed pipe shaft. Each lath section shall be a continuous single strip piece without any joint.

The springs shall be, preferably of coiled type. The spring shall be manufactured from high tensile spring steel wire or strip of adequate strength to balance the shutters in all positions. The spring pipe shaft etc. shall be supported on strong mild steel brackets.

3.24.8 Guide Channels: - The guide channels shall be of mild steel deep channel section and of rolled, pressed or built up (fabricated) construction. The thickness of the sheet used shall not be less than 3.15 mm. The minimum depths for guide channels shall be as follows:

**Table 3.14** THE MINIMUM DEPTHS FOR GUIDE CHANNELS

| Clear width of shutter | Depth of guide channel |
|---|---|
| Up to 3.5 m | 60 mm |
| 3.5 m and above | 75 mm |

The gap between the two legs of the guide channel shall be sufficient to allow the free movement of the curtain and at the same time close enough to prevent the rattling of the curtain due to wind.

Each guide channel shall be provided with a minimum of three fixing cleats or supports for attachment to the walls or column by means of bolts or screws. The spacing of cleats shall not exceed 0.75 m. Alternatively the guide channels may also be provided with suitable dowels, hooks or pins for embedding in the walls.

The guide channels shall be attached to the jambs, plumb and true, either in the overlapping fashion, projecting fashion or embedded in grooves, depending on the method of fixing. Top cover of shaft, spring etc. shall be of the same material as that of lath.

3.24.9 Collapsible Gates: - These shall be procured from a reputed manufacturer and shall be fabricated from the mild steel sections. The gates shall consist of double or single collapsible gates depending on the size of the opening. These shall consist of vertical double channels each 20 x 10 x 2 mm at 10 cm centres braced with flat iron diagonals 20 x 5 mm and top and bottom rails of T-iron 40 x 40 x 6 mm @ 3.5 kg/m with 40 mm dia ball bearings in every fourth double channel, unless otherwise specified. Wherever a collapsible gate is not provided within the opening and is fixed along the outer surface T-iron at the top may be replaced by flat iron 40 x 10 mm.

The collapsible gate shall be provided with necessary bolts and nuts, locking arrangement, and stopper handles. Any special fittings like spring, catches and locks, shall be so specified in the description of item where so required. The gate shall open and close smoothly and easily.

3.24.10 *Steel back flap hinges*: - They shall conform to IS 3843. Steel back flap hinges shall be of the following two types:

a) Light weight hinges, and
b) Heavy weight hinges

Back flap hinges shall be well made and shall be free from flaws and defects of any kind. All hinges shall be cut clean and square and shall be provided with mild steel hinges pins. The hole for the hinge pin shall be central and square to the knuckles. All sharp edges and corners shall be removed. Unless specified otherwise, the hinges shall be oxidized or finished bright with smooth and rust free surface. Hinges shall be packed in cardboard boxes or in any other approved packing in the following quantities:

| | |
|---|---|
| Size up to 25 mm | 30 pieces in each package |
| Size over 25 up to and including 75 mm | 10 pieces in each package |

3.25 **Aluminium Doors, Windows and Ventilators**: - These shall be made from aluminium alloy extruded sections complying with the requirement of IS: 1948.

Doors, windows and ventilators shall be designated by symbols denoting their width, type and height in succession in the following manner:

(a) Width - It shall be indicated by the number of modules in the width of opening.

(b) Type - It shall be indicated by the following letters of alphabet:

C = Centre-hung shutters,

F = Fixed-glass panes,

H = With horizontal glazing bars,

N = Without horizontal glazing bars,

S = Side-hung shutters, and

T=Top-hung shutters.

(c) Height - It shall be indicated by the number of modules in the height of opening.

Composite doors, windows or ventilators shall be designated in the following manner:

(a) A 12 module wide and 21 module high horizontally glazed side-hung door coupled on its two sides with two side-hung horizontally glazed windows 6 module wide and 12 module high is designated by 6HS 12/12HS21/6HS12.

(b) Two 10 module wide and 12 module high horizontally glazed side-hung windows coupled side by side with two fixed glass pane ventilators at top, each 10 module wide and 6 module high, is designated by

10HF6/10HF6
10HS12/10HS12

Glass panes used for doors, windows and ventilators shall weigh at least 7.5 kg/$m^2$ and shall be free from flaws, specks, or bubbles. All panes shall have properly squared corners and straight edges. Frames shall be square and flat, the corners of the frame being fabricated to a true right angle. Both the fixed and opening frames shall be constructed of sections, which have been cut to length, mitred and welded at the corners. Where hollow sections are used with welded joints, argon-arc welding or flash butt welding shall be employed (gas welding or brazing not to be done). Subdividing bars of units shall be tenoned and riveted into the frame.

Aluminium doors, windows and ventilators may be supplied in either matt, scratch-brush or polished finish. They may, additionally, also be anodized, if so required by the purchaser. If colour anodizing is to be done then only approved light-fast shades should be used. A thick layer of clear transparent lacquer based on methacrylates or cellulose butyrate, shall be applied on aluminium doors, windows and ventilators by the suppliers to protect the surface from wet cement during installation. This lacquer coating shall be removed after installation is complete. Glazing shall be provided on the outside of the frames. If required, glazing clips may be provided as extra fittings by mutual arrangement between the purchaser and the supplier. Four glazing clips may be provided per glass pane, except for door type 8HS21 where the glazing clips shall be six per glass pane. In case of doors, windows and ventilators without horizontal glazing bars the glazing clips shall be spaced according to the slots in the vertical members, otherwise, the spacing shall be 30 cm. All doors, windows and ventilators shall be dispatched with the opening parts suitably secured to preserve alignment when fixing and glazing. Fixing lugs, coupling fittings and all hardware shall be dispatched separately. Composite windows shall be dispatched uncoupled.

3.25.1 *Aluminium door/windows fittings: -*

3.25.1.1 Butt hinges**: -** These shall be manufactured from extruded sections. These shall be well made and free from flaws and defects of all kinds. These shall generally conform to IS 205. They shall be anodized and the size shall be as specified.

The hinge pin shall be made of mild steel or brass or stainless steel, in the case of brass hinges. It may also be made of phosphor bronze, if so required by the purchaser. The hinge pin shall be of aluminium alloy or mild steel (galvanized) or stainless steel in case of aluminium alloy hinges. The aluminium alloy hinge pin shall be hard anodized to a minimum thickness of 0.015 mm and sealed with oil, wax or lanolin. The hinge pin shall be firmly riveted or suitably notched and shall be properly finished. The movement of the hinges shall be free, easy and square, and shall not have any play or shake. Washers shall be provided between the knuckles and these shall be of the same diameter as the butt and shall be made of nylon, plastic, stainless steel or other suitable material. Hinges shall be free from all defects. All sharp edges shall be rounded. Brass hinges shall have bright or satin finish and shall be suitably protected against discoloration. Aluminium alloy hinges shall be anodized and the quality of anodized finish shall not be less than Grade AC 10 of IS 1868.

3.25.1.2 Knuckles: - Number of knuckles in each hinge pin shall not be less than 5. The number of knuckles in case of sizes less than 40 mm shall be three. The sides of the knuckles shall be straight and at right angle to the flap. The movement of the hinge pin shall be free and easy and working shall not have any play or shake.

3.25.1.3 Screw holes: - The screw holes shall be suitable for counter sunk head wood screws, and of the specified sizes for different types of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of wood screw specified.

3.25.1.3 Aluminium handles: -The handles shall be well made and free from defects. These shall be finished correct to shape and dimensions. All edges and corners shall be finished smooth so as to facilitate easy handling. Cast handles shall be free from casting defects. Where the grip portion of the handle is joined with the piece by mechanical means, the arrangement shall be such that the assembled handle shall have adequate strength comparable to that of integrally cast type handles. These shall be of cast aluminium of specified size, and of shape and pattern as approved by the Engineer. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size, and window handles of 75 mm size unless otherwise specified. These shall be fixed with 25 mm long wood screws of designation No.6. Aluminium handles shall be anodized and the anodic coating shall not be less than grade AC-15 as per IS1868.

3.25.1.4 Aluminium hooks and eyes: - These shall be made of aluminium alloy. It shall be anodized and all edges and corners shall be finished smooth. These shall be well made and free from defects. They shall be finished to the correct shape and dimensions so as to function properly when they are in use. Cast hooks, eyes shall be free from casting and other defects. Sizes of hooks and eyes shall be determined by the length of the hooks measured out to out.

3.25.1.5 Aluminium kicking plate: - Aluminium kicking plate shall be anodized and the anodic coating shall not be less than grade AC-10 of IS 1868. It shall be made from a plate of thickness 4.0 mm, size and shape of the plate shall be as specified. The edges shall be filed smooth.

3.25.1.6 Aluminium Sliding Door bolt: - This shall be made of Aluminium alloy and shall generally conform to IS 2681. It shall be anodized and all edges and corners shall be finished smooth. All screw holes shall be counter sunk to suit the counter sunk head of wood screws of specified sizes. The size shall be as specified.

3.25.1.7 Aluminium Tower bolts- (barrel type): - Aluminium barrel tower bolts shall be manufactured from extruded sections of Aluminium alloy. The knob shall be properly screwed to the bolt and riveted at the back. The bolt and barrel shall be anodized. The anodic film may be either transparent or dyed as specified. The quality of anodized finished shall not be less than grade AC - 10 of IS1868. Size of the bolt shall be as specified.

3.25.1.8 Aluminium flush bolts: - These shall be of cast aluminium alloy or extruded aluminium alloy as specified. Only one material shall be used in the manufacture of all the components of flush bolts except spring, which shall be of phosphor bronze or steel strip. The length of the bolt shall be such that, when the bolt is pulled down, the top of the bolt shall be flush with the top of the lip face. The top of the bolt shall be given a taper of 45 degree to enable easy push and pull. Aluminium flush bolts shall be anodized and the quality of the anodized finish shall not be less than grade AC 15 of IS 1868.

3.25.1.9 Aluminium Screws: - They shall be of the slotted counter sunk head type of length as specified. The designation number shall be as required.

3.25.1.10 *Aluminium* Door Stopper 150 mm: - Aluminium door stopper shall be anodized and the anodic coating shall not be less than the grade AC-10 of IS 1868. The size and pattern of the door stopper shall be approved by the Engineer-in- charge. The size shall be determined by its length.

3.26 **Brass fittings: -** These shall be well made and shall be free from flaws and defects of all kinds. These shall generally conform to IS 204, IS 205, IS 207 or IS 208 as applicable. The fittings shall be finished bright (or chromium plated) as applicable.

3.26.1 *Mortice latch (Brass) 100 mm size:* - The size of the mortice latch is measured by the length of the body towards face. A variation of +/- 3 mm shall be permissible. These shall be well made and shall be free from flaws and defects of all kinds. These shall be finished bright.

Mortice latch, with one head bolt and a pair of lever handles shall have steel casing and brass bolt shall be right or left handed as directed by the Engineer. The latch for single leaf door shall be plain face and that of double leaf door a rebated face. The end bolt shall be reversible. The bolt shall not project from the face of the fore end of the lock. The section of the bolt shall not be less than 12x16 mm.

3.27 **MS fittings: -**

3.27.1 *Butt hinges* - Mild steel butt hinges shall conform to IS 1341 and shall be of the following types:

a) Light weight hinges
b) Medium weight hinges
c) Broad type hinges
d) Square type hinges
e) Heavy type I and II hinges

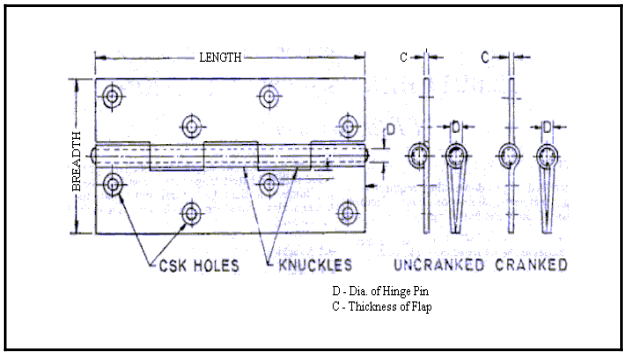



**Figure 3.2** A TYPICAL MILD STEEL BUTT HINGE

Hinges shall be well made and shall be free from flaws and defects of all kinds. All hinges shall be cut clean and square and shall be provided with mild steel hinge pins. The hole for the hinge pin shall be

central and square to the knuckles. All sharp edges and corners shall be removed. Unless otherwise specified, hinges shall be finished bright with smooth surfaces. Hinges shall be packed in cardboard boxes or in any other approved packing in the following quantities:

| | |
|---|---|
| Sizes 15, 20 and 25 mm | 30 pieces in each package |
| Sizes over 25 mm up to and including 75 mm | 20 pieces in each package |

| | |
|---|---|
| Sizes above 75 mm | 10 pieces in each package |

3.27.2 *MS handles*: - These shall be well made and free from defects. These shall be finished correct to shape and dimension. All edges and corners shall be finished smooth so as to facilitate easy handling. These shall be of mild steel sheets pressed into an oval section. These shall conform to IS Specification for door handles IS 208. The size of the handles shall be determined by the inside grip of the handle. These shall be copper oxidized (black finished) or as specified. Size shall be as specified.

3.27.3 *Hooks and Eyes*: - These shall be of mild steel and shall be copper oxidized (black finish) or as specified. These shall be correct to shape and dimensions so as to function properly when they are in use. The size is determined by the length of the hooks measured out to out. Size shall be as specified.

3.27.4 *MS sliding bolt*: - These shall be made of M.S. sheets and M.S. rods and shall generally conform to IS 281. M.S. The sliding door bolt shall be copper oxidized (black finish) or as specified. The size shall be as specified.

3.27.5 *MS Tower bolts (Barrel/Flush type)*: - Tower bolts shall be well made and shall be free from defects. The bolts shall be finished to the correct shape and shall have a smooth action. All tower bolts are made with sheet 1.2 mm thickness and shall have counter sunk screw holes to suit counter sunk head wood screws. All sharp edges and corners shall be removed and finished smooth. Size shall be as specified.

3.27.6 *MS Screws*: - These shall be of the slotted counter sunk head type of length as specified. The designation number shall be as required.

3.27.7 *MS Door Stopper 150 mm*: - This shall be of MS. The size and pattern of the door stopper shall be as approved by the Engineer.

3.27.8 *MS Rivets***: -** Rivet shall be made from rivet bars of mild steel as per IS 1148. The tolerance on diameter of bars shall be as follows:

**Table 3.15** THE TOLERANCE ON DIAMETER OF BARS

| Diameter of bars (mm) | Maximum tolerance (mm) |
|---|---|
| Below 20 | (-) 0.40 |
| 20 | (-) 0.45 |
| 22 and 24 | (-) 0.50 |
| Over 24 | (-) 2 percent on diameter |

Length of the rivet shall be as required.

3.27.9 *MS Bolts*: - All bolts head and nuts shall be hexagonal and of equal size, unless specified otherwise. The screwed thread shall conform to IS 1363 and the threaded surface shall not be tapered. The nominal length of the bolt shall be the distance from the underside of the head to the further end of the shank and the nominal diameter of the bolt shall be the diameter at the shank above the screwed threads. The bolts shall be of such length as to project at least two clean threads beyond the nuts when fixed in position. The nuts shall fit in the threaded ends of bolts properly.

3.27.10 *MS Holding down bolts*: - They shall be of mild steel round bars with anchor plates of mild steel. The bolt shall have threads as required and shall be supplied with washers and nuts.

3.28 **Continuous (Piano) Hinges:** – Hinges shall be well made and the hole for the hinge pin shall be central and square to the knuckles. Hinges shall conform to IS 3818.

Mild steel hinges shall be protected with anticorrosive treatment, such as bright polished, chromium plated or oxidized finish. Aluminium hinges shall be anodized and the quality of anodized finish shall not be less than that of Grade AC 10 of IS 1868

The hinges shall be packed in a polyethylene sheet in bundles of 10 or 12. The bundle shall be suitably packed in card-board boxes lined with weather-proof paper.

3.29 **Rising butt hinges**: - Rising butt hinges shall conform to IS 9106 and shall be of the following types according to the material used:

**Table 3.16** TYPES OF RISING BUTT HINGES ACCORDING TO MATERIAL USED

| Type | Material |
|---|---|
| 1 | Cold rolled mild steel |
| 2 | Cast iron |
| 3 | Extruded brass |

Hinges shall be well made and shall be free from flaws and defects. The movement of the hinge shall be firm and easy to operate when fitted. Unless specified otherwise, the hinges shall be finished bright with smooth surfaces. The brass hinges shall have bright or satin finish and shall be suitably protected against discolouration. Hinges shall be packed in card boxes or in any other approved packing. The number of hinges in a packing shall be ten.

3.30 **Double- acting spring hinges**: - They shall conform to IS 453 and shall be of the following two types according to the material used:

a) Mild steel double-acting spring hinges, and
b) Brass double-acting spring hinges.

Double-acting spring hinges and corresponding blank hinges shall be of the following sizes:

**Table 3.17** SIZES OF DOUBLE – ACTING SPRING HINGES

| Size of spring hinge (mm) | Size of blank hinge (mm) |
|---|---|
| 101 | 70 |
| 125 | 75 |
| 150 | 75 |

3.30.1 *Mild Steel Hinges* - The cylindrical casing shall be made either from mild steel sheet of 1.60 mm thickness, lap-jointed and brazed, welded or riveted; or from solid drawn tube of thickness not less than 1.60 mm; or from mild steel sheet of 1.60 mm thickness, pressed to form the two casings and the distance piece. The casing shall be closed at both ends by mild steel caps having inside ends like forks to engage the ends of the

spring. The flaps shall be of mild steel sheet of 1.60 mm thickness. In each casing, one of the caps shall be secured to the casing by means of a rivet and the other cap to the flap by means of a removable pin. The forks shall engage with the two ends of the spring. The casing, the flaps and the caps shall be held together by a mild steel spindle of 4 mm diameter fitted with an ornamental cap at each end.

3.30.2 *Brass Hinges* - The cylindrical casing shall be made either from brass sheet of 1.60 mm thickness, lap-jointed and brazed, or from solid drawn brass tube of not less than 1.60 mm thickness. The casing shall be closed at both ends with cast brass caps machined to accommodate the forks. The forks may be of mild steel or rolled brass forged and turned to shape and finished as shown in Figure 3.2. The connecting piece shall be of cast brass and shall be brazed on to the caps at both ends. The flaps shall also be of cast brass or extruded sections of brass and shall conform to the thickness given below. In each casing, one of the forks shall be fixed to the cap and the other to the flap by means of removable pins. The forks shall engage the two ends of the spring:

**Table 3.18** FLAP THICKNESS OF BRASS HINGES

| Size of brass hinge (mm) | Thickness of flap | |
|---|---|---|
| | Cast (mm) | Extruded (mm) |
| 101 | 4.0 | 3.2 |
| 125 | 5.0 | 4.0 |
| 150 | 5.6 | 5.0 |

Blank hinges shall be made of cast brass or extruded sections of brass and the thickness of flap shall conform to that specified for the corresponding sizes of spring hinges.

Unless otherwise specified, the finish of the hinges shall be as follows:

a) Mild Steel Hinges - Stove-enamelled black or copper-oxidized

b) Brass Hinges – satin, bright, nickel-plated, or copper-oxidized

Each hinge shall be wrapped individually in craft paper and packed in cartons to prevent ingress of moisture.

3.31 **Tee and strap hinges**: - It shall conform to IS: 204 and shall be of the following types:

| Type | Designation |
|---|---|
| 1 | Light weight |
| 2 | Medium weight |
| 3 | Heavy weight |

Strap hinges shall be of the following types:

| Type | Designation |
|---|---|
| 1 | Light weight strap |
| 2 | Medium weight |
| 3 | Heavy weight |

Hinges shall be well made, free from burrs, flaws and defects of any kind. The movement shall be square, and the working shall be free and easy, without any play or shake. The hole for the hinge pin shall be central to the boss and shall be square. The hinge pin shall be firm and riveted over, so that the heads are well formed. All screw holes shall be clean and countersunk and shall be suitable for countersunk head wood screws (see IS 6760) of the numbers specified in Table 2 to table 7 for different types and sizes of hinges. Tee and strap hinges shall be either bright finished or stove enamelled black, as specified by the purchaser. Hinges shall be packed in cardboard boxes or in any other approved packing in the following quantities:

| | |
|---|---|
| Sizes up to and including 125 mm | 20 pieces in each package |
| Sizes 150 mm and above | 10 pieces in each package |

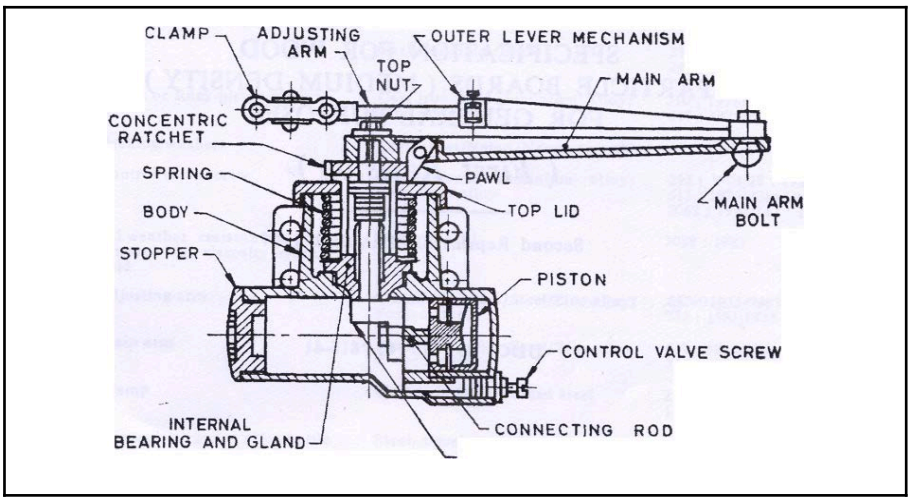



**Figure 3.3** Typical Sketch of Hydraulic door closer showing main components (Bottle Type)

3.32 **Door handles for mortice locks (vertical type):** They shall conform to IS 4992. The door handles shall be suitable for fitting to the doors.

The connecting rod shall fit snugly both in the follower in the mortice lock and the socket handle and when fitted shall work positively in combination with the follower. One sample of door handle picked out at random from a lot of 100 handles when fitted to a lock and operated 1000 times shall not show any damage or ineffectiveness in working. When the door handle is in its extreme position in the lock and pulled horizontally with a load of 100 kg, it shall not develop cracks, lose shape or get damaged. Door handles shall be free from all defects. All sharp edges shall be removed.

Brass door handles shall have natural finish or shall be bright electro-chromium plated. Aluminium alloy door handles shall be anodized and the quality of anodized finish shall not be less than that of Grade AC 10 of IS: 1868. Zinc base alloy die cast handles and mild steel handles shall be bright chromium plated.

3.33 **Hydraulically regulated door closers: -** It shall conform to IS 3564. A hydraulic door closer (hereinafter called closer) is equipment for automatic closing of doors by the help

of spring control valve such that the phase of closing is slowed down by the hydraulic damper.

Hydraulically regulated door closer shall be of the following types:

a) Bottle type (Type A), and
b) Tubular type (Type B).

The nominal sizes of door closers in relation to the mass and the width of the door size, to which it is intended to be fitted, shall be as given in Table 3.19.

The door closer may be polished or painted and finished with lacquer in colours as agreed to between the purchaser and the manufacturer. In the case of an aluminium body, it may be anodized. In case anodizing is done, the thickness of the anodic coating shall not be less than Grade AC 15 of IS 1868. All dents, burrs and sharp edges shall be removed from various components and they shall be picked, scrubbed and rinsed to remove grease, rust, scale or any other foreign element. After pickling, all the mild steel parts shall be given phosphate treatment in accordance with IS 3618.

**Table 3.19** DESIGNATION OF DOOR CLOSERS

| Sl. No | Designation of closer | Mass of the door | Width of the door | Remarks |
|---|---|---|---|---|
| (I) | 1 | Up to 35 | Up to 700 | For light doors such as double leaved and toilet doors |
| (II) | 2 | 36 to 60 | 701 to 850 | Interior doors, such as of bedrooms, kitchen and store |
| (III) | 3 | 61 to 80 | 851 to 1000 | Main doors in a building, such as entrance doors. |

3.34 **G.I. Barbed Wire: -** The barbed wire shall be galvanized steel as specified and it shall conform to IS 278. The wire shall be manufactured from steel by any process and shall not contain sulphur and phosphorus exceeding 0.065 percent. The galvanized steel barbed wires shall be of two types: Type A (Iowa Type) and Type B (Glidden Type).

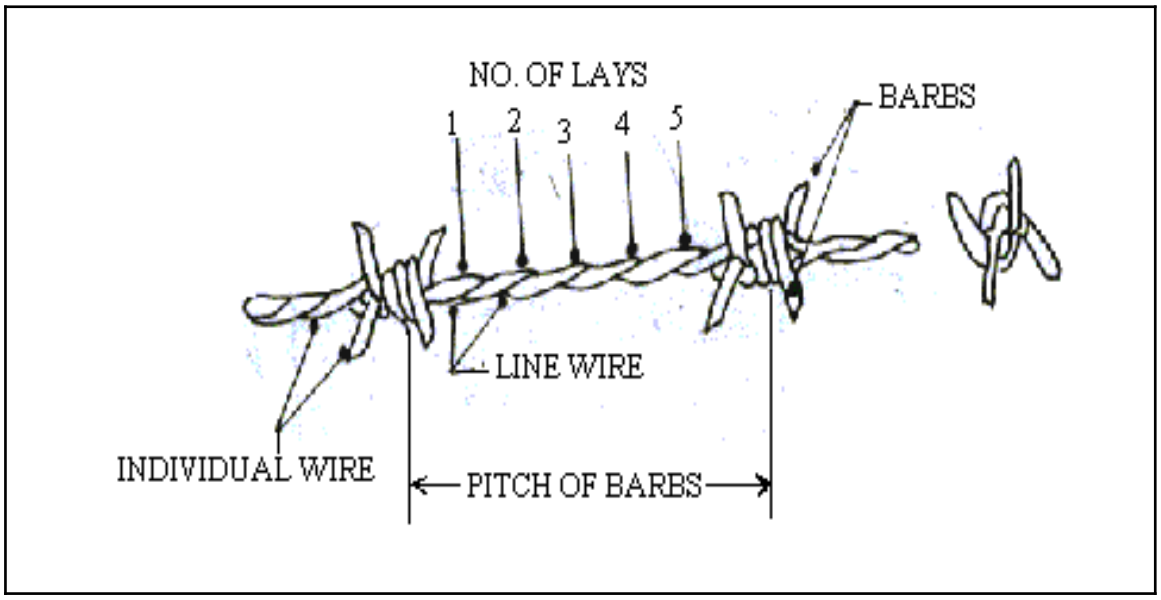



**Figure 3.4** DETAILS OF BARBED WIRE (TYPE A)

3.34.1 *Type A (Iowa Type)*: The barbs shall have four points and shall be formed by twisting two-point wires, each two turns, tightly around both line wires making altogether four complete turns.

3.34.2 *Type B (Glidden Type)*: - The barbs shall have four points and shall be formed by twisting two points wires, each two turns, tightly around one line wire making altogether four complete turns.

The galvanized steel barbed wire shall be of the size designations given in Table 3.20.

**Table 3.20** SIZE DESIGNATION OF GALVANIZED STEEL BARBED WIRE.

| Size Desig-nation | Nominal diameter of wire | | Weight of completed bar | | Distance between two barbs |
|---|---|---|---|---|---|
| | Line wire | Point wire | Max. (gm/m) | Min. (gm/m) | |
| 1 | 2.50 | 2.00 | 125 | 108 | 75±12 |
| 2 | 2.50 | 2.00 | 103 | 89 | 150±12 |
| 3 | 2.24 | 2.00 | 106 | 97 | 75±12 |
| 4 | 2.24 | 2.00 | 85 | 78 | 150±12 |

The number of lays between the two consecutive barbs shall vary between 2 to 7. The barbed wire shall be formed by twisting together two line wires, one or both containing the barbs. The sizes of the line and point wire and barb spacings shall be as specified. The permissible deviation from the nominal diameter of the line wire and the point wire shall not exceed +/- 0.08 mm. The line and point wire shall be circular in section, free from scales and other defects and shall be uniformly galvanized. The line wire shall be in continuous lengths, and shall not contain any welds other than those in the rod before it is drawn. The distance between two successive splices shall not be less than 15 metres. It shall have the tensile properties as specified in Table 3.21.

**Table 3.21** TENSILE PROPERTIES

| Size of wire(mm) | Tensile strength of line wire ($Kgf/mm^2$) | Minimum breaking load of completed barbed wire (Kgf) |
|---|---|---|
| 2.5 | 40 to 60 | 375 |
| 2.24 | 40 to 60 | 300 |

The number of reels to be selected at random for the purpose of testing shall be as given below.

**Table 3.22** THE NUMBER OF REELS TO BE SELECTED AT RANDOM FOR THE PURPOSE OF TESTING

| | Sampling criteria |
|---|---|
| No. of reels in the lot | No. of reels to be selected |
| Up to 25 | 3 |
| 26 to 50 | 4 |

| | |
|---|---|
| 51 to 150 | 5 |
| 151 to 300 | 7 |
| 301 and above | 10 |

3.35 **G.I Washer**: - These shall be 25 mm in diameter and 1.6 mm thick. The galvanizing shall be uniform

3.36 **Limpet Washer**: - These shall be cup shaped washers made of 20g G.I. sheet.

3.37 **Corrugated Galvanised Iron (CGI): -** CGI sheets shall be of the thickness specified and shall conform to IS 277. The sheets shall be free from cracks, split edges, twists, surface flaws etc. They shall be clean, bright and smooth. The galvanizing shall be uninjured and in perfect condition. The sheets shall show no sign of rust or white powdery on the surface. The corrugations shall be uniform in depth and pitch and parallel with the sides.

The total weight of zinc coating shall be not less than 750 gms/$m^2$ (both sides inclusive). The minimum weight of a sheet of 24 g shall be 5.7 Kg/$m^2$. The depth of corrugation shall be 18 mm and shall have a pitch of 75 mm (nominal).

**PPGI/PPGL:** The PPGI/PPGL shall conform to IS 15965.

3.38 **Corrugated roofing sheets made from coir, wood wool and cement**: - They shall conform to the requirements given in IS 10388. The finished sheets when delivered shall be free from visible defects that impair appearance or serviceability. The corrugation of the sheets shall be regular and well defined. The surface of the sheets shall be of uniform texture and shall have rectangular shape with trimmed edges.

3.39 **Glass: -**

3.39.1 *Plain Glass*: - The glass shall reasonably be free from flaws, blisters, stains, scratches and bubbles so as not to disturb visibility through the glass. Blisters exceeding 4 mm shall not be present. Blisters less than 4 mm, if present, shall be less than 30/$m^2$ and shall be fairly uniformly distributed. Bubbles below 2 mm need not be considered. It shall conform to IS 1761 in general. The tolerance in length and width shall be ±1.5 mm for glass of thickness 2.5 mm and below ± 2 mm for glass of thickness above 3 mm. Thickness of glass shall be as specified.

3.39.2 *Frosted glass*: - It shall be free from waviness and the thickness shall be as specified.

3.40 **Glazed tiles: -**

3.40.1 *White glazed tiles 150 x 150 mm*: - The tiles shall be of approved make and shall generally conform to IS 777. They shall be flat, and true to shape. They shall be free from cracks, crazing spots, chipped edges and corners. The glazing shall be of uniform shade. The tiles shall be of nominal size 150 mm x 150 mm with equal sides. The maximum variation from the stated sizes, other than the thickness of tiles shall be ± 1.0 mm. The thickness shall be 5.0 mm and the tolerance shall be 0.5 mm. The top surface of the tile shall be glazed.

The glaze shall be glossy or matt as specified. The underside of tiles shall be completely free from glaze. The edges of the tiles shall preferably be free from glaze; however, any glaze if unavoidable shall be permissible on any one edge of the tile.

3.40.2 *Coloured glazed tiles*: - Only the glaze shall be coloured as specified. The sizes and other specifications shall be the same as white glazed tiles.

3.40.3 Vitrified Ceramic Tiles (Wall / Floor / 3D): - The vitrified ceramic tiles shall conform to IS 15622:2017 (Ceramic Tiles – Specification) or latest revision and shall be of approved make suitable for wall and floor applications including skirting, dado, risers, steps, landings and flooring as specified in the drawings and BOQ.

The tiles shall be classified as **B Ia group ceramic tiles** as per IS 15622 having **water absorption not exceeding 0.5% by mass**, confirming a dense vitrified ceramic body suitable for heavy-duty applications.

The tiles shall be manufactured from refined blends of clay, feldspar, silica and other suitable raw materials and fired at high temperature to achieve a dense, hard and vitrified structure.

The tiles shall be free from cracks, warping, crazing, pinholes, blisters, delamination, chipped edges and other visible manufacturing defects.

The tiles shall have uniform colour, shade and finish. In case of 3D tiles, the surface shall be digitally printed or factory-textured with durable UV-stable finish as specified.

The tiles shall conform to IS 15622 requirements for:

- Adequate breaking strength suitable for wall and floor applications
- Abrasion resistance appropriate to service condition
- Chemical resistance to normal household and mild chemical exposure
- Stain resistance under normal usage conditions

The tiles shall be flat and true to shape with straight edges to ensure proper joint alignment. Where rectified tiles are specified, edges shall be machine-cut to achieve uniform and narrow joints.
The dimensional tolerances shall be as per IS 15622 requirements, including permissible variation in size (generally ±1.0 mm or as applicable for module type) and uniform thickness.
The underside surface shall be suitable for proper bonding with cement mortar or approved tile adhesive conforming to IS 15477 or equivalent approved standard.

The surface finish shall be matt, glossy, satin, polished or textured as specified in the BOQ.

Tiles shall be supplied in original manufacturer packaging with shade code, batch number, size and grade clearly marked. Manufacturer's test certificates confirming compliance with IS 15622 shall be submitted prior to approval and procurement.

3.41 **Slate tiles**: - They shall conform to IS 6250. The slate for roofing shall be free from veins, cracks, or other similar source of weakness. They shall be of uniform colour and texture and shall not contain white patches and deleterious minerals. The slate shall be of reasonably straight cleavage and the grains shall be longitudinal.

The standard size of slate tiles shall be as follows:

**Table 3.23** THE STANDARD SIZE OF SLATE TILES

| Length (mm) | Breadth (mm) | Height (mm) |
|---|---|---|
| 600 | 300 | 15 min |
| 500 | 250 | 15 min |

A tolerance of ± 5 mm shall be allowed on length and breadth.

Physical Properties of slate tiles shall conform to requirements given in Table 3.24.

Unless otherwise specified the slates shall be of uniform thickness and rectangular shape with reasonably full corners and the edges shall be true. The surface of the slate shall be such as to permit proper laying. The exposed surfaces shall be finished as specified and in accordance with an approved sample. Each slate tile shall be marked in a suitable manner with the manufacturer's identification mark or initial.

**Table 3.24** PHYSICAL PROPERTIES OF SLATE TILES

| Sl. No | Characteristic | Requirement |
|---|---|---|
| (i) | Water absorption | (a) Maximum average: 2 percent by mass<br>(b) Variation should not exceed 20 percent between individual sample |
| (ii) | Modulus of rupture | 60 N/mm$^2$ (dry), Min<br>40 N/mm$^2$ (wet), Min |
| (iii) | Depth of softening | 0.05 mm, Max |
| (iv) | Permeability | No water shall ooze from the bottom |
| (v) | Sulphuric acid immersion | Shall show no sign of delamination along the edge or swelling, softening, flaking of the surface and shall not exhibit gaseous evolution during immersion |
| (vi) | Wetting and drying | Shall show no sign of delamination or splitting along the edge no flaking of the surface |

3.43 **Limestone (slab and tiles): -** They shall conform to IS 1128. The stone shall be without any soft veins, cracks or flaws and shall have a uniform texture. Limestone slabs and tiles shall be supplied in sizes specified in Table 3.25. The sizes in between (of length and breadth) shall be reckoned as the next lower size.

**Table 3.25** STANDARD SIZES OF LIMESTONE SLABS AND TILES

| Length | Breadth | Thickness |
|---|---|---|
| 15 to 60 cm in stages of 5 cm | 15 to 60 cm in stages of 5 cm | 15 to 95 cm in stages of 10 cm |
| 60 to 100 cm in stages of 10 cm | 30 to 100 cm in stages of 10 cm | 15 to 95 cm in stages of 10 cm |
| 100 to 150 cm in stages of 10 cm | 30 to 100 cm in stages of 10 cm | 25 to 95 cm in stages of 10 cm |

The tolerances in thickness shall be +5 mm up to 25 mm thickness and ± 5 mm for thickness above 25 mm. Machine cut slabs with true and square edges to the exact sizes (with tolerance of ± 1 mm) shall be supplied if so specified by the purchaser. The tolerance in thickness shall be as mentioned above.

3.44 **Sandstone (slabs and tiles): -** They shall conform to IS 3622. The stone shall be without any soft veins, cracks and flaws and shall have a uniform texture and colour. Rough cut Sandstone slabs and tiles of rough cut edges shall be of sizes as specified below:

| Length | Breadth | Thickness |
|---|---|---|
| 15 to 360 cm in stages of 5 cm | 15 to 90 cm in stages of 5 cm | 15 to 100 mm in stages of 5 mm |

The tolerance for thickness shall be ± 3 mm. The physical properties of sandstone slabs shall conform to the requirement of Table 3.26, when tested in accordance with the provisions of the appropriate Indian Standards given in Table 3.26.

**Table 3.26** PHYSICAL PROPERTIES OF SANDSTONE SLABS

| Sl. No | Characteristic | Requirement | Method of test (Reference - IS) |
|---|---|---|---|
| (i) | Water absorption | No more than 2.5 percent by mass | IS1124 |
| (ii) | Transverse strength | Not less than 7 $N/mm^2$ (70 $Kgf/cm^2$) | IS1121 (part 2) |
| (iii) | Resistance to wear | Not greater than 2 mm on an average and 2.5 mm for any individual specimen | IS 1706 : 1972 |
| (iv) | Durability | Shall not develop signs of spalling, disintegration or cracks. | IS 1126:1974 |

3.45 **Chequered cement concrete tiles:** - Chequered tiles are cement tiles or terrazzo tiles with the centre to centre distance of chequers not less than 25 mm and not more than 50 mm, the grooves in the chequers being uniform and straight with the depth of grooves not less than 3 mm.

Chequered cement flooring tiles shall be manufactured from a mixture of cement, natural aggregates, and colouring materials where required, by pressure process. During manufacture, the tile shall be subjected to a pressure of not less than 14 N/mm$^2$. The tiles shall conform to IS 13801. The proportion of cement to aggregate in the baking of the tiles shall be not leaner than 1:3 by mass. Where colouring material is used in the wearing layer, it shall not exceed 10 % by mass of cement used in the mix. On removal from the mould, the tiles shall be kept in moist condition continuously for such a period that would ensure their conformity to the requirements of this standard. Tiles shall be stored under cover.

The size of chequered cement flooring tiles shall be as follows:

**Table 3.27** SIZE OF CHEQUERED CEMENT FLOORING TILES

| Length (mm) | Breadth (mm) | Height (mm) |
|---|---|---|
| 200 | 200 | 22 |
| 250 | 250 | 22 |
| 300 | 300 | 25 |

*NOTE – The thickness shall be measured at two points situated approx. 50 mm from the ends on the fracture line of the tile that is tested for wet transverse strength. The total thickness is the arithmetic mean of these two measurements.*

Half tiles rectangular in shape shall also be available. Half tiles for use with full tiles in the floor shall have dimensions which shall be such as to make two half tiles when joined together, to match with the dimensions of the one full tile.

Tolerances on length or breadth of tiles shall be ± 1 mm. In addition, the difference in length of side between the longest side and the shorter side in the sample shall not exceed 1 mm. Tolerance on thickness shall be + 5 mm. In addition the difference in thickness between the thickest and the thinnest tile in the sample shall not exceed 3 mm. The thickness of the wearing layer measured from the top of the chequers shall not be less than 6 mm. The thickness of the wearing layer shall be measured at several points along the fracture line of the tile that was tested for wet transverse strength. The arithmetic mean of the two measurements, which yielded the lowest value, shall be the minimum thickness of the wearing layer.

Unless otherwise specified, the tiles shall be supplied with initial grinding and grouting of the upper layer. The upper layer of the tiles shall be free from projections, depressions, cracks (hair cracks not included), holes, cavities and other blemishes. The edges of the tile may be rounded.

The colour and texture of the wearing layer shall be uniform throughout its thickness. No appreciable difference in the appearance of the tiles, from the point of view of colour of aggregate, its type and its distribution on the surface of the wearing layer shall be present.

3.46 **Cement concrete flooring tiles: -** These shall conform to IS 1237. Cement concrete flooring tiles shall be of two classes as given below depending on the duty they perform:

a) General Purpose Tiles- Used for flooring in such places where normally light loads are taken up by the floors; such as office buildings, schools, colleges, hospitals and residential buildings.

b) Heavy duty floor tiles- Used for heavy traffic conditions; such as foot paths, entrances and staircases of public buildings, passages of auditoriums and storage go-downs.

Cement concrete flooring tiles shall be manufactured from a mixture of cement, natural aggregates, and colouring material where required, by pressure process. During manufacture, the tiles shall be subjected to a pressure of not less than 14 $N/mm^2$ (140 $kg/cm^2$). The proportion of cement to aggregate in the baking of the tiles shall be not leaner than 1:3 by mass. Where colouring material is used in the wearing layer, it shall not exceed 10 % by mass of cement used in the mix. On removal from the mould, the tiles shall be kept in moist condition continuously for such a period that would ensure their conformity to the requirements of this standard. Tiles shall be stored under cover.

The size of cement concrete flooring tiles shall be as follows:

**Table 3.28** SIZE OF CEMENT CONCRETE FLOORING TILES

| Length (mm) | Breadth (mm) | Height (mm) |
|---|---|---|
| 200 | 200 | 20 |
| 250 | 250 | 22 |
| 300 | 300 | 25 |

Half tiles rectangular in shape shall also be available. Half tiles for use with full tiles shall have dimensions which shall be such as to make two half tiles when joined together, match with the dimensions of the one full tile. Tolerances on length or breadth of tiles shall be ± 1 mm. In addition, the difference in length of side between the longest side and the shorter side in the sample shall not exceed 1mm. Tolerance on thickness shall be + 5 mm. In addition the difference in thickness between the thickest and the thinnest tile in the sample shall not exceed 3 mm.

Unless otherwise specified, the tiles shall be supplied with initial grinding and grouting of the wearing layer. The wearing layer of the tiles shall be free from projections, depressions, cracks (hair cracks not included), holes, cavities and other blemishes. The edges of the wearing layer may be rounded. The colour and texture of the wearing layer shall be uniform throughout its thickness. No appreciable difference in the appearance of the tiles, from the point of view of colour of aggregate, its type and its distribution on the surface of the wearing layer shall be present.

3.47 **Linoleum sheets and tiles**: - These shall conform to IS 653 and shall be of following types:

a) Plain Linoleum: The composition of plain linoleum shall be of uniform colour extending evenly throughout the full thickness from the wearing surface to the hessian backing.

b) Moire, Jaspe and Marble Linoleum: The composition of moiré, jaspe and marble linoleum shall be of different colours. The colours shall extend from the wearing surface to the backing at random to form a variegated surface.

Unless otherwise specified the linoleum sheets of all thickness shall be supplied in rolls of lengths not less than 5.5 m. The standard width of the sheets shall be 2.0 m. The size of tiles shall be 225, 300 and 450 mm square. The standard overall thickness of the linoleum tiles are 4.5 mm, 2.0 mm and 1.65 mm. Cork tiles if supplied shall be of sizes and thickness as specified for tiles and sheets. The permissible deviation in thickness shall be ± 5 percent. The wearing surface of linoleum shall be smooth, uniform and shall be free from indentations, cracks and protruding particles. The hessian backing shall not be painted unless otherwise specified. The linoleum sheet shall be tightly wound on cores of mandrels of diameter not less than 75 mm. The rolls shall be wrapped in kraft paper (the weight of which shall not be less than 50 g/m$^2$) securely tied or otherwise fastened and finally packed in strong hessian or sacking. The ends of the rolls shall be suitably protected by means of cardboard or other suitable disc to avoid any damage. The linoleum tiles shall be packed in cardboard boxes.

3.48 **Clay ridge and Ceiling tiles**: - Ridge and ceiling tiles shall be of two classes, namely Class AA and Class A with their characteristics as specified in Table 3.29.

**Table 3.29** CLASSIFICATION OF RIDGE AND CEILING TILES

| Sl. No | Characteristic | Requirement for | |
|---|---|---|---|
| | | Class AA | Class A |
| (i) | Water absorption percent (for ridge and ceiling tiles), Max. | 18 | 20 |
| (ii) | Breaking strength ( for ridge tiles only), KN, Min. | Average 0.015 (1.5 Kg) | 0.0110 (1.10 Kg) |
| | | Individual 0.0125 (1.25 Kg) | 0.0095 (0.95 Kg) |

Ridge and ceiling tiles shall conform to IS 1464. The tile shall be made from good soils of even texture and shall be uniformly well burnt. They shall be uniform in shape and shall be free from irregularities, such as twists, bends, cracks and laminations. The tiles shall be free from impurities like particles of stone, lime or other foreign materials visible to the naked eye, either on the surface or on the fractured surface of the tile obtained by breaking the sample. However, occasional particles up to 2 mm in size shall be permissible. When struck, tile shall give a ringing sound and when broken, the fracture shall be clean, dense and sharp at the edges.

The length of ridge tile measured from face to face excluding the portion containing the catch shall be 375, 400 and 435 mm. The tolerance on the length of ridge tile shall be ± 5 mm. When a ridge tile is placed on a horizontal plane, the triangle formed in elevation

by producing the inner faces of the tile shall have a base of 265 mm and height of 100 mm with a tolerance of ± 5 mm. The thickness of the ridge tiles shall be not less than 10 mm throughout excluding ornamentation, etc. The rib at the rear end of the tile shall be of such a height and shape as to prevent effectively the tendency of the front face of the tile interlocked to slide over it.

The ceiling tiles shall of two types:

a) Double lug, and
b) Single lug.

The length of the double lug ceiling tile at the bottom shall be such that when a tile is placed between two battens the space between the face of the batten and that of the end of tile shall be between 3 mm and 6 mm. The length of the single lug ceiling tile at the bottom shall be 30 mm less than the face to face spacing of battens. The length of the lug shall not be more than 20 mm. The thickness of the tile or lug shall be not less than 10 mm. The ornamentation on the bottom face shall not reduce the minimum thickness.

3.49 **Hollow clay filler tiles:** - They shall conform to IS 3951(PART I). The tiles shall be made from suitable clay. The tiles shall be free from cracks, flaws and nodules of free lime. They shall be of uniform colour and shall be thoroughly burnt. They shall have plane rectangular faces with parallel sides and have straight right angled edges. They shall have a fine compact and uniform texture. The external faces of the tiles shall be serrated for the facility of application of plastering and re-colouring. The tiles shall be free from excessive winding or bowing and all external angels shall be right angles. The tiles shall be tested for trueness of shape. The standard sizes of tiles shall be as follows:

**Table 3.30** STANDARD SIZES OF HOLLOW CLAY FILLER TILES

| Length (mm) | Breadth (mm) | Height (mm) |
|---|---|---|
| 340 | | |
| 390 | | |
| 440 | | |
| 490 | | |
| 540 | 350, 300, 25 or 200 | 80, 90, 100, or 110 |
| 590 | | |
| 640 | | |
| 690 | | |
| 740 | | |

3.50 **Timber: -** Class A & B -Forestry Services Classification: - This shall be of good quality and well-seasoned. It shall have uniform colour, reasonably straight grains and shall be free

from dead knots, cracks, shakes and sapwood. The moisture content shall be within the limits specified in Table 3.31.

**Table 3.31** PERMISSIBLE MOISTURE CONTENT OF TIMBER FOR DIFFERENT USES

| Sl. No | Use | Tolerance | Percentage |
|---|---|---|---|
| 1 | Beams and rafters | 20 | Average moisture content of all the samples in a given lot +3% and moisture content of individual samples +5% of the maximum permissible moisture content. These tolerance are the absolute values over the percentage moisture content |
| 2 | Doors and windows | | |
| | (a) 50 mm and above in thickness | 16 | |
| | (a) Thinner than 50 mm | 14 | |
| 3 | Furniture and cabinet making | 15 | No tolerance on moisture content is permitted |

No individual hard and sound knot shall be more than 25 mm in diameter and the aggregate area of all the live knots shall not exceed 1% of the area of the piece.

3.51 **Ballies: -** Ballies are thin round poles usually without bark. Ballies used for the general purpose shall conform to IS 3337. They shall be of hard wood and straight.

Unless otherwise specified, bark shall be completely removed and all the branches and excrescences shall be dressed down flush with the surface. The top and bottom ends shall be cut square. The diameter at the thin end shall not be less than 75 mm and at the thick end not less than 125 mm. The diameters shall be measured excluding the bark thickness.

Unless otherwise 'ordered', the Ballies shall confirm to the dimensions given below.

**Table 3.32** DIMENSIONS OF BALLIES

| Sl. No | Diameter at the top (cm) | Diameter at the butt end (cm) | Length (m) |
|---|---|---|---|
| 1 | Over 8.5 up to 12.5 | Over 15 up to 20 | 3 to 9 |
| 2 | Over 6.5 up to 8.5 | Over 11.5 up to 15 | 3 to 9 |
| 3 | Over 5 up to 6.5 | Over 7.5 up to 11.5 | 3 to 9 |

Ballies shall be air-dried to a moisture content not exceeding 20 % within a depth of 12 mm from the surface when measured at one-third length of the ballies from it butt ends. They shall be reasonably straight, and shall be free from cuts across the grain, live insect attack, any kind of decay (rot), pronounced spiral or twisted grain, hollow heart and dead knots exceeding 5 cm in diameter. The length shall be measured between the extreme ends of ballies. Ballies shall not be more than 7.5 cm shorter or more than 15 cm longer than the 'ordered' length. The top and butt end diameters shall be measured at the extreme ends of the ballies. Whenever required the entire ballies or the butt ends

up to the specified length shall be preserved by dipping, brushing or spraying with any one of the following compositions:

a) Creosote-fuel oil mixture 50:50,
b) 6 % solution of copper-chrome-arsenic composition,
c) 6 % of acid-cupric-chromate composition,
d) 8 % solution of copper-chrome-boric composition, and
e) 1.0 % solution of sodium pentachlorophenate.

3.52 **Plywood: -** Plywood for general purposes shall be of the following two grades, depending upon the bond strength developed by the adhesive used for bonding the veneers:

a) Boiling water resistant or BWR grade, and

b) Moisture resistant or MR grade.

They shall be classified into three types, namely, AA, AB and BB based on the quality of the two surfaces, namely, A and B in terms of general permissible defects. The type of plywood shall, therefore, be designated by the kind of surfaces of the panels. The better quality surface shall be called 'face', and the opposite side shall be called 'back'. If the face and the back are of the same quality, they are not distinguished. The type of plywood shall denote first the quality of face followed by the quality of back. For example, Type AA shall have both surfaces of quality A, Type AB shall have face of quality A and the back of quality B and Type BB shall have both surfaces of quality B.

The plywood may be manufactured from any species of timber and shall comply with the requirements of IS 303. The veneers for all the grades shall be either rotary cut or sliced. The veneers shall be sufficiently smooth to permit an even spread of adhesive. Treatment shall be given to the plywood either at the veneer stage or after converting the veneers into boards. The plywood boards shall be of uniform thickness within the tolerance limits. The faces of plywood boards shall be reasonably smooth and face veneers shall be of reasonably uniform thickness. Slight sanding may be given to rough boards in order to make them reasonably smooth.

3.52.1 *Teak ply 4 mm thick*: - The face veneers shall be of teakwood.

3.52.2 *Commercial Ply wood, 4 mm thick*: - It shall be a 3 ply board. The veneers for the ply wood shall either rotary out or sliced. The veneer shall be sufficiently smooth to permit even spread of glue. The thickness of all veneers shall be uniform within a tolerance of ± 5%, face veneers on either side of the centre one shall be of the same thickness and species. The veneers shall have been bonded with BWR (Boiling water proofing) type synthetic resin adhesive.

3.53 **Insulating Board: -** This shall be of approved quality and generally conform to IS 3348. It shall have square edges. For length and width a tolerance of ±3 mm on dimension of 120 cm and below and one of ±6 mm on dimensions above 120 cm is permissible. Thickness variation up to ± 0.75 mm is permissible on thickness of 9 and 12 mm and ±1.25 mm on thickness of 18 and 25 mm.

3.54 **Block board with one side commercial ply and other side teak ply: -** It is a board having a core made of strips of wood, each not exceeding 25 mm width, laid separately or glued or otherwise joined to form a slab which is glued between two or more outer veneers with the direction of the grain of the core blocks running at right angles to that of the adjacent veneers. The length of the majority of strips shall extend to the full length of

the board and joints are permissible provided the jointed strips are distributed between full length strips and the joints are staggered. In any one block board, the strips shall be of one species of timber only.

The block boards shall be grade I exterior grade type, bonded with BWR (Boiling Water Proofing) type synthetic resin glue. The face panel shall be formed by gluing by the hot-press process on both faces of the core either plywood or cross- bands and face veneers.

The thickness of the cross bands as such or in the plywood shall be between 1 mm and 3 mm. The thickness of the face veneer as such or in the plywood shall be between 0.5 mm and 1.5 mm for commercial veneers and between 0.5 mm and 1.0 mm for decorative veneers. The combined thickness of cross-bands and face veneer shall not be less than 2.5mm. The plywood conforming to these requirements shall be glued under pressure on both faces of the core. When the panel consists of cross- bands and face veneer glued separately, the cross-bands shall be laid with their grains at right angles to those of the core and glued to both faces. Face veneer shall then be laid with their grains at right angles to those of the cross-bands. Where it is described to have wooden strips in the block board core horizontal rather than vertical, this shall be permitted only if a 3-ply panel is pressed on either side of the core and the total is a 7-ply construction. Application of a decorative face veneer on a finished face panel having veneer in the same direction as proposed shall be avoided.

Tolerance on width and height of the board shall be ±3 mm tolerance on thickness shall be±1.2 mm. The thickness shall be uniform with a permissible variation of not more than 0.8 mm when measured at any two points. The thickness of the board shall be as specified.

3.55 **Low density particle boards**: - Low density particle boards having specific gravity not exceeding 0.4 shall confirm to IS 3129. The boards may be made of timber and other ligno-cellulose material like bagasse, solapith, jute sticks, rice husk, pea-nut shells, etc. These shall be light weight materials of bulk density preferably not exceeding 400 kg/$m^3$ and shall be free from extraneous matter and dust. The adhesive used for bonding particles together shall be BWR or BWP type conforming to IS 848: 1974. The adhesive shall be either a phenol-formaldehyde or Urea-Formaldehyde type fortified with melamine. Particle boards shall be manufactured from low density wood or other lingo-cellulose material by first milling or disintegrating the same into particles of predetermined sizes, drying the same in a mechanical drier to pre-determined moisture content between 7 and 12 % and grading the same according to size in a sifting machine. The graded particles of predetermined size and thickness are then thoroughly mixed with adhesive in a predetermined proportion between 6 to 10 % and formed into a mat and pressed under flattened type hot press at an appropriate pressure to pre-determined thickness and density not exceeding 400 kg/$m^3$.

A suitable preservative, sizing material and fire retardants may be added to the particle mix.

The sizes of the insulation particle boards shall be as given below:

**Length in mm** – 36500, 3000, 2700, 24700, 2100, 1800, 1500, 1200, 1000, 900, 600, 450 and 300

**Width in mm** – 1800, 1500, 1200, 1000, 900, 600, 450 and 300

The thickness of insulation particle boards in mm shall be as given below:

50, 45, 40, 35, 30, 27, 25, 22, 19, 16 and 12.

The permissible tolerances on the nominal sizes of finished boards shall be as follows:

**Table 3.33** PERMISSIBLE TOLERENCES ON DIMENSION OF LOW DENSITY PARTICLE BOARDS

| Dimension | Nominal size | Tolerances |
|---|---|---|
| Length | For all lengths | ± 8 mm |
| Width | For all widths | ± 8 mm |
| Thickness | Above 25 mm | ± 1 mm |
| | Up to and including 25 mm | ± 0.8 mm |

The surface of the board may be plain, embossed with design or perforated. It may be treated or coated with fire-retardant composition and should be able to take a coat of oil distemper or plastic emulsion paint.

3.56 **Medium density wood Particle boards**: - The medium density particle boards for general purposes, having specific gravity in the range 0.5 to 0.9 shall comply with the requirements of IS 3087. The particle board shall be of the following classes.

**Table 3.34** CLASS OF MEDIUM DENSITY WOOD PARTICLE BOARD

| Class | Type | Designation |
|---|---|---|
| Flat pressed, single layer | - | FPS |
| Flat pressed-three layer | 1 | FPT – 1 |
| Multilayer and graded | 2 | FPT – 2 |
| Extrusion pressed, solid | - | XPS |
| Extrusion pressed, tubular | - | XPT |

The flat pressed-three layer, multilayer and graded class shall be of two types, namely, Type 1 and Type 2; the grading is based on the physical and mechanical properties.

Wood particles for the manufacture of particle boards shall be produced by cutting wood and/or any other suitable lingo-cellulosic materials into shavings, flakes, splinters or slivers on a suitable chipping machine. The wood particles shall be dried in a mechanical drier. The dried particles shall be graded to required sizes and thoroughly blended with the requisite quantity of adhesives in mechanical mixers or applicators. The required sizing material may be added at this stage, either mixed with the binder or separately introduced into the mixer. Care shall be taken that the moisture content of the binder does not excessively increase the moisture content of the chips. The well-blended chips are then formed into a mat and pressed into panels by passing into the pressing machine under controlled heat pressure and time conditions. The hot pressed boards are subsequently cooled, conditioned to attain equilibrium moisture content and sanded on both sides to attain uniform thickness and finally trimmed and cut to standard sizes. In case of three-layer particle boards, the construction shall be well-balanced about the central plane. In case of single-layer particle board, the particles

shall be uniformly laid. Care shall be taken that no asymmetric grading of chips takes place.

The particle boards shall be of uniform thickness and uniform density throughout the length and width of the boards. All particle boards shall be flat. Both surfaces of the particle board shall be sanded to a smooth finish. The size of wood particle boards in mm shall be as given below:

**Length**: 4850 (4800), 3650 (3600), 3000, 2750 (2700), 2400, 2100, 1800, 1500, 1200, 1000, 900

**Width**: 1850, 1800, 1500, 1200, 1000, 900, 600 and 450

***Note*** – *Values which are underlined are multiples of the 300 mm module for building boards.*

The thickness of particle boards shall be as given below:

6, 9, 12, 15, 18, 19, 22, 25, 27, 30, 35 and 40 mm

The following tolerances on dimensions of finished boards shall be permissible:

**Table 3.35** TOLERANCES ON DIMENSIONS OF MEDIUM DENSITY WOOD PARTICLE BOARD

| Sl. No | Dimensions | Tolerances |
|---|---|---|
| a) | Length – for all lengths | ± 8 mm |
| b) | Width – for all widths | ± 8 mm |
| c) | Thickness – above 25 mm | ± 2.5 mm |
| | Up to and including 25 mm | ± 5 mm |

The lengths of the two diagonals of a wood particle board, rectangular panel, shall not differ by more than 2.5 mm maximum. The edges of the board shall be straight with a tolerance of 3 mm.

The particle board shall not crack or split when drilled, sawed and nailed perpendicular to the surface.

3.57 **High density wood particle boards**: - High density wood particle board in a flat sheet or moulded forms shall conform to IS 3478. They shall be manufactured by converting the specified timbers into suitable wood particles; seasoning the same to a moisture content not exceeding 8 percent blending thoroughly with requisite quantity of the specified adhesive and sizing material and then felting into the required thickness and form and pressing in a hot press under high pressure usually of the order of 1 kg/mm$^2$ to 2 kg/mm$^2$ under controlled conditions of heat, pressure and pressing time. In moulded particle boards the resin mixed chips shall be pressed in suitable moulds to the required shape under controlled conditions of heat, pressure and moulding time.

3.58 **Veneered particle boards**: - Veneered particle boards shall be of two grades, namely, exterior (Grade I) or interior (Grade II). Each grade shall of the following four types:

a) Type 1, Veneered particle board, solid core, general purpose – These are veneered particle boards with faces of veneer of general purpose type.

b) Type 2, veneered particle board, solid core, decorative – these are veneered particle boards with solid core but faced on one side or on both sides with ornamental veneers.

c) Type 3, Veneered particle board, tubular core, general purpose – These are veneered particle boards with tubular core and faced with veneer of general purpose type.

d) Type 4, Veneered particle board, tubular core, decorative – These are veneered particle boards with tubular cores faced with decorative veneers on one or both sides.

Particle boards used for the core of veneered particle board shall be of medium density conforming to IS 3087. Veneers used for cross-brand and faces shall be either sawn or rotary cut or sliced and shall sufficiently smoothed to permit even spread of glue. Timbers for face veneers of commercial type of veneered particle boards, interior grade (Grade II), and for cross-bands where used, in all types and grades shall be Class I or Class II of IS 303. Timbers for face veneers for commercial type of veneered particle boards, exterior grade (Grade I), shall be of Class I only of IS 303. Timbers for face veneers for decorative types of veneered particle boards shall be as specified for face veneers in IS 1328. Face veneers for commercial types of veneered particle boards shall be of Type A or Type B and for cross-band veneers shall be Type C or Type D as specified in Table 1 of IS 303. Face veneers for decorative type veneered particle boards shall be of qualities suitable for Grade I veneered decorative plywood covered in IS 1328. The adhesives used for bonding veneers shall be BWP or BWR conforming to IS 848 for exterior grade (Grade I) veneered particle boards and WWR or CWR conforming to IS 848 for interior grade (Grade II) veneered particle board.

The construction of Cross-Bands and Veneers shall be well-balanced around the central line. When only one side is provided with a decorative face the back face shall be so designed with material and thickness as to balance the stress likely to be developed in the face veneers.

Cross-band, where used, shall neither be less than 1.0 mm nor more than 3.0 mm in thickness. Face veneers shall be between 0.5 mm and 1.6 mm in thickness for commercial veneers and 0.5 mm to 1.0 mm in thickness for decorative veneers. The veneers shall be of uniform thickness within a tolerance of ± 5 percent. The decorative veneers shall be spliced or taped at the edges. The joining of veneers shall be such as to develop a decorative match to obtain the required match in figure on the spliced or taped veneers. The veneers may have end-grain joints in cases of special matching like centre-matching, V-matching, etc. Cross-bands, where used, shall be laid in such a manner that there are no gaps exceeding 0.8 mm and no overlaps. The cross-bands shall be free from dry rot and dead knots. The veneers used shall have moisture content not exceeding 14 percent and the veneered particle board after pressing shall be conditioned to a moisture content not less than 5 % and not more than 15 %. The face veneers in case of veneered particle boards of the extrusion press type shall have their grain direction parallel to the direction of extrusion, that is, at right angles to the bulk orientation of the grains of the particles except in cases of 5 ply veneered particle boards in which case there need not be any distinction in this respect. In case of 5 ply veneered particle boards, the face veneers shall be made with its grain direction at right angles to the grain direction of the cross-bands. In all cases, the grains on both the faces of the assembled board shall run in the same direction. Veneered particle boards shall be made either by glueing particle boards between the veneer or, alternatively, between

two sheets of plywood, but the total thickness of the skin of either side shall not exceed 5 mm. The thickness of the two skins shall be equal and uniform if the same species is used and no other provision is made for balanced construction. The adhesive used for either glueing the skin or glueing the plywood shall conform to 4.3 for the various grades. Lipping, where provided, shall be internal when it shall have a total depth not less than 22 mm and thickness same as the thickness of the particle board core and shall be made out of well-seasoned timber battens of species of Class I or II as specified in IS 16590. The lipping may also be, if so agreed to by the purchaser, of suitable veneer glued on to the edges by use of a suitable adhesive.

All veneered particle boards shall be flat and squarely cut, and shall be uniform in thickness within the tolerance limits specified. Both faces of veneered particle boards shall be sanded to a smooth even surface.

The dimensions of veneered particle boards shall be quoted in the following order:

The first dimensions shall represent the length, that is, the dimension parallel to the grain of the faces, second the width and the third the thickness.

The standard thickness of veneered particle boards shall be the following:

6,10,12,20.25,30,35,40,45 and 50 mm

The standard size of veneered particle boards shall be as follows:

a) Length - 480, 365, 300, 270, 240, 210, 180, 150, 120, 100 and 90 cm; and
b) Width - 180, 150, 120, 100, 90 and 45 cm.

The tolerances in length and width of finished board above 150 cm shall be ± 10 mm and up to 150 cm shall be ± 5 mm. The tolerance in thickness of all sizes shall be ± 1 mm.

The length of the two diagonals of a veneered particle board shall not differ by more than 2.5 mm. The edges of the veneered particle board shall be straight with a maximum deviation of 3 mm.

3.59 **Prelaminated particle boards**: - A prelaminated particle board is a particle board laminated on both surfaces by synthetic resin impregnated base papers under the influent of heat and pressure or with finished foils under the influence of pressure or pressure and heat depending upon the type of binder used. They shall be of two grades, namely, Grade I and II corresponding to IS: 3087. Each grade shall be of three types, namely, Types I, II and III classified by the surface abrasion characteristics. They shall be made from particle boards having a superfine and closed surface with high face strength and steep density gradient across the thickness. They shall conform to IS 12823. The finish of the paper overlaid board depends on the surface of caul plates used. Common surface finishes in use are glossy, matt textured (soft, swede, wood pore and leather), etc. The surface finish of the foil finished boards depends on the original finish of the foil used.

3.60 **Plain Gypsum plaster boards**: - They shall conform to IS 2095 (Part 1). Gypsum plaster used for its manufacture shall conform to IS 2547 (Part 1). Gypsum plaster boards consist of a gypsum plaster core with or without fibre encased in and firmly bonded to strong durable paper liners to form rectangular boards. Core shall be dried across full width. The face and back papers shall be securely bonded to the core. The paper surfaces may vary according to the use of the particular type of board, and the core may contain additives to impart additional properties. The longitudinal edges are paper

covered and profiled to suit the application. The paper covered edges of gypsum wall boards are square, tapered, bevelled or rounded. The paper covered edges of the gypsum baseboard are square or rounded. Other profiles may be produced for special purposes. The ends of the gypsum plaster board are square-cut.

The width, length and thickness of the boards shall be as given in Table 3.36. The lengths of the two longitudinals of the boards shall not differ more than ± 3 mm per meter length of the diagonal.

**Table 3.36** DIMENSIONS OF PLAIN GYPSUM PLASTER BOARDS

| Types of board | Width (mm) | Length (mm) | Thickness (mm) |
|---|---|---|---|
| Wallboard | 600, 900 and 1200 | 1800 to 3600 in steps of 100 | 9.5, 12.5, 15, 19, 23 and 25 |
| Baseboard | 400 and 900 | 1200, 1500 and 1800 | 9.5 and 12.5 |

The tolerance on dimensions shall be as given below:

**Table 3.37** THE TOLERANCE ON DIMENSIONS

| Types of board | Width (mm) | Length (mm) | Thickness (mm) |
|---|---|---|---|
| Gypsum wallboard | 0 - 5 | 0 - 6 | ± 0.6 |
| Gypsum baseboard | | | |
| a) Non - perforated | 0 - 8 | 0 - 6 | ± 0.6 |
| b) Perforated | 0 - 8 | 0 -16 | ± 0.6 |

The minimum quantity of mass of plaster per m2 of board of 12 mm thickness shall not be less than 9 kg. The surfaces of the boards shall be true and free from imperfections that would render the boards unfit for use with or without decoration.

3.61 **Reinforced Gypsum plaster boards**: - They shall conform to IS 2095 (Part 3). Fibrous Gypsum Plaster Board is a composition of gypsum plaster and sisal, coconut, jute or other fibre forming body of regular dimensions. Glass Reinforced Gypsum Boards is made of gypsum plaster and glass fibre forming a body of regular dimensions. The boards shall be square or rectangular in shape.

Length, width and thickness of the board; the minimum mass of plaster per square meter of board; and the minimum density of board shall be as per the value specified in the Table 3.38.

**Table 3.38** DIMENSIONS AND OTHER PARTICULARS OF FIBROUS GYPSUM PLASTER BOARD AND GRC BOARD

| Board | Thickness, T (mm) | Length, L (mm) | Width, W (mm) | Mass of plaster per $m^2$ of board (kg) min. | Density ($kg/m^3$) min. |
|---|---|---|---|---|---|
| Fibrous Gypsum Plaster | 12 | 1200 | 400 | 10 | 834 |
| | | 1500 | 600 | | |
| | | 1800 | 900 | | |
| | | | 1200 | | |
| Board GRG Board | 4 | 2000 | 1000 | 4.10 | 2500 |
| | 6 | 3000 | 1200 | 6.15 | |
| | 8 | | | 8.20 | |
| | 10 | | | 10.25 | |
| | 12 | | | 12.30 | |

Tolerances shall be as given below:

a) Length + 0 mm
- 6

b) Width + 0 mm
- 5

c) Thickness ± 1.0 mm

The surface of the boards shall be true and free from imperfection that would render the board unfit for uses. The edge shall be straight and the corners shall be square.

3.62 **Timber panelled and glazed shutters: -** This shall comply with the requirements given in IS 1003 (Part1). Timber suitable for manufacture of door shutters shall be in accordance with IS 12896. Each class of species stands on the same footing functionally (irrespective of cost). Timber used for rails and stiles shall be of the same species. All the panels where they are of solid wood shall be of one species, which may or may not be of the same species as that of rails and stiles. Timber panelled shutters shall be constructed in the form of timber framework of stiles and rails with panel inserts of timber, plywood, blockboard, veneered particle board, asbestos cement sheets, wire gauge or glass. The panels shall be fixed by either providing grooves in the stiles and rails or beading or both. The stiles, top rails and lock rails shall be joined to each other by mortice and tenon joints.

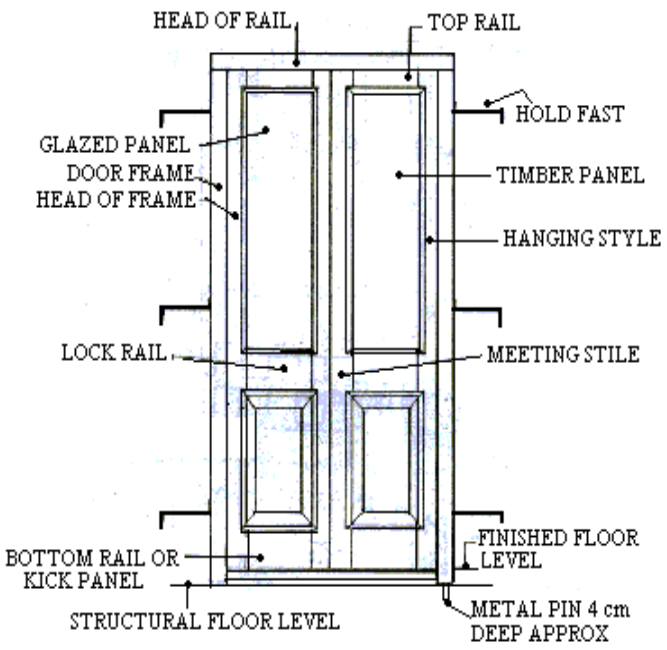



**Figure 3.5** TYPICAL ILLUSTRATION OF DOUBLE PANELLED DOOR WITH TIMBER AND GLAZED PANELS

All members of the door shutters shall be straight, smooth and well planed faces at right angles to each other. Any warp or bow shall not exceed 1.5 mm. The right angle for the shutters shall be checked by measuring the two diagonals from one extreme corner to the opposite one and the difference between the two diagonals shall not be more than 3 mm.

3.62.1 *Timber panelling*: - Timber panels shall be preferably made of timber of large width; the minimum width and thickness of a panel shall be 100 mm and 15 mm respectively. When made from more than one piece, the pieces shall be jointed with a tongued and grooved joint, depth of joint extending to one-third of thickness of panel and the thickness of joint also to one-third of panel. The grains of timber panels shall run along the longer dimensions of the panels. The panels shall be designed such that no single panel exceeds 0.5 $mm^2$ in area.

3.62.2 *Plywood Panelling***: -** Each plywood panel shall be of one piece of not less than 9 mm thickness for 2 or more panel construction and 12 mm thickness for single panel construction. There shall be no restriction on the size of the panel.

3.62.3 *Blockboard Panelling*: - Each blockboard panel shall be of one piece of thickness 12 mm or more and there shall be no restriction on the size of panel.

3.62.4 *Particle Board Panelling*: - Panels shall be made of one piece of veneered particle board. The thickness of particle boards used shall not be less than 12 mm.

3.62.5 Wire gauge Panelling: - Wire gauge panel shall be so designed that no single panel exceeds 0.5 sq. mm in area.

3.62.6 *Asbestos cement Panelling*: - Asbestos cement sheets for panelling shall consist of two or more panels. Thickness of each panel shall not be less than 6 mm.

Sizes and types of timber panelled and glazed shutters shall generally conform to specification given in IS 1003 (Part 1).

All door shutters shall be sanded and finished smooth. Panels of shutters shall be flat and well sanded to a smooth and level surface. All surfaces of the door shutters which are required to be painted or polished or varnished ultimately shall be covered initially before delivery by protective coat of primer polish or varnish as specified in IS: 2338 (Part 1) and IS: 2338 (Part 2). The glass used for panels shall be of good and durable quality, weighing not less than 10 kg/sq. m and thickness shall not be less than 4 mm. The particular type, quality and shade shall be as agreed between the purchaser and the supplier.

3.63 **Bamboo: -** They shall be reasonably straight and the diameter specified under the item shall be the minimum diameter.

3.64 **Firewood**: - This shall be of the variety as approved by the Engineer.

3.65 **Distemper: -**

3.65.1 *Dry Distemper*: - Dry distemper shall be of approved brand and manufacture. The shade shall be approved by the Engineer before application of the distemper. It shall conform to IS 427.

3.65.2 *Acrylic Distemper*: - Acrylic washable distemper shall be of approved brand and manufacture. The shade of the oil bound distemper shall be approved by the Engineer before application. It shall conform to IS 428.

3.66 **Primer: -**

3.66.1 *Cement Primer*: - The cement primer shall be composed of a medium and pigment which are resistant to the alkalis present in cement, lime or lime cement in wall finish and should provide a barrier for the protection of subsequent coats of oil bound distemper or paints. Cement primer shall be of approved brand and manufacture.

3.66.2 *Distemper primer*: - Ground white chalk (whiting) shall be used for preparing distemper primer. Whiting shall be dissolved in sufficient quantity of warm water and thoroughly stirred to form a thin slurry which shall be screened through a clean coarse cloth. Two kg. of gum and 0.4 kg. of copper sulphate dissolved separately in hot water shall be added for every cum. of the slurry which shall then be diluted with water to the consistency of milk so as to make a wash ready for use. Rate of distemper primer shall include cost of all materials and labour involved in above operations. The unit of measurement shall, however, be one kg. of whiting.

3.66.3 *Ready mixed pink primer*: - It shall be of approved brand and manufacture. It may be a pink primer conforming to IS 3536 or aluminium primer.

3.66.4 *Synthetic red oxide primer*: - It shall be of approved brand and manufacture.

3.66.5 *Zinc Chromate Primer*: - This shall generally conform to IS 2074 and shall be of approved brand and manufacture.

3.67 **Paints: -**

3.67.1 *Aluminium paint*: - Aluminium paint shall be (conforming to IS 2339) of reputed brand and manufacture. The paint comes in compact dual containers with the paste and the medium separately. The two shall be mixed together to proper consistency before use.

3.67.2 *Black Japan paint*: - Black Japan paint shall conform to IS 2335. The paint shall be of reputed brand and manufacture.

3.67.3 *Red corrugal paint*: - It shall be superior quality ready mixed paint, suitable for painting over GI sheets, of reputed brand and manufacture.

3.66.4 *Synthetic enamel paint*: - Synthetic enamel paint shall conform to IS 1932 and shall be of reputed brand and manufacture and of the required colour.

3.67.5 *Water proofing cement paint*: - The water proof cement paint shall conform to IS 5410 and shall be of reputed brand and manufacture.

3.67.6 *Vinyl Plastic Emulsion Paint*: - This shall be of reputed brand and manufacture, and of the required shade as approved by the Engineer. The paint shall conform to the requirements of IS 5411.

3.68 **Oil type wood preservative: -** Oil type wood preservative shall be of specified quality and reputed make, conforming to IS 218. Generally it shall be creosote oil type-I or anthracene oil.

3.69 **Putty: -** Glazier's putty shall be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 litre of varnish to 18 Kg. of paste.

*Wood putty shall be prepared as follows*: - On a piece of wood say 20 x 15 cm. face and on the side where cross grains appear, a small quantity of glue size shall be poured and the surface scraped with the edge of a fine carpenter's chisel. Very fine wood powder shall be mixed with the glue to form a stiff paste.

3.70 **Animal glue**: - Animal glue for general wood-working purposes shall comply with the requirements given in IS 852. The glue shall be prepared from skin or bone material. It shall be supplied in the form of sheets, cakes, granules, pearls, flakes or powder, or in a kibbled form, as specified by the purchaser. The odour of a freshly prepared hot solution of the glue shall not be objectionable. Animal glue used for Traditional Bhutanese painting shall also conform to requirements given in IS 852.

**II. Sanitary Installation, Water Supply and Drainage**

3.71 **GI Pipe & Pipe fittings: -**

3.71.1 *G.I Pipe*: - The pipes (tubes) shall be galvanized mild steel hot finished seamless (HFS) or welded (ERW) screwed and socketed conforming to the requirements of IS 1239 (Part. I) for medium grade. These shall be of the diameter (nominal bore) specified in the description of the item. Galvanizing shall conform to IS 4736. The zinc coating shall be uniform, adherent, reasonably smooth and free from imperfections such as flux, ash and dress inclusions, bare patches, black spots, pin holes, lumpings, runs, rust stains, bulky white deposits and blisters. The pipes and sockets shall be cleanly finished, well galvanized in and out free from cracks, surface flaws, laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.

All screwed tubes sockets shall have pipe threads conforming to the requirements of IS 554. Screwed tubes shall have taper threads while the sockets shall have parallel threads. All tubes shall withstand a test pressure of 50 kg/cm$^2$ without showing defects of any kind. The fittings shall be of mild steel tubular or wrought steel fittings conforming to IS 1239 (Part II). The fittings and sockets shall be designated by the respective nominal bores of the pipes for which these are intended.

The details of pipes and sockets shall be as per Table 3.39.

**Table 3.39** PARTICULARS OF MEDIUM GRADE G.I. PIPES

| Nominal bore (mm) | Dimensions of pipes | | | Dimensions of Ord. sockets | | Weight of pipe (plain end) (kg/m) |
|---|---|---|---|---|---|---|
| | Outside diameter | | Thickness | Approx. OD (mm) | Min. length (mm) | |
| | Max. (mm) | Min. (mm) | (mm) | | | |
| 15 | 21.8 | 21.0 | 2.65 | 26.90 | 34 | 1.22 |
| 20 | 27.3 | 26.5 | 2.65 | 33.70 | 36 | 1.58 |
| 25 | 34.2 | 33.3 | 3.25 | 42.60 | 43 | 2.44 |
| 32 | 42.9 | 42.0 | 3.25 | 51.00 | 48 | 3.14 |
| 40 | 48.8 | 47.9 | 3.25 | 57.00 | 48 | 3.61 |
| 50 | 60.8 | 59.7 | 3.65 | 70.00 | 56 | 5.10 |
| 65 | 76.6 | 75.3 | 3.65 | 88.90 | 65 | 6.51 |
| 80 | 89.5 | 88.0 | 4.05 | 101.60 | 71 | 8.47 |

Tolerance on Thickness and Weight

(a) Thickness

1. Medium tubes Butt welded — + not limited, - 10 percent.
2. Medium tubes Seamless — + not limited, - 12.5 percent.

(b) Weight

1. Single tube (irrespective of quantity) — + 10 percent, - 8 percent
2. For quantities of less than 150 m of one size. — + 10 percent, - 8 percent
3. For quantities of 150 m and over of one size. — + 4 percent

3.71.2 *G.I Union*: - The G.I. union shall conform to IS 1239 (part.II). The size shall be as specified.

3.72 **Ductile Iron Pipe and Pipe Fittings:**

3.72.1 **DI Pipe**: These pipes shall be of good quality metal conforming to the requirements of IS 8329:2000. These shall be of the diameter specified (nominal size) as specified in the description of the item.

These pipes are classified as K7, K8, K9, K10, K12. depending on service conditions and manufacturing process.

The standard working length of socket and spigot pipes shall be 4m, 5m, 5.5m and 6m, and for flanged pipes shall be 4m, 5m and 5.5m. The nominal values of the internal diameters of centrifugally cast pipes expressed in mm are approximately equal to the numbers indicating their nominal sizes, DN. The nominal wall thickness of pipes shall be found as a function of DN as given by:

$$e = K(0.5 + 0.001DN) \quad \text{----------(a)}$$

with a minimum of 5 mm for K7, 6mm for K8, 7mm for K12. The dimensions of the DI pipes are given in the table below:

**Table 3.40** DIMENSIONS OF DI PIPES

| Nominal Diameter, DN (mm) | External Diameter, DE (mm) | Barrel Wall Thickness "e" in mm | |
|---|---|---|---|
| | | K7 | K9 |
| 80 | 98 | 5.0 | 6.0 |
| 100 | 118 | 5.0 | 6.0 |
| 125 | 144 | 5.0 | 6.0 |
| 150 | 170 | 5.0 | 6.0 |
| 200 | 222 | 5.0 | 6.3 |
| 250 | 274 | 5.3 | 6.8 |
| 300 | 326 | 5.6 | 7.2 |

DI pipes designed for water intended for human consumption, DI pipes and their joints shall not have any detrimental effects on the properties of the water for its intended use.

Tolerance on external diameter:

The tolerances on the values of the external diameter (DE) of DI pipes when measured circumferentially using a diameter tape shall not exceed the values given in the table below.

**Table 3.41** TOLERANCES ON DIMENSIONS OF DI PIPES

| DN | Nominal | Tolerance |
|---|---|---|
| 80 | 98 | +1,-2.2 |
| 100 | 118 | +1,-2.8 |
| 125 | 144 | +1,-2.8 |
| 150 | 170 | +1, -2.9 |
| 200 | 222 | +1,-3 |
| 250 | 274 | +1, -3.1 |
| 300 | 326 | +1, -3.3 |

The negative tolerances of the external diameter depend on the design of each type of joint and the values stated below are the maximum allowed. For interchangeability, all pipes should be within the tolerances specified.

Tolerance on Ovality: All pipes should be as far as possible circular internally and externally. The tolerance for out of roundness of the socket and spigot ends in the jointing zone for push-on-joint and for mechanical joint is given below:

**Table 3.42** TOLERANCES ON OVALITY OF DI PIPES

| Nominal Diameter mm | Allowable difference between minor axis and DE, min. : - Push- on- Joint pipes in mm | Maximum Ovality of the External Diameter, DE: - Mechanical Joint Pipe, mm |
|---|---|---|
| 80 | 1.0 | 5 |
| 100 | 1.0 | 5 |
| 125 | 1.0 | 5 |
| 150 | 1.0 | 5 |
| 200 | 1.0 | 10 |
| 250 | 1.0 | 10 |
| 300 | 1.0 | 10 |

Tolerance on thickness: The tolerance on wall thickness (e) and the flange thickness (b) of the pipes shall be as follows:

**Table 3.43** TOLERANCES ON THICKNESS OF DI PIPES

| Dimensions | Tolerance, mm |
|---|---|
| 1. Wall thickness (e) | -(1.3 + 0.001DN) |
| 2.Flange thickness(b) | ± (2 +0.05b) |

The tolerance on e is subject to minimum thickness against classes K7,K8 and K12 given in equation (a) above.

Tolerance on length: The tolerance on length of pipes shall be as follows:

**Table 3.44** TOLERANCES ON LENGTH OF DI PIPES

| Types of casting | Tolerance, mm |
|---|---|
| 1) Socket and Spigot and plain ended pipe | ± 100 |
| 2) Flanged pipes | ± 10 |

Permissible deviation from a straight line: The pipes should be reasonably straight. When the pipe is rolled along gantries, separated by distance approximately two thirds the length of the pipe to be checked, the maximum deviation from a straight line in mm shall not be greater than 1.25 times the length L, in meters of the pipe.

Tolerance on the various dimensions of flanges shall be as per IS 8329:2000.

DI pipes shall be delivered externally and internally coated. External coating of the pipes should be either metallic zinc with finishing layer or zinc rich paint with finishing layer or bituminous paint or using external sleeving. The internal lining must be either of Portland cement (with or without additive) mortar or blast furnace slag mortar or high alumina (calcium aluminate) cement mortar or cement mortar with seal coat or bituminous paint depending on the internal conditions of use. Further details can be obtained as per IS 8329: 2000.

3.72.2 **DI pipe fittings:**

The fittings to be used must be of the diameter specified in the specifications. The DI pipe fittings must conform to IS 9523:2000. The external and internal coating should be similar to the DI pipes as explained above.

3.73 **HDPE Pipe & Pipe fittings: -**

3.73.1 *HDPE Pipes for Sewerage:* - The pipes shall confirm to IS 14333:1996. It shall be designated according to the pressure rating given below:

**Table 3.45** PRESSURE RATINGS OF HDPE PIPES AND FITTINGS

| Pressure rating of pipes | Maximum permissible working pressure(Mpa) |
|---|---|
| PN 2.5 | 0.25 |
| PN 4 | 0.40 |
| PN 6 | 0.60 |
| PN 8 | 0.80 |
| PN 10 | 1.00 |
| PN 12.5 | 1.25 |
| PN 16 | 1.60 |

The nominal diameter of pipes shall be:

*63,75, 90,110,125,140,160,180, 200, 225, 250,280, 315, 355, 400, 450, 500, 560 and 630mm.*

The colour of the pipes shall be black. The HDPE used for the manufacture of pipes shall conform to designation PEEWA-45-T-066 of IS 7328.

The outside diameters of pipes, tolerance on the same and ovality of pipes shall be as given in Table 3.46.

**Table 3.46** OUTSIDE DIAMETER, TOLERANCE AND OVALITY OF PIPES

| Nominal diameter, DN (mm) | Outside diameter, DE (mm) | Tolerance (mm), Only +ve tolerance | Ovality (mm) |
|---|---|---|---|
| 63 | 63 | 0.6 | 1.5 |
| 75 | 75 | 0.7 | 1.6 |
| 90 | 90 | 0.9 | 1.8 |

| | | | |
|---|---|---|---|
| 110 | 110 | 1.0 | 2.2 |
| 125 | 125 | 1.2 | 2.5 |
| 140 | 140 | 1.3 | 2.8 |
| 160 | 160 | 1.5 | 3.2 |
| 180 | 180 | 1.7 | 3.6 |
| 200 | 200 | 1.8 | 4.0 |
| 225 | 225 | 2.1 | 4.5 |
| 250 | 250 | 2.3 | 5.0 |
| 280 | 280 | 2.6 | 9.8 |
| 315 | 315 | 2.9 | 11.1 |
| 355 | 355 | 3.2 | 12.5 |
| 400 | 400 | 3.6 | 14.0 |
| 450 | 450 | 4.1 | 15.6 |
| 500 | 500 | 4.5 | 17.5 |
| 560 | 560 | 5.0 | 19.6 |
| 630 | 630 | 5.7 | 22.1 |

The outside diameter of the pipe shall be taken as the average of two measurements taken at right angles for pipes up to 110 mm diameter. Alternatively and for higher sizes, the diameter shall be measured preferably by using a flexible P tape or a circometer, having an accuracy of not less than 0.1 mm.

The length of the straight pipe shall be 5m to 20m. Short lengths of 3m (minimum) up to a maximum of 10 % of the total supply may be permitted.

The pipes supplied in coils shall be coiled on drums of minimum diameter of 25 times the nominal diameter of the pipe ensuring that kinking of pipe is prevented.

The internal and external surfaces of the pipes shall be smooth, clean and free from grooving and other defects. The ends shall be clearly cut and shall be square with the axis of the pipes. Each straight length of pipes shall be clearly marked in indelible ink/paint with Manufacturers name/Trade Mark, Designation of pipe and Lot number/Batch Number.

Each pipe may also be marked with the Standard Mark.

*3.73.2 HDPE pipes for water supply as per IS 4984*: - Pipes shall be designated according to the material grade, pressure rating and nominal diameter. Pipes shall be classified by pressure rating (PN) corresponding to the maximum permissible working pressure at 30°C, as per table 3.43.
The nominal diameter of pipes shall be 16, 20, 25, 32, 40, 50, 63, 75, 90, 110, 125, 140, 160, 180, 200, 225, 250, 280, 315, 355, 400, 450, 500, 560, 630, 710, 800, 900 and 1000 mm.

The colour of the pipes shall be black.

The outside diameters of pipes, tolerance on the same and ovality of the pipe shall be as given in Table 3.45 conforming to IS: 4984.

The length of the straight pipe shall be 5m to 20m. Short lengths of 3m (Minimum) up to a maximum of 10% of the total supply may be permitted. The pipes supplied in coils shall be coiled on drums of minimum diameter of 25 times the nominal diameter of the pipe ensuring that kinking of pipe is prevented. The internal and external surfaces of the pipes shall be smooth, clean and free from grooving and other defects.

Each straight length of pipe shall be clearly marked in indelible ink/paint with Manufacturer's name/Trade Mark, Designation of pipe and Lot number/Batch number.

3.73.3 *Fabricated HDPE fittings for potable water supplies*: - These shall conform to IS 8360 (Part 1). The pipe used for the fabrication of HDPE fittings for potable water supplies shall conform to IS 4984. The sizes of the fittings shall be designated by their outside diameter at the free end. The outside diameters and corresponding wall thickness of fittings at the free ends for weld shall comply with those given in Table 3.47. A fitting duly plugged, when subjected to a hydraulic proof test of twice the recommended working pressure at ambient temperature and for a period of one hour shall not show any sign of localized swelling, leakage or weeping, and shall not burst during the prescribed test duration.

**Table 3.47** OUTSIDE DIAMETER, TOLERANCE AND OVALITY OF PIPES

| Nominal diameter, DN (mm) | Outside diameter, DE (mm) | Tolerance (mm), Only +ve tolerance | Ovality (mm) |
|---|---|---|---|
| 16 | 16.0 | 0.3 | 1.2 |
| 20 | 20.0 | 0.3 | 1.2 |
| 25 | 25.0 | 0.3 | 1.2 |
| 32 | 32.0 | 0.3 | 1.3 |
| 40 | 40.0 | 0.4 | 1.4 |
| 50 | 50.0 | 0.5 | 1.4 |
| 63 | 63.0 | 0.6 | 1.5 |
| 75 | 75.0 | 0.7 | 1.6 |
| 90 | 90.0 | 0.9 | 1.8 |
| 110 | 110.0 | 1.0 | 2.2 |
| 125 | 125.0 | 1.2 | 2.5 |
| 140 | 140.0 | 1.3 | 2.8 |
| 160 | 160.0 | 1.5 | 3.2 |
| 180 | 180.0 | 1.7 | 3.6 |
| 200 | 200.0 | 1.8 | 4.0 |
| 225 | 225.0 | 2.1 | 4.5 |

| | | | |
|---|---|---|---|
| 250 | 250.0 | 2.3 | 5.0 |
| 280 | 280.0 | 2.6 | 9.8 |
| 315 | 315.0 | 2.9 | 11.1 |
| 355 | 355.0 | 3.2 | 12.5 |
| 400 | 400.0 | 3.6 | 14.0 |
| 450 | 450.0 | 4.1 | 15.6 |
| 500 | 500.0 | 4.5 | 17.5 |

3.73.4 *Injection moulded HDPE fittings for potable water supplies*: - The fittings shall conform to IS 8008 (Part 1). It shall be moulded from a compound consisting of virgin polyethylene in which carbon black and a suitable non-toxic anti-oxidant are evenly dispersed. The addition of not more than 10 percent of the manufacturer's own rework material resulting from the manufacture of fittings to the standard IS 8008 (Part 1) is permissible. The sizes of the fittings shall be designated by their outside diameters at the free ends. The outside diameters and corresponding wall thickness of fittings at the free ends for weld shall comply with IS 4984.

*3.73.5 HDPE Pipes for Water Supply as per ISO 4427-2*

HDPE pipes for potable water supply, raw water conveyance and pressure drainage applications shall conform to ISO 4427-2:2019. The pipes shall be manufactured from polyethylene compounds designated as PE 80 or PE 100 suitable for potable water applications.

The pipes shall be designated according to:

- Material grade (PE 80 / PE 100),
- Nominal outside diameter (dn),
- Standard Dimension Ratio (SDR), and
- Pressure rating (PN).

The pipes shall be classified by pressure rating corresponding to the maximum allowable operating pressure. Pressure ratings shall correspond to the applicable PE material grade and SDR classification in accordance with ISO 4427-2.

**Table 3.48** Pressure Ratings of HDPE Pipes and Fittings *(As per ISO 4427-2:2019)*

| **Pressure Rating** | **Maximum Allowable Operating Pressure (MPa)** |
|---|---|
| PN 4 | 0.40 |
| PN 5 | 0.50 |
| PN 6.3 | 0.63 |
| PN 8 | 0.80 |
| PN 10 | 1.00 |

| | |
|---|---|
| PN 12.5 | 1.25 |
| PN 16 | 1.60 |
| PN 20 | 2.00 |
| PN 25 | 2.50 |

The nominal diameters of pipes shall be:
16, 20, 25, 32, 40, 50, 63, 75, 90, 110, 125, 140, 160, 180, 200, 225, 250, 280, 315, 355, 400, 450, 500, 560, 630, 710, 800, 900 and 1000 mm.

The colour of pipes for potable water supply shall be black with blue stripes or fully blue.

The outside diameters, tolerances and out-of-roundness (ovality) of pipes shall conform to Table 3.47 and ISO 4427-2.

The length of straight pipes shall generally be between 5 m and 20 m. Short lengths of minimum 3 m may be supplied up to a maximum of 10% of the total supply quantity. Pipes supplied in coils shall be coiled on drums of sufficient diameter to prevent kinking or deformation of pipes.

The internal and external surfaces of pipes shall be smooth, clean and free from scoring, cavities, blisters, cracks, inclusions and other defects detrimental to performance.

Each straight length of pipe shall be clearly and permanently marked at regular intervals with:

- Manufacturer's name or trademark,
- Material designation,
- Nominal diameter,
- SDR and pressure rating,
- Batch or lot number,
- Date of manufacture, and
- Reference to ISO 4427-2.

Pipes shall be suitable for butt fusion, electrofusion or mechanical jointing systems conforming to ISO 4427 requirements.

*3.73.6 Fabricated HDPE Fittings for Potable Water Supply as per ISO 4427-3*

Fabricated HDPE fittings for potable water supply shall conform to ISO 4427-3:2019.

The pipe used for fabrication of fittings shall conform to ISO 4427-2. The fittings shall be designated by their nominal outside diameter and SDR classification.

The outside diameters and corresponding wall thicknesses of fittings at the fusion ends shall comply with the dimensions specified in ISO 4427-2.

The fabricated fittings shall be homogeneous and free from cracks, voids, sharp edges, inclusions and other defects adversely affecting performance.

A fitting, when subjected to hydrostatic pressure testing in accordance with ISO 4427 requirements, shall not show any sign of leakage, sweating, localized swelling or bursting during the specified test period.

*3.73.7 Injection Moulded HDPE Fittings for Potable Water Supply as per ISO 4427-3*

Injection moulded HDPE fittings for potable water supply shall conform to ISO 4427-3:2019.

The fittings shall be moulded from virgin polyethylene compound suitable for potable water applications, with uniformly dispersed carbon black and approved antioxidants. The use of manufacturer's own clean rework material generated during production may be permitted provided the finished fittings fully comply with ISO 4427 requirements.

The fittings shall be designated by their nominal outside diameter and SDR rating.

The dimensions, tolerances and wall thicknesses at the fusion ends shall comply with ISO 4427-2 requirements for matching pipes.

The fittings shall be suitable for butt fusion, electrofusion or mechanical jointing systems as specified for the pipeline installation.

**Table 3.49** Mean Outside Diameters and Out-of-Roundness of Pipes ***(As per ISO 4427-2:2019)***

| Nominal Diameter DN/OD (mm) | Outside Diameter dn (mm) | Tolerance (mm), Only +ve tolerance | Maximum Out-of-Roundness (mm) |
|---|---|---|---|
| 16 | 16.0 | 0.3 | 1.2 |
| 20 | 20.0 | 0.3 | 1.2 |
| 25 | 25.0 | 0.3 | 1.2 |
| 32 | 32.0 | 0.3 | 1.3 |
| 40 | 40.0 | 0.4 | 1.4 |
| 50 | 50.0 | 0.4 | 1.4 |
| 63 | 63.0 | 0.4 | 1.5 |
| 75 | 75.0 | 0.5 | 1.6 |
| 90 | 90.0 | 0.6 | 1.8 |
| 110 | 110.0 | 0.7 | 2.2 |
| 125 | 125.0 | 0.8 | 2.5 |
| 140 | 140.0 | 0.9 | 2.8 |
| 160 | 160.0 | 1.0 | 3.2 |
| 180 | 180.0 | 1.1 | 3.6 |
| 200 | 200.0 | 1.2 | 4.0 |
| 225 | 225.0 | 1.4 | 4.5 |

| | | | |
|---|---|---|---|
| 250 | 250.0 | 1.5 | 5.0 |
| 280 | 280.0 | 1.7 | 9.8 |
| 315 | 315.0 | 1.9 | 11.1 |
| 355 | 355.0 | 2.2 | 12.5 |
| 400 | 400.0 | 2.4 | 14.0 |
| 450 | 450.0 | 2.7 | 15.6 |
| 500 | 500.0 | 3.0 | 17.5 |
| 560 | 560.0 | 3.4 | 19.6 |
| 630 | 630.0 | 3.8 | 22.1 |
| 710 | 710.0 | 4.3 | — |
| 800 | 800.0 | 4.8 | — |
| 900 | 900.0 | 5.4 | — |
| 1000 | 1000.0 | 6.0 | — |

**Notes:**

1. All dimensions are in millimeters.
2. Mean outside diameter tolerances are in accordance with ISO 11922-1.
3. For straight pipes with diameters 710 mm and above, the permissible out-of-roundness shall be subject to agreement between manufacturer and purchaser.
4. For coiled pipes, out-of-roundness requirements may be specified by agreement between manufacturer and purchaser.

*3.73.8 HDPE Double Wall Corrugated Pipe as per IS 16098 Part 2: 201*

Corrugated structured wall polyethylene (PE) pipes shall conform to IS 16098 (Part 2): 2013 for structured-wall plastics piping systems for non-pressure underground drainage and sewerage applications. The pipes shall be of Type B construction having smooth internal surface and corrugated/profiled external surface.

The pipes shall be manufactured from polyethylene (PE) compound conforming to the requirements of IS 16098 (Part 2): 2013. Only virgin material or manufacturer's own clean reprocessed material generated during production shall be used. Reprocessed material from external sources shall not be permitted. The pipes shall be free from cracks, pinholes, blisters, delamination, foreign inclusions and other visible defects affecting structural performance or durability.

The pipes shall be designated by nominal inside diameter (DN/ID) and Nominal Ring Stiffness (SN) class as specified in the drawings or BOQ. The pipes shall comply with dimensional

tolerances, profile geometry, wall construction and socket dimensions specified in IS 16098 (Part 2): 2013.

**Table 3.50** Nominal Diameter and Minimum Wall Thickness of HDPE DWC Pipes

| Nominal Diameter, DN/ID (mm) | Minimum Mean Inside Diameter, dim min (mm) | Minimum Inner Wall Thickness, e4 min (mm) | Minimum Socket Length, Amin (mm) |
|---|---|---|---|
| 75 | 71 | 1 | 27 |
| 100 | 95 | 1 | 32 |
| 125 | 120 | 1.2 | 38 |
| 135 | 130 | 1.2 | 39 |
| 150 | 145 | 1.3 | 43 |
| 170 | 165 | 1.4 | 48 |
| 200 | 195 | 1.5 | 54 |
| 225 | 220 | 1.7 | 55 |
| 250 | 245 | 1.8 | 59 |
| 300 | 294 | 2 | 64 |
| 400 | 392 | 2.5 | 74 |
| 500 | 490 | 3 | 85 |
| 600 | 588 | 3.5 | 96 |
| 800 | 785 | 4.5 | 118 |
| 1000 | 985 | 5 | 140 |

| | | | |
|---|---|---|---|
| 1200 | 1185 | 5 | 162 |

**Ring Stiffness Classification**

The pipes shall be designated in the following Nominal Ring Stiffness (SN) classes in accordance with IS 16098 (Part 2): 2013:

**Table 3.51** Nominal Ring Stiffness (SN) classes

| Pipe Size | Applicable SN Classes |
|---|---|
| DN ≤ 500 mm | SN 4, SN 8 or SN 16 |
| DN > 500 mm | SN 2, SN 4, SN 8 or SN 16 |

3.74 **PVC Pipe & Pipe fittings: -**

3.74.1 *UPVC pipes for soil and waste discharge systems inside buildings including ventilation and rain water system:* - Pipes shall be designated by the nominal outside diameter DN, in mm. Nominal outside diameter DN of pipes shall be 40, 50, 63, 75, 90,110,125,140 and 160 mm. They shall conform to IS 13592 and shall be of types as given below:

Type A – for use in ventilation pipe work and rain water applications

Type B – for use in soil and waste discharge systems

The material from which the pipes are produced shall consist essentially of polyvinyl chloride to which may be added only those additives that are needed to facilitate the manufacture of sound pipes of good surface finish, mechanical strength, and opacity under condition of use. The material should also consist of sufficient quantity of stabilizer to withstand thermal aging and exposure to ultra-violet light. The surface colour of the pipes shall be a dark shade of grey. Pipes shall be supplied in nominal length of 2, 3, 4 and 6 m either plain or with sliding/grooved socket. Tolerances on specified length shall be +10 mm and – 5 mm.

The internal and external surfaces of the pipes shall be smooth and clean, free from groovings and other defects. The end shall be clearly cut and shall be square with the axis of the pipe. The end may be chamfered on the plain sides. Slight shallow longitudinal grooves or irregularities in the wall thickness shall be permissible provided the wall thickness remains within the permissible limits.

Each pipe shall be clearly and indelibly marked with Manufacturer's name or trademark, Nominal outside diameter of pipe, Type A or Type B as appropriate and Batch Number.

3.74.2 *Fabricated PVC fittings for potable water supplies:* - Fittings of sizes from 63 to 315 mm shall conform to IS 10124 (Part 1). The pipes used for the fabrication of PVC fittings for potable water supplies shall conform to IS 4985.

The sizes of fittings shall be designated by the nominal diameters of the pipe given in IS 4985:1988 with which they are to be used. The minimum socket length of any fitting shall be as given by expression.

$$L = 0.5\ D + 6 \text{ mm}$$

where L = socket length, and

D = nominal inside diameter of fitting.

The out of roundness tolerances of socket inside diameter i.e. the maximum out of roundness tolerance shall be

(a) equal to 0.007 D or
(b) equal to 0.2 mm (if 0.007 D is less than 0.2 mm)

All fittings shall be clearly and indelibly marked at a prominent place visible with

(a) Manufacture's name or identification mark
(b) Size of fitting and the appropriate class
(c) Degree of bend in case of fabricated bends and
(d) Fitting shall be marked in colour as indicated below for different classes of fittings:

| *Class of the fitting* | *Colour* |
|---|---|
| Class 1 (0.25 MPa) | Red |
| Class 2 (0.4 MPa) | Blue |
| Class 3 (0.6 MPa) | Green |
| Class 4 (1 MPa) | Yellow |

3.74.3 *UPVC injection moulded fittings for soil and waste Discharge system for inside and outside buildings including ventilation and rain water system:* - Fittings shall conform to IS 14735. It shall be of the following type:

a) Tee (87.5°), Wye (45°) single, double (cross) or reducing, with or without inspection doors;

b) Bend, with or without inspection doors (87.5º, 45º, 22°)

c) Reducer;

d) Coupler;

e) Socket plug;

f) Cleansing pipe;

g) Adaptor (for connecting UPVC pipes to other materials);

h) Vent cowl;

i) Pipe clip; and

j) Waste trap with strainer (Nahani trap with jail).

The sizes of the fittings shall be designated by the diameters of their sockets. The nominal inside diameter of the sockets of the fittings shall correspond to the nominal outside diameters of the pipes given in IS 13592. Colour of fittings shall be uniform dark shade of grey.

Sockets of fittings shall be either of solvent cement type or rubber ring type. Rubber ring socket fittings shall be supplied complete with rubber sealing rings and when applicable, ring seal adapters. Sealing rings shall be made of elastomers as specified in IS 5382, having IRHD hardness of 50 ± 5. The maximum out-of-roundness tolerance (maximum diameter – minimum diameter) shall be within 0.7 % of the nominal diameter DN. Mean inside diameter of the socket shall be equal to the mean outside diameter of the pipe of the same size.

Dimensions of waste trap (nahani trap) shall be as given below:

| | | |
|---|---|---|
| Maximum diameter of rim of bowl | = | 135.0 mm |
| Minimum depth of bowl | = | 80.0 mm |
| Minimum water seal | = | 10.0 mm |
| Minimum spigot length | = | 70.0 mm |
| Spigot end outside diameter | = | 75.0 + 2 mm |

The spigot ends of fittings shall be chamfered to an angle of $15^{o} \pm 1^{o}$, to the axis of the pipe.

A fitting shall have any of the following configurations of socket and spigot:

a) A solvent cement type socket at each end of the fitting;

b) A rubber ring type of socket at each end of the fitting;

c) A solvent cement type socket at one or two ends, and a spigot at the other end, or at each of the other ends (as applicable) of the fitting;

d) A rubber ring type of socket at one or two ends, and a spigot at the other end, or at each of the other ends (as applicable) of the fitting; and

e) A solvent cement type socket at one or two ends, and a rubber ring type socket at the other end or at each of the other ends (as applicable) of the fitting.

When so required, fittings shall be supplied with an access opening, with threaded caps. Dimension of access opening shall be as per Table 3.52.

**Table 3.52** DIMENSIONS OF ACCESS OPENING

| Sl. No | Nominal diameter (mm) | Minimum clear opening (Diameter), mm |
|---|---|---|
| I. | 40 to 50 | Equal to inside diameter of fitting |
| II. | 63 to 90 | 54.0 |
| III. | 110 to 140 | 63.0 |
| IV. | 160 | 75.0 |

Vent cowls may be of suitable length with perforations/openings. The dimensions of wall thickness and socket depth may be as per Table 3.53:

**Table 3.53** DIMENSION OF VENT COWL

| Sl. No | Nominal diameter (mm) | Socket depth (mm) | Wall thickness of socket, min. (mm) |
|---|---|---|---|
| I. | 40 to 60 | 20.0 | 1.8 |
| II. | 75 to 90 | 22.0 | 2.0 |
| III. | 110 to 160 | 24.0 | 2.0 |

Pipe clips may be of GI/Anti-corrosive material.

The internal and external surfaces of fittings shall be smooth and clean, and free from groovings and other defects. The end shall be clean and shall be square with the axis of the appropriate line. Slight shallow longitudinal grooves or irregularities in the wall thickness shall be permissible provided the wall thickness remains within the permissible limits. Each fitting shall be clearly and indelibly marked with Manufacture's name or trademark and Nominal diameter of fitting and angle where applicable. The fitting may also be marked with the standard mark. The batch number shall be marked on the carton/packing.

3.74.4 *Injection Moulded PVC socket fittings with solvent cement joints for water supplies***: -** These shall conform to IS 7834 (Part 1). The material from which the fittings are produced shall substantially consist of polyvinyl chloride. The sizes of the fittings shall be designated by the diameters of their sockets. The inside diameters of the sockets of the fittings shall correspond to the outside diameter of the pipes given in IS 4985. Thickness at any place in a pipe shall not be less than 3 mm. The minimum socket length of any fitting shall be as given by the expression:

$$L = 0.5D + 6 \text{ mm; with a minimum of } 12 \text{ mm,}$$

where L = Socket length.

D = nominal inside diameter of fitting

The maximum out-of-roundness tolerances of socket inside diameter shall be less than or equal to 0.007D or equal to 0.2 mm (if 0.007D is less than 0.2mm). All fittings shall be cleanly and indelibly marked at a prominent place visible with manufacturer's identification mark and size of the fitting and the appropriate class of IS 4985 to which the pressure rating of the fitting corresponds. It shall also be marked with standard mark.

3.75 **Valves & Cocks: -**

3.75.1 *Copper alloy Gate, Globe and Check valves for waterworks purposes*: - They shall conform to IS 778 and shall have screwed or flanged ends, integral or renewable body seats and screwed-in, screwed-on or bolted bonnets or covers.

3.75.2 *Gate valves* – The gate valves shall be of the following types, having inside screw with rising or non-rising stem or outside screw with rising stem.

a) Solid Wedge Type – (in which the gate shall be of one piece and solid except for the hole not more than 2 mm in the diameter for the spindle for the size up to and including 25 mm, and not more than 3 mm for sizes above 25 mm

to accommodate the spindles; and in which no material has been removed from the surface of the gate);

b) Solid wedge types; and

c) Double disc type.

3.75.3 *Globe valves:* - The globe valves shall be of the following types having rising stem with inside or outside screw:

a) Straight type, and

b) Right angle type.

3.75.4 *Check valves*: -The Check valves shall be of the following types:

a) Swing type (for use with the axis of the body end ports horizontal or vertical); and

b) Lift type with disc or ball check (for use with the axis of the body end ports horizontal or vertical or in applications where the axis of the body end ports are at right angles).

Nominal sizes of screwed end valves shall be as follows:

*8(1/4), 10(3/8), 15(1/2), 20(3/4), 25(1), 32(11/4), 40(1 1/2), 50(2), 65(2 1/2), 80(3) and 100 mm (4).* The nominal sizes shown in parentheses refer to the size of screw threads according to IS 554

The nominal sizes of flanged valves shall be as follows:

15, 20, 25, 32, 40, 50, 65, 80 and 100 mm.

The nominal sizes of valves shall be designated by the nominal bore of the pipe to which the valve is normally fitted. The actual bore shall not be less than the nominal sizes mentioned above.

The valves shall be of two classes as given below:

*Class 1 valves – Valves of this class are suitable for non-shock cold working pressure up to 1.0 MPa (cold service means a temperature not exceeding 45$^{o}$C)*

*Class 2 Valves – Valves of this class are suitable for non-shock cold working pressure up to 1.6 MPa.*

III.75.5 *Swing check type reflux (Non-return) valves for waterworks purposes*: - Reflux valves shall be designated by nominal pressure (PN) defined as maximum permissible gauge pressure (MPa). The nominal pressure for the various sizes shall be as follows:

**Table 3.54** NOMINAL PRESSURE FOR THE VARIOUS SIZES OF REFLUX VALVES

| Sl. No | Size of valves (mm) | Nominal pressure (MPa) |
|---|---|---|
| I. | 50 to 125 | 1.6 |
| II. | 150 to 300 | 1.0 |
| III. | 350 to 600 | 0.6 |

Reflux valves shall conform to IS: 5312 (Part 1) and shall be of the following nominal sizes:*50, 65, 80, 100, 125, 200, 250, 300, 350, 400, 450, 500 and 600 mm.*

The nominal size shall refer to the nominal bore of the waterway. The actual bore at any point shall not be less than the nominal size.

III.75.6 *Sluice valves for waterworks purposes (50 to 1200 mm size)*: - Sluice valves shall be designated by nominal pressure (PN), defined as the maximum permissible gauge working pressure (MPa) as follows:

**Table 3.55** NOMINAL PRESSURE FOR THE VARIOUS SIZES OF SLUICE VALVES

| Sl. No | Nominal Pressure, PN (MPa) | Nominal Sizes (mm) |
|---|---|---|
| I. | PN 1.0 | 50 to 1200 |
| II. | PN 1.6 | 50 to 600 |

It shall conform to IS: 14846:780 and shall be of the following sizes:

*50, 65, 80, 100, 125, 150, 200, 250, 300, 350, 400,450, 500, 600, 700,750, 800, 900, 1000, 1100, and 1200mm.*

Sluice valves shall refer to the nominal bore of the waterway. The actual bore at any point shall not be less than the nominal sizes.

3.74.7 *Flanged reflux valves of multi-door, swing check type used for waterworks purpose (400 to 1200 mm size)*: - Classes of reflux valves shall be designated by nominal pressure (PN), defined as the maximum permissible gauge working pressure in MPa as follows:

PN 0.6 and PN 1

The valves shall conform to IS: 5312 (Part 2) and shall be of the following nominal sizes:

400, 450, 500, 600, 700, 750, 800, 900, 1000, 1100 and 1200 mm.

The nominal size shall refer to the nominal bore of the waterway.

III.75.7 *Non-rising stem type sluice valves (350 to 1200 mm size)*: - It is used for water supply up to 45°C and has double-flanged ends for connections. It shall conform to IS 14846:2000 and shall be designated by nominal pressure (PN) defined as the maximum permissible gauge working pressure in MPa for the sizes indicated as follows:

**Table 3.56** NOMINAL PRESSURE FOR THE VARIOUS SIZES OF SLUICE VALVES

| Sl. No | Nominal Pressure, PN (MPa) | Nominal Sizes (mm) |
|---|---|---|
| I. | PN 0.4 | 700 to 1200 |
| II. | PN 0.6 | 350 to 1200 |
| III. | PN 1.0 | 350 to 1200 |
| IV. | PN 1.6 | 350 to 600 |

Sluice valves shall be of the following sizes: 350, 400, 500, 600, 700, 750, 800, 900, 1000, 1100 and 1200 mm.

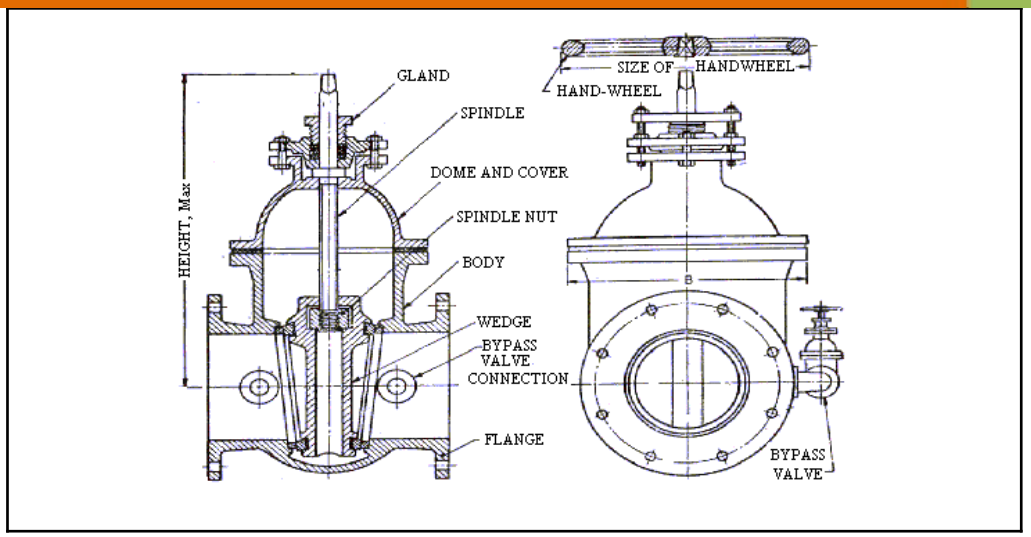



**Figure 3.6** TYPICAL SKETCH OF A SLUICE VALVE

NOTE: - Shapes of parts are only illustrative but the dimensions and the minimum requirements where specified are binding.

3.75.9 *Ball valve (Float valve):* **-** This shall conform to IS 1703. The float valve shall be of High Pressure (HP) type designed for use on mains having pressure of 0.175 MPa or above and Low Pressure (LP) type designed for use on mains having a pressure less than 0.175 MPa. Float valves shall be of 15, 20, 25, 32, 40 and 50 mm nominal sizes. The float shall be made of polythene and shall conform to IS 9762.

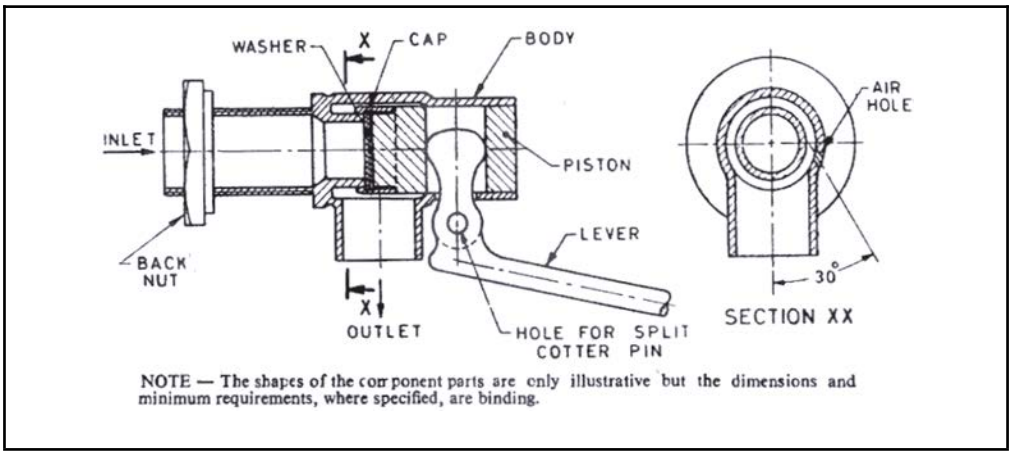



**Figure 3.7** BALL VALVE (ASSEMBLY)

The inlet shank, seat, outlet nose and socket for piston shall be cast in one single unit to constitute the body of the valve. The inlet shank shall be horizontal. In case of 15 mm size the inlet shank may either be horizontal or vertical. The lever may be made in one piece or the short arm and rod may be separately constructed.

Each float valve, while in closed position, shall withstand an internally applied hydraulic pressure of 1.5 MPa for a period of 2 minutes without leakage or sweating. All float valves shall have an air hole in the body discharging downwards. The diameter of the hole shall be 3 mm except in the case of float valves of nominal size 15 mm and 20 mm in which the diameter of the hole may be reduced to 2.5 mm.

3.75.10 *Brass bib cock /Brass stop cock*: - A bib cock (bib tap) is a draw off tap with horizontal inlet (i.e. screwed male inlet) and free outlet and stop cock (stop tap) is a valve with a suitable means of connections for insertion in a pipe line for controlling or stopping the

flow. They shall be of specified size and shall be of screw down type and shall conform to IS 781. The nominal sizes of bib taps shall be 8, 10, 15,20 and 25 mm. The nominal sizes of stop valves shall be 8, 10, 15, 20,25, 32,40 and 50 mm. Nominal sizes of the bib tap and stop valves shall be designated by the nominal bore of the socket or pipe outlet to which the tap or valve is normally fitted. The closing device shall work by means of a disc carrying a renewable non-metallic washer which shuts against water pressure on a seating at right angles to the axis of the threaded spindle which operates it. The handle shall be either crutch or butterfly type securely fixed to the spindle. Valve shall be of the loose leather seated pattern. The cocks (taps) shall open in anticlock-wise direction.

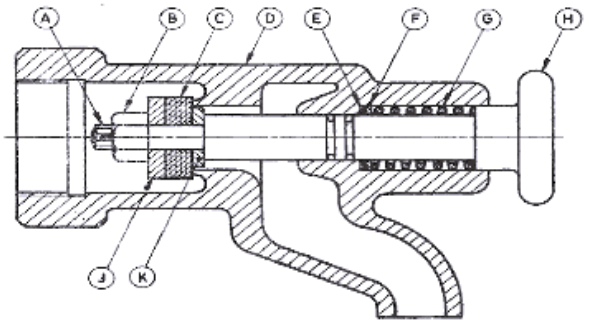
The bib cock and stopcock shall be polished bright. The minimum finished weight of 15 mm bib cock and stop cock shall be of 400 gms.

3.75.11 *Self-closing taps for water supply purposes*: - A self closing tap is a draw–off tap which remains in the open position so long as a lever handle is kept pressed up, down or sideways, or a pushbutton is kept pressed in, and closes by itself when the button or the lever handle is released; the self closing taps may incorporate a device which closes the tap even without the release of the button or the handle after a fixed quantity is discharged.

Self-closing taps shall be of the following nominal sizes:

a) 15 mm, and
b) 20 mm.

Nominal sizes shall refer to the nominal bore of the inlet connection. Self-closing taps shall conform to IS 1711. The force required for operating the self-closing tap for its full opening shall not exceed 70 N. For self-closing taps, which operate against heads exceeding 2 m, a non-concussive function is essential and provision to this effect shall be made in the design.




A - SPINDLE
B - NUT FOR WASHER
C - SEAT WASHER
D - BODY
E - WASHER
F - BRASS WASHER
G - SPRING
H - PUSHBUTTON
J - BRASS WASHER
K - BRASS WASHER

**Figure 3.8** SELF-CLOSING TAPS (CONCUSSIVE PUSHBUTTON TYPE - For Heads not exceeding 2 m)

When the tap is assembled complete with its component parts, it shall withstand an internally applied hydraulic pressure of 2 MPa for a minimum period of 2 minutes without leakage or sweating.

3.75.12 *Plug cocks for water supply purposes*: - It is a shut off device comprising a body having a taper seating into which is fitted a plug which can be turned to move its port relative to the body ports to control the flow of water. The plug is retained in the body

by means of a washer, screw and nut at its smaller end. Plug cocks shall have each body end suitable for one of the following types of joints:

a) Plain ends for a lead (wiped) joint,
b) Socket end for capillary solder joint,
c) Union and tail piece for lead (wiped) joint,
d) Union and tail piece for capillary solder joint, and
e) Union for copper tube compression joint.

Ends for (b), (d) and (e) shall be as specified.

Plug cocks shall be of nominal sizes 15, 20 and 25 mm. The nominal size of the plug cock shall be denoted by nominal bores of the end ports in the body. The component parts of the plug cocks shall be of brass or leaded tin bronze. The plug cock shall conform to IS 3004.

All parts shall be efficiently cleaned and the minimum quantity of a lubricant shall be applied to the seating surfaces of the body and plug to ensure smooth working.

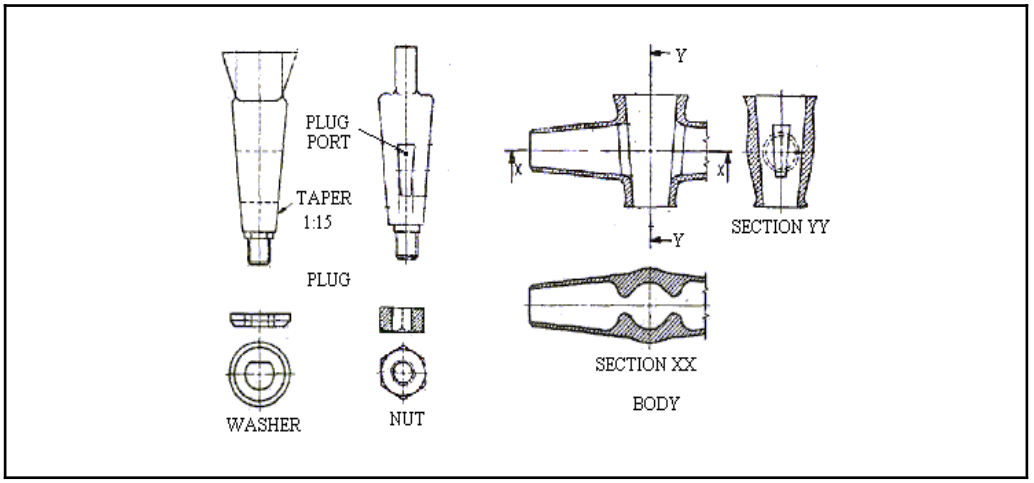



**Figure 3.9** PLUG COCK AND COMPONENT PARTS

3.75.13 Ferrules for water services: - Ferrules shall be of nominal sizes 8, 10, 15, 20, 25, 32, 40 and 50 mm and shall conform to IS 2692. Every ferrule, complete with its component parts, shall withstand a hydraulic pressure of at least 1.5 MPa, applied for two minutes, and during this period it shall neither leak nor sweat.

3.76 **Bathroom fittings: -**

3.76.1 *C.P. brass pillar cock*: - Pillar tap is a draw-off tap with a vertical inlet and an uptilted or a horizontal outlet. It shall be nickel-chromium plated and shall conform to IS 1795.

The nominal sizes of the pillar tap shall be 15 mm or 20 mm as specified. The nominal size shall be designated by the nominal bore of the pipe outlet to which the tap is to be fitted. Every pillar tap complete with component parts, shall withstand an internally applied hydraulic pressure of 2 MPa (20 kgf/cm$^2$.) maintained for a period of 2 minutes during which period it shall neither leak nor sweat.

Minimum finished weights of 15 mm. and 20 mm. pillar taps shall be as below: -

**Table 3.57** MINIMUM FINISHED WEIGHTS OF 15 MM. AND 20 mm PILLAR TAPS

| Particulars | Weights for 15 mm | |
|---|---|---|
| | 15 mm size (gms) | 20 mm Size (gms) |
| Body | 255 | 505 |
| Washer plate loose valve | 15 | 28 |
| Back nut | 40 | 50 |
| Tap | 650 | 1175 |

3.76.2 *Copper alloy fancy single taps, combination tap assembly and stop valves for water services*: - These shall conform to IS 8931. The nominal size shall be designated by the nominal bore of the pipe outlet to which the taps and valves are normally fitted. The nominal size shall be as follows:

**Table 3.58** NOMINAL SIZE OF COPPER ALLOY FANCY SINGLE TAPS, COMBINATION TAP ASSEMBLY AND STOP VALVES FOR WATER SERVICES

| Particular | Nominal size (mm) |
|---|---|
| Pillar taps | 15 mm |
| Bib taps | 15 mm |
| Combination tap assembly | 15 mm |
| Stop valve | 15 mm and 20 mm |
| Angle stop valve | 15 mm and 20 mm |

No point of body of the taps subjected to street water pressure, except where a lesser thickness is specified, shall have a thickness less than 2 mm. The significant surfaces of taps, combination tap assembly, bib tap, stop valves and angle stop valves shall be chromium plated. However, the body of concealed stop valve and side stop valve of pillar mounting combination tap assembly may be polished bright or may have an unpolished surface, as 'Cast' finish. The taps shall be marked with manufacturer's name or trade mark and letter 'H' or 'C' for hot and cold water respectively and direction of flow in case of stop valves.

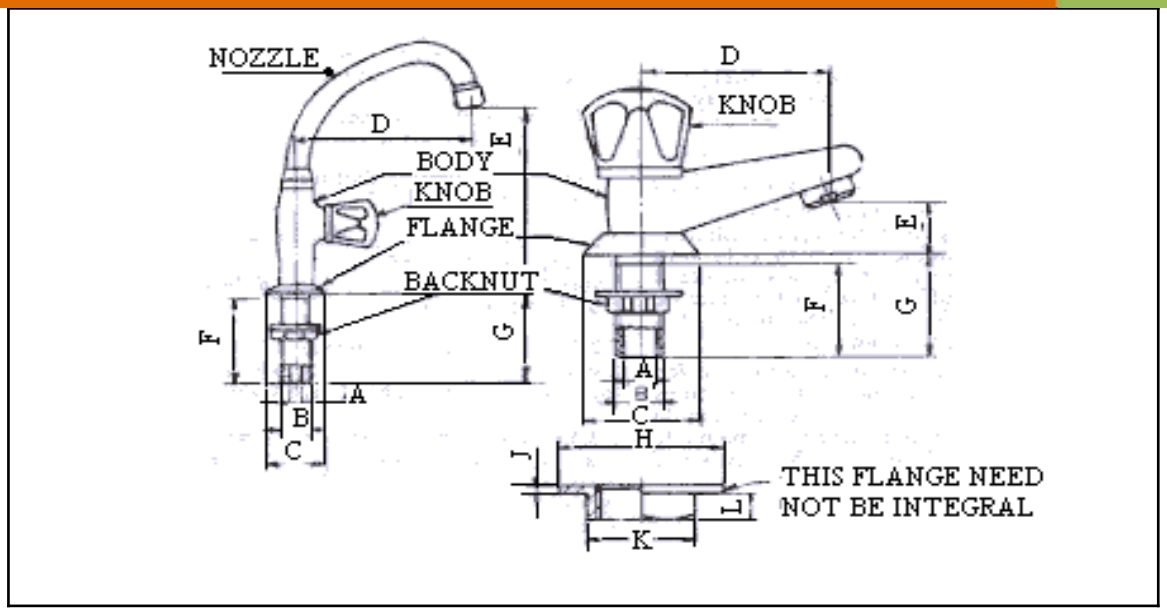



**Figure 3.10** BODIES FOR PILLAR TAPS (TYPICAL DETAILS)

*NOTE - The Nozzle may either be manufactured from cast or from wrought material (brass tube).*

*Conforming to IS 2643 (Part 3)
Dimensions of Bodies for Pillar Tap, Size 15 mm are as given in the Table 3.59.

**Table 3.59** DIMENSIONS OF BODIES FOR PILLAR TAPS, Size 15mm.

**All dimensions in millimeters**

| **Sl. No** | **Particulars** (see Fig. 3.10) | | **Dimensions** | |
|---|---|---|---|---|
| | | | **Min.** | **Max.** |
| 1. | Bore of inlet shank, | A | - | 14.5 |
| 2. | Thread of inlet shank | B | *G1/2B | - |
| 3. | Diameter or size across fiats | C | 42 | - |
| 4. | Horizontal length from center of body to center of outlet | D | 80 | - |
| 5. | Height from flange to center outlet | E | 25 | - |
| 6. | Length of thread | F | 42 | - |
| 7. | Length of shank | G | 50 | - |
| 8. | Diameter of flange | H | 38 | - |
| 9. | Thickness of flange | J | 2 | - |

| | | | | |
|---|---|---|---|---|
| 10. | Size across flats | K | 25 | - |
| 11. | Height of flats | L | 7 | - |

3.77 **Bathroom Accessories: -**

3.77.1 *Soap dish with brackets (C.P.)*: - This shall be of C.P. brass and of design approved by the Engineer.

3.77.2 *Toilet paper holder*: - Toilet paper holder shall be of C.P. Brass as specified and of size and design approved by the Engineer - C.P. Brass screws shall be used for fixing. Chromium plating shall be grade `B' type of IS 1068.

3.77.3 *C.P. brass towel rail with bracket*: - The rail shall be of C.P. brass with two C.P. brass brackets. The size of the rail shall be 60 mm x 20 mm dia. and 1.25 mm thick.

3.77.4 *Liquid soap container (C.P.)*: - This shall be supplied with brackets (C.P.). It shall be of approved design.

3.77.4 *Glass shelf*: - Glass shelf consists of an assembly of glass shelf, with anodized aluminum railing and C.P. brass brackets. The shelf shall be of best quality with edges rounded off, and shall be free from flaws, specks or bubbles. The size of the shelf shall be 60 x 12 cm. and thickness not less than 5.5 mm. The shelf shall have C.P. brass brackets, which can be fixed with C.P. brass screws to rawl plugs, embedded in the walls.

3.77.4 *Bevelled edge mirror* (Superior quality): - The mirror shall be of superior sheet glass with edges rounded off or bevelled, as specified. It shall be free from flaws, specks or bubbles. The size of the mirror shall be 60 x 45 cm. and its thickness shall not be less than 5.5 mm. It shall be uniformly silver plated at the back and shall be free from silvering defects. Silvering shall have a protective uniform covering of red lead paint.

3.78 **Sanitary Appliances: -**

3.78.1 *Kitchen sink*: - Kitchen sink shall be of white glazed vitreous china or vitreous enamelled steel conforming to IS 771 (Part 2): 1985 and IS 8718 respectively. The white glazed vitreous china sink shall be of one piece construction, including a combined overflow. The floor of the sink shall gently slope towards the outlet. The outlet shall in all cases be suitable for waste fittings having flanges of 88 mm dia. and the waste hole shall have minimum dia. of 65 mm at the bottom to suit the waste fittings. The waste hole shall be either rebated or bevelled, having depth of 10 mm. The sink shall have overflow of the weir type and their inverts shall be 30 mm below the top edge.

The vitreous enameled steel kitchen sink shall be constructed of the fewest practicable number of sections compatible with the manufacturing practice to ensure a suitable finished surface for the reception of the enamel. Any welded surface shall be adequately cleaned off inside and outside the sinks. The vitreous enamelled steel sinks suitable for kitchen use shall be of the following patterns:

a) Flat-rim kitchen sink;
b) Flat-rim ledge kitchen sink; and
c) Flat-rim ledge kitchen sink, with double compartment.

3.78.2 *Laboratory Sink*: - Laboratory sink made of glazed fire-clay shall conform to IS 771 (Part 2) and vitreous china to IS 2556 (Part 5). The sink shall be of one piece construction with

or without rim and with or without combined overflow. The invert of the overflow where provided shall be minimum 30 mm below the top edge. The sink shall have a circular waste hole into which the interior of the sinks shall drain. The waste hole shall be either rebated or bevelled with an overall diameter of 65 mm and a depth of 10 mm to suit a waste fitting having a flange of 64 mm diameter. Inside surfaces of sinks shall be uniform and smooth in order to ensure an efficient draining.

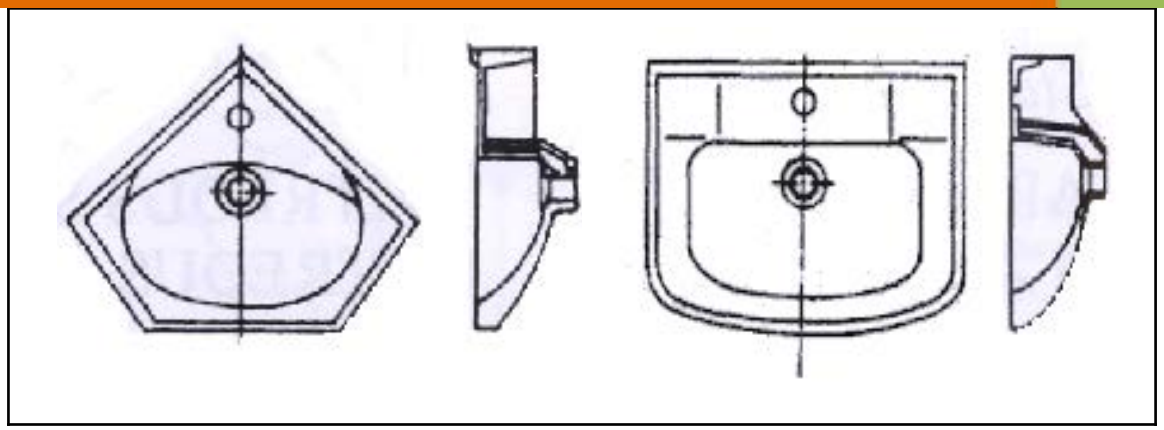
3.78.3 *Stainless steel sinks for domestic purposes*: - These shall conform to IS 13983 and shall be of the following types:

| | |
|---|---|
| Type A1 or A2 | : Single bowl without drainer |
| Type B1 or B2 | : Double bowl without drainer |
| Type C | : Single bowl single drainer, right or left hand |
| Type D | : Single bowl double drainer |
| Type E1, E2 or E3 | : Double bowl single drainer, right or left hand |
| Type F | : Double bowl double drainer |

Sinks shall be constructed of the lowest practicable numbers of sections compatible with the manufacturing practice to ensure a smooth surface. The sink bowl shall have rounded corners to facilitate cleaning. Drainers shall be fluted or grooved and shall be inclined towards the sink bowl. Sink bowls shall be designed /constructed with a fall to the waste outlet. The waste outlet fitting shall be recessed type. Thickness at any point of sink, after forming, shall not be less than 0.75mm. The depth of the sink bowl shall be 150 mm minimum, when measured from top edge of the bowl to the base of the sink. The minimum internal dimensions, when measured on the bowl centre lines across the top of the bowl, shall be 380 mm x 340 mm for rectangular bowls and 360 mm for round bowls.

Sinks may be supplied with a bright or dull finish, as desired by the purchaser.

3.78.4 White vitreous wash basin: - Wash basin shall be of flat/angle back type conforming to IS 2556 (Pt.IV) (see fig. 3.11). It shall be of one piece construction, including a combined overflow. All internal angles shall be designed so as to facilitate cleaning. Each basin shall have a skirting at the back. The basin shall be provided with single or double tap holes as specified. The tap holes shall be 28 mm square or 30 mm round or 25 mm round for the pop up hole. Each basin shall have a circular waste hole to which the interior of the basin shall drain. The waste hole shall be either rebated or bevelled internally with dia. of 65 mm at top. Stud slots to receive the brackets on the underside of the wash basin shall be suitable for brackets with stud not exceeding 13 mm, 5 mm high and 305 mm from the back of the basin to the centre of the stud. The stud slot shall be of depth sufficient to take 5 mm stud.



**a.** ANGLE BACK **b.** FLAT BACK

**Figure 3.11** WHITE VITREOUS CHINA WASH BASINS

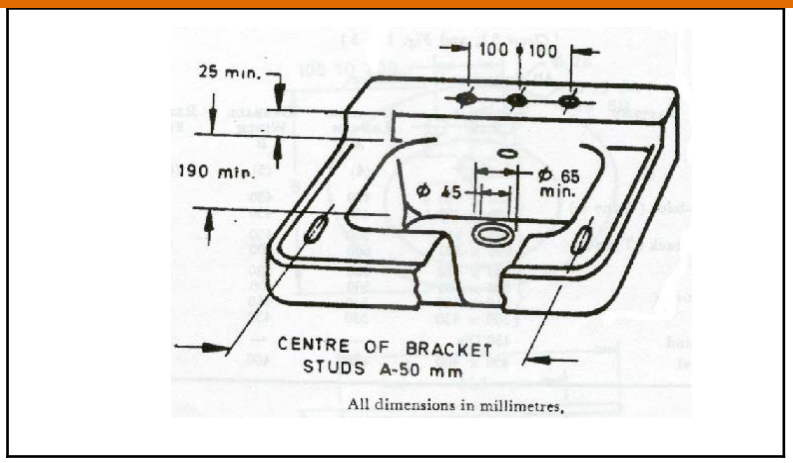
| Dimension | Tolerance |
|---|---|
| (a) On dimensions 75 mm and over | +/- 4 percent |
| (b) On dimensions less than 75 mm | +/- 2 mm |
| (c) Diameter of the waste hole | +/- 3 mm |

3.78.5 *Pedestal*: - White glazed pedestals for wash basins, shall be provided where specified. The quality of the glazing of the pedestal shall be exactly the same as that of the basin along with which it is to be installed. It shall be completely recessed at the back to accommodate supply and waste pipes fittings. It shall be capable of supporting the basin rigidly and adequately and shall be designed to make the height from the floor to top of the rim of the basin 75 to 80 cm.

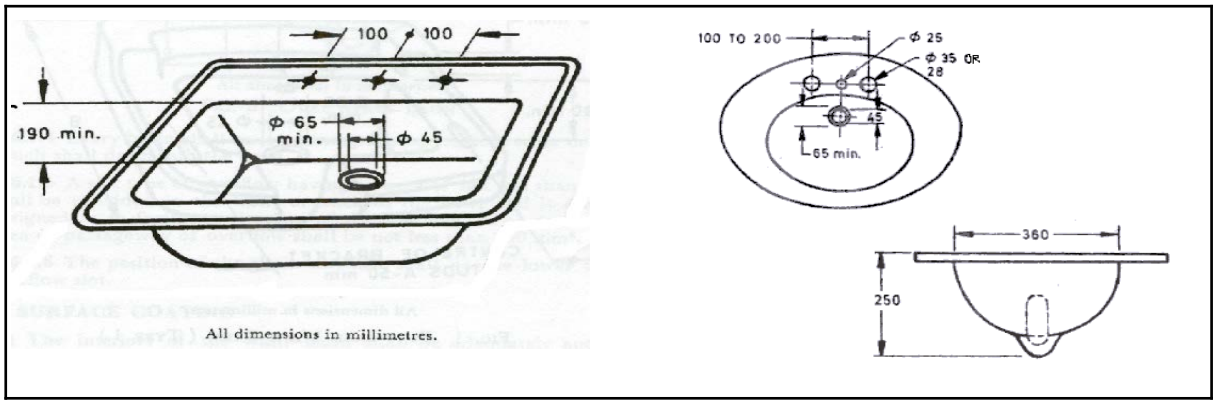
3.78.6 *Vitreous enamelled Steel Wash basin*: - The wash basin shall be of following patterns (see fig 3.12):

a) Flat-back
b) Flat rim
c) Round, and
d) Oval

Wash basin shall conform to IS 8727: 1978. They shall be constructed of the fewest practicable number of sections compatible with the manufacturing practice to ensure a suitable finished surface for the reception of the enamel. All internal angles shall be designed so as to facilitate cleaning. Every basin shall have an integral soap holder recess or recesses which shall drain into the bowl.




**a.** FLAT-BACK WASH BASIN (TYPE II)




**b.** FLAT-RIM WASH BASIN **c.** OVAL WASH BASIN

**Figure 3.12** DIFFERENT TYPES OF STEEL WASH BASINS

3.78.7 *Vitreous china Universal Water closet*: - Universal water closet shall be of one of the following sizes or as specified:

Size 1 560 x 460 mm, 'P' or 'S' trap

Size 2 640 x 460 mm, 'P' or 'S' trap

Functional dimensions shall be as given below in Table 3.60.

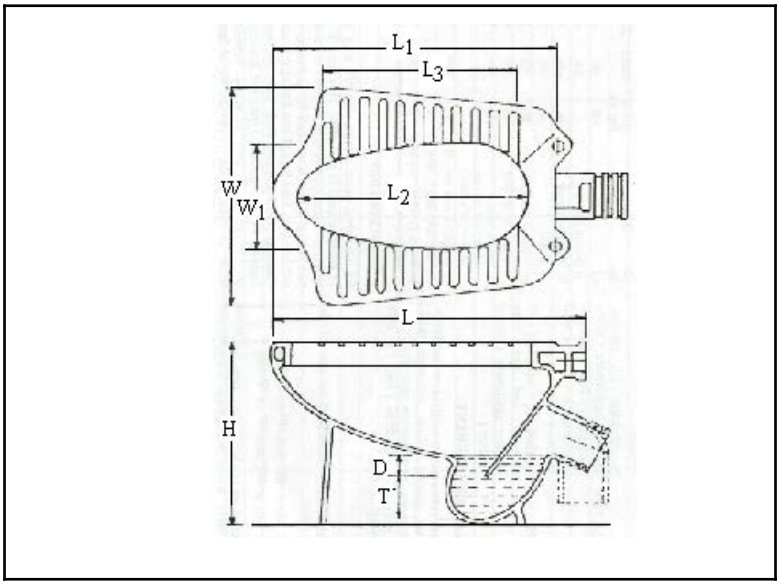



**Figure 3.13** UNIVERSAL WATER CLOSET (Functional dimensions)

**Table 3.60** FUNCTIONAL DIMENSIONS

**All dimensions in millimeters**

| **Sl. No** | **Particulars** (see Fig. 3.13) | **Size 1** | **Size 2** |
|---|---|---|---|
| 1. | Overall length, L | 570 | 650 |
| 2. | Width of closet, W | 460 | 460 |
| 3. | Height, H | 380 | 380 |
| 4. | Width of opening, W1 | 220 | 220 |
| 5. | Length of opening, L2 | 370 | 450 |
| 6. | Length of seat, L1 (bolt hole centers to front of closet) | 450 | 530 |
| 7. | Length of foot rest, Min, L3 | 260 | 330 |
| 8. | Trap inlet depth, Min, T | 75 | 75 |
| 9. | Depth of water seal, Min, D | 50 | 50 |

They shall conform to IS 2556 (Part 15). Universal water closets with P traps shall be manufactured in one piece. However, 'S' trap universal water closets may be made in one or two pieces. Each closet shall be provided with not less than four fixing holes having a minimum diameter of 6.5 mm and shall have an integral flushing rim of suitable type. The flushing rim shall be box type with adequate number of holes. It shall also have an inlet or supply horn for connecting the flush pipe. The inlet shall be of the self draining type and a weep hole shall be provided at the flushing inlet of the closet.

The inside surface of water closets and traps shall be glazed uniform and smooth in order to ensure an efficient flush. The grooved part of the outlet of the closets and that of the bends where provided shall not be glazed. The closet, when sealed at the outlet and vent (if provided) shall be capable of holding not less than 10 litres of water between the normal water level and the highest possible water level of the closet as installed.

3.78.8 *Vitreous china Integrated Squatting pans*: - They shall conform to IS 2556 (Part 14). The pan shall be provided with either box or open rim. The flushing inlet may be located either at the narrow end or broad end or at both ends as stipulated by the purchaser.

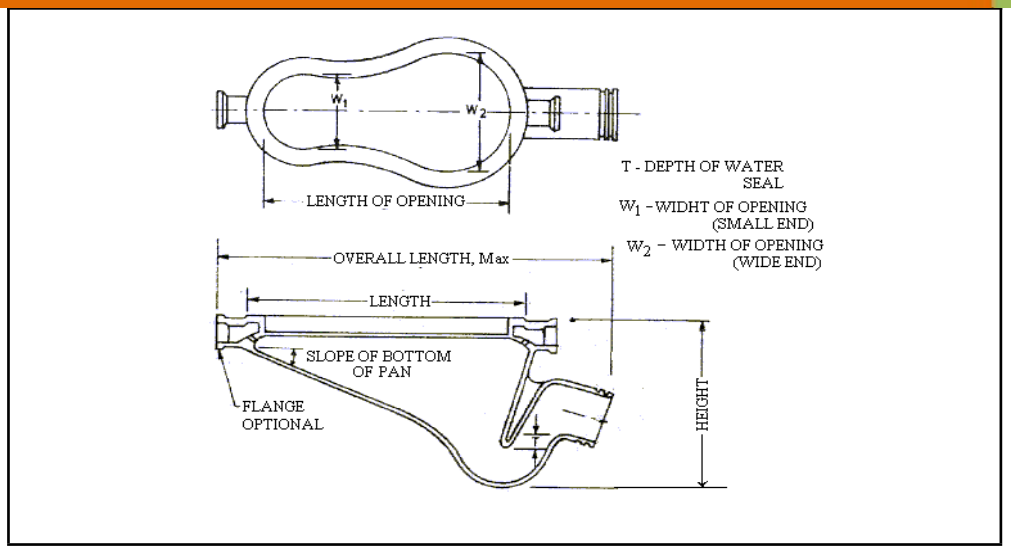



**Figure 3.14** INTEGRATED SQUATTING PAN

3.78.9 *Vitreous china pedestal close coupled washdown and water closet*: - They shall conform to IS 2556 (Part 8).

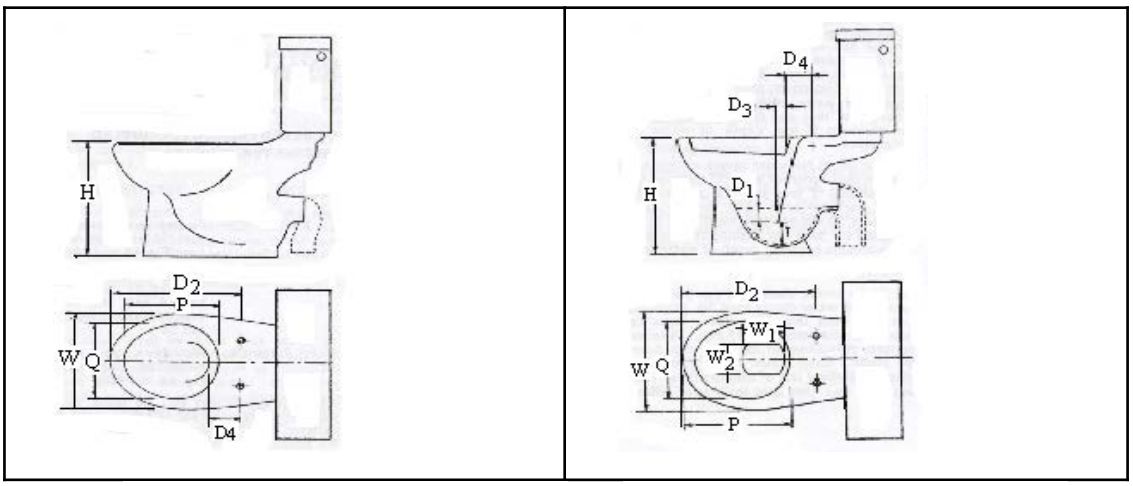
The pedestal closet with close-coupled cistern shall be one of the following patterns (see fig. 3.15) or as specified:

Pattern 1 – Double trap pattern with 'S' trap or 'P' trap

Pattern 2 – Single trap pattern with 'S' trap or 'P' trap

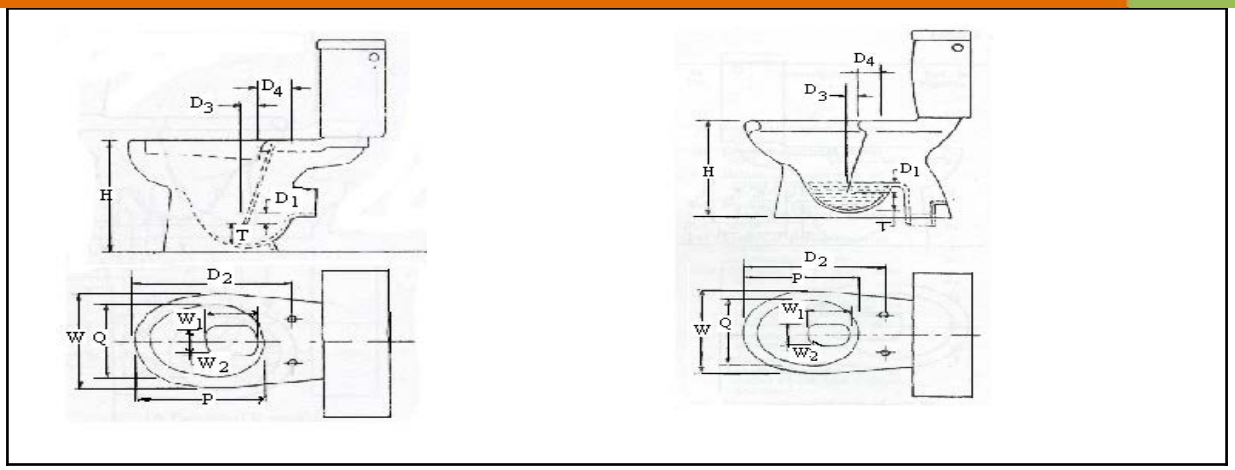
Pattern 3 – Washdown pattern with 'P' trap or 'S' trap or concealed 'S' trap

Pattern 4 – Washdown pattern with horizontal outlet




a. SYPHONIC WATER CLOSET - SINGLE OR DOUBLE TRAP PATTERN

b. WASHDOWN WATER CLOSET FOR CLOSE COUPLED SUITE, P OR S TRAP




c. WASHDOWN WATER CLOSET FOR CLOSE COUPLED SUITE - CONCEALED S TRAP

d. HORIZONTAL OUTLET WC FOR CLOSE COUPLED SUITE

**Figure 3.15** DIFFERENT PATTERNS OF PEDESTAL CLOSET WITH CLOSE-COUPLED CISTERN

The water closet shall be of one piece construction. Each water closet shall be provided with not less than two floor fixing holes having a minimum diameter of 6.5 mm. Alternatively, suitable provision for fixing to the floor shall be made. Each water closet shall have an integral flushing rim of suitable type. The flushing rim and the inlet shall be of self- drainage type and weep-hole shall be provided at the flushing inlet of the water closet. Each water closet shall have an integral trap with either 'S' or 'P' outlet or concealed 'S' trap or horizontal outlet. Suitable provision shall be made for connecting a flushing cistern at the back of the closet and on top of the inlet using a suitable (resilient) gasket to make the system leak proof.

The inside surface of the water closet and trap shall be glazed uniform and smooth in order to ensure an efficient flush. Flushing cistern for water closets shall be of low level coupled type conforming to IS 774 or IS 7231.

3.78.10 *European Type W.C Pan pedestal type*: - Water closet shall be of white vitreous china conforming to IS 2556 (Pt.I) and 2556 (Pt.II) as specified and shall be of "Wash Down Type". The water closet shall be of one piece construction. Each shall have not less than two holes having minimum dia. of 6.5 mm for fixing to the floor and shall have an integral flushing rim of suitable type. It shall have an inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. The W.C. shall have a weep hole at the flushing inlet. Each W.C. shall have an integral trap with either "S" or "P" outlet with at least 75 mm water seal. Where required, the W.C. shall have an antisiphonage 50 mm dia. vent horn on the outlet side of the trap. For efficient flushing the inside surface of W.C. and traps shall be uniform and smooth.

The serrated part of the outlet shall not be glazed externally.

| **Dimension** | **Tolerances** |
|---|---|
| (a) On dimensions 75 mm and over | +/- 4 percent |
| (b) On dimensions less than 75 mm | +/- 2 mm |
| (c) On all angles | +/- 3 degree |

3.78.11 *Indian Type W.C. pans*: - It shall be of white vitreous china confirming to IS 2556 (Pt.III). Each pan shall have an integral flushing rim of suitable type. It shall also have inlet or supply horn for connecting the flush pipes. The flushing rim and inlet shall be of the self-draining type. It shall have a weep hole at the flushing inlet to the pan. The flushing inlet shall be in the front, unless otherwise specified. The inside of the bottom of the pan shall have a sufficient slope from the front towards the outlet and the surface shall be uniform and smooth to enable easy and quick disposal while flushing. The exterior surface of the outlet below the flange shall be an unglazed surface, which shall have grooves at right angles to the axis of the outlet. In all cases the pan shall be provided with a (100 mm)

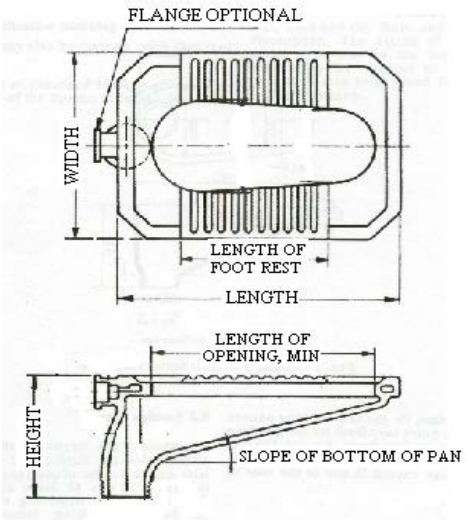
S.C.I. trap "P" or "S" type with 50 mm water seal and 50 mm diameter vent horn. The following tolerances may be allowed on dimension specified, Long pattern and Orissa Pattern: -

(a) On dimensions 75 mm and over +/- 4 percent

(b) On dimensions less than 75 mm +/- 2 mm

(c) On all angles +/- 3 degree

(d) The top surface of long pattern shall not at any point vary from its designed plane or contour by more than 6 mm for size 580 mm squatting pan. The value shall not exceed 10 mm for Orissa pattern pan (See fig. 3.16).




NOTE - Footrest may be flushed or raised, clearance permissible between raised footrest and rim opening.

**Figure 3.16** ORRISA PATTERN SQUATTING PAN

3.78.12 *Glass Fibre Reinforced Polyester Resin Squatting Pans*: - These shall confirm to IS 11246. The contact moulded or cold-pressed squatting pan shall consist of two or more layers of fibre-glass chopped strand or requisite quantity of rovings to build up a minimum thickness of 1.8 mm excluding surface coat, throughout the body of the pan, with additional reinforcement at the rim and the outlet. For compression moulded squatting pans the process shall be carried out using SMC (Sheet Moulding Compound) and matched metal dies under required temperature and pressure.

The surface of the moulded pans shall be free from pin holes, unevenness, crazing, cracks, and resin areas. It shall contain no impurities. The surface shall be coated with

high gloss, scratch and chemical resistant coating. The surface of the pan shall be smooth and free from any sharp edges and unwanted curves, etc.

The minimum mass of hand laid pans shall be 750 gm and for sheet moulding compound (SMC) shall be 900 gm.

3.78.13 *Vitreous china Urinals and partition plates*: - The urinals shall be of one of the following patterns and sizes or as specified:

i) Bowl (flat back) with flushing rim

a) Size 1 – 440 x 265 x 355 mm with side fixing arrangements; and
b) Size 2 – 440 x 265 x 315 mm with top and bottom fixing arrangement
ii) Bowl (flat back) without flushing rim (see fig. 3.17b)

a) Size 1 – 410 x 265 x 305 mm, and
b) Size 2 – 590 x 375 x 390 mm.
iii) Bowl (angle back) with flushing rim (see fig 3.17c) Size – 345 x 420 x 270 mm.

iv) Bowl (angle back) without flushing rim (see fig. 3.17a)
a) Size 1 – 450 x 350 x 275 mm, and
b) Size 2 – 580 x 500 x 300 mm.
v) Squatting plate

a) Size 1 – 450 x 350 mm, and
b) Size 2 – 600 x 350 mm.

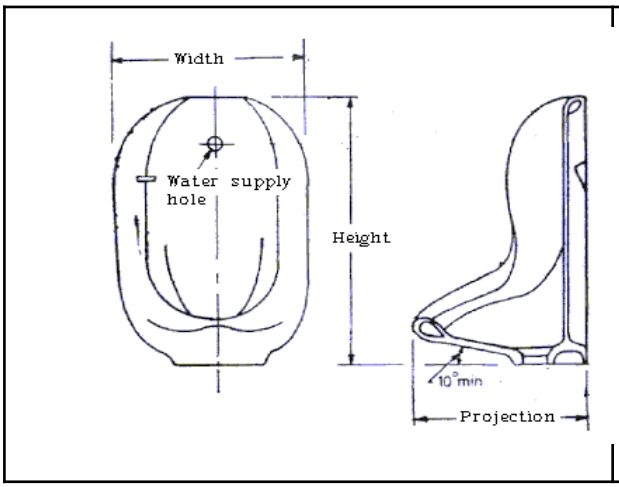



**Figure 3.17 (a)** BOWL URINAL FLAT BACK (WITHOUT FLUSHING RIM)

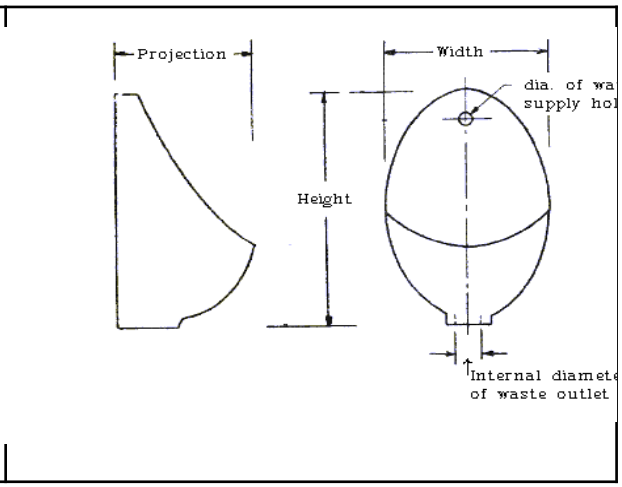



**Figure 3.17 (b)** BOWL TYPE ANGLE BACK URINAL WITHOUT RIM

Partition plates shall be one of the following sizes or as specified:

a) *Size 1* – 675 x 325 x 85 mm, and
b) *Size 2* – 825 x 450 x 100 mm.
They shall conform to IS 2556 (Part 6).

Bowl shall be of one piece construction. Bowl urinal (flat back) with flushing rim and bowl urinal (angle back) with flushing rim shall have an integral flushing box rim with minimum 12 holes, well distributed in the rim to ensure satisfactory flushing. Bowl urinal (flat back) without flushing rim and bowl urinal (angle back) without flushing rim shall be

without integral outlet and overflow. Bowl urinals shall be provided with adequate means of support, preferably of the concealed type.

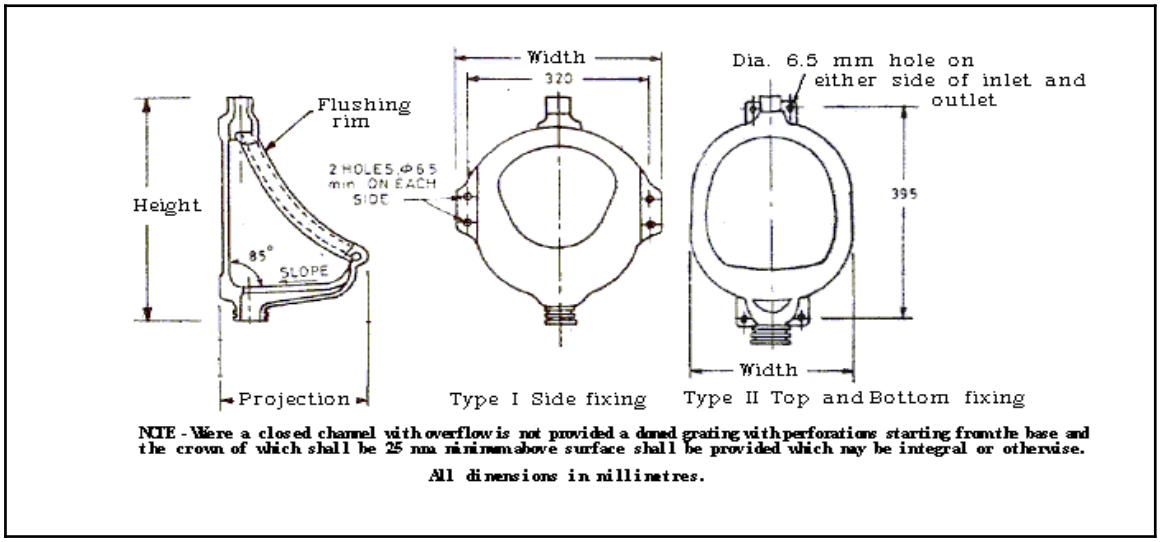



**Figure 3.17 (c)** BOWL PATTERN URINAL (FLAT BACK) WITH FLUSHING RIM

Squatting plate type urinal shall be of one piece construction having an integral longitudinal flushing pipe of suitable type which may be connected to the flush pipe. The integral flushing type shall be connected to the sump by three 13 mm diameter holes. The design of urinals shall be such that when properly installed there should be no liquid left over in the bottom of the pan of the urinal after flushing.

Partition plates shall be of one piece construction and provided with fixing arrangement at the flat back top and bottom. A counter sunk hole of diameter 8 mm (min) at the bottom may also be provided for the purpose of keeping it fixed.

Inside and outside visible surfaces of urinals shall be glazed, uniform and smooth. The finish shall ensure efficient flush. The inside surfaces of the inlet and outlet not visible shall be smooth but not glazed. In case of integrated outlets the serrated part of the outlet shall not be glazed externally.

3.78.13 *Glazed fire-clay stall urinals*: - These shall conform to IS 771 (Part 3) and shall be of following types and sizes or as specified:

Type 1 – 1140 x 460 x 400 mm

Type 2 – 1500 x 520 x 400 mm

Stall urinals shall be manufactured either as a single urinal or as a range of two or more urinals as specified by the purchaser. The inside surface of the urinals shall be regular and smooth throughout to ensure efficient flushing. The bottom of urinals shall have sufficient slope from front towards the outlet such that there is efficient draining of the urine.

3.78.14 *C.I. Bath tub:* **-** It shall be of one-piece construction including integral overflow and with detachable feet. The interior and turned over edges of the tubs shall be evenly coated with vitreous enamel thoroughly fused to the C.I. base. The enamelling shall conform to IS 772 and shall be of acid and alkali resisting quality. The enamel coating shall be adequate and even and shall cover the entire surface. The enamelled surface shall be glossy, smooth and free from craze, chips and other flaws. The exterior of the bath shall be coated with two coats of approved paint over a priming coat.

The overall dimensions shall be as given unless otherwise specified:

| | |
|---|---|
| Length, over all | 170 cms |
| Width, over all | 73-74 cms |
| Width inside | 58 cms |
| Depth inside at (waste) | 43 cms |
| Height overall exclusive of feet | 44 cms |

Each tub shall be provided with double tap holes. The tap holes shall be square. Each tub shall have a circular waste hole to which the interior of the bath tub shall drain. Where so specified bath tubs of other material shall be used in place of cast iron bath.

3.78.15 *Vitreous enamelled Steel bath tub:* **-** It shall conform to IS 3489. The bath tub shall be constructed of the fewest practicable number of sections compatible with the manufacturing practice, which shall be such as to ensure a suitable finished surface for the reception of the enamel. Any welded surface shall be adequately cleaned off inside and outside the bath tubs. The necessary surface shall be free from undulations, drawing lines and other defects deleterious to the provision of satisfactory enamel coating.

Bath tub shall have a circular waste hole into which the interior of the tub shall drain. For safety of the users, bath tubs shall be flat-bottomed as practicable. The fall along the bottom, head and to the outlet shall be adequate for complete emptying.

Each tub shall be provided with supports made of cast iron, mild steel or any other suitable material.

3.78.16 *Vitreous china pedestal type Bidets*: - They shall conform to IS 2556 (Part 9) and shall be one of the following patterns and sizes or as specified:

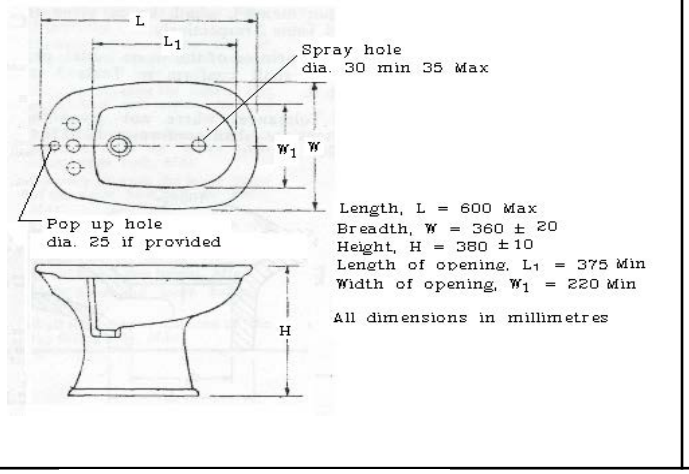



**Figure 3.18 (a)** PATTERN 1

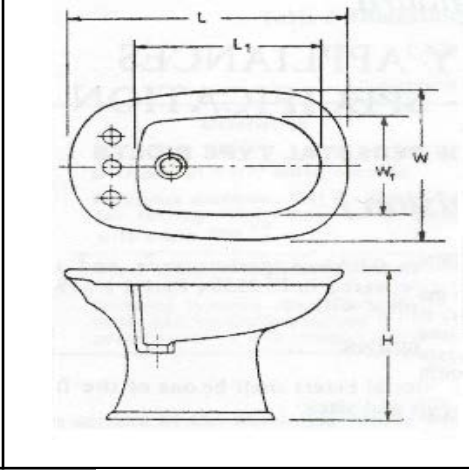



**Figure 3.18 (b)** PATTERN 2

*Pattern 1 – Pedestal bidets with flushing rim and spray holes (see fig 3.18 a)*

*Pattern 2 – Pedestal bidets without flushing rim and over rim supply (see fig 3.18 b)*

Pedestal bidets shall be of one piece construction. A pedestal bidet with flushing rim shall have three tap holes and a spray hole. The pop-up hole shall be optional. The central hole shall have the provision to supply water to the rim. A pedestal bidet without flushing rim shall be provided with one or three tap holes and without any spray hole. Each bidet shall be provided with a waste outlet with or without overflow arrangement. Suitable provision shall be made for fixing the bidet to the floor.

The inside surface of the bidet and waste outlet shall be glazed uniform, smooth for efficient draining.

3.78.17 *Flushing cistern*: -Cisterns shall be made in nominal sizes of 5 and 10 litres and shall have a discharge capacity equal to the nominal sizes with a tolerance of ± 0.5 litres. The flushing cistern shall be automatic or manually operated, high level or low level as specified for water closets and urinals. A high level cistern is intended to operate with minimum height of 125 cm and low level with a maximum height of 30 cm between top of the pan and underside of the cistern. Cistern shall be of cast Iron, white glazed vitreous china or pressed steel as specified complying with the requirements of the IS 774 and IS 2326 respectively. The body thickness of the cast iron cistern shall not at any place be less than 5 mm and that vitreous china 6 mm. The body of the pressed steel cistern shall be of seamless or welded construction. The body and the cover of pressed steel cistern shall be of thickness not less than 1.6 mm and 1.3 mm respectively before coating and shall be vitreous enamelled or otherwise protected against corrosion by equally efficient coating. The depth of the body of the cistern shall provide for a clearance of not less than 25 mm between the highest level that can be reached by water before siphonage commences and the spillover level of the top of the cistern. The cistern shall be free from manufacturing faults and other defects affecting their utility. All working parts shall be designed to operate smoothly and efficiently. Cistern shall be mosquito proof. The breadth of a low level cistern from front to back shall be such that the cover or seat, or both, of the water closet pan shall come to rest in a stable position when raised. The cistern shall have a removable cover, which shall fit closely on it and be secured against displacement. In designs where the operating mechanism is attached to the cover, this may be made in two sections, but the outer section supporting the mechanism shall be securely bolted or screwed to the body. The outlet fitting of each cistern shall be securely connected to the cistern outlet and made airtight by means of a coupling nut. In the case of high-level cistern, the outlet shall be of 32 ± 1 mm nominal bore and in case of low-level cistern the outlet shall be of 38 ± 1 mm nominal bore. The steel flush pipe shall be not less than 1 mm thick whereas the lead flush pipe shall have a minimum thickness of 3.5 mm. For high density polyethylene and unplasticized PVC pipes, the outside diameter of the pipe shall be 40 mm. When PVC plumbing pipes are used, the outside diameter of pipe shall be 40 mm for high-level cisterns and 50 mm for low-level cisterns. No flush pipe is required for coupled cisterns.

In the case of a high-level manually operated cistern, the lever arm of the cistern shall have a suitable hole near and through which a split ring or a 'S' hook shall pass. A chain shall be attached to the ring or hook. The chain shall be of C.I. and strong enough to sustain a suddenly applied pull of 10 kg or a dead load of 50 kg without any apparent or permanent deformation of the shape of the link. The chain shall terminate in a suitable handle or pull, which shall be of pottery, galvanized iron, non-ferrous metal or a moulding in any heat resisting and non-absorbent plastic. The finish shall be smooth and free from burrs. In case of low level flushing cistern the handle shall be of chromium

plated brass. In the case of manually operated cistern the siphonic function of the flushing cistern shall be capable of being rapidly brought into action by the operating level but shall not self siphon or leak. The discharge rate of the cistern shall be about 5 liters in 3 seconds, when connected to an appropriate flush pipe and there shall be no appreciable change in the force of flush pipe and there shall be no appreciable change in the force of flush during the period of discharge.

3.79 **Fittings and Accessories for Sanitary Appliances: -**

3.79.1 *Waste plug and its accessories for Sinks and Wash basins*: - They shall conform to IS 3311. Sinks and Wash basins shall be provided with a waste plug of suitable dia., chain and stay. The plug shall be of a rubber or other equally suitable material and shall be water tight when fitted. Plug chain shall be of brass wire of 1.80 mm with oval links approximately 13 mm in length and shall be chromium plated. It shall have an overall length from the collar to stay of not less than 300 mm. There shall be a triangular D-shackle at each end, one of which shall be brazed to the plug and the other securely fixed to the stay. Chain stay shall be of bolt type or screw type as specified by the purchaser and shall be made of brass or any other equally suitable corrosion resistant material. The shank of the stays shall be fully threaded to the underside of the flange.

The plug chain and stay shall be chromium plated. The quality of chromium plating shall not be less than Service Grade No.2 of IS 4827.

3.79.2 *Waste fittings for Sinks and Wash basins:* **-** They shall conform to IS 2963. The fittings shall in all respects be sound, free from laps, blow holes and pitting, and other manufacturing defects. External and internal surfaces shall be clean and smooth. The body and nut shall be truly machined so that the nut smoothly moves on the body. The body of the waste fittings shall be manufactured from brass conforming to Grade 3 of IS 292-1961 or leaded tin bronze conforming to Grade 2 of IS 318-1962. Nuts shall be made out of brass rod conforming to Type 1 half hard of IS 319. The fittings shall be nickel chromium plated. The thickness of plating shall not be less than Service Grade no. 2 of IS 4827. The plating shall be capable of taking high polish, which will not easily tarnish or scale. Waste fittings for wash basins shall be of nominal size 32 mm. Waste fittings for sinks shall be of nominal size 50 mm.

3.79.3 *P.V.C. Waste*: - The internal and external surface of the P.V.C. waste shall be smooth and clean. The threading shall be for the full length and the nut shall move smoothly. The size shall be as specified.

3.79.4 *M.I. or C.P. brass trap*: - The trap shall be of `U' type or the bottle type as required. The size shall be as specified.

3.79.5 *Copper alloy cast traps 'P' and 'S' types and their associated components*: - They shall conform to IS 5219 (Part 1) and shall be manufactured in the following nominal sizes:

32, 40, and 50 mm.

These are used in wash basins, sinks, bath tubs and similar waste appliances.

The castings shall be of brass with copper content not less than 56 percent and shall be sound in all respects, free from blow holes, laps and sand pittings. The external surface of traps and associated components (tail pipes, coupling nuts, blank nuts, clean out plugs, removable caps and washers) shall have one of the following finishes:

a) Self-colour, free from grease and tool marks;

b) Polished; and
c) Nickel or chromium plated.

Inlets of every trap shall have internal threads conforming to the basic profile of ISO metric screw threads (IS 1362 – 1962) and shall be provided with a tail pipe and a coupling nut. The tail pipe shall be screwed on to the inlet with a minimum engagement of 8 mm and secured in position by soldering. Outlet of trap shall be either with plain ends suitable for connection to lead pipe or with external parallel pipe threads of fastening type conforming to IS 2643– 1964.

3.79.6 *100 mm H.C.I P-trap*: - The floor trap shall be P type with a minimum of 50 mm water seal and shall be of self cleaning design. The exit shall be the same as the size of the waste pipe.

3.79.7 *Foot rest*: - Foot rest shall be of vitreous china conforming to IS 2556 (Pt. X).

*3.79.8 Plastic seat and lid with C.P. brass hinges and rubber buffers*: - Thermoset and thermoplastic seats and covers for water closets shall conform to IS 2548 (part 1) and IS 2548 (Part 2) respectively. The thermoset seats and covers shall be of Type PF Moulded from phenolic plastics, and Type UF Moulded from urea-formaldehyde. The underside of the seats may be either flat or recessed. Where the underside is flat, the seat shall be solid moulding, and where the underside is recessed, the section shall be not less than 3 mm at any point. The seat may be of the closed or open front pattern. The cover shall completely cover the aperture of the seat and shall be so designed that it is capable of being raised easily from the seat. The design shall enable it to be connected to the seat by a hinging device. The cover shall not be less than 3 mm in thickness at any point. The surfaces of the seats, covers and components shall be smooth, free from blisters and delamination and reasonably free from flowlines, contamination, streaking and unintended colour variation. Lacquer shall not be used for surface finishing.

Each seat shall have at least four rubber or plastic buffers which shall be securely fixed to the underside of the seat. The buffer shall be so located that the seat is properly supported by the top surface of the water closet.

3.79.9 *Flush valves and fittings for water closets and urinals*: - These shall conform to IS 9758. The nominal sizes of the flush valves shall be 15, 25 and 32 mm. The nominal size shall be the nominal bore of the supply pipe to which the valve is connected. The flush valves of above mentioned nominal sizes shall have an outlet of 20, 32, and 40 mm outside diameter respectively and shall have threads conforming to IS 2643 (Part 1):1975. The outlet of the flush valve shall be provided with a brass coupling nut, so that the flush valve may be connected to the flushing pipes. The flush valve shall be self-closing and non-concussive in action and shall be provided with a push button or lever for operation.

Discharge capacities of flush valves and tolerances of the same shall be as under:

5 litres

} ± 0.5 litres

10 litres

A flush valve shall be capable of working under pressure of 0.15 to 0.5 MPa and shall be capable of discharging the full capacity in a single operation.

The outside of the body shall be polished bright and chromium plated which shall be of quality not less than service grade 3 of IS 4827: 1968. The plating shall be capable of

taking high polish, which shall not easily tarnish or scale. For concealed work concealed parts need not be plated.

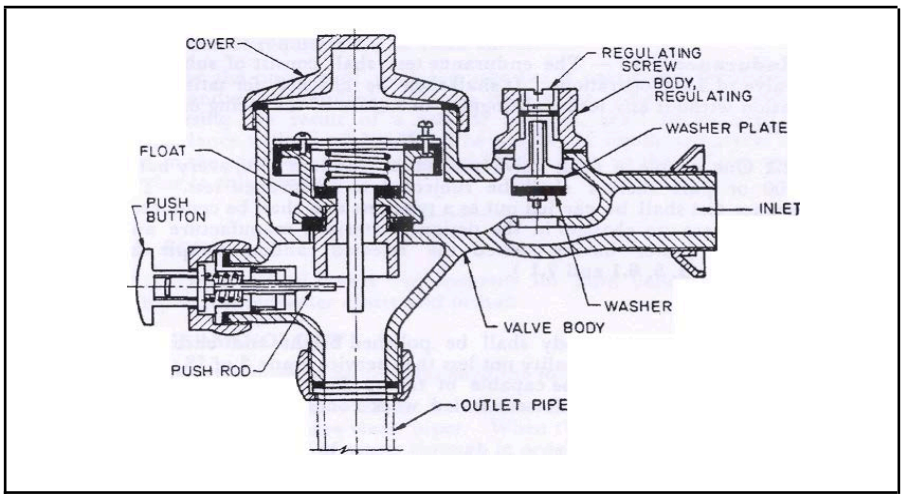
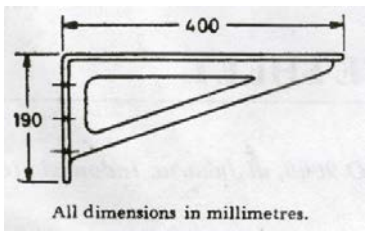


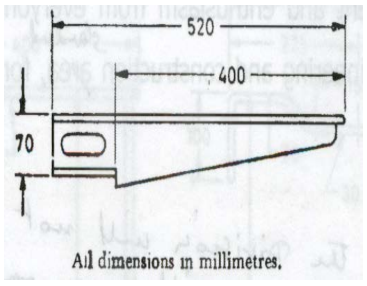

**Figure 3.19** TYPICAL SKETCH OF A FLUSH VALVE

3.79.10 *32 mm dia galvanized steel telescopic flush pipe with brass union*: - The flush pipe shall be of medium quality galvanized iron having nominal internal diameter of 32 mm. The flushing pipe shall be of suitable length with bends etc. as required for fixing it with front or back inlet, of W.C. pan. In case of high-level cistern, the flush pipe shall be a vertical pipe 125cm long and having nominal internal dia 32mm.

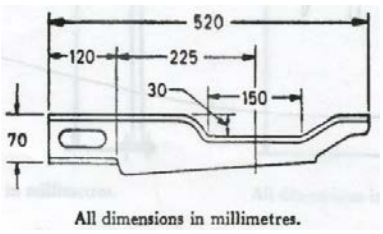
3.79.11*R.S. or C.I. brackets and supports* (see fig 3.20): - The C.I. brackets and supports shall conform to m IS: 775. Cast Iron used for the manufacture of brackets and supports shall be of quality not inferior to Grade 15 of IS 210:1962. Castings shall be free from blow holes, cracks and other defects. The article shall be cleanly cast and true to shape. Steel brackets and straps shall be cleanly finished with smooth edges, free from mill scale and oxide coating. The brackets and supports shall be protected properly by suitable impervious paint of approved quality.



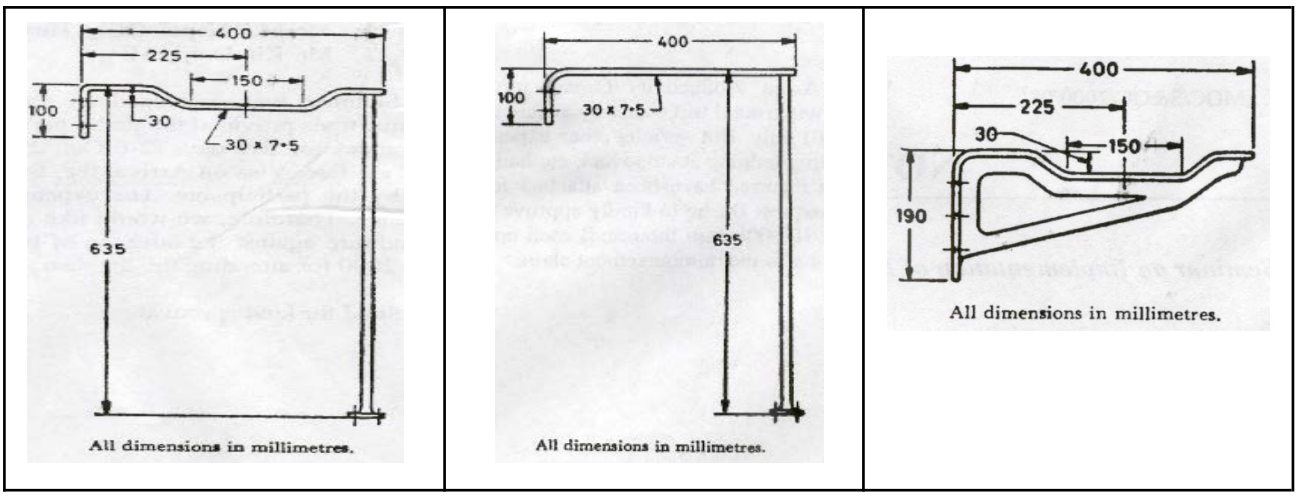

**a.** WALL FIXING BRACKET FOR SINK




**b.** CANTILEVER SUPPORT FOR SINK




**c.** RECESSED CANTILEVER SUPPORT FOR SINK




**d.** STRAP AND LEG SUPPORT WITH RECESS FOR SINK

**e.** STRAP AND LEG SUPPORT FOR SINK

**f.** WALL FIXING BRACKET WITH RECESS FOR SINK

**Figure 3.20** R.S OR C.I BRACKETS AND SUPPORTS

3.79.12 *Mosquito Proof coupling*: - Mosquito proof coupling of rigid PVC or any other suitable material shall be as per approved municipal design and approved by the Engineer.

3.79.13 *G.I. over flow pipe*: - G.I. over flow pipe shall be of 20 mm nominal bore and shall have a non-corrodible mosquito proof brass cover, having 1.25 mm dia. Perforation**.**

3.80 **CI Pipe & Pipe fittings: -**

3.80.1 *H.C.I Pipes and S.C.I Pipes & fittings*: - The pipes and fittings shall be sand cast iron pipes conforming to IS 1729. The pipe shall have spigot and socket ends with beads on the spigot end. The pipes and fittings shall be true to shape, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. They shall be sound and nicely cast. They shall be free from cracks, laps, pipe holes and other imperfections and shall be neatly dressed and carefully fettled.

The ends of pipes and fittings shall be reasonably square to their axis. The length of pipes shall be 1.5/1.8/2.0 m. including socket ends. The pipes and fittings shall be supplied without ears, unless specified or directed otherwise. All pipes and fittings shall ring clearly when struck over with a light hand hammer and shall be capable of being easily worked with a drill or file. All pipes and fittings shall be coated internally and externally with the same material at the factory, the fittings being preheated prior to total immersion in a bath containing a uniformly heated composition having a tar or other suitable base. The coating material shall have good adherence and shall not scale off. In all instances where the coating material has a tar or similar base it shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 77 degree C., but not so brittle at a temperature of 0 degree C. as to chip off when scribed lightly with a pen knife.

The thickness of fitting and their socket and spigot dimension shall conform to the thickness and dimension specified for the corresponding sizes of straight pipes. The tolerance in weights and thickness shall be the same as for straight pipes. The access door fittings shall be designed so as to avoid dead spaces in which filth may accumulate.

Doors shall be provided with 3 mm rubber insertion packing and when closed and bolted, these shall be water tight.

The standard weights and thickness of pipes shall be as follows:

**Table 3.61** STANDARD WEIGHTS AND THICKNESS OF CI PIPES

| Nominal dia of base (mm) | Thickness 1.5 m long (mm) | Overall (Kg) | Weight of pipe 1.5 m long (Kg) | Excluding ears 2.0 long |
|---|---|---|---|---|
| 50 | 5.0 | 9.61 | 11.41 | 12.65 |
| 100 | 5.0 | 18.1 | 21.67 | 24.15 |
| 150 | 5.0 | 26.7 | 31.92 | 35.66 |

A tolerance up to 15 percent in thickness and 20 mm in length will be allowed. For fittings tolerance in length shall be + 25 mm and - 10 mm. There will be no limit on the + tolerance on thickness.

A tolerance up to - 10 percent will be allowed against the standard weights.

3.80.2 *H.C.I heel rest bend*: - Specifications of fittings under paragraph "S.C.I pipes & Fittings" shall apply.

3.80.3 *100mm C.I Head/bends*: - These shall be of approved manufacture, true, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. These shall be sound and uniform castings, free from laps, pin holes or other imperfections and shall be neatly finished and carefully fitted both inside and outside. The ends of the pipes shall be reasonably square to the axis. Bends shall be of the nearest degree as actually required at site. Heads shall be of the flat or corner type as required. Offset shall be of the projection as stipulated in the description of the item. Standard shoes shall be of over all vertical length, 205mm for 100mm dia pipe.

The thickness of the fittings and details of spigots and sockets shall be the same as those of the corresponding size of straight pipes. The fittings shall be supplied without ears unless otherwise specifically mentioned. The fittings shall be factory painted with a tar based composition both inside and outside which shall be smooth and tenacious. Every fitting shall ring clearly when struck anywhere with a light hand hammer. The fittings shall be of standard size and their weight shall be as given below: -

| | |
|---|---|
| 100mm head | 6.8 kg. |
| 100mm bend | 4.5 kg. |
| 100mm Shoe | 4.1 kg. |
| 100mm Offset 75 mm projection | 5.5 kg. |
| 100mm Offset150 mm projection | 6.4 kg. |

A tolerance of -5% shall be allowed over weights mentioned above.

3.80.4 *CI rain water pipe 100mm dia*: - Pipes shall be of approved manufacture, true, smooth and cylindrical, their inner and outer surfaces being as nearly as practicable concentric. These shall be sound and uniform castings, free from laps, pin holes or other imperfections and shall be neatly finished and carefully fitted both inside and outside. The ends of pipes shall reasonably square to their axis. The pipes shall be factory painted

both inside and outside. The diameter shall be 100mm and the full length shall be 1.8 metres including socket ends. When shorter pipes are cut from full lengths they shall be cut with a hacksaw. The dimensions and weight shall be as follows:

| | |
|---|---|
| External diameter | 104 |
| Thickness | 3 mm |
| Weight of 1800mm pipe without ears | 14.0 kg |

Tolerance on diameter shall be 3.5mm and on thickness 1mm the tolerance on weight shall be 10 percent.

3.81 **Water storage tanks: -**

3.81.1 *Hot pressed moulded thermosetting glass fibre reinforced polyester resin (GRP) sectional water storage tanks*: - GRP panels used in manufacturing water storage tanks shall conform to IS 14399 (Part 1). Panel is a GRP composite produced by hot compression moulding of SMC (Sheet Moulding Compound) into specified dimensions. The material to be used shall be composed of unsaturated thermosetting polyester resin (food grade) reinforced with glassfibre. This system will include catalysts and may include pigments (compatible with unsaturated polyester resin) and ultra violet stabilizers. These materials coming in contact or likely to come in contact with water should not constitute toxic hazard, should not support microbial growth and should not give rise to unpleasant taste or odour, cloudiness or discolouration of water. Tank manufacturers should ensure and obtain certificates to this effect from the raw material manufacturer.

The panels shall be manufactured with a combined double flange at an angle of $45^{o}$ and $90^{o}$ to the face of the panels on all four sides or a single flange at an angle of $90^{o}$ to the face of the panels on each of the 2, 3 or 4 sides. The flange shall be provided with holes to accommodate fasteners according to the position of the panels in the tank and they should be free from irregularities. The joint width (land width) of the flanges shall not be less than 45 mm. The nominal external size of the unit panels shall be 1 m x 0.5 m or 0.5 m x 0.5 m or as specified. Tolerance in the external dimensions of each panel shall be ± 0.2 percent of the external dimensions. Tolerance on angles shall be within ± $0.3^{o}$

The type and corresponding minimum thickness of the panels shall be as follows:

| **Type of Panel** | **Min Thickness, mm** |
|---|---|
| A | 3 |
| B | 4 |
| C | 5 |

The internal and external surfaces of the panels when visually inspected shall be free from the following defects:

a) Small pits appear on the surface.
b) Poor impregnation of fibre glass with resin.
c) Cuts, cracks and scratches exposing the glass reinforcement.
d) Sharp projections, exposed fibres or glass reinforcement too close to the surface.
e) Surface and non-structural repair marks.
f) Blisters on the surface caused by air pockets.

3.81.2 *Rotational moulded polyethylene water storage tanks*: - Tank shall be of cylindrical vertical (see fig. 3.21) and Rectangular Loft types, and shall conform to IS 12701. The material of construction of tank, lid and fittings which come in contact with water shall be such that it does not impart any taste, colour or odour to water, nor have any toxic effect, it shall not contaminate water thereby making it unpotable. Owing to limitations of rotational moulding process, the wall thickness of the water storage tank at bottom, top and cylindrical sides at bottom and top edges where the shape of tank changes is usually found to be much greater than the wall thickness at other surfaces.

The internal and external surface of the water storage tank shall be smooth, clean and free from other hidden internal defects, such as air bubbles, pits and metallic or other foreign material inclusions. The mould parting line and excess material near the top rim of the tank shall be cut and finished to the required level. Defects like air bubbles and pits at the mould parting line and at the top rim of the main-man-hole shall be repaired by hot-air filler rod welding method. The tensile strength of the wall of water tanks shall not be less than 12 N/mm$^2$.

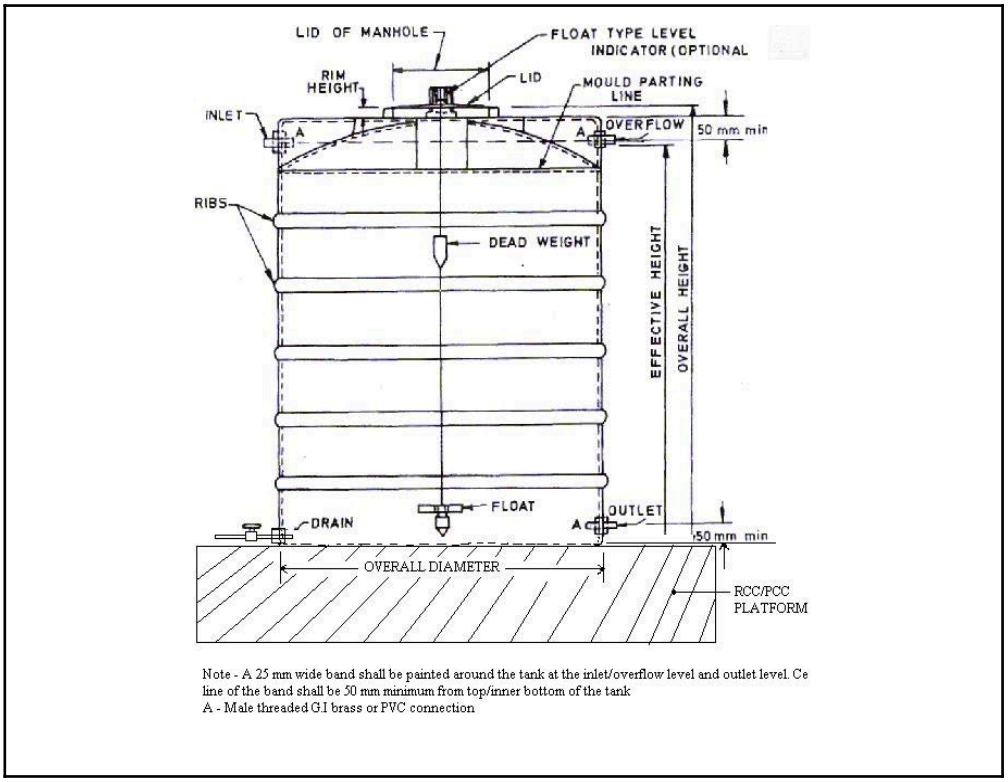



**Figure 3.21** TYPICAL DETAILS OF CYLINDRICAL VERTICAL TANK

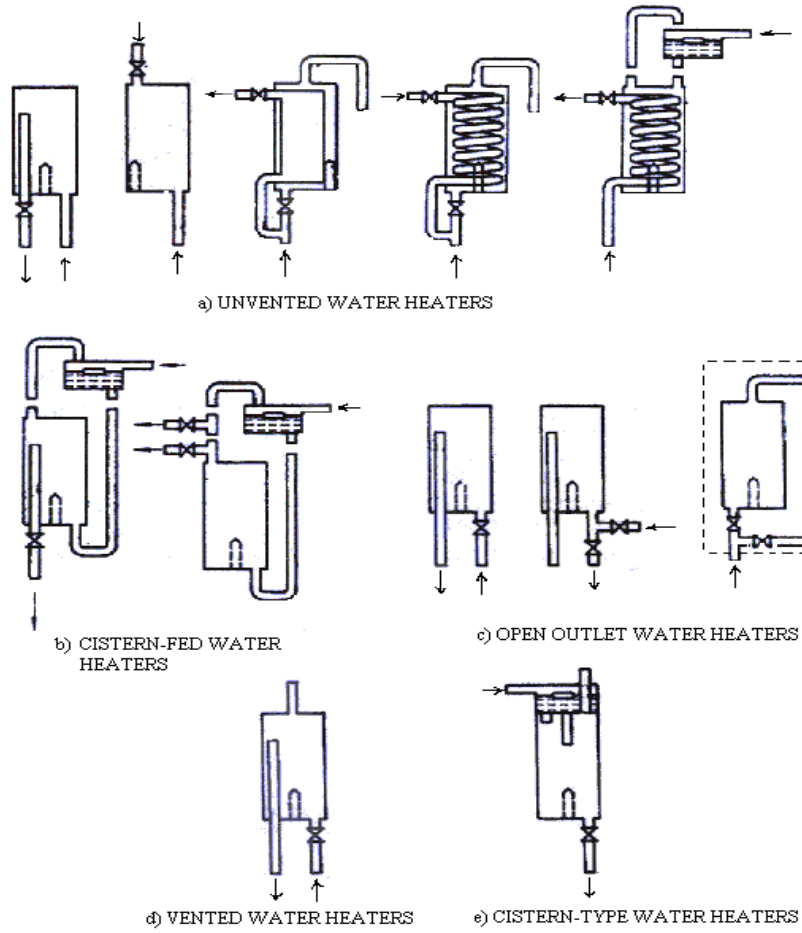



**Figure 3.22** SCHEMATIC REPRESENTATION OF STORAGE WATER HEATERS

3.82 **Electric water heaters: -**

3.82.1 *Stationary storage type electric water heaters*: - They shall conform to IS 2082. Water heaters shall be so constructed that, in normal use, there will be no electrical or mechanical failure that might impair compliance with requirements of IS 2082. The insulation shall not be damaged and contacts and connections shall not work loose as a result of heating vibration, etc. Compliance is adequately checked by the test of the clauses of the IS 2082.

The external finish used on metal components shall be of a heat and moisture resisting nature and shall not be adversely affected by variation in temperature occurring under normal operating conditions or after the endurance test.

Clause 3 of IS 302-2-21 (1992) shall apply for general requirements.

Clause 5 of IS 302-2-21 (1992) shall apply for Ratings.

Clause 6 of IS 302-2-21 (1992) shall apply for classifications.

The water heater shall comply with the requirement given in 8 to 31 of IS 302-2-21 (1992) for safety requirements.

Wall-mounted water heaters are mounted on a panel situated at least 150 mm from any structural wall. They are positioned so that there is a clear space of at least 250 mm above and below the heater and at least 700 mm at the sides and front. Floor-mounted

water heaters are placed on the floor or any stand supplied with them. A false floor may be used to facilitate measurements.

3.83 **Other miscellaneous items: -**

3.83.1 *Draining Board*: - The draining board shall be manufactured from well seasoned teak wood (second class) and designed to ensure that all liquid shall discharge directly into the sink. The drawing board shall have a fluted surface with smooth finish capable of being easily cleaned.

The board shall be of one piece or jointed with tongued and grooved joints. Only one cardinal joint shall be permissible. The joints shall be properly glued inside with waterproof glue. In case of board with joint, two battens each 50 mm x 25 mm size shall be fixed with screws. To prevent water running back at 6 x 6 mm deep groove shall be cut in the underside of the board, parallel to and with its centre line 6 mm away back from the drip edge.

The draining board shall be provided with 15 mm thick back and side skirting. The size of the board measured from outside of skirting shall be 75 x 45 x 2.5 cm, 60 x 45 x 2.5 cm or as specified. The skirting measured from inside shall be 65 mm to 75 mm high with edges rounded off. The entire surface including bottom of the board shall be finished smooth.

The draining board shall be finished on all sides with bees wax.

3.83.2 *Cast iron gratings for drainage purpose*): -These shall conform to IS 5961. The frame and the cover shall be cleanly cast and they shall be free from air and sand holes, cold shuts and warping which are likely to impair the utility of castings. The minimum weight of cast iron gratings shall be 75 kg. The drainage cover and frame shall be coated with a material having tar base with a black bituminous composition after the surface is rendered smooth by chipping the projections, if any; the surface shall also be clean, dry and free from any rust before coating. The coating shall be smooth and tenacious which will flow when exposed to a temperature of 63$^{o}$C and shall not be so brittle as to chip off at temperature of 0$^{o}$C.

3.83.3 *Asbestos cement pipes*: - They shall be made from a thorough and homogenous mixture of ordinary Portland cement conforming to IS 269 and asbestos fibre free from loading and from organic fibres. The pipe shall conform to IS 1592. The pipe shall be capable of withstanding a pressure of 5 kg/cm$^2$. The variation of the internal dia. shall not be more than 10% of the nominal internal dia. The interior of the pipe shall have smooth finish and regular surface and regular internal diameter. It shall be straight within tolerance limits.

3.83.4 *R.C.C. Non pressure Pipes*: - The pipes shall be of the class specified. These shall conform to IS 458. The reinforced pipes shall be manufactured by the spun process. All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding. The concrete used shall be not leaner than 1:2:4. The maximum size of aggregate should not exceed one third of the thickness of pipe or 20 mm whichever is smaller. The minimum cover shall be as specified for the thickness of pipe.

3.83.5 *Glazed stoneware pipe and fittings*: - All pipes with spigot and socket ends shall conform to IS 651:2007. These shall be sound free from visible defects such as fire cracks

or hair cracks. The glaze of the pipes shall be free from crazing. The pipe shall give a sharp clear note when struck with a light hammer. There shall be no broken blisters. The length of the pipes shall be 60, 75, 90 cm, exclusive of the internal depth of the socket. The permissible tolerance on length shall be within ± 10 mm for pipes of 600 and 750 mm length. The thickness of the pipe (100 mm dia.) shall be 12 mm. Colour of pipes/fittings may vary from yellow to dark brown/black.

3.83.6 *Spun yarn*: - Spun yarn shall be of clean hemp and of good quality. It shall be soaked in hot coal tar or bitumen and cooled before use.

3.83.7 *Holder bat clamp 32 mm dia.*: - The clamp shall be made from 1.5 mm thick M.S. plate of 32 mm width, bent to required shape and size to fit tightly on the socket of the pipe, when tightened with screw bolts. It shall be formed of two semi-circular pieces with flanged ends on both sides, with holes to fit in the screw, bolts and nuts, 40 mm long.

3.83.8 *Cast iron manhole covers and frames*: - Manhole covers and frames conforming to IS 1726 shall be of following four grades and types:

**Table 3.62** GRADES AND TYPES CAST IRON MANHOLE COVERS AND FRAMES

| Grades | Grade designation | Type/shape of cover |
|---|---|---|
| Light - duty | LD – 2.5 | Rectangular |
| | | Square |
| | | Circular |
| Medium duty | MD -10 | Circular |
| | | Rectangular |
| Heavy duty | HD - 20 | Circular |
| | | Lamphole |
| | | Square |
| | | Rectangular |
| | | (Scrapper manhole) |
| Extra-Heavy-Duty | EHD-35 | Circular |
| | | Square |
| | | Rectangular |
| | | (Scrapper manhole) |

Manhole covers and frames shall be manufactured from appropriate grades of grey cast-iron, not inferior to FG 150 Grade of IS 210:1978.

The manhole cover and frame shall be coated with a material having base with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63°C and shall not be so brittle as to chip off at temperature of 0°C.

3.83.9 *Water meters (Domestic type)*: - Water meters with threaded end connections of size up to and including 50 mm, having nominal flow rates in the range of 1.5 to 15 kl/h,

suitable for measuring the flow of cold potable water at a nominal pressure of 1 MPa (max) and ambient pressure, and also semipositive (piston type) and inferential (turbine type) including magnetic type water meters having dry or wet dial shall conform to IS: 779. Water meters shall be of the following nominal sizes: 15, 20, 25, 40 and 50 mm. The nominal size is denoted by the nominal bore of its end connections.

Based on the maximum verification scale interval and metrological characteristics, meters have been classified as class 'O', class 'A' and class 'B'.

Water meters shall be made of materials of adequate strength and stability for the purpose for which the water meter is to be used. It must be constructed through out of materials, which are resistant to internal and normal external corrosion and if necessary be protected by some suitable surface treatment. Parts coming in contact with water shall be made of materials resistant to corrosion and shall be nontoxic and non-tainting. Use of dissimilar metals in contact under water should be avoided as far as possible in order to minimize electrolytic corrosion. Water temperature variation within the temperature range specified must not adversely affect the materials used in the construction of the water meter.

The water meter shall be constructed in such a way as to:

a) give a long service and guarantee against any fraud or tampering; and
b) conform with provisions of IS: 779, under normal conditions of use.

3.83.10 *Water meters (Bulk type)*: - Vane-wheel (impeller) type water meters from 50 to 300 mm and Helical type water meters from 50 to 500 mm shall conform to IS: 2373. Water meters and their parts, especially coming in continuous contact with water, shall be made of materials resistant to corrosion and shall be non-toxic and non-tainting; where cost iron is used, it shall be protected suitably against corrosion. Use of dissimilar metals in contact under water should be avoided as far as possible in order to minimize electrolytic corrosion. The water meter shall be provided with flanges for connection at both ends, the internal diameter of which shall be equal to the nominal size of the meter. The flanges shall be machined flat, that is, without a raised joint face. The water meter shall be suitable for use with water up to 45$^{o}$C. Meters shall satisfactorily withstand a pressure of 1.6 MPa (16 kg/cm$^{2}$).

3.83.11 *Water meter boxes (Domestic type):* - Water meter boxes may be made of any suitable material, such as cast iron, mild steel or reinforced concrete and shall conform to IS: 2104. Water meter boxes shall be of two sizes, namely size 1 and size 2. Size 1 shall be suitable for the installation of water meters of nominal sizes 15, 20 and 25 mm and size 2 for water meters of nominal sizes 40 and 50 mm. The box shall be of oval or rectangular shape. The inside clear dimensions of boxes shall be suitable for the sizes of water meters, which they have to accommodate. The minimum clear dimensions shall be as given below:

**Table 3.63** MINIMUM CLEAR DIMENSIONS OF WATER METER BOXES (DOMESTIC TYPE)

| Size | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|
| 1 | 600 | 600 | 500 |
| 2 | 900 | 600 | 600 |

A slot in the shape of an inverted 'U' shall be provided on the short sides of the box along their centre lines for passage of pipe. Locking arrangement may be provided either

with a dog-and-clamp arrangement with the dog to operate by an ordinary sluice valve key, or alternatively, by means of a padlock. Suitable anchorage for fixing the box to the concrete or masonry bed plate on which the water meter would be installed shall be provided.

3.84 **CPVC pipes: -**

CPVC pipes & fittings used in hot & cold potable water distribution systems shall conform to requirement of IS 15778. The material from which the pipe is produced shall consist of chlorinated polyvinyl chlorides. The polymer from which the pipe compounds are to be manufactured shall have chlorine content not less than 66.5%.

The internal and external surfaces of the pipe shall be smooth, clean and free from grooving and other defects. The pipes shall not have any detrimental effect on the composition of the water flowing through it.

Diameter and wall thickness of CPVC pipes are as per given in Table 3.64 below.

**Table 3.64** DIAMETERS AND WALL THICKNESS OF CPVC PIPES

| S.No | Nomi-nal size | Nominal outside diameter | Mean Outside diameter | | Outside diameter at any point | | Class1, SDR11 | | | Class 3, SDR 17 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Min | Max | Avg. Max | Min | Max | Avg. Max | Min | Max |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) |
| (i) | 15 | 15.9 | 15.8 | 16 | 15.8 | 16.0 | 2.2 | 1.7 | 2.2 | - | - | - |
| (ii) | 20 | 22.2 | 22.1 | 22.3 | 22.0 | 22.4 | 2.5 | 2.0 | 2.5 | - | - | - |
| (iii) | 25 | 28.6 | 28.5 | 28.7 | 28.4 | 28.8 | 3.1 | 2.6 | 3.1 | - | - | - |
| (iv) | 32 | 34.9 | 34.8 | 35 | 34.7 | 35.1 | 3.7 | 3.2 | 3.7 | - | - | - |
| (v) | 40 | 41.3 | 41.2 | 41.4 | 41.1 | 41.5 | 4.3 | 3.8 | 4.3 | - | - | - |
| (vi) | 50 | 54 | 53.9 | 54.1 | 53.7 | 54.3 | 5.5 | 4.9 | 5.5 | - | - | - |
| (vii) | 65 | 73 | 72.8 | 73.2 | 72.2 | 73.8 | - | - | - | 4.8 | 4.3 | 4.8 |
| (viii) | 80 | 88.9 | 88.7 | 89.1 | 88.1 | 89.7 | - | - | - | 5.9 | 5.2 | 5.9 |
| (ix) | 100 | 114.3 | 114.1 | 114.5 | 113.5 | 115.1 | - | - | - | 7.5 | 6.7 | 7.5 |
| (x) | 150 | 168.3 | 168.0 | 168.6 | 166.5 | 170.1 | - | - | - | 11.1 | 9.9 | 11.1 |

**Notes**

1. For CPVC pipes SDR is calculated by dividing the average outer diameter of the pipe in mm by the minimum wall thickness in mm. If the wall thickness calculated by this formula is less than 1.52 mm, it shall be increased to 1.52 mm. The SDR values shall be rounded to the nearest 0.5.

3.84.1 *Dimensions of Pipes:* The outside diameter, at any point and wall thickness shall be as given in Table 3.64.

3.84.2 *Diameter:* The outside diameter and outside diameter at any point as given in Table 3.58 shall be measured according to the method given in IS 12235 (part 1).

3.84.3 *Diameter at any point:* The difference between the measured maximum outside diameter and measured minimum outside diameter in the same cross-section of pipe (also called tolerance on ovality) shall not exceed the greater of the following two values:

(a) 0.5 mm, and

(b) 0.012 $d_n$ rounded off to the next higher 0.1 mm.

3.84.4 *Wall Thickness*:The wall thickness of the pipes shall be as given in Table 3.58. Wall thickness shall be measured by any of the three methods given in IS 12235 (part 1). To check the conformity of the wall thickness of the pipe throughout its entire length, it is necessary to measure the wall thickness of the pipe at any point along its length. This shall be done by cutting the pipe at any point along its length and measuring the wall thickness as above. Alternatively, to avoid destruction of the pipe, non-destructive testing methods such as the use of ultrasonic wall thickness measurement gauges shall be used at any four points along the length of the pipe.

Tolerance on Wall Thickness

(a) For pipes of minimum wall thickness 6 mm or less, the permissible variation between the minimum wall thickness ($e_{Min}$) and the wall thickness at any point (e), (e - $e_{Min}$) shall be positive in the form of +y, where y=0.1 $e_{Min}$+0.2 mm.

(b) For pipes of minimum wall thickness greater than 6mm, the permissible variation of wall thickness shall again be positive in the form of +y, where y would be applied in two parts.

(c) The average wall thickness shall be determined by taking at least six measurements of wall thickness round the pipe and including both the absolute minimum and absolute maximum measured values. The tolerance applied to this average wall thickness from these measurements shall be within the range 0.1 $e_{Min}$+0.2 mm (see Table 3.58).

(d) The maximum wall thickness at any point shall be within the range 0.15$e_{Min}$ (see Table 3.58).

(e) The results of these calculations for checking tolerance shall be rounded off to the next higher 0.1 mm.

3.84.5 *Effective Length (Le):*If the length of a pipe is specified, the effective length shall not be less than that specified. The preferred effective length of pipes shall be 3, 5 or 6 m. The pipes may be supplied in other lengths where so agreed upon between the manufacturer and the purchaser.

3.84.6 *Pipe Ends:*The ends of the pipes meant for solvent cementing shall be cleanly cut and shall be reasonably square to the axis of the pipe or may be chamfered at the plain end.

**Physical and Chemical Characteristics**

3.84.7 *Visual Appearance:* The colour of the pipes shall be off-white. Slight variations in the appearance of the colour are permitted. The internal and external surface of the pipe shall be smooth, clean and free from grooving and other defects.

3.84.8 *Opacity:* The wall of the plain pipe shall not transmit more than 0.1 per cent of the visible light falling on it when tested in accordance with IS 12235 (Part 3).

3.84.9 *Effect on Water:* The pipes shall not have any determinate effect on the composition of the water flowing through them, when tested as per 10.3 of IS 4985.

3.84.10 *Reversion Test:* When tested by the method prescribed in IS 12235 (Part 5/ Sec 1 and Sec 2), a length of pipe 200 ±20 mm long shall not alter in length by more than 5 per cent.

3.84.11 *Vicat Softening Temperature*: When tested by the method prescribed in IS 12235 (part 2), the Vicat softening temperature of the specimen shall not be less than 110°C.

3.84.12 *Density:* When tested in accordance with IS 12235 (Part 14), the density of the pipes shall be between 1450kg/m3 and 1650kg/m3.

**Mechanical Properties**

3.84.13 *Hydrostatic Characteristics:* When subject to internal hydrostatic pressure test in accordance with the procedure given in IS 12235 (part 8/Sec 1), the pipe shall not fail during the prescribed test duration. The temperatures, duration and hydrostatic (hoop) stress for the test shall conform to the requirements given in Table 3.65. The test shall be carried out not earlier than 24 h after the pipes have been manufactured.

**TABLE 3.65** REQUIREMENTS OF PIPES FOR INTERNAL HYDROSTATIC PRESSURE TEST

| **Sl. No** | **Test** | **Test Temperature, Min (°C)** | **Test Period (hr.)** | **Hydrostatic (Hoop) Stress (MPa)** |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| (i) | Acceptance | 20 | 1 | 43.0 |
| (ii) | Type | 95 | 165 | 5.6 |
| (iii) | Type | 95 | 1000 | 4.6 |
| (iv) | Type | 95 | 8760 | 3.6(Test for thermal stability) |

3.84.14 Thermal Stability by Hydrostatic Pressure Testing: When subject to internal hydrostatic pressure test in accordance with the procedure given in IS 12235 (Part 8/Sec 1) and as per requirement given in Table 3.59, Sl. No. (iv), the pipe shall not burst or leak during the prescribed test duration.

3.84.15 *Resistance to External Blow at 0°C:* When tested by the method prescribed in IS 4985, with classified striker mass and drop height as given in Table 3.66, the pipe shall have a true impact rate of not more than 10 per cent.

**TABLE 3.66** CLASSIFIED STRIKER MASS AND DROP HEIGHT CONDITIONS FOR THE FALLING WEIGHT IMPACT TEST

| Sl.No. | Nominal Pipe Size (mm) | Mass of falling weight (Kg) | Falling height (mm) |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| (i) | 15 | 0.5±0.5% | 300±10 |
| (ii) | 20 | 0.5±0.5% | 400±10 |
| (iii) | 25 | 0.5±0.5% | 500±10 |
| (iv) | 32 | 0.5±0.5% | 600±10 |
| (v) | 40 | 0.5±0.5% | 800±10 |
| (vi) | 50 | 0.5±0.5% | 1000±10 |
| (vii) | 65 | 0.8±0.5% | 1000±10 |
| (viii) | 80 | 0.5±0.5% | 1200±10 |
| (ix) | 100 | 1.0±0.5% | 1600±10 |
| (x) | 150 | 1.6±0.5% | 2000±10 |

3.84.16 *Flattening Test:* When tested by the method prescribed in IS 12235 (part 19), pipe shall show no signs of cracking, splitting and breaking.

3.84.17 *Tensile Strength:* When tested by the method prescribed in IS 12235 (Part 19), the tensile strength at yield shall not be less than 50 MPa at 27 ± 2°C.

3.84.18 *Fittings:* The fittings shall be as follows:

(a) Plain CPVC solvent cement fittings from size 15 mm to 160 mm.

(b) Brass threaded fittings.

(c) Valve from size 15 mm to 160 mm

(d) *Brass Threaded Fittings:* All types of one end brass threaded male/female adaptors in various fittings like coupler, socket, elbow, tee are available for transition to other plastic/metal piping and for fixing of CP fittings. Ball Gate valves in CPVC are available in all dimensions. All fittings shall carry the following information:

(1) Manufacturer's name/trade mark.

(2) Size of fitting

3.85 **AAC Blocks: -**

Autoclaved Aerated Concrete Blocks (AAC): concrete shall be made in sizes and shapes to fit different construction needs conforming to IS: 2185 (part 3)-1984. They include stretcher, corner, double corner or pier, jamb, header, bull nose, and partition block, and concrete floor units.

All units shall be sound and free of cracks or other defects which interfere with the proper placing of units or impair the strength or performance of the construction. Minor chipping resulting from customary methods of handling during delivery, shall not be

deemed grounds for rejection. Where units are to be used in exposed wall construction, the face or faces that are to be exposed shall be free of chips, cracks, or other imperfections; except that, if not more than 5 percent of the consignment contains slight cracks or small chipping not larger than 25 mm, this shall not be deemed grounds for rejection.

Concrete blocks shall be referred to by its nominal dimensions. The term 'nominal' means that the dimension includes the thickness of the mortar joint. Actual dimensions shall be 10 mm short of the nominal dimensions (or 6 mm short in special cases where finer jointing is specified). The nominal dimensions of the concrete block shall be as follows:

| | |
|---|---|
| Length | 400, 500 or 600 mm |
| Height | 200, 250 or 300 mm |
| Width | 100, 150, 200 or 250mm |

In addition, blocks shall be manufactured in half lengths of 200, 250 or 300 mm to correspond to full lengths. The maximum variation in the length of the units shall not be more than ± 5mm and maximum variation in the height and width of the unit, not more than ± 3 mm (*see* Fig 3.23 for mode of measurement). Subject to the tolerances specified, the masonry units shall be flat and rectangular, opposite faces shall be parallel, and rises shall be square. The bedding surfaces shall be all at right angles to the faces of the blocks.

Blocks of sizes other than those specified may also be used if so specified. In the case of special concrete masonry units such as jallie or screen wall blocks and ornamental blocks, the specified sizes may not necessarily apply.

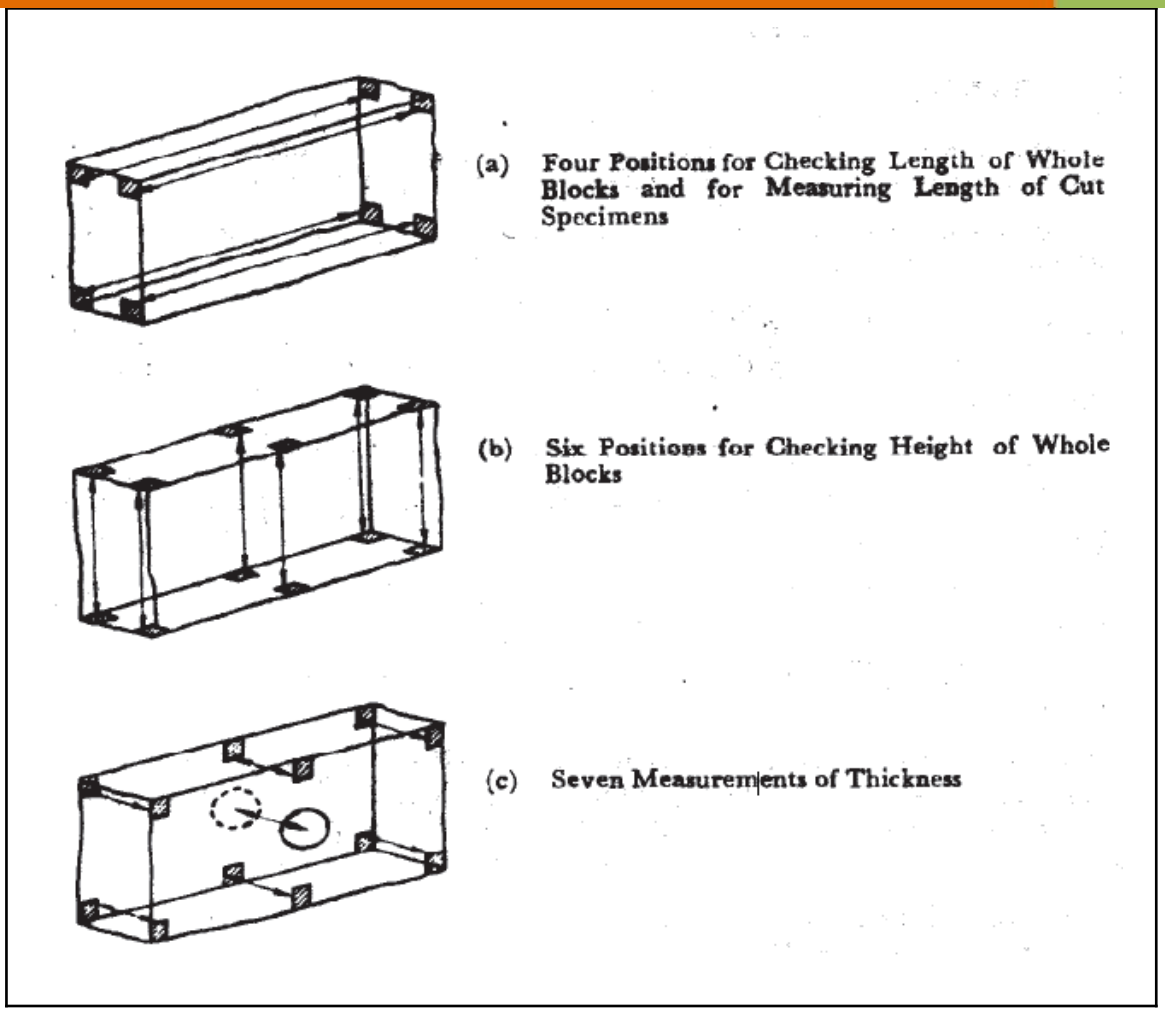



**Figure 3.23** AUTOCLAVED AERATED (CELLULAR) CONCRETE BLOCKS

The autoclaved aerated (cellular) concrete blocks shall be classified in two grades according to their compressive strengths as indicated in table below:

**TABLE 3.67** PHYSICAL PROPERTIES OF AUTOCLAVED AERATED (CELLULAR) CONCRETE BLOCKS

| Sl. No | Density in oven dry condition ($kg/m^3$) | Compressive strength (Min) $N/mm^2$ | | Thermal conductivity in air dry condition W/m.k |
|---|---|---|---|---|
| | | Grade-1 | Grade-2 | |
| (i) | 451 to 550 | 2.00 | 1.50 | 0.21 |
| (ii) | 551 to 650 | 4.00 | 3.00 | 0.24 |
| (iii) | 651 to 750 | 5.00 | 4.00 | 0.30 |
| (iv) | 751 to 850 | 6.00 | 5.00 | 0.37 |
| (v) | 851 to 1000 | 7.00 | 6.00 | 0.42 |

The minimum compressive strength; being the average of twelve units, the block density shall conform to the requirement specified in table 3.61 when tested as per testing procedure specified in IS: 2185 (part 3)-1984.

**3.86 Geotextile:**

Geotextile shall be made of polyethylene or polypropylene or polyester or similar fibres, either woven or nonwoven in variety, through machine made process of heat bonding or needle punching or weaving techniques. These fabrics are required to pass water through but retain the particles, which require specific cross-plane permeability or permittivity and apparent opening size or equivalent opening size or 095. The above two requirements along with the requirement of strength and durability denote general characteristics of geotextiles to be used.

(a) Sustain a load of not less than 10 kN/m at break and have a minimum failure strain of 10 per cent when determined in accordance with BS:6906 (Part 1) or shall have a grab tensile strength more than 0.4kN/m and elongation corresponding to this limit in accordance with ASTM D 4632.

(b) The apparent opening size shall satisfy the following †*

**TABLE 3.68** APPARENT OPENING SIZE

| Test Method ASTM D4751 | Units mm | Requirements per cent in-situ soil passing 0.075mm | | |
|---|---|---|---|---|
| | | <15 | 15 to 50 | >50 |
| | | 0.43 | 0.25 | 0.22** |

*These default filtration property values are based on the predominant particle size of in situ soil. In addition to the default permittivity value, the Engineer may require geotextile permeability and/or performance testing based on engineering design for drainage systems in problematic soil environments.

† Site specific geotextile design should be performed especially if one or more of the following problematic soil environments are encountered; unstable or highly erodible soils such as non-cohesive silts; gap graded soils; alternating sand/silt laminated soils; dispersive clays; and/or rock flour.

**For cohesive soils with a plasticity index greater than 7, geotextile maximum average roll values for apparent opening size is 0.30mm.

**(c)** Allow water to flow through it at right angles to its principal plane, in either direction at a rate of not less than 10 litres/$m^2$ /sec. Under a constant head of water of 100mm, determined in accordance with BS: 6906 (Part 3) or ASTM D 4491 or as stated in the design drawing. The flow rate determined in the test shall be corrected to that applicable to a temperature of 15°C using published data on variation in viscosity of water with temperature.

**(d)** Have a minimum puncture resistance of 200N when determined in accordance with BS: 6906 (Part 4) or ASTM D 4833.

**(e)** Have a minimum tear resistance of 150N when determined in accordance with ASTM Standard D 4533.

The composite drain shall have a flow rate through each face of the drain of more than 75 per cent of the value determined by direct measurement of the composite drain using BS: 6906 (Part 3). The composite drain shall have values of long-term in-plane flow rates as stated in the design drawing.

**Testing and acceptance:** Geotextiles shall be tested in accordance with tests prescribed by BIS. In absence of IS Codes, tests prescribed either by ASTM or British Standards or International Standards Organization, shall be conducted.

### 3.87 Gabion Crates

Gabions shall consist of steel wire mesh crates. The steel wire shall be mild steel wire complying with IS 280-197. All wire used in the manufacture of the crates and for use as diaphragms, binding and connecting wire shall be galvanised with an extra heavy coating of zinc by an electrolytic galvanising process. The weight of deposition of zinc shall be in accordance with IS 4826-1979. Zinc coating shall be uniform and shall be able to withstand a minimum number of dips and adhesion test specified as per IS 4826-1979. Tolerance on diameter of wire shall be 2.5 percent. The tensile strength shall be between 300 to 550 N/mm2.

The wire shall be mechanically woven into a hexagonal mesh of standard size with tolerance of +16 and -4. The tightness of the twisted joints shall be such that a force of 7 KN is required to pull on one wire to separate it from the other wire provided that each wire is prevented from turning and the whole process is done in one plane. All edges of the crates shall be finished with a selvedge wire. Gabions shall be manufactured in the standard sizes shown in the following table.

**Table 3.69** STANDARD SIZES OF GABIONS

| **Dimensions** (m) | **Diaphragms** (No) | **Dimensions of Diaphragms** (m) | **Volume of Crate**($m^3$) |
|---|---|---|---|
| 1 x 1 x 1 | 1 | 1 x 1 | 1 |
| 1.5 x 1 x 1 | 1 | 1 x 1 | 1.5 |
| 2 x 1 x 1 | 1 | 1 x 1 | 2 |
| 3 x 1 x 1 | 2 | 1 x 1 | 3 |
| 2 x 1 x 0.5 | 1 | 1 x 0.5 | 1 |

Diaphragms shall be manufactured of the same materials as the parent gabion and shall have selvedge wire throughout their perimeter. The number and size of diaphragms to be provided with each crate shall be as in the table 3.63. All crates shall be supplied with binding and connecting wire.

### 3.88 Welded Wire Gabions

The wire used in the manufacture of welded wire fabric shall be manufactured from zinc-coated steel wire conforming to IS 4826 (heavy coated) or IS 12753 (heavy coated). Gabions and gabion mattresses shall be manufactured with all components mechanically connected at the production facility with the exception of the mattress lid which may be supplied separately. All gabions and gabion mattresses shall be supplied in the collapsed form, either folded and bundled or rolled, for shipping. Specification of welded gabions such as classifications, manufacture and materials, mechanical properties, physical properties and dimensions should be as per IS 16013:2021.

**Table 3.70** TYPICAL WELDED GABION SIZE

| Sl. No | Length (m) | Height (m) | Width (m) | Number of cells | Capacity ($m^3$) |
|---|---|---|---|---|---|
| i) | 1.8 | 0.9 | 0.9 | 2 | 1.46 |
| ii) | 2.7 | 0.9 | 0.9 | 3 | 2.19 |
| iii) | 3.6 | 0.9 | 0.9 | 4 | 2.92 |
| iv) | 1.2 | 1.2 | 1.2 | 1 | 1.73 |
| v) | 2.7 | 0.9 | 0.3 | 3 | 0.73 |
| vi) | 2.7 | 0.9 | 0.45 | 3 | 1.09 |

**Table 3.71** TYPICAL WELDED GABION WIRE DIAMETER

| SL. No | Mesh Opening (mm) | Minimum Nominal Diameter metallic-coated wire (mm) | Minimum Diameter, PVC coated (Including Coating) Wire (mm) |
|---|---|---|---|
| i) | 75 x 75 / 38 x 75 | 3.0 | 3.80 |
| ii) | 100 x 100 / 50 x 100 | 4.0 | 4.80 |
| iii) | 150 x 150 / 75 x 150 | 4.0 | 4.80 |
| iv) | Lacing Wire | 4.0 | 3.80 |
| v) | Performed wire spiral binders | 4.0 | 3.80 |
| vi) | Stiffeners | 4.0 | 4.80 |
| The metallic-coated wire shall have the size tolerances in accordance with IS 4826 (heavy coated) or IS 12753 (heavy coated) or IS 432 (part 2) for class B. | | | |
| The minimum thickness of the PVC overcoats which covers the wire shall be 0.40 mm measured radically at any cross-section transverse to the wire length | | | |

### 3.89 Fiber reinforced polymer

Fiber Reinforced Polymer is a composite material engineered from two or more different materials, resulting in a new material with superior quality and performance. In the Composites, glass fiber is used to reinforce polyester resin matrix, with other additional inputs like catalyst, filler, pigments, etc. to mold varying sizes and shapes of FRP products. The test on FRP should be carried on as per IS 14856: 2000.

**Table 3.72** Test parameters

| Sl. No | Test parameters | unit | required |
|---|---|---|---|
| i) | Fiber glass content | %(w/w) | >25.00 |
| ii) | Tensile Strength | $N/mm^2$ | >100 |
| iii) | Water absorption | %(w/w) | <0.50 |
| iv) | Fire retardancy | - | 100mm length of the specimen shall not burn within 60secs |

| | | | |
|---|---|---|---|
| v) | Exposure to natural condition | - | Neutral |
| vi) | Surface Distortion | - | Neutral |
| Vii) | Colour Distortion | - | Neutral |

### 3.90 FRP cornices

Identify each FRP cornice unit with a manufacturing trade mark/batch number and date of manufacturing.

Products Dimensions: As per the Drawing and Dimension provided in the design.
Products Thickness: 3.6 to 3.7mm
Weight: 0.49 kg/ft$^2$

**Tolerance**

A. Part Thickness: + or – 0.5mm.
B. Gel Coat Thickness: + or – 0.5mm
C. Length: + or –10mm
D. Weight: + or – 3%.

### 3.91 Glassfibre Reinforced Concrete (GRC)

Glassfibre Reinforced concrete (GRC) is a specialized type of concrete that incorporates glass fibers for added strength, durability, and flexibility. It is designed to overcome some of the limitations of traditional concrete, particularly its relatively low tensile strength and brittle nature.
All aspects of GRC production from raw materials, through production, curing and storage to quality assurances and testing, should be carried out as per “Specification for the manufacture, curing and testing of Glass fibre Reinforced Concrete (GRC) products” published by The International Glassfibre Reinforced Concrete Association (GRCA).

**Table 3.73** GRC Product tolerance

| SL. No. | Parameter | Tolerance |
|---|---|---|
| 1. | Overall Dimensions Length and Width, Finish Dimensions | +/-0.05% of element dimensions or<br>+/- 3mm per 3000mm for dims above 3000mm |
| 2. | Skin Thickness | +4.0mm<br>- 0.0 mm |

| | | |
|---|---|---|
| 3. | Architectural Facing Thickness | + 3.0mm<br>- 0.0mm |
| 4. | Edge Return Thickness | +12.0mm<br>- 0.0mm |
| 5. | Panel Depth (Finish Surface to RIB) | +10.0mm<br>- 6.0mm |
| 6. | Angular Deviation of Side Mould | 0.75mm per 75 mm of Depth or 1.5mm max. |
| 7. | Variation from Square or Skew<br>(Difference in two Diagonals) | 3mm per 1800mm or 6mm maximum |
| 8. | Deviation | Not more than 6mm in 6000mm, |
| 9. | Straight Line | non-accumulative |
| 10. | Bowing (concave or convex) | Not to exceed length of bow of any part divided by 360, of a flat surface |

### 3.92 Mineral Fiber Board Ceiling

Mineral Fiber Ceiling tiles shall be made from granulated high-density mineral wool and should have superior sound absorption, heat insulation, fire resistance, and sag resistance properties.

**Table 3.74** Specifications for Mineral Fiber Ceiling Tiles

| **Properties** | **Specification** |
|---|---|
| Edge Details | Beveled Tegular Edge or Square Lay in edge as required |
| Dimension | Min 595 mm x 595 mm |
| Thickness | 16mm or 19mm as required |
| Weight | 3.6 Kg/m2 (for 16mm thick) & 5.29 Kg/m2 (for 19mm thick) |
| Relative Humidity | 99% RH resistant |
| Fire Reaction | Class 0/Class 1 as per BS:476 (Part-6 & 7)<br>Class A as per ASTM E-84 |
| Thermal Conductivity | 0.052 W/m–K – 0.057 W/m–K as per ASTM C518 |
| Acoustic Control | Noise reduction coefficient (NRC) = 0.50 to 0.60 as per ASTM C423 |
| Light Reflectance | > 85%. as per ASTM E1477 |
| Dimensional Tolerances | ±3mm |

### 3.93 Mineral Fiber Board Ceiling

The suspension system shall have the following properties:

**Table 3.75** Specifications for Suspension System and Mineral Fiber Ceiling

| | **Specification** |
|---|---|
| **Frame Material** | Hot-dipped galvanized steel (Galvanized at 120 g/sq.m on all sides as per IS 277: 2003) |
| **Main Runner Dimensions** | 3600(L) x 38(H) x 24(W) mm |
| **Cross Tee Dimensions** | 1200/ 600(L) x 38(H) x 24(W) mm |
| **Cross Tee End Detail** | The end details of the cross tee shall be made of pre-hardened steel and fixed to the ends of the cross tee to provide double locking between “cross tee to cross tee” and “cross tee to main beam.” |
| **Wall Angle dimensions** | 3000(L) x 24(H) x 24(W) m |
| **Hanger Material** | 6 mm dia fully threaded galvanized steel hanger rod galvanized at 80 g/sq.m including all sides. (For ceiling suspended at a distance **> 600 mm)** |
| | Pre-straightened galvanized iron hanger wire with a minimum diameter of 2.5 mm having a tensile strength of 344-413 MPa and a minimum loading strength of 110 kgs. (For ceiling suspended at a distance **≤ 600 mm**) |

### 3.94 Polyurethane foam (PUF)

Polyurethane foam (PUF) panels shall consist of factory manufactured sandwich panels comprising pre-painted galvanized iron (PPGI) / pre-painted galvalume steel outer and inner facings with rigid polyurethane foam (PUF) insulation core.

The outer sheet shall be minimum 0.50 mm thick BMT pre-painted galvanized iron/galvalume steel sheet with minimum Z120/AZ150 coating. The inner sheet shall be a minimum 0.40 mm thick BMT pre-painted galvanized iron/galvalume steel sheet. The steel sheets shall have minimum yield strength of 240 MPa.

The polyurethane foam insulation core shall have density not less than 40 ± 2 kg/m³ and thermal conductivity not exceeding 0.023 W/mK. The foam shall be rigid, uniform, closed cell type and fully bonded to the metal facings.

All materials shall conform to the latest editions of the following standards where applicable:

**Table 3.76** Applicable Codes for PUF

| Sl. No. | Standard / Code | Description |
|---|---|---|
| **1** | IS 277 | Galvanized steel sheets |
| **2** | IS 14246 | Pre-painted galvanized steel sheets |
| **3** | ASTM A653 / ASTM A792 | Galvanized / Aluzinc coated steel sheets |
| **4** | EN 14509 | Self-supporting double skin metal faced insulating panels |
| **5** | ASTM E84 / DIN 4102 | Fire performance |
| **6** | IS 875 (Part 3) | Wind load considerations |
| **7** | IS 16203:2016 | PUF |

**Table 3.77** PUF Panel Technical Properties

| Sl. No. | Property | Requirement |
|---|---|---|
| 1 | Panel type | Factory-made prefabricated PUF sandwich roofing panel |
| 2 | Core material | Rigid polyurethane foam insulation |
| 3 | Foam density | 40 ± 2 kg/m³ |
| 4 | Thermal conductivity | Maximum 0.022 W/m·K at 10°C |
| 5 | Closed cell content | Minimum 90% |
| 6 | Water absorption | Maximum 0.5% by volume |
| 7 | Dimensional stability | ± 2% |
| 8 | Compressive strength at 10% deformation | Minimum 2.0 kg/cm² |
| 9 | Outer facing sheet | PPGI / pre-painted galvalume steel sheet |
| 10 | Outer sheet thickness | Minimum 0.50 mm BMT |
| 11 | Inner facing sheet | PPGI / pre-painted galvalume steel sheet |
| 12 | Inner sheet thickness | Minimum 0.40 mm BMT |
| 13 | Metallic coating | Minimum Z120 / AZ150, unless otherwise specified |
| 14 | Steel strength | Minimum 240 MPa |
| 15 | Standard panel width | 1000 mm ± 2 mm |

| | | |
|---|---|---|
| 16 | Panel thickness | 30mm, 40 mm, 50 mm, 60 mm, 80 mm, 100 mm, 120 mm, 150 mm or as specified |
| 18 | Joint system | Side interlocking / tongue-and-groove or approved roofing joint |
| 19 | Surface finish | Pre-painted, uniform colour and finish |

**Table 3.78** Tolerances for PUF

| Dimension | Tolerance |
|---|---|
| Length | ± 5 mm |
| Width | ± 2 mm |
| Thickness | ± 3 mm |

### 3.95 Rockwool

Rockwool insulation shall be resin bonded stone wool/mineral wool manufactured from molten rock fibers and bonded with suitable thermosetting resin. The material shall be non-combustible, rot-proof, moisture resistant, vermin proof, and free from asbestos and harmful impurities. The insulation shall conform to IS 8183 and relevant test methods specified in IS 3144 and IS 3346.

**Table 3.79:** Physical Properties of Rockwool

| Property | Requirement |
|---|---|
| Standard | IS 8183 |
| Material Type | Resin Bonded Rockwool / Stone Wool |
| Bulk Density | 12–160 kg/m³ |
| Thickness | 25, 40, 50, 65, 75 mm or as specified |
| Thermal Conductivity | As per IS 8183 |
| Combustibility | Non-combustible |
| Moisture Absorption | As per IS 8183 |
| Shot Content | As per IS 8183 |

**Incombustibility:** The material shall satisfy the incombustibility requirements of IS 3144. Loss in mass after test shall not exceed the limits specified in the standard.

**Fibre Diameter:** Mean fibre diameter shall not exceed 7 microns when tested in accordance with IS 3144.

**Table 3.80:** Bulk Density Classification of Rockwool as per IS 8183

| Group | Bulk Density (kg/m³) | Maximum Recommended Hot Face Temperature |
|---|---|---|
| 1 | 12–50 | Up to 250°C |
| 2 | 51–80 | Up to 400°C |
| 3 | 81–120 | Up to 550°C |
| 4 | 121–160 | Up to 750°C |

**Dimensions (As per IS 8183 Clause 4.9):** The bonded mineral wool shall be supplied in widths of 50, 60, 75 and 100 cm and lengths of 100, 120 and 140 cm, or as agreed to between the purchaser and the supplier. The method for determination of these dimensions shall be as prescribed in IS 3144. The thickness of the bonded mineral wool shall be 25, 40, 50, 65 and 75 mm, or as agreed to between the purchaser and the supplier. The method for determination of thickness shall be as prescribed in IS 3144.

**Dimensional Tolerances (As per IS 8183 Clause 4.9.1):** For width and length, the dimensional tolerance of the bonded mineral wool slabs shall be −0.5 percent. For nominal thickness in the range of 25 mm to 75 mm, the tolerance shall be −2 mm. Positive tolerance in all dimensions shall be permitted. However, for nominal thickness outside this range, the upper tolerance shall be as agreed to between the purchaser and the manufacturer. The material shall be supplied with manufacturer's test certificates confirming compliance with IS 8183, IS 3144, and IS 3346.

### 3.96 Laminated MDF and HDF Flooring

Laminated MDF and HDF flooring shall be factory-manufactured flooring boards consisting of a fibreboard core, decorative laminate surface layer, protective wear layer and balancing backing layer, complying with EN 13329 and approved manufacturer's technical data sheets.

MDF core boards shall conform to IS 12406:2003 where applicable, with density generally in the range of 600–800 kg/m³. HDF core boards shall have density not less than 800 kg/m³ and shall comply with the manufacturer's tested performance data.

The flooring boards shall be uniform in thickness and shall be free from warping, swelling, delamination, chipped edges, cracks, surface defects and other manufacturing defects affecting appearance, strength or durability. The flooring shall satisfy the specified requirements for abrasion resistance, surface soundness, thickness swelling, dimensional stability, stain resistance and formaldehyde emission as specified in EN 13329 and supported by valid manufacturer's test certificates.

The locking system shall be tongue-and-groove or click-lock type suitable for floating floor installation without direct nailing to the base floor. All planks used within a room or continuous area shall be from the same batch to maintain uniform colour, shade and texture.

Underlay shall consist of approved foam, polyethylene foam or equivalent resilient material capable of reducing impact sound and accommodating minor surface irregularities. Where flooring is laid over concrete or screed surfaces, approved polyethylene vapour barrier membrane of suitable thickness shall be provided to prevent upward moisture migration.

Skirting boards, edge trims, reducers, transition strips and other accessories shall be compatible with the flooring system and shall match the colour and finish of the laminate flooring.

**Table 3.81:** Minimum Material Requirements

| **Property** | **Laminated MDF Flooring** | **Laminated HDF Flooring** |
|---|---|---|
| Core material | Medium Density Fibreboard (MDF) | High Density Fibreboard (HDF) |
| Applicable reference | IS 12406:2003 / EN 13329 | EN 13329 |
| Density | 600–800 kg/m³ | Minimum 800 kg/m³ |
| Abrasion Class Rating | AC1 – AC3 | AC3 – AC5 |
| Thickness Options | 6 mm, 7 mm, 8 mm | 8 mm, 10 mm, 12 mm |
| Stain Resistance | Grade 5 | Grade 5 |
| Standard Size | 1220 mm × 200 mm | 1220 mm × 200 mm |

**Table 3.82:** Dimensional Requirements

| **Property** | **Requirement** |
|---|---|
| Squareness | q max ≤ 0.20 mm |
| Straightness | s max ≤ 0.30 mm/m |
| Opening between elements | Average ≤ 0.15 mm; Maximum ≤ 0.20 mm |
| Height difference (Lipping) | Average ≤ 0.10 mm; Maximum ≤ 0.15 mm |
| Flatness | As per EN 13329 |

### 3.97 uPVC Ceiling Panel

The panels shall be of approved make, colour, texture, profile, design and pattern. Unless otherwise specified, the thickness of the PVC soffit panels shall be **not less than 8 mm**, or as shown in the drawings and approved by the Engineer.

The panels shall have a smooth, decorative or textured factory-finished surface. The surface shall be uniform in colour, texture and finish and shall be free from cracks, warping, blistering, pinholes, dents, waviness, delamination, discoloration and other visible defects.

The panels shall be moisture-resistant, termite-resistant, fungus-resistant, corrosion-resistant, non-absorbent and suitable for normal atmospheric exposure. For external or semi-exposed soffit applications, the panels shall be UV-stabilized and weather-resistant to reduce fading, brittleness, cracking and surface deterioration.

The panels shall be dimensionally stable and shall not sag, twist, warp or permanently deform under normal service conditions when installed in accordance with the manufacturer's recommendations. The material shall have adequate stiffness and impact resistance suitable for ceiling applications.

**Table 3.83:** General Technical Data

| Sl. No. | Property | Requirement / Technical Data | Test Standard / Reference |
|---|---|---|---|
| 1 | Material type | Rigid UPVC / rigid polyvinyl chloride panel | IS 6307 / ISO 1163 |
| 3 | Thickness | Minimum 8 mm, unless otherwise specified | IS 6307 |
| 4 | Surface finish | Smooth, decorative or textured factory finish | Visual inspection |
| 5 | Colour and appearance | Uniform colour, texture and finish; free from cracks, warping, blistering, pinholes, dents, discoloration and visible defects | IS 6307 |
| 6 | Density | 1.35 – 1.55 g/cm³ | ISO 1183 |
| 7 | Tensile strength | Minimum 40 MPa | ISO 527 |
| 8 | Flexural strength | Adequate to resist bending under self-weight without permanent deformation | ISO 178 |

| | | | |
|---|---|---|---|
| 9 | Flexural modulus | Sufficient stiffness to prevent sagging between supports | ISO 178 |
| 10 | Impact resistance | Shall resist minor impact without cracking or brittle failure | IS 6307 |
| 11 | Vicat softening temperature | Adequate to prevent softening under normal service temperature | IS 6307 / ISO 306 |
| 12 | Heat deflection temperature | No deformation under normal service temperature conditions | ISO 75 |
| 13 | Water absorption | Negligible / non-absorbent | Manufacturer's test certificate |
| 14 | Moisture resistance | Suitable for humid and semi-exposed soffit conditions | Manufacturer's test certificate |
| 15 | Dimensional stability | No warping, shrinkage, twisting or permanent deformation under normal service conditions | IS 6307 |
| 16 | Coefficient of thermal expansion | Controlled to avoid joint distortion; expansion gaps shall be allowed during installation | Manufacturer's data |
| 17 | UV resistance | UV-stabilized and suitable for protected external soffit exposure | Manufacturer's test certificate |
| 18 | Chemical resistance | Resistant to mild cleaning agents and normal atmospheric exposure | Manufacturer's test certificate |
| 19 | Biological resistance | Resistant to termite, fungus and microbial attack under normal service conditions | Manufacturer's data |
| 20 | Fire behaviour | Self-extinguishing / low flame spread / non-dripping, subject to certified test report | Manufacturer's fire test certificate |
| 21 | Workability | Suitable for cutting, drilling and fixing without cracking or splitting | Site verification |
| 22 | Compatibility | Compatible with PVC trims, joining strips, stainless steel screws and corrosion-resistant fasteners | Manufacturer's recommendation |

**Table 3.84:** Technical Data for Particular Thickness

| Technical Information | Applicable Standard | 8 mm | 9 mm | 12.5 mm |
|---|---|---|---|---|
| Weight (kg/m²) | ±0.2 | 6.0 | 6.2 | 7.2 |
| Board Density (kg/m³) | Minimum | 750 | 653 | 576 |
| Material | - | Moisture Resistant Ceiling tiles | | |
| Faceside Material | - | High Quality PVC | | |
| Backside Material | - | High Quality PET metalized foil | | |
| Available Size, mm | - | 595 × 595 / 603 × 603 | | |
| Available Pattern | - | 154 / 238 / 239 | | |
| Flexural Strength – Longitudinal (N) | ASTM C1396 | ≥ 279 | ≥ 343 | ≥ 476 |
| Flexural Strength – Longitudinal (N) | EN 520 | ≥ 344 | ≥ 400 | ≥ 550 |
| Flexural Strength – Transverse (N) | ASTM C1396 | ≥ 94 | ≥ 116 | ≥ 157 |
| Flexural Strength – Transverse (N) | EN 520 | ≥ 134 | ≥ 160 | ≥ 210 |
| Nail Pull Resistance (N) | ASTM C1396 | ≥ 225 | ≥ 249 | N/A |
| Light Reflection | - | 0.75 standard for white PVC facing | | |
| Chemical & Microbial | - | Excellent resistance | | |
| Humidity Resistance | - | Up to 90% relative humidity (RH) at max 30°C | | |

### 3.98 Wood Plastic Composite (WPC) Wall Panels

WPC wall panels shall be factory manufactured composite boards made from a homogeneous mixture of wood fibre/wood flour and thermoplastic polymers with suitable additives to enhance strength, durability and stability.

The panels shall be suitable for interior wall cladding applications and shall be supplied in finished form with required surface texture and colour. The material shall be dimensionally

stable, moisture resistant, termite resistant and fungus resistant. The panels shall be free from cracks, warping, delamination, bubbles, discoloration and other manufacturing defects.

**Applicable Codes / Standards**

The material shall conform to relevant provisions of the following standards where applicable:

**Table 3.85:** Applicable Standards

| Sl. No. | Code | Description |
|---|---|---|
| **1** | IS 14276 | Wood based panels – Specifications (reference for panel quality principles) |
| **2** | IS 2046 | Decorative plywood / surface finish quality (reference for finishing quality) |
| **3** | ISO 178 | Determination of flexural properties of plastics |
| **4** | ISO 527 | Tensile properties of plastics |
| **5** | ISO 9001 | Quality management system for manufacturing |

**Table 3.86:** Technical Requirements for WPC

| Sl. No. | Description | Requirement |
|---|---|---|
| **1** | Material Type | Wood Plastic Composite (WPC) |
| **2** | Composition | Wood fibre/wood flour + thermoplastic polymer (PVC/PE/PP based) |
| **3** | Thickness | Minimum 10 mm or as specified |
| **4** | Moisture Resistance | Resistant to water absorption and swelling |
| **5** | Termite/Fungus Resistance | Fully resistant |
| **6** | Dimensional Stability | No significant expansion, shrinkage or warping |
| **7** | Surface Finish | Smooth / textured / wood grain finish as approved |
| **8** | Colour | As approved by Engineer-in-Charge |
| **9** | Density | Uniform high-density composite |
| **10** | Fire Behaviour | Self-extinguishing / low flame spread characteristics |

### 3.99 Rigid PVC (uPVC) Wall Panels

Rigid PVC (uPVC) wall panels shall be factory manufactured extruded unplasticized polyvinyl chloride panels of approved make, colour, texture and finish.

The panels shall be suitable for interior wall and ceiling cladding applications including wet areas such as bathrooms and kitchens.

The material shall be waterproof, termite resistant and fungus resistant. The panels shall be dimensionally stable and shall not exhibit warping, cracking, delamination or discoloration under normal service conditions.

The panels shall be supplied in finished form with smooth, grooved or decorative surface texture as approved.

**Table 3.87:** Applicable Standards

| Sl. No. | Code | Description |
|---|---|---|
| **1** | ISO 1163 | Plastics – PVC moulding and extrusion materials |
| **2** | ISO 9001 | Quality management system |
| **3** | ISO 178 | Flexural properties of plastics |
| **4** | ISO 527 | Tensile properties of plastics |

**Table 3.88:** Technical Requirements for Rigid PVC

| Sl. No. | Description | Requirement |
|---|---|---|
| **1** | Material Type | Rigid UPVC (Unplasticized PVC) |
| **2** | Thickness | Minimum 8 mm or as specified |
| **3** | Moisture Resistance | 100% waterproof |
| **4** | Termite/Fungus Resistance | Fully resistant |
| **5** | Dimensional Stability | No warping, shrinkage or deformation |
| **6** | Surface Finish | Smooth / grooved / decorative as approved |
| **7** | Colour | As approved by Engineer-in-Charge |
| **8** | Fire Behaviour | Self-extinguishing / low flame spread |

| | | |
|---|---|---|
| **9** | Application | Interior walls and ceilings including wet areas |

### 3.100 Toughened/ Tempered Glass

**General**

Tempered or toughened glass is a type of safety glass processed by controlled thermal or chemical treatment to increase its mechanical strength, thermal resistance and impact resistance compared to ordinary annealed float glass.

The toughening process introduces compressive stresses on the outer surfaces of the glass and balancing tensile stresses within the core. These residual stresses significantly improve the strength and thermal shock resistance of the glass.

When fractured, fully toughened safety glass disintegrates into relatively small granular fragments rather than large sharp shards, thereby reducing the risk of serious injury.

**Manufacturing Process:**

**1. Thermal Toughening Process**

Most toughened safety glass is manufactured by thermal tempering. In this process, annealed float glass is heated uniformly to approximately 620°C–680°C and subsequently subjected to rapid air quenching using high-pressure cold air jets.

Rapid cooling causes:

(d) the outer surfaces to solidify first and enter compression,

(e) while the inner core remains in tension.

The magnitude of residual stress depends upon:

(c) glass thickness,

(d) thermal expansion coefficient,

(e) cooling rate,

(f) and thermal conductivity.

Higher residual surface compression results in improved:

d) impact resistance,

e) flexural strength,

f) and thermal shock resistance.

**2. Chemical Toughening Process**

Chemical toughening is achieved through ion exchange treatment. In this process, glass is immersed in molten potassium nitrate bath at approximately 400°C, where smaller sodium ions within the glass surface are replaced by larger potassium ions.

This process creates a highly compressed surface layer generally exceeding 0.1 mm depth with significantly increased surface compression.

Chemically toughened glass provides:

e) higher surface strength,

f) reduced optical distortion,

g) and improved scratch resistance

The technical properties for various types of glasses are present in the table.

**Table 3.89:** Technical Properties for various types of glasses

| **Property** | **Annealed / Float Glass** | **Heat-Strengthened Glass** | **Fully Toughened / Tempered Glass** | **Laminated Toughened Glass** |
|---|---|---|---|---|
| Manufacturing Process | Float glass with slow controlled cooling / annealing | Heat-treated with controlled heating and moderate cooling | Heat-treated with rapid cooling / air quenching | Two or more toughened glass plies bonded with interlayer |
| Basic Structure | Single monolithic glass sheet | Single monolithic heat-treated glass sheet | Single monolithic fully toughened glass sheet | Multi-layer glass with polymer interlayer |
| Residual / Surface Compressive Stress | 24–69 MPa | 24–52 MPa as per AS 1288 | ≥69 MPa as per AS 1288; 80–150 MPa typical | Depends on glass ply used; toughened plies generally follow toughened glass stress range |
| Relative Strength | Baseline / weakest type | At least 2 × annealed glass | At least 4 × annealed glass | Depends on glass thickness, number of plies and interlayer |
| Density | 2500 kg/m³ | 2500 kg/m³ | 2500 kg/m³ | Approx. 2500 kg/m³ for glass plies, plus interlayer weight |

| | | | | |
|---|---|---|---|---|
| Young's Modulus, E | 70 GPa | 70 GPa | 70 GPa | 70 GPa for glass plies |
| Poisson's Ratio | 0.22 | 0.22 | 0.22 | 0.22 for glass plies |
| Torsional / Shear Modulus, G | 28.7 GPa | 28.7 GPa | 28.7 GPa | 28.7 GPa for glass plies |
| Max. Compressive Strength | (200) 120 MPa | (200) 120 MPa | (200) 120 MPa | Depends on laminate build-up |
| (Max.) Tensile Strength | (45) 20 MPa | (70) 40 MPa | (120) 80 MPa | typically, 120–200 MPa |
| Breakage Pattern | Large and sharp fragments | Larger fragments | Very small "dice" / granular fragments | Cracked fragments remain bonded to interlayer |
| Plastic Deformation | Nil | Nil | Nil | Nil in glass; interlayer may deform |
| Failure Behaviour | Brittle sudden failure | Brittle sudden failure | Brittle sudden fragmentation | Cracked but retained by interlayer |

**3.101 PVC Soffit Ceiling System**

**General**

PVC soffit ceiling panels shall be factory-manufactured rigid unplasticized polyvinyl chloride panels suitable for soffit ceiling, eaves, balcony, verandah and semi-exposed ceiling applications. The panels shall be manufactured from rigid PVC resin compounded with suitable stabilizers, pigments, impact modifiers and other additives necessary to provide durability, dimensional stability, moisture resistance, impact resistance and uniform surface finish.

The PVC soffit panels shall generally conform to the relevant requirements of **IS 6307:1985 – Specification for Rigid PVC Sheets**, where applicable. The panels shall also comply with the approved manufacturer's technical data sheets, test certificates and project requirements.

Equivalent approved international standards such as **ISO 1163, ISO 178, ISO 527, ISO 306 and ISO 1183** may be accepted where supported by valid test certificates.

**PVC Ceiling Panels**

The panels shall be of approved make, colour, texture, profile, design and pattern. Unless otherwise specified, the thickness of the PVC soffit panels shall be **not less than 8 mm**, or as shown in the drawings and approved by the Engineer.

The panels shall have a smooth, decorative or textured factory-finished surface. The surface shall be uniform in colour, texture and finish and shall be free from cracks, warping, blistering, pinholes, dents, waviness, delamination, discoloration and other visible defects.

The panels shall be moisture-resistant, termite-resistant, fungus-resistant, corrosion-resistant, non-absorbent and suitable for normal atmospheric exposure. For external or semi-exposed soffit applications, the panels shall be UV-stabilized and weather-resistant to reduce fading, brittleness, cracking and surface deterioration.

The panels shall be dimensionally stable and shall not sag, twist, warp or permanently deform under normal service conditions when installed in accordance with the manufacturer's recommendations. The material shall have adequate stiffness and impact resistance suitable for ceiling applications.

**Table 3.90:** Technical Data for PVC Ceiling Panels

| Sl. No. | Property | Requirement / Technical Data | Test Standard / Reference |
|---|---|---|---|
| 1 | Material type | Rigid UPVC / rigid polyvinyl chloride panel | IS 6307 / ISO 1163 |
| 3 | Thickness | Minimum 8 mm, unless otherwise specified | IS 6307 |
| 4 | Surface finish | Smooth, decorative or textured factory finish | Visual inspection |
| 5 | Colour and appearance | Uniform colour, texture and finish; free from cracks, warping, blistering, pinholes, dents, discoloration and visible defects | IS 6307 |
| 6 | Density | 1.35 – 1.55 g/cm³ | ISO 1183 |
| 7 | Tensile strength | Minimum 40 MPa | ISO 527 |

| | | | |
|---|---|---|---|
| 8 | Flexural strength | Adequate to resist bending under self-weight without permanent deformation | ISO 178 |
| 9 | Flexural modulus | Sufficient stiffness to prevent sagging between supports | ISO 178 |
| 10 | Impact resistance | Shall resist minor impact without cracking or brittle failure | IS 6307 |
| 11 | Vicat softening temperature | Adequate to prevent softening under normal service temperature | IS 6307 / ISO 306 |
| 12 | Heat deflection temperature | No deformation under normal service temperature conditions | ISO 75 |
| 13 | Water absorption | Negligible / non-absorbent | Manufacturer's test certificate |
| 14 | Moisture resistance | Suitable for humid and semi-exposed soffit conditions | Manufacturer's test certificate |
| 15 | Dimensional stability | No warping, shrinkage, twisting or permanent deformation under normal service conditions | IS 6307 |
| 16 | Coefficient of thermal expansion | Controlled to avoid joint distortion; expansion gaps shall be allowed during installation | Manufacturer's data |
| 17 | UV resistance | UV-stabilized and suitable for protected external soffit exposure | Manufacturer's test certificate |
| 18 | Chemical resistance | Resistant to mild cleaning agents and normal atmospheric exposure | Manufacturer's test certificate |
| 19 | Biological resistance | Resistant to termite, fungus and microbial attack under normal service conditions | Manufacturer's data |
| 20 | Fire behaviour | Self-extinguishing / low flame spread / non-dripping, subject to certified test report | Manufacturer's fire test certificate |
| 22 | Compatibility | Compatible with PVC trims, joining strips, stainless steel screws and corrosion-resistant fasteners | Manufacturer's recommendation |

**Table 3.91:** Technical Information

| **Technical Information** | **Applicable Standard** | **8 mm** | **9 mm** | **12.5 mm** |
|---|---|---|---|---|
| Weight (kg/m²) | ±0.2 | 6.0 | 6.2 | 7.2 |
| Board Density (kg/m³) | Minimum | 750 | 653 | 576 |
| Material | - | Moisture Resistant Ceiling tiles | | |
| Faceside Material | - | High Quality PVC | | |
| Backside Material | - | High Quality PET metalized foil | | |
| Available Size, mm | - | 595 × 595 / 603 × 603 | | |
| Available Pattern | - | 154 / 238 / 239 | | |
| Flexural Strength – Longitudinal (N) | ASTM C1396 | ≥ 279 | ≥ 343 | ≥ 476 |
| Flexural Strength – Longitudinal (N) | EN 520 | ≥ 344 | ≥ 400 | ≥ 550 |
| Flexural Strength – Transverse (N) | ASTM C1396 | ≥ 94 | ≥ 116 | ≥ 157 |
| Flexural Strength – Transverse (N) | EN 520 | ≥ 134 | ≥ 160 | ≥ 210 |
| Nail Pull Resistance (N) | ASTM C1396 | ≥ 225 | ≥ 249 | N/A |
| Light Reflection | - | 0.75 standard for white PVC facing | | |
| Chemical & Microbial | - | Excellent resistance | | |
| Humidity Resistance | - | Up to 90% relative humidity (RH) at max 30°C | | |

# SECTION - 4: CARRIAGE OF MATERIALS

# SECTION 4: CARRIAGE OF MATERIALS

4.1 Carriage of building materials up to 5 kms lead

4.2 Long distance carriage of building materials per kilometer.

a. Hill Section
b. Plain Section

*Note:* On return trips, if load is provided, 50 percent of the rates would be paid for materials carried in the return trip

4.2.1 **General: -** The carriage of materials shall be done as directed by the engineer. Any tools and plants required for the work shall be arranged by the contractor. The carriage of materials includes loading within a lead of 50 metres, unloading and stacking within a lead of 50 metres.

4.2.2 **Responsibility for loss or damage**: - Loading, carriage, unloading and stacking shall be done carefully to avoid loss or damage to materials. In case of any loss or damage, recovery shall be affected from the contractor at twice the departmental issue rates of the materials. If the departmental issue rates of the materials are not available then the recovery shall be affected at twice the prevailing market rates as determined by the engineer.

4.2.3 **Leads:** - All distances shall be measured over the shortest practical route and not necessarily the route actually taken. Carriage shall be reckoned in one km unit. Distance of 0.5km or more shall be taken as 1 km and distance of less than 0.5km shall be ignored.

4.2.4 Stacking: - For stacking the materials, the following procedures shall be followed:-

i. Earth, dismantled materials and such similar materials shall be stacked by leveling the materials in layers.
ii. Cement bags, M.S bars, bricks shall be stacked in regular tiers
iii. Pipes of R.C.C, S.W, G.I, C.I etc. shall be stacked in rows.
iv. Lime, stone, metal, steam coal, sand and similar materials shall be stacked as directed.

4.2.5 **Measurements: -** Length, breath and height of stacks shall be measured correct to 10 mm. The quantity shall be worked out in cubic metres correct to two places of decimal. Void deductions need not be done separately since the volume used for transportation rates already includes necessary void deductions.

4.2.6 *Rate: - The rate for carriage of materials is inclusive of all operations described above*

**4.3** Carriage of materials by manual labour including loading, unloading, and stacking for lead less than 0.5 km

4.3.1 Normal Carrying capacity of selected building materials up to a lead of the first 50 m by 8 nos labourers in an 8 hour shift is as below:

a. Lime, moorum, building rubbish – 25 cum
b. Earth – 25 cum
c. Excavated rock – 25 cum
d. Sand or stone aggregate of less than 40 mm size – 20 cum
e. Stone aggregate of size 40 mm or more – 20 cum
f. Soling stone – 18 cum
g. Bricks – 9000 nos
h. Brick tiles – 15000 nos

For carrying the above quantity of materials to every further lead of 50 m or part thereof upto a distance of 0.5 km within a shift of 8 hours approximately, 1.75 extra. Labourers would be required. Add 10% for stacking the quantity of materials conveyed in 8 hours shift

4.3.2 Normal Carrying capacity of selected building materials up to a lead of first 50 m by 9.5 nos labourers in an 8 hour shift is as below:

a. Stone blocks and other heavy materials like GI, CI pipes less than 100 mm dia – 36 tonnes
b. cement – 45 tonnes
c. steel – 20 tonnes
d. timber - 35 cum
e. stone ware pipes 600 mm long
    - 100 mm dia – 1785 m or 2975 nos
    - 150 mm dia – 1086 m or 1810 nos
    - 200 mm dia – 777 m or 1295 nos
    - 230 mm dia – 607.2 m or 1012 nos
    - 250 mm dia – 465 m or 775 nos
    - 300 mm dia – 327 m or 545 nos
f. RCC pipes, steel cylinder RC pipes, CI and unreinforced cement pipes 3.66 m long
    - 100 mm dia – 1317.6 m or 360 nos
    - 125 mm dia – 1083.36 m or 296 nos
    - 150 mm dia – 933.3 m or 255 nos
    - 200 mm dia – 629.50 m or 172 nos

For carrying the above quantity of materials to every further lead of 50 m or part thereof upto a distance of 0.5 km within a shift of 8 hours approximately, 1.5 nos extra labourers would be required.

# SECTION - 5: SPECIFICATIONS OF WORKS

# 5.1 CHAPTER 1: DISMANTLING & DEMOLITION WORK

## 5.1.1 General

Dismantling implies careful removal of materials from a structure or a part of it without damage. Demolition implies breaking up whole or part of work, structure etc. The work consists of removing any structure(s) which are in place but interfere with the new construction or are not suitable to be in place, and of salvaging and disposing of the resulting materials and back filling the resulting trenches and pits.

The scheme for dismantling (generally in the reverse order of the one in which the structure was constructed) shall be approved by the Engineer before starting the work. Necessary propping, shoring, underpinning, shielding and fencing of areas shall be carried out so that no damage is caused to adjoining work, people or property, in any manner. Temporary enclosures, partitions etc shall be provided as required. Nuisance of dust shall be kept down to the minimum. Personal Protective Equipment such as helmets, goggles, safety belts etc. shall be used wherever required as per the directives of the Engineer. First aid equipment shall be made available at all demolition works of any magnitude. OHS guidelines must be followed and practised to prevent any workplace hazard or accident.

Dismantling shall be done in a systematic manner. Materials likely to be damaged by dropping shall be carefully removed and lowered (not thrown) and properly stacked. Nails, screws and bolts, shall wherever required, be removed by use of proper tools in order to remove items fixed with them. The latter should not be removed by tearing or ripping off.

All operations necessary for the removal of any existing structure that might endanger new construction shall be removed completely prior to the start of the work.

All materials obtained from dismantling or demolition shall be the property of the Government unless otherwise specified and such materials shall be kept in safe custody until they are handed over to the Engineer. All serviceable materials shall be stacked properly. Unserviceable materials shall be disposed off as directed by the Engineer. The distinction between the serviceable and unserviceable materials shall be as per the direction of the Engineer.

## 5.1.2 Concrete

*DD0001* *Demolishing cement concrete 1:3:6 & richer, including disposal of materials within 50m lead.*

*DD0002* *Demolishing cement concrete 1:4:8 & leaner, including disposal of materials within 50m lead.*

*DD0003* *Demolishing reinforced concrete, including stacking steel bars and disposal of rubbish within 50m lead.*

## 5.1.3 Lime Concrete

*DD0004* *Demolishing lime concrete and disposal of rubbish within 50m lead*

## 5.1.4 Stone Masonry

*DD0005* *Demolishing stone rubble masonry including stacking useful materials & disposal of rubbish within 50m lead - In lime mortar*

*DD0006* *Demolishing stone rubble masonry including stacking useful materials & disposal of rubbish within 50m lead - In cement mortar*

*DD0007* *Dismantling dressed ashlar face stone work including stacking useful materials & disposal of rubbish within 50m lead - In lime mortar*

*DD0008* *Dismantling dressed ashlar face stone work including stacking useful materials & disposal of rubbish within 50m lead - In cement mortar*

*DD0009* *Removing mortar from stones, cleaning stones and concrete articles, and arranging in stacks – In lime mortar*

*DD0010* *Removing mortar from stones, cleaning stones and concrete articles, and arranging in stacks – In cement mortar*

### 5.1.5 Brick & Hollow Block Masonry

*DD0011* *Demolishing hollow block masonry including stacking useful materials & disposal of rubbish within 50m lead.*

*DD0012* *Demolishing reinforced brickwork, including stacking of steel bars and disposal of rubbish within 50m lead.*

*DD0013* *Extra, for scraping, cleaning, straightening reinforcement from Reinforced Concrete & reinforced brick work.*

*DD0014* *Extra for cutting reinforcement bars in reinforced cement concrete and reinforced brickwork (payment to be made for the cross sectional area of RCC or RB work)*

*DD0015* *Demolishing brick work including stacking useful materials & disposal of rubbish within 50m lead- In mud mortar*

*DD0016* *Demolishing brick work including stacking useful materials & disposal of rubbish within 50m lead- In lime mortar*

*DD0017* *Demolishing brick work including stacking useful materials & disposal of rubbish within 50m lead- In cement mortar*

*DD0018* *Removing Mortar from bricks and cleaning bricks including stacking useful materials within 50m lead- In mud mortar*

*DD0019* *Removing Mortar from bricks and cleaning bricks including stacking useful materials within 50m lead- In lime mortar*

*DD0020* *Removing Mortar from bricks and cleaning bricks including stacking useful materials within 50m lead- In cement mortar*

**Measurement:** Parts of work required to be dismantled and those required to be demolished shall be measured separately. The length, breadth and thickness shall be measured correct to 10mm and the cubical contents shall be worked out correct to two places of decimal. In measuring thickness of roofs provided with water proofing treatments with bitumen felts, the thickness of water proofing treatment shall be ignored. Where reinforcement steel or structural steel is required to be separated, the work shall be measured separately in kg of salvaged steel.

**Rate:** The rate shall include the cost of all labour involved and tools used in demolishing and dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing of unserviceable material within a distance of 50 metres.

The rate shall also include for temporary shoring for the safety of portions not required to be pulled down, or of adjoining property, and providing temporary enclosures or partitions, where considered necessary.

### 5.1.6 Steel Work

*DD0021* *Dismantling steelwork in single sections including dismembering and stacking within 50m lead- In RS joists*

*DD0022* *Dismantling steelwork in single sections including dismembering and stacking within 50m lead- In channels, angles, tees and flats*

*DD0023* *Dismantling steelwork in built up sections in channels, angles, tees and flats in all gusset plates, bolts, nuts, cutting rivets, welding etc. including dismembering and stacking within 50 m lead*

*DD0024* *Dismantling steelwork in built up sections without dismembering and stacking within 50 m lead*

**Measurement:** The length and width shall be measured correct to 10mm and the area worked out correct to two places of decimal. All steel and iron work shall be measured in kg. The weight shall be computed from standard tables unless the actual weight can readily be determined.

**Rate:** The rate shall include the cost of all labour involved and tools used in dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing of unserviceable material within a distance of 50 metres.

The rate shall also include for temporary shoring for the safety of portions not required to be pulled down, or of adjoining property, and providing temporary enclosures or partitions, where considered necessary.

### 5.1.7 Wood Work

*DD0025* *Dismantling wood work of sectional area 40 sq.cm and above in frames,trusses (<10m span) including stacking within 50m lead*

*DD0026* *Dismantling wood work of sectional area <40 sq.cm in frames, trusses including stacking within 50m lead*

*DD0027* *Extra for dismantling trusses, rafters, purlins etc. of every additional span of 1 metre or part thereof for span >10m (sectional area > 40sq.cm)*

*DD0028* *Extra for dismantling trusses, rafters, purlins etc. every additional span of 1 metre or part thereof >10m (sectional area < 40sq.cm)*

*DD0029* *Dismantling doors, windows, and clerestory windows <3sq.m (steel, wood) including architrave, hold fasts, stacking within 50m lead*

*DD0030* *Dismantling doors, windows and clerestory windows >3sq.m (steel/wood) including architrave, holdfasts, stacking within 50m lead.*

*DD0031* *Taking out doors, windows and clerestory windows shutters <3sq.m (steel, wood) including stacking within 50m lead.*

*DD0032* *Taking out doors, windows and clerestory windows shutters >3sq.m (steel or wood) including stacking within 50m lead.*

Dismantling of doors, windows, clerestory windows, ventilators etc. (wood or metal) whether done separately or along with removal of wall by making recess in the wall shall be enumerated. Those exceeding $3m^2$ each in area shall be measured separately. The item shall include removal of frames, architraves, holdfasts and other attachments.

**Measurement:** The length, breadth and thickness shall be measured correct to 10 mm and the cubical contents shall be worked out correct to two places of decimal. In measuring thickness of roofs provided with water proofing treatments with bitumen felts, the thickness of water proofing treatment shall be ignored. Where reinforcement steel or structural steel is required to be separated, the work shall be measured separately in Kg of salvaged steel. For taking out only shutters the measurements shall be taken separately.

**Rate:** The rate shall include the cost of all labour involved and tools used in demolishing and dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing of unserviceable material within a distance of 50 metres.

The rate shall also include for temporary shoring for the safety of portions not required to be pulled down, or of adjoining property, and providing temporary enclosures or partitions, where considered necessary.

### 5.1.8 Flooring

*DD0040* *Dismantling wooden flooring including stacking of useful materials & disposal of rubbish within 50m lead.*

*DD0041* *Dismantling dry brick patching in floors, drains etc including stacking useful materials & disposal of rubbish within 50m lead*

*DD0042* *Dismantling stone slab flooring laid in cement mortar including stacking useful materials & disposal of rubbish within 50m lead*

*DD0043* *Dismantling jack arch roofing and floors including stacking useful materials & disposal of rubbish within 50m lead*

The flooring planks and the supporting members shall be dismantled and serviceable and unserviceable materials separated and stacked/disposed off as directed by the Engineer.

**Measurement:** Dismantling of floors (except concrete and brick floors) shall be measured in square meters. The length and width shall be measured correct to 10mm and the area worked out correct to two places of decimal.

**Rate:** The rate shall include the cost of all labour involved and tools used in dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing of unserviceable material within a distance of 50 metres.

The rate shall also include for temporary shoring for the safety of portions not required to be pulled down, or of adjoining property, and providing temporary enclosures or partitions, where considered necessary.

### 5.1.9 Roofing

*DD0045* *Dismantling G.I. sheets including ridges, hips, valleys, gutters, and stacking of materials within 50m lead*

*DD0046* *Dismantling tiled roofing with batten boarding etc. complete including stacking useful materials & disposal of rubbish within 50m lead*

The dismantling shall be done by taking out the fixing with proper tools and not by tearing off or ripping off. All materials shall be stacked as directed by the Engineer.

**Measurement:** The area shall be measured flat and not girthed. The length and width shall be measured correct to 10mm and area calculated nearest to two places of decimal.

**Rate:** The rate shall include the cost of all labour involved and tools used in dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing of unserviceable material within a distance of 50 metres.

The rate shall also include for temporary shoring for the safety of portions not required to be pulled down, or of adjoining property, and providing temporary enclosures or partitions, where considered necessary.

### 5.1.10 Metal Work

*DD0050* *Dismantling expanded metal or fabrics with necessary battens and beading including stacking useful materials within 50m lead.*

**Measurement:** The length and width shall be measured correct to 10mm and the area worked out correct to two places of decimal.

**Rate:** The rate shall include the cost of all labour involved and tools used in dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing of unserviceable material within a distance of 50 metres.

The rate shall also include for temporary shoring for the safety of portions not required to be pulled down, or of adjoining property, and providing temporary enclosures or partitions, where considered necessary.

### 5.1.11 Fencing

*DD0055* *Dismantling barbed wire or flexible wire including making rolls and stacking within 50m lead.*

*DD0056* *Dismantling steel fence posts, struts including all earth work, and demolishing of concrete, etc. in base & stacking within 50m lead.*

*DD0057* *Dismantling R.C.C fence posts or struts including all earth work and dismantling of the concrete footings/bases in R.C.C & stacking within 50m lead.*

*DD0058* *Cutting ballies or wooden posts of fencing at the point of projection above the concrete or ground level & stacking the same within 50m lead.*

**Measurement:** The posts, struts and ballies shall be measured in numbers, while the barbed wire will be measured in kilograms.

**Rate:** The rate shall include the cost of all labour involved and tools used in dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing of unserviceable material within a distance of 50 metres.

The rate shall also include for temporary shoring for the safety of portions not required to be pulled down, or of adjoining property, and providing temporary enclosures or partitions, where considered necessary.

**5.1.12 Ceiling & Cladding**

*DD0065* *Dismantling asbestos cement, celotex, hard board ceiling, partition, including stacking useful materials, and disposal of rubbish within 50m lead.*

*DD0066* *Dismantling of ekra wall in cement mortar 1:6 or richer, including stacking of useful materials and disposal of rubbish within 50m lead.*

*DD0067* *Dismantling old plaster or skirting, raking out joints and cleaning the surface for plaster including disposal of rubbish within 50m lead*

The dismantling shall be done by taking out the fixing with proper tools and not by tearing off or ripping off. All materials shall be stacked as directed by the Engineer.

**Measurement:** The stripping of ceilings shall be measured in square metres. The length and width shall be measured correct to 10mm and area calculated nearest to two places of decimal.

**Rate:** The rate shall include the cost of all labour involved and tools used in dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing of unserviceable material within a distance of 50 metres.

The rate shall also include for temporary shoring for the safety of portions not required to be pulled down, or of adjoining property, and providing temporary enclosures or partitions, where considered necessary.

**5.1.13 Pipes**

- *Dismantling of old S.W pipes including breaking joints, concrete bed, stacking of useful materials and disposal of rubbish within 50m lead.*

*DD0075* *100mm diameter*

*DD0076* *150mm diameter*

*DD0077* *200mm diameter*

- *Dismantling CI pipes including excavation and refilling trenches after taking out the pipes, breaking lead caulked joints, melting of lead and making into blocks, stacking of pipes at site and disposal of rubbish within 50m lead*

*DD0078* *Up to 150 mm dia*

*DD0079 From 150 mm up to 300 mm dia*

*DD0080 Above 300 mm dia*

- *Dismantling of G.I or HDPE pipes of diameter 100 mm to 250 mm including breaking joints, concrete bed, stacking of useful materials & disposal of rubbish within 50m lead.*

*DD0085 G.I Pipes*

*DD0086 HDPE Pipes*

**Measurement:** The work shall be measured in running meters inclusive of joints correct to 10mm for each diameter of pipe. If the joints, special and fittings etc. are required to be separated, it shall be so stated and enumerated.

**Rate:** The rate shall include the cost of all labour involved and tools used in dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing of unserviceable material within a distance of 50 metres.

The rate shall also include for temporary shoring for the safety of portions not required to be pulled down, or of adjoining property, and providing temporary enclosures or partitions, where considered necessary.

### 5.1.14 Precast Walls

- *Dismantling of precast concrete or stone slabs in walls, partition walls etc. including stacking of useful materials & disposal of rubbish within 50 m lead*

*DD0090 Up to 40 mm thickness*

*DD0091 Above 40 mm thickness and up to 74mm thickness*

The dismantling shall be done by taking out the fixing with proper tools and not by tearing off or ripping off. All materials shall be stacked as directed by the Engineer.

**Measurement:** The dimensions shall be measured correct to 10mm and the area worked out correct to two places of decimal.

**Rate:** The rate shall include the cost of all labour involved and tools used in dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing of unserviceable material within a distance of 50 metres.

The rate shall also include for temporary shoring for the safety of portions not required to be pulled down, or of adjoining property, and providing temporary enclosures or partitions, where considered necessary.

### 5.1.15 Road work

*DD0095 Dismantling water bound macadam road including stacking of useful materials & disposal of rubbish within 50 m lead*

*DD0096 Dismantling bituminous road including cutting, stacking of useful materials & disposal of rubbish within 50 m lead*

**Measurement:** Different types of road surfaces shall be measured separately. The dimensions shall be measured correct to 10mm and the area worked out correct to two places of decimal.

**Rate:** The rate shall include the cost of all labour involved and tools used in dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing of unserviceable material within a distance of 50 metres.

### 5.1.16 Cisterns

*DD0100* *Dismantling of flushing cistern of any size including stacking of useful materials & disposal of rubbish within 50 m lead*

**Measurement:** The work will be measured in terms of the number of cisterns dismantled.

**Rate:** The rate shall include the cost of all labour involved and tools used in dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing of unserviceable material within a distance of 50 metres.

# 5.2 CHAPTER 2: CLEARING & GRUBBING

## 5.2.1 General

Clearing and grubbing consist of the removal and disposal of all trees, stumps, roots, logs, shrubs, grass, weeds, fallen timber and other surface litter, wherever they occur within the right-of-way and within such other areas as directed by the Engineer.

Existing structures, such as old buildings, culverts, pipe lines, sewers, etc., within or adjacent to the area where they are required to be removed, shall be dismantled as per the Engineer's direction and shall be paid separately for the same.

In the case of Archaeological Monuments within or adjacent to the area, the contractor shall provide the necessary fencing all around as per the direction of the Engineer and protect the same during execution. Payment for the provision of fences shall be made separately.

During clearing and grubbing of the trees, shrubs, pole lines, fences, monuments, pipe lines etc. within or adjacent to the work site which are not to be disturbed shall be protected properly from injury or damage by the contractor at his own cost and nothing extra shall be paid for this.

Where necessary, the contractor shall take all appropriate precautions against soil erosion, water pollution, etc. Before starting the work/operations, the contractor shall submit to the Engineer his work plan for approval including the procedures to be followed for disposal of waste materials, etc. and the schedules for carrying out temporary or permanent erosion control works as stipulated under earth work.

Trunks, branches and stumps of trees shall be cleaned of limps & roots and stacked. Also boulders, stones and other unusable materials shall be neatly stacked on the spots as directed by the Engineer.

All branches of trees extending to the work site or above roadway shall be trimmed as directed by the Engineer and such work shall be considered incidental to clearing and grubbing for which no separate payment shall be made.

Methods, tools and equipment to be adopted for the work shall be such as to have no effect on the property to be preserved. Only those methods, tools and equipment approved by the Engineer shall be adopted in the work. If so desired by the Engineer, the Contractor shall demonstrate the efficacy of the type of equipment to be used before the commencement of the work.

## 5.2.2 Clearing Grass

*CG0001* *Clearing grass including removal of rubbish within 50m outside the periphery of the area cleared.*

All grass and rubbish shall be disposed off beyond 50m outside the periphery of the area cleared.

**Measurement:** Only the area over which the grass and rubbish has been removed shall be measured. The length and breadth shall be measured correct to 10mm and the area shall be calculated correct to two places of decimals.

**Rate:** The rate shall cover the cost of carrying out all the required operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to

complete the work. Where necessary, the rate shall also include handling; salvaging, piling and disposing of the cleared materials with all lift and lead up to 50m.

*CG0002* *Clearing jungle including uprooting of rank vegetation, grass, brushwood, saplings and trees of girth up to 300mm measured at height of 1m above ground level and disposal of rubbish within 50m lead*.

The work shall consist of cutting, removing and disposing of all materials such as rank vegetation, grass, brush-wood, shrubs, stumps trees and saplings of girth up to 300 mm measured at a height of 1m above ground level which, in the opinion of Engineer are unsuitable for incorporation in the works. Where clearance of grass is only involved, no payment shall be made under this item.

The roots of trees shall be dug at least up to 600mm from ground level or 300mm below formation level or 150mm below sub-grade level whichever is lower. All holes or hollows formed by digging up roots shall be carefully filled up with earth, well rammed and levelled.

**Measurements:** Only the area over which the jungle clearing has been done shall be measured. The length and breadth shall be measured correct to 10mm and area calculated in square metre correct to two places of decimal.

Cutting and removing of roots of trees of girth above 300 mm at a height of 1m above ground level shall be made separately in terms of number according to the sizes.

**Rates:** The rate shall cover the cost of carrying out all the required operations including cost of labour, materials, equipment hired, tools and plants, and incidentals necessary to complete the work. The rate shall also include removal of stumps of trees less than 300mm in girth excavation, back filling to the required density, where necessary as well as handling, salvaging, piling and disposing of the cleared materials with all lift and lead up to 50m.

### 5.2.3 Felling of Trees (Manually)

- *Felling trees (girth measured at a height of 1m above ground level) including cutting of trunks and branches, removal of roots and stacking of serviceable materials and disposal of rubbish within 50m lead.*

*CG0010* *Girth 300 mm to 600 mm*

*CG0011* *Girth 600 mm to 1200 mm*

*CG0012* *Girth 1200 mm to 2400 mm*

*CG0013* *Above 2400 mm*

While clearing jungle growth, the trees 300 mm and above in girth (as measured at a height of one metre above ground level) to be cut shall be approved by the Engineer and then marked at the site. Felling trees shall include taking out roots up to 600mm below ground level or 300mm below formation level or 150mm below sub-grade level whichever is lower.

All excavation below general ground level arising out of the removal of trees, stumps etc. shall be filled with suitable material in 200mm layer and compacted thoroughly so that the surfaces at these points conform to the surrounding area. The trunks and branches of trees shall be cleared of limbs and tops and cut to suitable pieces as directed by the Engineer.

Logs, branches, twigs of trees and other useful material shall be the property of the Government, and these serviceable materials shall be stacked in the manner as directed by the Engineer.

All unserviceable materials shall be disposed off as per the directions of the Engineer.

**Measurements:** Felling of trees (girth measured at a height of one metre above ground level or top of the stump if the height of the stump is less than 1m from the ground) shall be paid for in terms of number according to sizes given above.

**Rate:** The rate shall cover the cost of carrying out all the required operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work. The rate shall also include removal of stumps of trees greater than 300mm in girth excavation, back filling to the required density, where necessary, as well as handling, salvaging, piling and disposing of the cleared materials with all lift and lead up to 50m.

Where a contract does not include separate items of clearing or grubbing, it shall be considered as incidental and the contract unit price for the same shall be considered inclusive of clearing and grubbing operations.

### 5.2.4 Felling of Trees (Dozer)

- *Felling trees (girth measured at a height of 1m above ground level) including removal of roots and disposal of rubbish using Dozer or other suitable equipment (excluding cutting of trunks and branches and stacking of serviceable materials).*

| | |
|---|---|
| *CG0020* | *Girth 300 mm to 600 mm* |
| *CG0021* | *Girth 600 mm to 1200 mm* |
| *CG0022* | *Girth 1200 mm to 2400 mm* |
| *CG0023* | *Girth > 2400 mm* |

While clearing jungle growth, the trees 300mm and above in girth (measured at a height of one metre above ground level) to be knocked down shall be approved and marked at site by the Engineer. Felling trees shall include taking out roots up to 600mm below ground level or 300mm below formation level or 150mm below sub-grade level whichever is lower.

All excavation below general ground level arising out of the removal of trees, stumps etc. shall be filled with suitable material in 200mm layer and compacted thoroughly so that the surfaces at these points conform to the surrounding area.

Logs, branches, twigs of trees and other useful material shall be the property of the Government and where required, shall be disposed of as directed by the Engineer.

All unserviceable materials shall be disposed off as per the directions of the Engineer.

The felling of trees shall be carried out by using power chain or any other suitable equipment and shall minimize any damages including environmental harm. Blasting operations, if any, for felling of trees shall be carried out strictly in compliance with the guidelines set out in the RGOB Blasting Manual. Where only light construction plants are available explosives can be effectively used to remove stumps and trees.

Explosives should not be used for clearing when damage can be done to buildings. Debris may fly 150m or more and the noise can be excessive. Flying debris is hard to control especially when blasting dead stumps. Where there is no danger of damage from flying debris, the hole shall be slightly overloaded, as it is very difficult to bore a second set of holes in the shattered stumps.

The contractor shall obtain a licence from the competent authority for obtaining and storing the explosives. The contractor shall procure the explosives, fuses, detonators etc. from the concerned authority. The Engineer or his representative shall have the right to check the contractor's store and accounts of explosives. The contractor shall provide facilities for this.

All blasting work shall only be done under careful supervision of trained personnel and the contractor shall take all precautions as per rules for blasting operations.

The contractor shall be responsible for any damage arising out of accident to the workmen, public or property due to storage, transportation and use of explosives during blasting operations.

The holes shall be drilled on a slightly down slope with a 30mm wood auger and shall be placed in the parallel section of the trunk just above the butt. For trees up to 450 mm in girth one hole drilled about three-quarters ( ¾ ) of the way through the tree shall be sufficient. For larger trees a series of equally spaced radial holes drilled within about 25 to 50 mm centre to centre shall be used.

The placing and quantity of explosives required shall vary with each tree and is governed by the age, type and girth. As general rule 1.2kg to 1.52 kg of explosives per square meter of cross section shall be sufficient.

**Removal of stumps or standing tree:** The placing and quantity of explosives required shall vary with each tree and is governed by the size, type of stumps or tree, and the root system. Sandy or loose soils require heavier charges than clay soil. The charge shall be placed centrally under the butt. But if there is only one taproot the explosives shall be placed under the fork formed by two of the largest surface roots. In stumps 900mm in girth or over, the charge shall be split and placed at two or more places around the tree.

**Measurements:** Cutting of trees above 300mm in girth (measured at a height of one metre above ground level shall be paid for in terms of number according to sizes given above.

**Rate:** The rate shall cover the cost for carrying out all the required operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work. The rate shall also include removal of stumps of trees of all sizes, excavation, back filling to required density, where necessary, as well as disposing of the cleared materials with all lift and lead up to 50m.

Where a contract does not include separate items of clearing or grubbing, it shall be considered incidental and the contract unit price for the same shall be considered inclusive of clearing and grubbing operations.

### 5.2.5 Landslide Debris

*CG0030* *Clearing grass, removal of landslide debris and surface material including excavation & disposal within 50m lead*.

Clearance of earth shall be carried out to the required depths and profiles. The clearance of earth shall be done manually or using Bulldozer or any other earth moving equipment including excavating the same and disposal of the earth within 50m.

**Measurements:** The length, breadth and depth shall be measured correct to 10mm. In case the measurements are taken with staff and level, the level shall be recorded correct to 5mm and depth of cutting and heights of filling calculated correct to 5mm. The cubical contents shall be worked out to the nearest two places of decimal. Where the ground is not fairly uniform or where the site is required to be cleared, levels shall be taken before the start and after the completion of the work and the quantity of excavation in cutting computed from these levels.

**Rate:** The rate shall cover the cost for carrying out all the required operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work. The rate shall also include, where necessary, disposing of the cleared materials with all lift and lead up to 50m.

# 5.3 CHAPTER 3: EARTH WORK

### 5.3.1 General

This work shall consist of excavation, removal and satisfactory disposal of all materials necessary for the construction in accordance with requirements of these specifications and the lines, grades and cross-sections shown in the drawings or as indicated by the Engineer. It shall include the hauling and stacking of or hauling of suitable cut materials as required, to sites of embankment and sub-grade construction, and also the disposal of unsuitable cut materials in specified manner, trimming and finishing to specified dimensions or as directed by the Engineer. The excavation shall be done manually or by mechanical means as directed by the Engineer in charge considering feasibility, urgency of work, availability of labour/mechanical equipment and other factors involved.

Classification of materials for purpose of manual excavation shall be as follows:

**Ordinary Soil** – Generally any soil which can be excavated by the ordinary application of pick and shovel, rake or any other ordinary digging equipment; such as vegetable or organic soil, turf gravel, sand, silt loam, clay, peat etc.

**Hard Soil** – Generally any soil which requires close application of picks or jumpers or scarifiers to loosen; such as stiff clay, gravel, cobble stone, water bound macadam and soling of roads.

**Ordinary Rock**: Generally any rock which can be excavated by splitting with crow bars or picks and does not require blasting, wedging or similar means of excavation such as lime stone, sand stone, hard laterite, hard conglomerate and un-reinforced cement concrete below ground level. If required light blasting may be resorted to for loosening the materials but this will not in any way entitle the material to be classified as “Hard Rock”.

**Hard Rock** : Generally any rock or boulder for the excavation of which blasting is required such as quartzite, granite, basalt, reinforced cement concrete ( reinforcement to be cut through but not separated from concrete) below ground level and the like.

**Hard Rock (blasting prohibited)**: Hard rock requiring blasting as described above but where the blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging or any other agreed method.

**Marshy Soil**: This shall include soils like soft clays and peat excavated below the original ground level of marshes and swamps and soils excavated from other areas requiring continuous pumping or bailing out of water.

For machine excavation, materials shall be classified as follows:

**All types of soil**: Generally any strata, such as sand, gravel, loam, clay, mud, black cotton soil, moorum, shingle, river or nallah bed boulders, soling of roads, paths etc. and hard core macadam surface of any description (water bound, grouted tarmac etc.), lime concrete, mud concrete and their mixtures which for excavation yields to the application of picks, shovels, jumpers, scarifiers, ripper and other manual digging implements.

**All types of rock** which include the above mentioned categories of rocks.

**Authority for classification**: Engineer shall decide the classification of excavation, and his decision shall be final and binding on the Contractor. Merely the use of explosives in

excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engineer.

**Setting out:** After the site has been cleared (as per the specifications in Chapter 2), the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawing or as directed by the Engineer. The Contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete, etc., required in connection with the setting out of works and the establishment of bench marks. The Contractor shall be responsible for the maintenance of the benchmarks and other marks and stakes as long as they are required for the work in the opinion of the Engineer.

The ground levels shall be taken at 5m to 15m intervals in uniformly sloping ground and at closer intervals where local mounds, pits or undulations are met with. The ground levels shall be recorded in field books and plotted on plans. These plans shall be drawn to a suitable scale with North direction line and the position of benchmark invariably shown on it. The contractor and the Engineer shall sign the plan before the earthwork is started. The contractor shall, at his own expense, supply the labour required for taking levels.

Stripping and storing topsoil: When so directed by the Engineer, the topsoil existing over the sites of excavation shall be stripped to the specified depths and stockpiled at designated location for re-use in covering embankment slopes, cut slopes, and other disturbed areas where re-vegetation is desired. Prior to stripping the topsoil, all trees, shrubs etc. shall be removed along with their roots, with the approval of the Engineer.

Excavation: All excavations shall be carried out in conformity with the directions laid herein-under and in a manner approved by the Engineer. The works shall be so done that the suitable materials available from excavation are satisfactorily utilized as agreed upon beforehand.

While planning the excavation, the Contractor shall take adequate precautions against soil erosion, water pollution etc. and take appropriate drainage measures to keep the sites free of water.

The excavations shall conform to the lines, grades, side slopes and levels shown on the drawing or as directed by the Engineer. The Contractor shall not excavate outside the limits of excavation. Subject to the permitted tolerances, any excess depth/width excavated beyond the levels/dimensions specified on the drawing shall be made good at the cost of the Contractor with the suitable material of characteristics similar to that removed and compacted.

All debris and loose materials on the cut slopes shall be removed. No backfilling shall be allowed in order to obtain the required slopes excepting that when boulders or soft materials are encountered in the cut slopes, these shall be excavated to the approved depth on instructions of the Engineer and the resulting cavities filled with suitable materials and thoroughly compacted in an approved manner.

After excavation, the sides of the excavated areas shall be trimmed and contoured to minimize erosion and ponding, allowing natural drainage to take place. If trees were removed, new trees shall be planted as per the direction of the Engineer. The cost of planting the new trees shall be deemed to be incidental to the work.

**Methods, tools and equipment:** Only such methods, tools and equipment as approved by the Engineer shall be adopted for the work. If so desired by the Engineer, the Contractor shall demonstrate the efficacy of the type of equipment to be used before the commencement of the work. Methods, tools and equipment to be adopted for the work shall be such which will not affect the property to be preserved.

**Rocks excavation:** Rocks when encountered in the road excavation shall be removed up to the formation level or as otherwise indicated on the drawings. Where, however, unstable shale or other unsuitable materials are encountered at the formation level, these shall be excavated to the extent of 500 mm below the formation level or as otherwise specified. In all cases, the excavation operations shall be so carried out that at no point on cut formation the rock protrudes above the specified level. Rocks and large boulders which are likely to cause differential settlement and also local drainage problems should be removed to the extent of 500 mm below the formation level in full formation width including drains and cut through the side drains.

Slopes in rock cutting shall be uniform lines corresponding to the slope lines shown on the drawings or as directed by the Engineer. Notwithstanding the foregoing, all loose pieces of rock on excavated slope surface which moves when pierced by a crowbar shall be removed.

Where blasting is to be resorted to, the same shall be carried out as per the RGOB blasting manual and all precautions indicated therein observed.

**Marsh excavation:** The excavation of soils from marshes/swamps shall be carried out as per the programme approved by the Engineer. Excavation of marshes shall begin at one end and proceed in one direction across the entire marsh immediately ahead of back filling. The method and sequence of excavating and back filling shall be such as to ensure, to the extent practicable, the complete removal or displacement of all muck from within the lateral limits called for on the drawings or as staked by the Engineer, and to the bottom of the marsh, firm support or levels indicated.

**Blasting:** The contractor shall obtain a licence from the competent authority for obtaining and storing the explosives. The contractor shall procure the explosives, fuses,D cord, detonators etc. from the Government or as per the provision in terms and condition of the contract. The Engineer or his representative shall have the right to check the contractor's store and accounts of explosives. The contractor shall provide facilities for this.

All blasting work shall only be done under careful supervision of trained personnel and the contractor shall take all precautions as per rules for blasting operations.

The Contractor shall ensure safety measures for every worker present, through the provision of personal protective equipment. The contractor shall be responsible for any damage arising out of accident to the workmen, public or property due to storage, transportation and use of explosives during blasting operations.

### 5.3.2 Excavation (Manually)

- *Surface dressing of ground, including removal of vegetation and inequalities < 150mm deep, disposal of rubbish within 50m lead and 1.5m lifts.*

*EW0002 All types of soil*

Surface dressing shall include removing vegetation, cutting and filling up to a depth of 150mm and dressing the area. High portions of ground shall be cut down and hollows and

depressions filled up to the required level with the excavated earth so as to give an even, neat and tidy look to the site.

**Measurements:** Area of the ground dress shall be measured. Length and breadth shall be correct to 10mm and area worked out in square metre correct to two places of decimal.

**Rate:** The rate shall cover the cost for carrying out all the required operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work. The rate shall include, where necessary, disposing of the cleared materials with all lifts and lead up to 50m.

- *Ploughing the existing ground to a depth from 150mm to 250mm and watering the same.*

*EW0011* *All types of Soil*

**Measurement:** The actual area ploughed shall be measured. The length and width shall be measured correct to 10mm. The area shall be calculated correct to two places of decimal.

**Rate:** The rate shall cover the cost for carrying out all the required ploughing operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work. The rate shall include, where necessary, disposing of the cleared materials with all lifts and lead up to 50m.

- *Earth work in surface excavation not exceeding 300mm in depth but exceeding 1.5m in width, and area exceeding 10m$^2$ in plan, including disposal of excavated earth within 50m lead & 1.5m lift and disposed soil to be levelled & neatly dressed.)*

*EW0021* *All types of Soil*

Excavation exceeding 1.5m in width or/and 10m$^2$ in area on plan but not exceeding 300mm in depth in all types of soils and rocks shall be described as surface excavation.

**Measurements:** The length and breadth shall be measured correct to 10mm. In case the measurements are taken with staff and level, the level shall be recorded correct to 5mm and depth of cutting and heights of filling calculated correct to 5mm. The area shall be worked out to the nearest two places of decimal in square metres.

**Rates:** The rates shall cover the cost for carrying out all the required operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work. The rates shall also include, where necessary:

- Disposing of the cleared materials with all lifts and lead up to 50m;
- Bailing out or pumping of water in excavations from rains, subsoil water etc.;
- Protection and supporting of existing services i.e. pipes, water mains, cables met within the course of excavation. Care shall be taken not to disturb electric and communication cables, removal of which if necessary, shall be arranged by the Engineer.

- *Earth work in excavation over areas, exceeding 300mm in depth, 1.5m in width as well as 10m2 in area on plan, including disposal of excavated earth within 50m lead and 1.5m lift and disposed soil to be levelled and neatly dressed.*

*EW0031* *All types of Soil*

*EW0032* *All types of rock with or without blasting*

*EW0033 All types of rock requiring blasting*

*EW0034 All types of rock requiring chiselling (where blasting is prohibited)*

Excavation exceeding 1.5m in width or/and 10 $m^2$ in area on plan as well as exceeding 300mm in depth in all types of soils and rocks shall be described as excavation over areas.

**Measurements:** The length and breadth shall be measured correct to 10 mm. In case the measurements are taken with staff and level, the level shall be recorded correct to 5mm and depth of cutting and heights of filling calculated correct to 5mm. The area shall be worked out to the nearest two places of decimal in square metres.

**Rates:** The rates shall cover the cost for carrying out all the required operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work. The rates shall also include, where necessary:

- Disposing of the cleared materials with all lifts and lead up to 50m;
- Bailing out or pumping of water in excavations from rains, subsoil water etc.;
- Protection and supporting of existing services i.e. pipes, water mains, cables met within the course of excavation. Care shall be taken not to disturb electric and communication cables, removal of which if necessary, shall be arranged by the Engineer.

### 5.3.3 Excavation (Mechanically)

- *Earth work in excavation over areas using Excavator, exceeding 300mm in depth, 1.5m in width as well as 10m2 in area on plan, including dressing, levelling and disposal of excavated earth, lead up to 50m and lift up to 1.5m*

*EW0046 All types of soil*

*EW0047 All types of rock (blasted)*

This shall comprise:

(a) Excavation exceeding 1.5 m in width or/and 10$m^2$ in area on plan and exceeding 30 cm in depth.

(b) Excavation for basements, water tanks etc.

(c) Excavation in trenches for foundations exceeding 1.5 m in width or/and 10$m^2$ in area on plan.

Excavation over areas shall be carried out to the required depths and profiles.

**Cutting:** In firm soil, the sides of the trench shall be kept vertical up to a depth of 2m from the bottom. For a greater depth, the excavation profiles shall be widened by allowing steps of 500mm on either side after every 2m from the bottom. Alternatively the excavation can be done so as to give slopes of 1:4.

Where the soil is soft, loose or slushy, the width of steps shall be suitably increased or side sloped or the soil shored up as directed by the Engineer. It shall be the responsibility of the contractor to take complete instructions in writing from the Engineer regarding the stepping, sloping or shoring to be done for excavation deeper than 2 metres.

The bed of excavation shall be made to the correct level or slope and consolidated by watering and ramming. Soft/defective spots shall be dug out and filled with levelling

concrete as directed by the Engineer. The excess depth shall be made good by the contractor at his own cost with the concrete of the same mix as levelling concrete.

### 5.3.4 Blasting

- *Blasting of rocks complete but excluding the cost of collection and stacking of blasted rock*

*EW0056 All types of rock*

Where hard rock is met with and blasting operations are considered necessary, the contractor shall obtain the approval of the Engineer. For an ordinary rock, in general, the blasting operation is not adopted but if the contractor wishes to resort to blasting, he can do so with the permission of the Engineer but nothing extra shall be paid for this blasting.

The general procedures for procuring and use of explosives shall be as per clause 5.3.1 above.

Setting out and marking shall be as specified in clause 5.3.1 above.

### 5.3.5 Silent Blaster

- *Breaking of rocks using non-explosive blaster (silent blaster) in excavation over areas with depth >300mm, width >1.5m and area >10sq.m on plan including stacking of boulders or useful materials and disposal of rubbish etc. complete*

- *EW0066 All types of rock*

- *Breaking of rocks using non-explosive blaster (silent blaster) in foundation trenches width <1.5m, and area <10sq.m on plan including stacking of boulders or useful materials and disposal of rubbish etc. complete*

- *EW0076 All types of rock*

The Non-explosive blasting shall be used for demolishing concrete structures or breaking the rocks where explosive blasting is prohibited.

**Proportion:** The quantity of the compound required for breaking varies with the type & shape of rock or boulder, and presence or absence of inherent cleavages in the rock. In general, 4 kg of this non-explosive blasting compound shall be used per ton of rock to break it. The compound shall be mixed with water before use, most suitably in a plastic bucket. The quantity of water to be used for mixing shall be 600 ml for every 2 kg of the compound.

**Preparation:** The required quantity of water shall be taken in a plastic bucket and the compound shall be added gradually. It shall be stirred with a hand mixer or rod until the full quantity has been added and the material has turned into a flowable or slurry type consistency. If the slurry starts to stiffen, the batch of the slurry shall be discarded and a fresh one has to be prepared.

**Filling Holes**: The slurry prepared above shall be poured into the holes drilled one by one within ten minutes of mixing. The holes shall be filled up to 10mm below the top of the hole.

**Drilling Holes:** The size and diameter of holes to be drilled shall depend upon the nature of rock, or other structures to be demolished. Recommended pattern of drilling shall be as shown in the table below:

**Table 5.3.1** RECOMMENDED PATTERN OF DRILL HOLES

| Hole diameter (mm) | Hole spacing (mm) | Hole depth (mm) | Remarks |
|---|---|---|---|
| 25 | 200 | 500 | In case of shallow boulders, inclined holes may be drilled |
| 35 | 250 | 700 | |

The non-explosive blasting compound functions due to the expansive forces generated on the sides of the holes developing cracks and splitting the rock. While the chemical reaction starts immediately on mixing with water, the effect begins to manifest in 10 to 12 hours. It may take 24 to 48 hours for the full effect to materialize after pouring the slurry.

It is strongly recommended to use this silent blasting as per the instructions of the manufacturers for its full effect & maximum efficiency.

**Precautions:** The following precautions are to be taken while using the compound:

1. For making slurry, potable water shall be used;
2. Use cold water for mixing, where temperature exceeds 32°C;
3. Do not open the bag unless immediately used;
4. Use the slurry within 10 minutes of mixing, if not used discard it by diluting it with plenty of water and dump in any open area;
5. If the ambient temperature exceeds 32°C, cold water shall be poured to cool the surrounding of the drilled holes. However it is best to carry it out in late evening or early morning during hot weather.
6. Plastic sleeves shall be used in case the rock is suspected to have cleavages or cracks or is of a porous nature;
7. After pouring the slurry, the holes shall be covered by gunny bags or tarpaulins to protect from any spurting that might occur;
8. Operators must use personal protective equipments like goggles, helmet, hand gloves, etc;
9. If any part of the body comes in contact with slurry or powder, it shall be washed with plenty of water.

**Measurements:** The length, breadth and depth/height shall be measured correct to 10mm. In case the measurements are taken with staff and level, the level shall be recorded correct to 5mm and depth of cutting and heights of filling calculated correct to 5mm. The cubical contents shall be worked out to the nearest two places of decimal in cubic metres.

**Rates:** The rates shall cover the cost for carrying out all the required operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work. In case of rock, the rate shall also include the cost of all operations of blasting with explosive and accessories as mentioned above.

### 5.3.6 Rough Excavation & Banking

- *Earth work in rough excavation & banking of excavated earth in layers not exceeding 200 mm in depth for road, flood banks, guide banks & filling up ground depressions,*

*including watering, power rolling with ½ tones roller and rolling every 3rd and top most layer with power roller of minimum 8 tonnes, dressing up, lead up to 50m & 1.5m lift.*

*EW0085 All types of soil*

*- Banking excavated earth in layers not exceeding 200mm in depth, breaking clods, watering, rolling each layer with ½ tonnes roller, rolling every third layer and top most layer with power roller of minimum 8 tonnes and dressing up for road, flood banks, guide banks & depressions, etc. lead up to 50m & 1.5m lift.*

*EW0096 All types of soil*

*EW0097 Deduction for not rolling with power roller minimum 8 tonnes in layered banking works*

*EW0098 Deduction for not watering in layered, banking works*

Rough excavation shall mean bringing earth from hillside cutting, borrow pits, etc. where dressing of sides and bottom and reduction to exact level is not required. Hillsides cutting shall be done from top to bottom. Under no circumstances shall under-mining or under cutting be allowed. During excavation the contractor shall maintain the natural/man-made drainage of the area.

Cutting work, other than rough excavation, shall be executed true to levels, slope, shape and pattern indicated by the Engineer. The sides of excavation shall be dressed or trimmed, and bottoms shall be levelled or graded and rammed as directed by the Engineer.

All cutting shall be done to the required levels. In case it is taken deeper by the contractor, it shall be brought to the required levels by filling in with earth duly consolidated at the contractor's cost. However in case of hard rock, where blasting operations have been resorted to, cutting shall be measured to the actual level provided the Engineer is satisfied that the contractor has not gone deeper than what was unavoidable.

**Filling:** The earth from cutting shall be directly used for filling and no claim for double handling of earth shall be entertained. Filling shall be done in regular horizontal layers, each not exceeding 200mm in depth. The earth shall be free from all roots, grass and rubbish. All lumps and clods exceeding 80mm in any direction shall be broken and each layer shall be consolidated by ramming and rolling, etc. Watering shall be done, if so stipulated. The top surface of the finally finished area shall be neatly dressed.

The finished formation levels in case of filling shall be kept higher than the required level by making an allowance of 10% of depth of filling for future settlement in case of ordinary consolidated fills, and 5% in case where consolidation is done by heavy mechanical machinery under optimum moisture conditions.

**Measurements:** The length, breadth and depth shall be measured correct to 10mm. In case the measurements are taken with staff and level, the level shall be recorded correct to 5mm and depth of cutting and heights of filling calculated correct to 5mm. The cubical contents shall be worked out to the nearest two places of decimal in cubic metres.

Where excavation is in trench or in borrow pits, the measurements of cutting in trenches or borrow pits shall be made. In case of borrow pits, diagonal ridges, cross ridges or deadmen shall be left by the contractor to permit accurate measurements being taken on the completion of work. The position of deadmen etc. shall be fixed by the Engineer.

Deduction of such ridges and deadmen shall be made from the measurements, unless the same are required to be removed later on and the earth so removed is utilised in the work. In the later case nothing extra will be paid for their subsequent removal.

Where the ground is not fairly uniform or where the site is required to be levelled, levels shall be taken before the start and after the completion of work and the quantity of excavation in cutting computed from these levels.

Where it is not possible or convenient to take measurements from borrow pits or cutting, excavation shall be worked out from filling. The levels of the original ground before start of the work after site clearance, and after compaction of the fill shall be taken at suitable intervals. The quantity of fill shall be computed from these levels. The quantity of earthwork so computed shall be reduced by 10% in case of consolidated fills and by 5% in case the consolidation is done by heavy mechanical machinery, to arrive at net cubical contents. No such deduction shall be made where:

i) Consolidation is done by heavy mechanical machinery at the optimum moisture content or

ii) Consolidated filling is done in confined situations, such as under floors.

**Rates:** The rates shall cover the cost for carrying out all the required excavation and banking operations, including the cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work. In case of rock, the rate shall also include the cost of all operations of blasting with explosive and accessories or other means as mentioned above.

Protection and supporting of existing services i.e. pipes, water mains, cables met within the course of excavation should be provided. Care shall be taken not to disturb electric and communication cables, and, if necessary for removal it shall be arranged by the Engineer.

### 5.3.7 Trenches Excavation

- *Earthwork in excavation in foundation trenches or drains not exceeding 1.5m in width and 10sq.m in area on plan including dressing of sides & ramming of bottom, disposal of surplus excavated soil within 50m lead & 1.5m lift.*

*EW0106* *All types of Soil*

*EW0107* *All types of rock with or without blasting*

*EW0108* *All types of rock requiring blasting*

*EW0109* *All types of rock requiring chiselling (where blasting is prohibited)*

All excavation operations shall include excavation and getting out the excavated matter. Getting out shall include throwing the excavated earth at least one metre or half the depth of excavation whichever is more, clear off the edge of excavation. The subsequent disposal of the excavated material shall either be as directed by the Engineer under a separate item or as included in this item disposal up to 50 metres lead. Excavation shall be dug out to the exact dimensions as shown in the drawing or as directed by the Engineer.

Care shall be taken to cut the sides and bottom exactly to the required shape, slope and gradient, while carrying out excavation for drains work. The surface shall be dressed properly. If the excavation is done to a depth greater than that shown in the drawings or greater than that required by the Engineer, the excess depth shall be made good at the cost

of the contractor with stiff clay puddle at places where the drains are required to be pitched and with ordinary earth, properly watered and rammed, where the drains are not required to be pitched. In case the drain is required to be pitched, the back filling with clay puddles shall be done side by side as the pitching work proceeds. The brick pitched storm water drains shall be avoided as far as possible in filled up areas.

Excavation in ordinary rock shall be carried out by crowbars, pickaxes or pneumatic drills. Blasting operations are generally not required in this case. If the contractor wishes to resort to blasting, he can do so with the permission of the Engineer, but nothing extra will be paid to him on this account.

Excavation in hard rock shall be done by chiselling where blasting operation is prohibited or is not applicable. In trenches or drains where blasting is not otherwise prohibited, the excavation in hard rock shall be carried out by blasting in the first instance and finally by chiselling so as to obtain the correct section of the trench as per drawing. The blasting operation shall be strictly as per latest RGOB blasting manuals.

**Measurements:** The length, breadth and depth shall be measured correct to 10mm. The cubical contents shall be worked out to the nearest two places of decimal in cubic metres.

**Rates:** The rates shall cover the cost for carrying out all the required excavation and banking operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work. In case of rock, the rate shall also include the cost of all operations of blasting with explosive and accessories as mentioned above.

Protection and supporting of existing services i.e. pipes, water mains, cables met within the course of excavation. Care shall be taken not to disturb electric and communication cables, and, if necessary for removal it shall be arranged by the Engineer.

- *Extra for every additional lift of 1.5m or part thereof.*

*EW0115* *All types of soil*

*EW0116* *All types of rock*

**Measurement:** The earthwork beyond 1.5 m lift shall be measured in cubical contents.

**Rate:** Rate shall include all operations involved in the additional lift.

- *Extra for trench and pit works*

*EW0125* *Under water*

*EW0126* *In foul conditions*

The excavation shall be classified as below:

a) Work in or under water and/or liquid mud and

b) Work in or under foul positions.

Where water is met within excavation due to stream flow, seepage, springs or other reasons, the contractor shall take adequate measures such as bailing, pumping, construction of diversion channels, drainage channels, bunds, coffer dam and other necessary works to keep the foundation trench dry when necessary and to protect the green concrete/masonry against damage by erosion, or sudden rising of water level. The steady water level in the trial pits prior to the start of pumping operations shall be considered to be the subsoil water level in that area.

In excavations where sewage, sewage gases or foul conditions are met with from any source, the decision of the Engineer-in-Charge whether the work is in foul position or not shall be final.

The methods to be adopted in this regard and other details shall be done with the approval of the Engineer which however shall not relieve the contractor of the responsibility for the adequacy of dewatering, protection arrangements and for the quality and safety of the works.

Excavation shall be done within a timbered area in a manner similar to the excavation in dry soil in an open area or in trenches to prevent slipping of sides.

**Measurement:** The depth shall be measured from the level of foul position/ sub-soil water level and upto the centre of gravity of the cross sectional area of excavation actually done under the conditions classified above with the cubical contents measured correct to two places of decimals.

In case earth work in or under foul position is also in or under water and/or liquid mud, extra payment shall be admissible only for the earth work actually executed in or under foul position.

Planking and strutting as well as pumping and bailing of water due to the sources except for rain shall be measured and paid for separately.

**Rate:** The rates shall include cost of all the operations as may be applicable.

- *Excavating trenches of required width for pipes & sockets, cables, etc. ramming of bottom, dressing of sides, depth up to 1.5m including getting out the excavated soil and then refilling in layers not exceeding 200mm in depth including consolidating each deposited layer by ramming, watering, etc. and disposing of surplus material within lead of 50m :All types of soil*

*EW0134* *Pipes, cables etc. not exceeding 80mm diameter*

*EW0135* *Pipes, cables etc. exceeding 80mm diameter but not exceeding 300mm diameter*

*EW0136* *Pipes, cables etc. exceeding 300mm diameter*

*Excavating trenches of required width for pipes & sockets, cables, etc. ramming of bottom, dressing of sides, depth up to 1.5m including getting out the excavated soil and then refilling in layers not exceeding 200mm in depth including consolidating each deposited layer by ramming, watering, etc. and disposing of surplus material within lead of 50m :All types of rock with or without blasting*

*EW0155* *Pipes, cables etc. not exceeding 80mm diameter*

*EW0155* *Pipes, cables etc. exceeding 80mm diameter but not exceeding 300mm diameter*

*EW0156* *Pipes, cables etc. exceeding 300mm diameter*

*Excavating trenches of required width for pipes & sockets, cables, etc. ramming of bottom, dressing of sides, depth up to 1.5m including getting out the excavated soil and then refilling in layers not exceeding 200mm in depth including consolidating each deposited layer by ramming, watering, etc. and disposing of surplus material within lead of 50m :All types of rock requiring blasting*

*EW0164 Pipes, cables etc. not exceeding 80mm diameter*

*EW0165 Pipes, cables etc. exceeding 80mm diameter but not exceeding 300mm diameter*

*EW0166 Pipes, cables etc. exceeding 300mm diameter*

*Excavating trenches of required width for pipes & sockets, cables, etc. ramming of bottom, dressing of sides, depth up to 1.5m including getting out the excavated soil and then refilling in layers not exceeding 200mm in depth including consolidating each deposited layer by ramming, watering, etc. and disposing of surplus material within lead of 50m: All types of rock requiring chiselling (where blasting is prohibited)*

*EW0174 Pipes, cables etc not exceeding 80mm diameter*

*EW0175 Pipes, cables etc exceeding 80mm diameter but not exceeding 300mm diameter*

*EW0176 Pipes, cables etc exceeding 300mm diameter*

****Extra for excavating trenches for pipes, cables etc., 1.5m <depth <3m*

*EW0185 All types of soil*

*EW0186 All types of rock*

Excavation not exceeding 1.5m in width or/and 10sq.m in plan to any depth in trenches shall be described as excavation in trenches for pipes, cables etc.

Returning, filling and ramming after pipes, cables etc are laid and removal of surplus soil not exceeding 50m in lead shall also be included in this work.

Width of trench:

a) Up to 1m depth the width of the trench for the purpose of measurement of excavation shall be arrived at by adding 250mm to the external diameter of pipe (not socket), cable, conduit etc. Where a pipe is laid on a concrete bed/cushioning layer, the authorised width shall be the external diameter of the pipe plus 250mm or the width of the concrete bed/cushioning layer whichever is more.

b) For depths exceeding 1m, an allowance of 50mm per metre of depth for each side of the trench shall be added to the authorised width (i.e. the external diameter of pipe plus 250mm). This allowance shall apply to the entire depth of the trench.

c) Where more than one pipe, cable, conduit etc are laid, the diameter shall be reckoned as the horizontal distance from outside to outside of the outermost pipe, cable, conduit etc.

**Refilling:** Normally excavated earth shall be used for refilling. In case such earth contains deleterious salts, it shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150mm size in any direction and mixed with fine materials consisting of decomposed rock/earth as available so as to fill up the voids as far as possible and then the mixture is used for filling.

Filling in trenches for pipes and drains shall be commenced as soon as the joints of the pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of the pipes in layers not exceeding 200mm

and then watered, rammed and consolidated taking care not to damage the pipe below. In case of excavation of trenches in rock, the filling up to a depth of 300mm above the crown of pipe or barrel shall be done with fine material and the remaining filling mixed with fine material as available to fill up the voids, watered, rammed and consolidated in layers not exceeding 30 cm.

**Measurements:** The trenches shall be measured in running meters correct to 10mm in stages of 1.5m depths.

**Rates:** The rates shall cover the cost for carrying out all the required excavation and refilling operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work. In case of hard rock, the rate shall also include the cost of all operations of blasting with explosive and accessories as mentioned above.

Protection and supporting of existing services i.e. pipes, water mains, cables met within the course of excavation. Care shall be taken not to disturb electric and communication cables, and, if necessary for removal it shall be arranged by the Engineer.

### 5.3.8 Filling or Bedding

*EW0195* *Filling of trenches, sides of foundations, under floors in ground floor etc. in layers not exceeding 200mm in depth using selected available excavated materials including consolidating each deposited layer by ramming, watering etc. within lead 50 m & lift 1.5m*

Earth used for filling shall be free from stone, shingle or boulder larger than 75 mm in any direction and salts, organic or other foreign matter. Normally excavated earth from the same area shall be used for filling. However if such earth contains deleterious material, it shall not be used. All clods of earth shall be broken or removed.

The spaces around the foundations pipes and drains in trenches shall be cleared of all debris, brick bats etc. The filling shall be done in layers, not exceeding 200mm in each layer. Each layer shall be watered, rammed and consolidated before the succeeding one is laid. Earth shall be rammed with iron rammers where feasible and with the butt-ends of crowbars where rammers cannot be used. Special care shall be taken that no damage is caused to the pipes, drains and masonry or concrete in the trenches, under floor, etc.

**Measurements:** The cubical contents of foundation concrete and masonry in foundation up to ground level shall be worked out and the same deducted from the cubical contents of earthwork in excavation for foundations to arrive at the quantity for filling sides of foundation. For filling in plinths and under floors, depth shall be the consolidated depth.

**Rates:** The rates shall cover the cost for carrying out all the required filling operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work.

*EW0196* *Providing & laying sand bedding, including watering, ramming and dressing*

*EW0197* *Providing & laying dry earth bedding, including consolidating each deposited layer by ramming, watering and dressing complete*.

Sand filling shall be done similar to earth filling in plinth as specified above except that the consolidation shall be done by flooding with water. The surface of the consolidated sand shall be dressed to required level or slope. Concreting of the floor shall not be started until the sand filling is inspected and approved by the engineer.

**Measurements:** Volume of consolidated filling shall be measured. The dimensions shall be measured correct to 10mm and cubical contents worked out in cubic metres correct to two places of decimal.

**Rates:** The rates shall cover the cost for carrying out all the required filling operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work.

### 5.3.9 Timbering in trenches

- *Open timbering over areas including lagging & strutting of trenches, cuts (per sq.m face area timbered)*

*EW0205* *Depth not exceeding 1.5 m*

*EW0206* *Depth exceeding 1.5 m but not exceeding 3m*

*EW0207* *Depth exceeding 3 m*

- *Close timbering over areas including lagging & strutting of trenches, cuts (per sq.m face area timbered)*

*EW0215* *Depth not exceeding 1.5m*

*EW0216* *Depth exceeding 1.5m but not exceeding 3m*

*EW0217* *Depth exceeding 3m but not exceeding 4.5m*

- *Close timbering including lagging & strutting of shafts, wells, cesspits, manholes and packing cavities wherever required (per sq.m face area timbered)*

*EW0225* *Depth not exceeding 1.5m*

*EW0226* *Depth exceeding 1.5m but not exceeding 3m*

*EW0227* *Depth exceeding 3m but not exceeding 4.5m*

In case of open timbering, the entire surface of the side trench is not required to be covered. The vertical boards of (250x38) mm in section shall be spaced sufficiently apart to leave unsupported strips of 500mm average width. The detailed arrangement, sizes of the timber and the distance apart shall be subjected to the approval of the Engineer.

Close planking and strutting shall be done by completely covering the sides of the trench, generally with short upright members called `poling boards'. These shall be 250 x 38mm in section or as directed by the Engineer. The boards shall generally be placed in position vertically in pairs, one board on either side of the cutting. These shall be kept apart by horizontal walling of strong wood at a minimum spacing of 1.2 m cross strutted with ballies or as directed by the Engineer. The length and diameter of the struts shall depend upon the width of the trench.

Where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical `walling', which shall be strutted to similar timber pieces on the opposite face of the trench. The lowest boards supporting the sides shall be taken into the ground for a minimum depth of 75mm. No portion of the vertical side of the trench shall remain exposed, as otherwise earth is liable to slip out.

The withdrawal of the timber members shall be done very carefully to prevent collapse of the trench. It shall be started at one end and proceed systematically to the other end.

Concrete or masonry shall not be damaged while removing the planks. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried unless required by the Engineer to be left permanently in position.

**Measurement:** The dimensions shall be measured correct to 10mm and the area of face supported shall be worked out correct to two places of decimal.

**Rate:** The rate shall include all labours and use as well as waste of all necessary timber work as mentioned above including fixing and subsequent removal.

### 5.3.10 Dewatering

*EW0235* *Pumping out water caused by springs, river, seepage, broken water mains, drains, and alike*

If water is met within the excavations, care shall be taken to drain and discharge the water into suitable outlets so as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be repaired/restored to the original condition at his own expenses or compensated.

**Measurements:** The cubical contents of earthwork in excavation in trenches up to water level shall be worked out to arrive at the quantity for dewatering.

**Rates:** The rates shall cover the cost for carrying out all the required dewatering operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work.

### 5.3.11 Anti-termite Treatment

*EW0240* *Providing and injecting chemical emulsion for Pre-construction anti-termite treatment and creating a chemical barrier using Chlorpyriphos/ Lindane E. C 20% with 1% Concentration (Anti Termite Chemical)*

*-Providing and injecting chemical emulsion for Post-construction using Chlorpyriphos/ Lindane E. C 20% with 1% Concentration (Anti Termite Chemical)*

*EW0245* *Along outside of foundation*

*EW0246* *Along external walls below concrete/masonry apron*

*EW0247* *Under existing floors including drilling & plugging 12mm holes with mortar 1:2*

*EW0248* *In voids in masonry including drilling holes at 45 degree & plugging with cement mortar 1:2*

*EW0249* *In Woodwork (using chemical in oil or kerosene based solution) including drilling & plugging 6mm holes*

Prevention of the termites (from their subterranean) reaching the superstructure of the building and its contents can be achieved by creating a chemical barrier between the ground from where the termites come and contents of the building which may contain food for the termites. This is achieved by treating the soil beneath the building and around the foundation with a suitable insecticide.

Chemicals are available in concentrated form and the percentage of concentration specified above for use is achieved by diluting the concentrates with calculated quantities of water.

Chemicals shall be brought in sealed containers in adequate quantity for the work and kept in the joint custody of the contractor and the Engineer-in-charge.

**Pre-construction treatment:**

Chemical treatment is applied to the building in the early stages of its construction. Hand operated pumps shall be used for uniform spraying of the chemical, and graduated containers used for proper inspection of uniform spraying. The specified quantity of chemical is used for the required area.

Soil treatment is to be done when foundation trenches and pits are ready to take foundation concrete. The concrete is laid after the chemical emulsion is absorbed by the soil and the surface is quite dry. Treatment should not be carried out during ramming or when soil is wet with rain or sub-soil water. The foregoing applies also in case of treatment to the filled earth surface in plinth before laying the sub-grade for the floor.

The treated chemical barriers shall not be disturbed. If by chance disturbed, continuity and completeness of the barriers shall be restored.

**Treatment of column pits, wall-trenches and basement excavations:**

a) The bottom surface and the sides (up to a height of 30 mm) of excavation shall be treated with the chemical at the rate of 15 litres per sq.m of the vertical surface of substructure for each side.

b) If water is used for ramming, the chemical treatment shall be carried out by rodding the earth at 150mm centres close to the wall surface. The chemical emulsions shall be directed towards the concrete or masonry so that the earth in contact with them is well treated.

c) In the case of R.C.C. structures, the treatment shall start at a depth of 500mm below ground level. From this depth, the backfill around columns, beams and R.C.C basement walls shall be treated with 15 litres per sq.m as in (b) above.

**Top Surface of Plinth filling:** The top surface of the filling within plinth walls shall be treated with chemical emulsion at the rate of 5 litres per sq.m before sand/sub-grade is laid. Holes up to 50 to 75 mm deep at 150 cm both ways shall be made with crow bars for this purpose.

**Treatment of Junction of wall and floor**: A small channel 30 x 30mm shall be made at all junctions of wall and columns with the floor before laying the sub-grade and rod holes made in the channel (upto ground level) 150mm apart and chemical emulsion poured along the channel @ 15 litres/sq.m of the vertical wall or column so as to soak the soil right to the bottom. The soil shall be tamped into place after the operation.

**Treatment of soil along external perimeter of the building:** After building is complete, provide holes in the soil with iron rods along the external perimeter at intervals of 150 mm with depth of 300 mm and fill these holes with chemical emulsion at the rate of 5 litres per metre of perimeter of the external wall.

**Expansion Joints**: Treatment through the expansion joints shall be done @ 2 litres/linear metre of joint after the sub- grade has been laid.

**Treatment of soil around pipes and conduits**: The soil shall be loosened around each pipe or conduit for a distance of 150 mm and to a depth of 75 mm before treatment is commenced.

**Measurements:** The treatment shall be made on a square metre basis on the plinth area of the building at Ground floor for all operations described above. Nothing extra shall be measured.

**Rate:** The rate includes cost of all materials and labour involved in all the operations above including making holes, refilling and making goods the same.

**Post Construction Treatment:**

Hand operated pressure pumps and graduated containers shall be used as described earlier.

**Treatment outside and along foundations**: The soil in contact with the foundations along the external perimeter shall be treated with 15 litres per sq.m of vertical surface. Trenches, 500mm deep and as wide as a shovel shall be excavated exposing foundation wall surfaces and holes 150 mm apart made with iron rods close to wall face, extending from the bottom of the trench to top of footing or at least up to a depth of 500 mm. Half the total chemical shall be poured into these holes and rest sprayed on the backfill earth as it is returned into the trench directing the spray against the wall surface.

If there is a concrete or masonry apron around the building,12 mm diameter holes shall be drilled as close as possible to the plinth wall about 300 mm apart deep enough to reach the soil below and the chemical pumped into these holes to soak the soil below at the rate of 5 litres per linear metre.

In R.C.C framed structures, the backfill in contact with the column sides and plinth beams along the external perimeter of the wall shall be treated with the chemical at the rate of 15 litres per sq.m of the vertical surface of the structure. Trenches, as wide as a shovel and 500 mm deep (or up to the bottom of plinth beam if this level is less than 500 mm) are made and chemical emulsion shall be sprayed on the backfill earth as it is returned into the trench directing the spray against the concrete surface of the beam or column as the case may be.

**Treatment of soil under floors:** Chemical treatment shall be done by drilling 12 mm holes at the junctions of floor and walls along the cracks on the floor and along the constructional joints at intervals of 300 mm to reach the soil below. The chemical emulsion is pumped into these holes with the pump to soak the soil until refusal or upto a maximum of one litre per hole. The holes shall then be sealed with cement mortar 1:2 finished to match the existing floor. The mortar shall be cured for ten days.

**Treatment of voids in masonry:** Holes may be drilled in the masonry wall at plinth level and squirt chemical emulsion through the holes with a hand pump to soak the masonry. This treatment shall also be extended to internal walls having foundations in the soil. Holes shall also be drilled at wall corners, where door and window frames are embedded in the masonry at floor at ground. Squirting chemical emulsion shall be maximum one litre per hole. Care shall be taken to seal the holes after treatment.

**Treatment of woodwork**: Holes 6mm in diameter shall be drilled with a downward slant to the core of the woodwork, 150 mm centre to centre and covering the entire frame work.

a) Chemicals (emulsions in oil or kerosene based solutions) are in fused liberally into these holes. If the wood is not protected by paint or varnish give two coats of the chemicals.

b) Spray or infuse all the masonry surrounding the wood.

**Measurement**: All dimensions shall be measured correctly to 10mm of the surface (length as the case may be) actually provided with anti-termite treatment under the various heads mentioned above.

**Rate:** The rate shall include the cost of all materials and labour involved in the operations described including drilling, refilling and making good the holes.

**Special Note**: The chemicals mentioned are poisonous and hazardous. The chemicals can have an adverse effect on health when absorbed through the skin, inhaled as vapour/spray mist and swallowed. Persons using these chemicals should be warned of the dangers and instructed to take all possible precautions in using the chemicals.

The chemical concentrates also present a fire hazard. Flames should not be allowed near during mixing. Care should be taken to see that chemicals are not allowed to contaminate sources of drinking water.

# 5.4 Chapter 4: DRAINAGE

## 5.4.1 Plinth Protection

*Providing and laying Plinth Protection, grouted with fine sand mix including ramming and finishing the top smooth*

*DR0001* *With 50mm thick cement concrete 1:3:6, 20mm aggregate laid over 75mm thick layer of compacted gravel (40mm)*

*DR0002* *With 50mm thick cement concrete 1:3:6, 20mm gravel or shingles laid over 75mm thick layer of compacted gravel (40mm)*

*DR0003* *With 50mm thick cement concrete 1:3:6, 20mm aggregate laid over 75mm thick layer of compacted dry brick aggregate (40mm)*

DR0004 With *50mm thick* cement concrete 1:3:6, 20mm gravel or shingles laid over 75mm thick layer of compacted dry brick aggregate *(40mm)*

Plinth protection shall be provided, as specified, to the required width. It comprises 50 mm thick cement concrete 1:3:6 laid over 75mm bed of gravel or shingle or dry brick aggregate 40mm nominal size, grouted with fine sand. The outer edge shall be lined with bricks laid on edge and joints laid in cement mortar 1:4 (1 cement: 4 fine sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50.

**Preparation of Ground**: The ground, where plinth protection is to be laid, shall first be prepared to the required slope. The high portions of ground shall be excavated and hollows/depressions shall be filled up to the required level with the excavated earth and watered and rammed to give uniform outward slope. Preparation of any area involving cutting and filling up to a depth of 150 mm shall not be paid for separately but beyond 150 mm, separate payment shall be made. The bed shall be watered adequately and rammed with iron rammers. Surplus earth, if any, obtained shall be disposed of within a lead of 50 metres or as directed by the Engineer-in-charge.

**Brick Edging**: The edging shall be of bricks or of stones. Trenches of required depth and width shall first be made along the edge of the plinth protection to receive the edging. The bed of trenches shall be compacted to a firm and even surface. The bricks or stones shall be laid true to line in cement mortar 1:4 (1 cement: 4 fine sand) with length parallel and abutting the plinth protection. The top face of the brick edging shall be in one level, to conform to the finished level of the plinth protection adjacent to the edging. After the concreting is done, no portion of the edging shall project above the adjacent concrete surface.

**Sub-grade**: The sub-grade shall consist of a bed of dry brick aggregate or gravel or shingle of 40 mm nominal size. The aggregate shall be spread evenly over the prepared surface to 75mm depth (unconsolidated) and given a minimum outward slope of 1 in 50. The aggregate shall be carefully laid and packed, bigger size being placed at the bottom. It shall then be consolidated dry with heavy iron rammers. After the consolidation, the surface shall be checked with a straight edge and any depressions etc. is filled up and consolidated. The aggregate shall then be grouted evenly with fine sand @ 0.60 cu. m/10 sq. m, adequately watered to ensure filling of the voids by sand and again rammed with heavy iron rammers. The finished surface shall give a uniform appearance.

**Cement Concrete Topping:** After the sub-grade has been compacted and prepared as above, 50mm thick cement concrete 1:3:6 shall be laid in one operation, except that the top shall not be finished with neat cement slurry but shall be finished with only wooden floats. The concrete surface shall not be finished with mortar. The length of each panel shall not be more than 5m. The finished surface shall have a minimum outward slope of 1 in 50.

**Curing**: Specification for curing shall be same as described under "Chapter 6: Concrete Work"

**Measurement**: Length and breadth shall be measured correct to a cm and the area calculated in square metre correct to two places of decimal. No deduction shall be made nor any additional payment shall be made for any opening of pipes, etc. up to 0.1 sq. m.

**Rate:** The rate shall include cost of materials and labour involved in all the operations described above.

### 5.4.2 Open Surface Drain

*Constructing brick masonry open surface drain in cement mortar 1:4 including earth work in excavation 100mm thick concrete bed 1:5:10, 40mm aggregate and 25mm thick cement concrete 1:2:4,12 mm aggregate for filling haunches including 12mm cement plastering 1:4 with a floating coat of neat cement and disposal of surplus earth etc. complete*

*DR0010 100mm wide x 200mm depth*

*DR0011 150mm wide x 200mm depth*

*DR0012 250mm wide x 300mm depth*

*DR0013 300mm wide x 450mm depth*

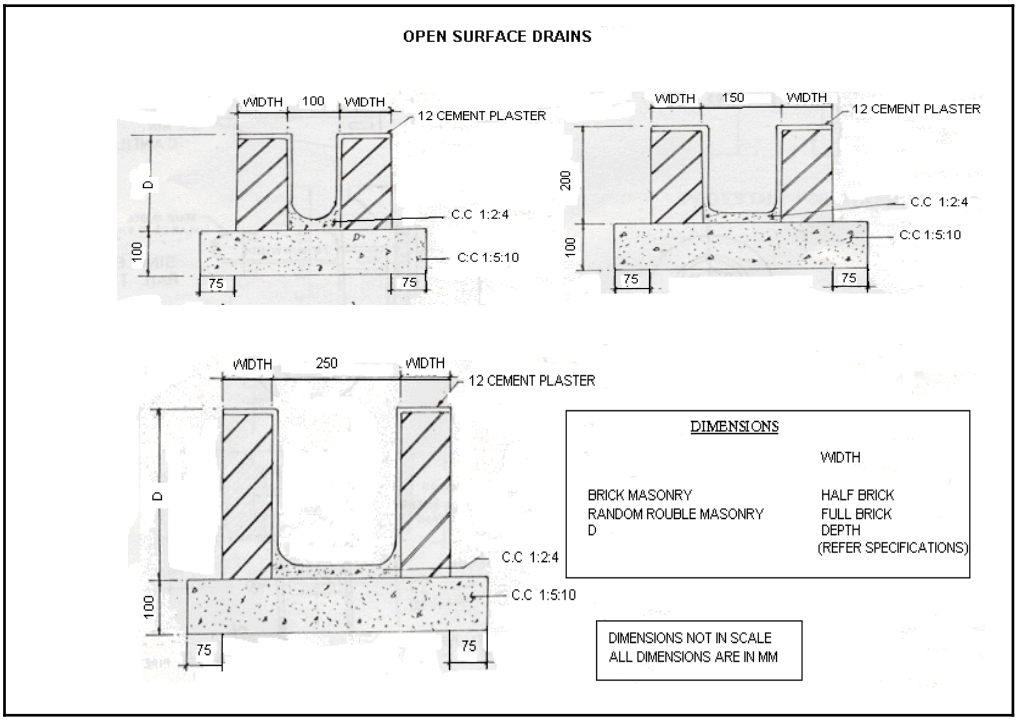



**Figure 5.4.1:** Brick Masonry Open Surface Drain

The open surface drains shall be of the size as specified in the item and laid to such gradients and in such locations as may be shown in the relevant drawing or as directed by the Engineer.

The width of the drain at the top shall be as specified, measured between the finished walls. The drain shall be given, as far as possible, a uniform slope from the starting point to the discharge point.

**Measurement**: The drain shall be measured in running metres, correct to 10 mm.

**Rate:** The rate shall include the cost of labour and materials involved in excavation, concreting, masonry, plastering, finishing etc. required for the item. Suitable deduction or extra payments on "per *meter additional depth"* basis shall be made in case there is a variation in average depths from those stated above.

- *Extra for additional depth of brick masonry drain*

*DR0020* *100mm wide .....per meter additional depth*

*DR0021* *150mm wide .....per meter additional depth*

*DR0022* *250mm wide .....per meter additional depth*

**Measurement:** The drain shall be measured in running metres, correct to 10mm.

**Rate:** The rate shall include additional excavation, masonry, finishing etc. involved in the additional depth.

*- Constructing random rubble masonry open surface drain in cement mortar 1:6 including earth work in excavation, 100mm thick concrete base 1:5:10, 40 mm aggregate 25mm thick cement concrete 1:2:4, 12mm aggregate for filling haunches, including 20mm cement plaster with a floating coat of neat cement and disposal of surplus earth complete*

*DR0030* *100 mm wide x 200mm depth*

*DR0031* *150mm wide x 200mm depth*

*DR0032* *250mm wide x 300mm depth*

*DR0033* *300mm wide x 450mm depth*

Specifications for random rubble masonry open surface drain shall be the same as for brick masonry open surface drain explained above.

**Measurement:** The drain shall be measured in running metres, correct to 10mm.

**Rate:** The rate shall include the cost of labour and materials involved in excavation, concreting, masonry, plastering, finishing etc. required for the item. Suitable deduction or extra payments on "per *meter additional depth"* basis shall be made in case there is a variation in average depths from those stated above.

- *Extra for additional depth of random rubble masonry drain*

*DR0040* *100mm wide .....per meter additional depth*

*DR0041* *150mm wide .....per meter additional depth*

*DR0042* *250mm wide .....per meter additional depth*

**Measurement:** The length shall be measured in running metres, correct to 10mm.

**Rate**: The rate shall include additional excavation, masonry, finishing etc. involved in the additional depth.

### 5.4.3 R.C.C Pipes & Fittings

- *Providing & laying NP2 class R.C.C pipes, including collars, jointing in cement mortar 1:2 and testing of joints etc. complete*

*DR0088* *100mm dia.*

*DR0089* *150mm dia.*

*DR0090* *225mm dia.*

*DR0091* *300mm dia.*

*DR0092* *450mm dia.*

*DR0093* *600mm dia.*

*DR0094* *750mm dia.*

*DR0095* *900mm dia.*

*DR0096* *1050mm dia.*

*DR0097* *1200mm dia.*

- *Providing and laying Non Pressure NP-3 class (Medium duty) R.C.C. spigot and socket type with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) including testing of joints etc. complete*

*DR0220* *450 mm, dia, NP – 3 spigot & socket*

*DR0221* *600 mm, dia, NP – 3 spigot & socket*

*DR0222* *900 mm, dia, NP – 3 spigot & socket*

*DR0223* *1000 mm, dia, NP – 3 spigot & socket*

*DR0224* *1200 mm, dia, NP – 3 spigot & socket*

**Trenches**: Trenches shall be so dug that the pipes may be laid to the required alignment and at the required depth. Cover shall be measured from top of pipe to the surface of the ground. The bed of the trench, if in soft or made up earth, shall be well watered and rammed before the pipes are laid and the depressions, if any, shall be properly filled with earth and consolidated in 20 cm layers.

If the trench bottom is extremely hard or rocky or loose stony soil, the trench shall be excavated at least 150mm below the trench grade. Rocks, stones or other hard substances from the bottom of the trench shall be removed and the trench brought back to the required grade by filling with selected fine earth or sand and compacted so as to provide smooth bedding for the pipe. Where excavation requires blasting operation, it shall be ensured that no pipes have been stacked in the vicinity and completed pipelines in the vicinity have already been covered. This is necessary to prevent damage to the exposed pipes in the vicinity by falling stones during blasting.

After the excavation of the trench is completed, hollows shall be cut at the required position to receive the socket of the pipes. These hollows shall be of sufficient depth to ensure that the barrels of the pipes rest throughout their entire length on the solid ground and that

sufficient spaces are left for jointing the underside of the pipe joint. These socket holes shall be refilled with sand after jointing the pipe. Roots of trees within a distance of 0.5m from the side of the pipeline shall be removed.

The excavated material shall not be placed within one metre or half of the depth of the trench whichever is greater, from the edge of the trench. The materials excavated shall be separated and stacked so that in refilling they may be re-laid and compacted in the same order to the satisfaction of the Engineer.

The trench shall be kept free from water. Shoring and timbering shall be provided wherever required. Excavation below the water table is to be done only after dewatering the trenches. Where the pipe line or drain crosses an existing road, the road crossing shall be excavated half at a time, the second half being commenced after the pipes have been laid in the first half and the trench refilled. Necessary safety measures for traffic as directed shall be adopted. When the pipeline is under a roadway, a minimum cover of 90cm is recommended for adoption but it may be modified to suit local conditions.

The trench shall only be excavated in advance of the laying of the pipe as specified by the Engineer. All pipes, water mains cables, etc. met within the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the electrical and communication cables met with during the course of excavation, removal of which, if necessary, shall be arranged by the Engineer. The excavation shall be carried out with manual labour or with suitable mechanical equipment as approved by the Engineer.

Where the pipes are to be bedded directly on soil, the bed shall be suitably rounded to fit the lower part of the pipe, the cost for this operation being included in the rate for laying the pipe itself.

**Laying:** Loading, transporting and unloading of concrete pipes shall be done with care. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain block is recommended. All pipe sections and connections shall be inspected carefully before being laid. Broken or defective pipes or connections shall not be used. Pipes shall be lowered into the trenches carefully. Mechanical appliances may be used. Pipes shall be laid true to line and grade as specified. Laying of pipes shall proceed with the upgrade of a slope.

Where joints are to be made with loose collars, the collars shall be slipped on before the next pipe is laid. Adequate and proper expansion joints shall be provided where directed. In case where the foundation conditions are unusual such as in the proximity of trees or holes, under existing or proposed tracks, manholes etc. the pipe shall be encased all-round in 15 cm thick cement concrete 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) or compacted with sand or gravel. In cases where the natural foundation is inadequate the pipes shall be laid either in a concrete cradle supported on proper foundations or on any other suitably designed structure. If concrete cradle bedding is used, the depth of concrete below the bottom of the pipe shall be at least 1/4th of the internal diameter of the pipe subject to a minimum of 10 cm and a maximum 30 cm. The concrete shall extend up the sides of the pipe at least to a distance of 1/4th of the outside diameter of pipes 300 mm and over in dia. The pipe shall be laid in this concrete bedding before the concrete has set. Pipes laid in trenches in earth shall be bedded evenly and firmly and as far up the haunches of the pipe as to safely transmit the load expected from the backfill through the pipe to the bed. This shall be done either by excavating the bottom of the trench to fit the curve of the pipe or by compacting the earth under and around the curve of

the pipe to form an even bed. Necessary provision shall be made for joints wherever required.

When the pipe is laid in a trench in rock hard clay, shale or other hard material the space below the pipe shall be excavated and replaced with an equalising bed of concrete, sand or compacted earth. In no place shall pipe be laid directly on such hard material. When the pipes are laid completely above the ground, the foundations shall be made even and sufficiently compacted to support the pipeline without any material settlement. Alternatively the pipeline shall be supported on rigid foundations at intervals. Suitable arrangements shall be made to retain the pipeline in the proper alignment, such as by shaping the top of the supports to fit the lower part of the pipe. The distance between the supports shall in no case exceed the length of the pipe. The pipe shall be supported as far as possible close to the joints. In no case shall the joint come outside of the supports. Care shall be taken to see that superimposed loads greater than the total load equivalent to the weight of the pipe when running full shall not be permitted. Suitably designed anchor blocks at change of direction and grades for pressure lines shall be provided where required.

**Jointing:** Joints are generally of rigid type. Where specified, flexible type joints may also be provided.

**Rigid Collar Joint**: This is a rigid joint. The two adjoining pipes shall be butted against each other and adjusted in the correct position. The collar shall then be slipped over the joint, covering equally both the pipes. The annular space shall be filled with a stiff mixture of cement mortar 1:2 (1 cement: 2 fine sand), which shall be rammed with a caulking tool. After a day's work, any extraneous materials shall be removed from the inside of the pipe and the newly made joint shall be cured.

**Semi Flexible Collar Joint**: This is made up of a loose collar, which covers two specially shaped pipe ends. Each end shall be fitted with a rubber ring which when compressed between the spigot and the collar, seal the joint. A stiff mixture of cement mortar 1:2 (1 cement: 2 fine sand) shall then be filled into the remaining annular space and rammed with a caulking tool. After the day's work, any extraneous material shall be removed from the inside of the pipe and the newly made joints shall be cured.

**Testing**: The testing shall be done as per IS 453:2003 section 10.

**Refilling of Trenches**: The specifications described under S.W pipes shall apply. In cases where pipes are not bedded on concrete special care shall be taken in refilling trenches to prevent the displacement and subsequent settlement at the surface resulting in uneven street surfaces and dangers to foundations etc. The backfilling materials shall be packed by hand under and around the pipe, and rammed with a shovel and light temper. This method of filling will be continued up to the top of the pipe. The refilling shall rise evenly on both sides of the pipe continuing up to 60 cm above the top of pipe so as not to disturb the pipe. No tamping shall be done within 15 cm of the top of pipe. The tamping shall become progressively heavier as the depth of the backfill increases.

**Measurements**: The lengths of pipes shall be measured in running metres nearest to 10mm as laid or fixed, from inside of one manhole to the inside of the other manhole. The length shall be taken along the centre line of the pipes over all fittings such as bend, junctions, etc., which shall not be measured separately.

Excavation, refilling, shoring and timbering in trenches, and cement concreting wherever required shall be measured separately under relevant items of work.

**Rate**: The rate shall include the cost of materials and labour involved in all the operations described above excluding the cost of Excavation, refilling, shoring and timbering in trenches, and cement concreting.

### 5.4.4 Manholes

- *Constructing Brick masonry manhole in cement mortar 1:5, R.C.C top slab with 1:2:4 20mm aggregate, base concrete 1:4:8 40mm aggregate, 12mm plaster in CM 1:3 finished with floating coat of neat cement and making channels in cement concrete 1:2:4 20mm aggregate neatly finished*

*DR0105* *Inside dimension 900mm x 800mm & 450mm deep including C.I. cover with a frame (weight >38kg.)*

*DR0106* *Inside dimension 900mm x 800mm & 600mm deep including C.I. cover with a frame (weight >38kg.)*

*DR0107* *Inside dimension 1200 x 900mm & 900mm deep including C.I. cover with a frame (weight >116kg.)*

- *Extra for additional depth of manholes*

*DR0115* *900mm x 800mm per meter additional depth*

*DR0116* *1200mm x 900mm per meter additional depth*

- *Constructing brick masonry chamber (inspection chamber) with bricks in cement mortar 1:4, C.I. cover with frame (light duty) 455x610 mm internal dimensions, total weight of cover with frame to be not less than 38 kg (weight of cover 23 kg and weight of frame 15 kg), R.C.C. top slab with 1:1.5:3 mix, foundation concrete 1:3:6, inside plastering 12 mm thick with cement mortar 1:4, finished smooth with a floating coat of neat cement on walls and bed concrete etc. complete as per standard design:*

*DR0120* *Inside dimensions 455x610 mm and 45 cm deep for single pipe line :*

*DR0121* *Inside dimensions 500x700 mm and 45 cm deep for pipe line with one or two inlets :*

*DR0122* *Inside dimensions 600x 850 mm and 45 cm deep for pipe line with three or more inlets :*

- *Constructing brick masonry chamber (inspection chamber) with bricks in cement mortar 1:4, FRP (Fiber Reinforced Polymer) cover light duty(LD - 2.5Tons) 450x600 mm dimensions, R.C.C. top slab with 1:1.5:3 mix, foundation concrete 1:3:6, inside plastering 12 mm thick with cement mortar 1:4, finished smooth with a floating coat of neat cement on walls and bed concrete etc. complete as per standard design:*

*DR0130* *Inside dimensions 455x610 mm and 45 cm deep for single pipe line :*

*DR0131* *Inside dimensions 500x700 mm and 45 cm deep for pipe line with one or two inlets :*

*DR0132* *CInside dimensions 600x 850 mm and 45 cm deep for pipe line with three or more inlets :*

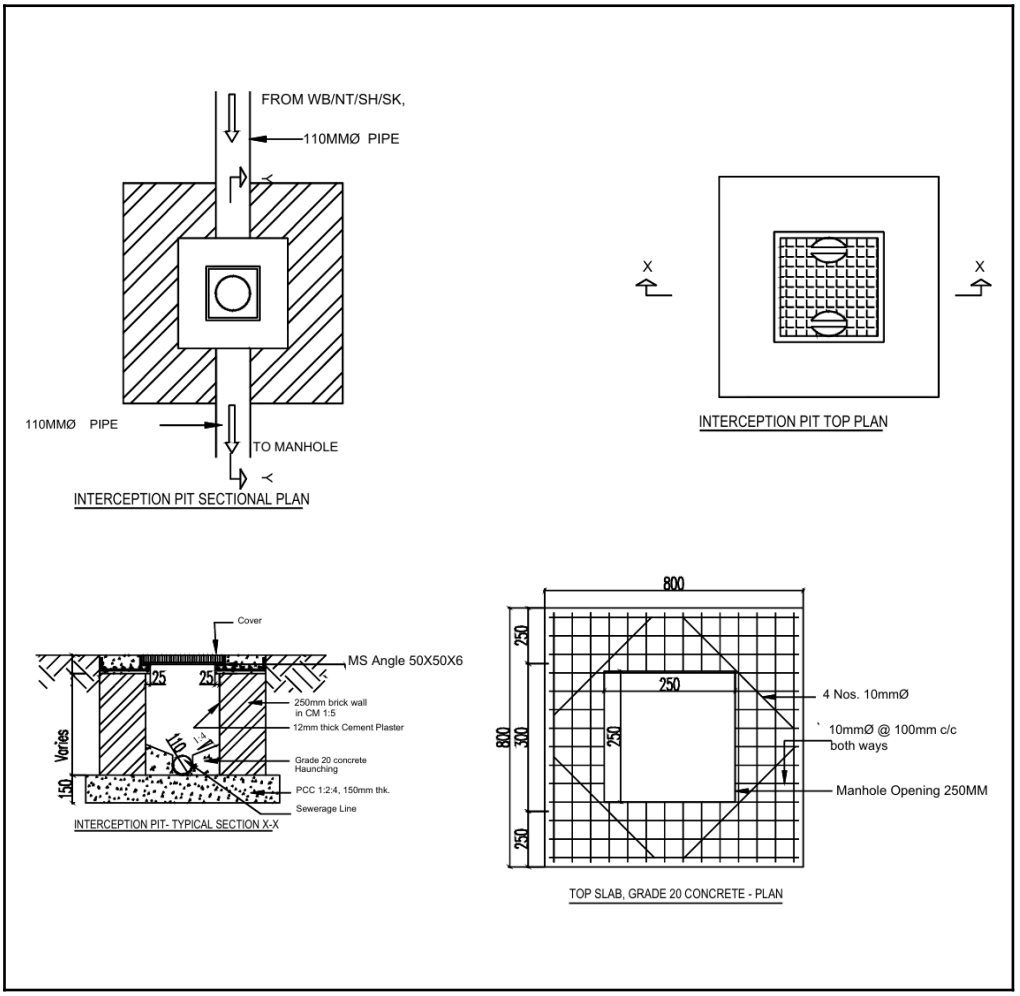
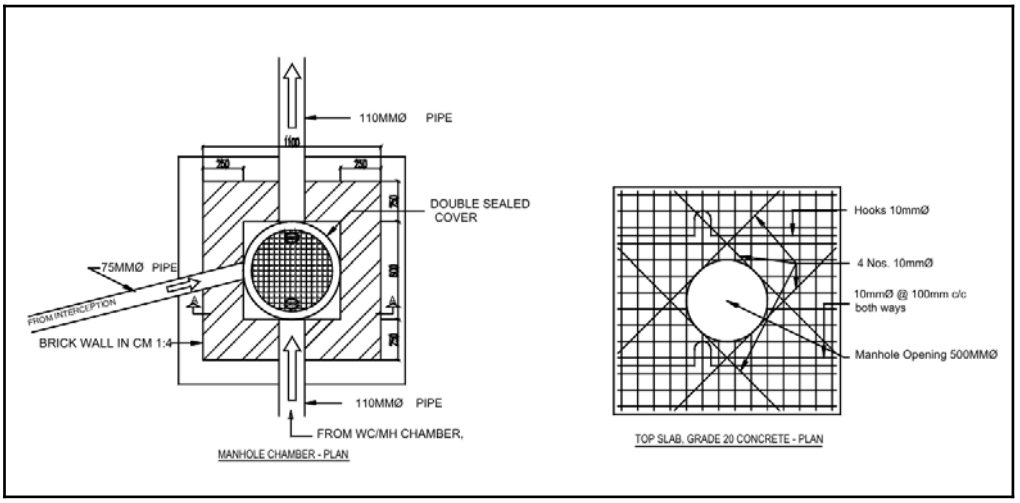



**Figure 5.4.2:** Drop Manhole



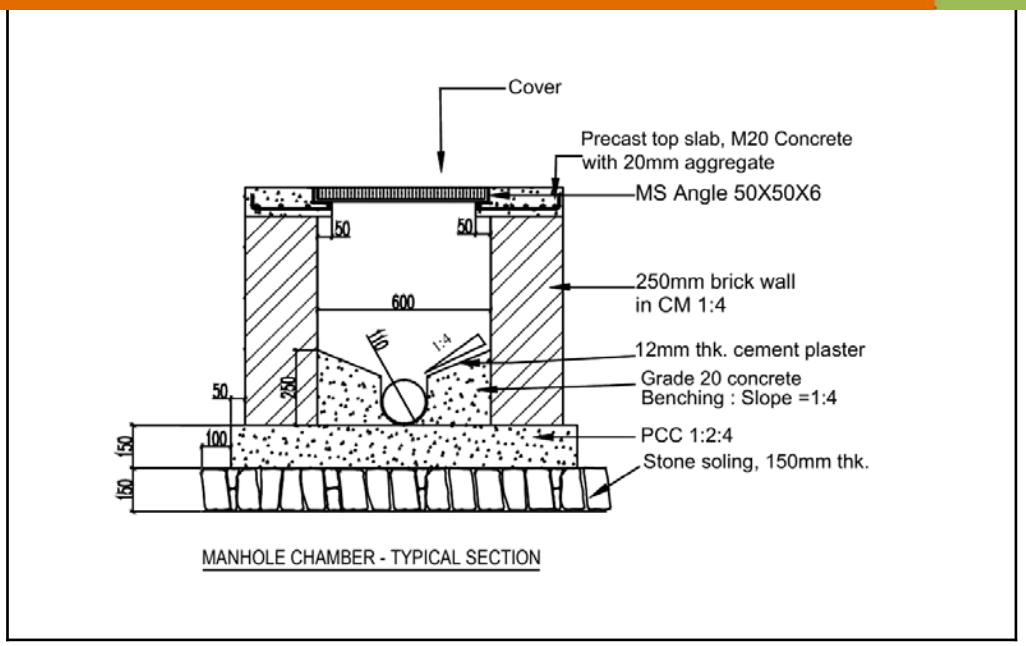



**Figure 5.4.3:** Inspection Chamber

**Constructing Manholes:**

At every change of alignment, gradient or diameter of a drain, there shall be manholes or inspection chamber. Bends and junctions in the drains shall be grouped together in a manhole as far as possible. The distance between two consecutive manholes shall be as per the design such that it is convenient to clean the sewer line from time to time.

Manholes of different types and sizes as specified shall be constructed in the sewer line at such places and to such levels and dimensions as shown in the drawings or as directed by the Engineer. The size specified shall indicate the inside dimensions between brick faces of the manholes. Where the diameter of the drain is increased, the crown of the pipe shall be fixed at the same level and necessary slope given in the invert of the manhole chamber. In exceptional cases and where unavoidable, the crown of the branch sewer may be fixed at lower level but in such cases the peak flow level of the two sewers shall be kept the same. Sewers of un-equal sectional area shall not be joined at the same invert in a manhole. The invert of the smaller sewer at its junction with main shall be at least 2/3 the diameter of the main above the invert of the main. The branch sewers shall deliver sewage in the manhole in the direction of main flow and the junction must be made with care so that flow in main is not impeded. No drain from house fittings, e.g. gully trap or soil pipe, etc. to manhole shall normally exceed a length of 6 m unless it is unavoidable.

Manholes 900 x 800 mm are generally constructed within compounds for house drainage only and near the buildings for house drainage. Manholes 1200 mm x 900 mm are generally constructed for main drainage work for depths less than 1.5 m. Before deciding the size of manholes, local byelaws shall be consulted. When manholes are constructed on footpaths, these shall be provided with cover of medium duty casting and when built within the width of the road under vehicular traffic, these shall be provided with cover of heavy-duty casting.

**Excavation**: The manhole shall be excavated true to dimensions and levels shown on the plans or as directed by the Engineer.

**Bed Concrete**: The manhole shall be built on a bed of cement concrete 1:4:8 (1 cement: 4 coarse sand: 8 graded stone aggregate 40 mm nominal size) unless required by local authorities. The thickness of the bed concrete shall be 20 cm for manholes upto 4.25 m depth and 30 cm for depths beyond 4.25 m unless otherwise specified or directed by the Engineer- in-charge. In bad ground, special foundations as suitable shall be provided.

**Brick Work**: The brickwork shall be with bricks in cement mortar 1:3 (1 cement: 3 fine sand). The external joints of the brick masonry shall be finished smooth, and the joints of the pipes with the masonry shall be made perfectly leak proof. The walls shall be built of one brick thickness for depths up to 4.25 m. Below the depth of 4.25 m in ordinary subsoil the wall thickness shall be increased to one and half brick and at 9.75 m below ground two brick thick walls shall be built.

**Plaster and Pointing**: The walls of the manholes shall be plastered inside with 12 mm thick cement plaster 1:3 (1 cement: 3 coarse sand) finished smooth. Where the saturated soil is met with also the external surface of the walls of the manholes shall be plastered with 12 mm thick cement plaster 1:3 (1 cement: 3 coarse sand) finished smooth up to 30 cm above the highest sub-soil water level. The plaster shall further be water proofed with addition of approved water proofing compound in a quantity as per manufacturer's specifications.

For earthwork excavation, bed concrete, bed concrete brickwork, plaster and pointing, R.C.C work and refilling of earth, respective specifications shall be followed.

**Benching**: The channels and benching shall be done in cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and rendered smooth with neat cement. The depth of channels and benching shall be as given below.

**Table 5.4.1** DEPTH OF CHANNEL AND BENCHING

| Size of drain (mm) | Top of channel at the centre above bed concrete (cm) | Depth of benching at side walls above bed concrete (cm) |
|---|---|---|
| 100 | 15 | 20 |
| 150 | 20 | 30 |
| 200 | 25 | 35 |
| 250 | 30 | 40 |
| 300 | 35 | 45 |
| 350 | 40 | 50 |
| 400 | 45 | 55 |
| 450 | 50 | 60 |

**Foot Rests**: All manholes deeper than 0.8 m shall be provided with M.S. footrests. These shall be embedded 20 cm deep with 20 x 20 x 10 cm blocks of cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 graded stone aggregate 20 mm nominal size). The block with M.S. foot rest placed in its centre shall be cast in-situ along with the masonry and surface finished

with 12 mm thick cement plaster 1:3 (1 cement: 3 coarse sand) finished smooth. Footrests shall be fixed 30 cm vertically and staggered laterally and shall project 10 cm beyond the surface of the wall. The top footrest shall be 45 cm below the manhole cover. Foot rests shall be painted with coal tar, the portion embedded in the masonry or cement concrete block being painted with thick cement slurry before fixing.

**Manhole Covers and Frames**: The frame of the manhole shall be firmly embedded to correct alignment and levels in R.C.C slab or plain concrete as the case may be on the top of the masonry. The specified cover and frame shall be fixed. After completion of the work, manhole covers shall be sealed by means of thick grease.

*DR0160* *Providing and fixing fibre-reinforced polymer chamber cover and frame of size 450 mm X 600 mm, light duty (25 kN load) for small valve and meter chambers with locking arrangements.*

*DR0161* *Providing and fixing fibre-reinforced polymer manhole cover and frame of size 600 mm X 600 mm, medium duty (100 kN load) for water tanks with locking arrangements.*

*DR0162* *Providing and fixing fibre-reinforced polymer manhole cover and frame of size 500 mm dia, heavy duty (200 kN load) for sewer manholes with lifting arrangements.*

**Measurements**: Manholes shall be measured in numbers under relevant items. The depth of the manhole shall be reckoned from the top level of C.I. cover to the invert level of the channel. The depth shall be measured correct to a cm. The extra depth shall be measured and paid as extra over the specified depth.

**Rate:** The rate shall include the cost of materials and labour involved in all the operations described above but shall exclude the cost of excavation, and water proofing material applied at the external surface of the manhole if required. These items shall be paid for separately under relevant items of work.

Payment for extra depth of manholes shall be made separately under relevant items of work.

# 5.5 Chapter 5: MORTARS

## 5.5.1 General

**Cement mortar**: The mortar shall be prepared by mixing cement and sand in the specified proportions.

The unit of measurement for cement shall be a bag of cement weighing 50kgs and this shall be taken as 0.035 cubic metre. Sand in specified proportion shall be measured in boxes of suitable size (35 x 25 x 40cm). It shall be measured on the basis of its dry volume. In case of damp sand, its quantity shall be increased suitably to allow for bulking.

**Lime mortar**: Lime before slaking, shall be quite fresh and generally in the form of lumps. Slaking shall be carried out on a masonry platform by sprinkling water gradually, till lime is slackened and reduced to powder form. During the process of sprinkling of water, the heap of lime shall be turned over and over again, and no more water shall be used than that required for lime to retain its powder form. Slaked lime shall be screened through sieve of IS sieve designation 3.35mm and the residue which does not pass through sieve shall be rejected. Slaked lime shall then be run into putty before use in mortar.

**Mud mortar**: Normally, pits shall not be dug at or near the site of work for obtaining earth for mud mortar. However, if any pits are allowed to be dug by the Engineer under special circumstances these shall not be deeper than 1.5m and shall be filled and dressed properly as soon as possible. The top 600mm. shall be filled with good earth in 200mm layers with clods broken watered, rammed and consolidated. The bottom layers may be filled with building rubbish mixed with earth laid in 20cm layers, watered, rammed and consolidated.

## *5.5.2* Cement Mortar

*MR0001* *Cement mortar 1:1 (1 cement: 1 sand)*

*MR0002* *Cement mortar 1:2 (1 cement: 2 sand)*

*MR0003* *Cement mortar 1:3 (1 cement: 3 sand)*

*MR0004* *Cement mortar 1:4 (1 cement: 4 sand)*

*MR0005* *Cement mortar 1:5 (1 cement: 5 sand)*

*MR0006* *Cement mortar 1:6 (1 cement: 6 sand)*

**Mixing:** The mixing of mortars shall be done in a mechanical mixer operated manually or by power. The Engineer may, however, relax this condition at his discretion, taking into account the nature and location of the work, practicability of the use of these machines etc. particularly keeping in view the utilisation or mortar turned out in one operation of the mixture before it sets initially or where items involving small quantities are to be done or if, in his opinion the use of mixers is not feasible. For items where the mixers are not to be used, the contractor shall take the permission of the Engineer before the commencement of work.

**Mixing In Mechanical Mixer:** Cement and sand in the specified proportions shall be mixed dry thoroughly in a mixer. Water shall then be added gradually and wet mixing continued for at least one minute. Care shall be taken not to add more water than that which shall bring the mortar to the consistency of a stiff paste. Only the quantity of mortar, which can be used

within 30 minutes of its mixing shall be prepared at a time. The mixer shall be cleaned with water each time before suspending the work.

**Hand Mixing:** The measured quantity of sand shall be levelled on a clean masonry platform and cement bags emptied on top. The cement and sand shall be thoroughly mixed dry by being turned over and over, backwards and forwards, several times till the mixture is of a uniform colour. The quantity of dry mix, which can be used within 30 minutes, shall then be mixed in masonry trough with just sufficient quantity of water to bring the mortar to the consistency of a stiff paste.

**Precautions**: mortar shall be used as soon as possible after mixing and before it begins to set, and in any case within half hour, after the water is added to the dry mixture.

**Retempering of Mortars**: In the case of mortar using cement, the mortar that has stiffened because of evaporation of water from the mortar may be re-tempered by adding water as frequently as needed to restore the requirements of consistency. But this re-tempering shall be permitted only within tj0 minutes from the time of addition of cement (this is as per IS 2250 - 1981)

**Measurements:** The cubical contents shall be worked out to the nearest two places of decimal in cubic metres.

**Rates:** The rates shall be payment in full for carrying out the required operations in the preparation of mortar including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work.

### 5.5.3 Lime Mortar

*MR0010 Lime mortar 1:2 (1 lime putty: 2 Brick Powder)*

*MR0011 Lime Mortar 1:1 :1 (1 Lime putty : 1 Brick Powder : 1 Sand)*

**Preparation of lime putty**: Three sufficiently large slaking vessels or tanks shall be made, one of these 500mm deep shall be at the higher level, the remaining 800mm deep shall be at lower level, such that the contents of the upper tank can flow into the next by gravity. The upper tank shall be filled to half the depth with water and sufficient quick lime added gradually to fill up the vessel to about half the depth of water. Lime shall be added to water and not water to lime. Stirring and hoeing shall start at once, taking care that lime does get exposed above water. The mix shall be stirred all through the slaking process at least 5 minutes after the boiling has stopped, and as the mix thickens, more water shall be added. The lime in a state of suspension shall then be allowed to pass through IS sieve designation 3.35mm and flow into another tank at a lower level, where it shall be kept standing for at least 72 hours before use. The lower tank shall be made of dry brick masonry with joints filled with sand. Water shall get partly evaporated and partly absorbed in ground and surplus water at top shall be removed, leaving lime putty in the form of paste. Lime putty so formed shall be kept wet till it is completely used. It can be stored without getting spoiled for a fortnight, provided it is protected from drying out.

**Proportioning:** Lime putty and brick powder shall be used in 1:2 proportion. They shall be measured in boxes of suitable sizes.

**Mixing and Grinding**: Lime putty, and brick powder shall be mixed on a watertight platform or in troughs. This shall then be sprinkled with necessary quantities of water and ground in a masonry lined mortar mill. The mill shall be constructed of best available bricks (with frog

down-wards) or stone in lime mortar. The outer edge of the mill shall be raised above the track followed by the driving animal. The track itself shall be sloped outwards and kept well consolidated and watered. No dust or mud shall be allowed to fall into the mortar being ground. The mill shall be provided with tell-tale arrangement for automatic counting of the revolutions. The mortar shall be ground by not less than 180 revolutions or for a minimum of three hours. The mortar shall be continuously raked and turned over during the grinding particularly from corners and sides. Water shall be added as required during grinding, care being taken not to add more water than that which shall bring the mortar to the consistency of a stiff paste. Alternatively, a mechanical mortar mill may be used for grinding. The ingredients shall be mixed on a watertight masonry platform or in trough as above. The mix shall then be fed into a mechanical mortar mill with the required addition of water, which shall be just sufficient to make mortar of a workable consistency. The mortar shall be mixed at least for three minutes after addition of water, when it shall be emptied from the mill.

**Measurements:** The cubical contents shall be worked out to the nearest two places of decimal in cubic metres.

**Rates:** The rates shall cover the cost for carrying out all the required operations in the preparation of mortar including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work.

### 5.5.4 Mud Mortar

*MR0015 Mud Mortar*

**Mixing:** Selected soil shall be broken up into fine powder and placed in regular stacks of about 300 mm height with raised edges. Size of stacks shall be regulated so that the mortar obtained is adequate to meet a day's requirement. Enough water shall then be mixed and matured for at least two days and after a lapse of 24 hours the mortar shall be trodden with man's feet and spades, turning over and over again to make it a homogenous mass of a working consistency. If the mortar becomes stiff due to loss of water by evaporation, more water should be added and the mortar re-tempered.

**Measurements:** The cubical contents shall be worked out to the nearest two places of decimal in cubic metres.

**Rates:** The rates shall cover the cost for carrying out all the required operations in the preparation of mortar including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work.

### 5.5.5 White Cement Mortar

*MR0020 White Cement mortar 1:2 (1 white cement : 2 sand)*

*MR0021 White Cement mortar 1:3 (1 white cement : 3 sand)*

*MR0022 White Cement mortar 1:5 (1 white cement :5 sand)*

Specifications are similar to cement mortar. Use white cement instead of normal cement.

### 5.5.6 Cement Lime Mortar

*MR0025 Cement lime mortar 1:1:3 (1 cement : 1 lime putty : 3 sand*

*MR0026 Cement lime mortar 1:1:6 (1 cement : 1 lime putty : 6 sand)*

This shall be prepared by mixing cement, lime putty/dry hydrated lime powder and sand in specified proportions. Mixing shall be done in a mechanical mixer (operated manually or by power as decided by the Engineer).

The Engineer may, however, permit hand mixing at his discretion, taking into account the nature, magnitude and location of the work and practicability of the use of mechanical mixers or where items involving small quantities are to be done or if in his opinion the use of mechanical mixer is not feasible. In case, where mechanical mixers are not to be used, the contractor shall take permission of the Engineer-in-Charge in writing before the commencement of the work.

**Proportioning** : Cement, lime putty/dry hydrated lime and sand shall be taken in specified proportions. Cement bags weighing 50 kg shall be taken as 0.035 cubic metre. Other ingredients in specified proportion shall be measured using boxes of size 40 x35x 25 cms. Sand shall be measured on the basis of its dry volume.

**Mixing and Grinding**

a) Mechanical Mixing: Lime putty and sand shall be mixed and ground in the manner described above in lime mortar before mixing the same with cement.

   In cases where factory made dry hydrated lime powder is used, prior grinding of lime and sand is not necessary. In that case mixing may be done in one operation in a mechanical mixer. Only the quantity of this mixture which could be used within two hours of its mixing with cement, shall be taken out and mixed thoroughly with specified quantity of cement in a mechanical mixer.

b) Hand Mixing: Cement and sand shall be mixed dry thoroughly on clean and water tight masonry platforms or in troughs. Lime putty shall be mixed with water to make milk of lime, which shall be added to the mixture of cement and sand. The mixture shall be kneaded back and forth for about 10 minutes with addition of milk or lime to obtain a mortar of workable consistency.

**Precautions**: Mortar shall be used as soon as possible after mixing and maximum within two hours. Mortar unused for more than two hours shall be rejected and removed from the site of work. Mixture of lime putty and sand can be kept for 72 hours for preparation of lime cement mortar in respect of Class "B' and 'C' lime and for six hours in case of Class 'A' lime provided it is kept damp and not allowed to dry.

**Measurements:** The cubical contents shall be worked out to the nearest two places of decimal in cubic metres.

**Rates:** The rates shall cover the cost for carrying out all the required operations in the preparation of mortar including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work.

# 5.6 CHAPTER 6: CONCRETE WORK

### 5.6.1 General

Water, Cement, fine aggregate and coarse aggregate shall conform to material specifications. Concrete can be specified by proportions or by nominating the required strength.

Concrete shall be prepared by mixing graded stone aggregate or gravel of normal size as specified with fine aggregate and cement in specified proportions with required quantity of water.

**Proportioning:** It shall be done by volume. Boxes of suitable size shall be used for measuring sand and aggregate. The internal dimensions of the boxes shall be generally 35 x 25 x 40cm deep or as otherwise approved by the Engineer. The unit of measurement for cement shall be a bag of 50 kg and this shall be taken as 0.035cum. While measuring the aggregate, shaking, ramming or heaping shall not be done. The proportioning of sand shall be on the basis of its dry volume and in case of damp sand allowance for bulkage shall be made by adopting the method prescribed under IS 2386 (part III).

**Mixing:** It shall be done in a mechanical mixer. Mixing by hand shall be employed only in special cases with the specific prior permission of the Engineer-in-Charge. Stone aggregate shall be washed with water to remove dirt, dust or any other foreign materials, where necessary.

**Machine Mixing:** The mixer drum shall be flushed clean with water. Measured quantity of dry coarse aggregate shall be followed with measured quantity of fine aggregate and then cement. In case damp sand is used, add half of the quantity of coarse aggregate followed by cement and sand. Finally add the balanced quantity of the coarse aggregate. The skip shall be raised and dry materials slipped into the drum. The dry materials shall be mixed for at least four turns of the drum, after which the correct quantity of water shall be added gradually while the drum is in motion, to ensure even distribution with the dry material. The total quantity of water for mixing shall be introduced before 25% of mixing time has elapsed and shall be regulated to achieve the specified water cement ratio. The complete contents of the mixed concrete shall be emptied before recharging. When the mixer is closed down for the day or at any time exceeding 20 minutes, the drum shall be flushed clean.

**Mixing time**: The materials shall be mixed for a period of not less than 2 minutes and until a uniform colour and consistency is obtained. The time shall be counted from the moment all the materials have been put into the drum.

**Hand Mixing**: Hand mixing shall be done on a smooth, clean and water-tight platform of suitable size in the following manner.

(a) Measured quantity of sand shall be spread evenly

(b) The cement shall be dumped on the sand and distributed evenly

(c) The sand and cement shall be mixed intimately with spade, turning the mixture over and over again, until it is of even colour throughout and free from streaks

(d) The sand cement mixture shall be spread out and a measured quantity of coarse aggregate shall be spread on its top. Alternatively the measured

quantity of coarse aggregate shall be spread out and the sand cement mixture shall be spread on its top.

(e) The above materials shall be mixed at least three times by shovelling and turning over by twist from centre to side, then back to the centre and again to the sides.

(f) A hollow shall be made in the middle of the mixed pile.

(g) Three quarters of the total quantity of water required shall be added while the material is turned in towards the centre with spades. The remaining water shall be added by a water-can fitted with a rose head, slowly turning the whole mixture over and over again until a uniform colour and consistency is obtained throughout the pile.

(h) The mixing platform shall be washed at the end of the day.

**Consistency:** The quantity of water to be used for each mix of 50kg cement, to give the required consistency shall not be more than 34 litres for 1:3:6 mix, 30 litres for 1:2:4 mix, 27 litres for 1:1 1/2:3 mix and 25 litres for 1:1:2 mix. In the case of vibrated concrete, the limit specified may be suitably reduced to avoid segregation. The quantity of water shall be regulated by carrying out regular slump tests.

The following slumps shall be adopted for different kinds of works:

**Table 5.6.1** SLUMPS FOR DIFFERENT KINDS OF WORK

| Works | Slump in mm | |
|---|---|---|
| | **Vibrator Used** | **Vibrator not used** |
| Mass concrete in foundation footings, retaining walls and pavement | 10-25 | 50-75 |
| Thin sections of flooring less than 75 mm thickness | 25-40 | 75 -100 |

The entire concrete used in the work shall be laid gently (not thrown) in layers not exceeding 150mm and shall be thoroughly vibrated by means of mechanical vibrators till a dense concrete is obtained. The Engineer may however relax the condition specifying use of mechanical vibrators at his discretion for certain items depending upon the thickness of the members and feasibility of vibrating the same and permit hand compaction. Hand compaction shall be done with the help of tamping rods so that concrete is thoroughly compacted and completely worked into the corners of the formwork. The layers of concrete shall be so placed that the bottom layer does not finally set before the top layer is placed. Compaction shall be completed before the initial setting starts i.e. within 30 minutes of addition of water to the dry mixture. For items where the vibrators are not to be used, it

shall be the duty of the contractor to take the permission of the Engineer before the start of work.

During cold weather, concreting shall not be done when the temperature falls below 4.5°C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone. Please see specifications relating to cold weather concreting Reinforced Cement Concrete. During hot weather, precautions shall be taken to see that the temperature of wet concrete does not exceed 38°C.

When the placing of concrete is suspended, necessary removal of laitance and roughening the surface for jointing future work shall be done before the concrete sets. When the work is resumed the previous work must be thoroughly cleaned, roughened, watered and a grout of neat cement slurry of the proportion, 1 Kg of cement per 2 litres of water applied uniformly.

Curing: Green work shall be protected from rain by suitable covering. The work should also be protected from damage and rain during construction.

After the concrete has begun to harden i.e. about 1 to 2 hours after its laying, it shall be protected with moist gunny bags, sand or any other material approved by the Engineer against quick drying. After 24 hours of laying of concrete, the surface shall be cured by flooding with water of minimum 25mm depth, or by covering with wet absorbent materials. The curing shall be done for a minimum period of 14 days. In special cases, curing may have to be done for more number of days as required by the Engineer.

Over the foundation concrete, the masonry work may be started after 48 hours of its laying, but the curing of cement concrete shall be continued along with the masonry work for a minimum period of 14 days.

Where cement concrete is used as sub-grade for flooring, the flooring may be commenced before the curing period of sub-grade is over but the curing of sub-grade shall be continued along with the top layer of flooring for a minimum period of 14 days.

The water used for curing shall not produce any objectionable stains or unsightly deposit on concrete surface. In special circumstances and locations curing by other means such as sealing material, insulating blankets etc. may be adopted with the specific prior approval of the Engineer.

The minimum compressive strength of mix 1 :1.5 :3 and 1 :2 :4 shall be as follows:

**Table 5.6.2** MINIMUM COMPRESSIVE STRENGTH

| **Mix** | **Compressive strength in kg/sq.cm at 28 days** | |
|---|---|---|
| | At 7 days | At 28 days |
| 1:1.5:3 | 175 | 265 |
| 1:2:4 | 140 | 210 |

### 5.6.2 Plain Concrete

*- Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth level*

*CW0001 1:1:2 (1 cement : 1 sand : 2 graded crushed rock 20 mm nominal size)*

*CW0002 1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)*

*CW0003 1:2:4 (1 cement : 2 sand : 4 graded crushed rock 20 mm nominal size)*

*CW0004 1:2:4 (1 cement : 2 sand : 4 graded crushed rock 40 mm nominal size)*

*CW0005 1:3:6 (1 cement : 3 sand : 6 graded crushed rock 20 mm nominal size)*

*CW0006 1:3:6 (1 cement : 3 sand : 6 graded crushed rock 40 mm nominal size)*

*CW0007 1:3:6 (1 cement : 3 sand : 6 graded gravel/shingles 40 mm nominal size)*

*CW0008 1:4:8 (1 cement : 4 sand : 8 graded crushed stone 40 mm nominal size)*

*CW0009 1:4:8 (1 cement : 4 sand : 8 graded crushed stone 50 mm nominal size)*

*CW0010 1:4:8 (1 cement : 4 sand : 8 graded gravel/shingles 40 mm nominal size)*

*CW0011 1:5:10 (1 cement : 5 sand : 10 graded crushed stone 40 mm nominal size)*

*CW0012 1:5: 10 (1 cement : 5 sand : 10 graded crushed stone 50 mm nominal size)*

*CW0013 1:5:10 (1 cement : 5 sand : 10 graded gravel/shingles 40 mm nominal size)*

*- Providing and laying in position plain cement concrete in retaining walls, return walls, walls (any thickness) including attached pilasters, columns, piers, abutments, pillars, posts, struts, buttresses, string or lacing courses, parapets, coping, bed blocks, anchor blocks, plain window sills, fillets etc. upto floor five level, excluding the cost of centering and shuttering*

*CW0020 1:1:2 (1 cement : 1 sand : 2 graded crushed rock 20 mm nominal size)*

*CW0021 1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)*

*CW0022 1:2:4 (1 cement : 2 sand : 4 graded crushed rock 20 mm nominal size)*

*CW0023 1:2:4 (1 cement : 2 sand : 4 graded crushed rock 40 mm nominal size)*

*CW0024 1:3:6 (1 cement : 3 sand : 6 graded crushed rock 20 mm nominal size)*

*CW0025 1:3:6 (1 cement : 3 sand : 6 graded crushed rock 40 mm nominal size)*

*CW0026 1:3:6 (1 cement : 3 sand : 6 graded gravel/shingles 40 mm nominal size)*

### 5.6.3 Pre-cast cement concrete

*- Providing and fixing upto floor five level pre-cast cement concrete lacing courses, copings, bed plates, anchor blocks, plain window sills, shelves, louvers, steps, staircases etc. including hoisting and setting in position with cement mortar 1:3 (1 cement : 3 sand) cost of required formwork and finishing smooth with 6 mm thick cement plaster on exposed surface complete*

*CW0050 1:2:4 (1 cement : 2 sand : 4 graded crushed rock 20 mm nominal size)*

*CW0051 1:3:6 (1 cement : 3 sand : 6 graded crushed rock 20 mm nominal size)*

*- Providing and fixing at or near ground level pre-cast cement concrete in kerbs, edgings etc. as per approval pattern and setting in position with cement mortar 1:3 (1*

*cement : 3 sand) cost of required formwork and finishing smooth with 6 mm thick cement plaster on exposed surface complete*

*CW0060 1:2:4 (1 cement : 2 sand : 4 graded crushed rock 20 mm nominal size*

*- Providing and fixing upto floor five level pre-cast cement concrete solid block including hoisting and setting in position with cement mortar 1:3 (1 cement : 3 sand) including the cost of required formwork and finishing smooth with 6 mm thick cement plaster on exposed surface complete*

*CW0070 1:2:4 (1 cement : 2 sand : 4 graded crushed rock 20 mm nominal size)*

*CW0071 1:3:6 (1 cement : 3 sand : 6 graded crushed rock 20 mm nominal size)*

*- Providing and fixing upto floor five level pre-cast cement concrete hollow block including hoisting and setting in position with cement mortar 1:3 (1 cement : 3 sand) including the cost of required formwork and finishing smooth with 6 mm thick cement plaster on exposed surface complete*

*CW0080 1:2:4 (1 cement : 2 sand : 4 graded crushed rock 20 mm nominal size)*

*CW0081 1:3:6 (1 cement : 3 sand : 6 graded crushed rock 20 mm nominal size)*

**Measurements:** The work under the following categories shall be measured separately:

(a) From foundation to plinth level.
(b) From plinth level to floor 5 level.
(c) From floor 5 levels and so on.
(d) Concrete work in the parapet shall be measured together with the corresponding work in the wall of the storey next below.

Cast-in-Situ concrete shall be classified and measured under one of the items given above.

Length and breadth shall be measured correctly to a 10 mm. The thickness of slab, partitions, etc. and the like shall be measured correct to the nearest 5mm.

The consolidated cubical contents shall be calculated net nearest to 0.01cu.m. Concrete laid in excess, of the sections shown in the drawing unless directed by the Engineer shall not be measured.

Precast cement concrete solid articles shall be measured separately and shall include use of moulds, finishing the top surfaces even and smooth with wooden trowel, before setting in position in cement mortar 1:3 (1 cement: 3 coarse sand).

No deduction shall be made for:

(a) Ends of dissimilar materials (e.g. joists, beams, posts, girders, rafters, purlins, trusses, corbels, step etc.) upto 500 sq.cm in section.
(b) Opening up to 0.1m2 or as specified.
(c) Volume occupied by pipes, conduits, sheathing etc. not exceeding 100 sq.cm each in cross sectional area.
(d) Volume occupied by reinforcement;

**Rate:** The rates shall cover the cost for carrying out all the required operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work.

*CW0135 Extra for all cement concrete work in super structure above floor five level for each four floors or part thereof*

**Measurement:** All concrete work above floor five levels shall be measured in cubical contents.

**Rate**: The rate shall include the cost of all the operations required for lifting to the next higher level floor two level. For subsequent floors, this extra rate shall be added to the rate derived for the floor level immediately below it.

*CW0136 Extra for laying concrete in or under water, mud, including the cost of pumping or bailing out water and removing slush etc. complete.*

*CW0137 Extra for laying concrete in or under foul conditions*

Concrete shall not be deposited under water if it is practicable to dewater the area and place concrete in a regular manner. Where found necessary to deposit any concrete under water the method, equipment materials, proportions of the concrete mix and slump to be used shall be approved by the Engineer before the work is started. If considered necessary, the Engineer may direct additional cement (to an extent of 10% more than that required for the same mix placed in the dry) to be added.

Concrete shall be deposited continuously until it is brought to required height. While depositing the top surface shall be kept as nearly level as possible and the formation of seams avoided. The concrete shall be deposited under water by any methods approved by the Engineer such as by piping, drop bottom bracket, or bags etc. If it is necessary to raise the water after placing the concrete, the level shall be brought up slowly without creating any waves or commotion tending to wash away cement or to disturb the fresh concrete in any way. To minimise the formation of laitance, great care shall be exercised not to disturb the concrete as far as possible while it is being deposited.

While working in slushy conditions, all possible precautions shall be taken to prevent the slush contaminating the concrete in any manner.

**Measurement: C**ubical contents of the concrete placed shall be measured correct to 0.01cu.m

**Rate:** The rates shall cover the cost for carrying out all the required operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work.

*CW0140 Extra for providing and mixing water-proofing materials in cement concrete works in the proportion 12 kg/cu.m or as recommended by manufacturers.*

Water proofing material shall be added to the concrete according to the specifications of the manufacturer.

**Measurement:** The volume of concrete where waterproofing materials have been added shall be measured correct to 0.01 cu.m

**Rate:** Rate shall include the quantity of water proofing material required and the labour involved in mixing of water proofing compound.

### 5.6.4 Lime concrete

- *Providing and laying lime concrete, with 40 % mortar comprising of 1:1:1 lime mortar, in footings and bases for columns excluding cost of formwork*

*CW0090 With graded stone aggregate of 40 mm*

*CW0091 With graded brick aggregate of 40 mm*

This shall be prepared by mixing coarse aggregate and lime mortar in the specified proportions with the required quantity of water. Lime shall conform to IS : 712-1984 and shall be classified as below:

Class A - Eminently hydraulic lime used for structural purposes.
Class B - Semi hydraulic lime used for lime concrete.

**Proportioning:** The proportions of aggregate to lime mortar shall be done by volume. Generally lime is prepared by mixing 100 parts of 40 mm nominal size graded stone aggregate, gravel or brick aggregate as specified and 40 parts of lime mortar of the specified mix.

**Mixing:** Concrete shall be mixed in a mechanical mixer. In exceptional circumstances hand mixing may be done with the specific permission of the Engineer in writing. Before mixing, bricks aggregate shall be well soaked with water for a minimum period of 2 hours and stone aggregate or gravel shall be washed with water to remove dirt, dust or any other foreign materials.

**Machine Mixing:** The mixer shall be flushed clean with water. Mixing shall be done by pouring a measured quantity of coarse aggregate Portland cement in any case which itself contains and wet ground mortar for one batch in the drum of the mixer, while it is revolving. The quantity of materials loaded in the drum shall not exceed the rated capacity of the mixer. The water shall be added gradually upto the required quantity and the wet mixing of the batch shall be continued for at least two minutes in the drum till concrete of uniform colour uniformly distributed materials and consistency is obtained. The consistency of the concrete shall be such that the mortar does not tend to separate from the coarse aggregate. If there is segregation after unloading from the mixer the concrete should be removed. The entire concrete of the batch shall be discharged before the materials for the new batch are poured into the drum. Before suspending the work, the mixer shall be cleaned by revolving the drum with plenty of water each time.

**Hand Mixing:** When hand mixing is specifically permitted by an Engineer, it shall be done on a clean and water tight masonry platform of sufficient size to provide ample mixing space. The specified lime mortar shall be laid on the top of the aggregate and turning shall be done over and again with addition of necessary quantity of water till a uniform mix of required consistency is obtained. The consistency of concrete shall be such that the mortar shall not tend to separate from the coarse aggregate.

**Placing and Compaction:** Concrete shall be laid (and not thrown) in layers while it is quite fresh. Each layer shall be thoroughly rammed and consolidated before the succeeding layer is placed. Consolidated thickness of each layer shall not exceed 15 cm. Joints where necessary shall be staggered in different layers unless otherwise specified. Ramming shall be done by heavy iron rammers of 4.5 kg to 5.5 kg. The area of each rammer shall not be more than 300 sq. cm. Ramming shall be continued till a skin of mortar covers the surface completely. Concrete laid on a particular day shall be consolidated thoroughly on the same day before the work is stopped. Ramming on the following day shall not be done. Freshly laid concrete shall be protected from rains by suitable coverings.

**Curing:** After the concrete has begun to harden i.e. about 24 hours after its placing and compaction, the curing shall be done by keeping the concrete damp with moist gunny bags, sand, or any other method approved by the Engineer for a minimum period of 7 days. Till then, masonry and flooring work over the foundation or base concrete shall not be started.
**Measurements:** Length, breadth and depth or thickness shall be measured correct to a cm and the consolidated cubic contents of the concrete shall be calculated net to the nearest 0.01 cubic metre. Concrete laid in excess of the dimensions shown in the drawings shall not be measured.

**Rate**: The rate shall include the cost of materials and labour involved in all operations described above.

### 5.6.5 Plum concrete

*Providing and laying in position plum concrete (concrete M15- 60% and boulder - 40%) excluding the cost of centering and shuttering*

*CW0095 All work upto plinth level*

**General**

This work shall be required to provide lining of drains and drainage structures or other works as shown on the drawings or as specified by the Engineer.

Plum concrete, also known as cyclopean or rubble concrete, is a type of concrete that's made by mixing large stones or boulders of sizes up to 300mm along with normal concrete mixture of fine aggregate, coarse aggregate and cement in specified proportions with required quantity of water.

**Materials**

The concrete shall comply with the requirements of chapter 6: concrete works. The grade of concrete shall be as shown on drawings or as directed by the Engineer. The stone shall comply with the requirements of chapter 10: Stone/Mud masonry

**Composition**

Composition of plum concrete shall consist of 60% of concrete with mix ratio of M15 and 40% of boulders of size upto 300mm by volume or as instructed by the Engineer. About 3% non-shrinking agent by weight of cement shall be added to concrete at the time of mixing.

**Construction**

The place to be filled up with the plum concrete shall be cleaned and chipped for adhesion with the concrete. Following completion of formwork, a layer of concrete minimum 100mm thick shall be laid upon which clean and moist stones shall be placed at a distance of min 100mm measured from face to face in any direction. The distance between the outer edge of the concrete mass and the nearest face of the stone to the edge shall not be less than 100mm. Then another layer of concrete having thickness not less than 100mm measured from the top of the stone to the top surface of the layer shall be laid and compacted.

After compaction, again stones shall be placed on the layer as described above and the process shall be continued until the top layer of the concrete is completed. The placing of the stones shall be staggered both in horizontal and vertical direction.

**Curing**

After placement and finishing, the concrete should be cured properly for at least seven days. Curing involves keeping the concrete moist and protected from drying out for a specific period. Common methods of curing include water spraying, covering with wet hessian bags, or using curing compounds.

**Measurements:** Length, breadth and depth or thickness shall be measured correct to a cm and the consolidated cubic contents of the concrete shall be calculated net to the nearest 0.01 cubic metre.

**Rate:** The rate shall include the cost of materials and labour involved in all operations described above.

# 5.7 Chapter 7: DAMP-PROOFING

### 5.7.1 Concrete Course

- *Providing and laying damp-proof course with cement concrete 1:2:4 (1 cement: 2 sand: 4 aggregate 12.5mm and down gauge)*

*DP0001* *25mm thick*

*DP0002* *40mm thick*

- *Providing and laying damp-proof course with cement concrete 1:2:4, (1 cement: 2 sand: 4 aggregate 20mm and down gauge)*

*DP0010* *50 mm thick*

Damp proof course shall consist of cement concrete of specified proportion and thickness. The surface of brickwork or stonework masonry shall be levelled and prepared before laying the cement concrete. Edges of the damp proof course shall be straight, even and vertical. Side shuttering shall consist of wooden forms and shall be strong and properly fixed so that it does not get disturbed during compaction and the mortar does not leak through. The concrete mix shall be of workable consistency and shall be tamped thoroughly to make dense mass. When the sides are removed, the surface should come out smooth without any honey-combing.

Damp proof course shall be cured for at least seven days, after which it shall be allowed to dry.

**Measurements:** The length and breadth shall be measured correct to 10mm and its area shall be calculated in square metres correct to two places of decimal. The depth shall not be less than the specified thickness at any section.

**Rates:** The rates shall be payment in full for carrying out the required operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work.

### *5.7.2* Bituminous Coating

*DP0015* *Applying a coat of hot bitumen (asphalt VG- 10 or equivalent) using 1.71 kg per sq.m including surface cleaning*

Before the Bitumen is applied, the surface shall be properly cleaned with brushes and finally with a piece of cloth lightly soaked in kerosene oil. The specified quantity of bitumen shall be applied uniformly all over the cleaned dried surface so that no blank spaces are left anywhere.

**Measurement:** The length and breadth shall be measured correct to 10 mm and the area worked out correct to two places of decimal.

**Rate:** Rate shall include all materials including the fuel and equipment required for heating the bitumen and all labour involved in above operations.

### 5.7.3 Moisture Barriers

- *Providing and laying plastic sheet moisture barrier*

*DP0020 200 micro-metre*

Before the plastic sheet is laid, the surface shall be properly cleaned with brushes. The specified plastic sheet moisture barrier shall be laid uniformly all over the cleaned dried surface so that no blank spaces are left anywhere. The sheet shall be stretched out to eliminate curls. The damp proofing membrane shall overlap from masonry walls by 100mm. One damp proofing membrane shall overlap the proceeding one by at least 200mm both ways. All overlap shall be firmly bonded with hot bitumen.

**Measurements:** The length and breadth shall be measured correct to 10mm and its area shall be calculated in square metres correct to two places of decimal. The thickness shall not be less than the specified thickness.

**Rates:** The rates shall be payment in full for carrying out the required operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work.

*DP0030 Bitumen felt type 3 Grade 2 Damp Proof Course (DPC) in walls, bases etc.*

The bitumen felt Type 3 Grade 2 shall conform to IS: 1322 (thickness about 3 mm and free of holes)

**Surface Preparation:** Surface shall be prepared by grouting cracks, providing cement mortar fillets to smoothen sharp edges, rounding off corners wherever required and cleaning and drying the surface all complete as directed by the Engineer.

The self-finished felt shall be cut to the required length, brushed clean of dust material and laid out flat on dry mortar to eliminate curls and subsequent stretching. The felt shall be laid in a single piece of 6 to 8 m length. Each length of felt shall be laid in position with a minimum overlap of 50 mm at the longitudinal edges. All overlaps shall be firmly bonded with hot bitumen. Streaks and trailing of bitumen near edges of laps shall be levelled by heating the overlap with blow lamps and levelling down any unevenness. Wherever the position of the vertical reinforcement bar lies, a slot shall be cut in the felt and a patch of DPC laid the other way to cover the slot in the main DPC. The patch of DPC shall be bound to the main DPC by hot bitumen. Extra 100 mm width to lap with DPM on inner face of wall for external walls or both faces of dividing walls shall be provided.

**Measurements**: The length and breadth shall be measured correct to the nearest centimetre.

**Rates**: Rate shall include all materials and labour involved in above operations.

### 5.7.4 Polymer Modified Cementitious Waterproofing Coating

*DP0040 - Providing & Applying polymer modified, flexible cementitious negative side waterproofing coating with elastic waterproofing polymers on interior surface in three coats @14.35 kg /10 sqm. one coat of self priming of cementitious waterproofing polymer and two coats of cementitious waterproofing polymer after scrapping and properly cleaning the surface to remove loose particles and paint film, complete in all respects.*

**Surface Preparation:** The substrate shall be structurally sound, clean and free from dust, laitance, oil, grease, loose particles, curing compounds, organic growth and all deleterious materials.

Surface preparation may include grinding, wire brushing, abrasive blasting, high-pressure water jetting or mechanical cleaning as necessary to obtain a clean and open-textured surface.

Honeycombs, blowholes, cracks and damaged areas shall be repaired using approved polymer modified repair mortars prior to application of waterproofing coating. Before application, the substrate shall be pre-wetted thoroughly to Saturated Surface Dry (SSD) condition. No standing water shall remain on the surface.

**Mixing:** Mixing shall be carried out strictly in accordance with manufacturer's recommendations using slow-speed mechanical mixers not exceeding 500 rpm.Only full pre-packed units shall be mixed.

No additional water, cement or other materials shall be added unless specifically permitted by the manufacturer. The mixed material shall be uniform, lump-free and used within the manufacturer's specified pot life.

**Application:** The waterproofing coating shall be applied in a minimum of two coats by brush, roller, trowel or spray as recommended by the manufacturer. The second coat shall be applied at right angles to the first coat after the initial coat has hardened sufficiently. The total dry film thickness shall generally be 2.0 – 3.0 mm.

Material consumption shall be as per manufacturer's recommendations to achieve the specified thickness and performance. Reinforcement mesh shall be embedded throughout the waterproofed area and at cracks, joints, corners and other vulnerable locations wherever required.

All joints, edges, penetrations and terminations shall receive full and continuous waterproofing treatment. Application shall not be carried out during rain or under adverse weather conditions not permitted by the manufacturer.

**Protection and Curing:** The coated surface shall be protected from direct sunlight, wind, rain, mechanical damage and early drying. Proper curing methods as recommended by the manufacturer shall be adopted.

**Measurement:** Measurement shall be based on the actual finished waterproofed surface area and shall be carried out in square metres ($m^2$) correct to two decimal places. No deduction shall be made for openings, penetrations or voids not exceeding 0.40 $m^2$ each, whereas for openings exceeding 0.40 $m^2$, deductions shall be made for the full area of such openings. Measurement shall be taken on the finished treated surface as executed at site.

**Rate:** The rate shall include the cost of materials, labour, surface preparation, cleaning, mechanical mixing, repair of substrate defects, reinforcement mesh where required, application of all coats, curing and protection, tools and plants, transportation and all incidental works necessary for proper completion of the waterproofing system as specified.

# 5.8 Chapter 8: REINFORCED CONCRETE

## 5.8.1 General

The concrete shall be as specified under concrete works. Concrete shall be always mixed by mechanical mixer unless otherwise the Engineer permits hand mixing.

**Consistency:** The concrete, which will flow sluggishly into the forms and around the reinforcements without any segregation of coarse aggregate from the mortar, shall be used. The consistency shall depend on whether the concrete is vibrated or hand tamped. It shall be determined by slump test as prescribed in IS 1199. The slumps of concrete for different types of works shall be as given below, unless otherwise specified:

**Table 5.8.1** SLUMPS OF CONCRETE FOR DIFFERENT TYPES OF WORK

| Sl. No | Types of Work | Slump in mm | |
|---|---|---|---|
| | | Vibrators used | Vibrators not used |
| 1 | Mass concrete in R.C.C foundation footings, and retaining walls | 10 - 25 | 80 |
| 2 | Beams, slabs and columns simply reinforced | 25 - 40 | 100 – 125 |
| 3 | Thin R.C.C section or section with congested steel | 40 - 50 | 125 - 150 |

## 5.8.2 General Concreting

- *Providing & laying in position reinforced cement concrete excluding the cost of centering, shuttering and reinforcement - all work upto plinth level*

*RC0001* *1:1:2 (1 cement : 1 sand : 2 graded crushed rock 20 mm nominal size)*

*RC0002* *1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)*

*RC0003* *1:2:4 (1 cement : 2 sand : 4 graded crushed rock 20 mm nominal size)*

- *Providing & laying in position reinforced cement concrete work in walls (any thickness) including attached pilasters buttresses, piers, abutments etc. upto floor five level excluding the cost of centering, shuttering and reinforcement*

*RC0005* *1:1:2 (1 cement : 1 sand : 2 graded crushed rock 20 mm nominal size)*

*RC0006* *1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)*

*RC0007* *1:2:4 (1 cement : 2 sand : 4 graded crushed rock 20 mm nominal size)*

- *Providing & laying in position reinforced cement concrete work in plinth and skirting courses, fillets, columns , pillars, posts and struts upto floor five level excluding the cost of centering, shuttering and reinforcement.*

*RC0009* *1:1:2 (1 cement : 1 sand : 2 graded crushed rock 20 mm nominal size)*

*RC0010* *1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)*

*RC0011 1:2:4 (1 cement : 2 sand : 4 graded crushed rock 20 mm nominal size)*

*- Providing & laying in position reinforced cement concrete work in suspended floor, roofs having slope upto 15o, landings, balconies, shelves and chajjas upto floor five level excluding the cost of centering, shuttering and reinforcement*

*RC0013 1:1:2 (1 cement : 1 sand : 2 graded crushed rock 20 mm nominal size)*

*RC0014 1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)*

*RC0015 1:2:4 (1 cement : 2 sand : 4 graded crushed rock 20 mm nominal size)*

*- Providing & laying in position reinforced cement concrete work in beams, lintels, bands, plain window sills, staircases, spiral staircases upto floor five level excluding the cost of centering, shuttering and reinforcement*

*RC0017 1:1:2 (1 cement : 1 sand : 2 graded crushed rock 20 mm nominal size)*

*RC0018 1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)*

*RC0019 1:2:4 (1 cement : 2 sand : 4 graded crushed rock 20 mm nominal size)*

*- Providing & laying in position reinforced cement concrete work in kerbs, steps and the like upto floor five level excluding the cost of centering, shuttering and reinforcement*

*RC0020 1:1:2 (1 cement : 1 sand : 2 graded crushed rock 20 mm nominal size)*

*RC0021 1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)*

*RC0022 1:2:4 (1 cement : 2 sand : 4 graded crushed rock 20 mm nominal size)*

*- Providing & laying in position reinforced cement concrete work in arches and arch ribs upto floor five level excluding the cost of centering, shuttering and reinforcement*

*RC0023 1:1:2 (1 cement : 1 sand : 2 graded crushed rock 20 mm nominal size)*

*RC0024 1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)*

*RC0025 1:2:4 (1 cement : 2 sand : 4 graded crushed rock 20 mm nominal size)*

*- Providing & laying in position reinforced cement concrete work in domes, vaults, shells folded plates and roofs having more than 15° upto floor five level excluding the cost of centering, shuttering and reinforcement*

*RC0026 1:1:2 (1 cement : 1 sand : 2 graded crushed rock 20 mm nominal size)*

*RC0027 1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)*

*RC0028 1:2:4 (1 cement : 2 sand : 4 graded crushed rock 20 mm nominal size)*

*- Providing & laying in position reinforced cement concrete work in vertical and horizontal fins individually or forming box louvers, fascias and eaves boards - upto floor five level excluding the cost of centering, shuttering and reinforcement*

*RC0029 1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)*

Concreting shall be commenced only after the Engineer has inspected the centering, shuttering and reinforcement as placed and passed the same.

In case of concreting of slabs and beams; wooden plank or cat- walks supported directly on the centering by means of wooden blocks or lugs shall be provided to convey the concrete to

the place of deposition without disturbing the reinforcement in any way. Labour shall not be allowed to walk over the reinforcement.

In the case of columns and walls, it is desirable to place concrete without construction joints. The programme of concreting in the vertical direction shall be restricted to one metre per hour. The concrete shall be deposited in its final position in a manner to preclude segregation of ingredients. In deep trenches and footings, concrete shall be placed through chutes as directed by the Engineer. In case of columns and walls the shuttering shall be adjusted so that the vertical drop of concrete is not more than 1.5 meters at a time.

**Cold weather concreting**: During cold weather, as a rule concreting shall not be done when the temperature falls below 4.5 degrees Celsius. However, in circumstances where it becomes necessary to deposit concrete at or near freezing temperatures, precautions shall be taken to ensure that at the time of placing it has a temperature of not less than 4.5 degree Celsius and that this temperature is maintained till the concrete is compacted and it is thoroughly hardened. When necessary, the ingredients shall be heated before mixing and concrete carefully protected after placing; in general heating water alone to about 60 degree Celsius may be sufficient for this purpose. Dependence shall not be placed on salt or other chemicals for the prevention of freezing. (Use of calcium chloride to accelerate the rate of hardening is not permitted as it is considered harmful). Concrete places shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone.

**Hot weather concreting:** During hot weather, precaution shall be taken to see that the temperature of wet concrete does not exceed 38 degrees Celsius. No concrete shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer. It is necessary that the time between mixing and placing of concrete shall not exceed 30 minutes so that the initial setting process is not interfered with.

Concrete shall be compacted into a dense mass immediately after placing, by means of mechanical vibrators designed for continuous operation. The Engineer may however, relax this condition at his discretion for certain items, depending on the thickness of members and feasibility of vibrating the same, and permit hand compaction instead. Hand compaction shall be done with the help of tamping rods so that concrete is thoroughly compacted and completely worked around the reinforcement, embedded fixtures, and into corners of the formwork. The layers of concrete shall be so placed that the bottom layer does not finally set before the top layer is placed. The vibrators shall maintain the whole of concrete under treatment in an adequate state of agitation, such that de-aeration and effective compaction is attained at a rate commensurate with the supply of concrete from the mixers. The vibration shall continue during the whole period occupied by placing of concrete, the vibrators being adjusted so that the centre of vibrations approximates to the centre of the mass being placed at the time of compacting.

Concrete shall be judged to be properly compacted, when the mortar fills the spaces between the coarse aggregate and begins to cream up to form an even surface. When this condition has been attained, the vibrator shall be stopped in case of vibrating tables and external vibrators. In case both internal and external vibrators are being used the internal vibrators shall first be withdrawn slowly after which the external vibrators shall be stopped so that no loose pocket is left in the body of the concrete. The specific instructions of the makers of the particular type of vibrator used shall be strictly complied with. Shaking of

reinforcement for the purpose of compaction should be avoided. Compaction shall be completed before the initial setting starts, i.e. within 30 minutes of addition of water to the dry mixture.

**Construction joints:** Concreting shall be carried out continuously upto the construction joints, the position and details of which shall be as shown in Structural drawing or as indicated in this specification or as directed by the Engineer. Such joints shall be kept to the minimum and shall not be located in valleys. The joints shall be kept at places where the shear force is the minimum and these shall be straight and at right angles to the direction of main reinforcement.

In case of columns, the joints shall be horizontal and minimum of 20 cm below the bottom of the beam running into the column head. The portion of the column between the stopping off level and the top of the slab shall be concreted with the beam. When stopping the concrete on a vertical plane in slabs and beams, an approved stop-board shall be placed with necessary slots for reinforcement bars or any other obstruction to pass the bars freely without bending. The construction joints shall be keyed by providing a triangular or trapezoidal fillet nailed on the stop-board. Inclined or feather joints shall not be permitted. Any concrete flowing through the joints of the stop-board shall be removed soon after the initial set. When concrete is stopped on a horizontal plane, the surface shall be roughened and cleaned after the initial set. When the work has to be resumed, the joint shall be thoroughly cleaned with wire brush and loose particles removed. A coat of neat cement slurry at the rate of 2.75kg of cement per square metre shall then be applied on the roughened surface before fresh concrete is laid.

**Expansion Joints:** Expansion Joints shall be provided as shown in the structural drawings or as directed by the Engineer including all formwork and labour necessary to form.

**Curing:** After the concrete has begun to harden i.e. about 1 to 2 hours after it's laying, it shall be protected from quick drying with moist gunny bags, sand or any other material approved by the Engineer. After 24 hours of laying of concrete, the surface shall be cured by flooding with water of minimum 25mm depth, or by covering with wet absorbent material. The curing shall be done for a minimum period of 14 days.

**Finishing:** In case of roof slabs, the top surface shall be finished even and smooth with wooden trowel, before the concrete begins to set.

Immediately on removal of forms, the Engineer shall examine the R.C.C. work before any defects are made good such as:

a) The work that has sagged or contains honeycombing to an extent detrimental to structural safety or architectural concept shall be rejected.

b) Surface defects of a minor nature may be accepted. On acceptance of such work by the Engineer, the same shall be rectified as follows:

1. Surface defects which require repair when forms are removed usually consist of bulges due to movement of forms, ridges at form joints, honeycombed areas, damage resulting from the stripping of forms, and bolt holes. Bulges and ridges are to be removed by careful chipping or tooling and the surface is then rubbed with a grinding stone. Honey combed and other defective areas must be chipped out, the edges being cut as straight as possible and perpendicularly to the surface, or preferably slightly undercut to provide a key at the edge of the patch.

2. Shallow patches are first treated with a coat of thin grout composed of one part of cement and one part of sand and then filled with mortar similar to that used in the concrete. The mortar is placed in a layer not more than 10mm thick and each layer is given a scratch finish to secure bond with the succeeding layer. The last layer is finished to match the surrounding concrete by floating, rubbing, or tooling on formed surfaces by pressing the form material against the patch while the mortar is still plastic.
3. Large and deep patches require filling up with concrete held in place by forms. Such patches are reinforced and carefully dowelled to the hardened concrete.
4. Holes left by bolts are filled with mortar carefully packed into place in small amounts. The mortar is mixed as dry as possible with just enough water so that it will be tightly compacted when forced into place.
5. Tiered holes extending right through the concrete may be filled with mortar with a pressure gun similar to the gun used for greasing motorcars.
6. Normally, patches appear darker than the surrounding concrete, possibly owing to the presence on their surface of less cement laitance. Where uniform surface colour is important, this effect shall be remedied by adding 10 to 20 percent of white Portland cement to the patching mortar, the exact quantity being determined by trial.
7. The same amount of care to cure the materials in the patches should be taken as with the whole structure. Curing must be started, as soon as possible, after the patch is finished to prevent early drying. Damp Hessian may be used but in some locations it may be difficult to hold it in place. A membrane-curing compound in these cases will come in most convenient.

c) The surface, which is to receive plaster or where it is to be joined with brick masonry wall, shall be properly roughened immediately after the shuttering is removed, taking care to remove the laitance completely without disturbing the concrete. The roughening shall be done by hacking. Before the surface is plastered it shall be cleaned and wetted so as to give a good bond between concrete and plaster. The R.C.C. work shall be done carefully so that the thickness of plaster required for finishing the surface is not more than 6mm.

d) The surface of R.C.C slab on which the cement concrete or mosaic floor is to be laid shall be roughened with brushes while the concrete is green. This shall be done carefully without disturbing the concrete.

**Measurement**: Dimensions shall be measured nearest to 10mm, except for the thickness of slab which shall be measured to nearest 5mm. The areas shall be worked out to nearest 0.01 square metres. The cubic contents shall be worked out to nearest 0.01 cubic metres.

Work under the following category shall be measured separately.

a) In foundation upto floor one level.

b) From floor one level to floor two level.

c) From floor two level to floor three level and so on-

d) R.C.C. above roof level shall be measured along with the R.C.C. work in floor just below.

No deduction shall be made for the following:

a) Ends of dissimilar materials (e.g. joints, beams, posts, girders, rafters, purlins, trusses, corbels, steps etc.) upto 500sq.cm in cross-section.

b) Opening upto 0.1 sq.m.

***Note:*** *In calculating area of opening upto 0.1 sq.m the size of opening includes the thickness of any separate lintels or sills. No extra labour for forming such openings or voids shall be paid for*.

c) The volume occupied by reinforcement.

d) The volume occupied by pipes, conduits, etc. not exceeding 100sq.cm each in a cross-sectional area. Nothing extra shall be paid for leaving and finishing such cavities and holes.

e) Small voids not exceeding 40 Sq.cm each in a cross-sectional area. Nothing extra shall be paid for leaving and finishing such cavities and holes.

Measurements shall be taken before any rendering is done in the concrete members. The measurement will not include rendering.

The measurement of R.C.C. work between various units shall be regulated as below:

a) Slabs shall be taken as running continuously through except when the slab is monolithic with the beam. In that case it will be from the face of the beam.

b) Beams shall be measured from face to face of columns and shall include haunches, if any, between columns and beams. The depth of the beam shall be from the bottom of the slab to the bottom of the beam, if the beam and slab are not monolithic. In case of monolithic construction where slabs are integrally connected with the beam, the depth of the beam shall be from the top of the slab to the bottom of the beam.

c) The columns shall be measured from top of column base to underside of the first floor slab and subsequently from top of floor slab to underside of the floor slab above. In case of columns for flat slabs, flare of column shall be included with column for measurement.

d) Chajja shall be measured inclusive of bearing. But when Chajja is combined with lintel, slab and beam, it shall be measured as a clear portion. Whenever vertical fins and chajjas are combined, chajjas shall be measured clearly between fins. The vertical fins shall be measured through.

e) The filling of expansion joints with bitumen filler, bitumen felt or any such material and the provision of copper or brass plate for covering, etc., shall be measured in running metres.

**Rate:** The rate includes the cost of materials and labour involved in all the operations described above except for the cost of centring and shuttering unless otherwise mentioned in the item.

***Note:*** *The 28 days cube test shall be the basis of determination of strength for R.C.C. work. Concrete that is less than the required strength shall not be accepted unless otherwise stated.*

### 5.8.3 Traditional Cornices

*- Bhutan type Traditional Cornices in R.C.C 1:1.5:3, 20mm aggregate including cost of formwork, finishing, 6mm thick plaster on the exposed surface with cement mortar 1:3, as per standard design, excluding cost of reinforcement & decorative painting.*

*RC0030 Single Storied building, including cost of Phana*

*RC0031 Multi Storied building at floor two level or other floors where Lhanglag is provided including cost of Lhanglag*

*RC0032 Multi Storied building at other floor levels, excluding cost of phana*

*RC0033 Phana*

*RC0034 Lintel cornice (only cornice portion at external face)*

*- Bhutan type Traditional Cornices in R.C.C 1:2:4, 20mm aggregate including cost of formwork, finishing, 6mm thick plaster on the exposed surface with cement mortar 1:3, as per standard design, excluding cost of reinforcement & decorative painting.*

*RC0040 Single Storied building, including cost of Phana*

*RC0041 Multi Storied building at floor two level or other floors where Lhanglag is provided including cost of Lhanglag*

*RC0042 Multi Storied building at other floor levels, excluding cost of phana*

*RC0043 Phana*

*RC0044 Lintel cornice (only cornice portion at external face)*

**Bhutan Cornice**: The profile of the cornice shall conform in all respects to the approved design and the work carried out as directed by the Engineer. Care shall be taken to see that cornice at each floor level is as per the design for that level, and to maintain proper line and level.

**Measurement**: Bhutan cornice shall be measured by length correct to 10mm, along the junction of the cornice and wall.

**Rate:** The rate includes the cost of materials and labour involved in all the operations described above except for the cost of centring and shuttering unless otherwise mentioned in the item.

### 5.8.4 Extra for R.C.C Works

*RC0050 Applying cement slurry on R.C.C slabs using 2.75 kg per sq.m for receiving C.C. floor including roughening, cleaning & dampen the surface*

The laitance shall be removed and then the surface of R.C.C./concrete hacked and cleaned before applying the cement slurry. The slurry shall be applied uniformly at the rate of 2.75 kg of dry cement per sq.m of the surface area.

**Measurement**: The length and breadth shall be measured correct to 10mm. and the area calculated correct to 0.1 sq.m.

**Rate:** The rate shall include all material and labour involved in above operation.

*RC0051 Extra, for all R.C.C work above floor 5 level for every four floors or part thereof, excluding cost of reinforcement*

**Measurement:** All the R.C.C. work above floor two level shall be measured in cubical contents floor wise.

**Rate**: The rate shall include the cost of all the operations required for lifting to the next higher level floor two level. Foe subsequent floors, this extra rate shall be added to the rate derived for the floor level immediately below it.

*RC0052 Extra, for rendering in cement mortar 1:2, the top of suspended floors/landings/staircase treads and risers*

*RC0053 Rendering smooth finishing of the exposed surface with 6mm thick cement mortar 1:3*

**Measurement:** The length and breadth shall be measured correct to 10mm and the area calculated correct to two places of decimal.

**Rate:** Rate shall include all material and labour involved in all operations described in the nomenclature of item.

*RC0054 Providing, throating or plastering drip and moulding to R.C.C. chajjas*.

Throating is to be provided in RCC chajjas or a plaster drip may be provided. Cement mortar 1:3 shall be used for the plaster drip.

**Measurement:** The length shall be measured correct to 10mm.

**Rate:** Rate shall include all material and labour involved in all operations described in the nomenclature of item.

### 5.8.5 Pre-cast Items

- *Providing & fixing, below & including fl.2 level, Precast R.C.C jali 1:2:4, 12.5mm aggregate, reinforced with mild steel wire 1.6mm dia., including roughening, cleaning, fixing, finishing in cement mortar 1:3 excluding plastering of the jambs, sills, soffits*

*RC0060 50 mm thick*

*RC0061 40 mm thick*

*RC0062 25 mm thick*

The jali shall be set in position true to plumb and level before the jambs, sills and soffits of the openings are plastered. It shall then be properly grouted with cement mortar 1:3 (1 cement: 3 sand) and re-checked for levels. Finally the jambs, sills and soffits shall be plastered embedding the jali firmly on all sides.

**Measurement**: The jali shall be measured for its gross superficial area. The length and breadth shall be measured correct to 10mm. The thickness shall not be less than that specified. The area shall be calculated correct to 0.01sq.m.

**Rate:** The rate shall be inclusive of materials and labour involved in all the operations described above except plastering of jambs, sills and soffits, which will be paid for under the relevant items of plastering.

- *Providing & fixing, below & including floor 2 level, Pre-cast R.C.C 1:2:4, 20mm aggregate including finishing, plastering with 6mm cement plaster 1:3 and formwork, but excluding reinforcement cost*

*RC0070* *String courses, copings, bed plates, anchor blocks, plain window sills*

*RC0071* *Small lintels & joists < 1.5m clear span, shelves*

*RC0072* *Joists, span > 1.5m, shelves*

The *Pre-cast* member shall be set in position true to plumb and level before the jambs, sills and soffits of the openings are plastered. It shall then be properly grouted with cement mortar 1:3 (1 cement: 3 sand) and re-checked for levels. Finally, the jambs, sills and soffits shall be plastered embedding the *Pre-cast* member firmly on all sides.

**Measurement:** The length, breadth and thickness shall be measured correct 10mm. and the cubical contents calculated correct to 0.01cu.m.

Pre-cast reinforced cement concrete shall be measured separately and shall include use of moulds, finishing the faces and hoisting and setting in position in cement mortar 1:3 (1 cement: 3 sand). Plain and moulded work shall be measured separately and the work shall be classified and measured separately in cubical contents. Reinforcement shall be measured separately.

**Rate:** The rate is inclusive of cost of labour and materials involved in all the operations described above except reinforcement, which shall be paid for separately.

### 5.8.6 Steel Reinforcement

*RC0083* *Providing & fixing Thermo-Mechanically Treated reinforcement bar (Yield Strength 500 MPa) for R.C.C work including cutting, bending, binding and placing in position complete*

The type and grade of reinforcement to be used shall be as indicated on the drawings. Where this information is not given on the drawings, hot rolled deformed bars having yield strength of 500 Mpa shall be used. Bars shall be bent cold (no heating shall be permitted), correctly and accurately to the size and shape as shown on the detailed drawings or as directed by the Engineer. Preferably, bars of full length shall be used and within the following tolerances:

**Table 5.8.2** TOLERANCES ON DIMENSIONS OF REINFORCEMENT BAR

| Sl. No | Dimension | Tolerance |
|---|---|---|
| 1 | Length of straight bars | ± 25 mm |
| 2 | Location of splices | ± 50 mm |
| 3 | Length of lap splices | ± 50 mm |

Minimum clear cover shall be as indicated on the drawings. Where cover is not indicated on the drawings, it shall be in accordance with the following:

**Table 5.8.3** MINIMUM CLEAR COVER FOR REINFORCEMENT

| Sl. No | Location | Clear cover |
|---|---|---|
| 1 | Slabs | 20 mm |
| 2 | Beam – main reinforcement | 30 mm |
| 3 | Beam – stirrups | 20 mm |
| 4 | Column – main reinforcement | 40 mm |
| 5 | Column - ties | 20 mm |
| 6 | Footings | 75 mm |

Overlapping of bars shall be as indicated on the drawings. The overlapping bars shall not touch each other and these shall be kept apart by 25 mm or 1.25 times the maximum size of the coarse aggregate whichever is greater, with concrete between them. But where this cannot be done, the overlapping shall be bound together at intervals not exceeding twice the dia. of such bars, with two strands of annealed steel wire of 0.90 mm to 1.6 mm thickness twisted tight. The overlaps shall be staggered for different bars and located at points, along the span, where neither shear nor bending moment is maximum. Where lap length is not explicitly shown on the drawings, the length shown in the following table shall be used:

**Table 5.8.4** LAP LENGTH OF THE REBAR

| Sl. No | Bar size | Lap length |
|---|---|---|
| 1 | 10 mm | 300 mm |
| 2 | 12 mm | 350 mm |
| 3 | 16 mm | 600 mm |
| 4 | 20 mm | 900 mm |
| 5 | 25 mm | 1100 mm |

The ends of rods shall be bent in to semi circular hooks, having clear diameter equal to four times the diameter of the bar, with a length, beyond the bend equal to four times the diameter of the bar. End hooks may, however, not be provided for cold twisted, hot rolled and CRS bars.

***Note:*** *Welding should not be used unless absolutely necessary. The reinforcement bar does not weld very well and the resulting splice can be a weak spot. Binding is better as welding can produce a reduction in strength as well.*

Reinforcement bars shall be placed in position as shown in the drawings. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.90 to 1.6 mm thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during the deposition of concrete.

The bars shall be kept in position by the following methods:

a) In case of beam and slab construction, pre-cast cover blocks in cement mortar 1:2 (1 cement: 2 coarse sand), about 4cm x 4cm section and of thickness equal to the specified cover shall be placed between the bars and shuttering, so as to secure and maintain the requisite cover of concrete over reinforcement.

b) In case of cantilevered and double layer reinforced beams or slabs, the vertical distance between the horizontal bars shall be maintained by introducing chain spacers or support bars of steel at 1.0 metre or at shorter spacing to avoid sagging.

c) In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them, or with blocks of cement mortar (1:2) suitably tied to the reinforcement.

d) In case of other R.C.C. structures such as arches, domes etc, cover blocks, spacers and templates shall be used as directed by the Engineer.

**Measurement**: Reinforcement including authorised spacer bars and laps shall be measured in lengths of different diameters, as actually used in the work nearest to 10mm and their weight calculated on the basis of standard tables. Wastage and un-authorised overlaps shall not be paid for. Annealed steel wire required for binding or tack welding shall not be measured, its cost being included in the rate of reinforcement. Wherever welding is resorted to in lieu of over laps such welds shall be measured separately in members for different size of reinforcement.

**Rate:** The rate of reinforcement shall include the cost of labour and materials as required for all operations described above except welding in lieu of over laps, which shall be paid for separately. No separate payment will be made for concrete spacer blocks, timber templates, tie wire or any other accessories required for the performance of the work.

### 5.8.7 Form Works

*- Providing & fixing centering and shuttering (formwork) using Timber, including strutting, propping etc. and removal of formwork -*

*RC0090 Foundation and plinth etc.*

*- Providing & fixing centering and shuttering (formwork) using Shuttering Plywood, including Timber frame and timber strutting, propping with complete form tie system etc. and removal of formwork -*

*RC0108 Foundation, footing and all works up to plinth level, etc.*

*RC0109 Walls, pilasters, buttresses, string course etc.*

*RC0110 Lintels, beams, girders, bresummers, cantileversetc.*

*RC0111 Columns, pillars, post, struts etc.*

*RC0112 Staircase (except spiral staircase) excluding landing*

*RC0113 Suspended floor, roof, landing, shelves and their supports, balconies, chajjas etc.*

*RC0114 Spiral staircase excluding landing*

*RC0115 Arches, curved, Domes,vaults, shell roof etc.*

*- Providing & fixing centering and shuttering (formwork) using Shuttering Plywood, including Timber frame and steel strutting, propping with complete form tie system etc. and removal of formwork -*

*RC0141 Foundation, footing and all works up to plinth level, etc.*

*RC0142 Walls, pilasters, buttresses, string course etc.*

*RC0143 Lintels, beams, girders, bresummers, cantilevers etc.*

*RC0144 Columns, pillars, post, struts etc.*

*RC0145 Staircase (except spiral staircase) excluding landing*

*RC0146 Suspended floor, roof, landing, shelves and their supports, balconies, chajjas etc.*

*RC0147 Spiral staircase excluding landing*

*RC0148 Arches, curved, Domes,vaults, shell roof etc.*

**Propping and Centering**: Props used for centering shall be of steel, timber posts, ballies or any other material approved by the Engineer. Use of brick masonry pillars in mud mortar shall also be permissible. In no case ballies shall be of diameter less than 100mm measured at mid length and 80mm at thin end. Maximum permissible spacing shall be 1.2m centre to centre. Ballies shall rest squarely on wooden sole plates of 40mm thickness and minimum bearing area of 0.1sq.m laid either on ground or on 40 x 40cm brick masonry pillars in mud mortar of height not exceeding 40cm. Double wedges shall further be provided between the sole plates and the wooden props so as to facilitate tightening and easing of shuttering without jarring the concrete. In case brick masonry pillars of adequate section are used instead of props, wooden sole plates shall be provided at the top of pillars and double wedges inserted between the sole plate and the bottom of shuttering.

Formwork and concreting of the upper floor shall not be done until concrete of the lower floor has been set for at least 28 days. In case of balconies and cantilever beams, coming one above the other, the members being cast shall be supported by props on two floors below the floor where initial support has been done. Ballies shall rest squarely on wooden sole plates of 40mm thickness and with minimum bearing area of 0.1sq.m.

The details of formwork stated above shall be applicable for spans of 4.50m and height upto

3.50 metres. In case any of these limits is exceeded the formwork shall be properly designed for the self-weight, weight of reinforcement, weight of fresh concrete, various live loads imposed during the construction process (such as workmen and equipment) as per the guideline for Formwork Design.

Dumping of concrete, movement of construction equipment and action of the wind may produce lateral forces which must be resisted by the form work to prevent lateral failure for which suitable horizontal as well as diagonal bracings shall be provided. The permissible stresses in bending, buckling load of props, permissible deflection of shuttering should not be exceeded.

In case the height of centering exceeds 3.50 metres, the props may be provided in multi-stages. Before the concreting is started, the props and wedges shall be thoroughly checked to see that these are intact, and take suitable action in case these are loose. While

the concreting is in progress, at least one carpenter shall be readily available at the site. The carpenter shall keep a constant watch on the props and take immediate remedial measures, as soon as any of these get loosened. Care shall be taken that props and wedges do not get loose for a minimum period specified in Table 5.8.5.

**Shuttering**: The shuttering shall be of wood or shuttering plywood. The shuttering plywood shall conform to IS 4990 (2011). The shuttering shall have smooth and even surface and the joints shall not permit leakage of cement grout. Timber used shall be well seasoned, free from loose knots, projecting nails, splits or other defects that may mar the cement surface of concrete. It shall not be so dry as to absorb water from concrete and swell and bulge, or so green or wet as to shrink after erection. Species of timber that are not affected appreciably by its contact with water shall be used. The timber shall be accurately sawn and planed on the sides and the surface coming in contact with concrete. For exposed concrete faces, timber for shuttering shall be wrought on all faces in contact with concrete. Wooden formwork with metal sheet lining or steel plates stiffened by steel angles shall also be permitted. Where metal forms are used, all bolts and nuts shall be countersunk and well ground to provide a smooth plane surface. The chamfers, bevelled edges and mouldings shall be made in the formwork itself. Opening for fan clamps and other fittings connected with services shall be provided in the shuttering as directed by the Engineer-in-charge. As far as practicable, clamps shall be used to hold the forms together. Where use of nails is unavoidable minimum number of nails shall be used and these shall be left projecting so that they can be easily withdrawn. Use of double head nails shall be preferred.

**Surface Treatment for Shuttering**: The surfaces of timber shuttering that would come in contact with concrete shall be well wetted and coated with soap solution, raw linseed oil, form oil of approved manufacture or any other approved material (such as polythene/polyethylene sheets), to prevent adhesion of concrete to form work. Soap solution, for the purpose shall be prepared by dissolving yellow soap in water to get the consistency of paint. Inside surfaces of forms shall be thoroughly cleaned before application of any of the materials mentioned above. Release agents shall be applied strictly in accordance with the manufacturers' instructions and shall not be allowed to come in contact with any reinforcement. Re-use of the shuttering shall be permitted only after the inside surface has been thoroughly cleaned in the manner described above.

Contractor shall give the Engineer due notice before placing any concrete in the forms to permit him to inspect and accept the form work as to its strength alignment and general fitness, but such inspection shall not relieve the contractor of his responsibility for safety of workman, machinery, materials and for results obtained.

**Camber**: Suitable camber shall be provided in horizontal members of structures, especially in long spans to counteract the effects of deflection. The formwork shall be so assembled as to provide for such camber. The camber for beams and slabs shall be 4mm per metre (1 in 250) or as directed by the Engineer, so as to offset the subsequent deflection. For cantilevers, the camber at free end shall be 1/50th of the projected length or as directed by the Engineer.

**Form ties**: Form ties used in the formwork are typically made of high-tensile steel (minimum yield strength around 250–415 MPa) and are designed to resist the lateral pressure of fresh concrete without deformation. Common types include tie rods with wing nuts, she-bolts, and snap ties, usually with diameters ranging from 10mm to 30mm. These are spaced

depending on the concrete pressure, as per design. The form ties shall be fitted with plastic sleeving cones at each end. The part of the form ties if left inside the concrete shall have minimum cover as specified for reinforcement.

**Special Formwork**: For special types of work-locations like tall structures etc. use of special types of formwork like moving or climbing forms shall be permitted. The details of such formworks along with the sequence of working shall be approved from the Engineer before their erection.

**Removal of Form Work**: No formwork or any part thereof shall be removed without prior approval of the Engineer. The formwork shall be so removed as not to cause any damage to concrete due to shock or vibration. In a slab and beam construction, sides of beam shall be stripped first, then the under sides of slab and lastly the underside of the beam. Formwork must be so designed that they can be stripped in the order required i.e.

a) Shutters to vertical (non load bearing) faces e.g. column boxes, beam sides, wall forms,

b) Shutters forming soffits to slabs, horizontal and inclined which carry only light load, e.g. slabs, roofs, floors and canopies etc.

c) Soffit shutters carrying heavy loads e.g. beam and girder bottoms.

The whole of the formwork should be planned and a definite scheme of operation worked out. In no circumstances should forms be struck until the concrete reaches strength of at least twice the stress to which the concrete may be subjected at the time of striking. Where possible the formwork should be left longer as it would assist curing. Forms should be eased carefully in order to prevent the load being suddenly transferred to concrete. The period that shall elapse after the concrete has been laid, before easing and removal of centring and shuttering is undertaken shall be as given in Table below **:**

**Table 5.8.5** MINIMUM PERIOD FOR REMOVAL OF FORMWORK

| **Type of formwork** | **Minimum period before striking formwork** |
|---|---|
| Vertical formwork to columns, walls and beams | 16 – 24 h |
| Soffit formwork to slabs ( props to be re-fixed immediately after removal of formwork) | 3 days |
| Soffit formwork to beams ( props to be re-fixed immediately after removal of formwork) | 7 days |
| Props to slabs spanning upto 4.5 m | 7 days |
| Props to slabs spanning over 4.5 m | 14 days |
| Props to beams and arches spanning upto 6 m | 14 days |
| Props to beams and arches spanning over 6 m | 21 days |

***Note 1:*** *For rapid hardening cement, 3/7 of the above periods will be sufficient in all cases, except for vertical sides of slabs, beams and columns which should be retained for atleast 24 hours.*

***Note 2:*** *In case of cantilever slabs and beams, the centring shall remain till structures for counteracting or bearing down have been erected and have attained sufficient strength.*

***Note 3:*** *Proper precautions should be taken to allow for the decrease in the rate of hardening that occurs with all cements in cold weather.*

***Note 4:*** *Work damaged through premature or careless removal of forms shall be reconstructed.*

**Measurements**: Where it is stipulated that the formwork shall be paid for separately, measurement shall be taken of the area of shuttering in contact with the concrete surface. Dimensions of formwork shall be measured correct to 10mm. The measurements shall be taken separately under each of the items mentioned above.

Centring and shuttering where exceeding 3.5 metres height in one floor shall be measured and paid for separately.

Where it is not specifically stated in the description of the item that formwork shall be paid for separately, the rate of the R.C.C. item shall be deemed to include the cost of formwork.

No deductions from the shuttering due to the openings/ obstructions shall be made if area of such openings/obstructions does not exceed 0.1sq.m. Nothing extra shall be paid for forming such openings.

**Rate:** The rate of formwork includes the cost of labour, materials tools and plant required for all the operations described in this section including properly supporting the members until the concrete is cured, set and hardened as required. No separate payment shall be made for items such as form release agent, connections, provisions for openings and other items required for the completion of the work unless specified otherwise.

### 5.8.8 Expansion Joints

- *Providing & filling or fixing in position in expansion joints*

*RC0105 Blown bitumen*

The joints shall be thoroughly dry-cleaned and blown bitumen shall be treated as necessary and filled in the joints.

**Measurement:** Measurement shall be taken in cubic metres.

**Rate:** Rate shall include all material and labour involved in all operations described in the nomenclature of item.

- *Providing & filling or fixing in position in expansion joints*

*RC0106 bitumen mix filler of proportion 80 kg of hot bitumen, 1 kg of cement and 0.25 cu.m of sand for expansion joint*

The expansion joints shall be well cleaned and dry. Bitumen shall be heated as necessary and mixed with cement and sand in the specified proportion until a uniform mix is obtained. This is filled in the joints taking care to fill in properly.

**Measurement:** Measurement shall be taken in cubic metres.

**Rate:** Rate shall include all material and labour involved in all operations described in the nomenclature of item.

- *Providing & filling or fixing in position in expansion joints*

*RC0107 12 mm bitumen impregnated fibreboard*

The expansion joints are thoroughly cleaned and dry. A coat of bitumen primer is applied and the bitumen impregnated board of correct dimensions inserted. The joint is sealed with a sealing compound to a depth of about 25mm.

**Measurement**: The depth of the joints including the sealing and the length of the joint shall be measured in metres.

**Rate:** Rate shall include all material and labour involved in all operations described in the nomenclature of item.

- *Providing and fixing sheet-covering over expansion joints with iron screws as per design to match the colour shade of the distemper or wall treatment*

*RC0116 Aluminium fluted strip 3.15x150mm*

The covering, as specified shall be fixed over the expansion joints with rawl plugs and screws.

**Measurement:** The finished work will be measured in metres.

**Rate:** Rate shall include all material and labour involved in all operations described in the nomenclature of item.

### 5.8.9 Design Mix Concrete

*Providing & laying in position machine batched, machine mixed and machine vibrated M-30 design mix cement concrete for reinforced cement concrete structural elements, excluding the cost of centering, shuttering and reinforcement, including admixtures in recommended proportions (as per IS 9103) to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per the direction of the engineer. The mix design shall be carried out at site by a qualified engineer as per IS code 10262:2019.*

*RC0160 All work upto plinth level*

*RC0161 All work above plinth level.*

*Providing & laying in position machine batched, machine mixed and machine vibrated M-35 design mix cement concrete for reinforced cement concrete structural elements, excluding the cost of centering, shuttering and reinforcement, including admixtures in recommended proportions (as per IS 9103) to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per the direction of the engineer. The mix design shall be carried out at site by a qualified engineer as per IS code 10262:2019.*

*RC0166 All work upto plinth level*

*RC0167 All work above plinth level.*

*Providing & laying in position machine batched, machine mixed and machine vibrated M-40 design mix cement concrete for reinforced cement concrete structural elements, excluding the cost of centering, shuttering and reinforcement, including admixtures in recommended proportions (as per IS 9103) to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per the direction of the engineer. The mix design shall be carried out at site by a qualified engineer as per IS code 10262:2019.*

*RC0170 All work upto plinth level*

*RC0171 All work above plinth level.*

*Providing & laying in position machine batched, machine mixed and machine vibrated M-45 design mix cement concrete for reinforced cement concrete structural elements, excluding the cost of centering, shuttering and reinforcement, Including admixtures in recommended proportions (as per IS 9103) to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per the direction of the engineer. The mix design shall be carried out at site by a qualified engineer as per IS code 10262:2019.*

*RC0175 All work upto plinth level*

*RC0176 All work above plinth level .*

***5.8.9.1 General***

Design Mix Concrete is that concrete in which the design of the mix, i.e determination of proportions of cement, aggregate & water is arrived as to have target mean strength for specified grade of concrete. The minimum mix of M25 shall be used in all structural elements in both load bearing & RCC framed construction.

Mix design and proportioning - Mix design shall be done by an expert or a concrete technologist. Mix proportions shall be designed to ensure that the workability of fresh concrete is suitable for conditions of handling and placing, so that after compaction it surrounds all reinforcements and completely fills the formwork. When concrete is hardened, it shall have the stipulated strength, durability and impermeability.

Determination of the proportions by weight of cement, aggregates and water shall be based on the design of the mix. As a trial the manufacturer of concrete may prepare a preliminary mix according to provisions of SP: 23-1982. Reference may also be made to ACI 211.1-77 for guidance.

Mix design shall be tried and the mix proportions checked on the basis of tests conducted at a recognized laboratory approved by the Engineer. All concrete proportions for various grades of concrete shall be designed separately and the mix proportions established keeping in view the workability for various structural elements, methods of placing and compacting.

Standard Deviation - Standard deviation calculations of test results based on tests conducted on the same mix design for a particular grade designation shall be done in accordance with clause 9.2.4 of IS 456.

Acceptance Criteria and samples for testing - as per IS 456 :2000

Concrete of each grade shall be assessed separately.

Concrete is liable to be rejected if it is porous or honey-combed, its placing has been interrupted without providing a proper construction joint, the reinforcement has been displaced beyond the tolerances specified, or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer

***5.8.9.2 Cement Content of Concrete***

For all grades of concrete manufactured/produced, minimum cement content in the concrete shall be 310 kg per cubic metre of concrete. Also, irrespective of the grade of

concrete, the maximum cement content shall not be more than 500 kg per cubic metre of concrete. These limitations shall apply for all types of cements of all strengths.

Actual cement content in each grade of concrete for various conditions of variables shall be established by design mixes within the limits specified above.

***5.8.9.3 Water cement ratio and slump***

In proportioning a particular mix, the manufacturer/producer/contractor shall give due consideration to the moisture content in the aggregates, and the mix shall be so designed as to restrict the maximum free water cement ratio to less than 0.5.

Due consideration shall be given to the workability of the concrete thus produced. Slump shall be controlled on the basis of placement in different situations. For normal methods of placing concrete, maximum slump shall be restricted to 100 mm when measured in accordance with IS : 1199.

***5.8.9.4 Approval of Design Mix***

The producer/manufacturer/contractor of concrete shall submit details of each trial mix of each grade of concrete designed for various workability conditions to the Engineer for his comments and approval. Concrete of any particular design mix and grade shall be produced/manufactured for works only on obtaining written approval of the Engineer.

For any change in quality/quantity in the ingredients of a particular concrete, for which mix has been designed earlier and approved by the Engineer-in-Charge, the mix has to be redesigned and approval obtained again.

**Measurement:** The length, breadth and thickness shall be measured correct 10mm. and the cubical contents calculated correct to 0.01cu.m.

Pre-cast reinforced cement concrete shall be measured separately and shall include use of moulds, finishing the faces and hoisting and setting in position in cement mortar 1:3 (1 cement: 3 sand). Plain and moulded work shall be measured separately and the work shall be classified and measured separately in cubical contents. Reinforcement shall be measured separately.

**Rate:** The rate is inclusive of cost of labour and materials involved in all the operations described above except reinforcement, which shall be paid for separately.

# 5.9 Chapter 9: BRICK WORK

### 5.9.1 General

Bricks required for brick work in cement mortar shall be adequately soaked in stacks, before use, by profusely spraying with clean water at regular intervals for a period of not less than six hours so as to keep them wet to the satisfaction of the Engineer. Bricks required for masonry with mud mortar need not be soaked.

Brickwork shall be laid in English bond unless otherwise specified. For brick work in a half brick wall, bricks shall be laid in stretcher bonds. Half or cut bricks shall not be used; except where necessary to complete the bond. Closures, in such cases, shall be cut to the required size and used near the ends of the walls.

In exposed brickwork, selected bricks shall be used for the face work.

A layer of mortar shall be spread on full width over a suitable length of the lower course. Each brick shall be properly bedded and set home (in position) by gently tapping with a handle of trowel or wooden mallet. Its inside faces shall be buttered with mortar before the next brick is laid and pressed against it. On the completion of course, all vertical joints shall be fully filled from the top with mortar.

The walls shall be taken up truly plumb. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in alternate courses shall come directly one over the other.

Thickness of brick courses shall be kept uniform and for this purpose wooden straight edge with graduations indicating thickness of each course including joint shall be used. The height of windowsills, bottom of lintels and other such important points in the height of the wall shall be marked on the graduated straight edge.

Both the faces of walls of thickness more than one brick length shall be kept in proper plane. All connected brickwork shall be carried up simultaneously and no portion of work shall be left more than one metre below the rest of the work. Where this is not possible, in the opinion of the Engineer, the work shall be raked back according to bond (and not toothed) at an angle not steeper than 45 degree. The work done per day should not be more than one metre height.

All iron fixtures, pipes, outlets of water, hold fasts of doors and windows, which are required to be built into the walls shall be embedded in mortar or cement concrete as specified in their correct position, as directed by the Engineer, as the work proceeds.

The flue of the chimney shall be plastered with mud and cow dung mortar (3 mud: 1 cow dung) as the work proceeds. Nothing extra shall be paid for this 'pargeting'.

**Joints:** Brick shall be so laid that all joints are full of mortar. The thickness of joints shall not exceed 10mm. All face joints shall be raked to a minimum depth of 15mm by raking tool during the progress of work when the mortar is still green so as to provide proper key for the plaster or pointing to be done. Where plastering or pointing is not required to be done the joints shall be struck flush and finished at the time of laying.

The face of brickwork shall be cleaned on the same day on which brickwork is laid and all mortar dropping removed promptly.

**Curing:** Brickwork shall be protected from rain by suitable covering when the mortar is green. Masonry work in cement mortar shall be kept constantly moist on all faces for a minimum period of seven days. Brickwork carried out during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

**Scaffolding:** For all exposed brickwork, double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

For all other brickwork in buildings, single scaffolding shall be permitted. In such cases, the inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not be allowed in pillars/columns less than one metre in width, or immediately near the skewbacks of arches. The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering.

Note: In case of a special type of brickwork, scaffolding shall be approved from the Engineer in advance. Brickwork shall be protected from rain by suitable covering when the mortar is green. Masonry work in cement mortar shall be kept constantly moist on all faces for a minimum period of seven days. Brickwork carried out during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

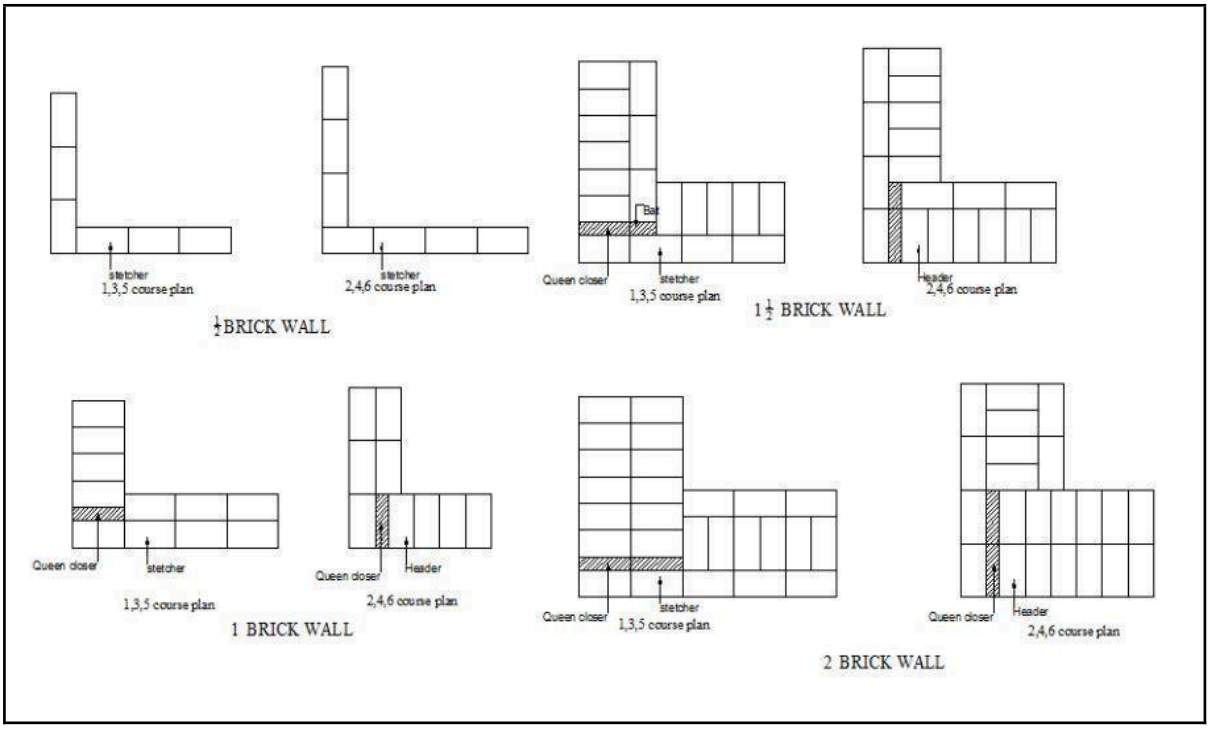



**Figure 5.9.1:** English Bond

### 5.9.2 Brick Masonry

#### *5.9.2.1 Concrete Block*

**Concrete block**

The concrete block should confirm to IS 2185: part 1

**Storage and Handling of Materials**

The blocks should be handled with care in transport as these are liable to get broken and damaged due to jolts and mishandling. These are to be stored at the site in such a way that they may not be able to absorb moisture from any source. These shall, therefore, be stacked on planks or such other supports and in inclement weather protected from rain.

**Wetting before Use**

In humid weather, blocks should not be wetted before lying. If the weather is dry (humidity below 50 percent), the bottom, top, and sides of blocks may be slightly moistened. Excessive wetting of blocks before use in masonry is likely to result in extensive shrinkage cracks.

**Mortar for Concrete Masonry Wall**

Mortar shall be composed of cement, lime and sand, unless otherwise specified. All lime other than dry hydrated lime shall be fully slaked. Concrete blocks shall be embedded with a mortar which is relatively weaker than the mix used for making blocks in order to avoid the formation cracks. A rich or strong mortar tends to make a wall too rigid thus localizing the effects of minor movements due to temperature and moisture variations resulting in cracking of the blocks. The recommended proportions of mortar measured by volume are given in Table 5.9.1 (as per IS 2572).

**Table 5.9.1** Mix Proportions of Mortar for Hollow and Solid Concrete Block Masonry

| | | **Normal Masonry without Reinforcement** | | | **Masonry with Reinforcement** | |
|---|---|---|---|---|---|---|
| **Sl. No.** | **Type of Work** | Cement | Lime | Sand | Cement | Sand |
| (i) | Normal Work | 1 | 1 | 9 – 10 | 1 | 7 – 8 |
| (ii) | When exposed to severe conditions or where the intensity of load is high, such as in foundations, pilasters, or portions of wall directly below heavily loaded lintels and beams | 1 | 1 | 6 – 7 | 1 | 4 – 5 |
| (iii) | Partitions of 100 mm nominal thickness | 1 | 1 | 7 – 8 | 1 | 5 – 6 |

Note: Alternative sand proportions are given for the mortar mixes in the table so that where the sand is well graded between the maximum and minimum particle sizes as per IS 2116 and IS 383 the higher figure should be adopted, but where the sand is not graded and is rather fine, the lower sand content should be used.

**Concrete block masonry work in foundation and basement**

For single storied houses, the hollow of blocks in the foundation and basement masonry shall be filled up with sand and only the top foundation course shall be of solid blocks. But for two or more storied houses generally solid concrete blocks should preferably be used in foundation courses, plinth, and basement walls. If hollow blocks are used, their hollows must be filled up with concrete comprising one part of cement, three parts of sand and six parts of gravel or crushed stone of 5 to 20 mm size. In special cases, the hollows may be left unfilled if so, approved by the appropriate authority.

In damp soils to prevent the rise of moisture from the ground due to capillary action, the foundation and basement masonry shall be laid in richer mortar (Table 5.9.1). In addition, a damp-proof course shall be provided which may consist of a 25 mm layer of 1: 2 cement mortars, or an approved type of bituminous course.

**Concrete block masonry in superstructure**

Hollow concrete block masonry in superstructure shall be laid in composite mortar comprising one part of cement, one part of lime and nine to ten parts of sand depending upon the grading of sand (Table 5.9.1). A lesser proportion of sand should be adopted if the sand to be used is either not properly graded or is rather fine.

**Horizontal (Bedding Joints)**

Mortar shall be spread over the entire top surface of the block including front and rear shells as well as the webs to a uniform layer of one centimeter thickness. Normally full mortar bedding shall be adopted as it enables fuller utilization of the load carrying capacity of the blocks. But where the walls carry light loads, such as panel walls, in a framed structure 'face shell' bedding may be used. In this type of bedding the mortar is spread only over the front and rear shells and not on the webs, which helps to arrest the seepage of water through the joints penetrating to the interior surface of the walls.

**Vertical (Cross) Joints**

For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed on the wall or to the next unit to be laid alongside it. But it will be more convenient to apply mortar on the edges of the succeeding unit when it is standing vertically and then placing it horizontally well-pressed against the previously laid unit. However, whatever the method used for applying mortar, care must be taken to produce well-compacted vertical joints.

In the case of two cell blocks, there is a slight depression on their vertical sides, which may also be filled up with mortar where it is considered necessary to secure greater lateral rigidity.

Mortar shall not be spread so much ahead of the actual laying of the units that it tends to stiffen and lose its plasticity, thereby resulting in poor bond. For most of the work, the joints, both horizontal and vertical, shall be 1cm thick. The mortar shall be raked out from the joint with a trowel to a depth of about 1 cm as each course is laid so as to ensure good bond for the plaster.

When the mortar has stiffened somewhat, it shall be firmly compacted with a jointing tool. This compaction is important, since mortar, while hardening, has a tendency to shrink slightly and thus pull away from the edges of the block. The mortar shall be pressed against

the units with a jointing tool after the mortar has stiffened to effect intimate contact between the mortar and the masonry unit and obtain a weather-tight joint.

It may be necessary to add mortar, particularly to the vertical joints to ensure that they are well-filled.

**Post construction cracks**

To mitigate post-construction cracks, reinforced cement concrete bands (RCC) should be provided with vertical bands spaced at 1.5m intervals and horizontal bands spaced at 1m intervals, if the wall span exceeds 3m.

#### *5.9.2.2 One Brick Masonry*

- *Providing & laying Brick work in Foundation & Plinth*

*BW0001* *In cement mortar 1:3*

*BW0002* *In cement mortar 1:4*

*BW0003* *In cement mortar 1:5*

*BW0004* *In cement mortar 1:6*

*BW0005* *In mud mortar*

- *Providing & laying ICEB (300mmX150mmX100mm) in Foundation & Plinth*

*BW0060* *In cement mortar 1:3*

*BW0061* *In cement mortar 1:4*

*BW0062* *In cement mortar 1:5*

*BW0063* *In cement mortar 1:6*

*BW0064* *In mud mortar*

- *Providing & laying ICEB (250mmX125mmX100mm) in Foundation & Plinth*

*BW0100* *In cement mortar 1:3*

*BW0101* *In cement mortar 1:4*

*BW0102* *In cement mortar 1:5*

*BW0103* *In cement mortar 1:6*

*BW0104* *In mud mortar*

- *Providing & laying locally manufactured concrete block brick in Foundation & Plinth*

*BW0140* *In cement mortar 1:3*

*BW0141* *In cement mortar 1:4*

*BW0142* *In cement mortar 1:5*

*BW0143* *In cement mortar 1:6*

- *Providing & laying locally manufactured concrete block brick in Foundation & Plinth*

*BW0145* *In cement mortar 1:3*

*BW0146 In cement mortar 1:4*

*BW0147 In cement mortar 1:5*

*BW0148 In cement mortar 1:6*

- *Providing & laying locally manufactured concrete block brick in Foundation & Plinth*

*BW0150 In cement mortar 1:3*

*BW0151 In cement mortar 1:4*

*BW0152 In cement mortar 1:5*

*BW0153 In cement mortar 1:6*

***5.9.2.3 AAC Blocks***

*BW0240 Providing and laying locally manufactured autoclaved aerated cement blocks masonry with 150mm/ 230mm/300 mm thick AAC blocks in super structure above plinth level up to floor V level with RCC band at sill level and lintel level with approved block laying polymer modified adhesive mortar all complete as per direction of Engineer-in-Charge. (The payment of RCC band and reinforcement shall be made separately).*

**Measurement**: Unless otherwise specified, all work shall be measured net as fixed in its proper position. Any extra work done by the contractor over the specified dimensions shall be ignored. Dimensions shall be measured correct to 10mm. Areas shall be worked out in sq.m correct to two places of decimal. Cubic contents shall be worked out in cu.m correct to two places of decimal.

Neither any deduction made nor any extra payment shall be made for the following:

a) Ends of dissimilar materials (i.e. joists, beams, posts, girders, rafters, purlins, trusses, steps etc.) each 500 sq.cm in section.

b) Opening each up to 0.1 sq.m. In calculating the area of the openings any separate lintels or sills shall be included along with the size of the openings but the end portions of the lintels shall be excluded and the extra width of the rebated reveals, if any, shall also be excluded.

c) Wall plates and bed plates, bearing of slabs, chajjas and the like, where the thickness does not exceed 10 cm and the bearing does not extend over the full thickness of the walls.

d) Drainage holes, and recesses for cement concrete blocks to embed holdfasts for doors, windows etc.

e) Necessary holes etc. for iron fixtures, pipes up to 300 mm dia.

f) Forming chases in masonry each up to a section of 350 sq.cm.

The work shall be measured separately under the following categories:

a) From foundation to floor 1 level (plinth level);

b) From floor 1 level to floor 2 level;

c) From floor 2 level to floor 3 level and so on;

d) Brickwork in parapet walls shall be measured along with the corresponding masonry in the walls of the storey just below it.

Corbels, string courses, projecting pilasters, aprons, sills, cornices, over-sailing courses and other projections etc. or splayed bull nosed or any other type of projection with made or cut bricks shall be fully described and measured separately in running metres stating dimensions of each projections.

Walls of half brick thickness or less shall each be measured separately and shall be given in square metres stating the wall thickness.

Brick wall beyond half brick up to and including three bricks in thickness shall be measured in multiples of half brick, which shall be deemed to be inclusive of mortar joints.

Where fractions of half bricks occur due to architectural or other reasons, the work shall be measured as follows:

a) If, as per drawings, the use of fraction of half bricks is required, the measurements shall be made for half brick.

b) If the thickness of the wall is required to be increased up to 20 mm beyond the structural thickness of half brick multiples the same shall be made up in mortar and paid for the specified thickness.

For walls beyond three brick thickness, actual thickness shall be measured.

Brick work in backing to stone or other type of facing shall be measured separately. The description shall include all cutting and wastage for bonding.

Masonry (excluding fire brick work) in chimney breasts, chimney stacks, smoke or air flues up to 0.25 sq.m sectional area, shall be measured as solid and no extra payment shall be made for pargeting and coring such flues. Where flues exceed 0.25 sq.m in sectional area, deduction shall be made for the same and pargeting and coring flues paid for separately.

Apertures for fireplaces shall not be deducted and extra labour shall not be measured for paying of jambs, throating and making arch to support the openings.

Square or Rectangular Pillars shall be measured as walls but extra payment shall be allowed for brick work in square or rectangular pillars over the rate for brick work in walls.

Circular Pillars shall be measured net as per actual dimensions, but extra payment shall be allowed for brickwork in circular pillars over the rate for brickwork in walls. Diameter as well as height shall be measured correct to 10 mm.

Tapered Walls shall be measured net as per actual dimensions, but extra payment shall be allowed for making tapered surface of brick masonry walls. The width as well as length and height shall be measured correct to 10mm.

Brickwork curved on plan to a mean radius exceeding 6 m shall be measured net and included with general brickwork. Brickwork circular on plan to a mean radius not exceeding 6 m shall be measured separately and shall include all cutting and waste and template. It shall be measured as the mean length of the wall.

**Rate**: The rate shall include the cost of materials and labour required for all the operations described above. This shall include the following:

a) Brick-on-edge courses, cut brick corners, splays, reveals, cavity walls, brickwork curved on plan to a mean radius exceeding 6 metres.

b) Raking out joints for plastering or pointing done as a separate item or finishing joint flush as the work proceeds.

c) Preparing tops and sides of existing walls for raising and extending.

d) Rough cutting and waste for forming gables, cores, skewbacks and spandrels of arches, splays at eaves and all rough cutting, unless otherwise specified.

*BW0010 Extra, for brick work in square or rectangular pillars*

*BW0011 Extra, for brick in circular pillars*

*BW0012 Extra, for brick work in superstructure above plinth level, up to floor two level*

*BW0070 Extra for ICEB work in square or rectangular pillars*

*BW0071 Extra for ICEB work in superstructure above plinth level, up to floor two level*

*BW0110 Extra for ICEB work in square or rectangular pillars*

*BW0111 Extra for ICEB work in superstructure above plinth level, up to floor two level*

*BW0170 Extra for concrete block brick in square or rectangular pillars*

*BW0171 Extra for concrete block brick in circular pillars*

*BW0172 Extra for concrete block brick work in superstructure above plinth level, up to floor two level*

**Measurement:** Measurement shall be the same as for brick works in foundation and plinth.

**Rate**: Rate shall include all extra labour, scaffolding etc. required for work.

*BW0013 Extra, for brick work in superstructure above floor two level*

*BW0072 Extra for ICEB work in superstructure above floor two level...per floor*

*BW0090 Extra for ICEB work in superstructure above floor 2 level...per floor*

*BW0112 Extra for ICEB work in superstructure above floor two level...per floor*

*BW0130 Extra for ICEB work in superstructure above floor 2 level...per floor*

*BW0173 Extra for concrete block brick work in superstructure above floor two level...per floor*

*BW0220 Extra, for concrete block half-brick masonry in superstructure above floor 2 level...per floor*

**Measurement:** Measurement shall be the same as for brick works in foundation and plinth.

**Rate**: Rate shall include all extra labour and scaffolding required for brickwork above floor two level.

*BW0014 Extra, for providing hoop iron 25x1.6mm or equivalent reinforcement in masonry at every third course, embedded in cement mortar*

*BW0174 Extra, for providing hoop iron 25x1.6mm or equivalent reinforcement in masonry at every third course, embedded in cement mortar*

2 nos. of 6 mm dia bars may be used instead of 25 mm x 1.6 mm hoop iron. The reinforcement shall be cleared of rust and loose flakes removed with wire brush, before the reinforcement is laid. The reinforcement shall be quite straight in the mortar.

**Measurement**: The length of the reinforcement measured correct to 1 cm and the weight calculated in kg correct to two places of decimal, based on standard weights.

**Rate**: The rate shall include the materials and labour involved in all the operations.

*BW0015 Extra, for mixing water-proofing compound in cement mortar*

*BW0175 Extra, for mixing water-proofing compound in cement mortar*

*BW0221 Extra, for mixing water-proofing compound in cement mortar*

Water proofing materials shall be added in the cement mortar according to the specifications of the manufacturer.

**Measurement:** Cubical contents shall be worked out in cu.m correct to two places of decimal only for the volume where cement mortar is mixed with water proofing compound.

**Rate:** Rate shall include the water proofing materials required and the labour involved in mixing of water proofing compounds.

### 5.9.3 Half Brick Masonry

- *Providing & laying Half-brick Masonry (125 mm) in superstructure below floor 2 level*

*BW0020 In cement mortar 1:3*

*BW0021 In cement mortar 1:4*

*BW0030 Extra, for half-brick masonry in superstructure above floor 2 level*

*BW0032 75mm thick brick masonry in cement mortar 1:3 in partitions etc in superstructure below floor 2 level*

*BW0033 Extra, for 75mm brick masonry in cement mortar 1:3 in partitions etc in superstructure above floor 2 level*

- *Providing & laying ICEB (300mmX150mmX100mm) in superstructure below floor 2 level*

*BW0080 In cement mortar 1:3*

*BW0081 In cement mortar 1:4*

- *Providing & laying ICEB (250mmX125mmX100mm) in superstructure below floor 2 level*

*BW0120 In cement mortar 1:3*

*BW0121 In cement mortar 1:4*

- *Providing & laying locally manufactured Concrete Hollow block brick Masonry (190 mm) in superstructure below floor 2 level*

*BW0190 In cement mortar 1:3*

*BW0191 In cement mortar 1:4*

- *Providing & laying locally manufactured Concrete Partition Hollow Block Masonry (90 mm) in superstructure below floor 2 level*

*BW0194 In cement mortar 1:3*

*BW0195 In cement mortar 1:4*

- *Providing & laying locally manufactured Concrete Solid Block Masonry (115 mm) in superstructure below floor 2 level*

*BW0198 In cement mortar 1:3*

*BW0199 In cement mortar 1:4*

- *Providing & laying locally manufactured Concrete Porous Brick Masonry (110 mm) in superstructure below floor 2 level*

*BW0202 In cement mortar 1:3*

*BW0203 In cement mortar 1:4*

The specification shall be the same as explained above in general brick works. However, in special cases like half brick walls for water tanks and long length of half brick thick walls etc. where reinforcement is considered necessary from structural consideration, the same shall be provided at required intervals and the cost of reinforcement shall be paid for separately. It shall be ensured that the reinforcement is fully embedded in the mortar.

**Measurement**: The length and height of the wall shall be measured correct to a cm. The area shall be calculated correct to 0.01 sq.m. Where half brick wall is joined to the main walls of one brick or greater thickness, the measurements for half brick wall shall be taken for its clear length from the face of the thicker wall.

**Rate**: The rate includes the cost of materials and labour involved in all the operation described above, except reinforcement, which is to be paid for separately.

*BW0031 Extra, for mixing water-proofing compound in cement mortar*

**Water proofing materials**: Water proofing materials shall be added in the cement mortar according to the specifications of the manufacturer.

**Measurement**: The length and height of the wall shall be measured correct to a cm. The area shall be calculated correct to 0.01 sq.m only for the area where cement mortar is mixed with water proofing compound.

**Rate**: Rate shall include the water proofing materials required and the labour involved in mixing of water proofing compound.

### 5.9.4 Brick Cornices

- *Providing & laying brick work in Bhutan type Traditional Cornices in cement mortar 1:3, including 12mm plaster in cement mortar 1:5, but excluding decorative painting. (Measurement to be taken along the cornice and wall junction)*

*BW0040 Floor two level*

*BW0041 Other Floor levels above floor two level*

The cornice at each floor level shall conform in all respects to the approved design and made as per the direction of the Engineer. The plastered brickwork shall conform to the dimensions and shape of the approved design. Care must be taken to maintain proper line and level.

**Measurement**: Measurement shall be taken of the cornice at each floor level along the line of junction of cornice and wall in running length correct to 10mm.

**Rate**: The rate shall include all work described in the item including materials and labour.

***Note**: Phana / Chhechukhanim is not recommended to install with brickwork (not advisable in seismic prone areas)*

### 5.9.5 Pointing on Brick Masonry

- *Pointing on brickwork with cement mortar 1:3*

*BW0050* *Flush pointing*

*BW0051* *Ruled pointing*

*BW0052* *Cut, weather struck pointing*

*BW0053* *Raised & cut pointing*

*BW0230* *Flush pointing*

*BW0231* *Ruled pointing*

*BW0232* *Cut, weather struck pointing*

*BW0233* *Raised & cut pointing*

**Preparation of Surface**: The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before pointing is commenced.

The joints shall be raked to such a depth that the minimum depth of the new mortar measured from either the sunk surface of the finished pointing or from the edge of the brick shall not be less than 12 mm.

**Mortar:** Mortar of specified mix shall be used.

**Application and Finishing**: The mortar shall be pressed into the raked out joints, with a pointing trowel, either flush, sunk or raised, according to the type of pointing required. The mortar shall not spread over the corner, edges or surface of the masonry. The pointing shall be then finished with the proper tool, in the manner described below:

**Flush Pointing:** The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks, tiles or stones so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and straight edge.

**Ruled Pointing**: The joints shall be initially formed as for flush pointing and then while the mortar is still green, a groove of shape and size as shown in drawings or as instructed, shall be formed by running a forming tool, straight along the centre line of the joints. This operation shall be continued until a smooth and hard surface is obtained. The vertical joints shall also be finished in a similar way. The vertical lines shall make true right angles at their junctions with the horizontal lines and shall not project beyond the same.

**Cut or Weather Struck Pointing**: The mortar shall first be pressed into the joints. The top of the horizontal joints shall then be neatly pressed back about 3 mm or as directed, with the pointing tool so that the joints are sloping from top to bottom. The vertical joints shall be rule pointed. The junctions of vertical joints with the horizontal joints shall be at true right angles.

**Raised and Cut Pointing**: Raised and cut pointing shall project from the wall facing with its edges cut parallel so as to have uniformly raised band about 6 mm raised and width 10 mm or more as directed.

The superfluous mortar shall then be cut off from the edges of the lines and the surface of the masonry shall also be cleaned off all mortar. The finish shall be such that the pointing is to the exact size and shape stipulated and the edges are straight, neat and clean.

**Curing**: The pointing shall be kept wet for seven days. During this period it shall be suitably protected from all damages.

The pointing lines shall be truly horizontal and vertical except where the joints are slanting as in random rubble masonry. Lines of joints from different directions should meet neatly at the junctions instead of crossing beyond.

**Measurement:** Length and breadth shall be measured correctly to 10mm and its area shall be calculated in square metre up to two places of decimals. Each type of pointing shall be measured separately.

Deductions and additions shall be made in the following way, in case of pointing on the external face only.

a) No deduction shall be made for ends of joists, beams, posts etc. and openings not exceeding 0.5 sq.m each, and no addition shall be made for reveals, jambs, soffits, sills, etc. of these openings.

b) Deductions for openings exceeding 0.5 sq.m but not exceeding 3 sq.m each shall be made as follows and no additions shall be made for reveals, jambs, soffits, sills etc. for these openings.

    i) When both the faces of the wall are pointed with the same pointing deduction shall be made for one face only.

    ii) When two faces of a wall are pointed with different pointing or if one face is plastered and other is pointed, deduction shall be made from the plaster or pointing on the side of frame for doors, windows, etc. on which the width of the reveal is less than that on the other side, but no deduction shall be made from the other side.

    iii) Where width of reveals on both faces of wall are equal, deduction of 50% of area of opening on each face shall be made from area of pointing or plaster as the case may.

    iv) For an opening having a doorframe equal to or projecting beyond thickness of wall, full deduction for opening shall be made from each pointed face of wall.

c) In case of openings of area above 3 sq.m each, deduction shall be made for the openings, but jambs, soffits and sills shall be measured.

The following shall be measured separately.

a) Raking out joints for old work only shall be measured and given in square metres.

b) Raking out joints of old work built in mud mortar, lime mortar and cement mortar shall each be measured separately.

c) Raking single detached joints as for flashing old work shall be given in running metres.

**Rate:** The rate shall include the cost of all materials and labour involved in all the operations for pointing as described above.

# 5.10 Chapter 10: STONE/MUD MASONRY

### 5.10.1 General

All stones shall be wetted before use. Masonry shall be laid truly in plumb or to required batter where so specified. Height of construction in a day shall not exceed 1m so as to avoid excess load on fresh mortar.

There are three main varieties of stone masonry in common use namely random rubble, coursed rubble and ashlars.

### 5.10.2 Rammed Mud walls

*SM0001 Constructing rammed mud walls in superstructure*

Only selected dry earth shall be taken or as approved by the Engineer. It should be free from any organic matters, grits, stones chips/boulder, etc unless approved otherwise. Normally, the earth from the same area shall be used. All clods of earth shall be broken or removed before laying.

The earth shall be laid in layers not exceeding 50 mm in each layer. It shall then be rammed with wooden planks or iron rammers if feasible. The density to be achieved shall not be less than that obtained in the laboratory.

**Measurement:** Measurement shall be the same as for random rubble masonry works.

**Rate**: The rate shall include all labour and materials involved in the work.

### 5.10.3 Random Rubble Masonry

- *Providing & laying Random Rubble Masonry with hard stone in foundation & plinth*

*SM0005 In cement mortar 1:4*

*SM0006 In cement mortar 1:5*

*SM0007 In cement mortar 1:6*

*SM0008 Hammer dressed, in mud mortar*

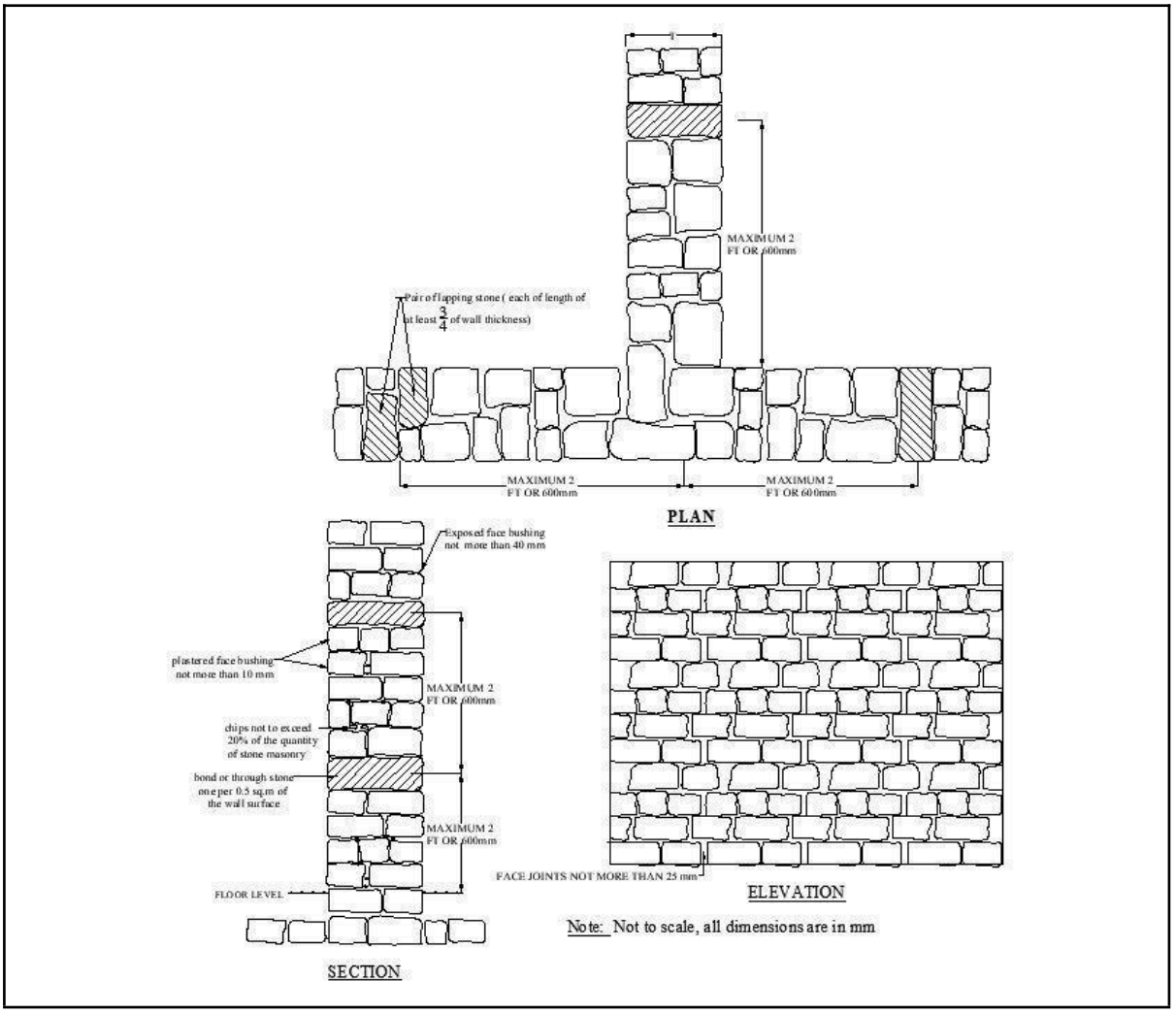
*SM0017 Extra for random rubble masonry work with hard stone in square or rectangular pillars*

*SM0018 Extra for random rubble masonry work with hard stone in circular pillars*

**Dressing:** Stones shall be hammer dressed, on the face, the sides and the beds, to enable it to come into close proximity with the neighbouring stone. The bushing in the face shall not project more than 4 cm in an exposed face, and one cm on a face to be plastered. The hammer dressed stone shall have a rough tooling for a minimum width of 2.5 cm along the four edges of the face of stone.

**Laying**: Every stone shall be carefully fitted to the adjacent stones, so as to form neat and close joints. Stones may be brought to level courses at plinth, windowsills and roof level. Levelling up at plinth level, window sills and roof level shall be done with concrete comprising of one part of the mortar as used for the masonry and two parts of graded stone aggregate of 20mm nominal size and shall be-included in the items. The bond shall be obtained by fitting in closely, the adjacent stones and by using bond-stones. Face stones

shall extend and bond well into the backing. These shall be arranged to-break joints as much as possible, and to avoid long vertical lines of joints.




**5.10.1** Random Rubble Masonry

The hearting or interior filling of the wall shall consist of rubble stones, which may be of any-shape but shall not pass through a circular ring of 15 cm inner diameter; thickness of these stones in any direction shall not be less than 10 cm. These shall be carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar, chips and spalls of stone being used wherever necessary to avoid thick mortar beds or joints and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The hearting will be laid nearly level with facing and backing, except that at about one metre intervals, vertical 'Plumb' projecting about 15 cm to 20 cm shall be firmly embedded to form a bond between successive courses.

The chips shall not be used below the hearting stone to bring these upto the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting, and then shall not exceed 20% of the quantity of stone masonry. The masonry in a structure shall be carried regularly. Where the masonry of one part has to be delayed the work shall be raked back at an angle not steeper than 45 degree.

**Bond Stones**: Bond or through stones running right through the thickness of walls, shall be provided in walls upto 60 cm thick and in case of walls above 60 cm thickness, a set of two or more bond stones overlapping each other by at least 15 cm shall be provided in a line from face to back.

In case of highly absorbent types of stones (porous lime stone and sand stone etc.) the-bond stone shall extend about two- third into the wall. Through stones in such cases may give rise-to-damp penetrations therefore, for all thickness of such walls, a set of two or more bond stones overlapping-each other by at least 15 cm shall be provided. Where bond stones of suitable lengths are not available cement concrete blocks of 1:3:6 mix (1 cement: 3 coarse sand: 6 graded stone aggregate 20 mm nominal size) conforming to sizes mentioned above shall be used.

At least one bond stone or a set of bond stones shall be provided for every 0.5 sq.m of the wall surface. All bond stones in stone masonry shall be marked suitably as directed by the Engineer-in-charge.

**Quoins or corner stone**: The quoins shall be of selected stones neatly dressed with the hammer and / or chisel to form the required angle, and laid header and stretcher alternately. The length of these stones shall be 45cm or more and at least 25% of the stones shall be 50cm or more in length.

**Jambs:** Stones used in jambs shall be similar to those in quoin, excepting the length of the stem, which shall be 45cm, or thickness of the wall whichever is less.

**Joints**: Stones shall be so laid that all joints are fully packed with mortar and chips. Face joints shall not be thicker than 20 mm.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

**Scaffolding**: Single scaffolding having one set of vertical support shall be allowed. The supports shall be sound and string tied together by horizontal pieces, over which the scaffolding planks shall be fixed. The inner end of the horizontal scaffolding member may rest in a hole provided in the masonry. Such holes, however, shall not be allowed in pillars less than one metre in width or near the skew-back of arches. The holes left in masonry work for supporting scaffolding shall be filled and made good with cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 stone aggregate 20 mm nominal size).

**Curing**: Masonry work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat-lime mortar, curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

**Protection**: Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

**Measurement**: The length, height and thickness shall be measured correct to 10 mm. The thickness of the wall shall be measured at joints, excluding the bushings. Only specified dimensions shall be allowed; anything extra shall be ignored. The quantity shall be calculated in cubic metres nearest to two places of decimal.

The work under the following categories shall be measured separately:

(i) From foundation to plinth level.

(i) Work in or under water and/or liquid mud

(ii) Work in or under foul positions.

(ii) From plinth level to floor two level.

(iii) From floor two level to floor three level and so on.

(iv) Stone masonry in parapet shall be measured together with the corresponding item in the wall of the storey next below.

No deduction shall be made nor extra payment made for the following:

(a) Ends of dissimilar materials (that is joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps etc.) upto 0.1 sq.m in section.

(b) Openings each upto 0.1 sq.m in area. In calculating the area of opening, any separate lintels or sills shall be included along with the size of the openings but the end portions of the lintels shall be included and the extra width of rebated reveals, if any, shall also be excluded.

(c) Wall plates and bed plates, and bearing of chajjas and the like, where the thickness does not exceed 10 cm and the bearing does not extend over the full thickness of the wall.

***Note:*** *The bearing of floor and roof slabs shall be deducted from wall masonry.*

(d) Drain holes and recesses for cement concrete blocks, to embed holdfasts for doors, windows etc.

(e) Building in the masonry iron fixture, pipes upto 300 mm dia. hold fasts of doors and windows.

(f) Forming chases in masonry each upto section of 350sq.cm. Masonry (excluding fix brick work) in chimney breasts, chimney stacks, smoke or air flues upto 0.20 sq.m in sectional area, shall be measured as solid and no extra payment shall be made for pargetting and coring such flues. Where flues exceed 0.20sq.m sectional area, deduction shall be made for the same pargetting and coring flues paid for separately. Apertures for fireplaces shall not be deducted and extra labour shall not be measured for splaying of jambs throating and making arch to support the opening.

**Square or Rectangular Pillars**: These shall be measured as walls, but extra payment shall be allowed for stone work in square or rectangular pillars over the rate for stone work in walls. Rectangular pillar shall mean a detached masonry support rectangular in section, such that its breadth does not exceed three times the thickness.

**Circular Pillars (Columns)**: These shall be measured as per actual dimensions, but extra payment shall be allowed for stone work in circular pillars over the rate for stone work in walls. The diameter as well as length shall be measured correct to a cm. Tapered walls, shall be measured net, as per actual dimensions and paid for as other walls.

**Curved Masonry**: Stone masonry curved on plan to a mean radius exceeding 6 metres shall be measured net and included with general stonework. Stone work circular on plan to a mean radius not exceeding 6 metres shall be measured separately, and shall include all cuttings and waste and templates. It shall be measured as the mean length of the wall.

**Rate**: The rate shall include the cost of materials and labour required for all the operations described above and shall include the following:

(a) Raking out joints for plastering or pointing done as a separate item, or finishing flush as the work proceeds.

(b) Preparing tops and sides of existing walls, for raising and extending.

(c) Rough cutting and waste for forming gables, cores, skewbacks, and spandrels of arches, splays and eaves and all rough cutting unless or otherwise specified.

(d) Bond stones or cement bond blocks.

(e) Leaving and making holes for pipes etc.

(f) Bedding and pointing wall plates, lintels, sills etc. in or on walls, bedding roof tiles and corrugated sheets in or on walls.

(g) Building in ends of joints, beams, lintels, etc. and making good; and

(h) Openings and flues for which no deduction is made.

*SM0015 Extra for random rubble masonry with hard stone in superstructure above plinth, below & including floor 2 level*

*SM0016 Extra for random rubble masonry with hard stone in superstructure above floor 2 level*

**Measurement:** Measurement shall be the same as for random rubble masonry in foundation and plinth.

**Rate**: The rate shall include all additional labour and scaffolding required in the work

*SM0019 Extra for random rubble masonry work with hard stone for mixing water-proofing materials in cement mortar*

The waterproofing compound shall be mixed in the proportion and in the way as recommended by the manufacturers.

**Measurement:** Measurement shall be the same as for random rubble masonry in foundation and plinth but only for the volume where cement mortar is mixed with water proofing compound.

**Rate**: The rate shall include the cost of water proofing compound and labour involved in mixing the compound with cement mortar.

### 5.10.4 Coursed Rubble Masonry

- *Providing & laying Coursed Rubble Masonry with hard stone hammer-dressed in foundation & plinth*

*SM0025 In cement mortar 1:3*

*SM0026 In cement mortar 1:4*

*SM0027 In cement mortar 1:5*

*SM0028 In cement mortar 1:6*

**Dressing**: Face stones shall be hammer dressed on all beds and joints so as to give them approximately rectangular block shape. They shall be squared on all joints and beds. The bed joint shall be dressed for at least 8 cm back from the face and side joints for at least 4 cm such that no portion of the dressed surface is more than 10 mm from a straight edge placed on it. The remaining portion of the stone shall not project beyond the surface of bed and side joints. The bushing on the face shall not project more than 4 cm on exposed face and one cm on a face to be plastered. The hammer dressed stone shall also have a rough tooling for a minimum width of 2.5 cm along the four edges of the face of the stone.

**Laying:** All stones shall be wetted before use. The walls shall be carried up truly plumb or to specified batter. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. The height of each course shall not be less than 15 cm nor more than 30 cm. Face stones shall be laid alternate headers and stretchers. No pinning shall be allowed on the face. No face stone shall be less in breadth than its height and at least one third of the stone shall tail into the work for length not less than twice the height. The hearting or the interior filling of the wall shall consist of stones carefully laid on their proper beds and mortar; chips and sprawl of stone being used where necessary to avoid thick beds of joints of mortar and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The chips shall not be used below the hearting stones to bring these upto the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10% of the quantity of stone masonry.

The masonry in a structure shall be carried up regularly but where breaks are unavoidable, the joints shall be raked back at angles not steeper than 45 degree. Toothing shall not be allowed.

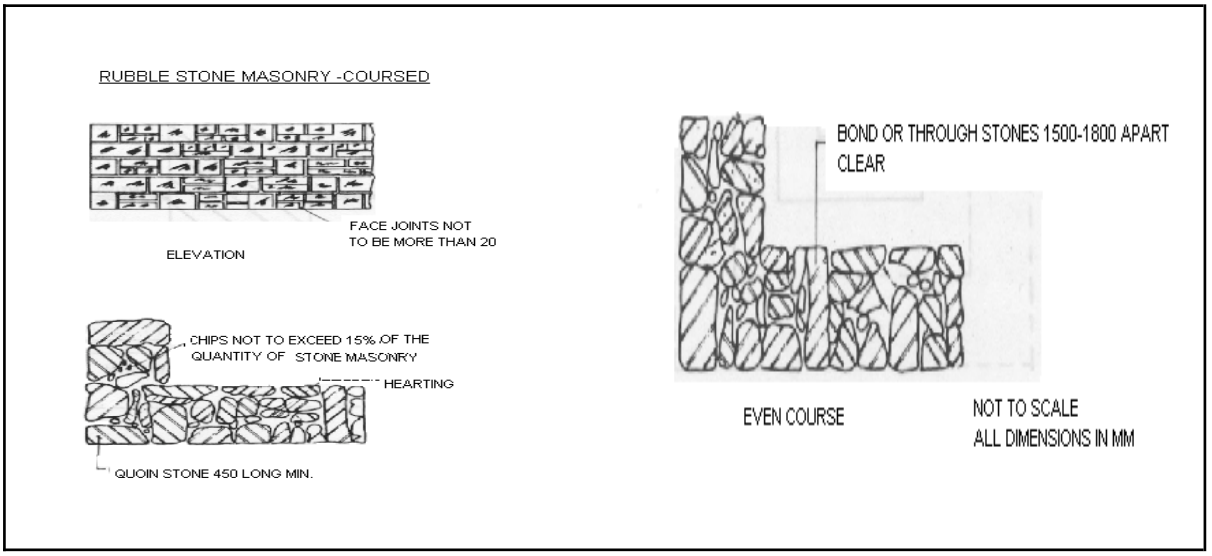



**Figure 5.10.2** Random Rubble Masonry

**Bond Stones**: Shall be as specified for random rubble masonry except that a bond stone or a set of bond stones shall be inserted 1.5 to 1.8 metres apart, in every course.

**Quoins:** The quoins shall be of the same height as the course in which they occur. These shall be at least 40 cm long and shall be laid stretchers and headers alternately. These shall be laid square on the beds, which shall be rough-chisel dressed to a depth of at least 10 cm.

In case of exposed work, these stones shall have a minimum of 2.5 cm wide chisel drafts at four edges, all the edges being in the same plane.

**Jambs:** Stones used in jambs shall be similar to those in quoin, except that minimum length of the stem, which shall be 40cm, or thickness of the wall whichever is less.

**Joints:** All bed joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar. The face joints shall not be more than 20mm thick. When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

**Curing**, **Scaffolding**, **Measurements** and **Rates** shall be as specified for random rubble masonry.

*SM0035 Extra, for C.R. masonry with hard stone in superstructure above plinth, below & including floor 2 level*

*SM0036 Extra, for C.R. masonry with hard stone in superstructure above floor 2 level*

*SM0037 Extra, for C.R masonry with hard stone in square or rectangular pillars*

*SM0038 Extra, for C.R masonry with hard stone in circular pillars*

*SM0039 Extra, for C.R masonry with hard stone chisel dressed in foundations and plinth*

*SM0040 Extra, for C.R masonry with hard stone chisel dressed in superstructure above plinth, below & including floor 2 level*

**Measurement:** Measurement shall be the same as for random rubble masonry works.

**Rate:** The rate shall include all additional labour and scaffolding involved in the work.

*SM0041 Extra, for C.R masonry with hard stone for mixing water-proofing materials*

**Measurement:** Measurement shall be the same as for random rubble masonry works but only for the volume where cement mortar is mixed with water proofing compound.

**Rate:** The rate shall include the cost of water proofing materials and additional labour for mixing in cement mortar.

### 5.10.5 Dry Hand Packed Rubble Masonry

*SM0050 Providing and laying dry hand packed rubble masonry with stone boulders of size exceeding 0.04 Cu.m*

Stones as obtained from the quarry shall be used without dressing. The size of the stones shall be such that each is not less than .04 cum.

Masonry courses shall be normal to-face batter. Each course shall be laid after spreading earth or stone dust. About half of the stone shall tail into the wall by twice their height, and their height shall not be less than 200 mm.

**Measurements:** The length, breadth and height shall be measured correct to 10 mm. and the volume calculated correct to 0.01 cum.

**Rate:** The rate shall include all materials and labour involved in all operation described above.

*SM0051 Dry hand packed rubble masonry hammer dressed (facing), with stone-boulder of size exceeding 0.04 Cu.m*

Specification shall be as specified for random rubble masonry except that the face stone shall be of hammer dressed.

**Measurements:** The length, breadth and height shall be measured correct to 10 mm. and the volume calculated correct to 0.01 cum.

**Rate:** The rate shall include all materials and labour involved in all operations described above.

*SM0052 Dry hand packed rubble masonry chisel dressed (facing) with stone-boulder of size exceeding 0.04 Cu.m*

Specification for this work shall be as specified for RRM except that the face stone shall be hammer dressed.

**Measurements:** The length, breadth and height shall be measured correct to 10 mm. and the volume calculated correct to 0.01 cum.

**Rate:** The rate shall include the materials and labour involved in all operations described above.

**5.10.6 Stone Masonry in Concrete Mortar**

*SM0060 Providing and laying with hard stone (average volume 0.008 Cu.m) hand packed stone masonry in cement concrete mortar 1:2:4, 20mm aggregate*

*SM0061 Providing & laying with hard stone (average volume 0.008 Cu.m) hand packed stone masonry in cement concrete mortar 1:3:6, 20mm aggregate*

Specification shall be as specified for random rubble masonry except that for bedding each course of stones instead of spreading earth or stone dust, cement concrete of specified mix shall be used to fill up all voids in the course already laid and to provide proper bedding to the course to be laid.

**Measurements:** The length, breadth and height shall be measured correct to 10 mm. and the volume calculated correct to 0.01 cum.

**Rate:** The rate shall include the materials and labour involved in all operations described above.

*SM0062 Providing and laying hammer dressed stone masonry with hard stone (average volume 0.008 Cu.m) in cement concrete mortar 1:2:4 20mm aggregate*

*SM0063 Providing and laying hammer dressed stone masonry with hard stone (average volume 0.008 Cu.m) in concrete mortar 1:3:6 20mm aggregate*

*SM0064 Providing and laying rubble masonry chisel dressed (facing) with hard stone (average volume 0.008 cu.m) in concrete mortar 1:2:4 20mm aggregate*

*SM0065 Providing and laying rubble masonry chisel dressed (facing) with hard stone (average volume 0.008 cu.m) in concrete mortar 1:3:6 20mm aggregate*

The stones shall be hammer/ Chisel dressed as required so as to get fairly rectangular faces on all sides. The joints shall be as thin as possible.

**Measurements:** The length, breadth and height shall be measured correct to 10 mm. and the volume calculated correct to 0.01 cum.

**Rate:** The rate shall include the materials and labour involved in all operations described above.

**5.10.7 Stone Soling, Filling & Edging**

*SM0070 Providing and laying Hammer dressed dry stone soling*

*SM0071 Providing and laying Chisel dressed dry stone soling*

*SM0072 Providing and laying Hand packed stone filling or soling with stones*

Stones as obtained from the quarry shall be packed with their broader surface as base. The packing shall be as dense as possible and the interstice shall be filled with small stones. The height of stones shall be as per the thickness of soling required. The stones shall be arranged neatly and the joints shall be as thin as possible.

**Measurements:** The length, breadth and height shall be measured correct to 10 mm. and the volume calculated correct to 0.01 cum.

**Rate:** The rate shall include the materials and labour involved in all operations described above.

*SM0073 Providing and laying Hammer dressed stone edging 150 x 250 mm with stones including excavation, refilling and disposal of surplus earth within lead 50 m lead*

Trenches shall first be made as directed by the Engineer. The stones shall be laid true to line and gradient. The joints shall not be more than 1 cm thick.

**Measurement:** The stone edging shall be measured in running metre correct to 10 mm.

**Rate:** The rate shall include all materials and labour involved in the work.

**5.10.8 Stone Pavement**

*SM0080 Providing and laying hammer dressed 150mm thick flat stone pavement with hammer dressed stone edging 150mm wide & 250mm deep on both sides, including grouting joints with cement concrete mortar 1:3:6, 12mm aggregate*

*SM0081 Providing and laying hammer dressed 150mm thick flat stone pavement with hammer dressed stone edging 150mm wide & 250mm deep on both sides, including pointing with cement mortar 1:3*

*SM0082 Providing and laying hammer dressed 150mm thick flat stone pavement with hammer dressed stone edging 150mm wide & 250mm deep on both sides, including filling in joints with sand or earth etc*

Stones shall be hammer dressed on the face, the sides and the beds to enable it to come into close proximity with the neighbouring stones. The joints shall be grouted/filled as specified in the item.

**Measurement:** The length and width shall be measured correct to 10 mm. The area calculated correctly to 0.01 sqm.

**Rate:** The rate shall include all materials and labour involved in the item.

**5.10.9 Flat Stone (Dolep) Paving**

- *Providing & laying hammer dressed flat stone paving in cement mortar 1:6 on prepared bedding (excluding the cost of bedding)*

*SM0090 20mm*

*SM0091 30mm*

*SM0092 40mm*

- *Providing & laying chisel dressed flat stone paving in cement mortar 1:6 on prepared bedding (excluding the cost of bedding)*

*SM0100 20mm*

*SM0101 30mm*

*SM0102 40mm*

Stones shall be hammer dressed or chisel dressed as specified on the face, the sides and the beds to enable it to come into close proximity with the neighbouring stones. The joints shall not be more than 10mm. Each stone shall be 20mm or more in thickness and laid over the concrete bed that shall be approved by the Engineer.

**Measurement***:* The length and width shall be measured correct to 10 mm. The area shall be calculated correct to 0.01 sq.m.

**Rate:** The rate shall include all materials and labour involved in the item.

- *Providing and Laying hammer dressed dry dolep paving including preparation of bedding*

*SM0093 30mm*

*SM0094 40mm*

- *Providing and Laying Chisel dressed dry dolep paving including preparation of bedding*

*SM0103 30mm*

*SM0104 40mm*

Stones shall be hammer dressed or chisel dressed as specified on the face, the sides and the beds to enable it to come into close proximity with the neighbouring stones. The joints shall not be more than 10mm. Each stone shall be 30mm or more in thickness and be laid over the prepared bed. The bed shall be prepared using the materials (mud/stone chip) available at site and shall be approved from the Engineer.

**Measurement***:* The length and width shall be measured correct to 10 mm. The area shall be calculated correct to 0.01 sq.m.

**Rate:** The rate shall include all materials and labour involved in the item.

**5.10.10 Pointing in Stone Masonry**

- *Providing & laying pointing on stonework with cement mortar 1:3*

*SM0110 Flush pointing*

*SM0111 Ruled pointing*

*SM0112 Raised and cut pointing*

The holes left in masonry works for scaffolding purposes shall be filled and made good before pointing.

**Preparation of Surface**: The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence, if any, shall be removed by brushing and scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before pointing is commenced.

In case of concrete surface if a chemical retarder has been applied to the formwork, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface. The joints shall be raked to such a depth that the minimum depth of the new mortar measured from either the sunken surface of the finished pointing or from the edge of the stone shall not be less than 12 mm.

**Mortar:** Mortar of specified mix shall be used. The mortar shall be pressed into the raked out joints, with a pointing trowel, either flush, sunk or raised, according to the type of pointing required. The mortar shall not spread over the corner, edges or surface of the masonry. The pointing shall be then finished with the proper tool, in the manner described below:

**Flush Pointing:** The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the stones so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and straight edge.

**Ruled Pointing**: The joints shall be initially formed as for flush pointing and then while the mortar is still green, a groove of shape and size as shown in drawings or as instructed, shall be formed by running a forming tool, straight along the centre line of the joints. This operation shall be continued till a smooth and hard surface is obtained. The vertical joints shall also be finished in a similar way. The vertical lines shall make true right angles at their junctions with the horizontal lines and shall not project beyond the same.

**Raised and Cut Pointing:** Raised and cut pointing shall project from the wall facing with its edges cut parallel so as to have uniformly raised band about 6 mm raised and width 10 mm more as directed. The superfluous mortar shall then be cut off from the edges of the lines and the surface of the masonry shall also be cleaned off all mortar. The finish shall be such that the pointing is to the exact size and shape stipulated and the edges are straight, neat and clean.

**Curing:** The pointing shall be kept wet for seven days. During this period it shall be suitably protected from all damages. The pointing lines shall be truly horizontal and vertical except

where the joints are slanting as in random rubble masonry. Lines of joints from different directions should meet neatly at the junctions instead of crossing beyond.

**Measurement:** Length and breadth shall be measured correct to a 10 mm and its area shall be calculated in square metres upto two places of decimals. The various types of pointing for example, struck, keyed, flush, tuck, etc. shall each be measured separately. Pointing in a single detached joint as for flashing shall be given in running metres. Deductions and additions shall be made in the following way, in case of pointing on the external face only.

(a) No deduction shall be made for ends of joists, beams, posts etc. and openings not exceeding 0.5 sq.m each, and no addition shall be made for reveals, jambs, soffits, sills, etc. of these openings.

(b) Deductions for openings exceeding 0.5 sq.m but not exceeding 3 sq.m each shall be made as follows and no additions shall be made for reveals, jambs, soffits, sills etc. for these openings.

(i) When both the faces of the wall are pointed with the same pointing deduction shall be made for one face only.

(ii) When two faces of wall are pointed with different pointing or if one face is plastered and other is pointed deduction shall be made from the plaster or pointing on the side of frame for doors, windows, etc. on which the width of the reveal is less than that on the other side, but no deduction shall be made from the other side.

(iii) Where width of reveals on both faces of wall are equal, deduction of 50% of area of opening on each face shall be made from area of pointing or plaster as the case may.

(iv) For an opening having a doorframe equal to or projecting beyond thickness of wall, full deduction for opening shall be made from each pointed face of wall.

(c) In case of openings of area above 3 sq.m each, deduction shall be made for the openings, but jambs, soffits and sills shall be measured.

The following shall be measured separately.

(a) Raking out joints for old work only shall be measured and given in square metres.

(b) Raking out joints of old work built in mud mortar lime mortar and cement mortar shall each be measured separately.

(c) Raking out joints of different types of old walls; floors, etc. shall each be measured separately.

(d) Raking single detached joints as for flashing old work shall be given in running metres.

**Rate:** Rate shall include the cost of all materials and labour involved in all the operations described above.

### 5.10.11 Gabion Works

- *Providing & filling hand-packed stone in G.I mesh 4mm (8swg) including supplying, weaving, placing in position, securing & fastening of mesh complete*

*SM0120 Double-knotted mesh, 100 mm*

*SM0121 Double-knotted mesh, 150 mm*

*SM0122 Chain-link mesh, 100 mm*

*- Providing & filling hand-packed stone in G.I mesh of wire 3.00 mm, including supplying of machine woven mesh complete.*

*SM0125 Doubly twisted hexagonal mesh 90mm x 100mm opening.*

*SM0126 Doubly twisted hexagonal mesh 100mm x 120mm opening*

*- Providing & filling hand-packed stone in G.I mesh of wire 2.7 mm, including supplying of machine woven mesh complete.*

*SM0127 Doubly twisted hexagonal mesh 90mm x 100mm opening*

*SM0128 Doubly twisted hexagonal mesh 100mm x 120mm opening*

The gabion wall constructed shall satisfy the basic requirements such as stability, flexibility and durability. It shall also satisfy environmental and safety requirements.

The G.I wire shall be of mention diameter having tensile strength of 300-400 Mpa confirming to IS: 280. The size of the mesh shall be as specified in the items.

Sausages shall be fixed as directed by the Engineer. The different blocks shall be secured properly. The crates shall be placed in position before filling with boulders. It shall be filled by carefully hand packing boulders as tightly as possible and not by merely throwing stones.

**Measurements:** Measurement shall be taken in cubical content correct to 0.01 cu.m.

**Rate:** The rate shall include all materials and labour involved in the work.

**5.10.12 Pre-cast Stone Masonry Block**

*- Providing & laying Pre-cast Stone Masonry blocks (1:5:8) in cement mortar 1:6 in foundation and plinth*

*SM0130 30 cms thick*

*SM0131 20 cms thick*

*- Providing & laying Pre-cast Stone Masonry blocks (1:5:8) in cement mortar 1:6 in superstructure up to floor two level*

*SM0140 20 cms thick*

*SM0141 15 cms thick*

*SM0142 10 cms thick*

*SM0150 Extra, for Pre-cast Stone Masonry blocks in superstructure above floor two levels*

Pre-cast stone masonry has been developed to reduce the thickness and level of skill involved in the random rubble masonry walling. The blocks use stone spalls with lean concrete to produce blocks, which have stone texture on one face of the block. The blocks are cast using generally 30-35% stone spall content and 1:5:8 concrete with 12.5 mm to 10 mm stone chips having a slump of 15 to 20 mm. The moulds (generally of steel) can be opened out within 10 minutes of casting depending on the weather. Further, to

accommodate vertical reinforcement required for seismic forces in walls at corners and openings, special blocks of 29 x 9 x 14 cm and 19 x 9 x 14 cm with semi-circular recess on one face are to be used. Refer materials specification for detailed blocks manufacturing process.

**Masonry Construction**: Construction features are similar to those used in brick laying except that:

(a) Cutting of these blocks is not done, walls being planned to suit various dimensions of blocks available.

(b) Mortar used is not leaner than 1:6

(c) The blocks shall be dry at the time of laying in the wall. Wetting may generally not be necessary in a damp climate. The consistency of the mortar being used shall be adjusted to suit water suction by the blocks rather than the blocks be wetted to suit the mortar. If the climate is very hot the blocks shall be wetted on the surface by sprinkling water.

(d) For breaking of vertical joints, a smaller length of blocks is used.

(e) Only double scaffold shall be used and no holes are allowed in the masonry for scaffolding.

(f) The blocks shall be cured by frequent sprinkling with water for 2 weeks and air cured for another 2 weeks before laying in walls i.e. the blocks shall not be laid in masonry before one month of their casting.

The mortar joint at the external surface can be finished with any desirable pointing. The internal face may be plastered if so required with about 12 mm thick plaster.

**Measurement**: Unless otherwise specified, all work shall be measured net as fixed in its proper position. The length and height shall be measured correct to 10mm and area calculated correct to 0.1 sq.m.

**Rate:** Rate shall include all materials and labour described above, including scaffolding where necessary.

### 5.10.13 Rirrap wall

***Scope:*** *The work shall include placement of riprap stones, construction of toe protection and all incidental works necessary to complete the protection in a safe and durable manner.*

**Thickness of RipRap Layer:** The thickness of the riprap layer measured normal to the slope shall not be less than 1.5 times the median stone size (D50) and shall in no case be less than the maximum stone dimension. The minimum thickness shall be as specified in the Drawings or as per specifications.

**Bedding and Filter Layer:** Where riprap is placed over fine-grained soils, a filter layer shall be provided to prevent erosion of the underlying soil through the voids in the riprap. The filter layer may consist of graded granular material or approved geotextile. Granular filter material shall be placed to the specified thickness and compacted lightly to form a stable base. Geotextile fabric shall be laid smoothly without wrinkles, with adequate overlaps, and anchored to prevent displacement during placement of riprap.

**Placement of RipRap:** Riprap stones shall be placed either by manual (hand-placed) method or by mechanical(Dumped) method, as specified in the Drawings, in accordance with IS 8237.

*SM0160 - Providing and laying stone Riprap wall, (Excluding preparation of foundation, bedding and filter layers), hand placing approach and packing of stones, toe protection, and finishing complete in all respects, as per specification and drawings.*

**Manual Approach:** Where the manual method is adopted, stones shall be placed individually by hand to achieve close interlocking, proper seating and a dense, stable mass with minimum voids. Hand placement shall be adopted for critical works such as reservoir embankment slopes, spillways, toe protection, areas subject to wave action or overtopping flow, and other locations where enhanced stability is required.

The following table illustrates the minimum thickness of riprap as per IS 8237:1985.

**Table 1: Minimum Thickness of Hand Placed RipRap**

| Maximum Wave Height (m) | Minimum Riprap Thickness (mm) | Minimum Thickness of Filter Layer (mm) | |
|---|---|---|---|
| | | Finer | Coarser |
| 0 to 1.5 | 300 | 150 | 150 |
| 1.5 to 3.0 | 450 | 150 | 150 |
| Over 3.0 | 600 | 150 | 150 |

*SM0161 - Providing and laying stone riprap hand placing or mechanical approach and packing of stones, toe protection, and finishing complete in all respects (excluding preparation of foundation, provision and placement of bedding and filter layers), as per drawing and specifications.*

**Mechanical Approach:** Where the mechanical method is adopted, stones shall be placed using approved mechanical equipment in a controlled manner to avoid segregation, excessive impact or damage to the filter layer. Stones shall not be dropped from excessive height. After mechanical placement, stones shall be rearranged as necessary to ensure proper interlocking and required thickness.

**Table 2: Minimum Thickness of Dumped RipRap**

| Maximum Wave Height (m) | Minimum Average Rock Size ($D_{50}$) (mm) | Minimum Riprap Thickness (mm) |
|---|---|---|
| 0 to 1.5 | 300 | 600 |

| | | |
|---|---|---|
| 1.5 to 3.0 | 400 | 750 |
| Above 3 | 700 | 1000 |

Irrespective of the method adopted, the completed riprap shall form a dense, stable and well-graded layer of uniform thickness capable of resisting the design hydraulic forces without displacement.

**Tolerance:** The tolerance on the nominal thickness of riprap enforced on the performed profile shall be ±10 percent as per Clause 9.1 of IS: 8237:1985.

**Toe protection:** Toe protection shall be provided to prevent undermining of the riprap due to scour. Toe protection may consist of a toe trench, launching apron or toe berm as shown on the Drawings.

A toe trench shall be excavated below anticipated scour depth and filled with riprap to provide secure embedment. Where launching apron is specified, additional riprap shall be placed at the toe to allow settlement into position if scour occurs.

**Quality Control:** The Contractor shall ensure that the stone quality, gradation and placement conform to the specification. Stones that are cracked, undersized or weathered shall be rejected. The thickness of riprap shall be checked at random locations. Any loose or unstable stones shall be repositioned.

Where directed, the Contractor shall provide test certificates for specific gravity, abrasion resistance and soundness of stone.

**Measurement:** Riprap shall be measured in cubic metres based on the actual volume of stone placed in position as shown on the Drawings. Filter material shall be measured separately in cubic metres and geotextile in square metres where specified. Excavation for toe trench and foundation preparation shall be measured under the relevant earthwork section.

**Rate:** The rate for riprap shall include the cost of procuring stone, loading, transportation, unloading, construction of toe protection, placement of riprap stones by manual or mechanical method, labour, tools, equipment and all incidental works necessary to complete the work in accordance with this specification.

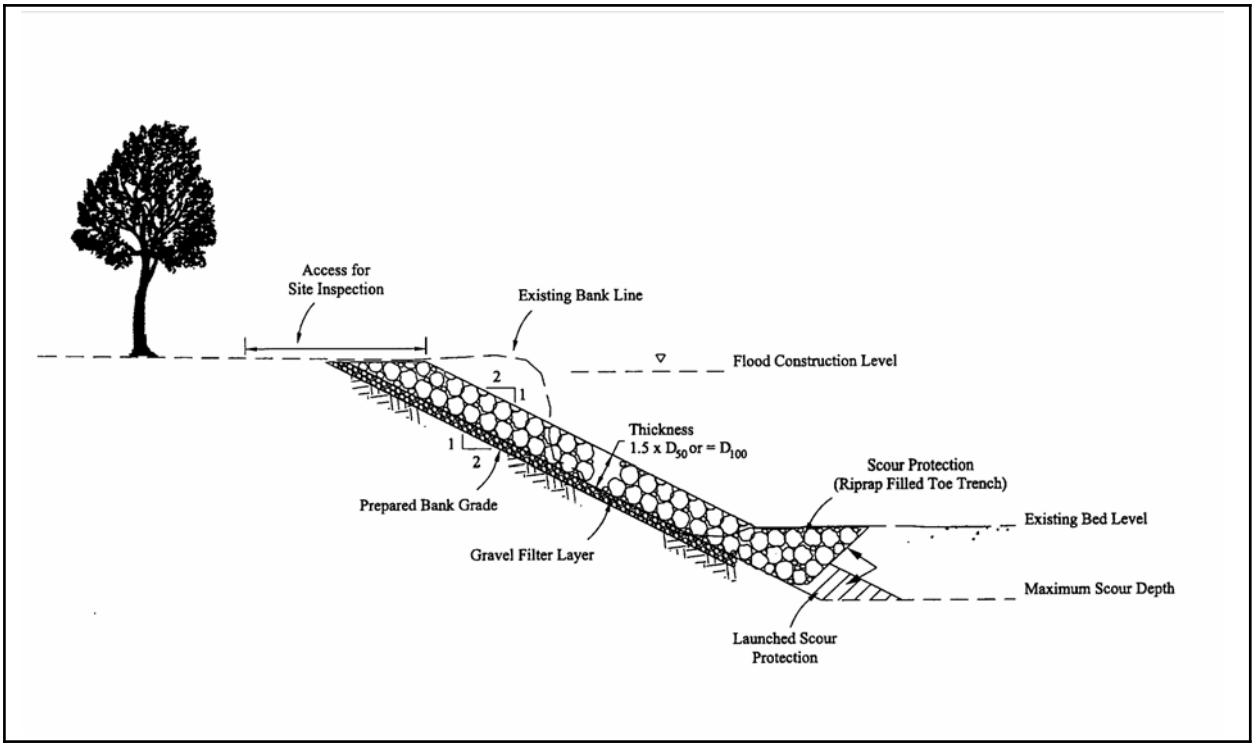



***Fig 5.10.3:*** *Cross Section of Typical Riprap Revetment.*

# 5.11 Chapter 11: WOOD WORK

### 5.11.1 Dressed Timber Framing

- *Providing & fixing in position dressed wood work in frames of doors, windows, clerestory windows and other frames, wrought and framed*

*WW0001* *Class 'A' (conifer)*

*WW0003* *Class 'B' (conifer)f*

*WW0004* *Class 'A' (broad leaf)*

*WW0005* *Class 'B' (broad leaf)*

Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The scantling shall be planned smooth and accurate to the full dimensions, rebates, rounding, and mouldings as shown in the drawings made, before assembling. Patching or plugging of any kind shall not be permitted except as approved by the Engineer. A tolerance of +2 mm and -3 mm shall be allowed in the finished cross-sectional dimensions of door and window frames.

**Joints:** Joints shall be mortise and tenon type, simple, neat and strong. Mortise and tenon joints shall fit in fully and accurately without wedging or filling. The joints shall be glued, framed, put together and pinned with hardwood or bamboo pins not less than 10mm dia. after the frames are put together pressed in position by means of a press.

**Surface Treatment**: Woodwork shall not be painted, oiled or otherwise treated before the Engineer has approved it. All portions of timber abutting against masonry or concrete or embedded in ground shall be painted with approved wood primer or with boiling coal tar.

**Glueing of Joints**: The contact surfaces of mortise and tenon shall be treated before putting together with bulk type synthetic resin adhesive of a make approved by the Engineer.

**Fixing in Position**: Before the frames are fixed in position these shall be inspected and approved by the Engineer. The frames shall be placed in proper position, and secured to walls or columns as the case may be, with metallic fastener, iron holdfasts or as directed by the Engineer.

In case of doorframes without sills, the vertical members shall be embedded in the flooring to its full depth. When sills are provided, these sills shall be embedded sunk in the floor to its full depth. The door frames without sills, while being placed in position, shall be suitably strutted and wedged in order to prevent warping during construction. The frame shall also be protected from damage during construction.

**Measurement:** Wood work wrought and framed shall be measured for finished dimensions. No allowance shall be paid for wastage and for dimensions supplied beyond those specified. Length of each piece shall be measured overall nearest to 10mm so as to include projections for tenons, scarves or mitres width and thickness shall be measured to the nearest mm. Cubical contents shall be worked out in cubic metres nearest to 0.01 cubic metre. Increase of mouldings, rounding, rebates, circular and varying sections, the sectional area of the piece shall be taken as the area of the least square or rectangle from which such a section can be cut.

**Rate:** The rate includes the cost of materials and labour involved in all the operations described above. Extra rate shall be allowed for hold fasts, metallic fasteners etc. unless otherwise specified.

- *Providing & fixing Class 'A' (conifer) moulded beading to door, window frames with iron screws including plugs, priming coat on unexposed surfaces*

*WW0010 50 x 12 mm*

*WW0011 50 x 20 mm*

The beading shall be made from the specified wood, true and accurate to the dimensions given in the working drawing, the rebates rounding and mouldings made and finished smooth. Fixing of such beading shall be done with screws, which shall be sunk into the woodwork and their tops covered with putty. The unexposed surfaces of beading shall be given a priming coat of paint.

**Measurement:** Measurement of the beading shall be taken in length to nearest 10mm. Plugs, provision and fixing are included in the rate and are not to be measured separately.

**Rate:** The rate shall include all work described in the item including materials and labour.

- *Providing & fixing joists, including hoisting, applying wood preservative on unexposed surfaces*

*WW0020 Class 'A' (conifer)*

*WW0021 Class 'B' (conifer)*

*WW0022 Class 'A' (broad leaf)*

*WW0023 Class 'B' (broad leaf)*

The specified timber shall be used and the joists made accurate to the dimensions given in the working drawing. Fixing shall be done true to line and level, and will be subject to approval of the Engineer before undertaking further work. The unexposed surfaces of the joists shall be given a coat of wood preservative.

**Measurement:** The length of the joists shall be measured to the nearest 10 mm and the breadth and depth to the nearest mm. The cubic contents shall be worked correct to two decimals.

**Rate:** The rate shall include all work described in the item including materials and labour.

- *Providing & fixing eaves board 225 x 25 mm with moulding fitted and fixed with necessary screws*

*WW0030 Class 'B' (conifer)*

The eaves board shall be fixed to the rafters with 65 mm long iron screws.

The timber shall be planed smooth and accurate to the full dimensions, rebates, rounding, and mouldings as shown in the drawings made before assembly. Patching or plugging of any kind shall not be permitted except as provided. Woodwork shall not be painted, or otherwise treated before the Engineer has approved it.

**Tolerance**: The finished work with a tolerance of + 1 mm in thickness and +2 mm in width shall be accepted.

**Measurement**: The eaves board shall be measured in length correct 5 mm.

**Rate:** The rate shall include all materials and labour involved in the work.

**5.11.2 A) Traditional Cornices (wooden)**

- *Providing, making & fixing woodwork dressed in traditional cornices complete as per standard design in Class 'B' (conifer), including applying wood preservative on unexposed surfaces, excluding decorative painting for multi-storied building*

*WW0035* *At floor two level including cost of lhanglag*

*WW0036* *At other floor levels above floor two level excluding phana*

*WW0037* *For single-storied structure including Phana*

*WW0038* *Phana*

*WW0039* *Lintel level*

The cornice at each floor level shall conform in all respects to the approved design and made as per the direction of the Engineer. Care must be taken to see that the dimensions, rounding and mouldings are uniform all along the length of the cornice, which must be to true line and level. Preservative shall be applied to the unexposed surfaces.

**Measurement**: Measurements shall be taken of the cornice at each floor level along the line of junction of the cornice and wall in running length correct to 10mm. The phana shall be measured separately, likewise correct to 10 mm.

**Rate:** The rate shall include all work described in the item including materials and labour.

- *Providing, making & fixing woodwork dressed in traditional Tshegay complete as per standard design*

*WW0045* *In Class 'B' (conifer)*

*WW0046* *In Class 'A' (conifer)*

Care must be taken to see that the dimensions, rounding and mouldings are uniform all along.

**Measurement**: Measurements shall be taken in square metre correct to 0.10 sq.m.

**Rate:** The rate shall include all work described in the item including materials and labour.

**5.11.2 B) Traditional Cornices (FRP)**

- *Providing & fixing FRP Bhutan type traditional cornices complete as per standard design including the cost of TMT re-bars and excluding decorative painting (Measurement to be taken along the cornice and wall junction line)*

*WW0050* *Single bho, phana, pem and dhung*

*WW0051* *Double bho, phana, pem and dhung*

*WW0052* *Double bho, phana, choetse, pem and dhung*

*WW0053* *Double bho, phana and dhung*

*WW0054* *Tshechukhanyim*

**Design requirements**

Installed FRP cornice and fastening systems shall be designed, engineered, fabricated, and installed as per design.

**Finish**

- Desired color finish may be integrated into the gelcoat/resin of FRP.
- Product is delivered with automotive grade surface primer, ready for traditional paintings and others
- Surface Texture/Exposed side shall be smooth or textured based upon approved sample.

**Pre installation Examination**

Before starting the installation of FRP cornices, the contractor should thoroughly inspect the site and ensure that the structure is ready for installation. This includes verifying on-site dimensions with the structural drawings and taking full responsibility for fitting the components to the structure.

Check that the bearing surfaces, where the cornices will be installed, are true and level. It is important for the proper alignment and stability of the cornices. Along the wall, mark a guide line at a distance from the ceiling equivalent to the size of the cornices. This guideline will help ensure accurate placement and alignment during the installation process. Ensure that the support framing has been constructed properly to allow for accurate placement, alignment, and connection of FRP cornice to the structure. The framing should provide adequate support for the weight of the cornices.

Report any discrepancies between the design dimensions and the field dimensions that could potentially affect the cornice installation. These discrepancies should be addressed and corrected before proceeding with the installation. If necessary, modified installation requirements should be approved by the Engineer.

**Installation**

At regular intervals, drill holes into the wall to insert TMT re-bars, which are typically 10-12mm in diameter. These re-bars will be fixed into the wall using appropriate anchors. Another TMT re-bar of 12mm diameter will be horizontally welded to these vertical re-bars. This forms the framework for attaching the cornices.

The TMT re-bars should have a threaded end that allows them to be fixed onto the cornices. Use a 14mm nut and bolt, along with two 4mm washers on each side, to secure the TMT re-bars to the cornices.

Use appropriate welding techniques to attach the cornices to the horizontal TMT re-bar. This ensures that the cornices are securely connected to the framework. Adjust the nut and bolts on the TMT re-bars to fix and align the cornices properly. This step ensures that the cornices are positioned correctly and aligned with the marked guideline on the wall.

Place a fiberglass cover over the installed cornices. This cover provides a protective layer and enhances the aesthetics of the cornices. Use fiberglass and reinforcing materials to cover all the joints between the cornices and any other connecting elements.



**Fig 5.11.1 FRP Cornice**

**Measurement**: FRP cornice shall be measured by length corrected to 10mm, along the junction of the cornice and wall.

**Rate:** The rate includes the cost of materials and labour involved in all the operations described above except for the cost of centering and shuttering unless otherwise mentioned in the item.

**5.11.2 C) Traditional Cornices (GRC)**

*Providing & fixing GRC Bhutan type traditional cornices complete as per standard design including the cost of TMT re-bars, MS plates and angles, excluding decorative painting (Measurement to be taken along the cornice and wall junction line)*

*WW0071* *Single bho, phana, pem and dhung*

*WW0072* *Double bho, phana, pem and dhung*

*WW0073* *Double bho, phana, choetse, pem and dhung*

*WW0074* *Double bho, phana and dhung*

*WW0075* *Tshechukhanyim*

**Pre installation Examination**

**1.Structural Assessment**: Conduct a structural assessment to evaluate the concrete surfaces to support the GRC cornice. Engage structural engineers, if necessary, to ensure the installation maintains structural integrity. .

**2.Design and Measurement**: Accurately determine the placement of the GRC cornice. Take precise measurements and mark the exact location for installation according to the building's architectural design.

**3. Wall Reinforcement**: Reinforced concrete cement is required within the wall to provide adequate structural support for the cornice.

**4. Level and Straight RCC Provision**: Ensure that the RCC (Reinforced Concrete Cement) provision for the GRC cornice is level and straight. Any irregularities in this provision can cause significant alignment problems during installation. Therefore, thoroughly check and correct the RCC provision to establish a solid and level foundation for the cornice.

**Installation**

**1. Embedded Anchors**: During the initial construction or renovation phase, integrate embedded anchors or brackets into the concrete structure. These anchors will provide secure attachment points for the GRC cornice.

**2. Angle rods**: Use angle rods to reinforce the cornice to the RCC wall

**3. Joints and Finishing**: The final step involves filling the joints with GRC mortar and performing necessary finishing touches. All cornices will be covered with cement board.

**Measurement:** GRP cornice shall be measured by length corrected to 10mm, along the junction of the cornice and wall.

**Rate:** The rate includes the cost of materials and labour involved in all the operations described above except for the cost of centering and shuttering unless otherwise mentioned in the item.

- *Providing and fixing of Traditional Bhutanese style GRC door cornice as per the standard design and detailed drawing, including the cost of nuts, bolts, anchors, sealant, complete*

*WW0730* *1000mmX425mm*

*WW0731* *1200mmX425mm*

*WW0732* *1410mmX425mm*

*WW0733* *1600mmX425mm*

*WW0734* *1800mmX425mm*

*WW0735* *2000mmX425mm*

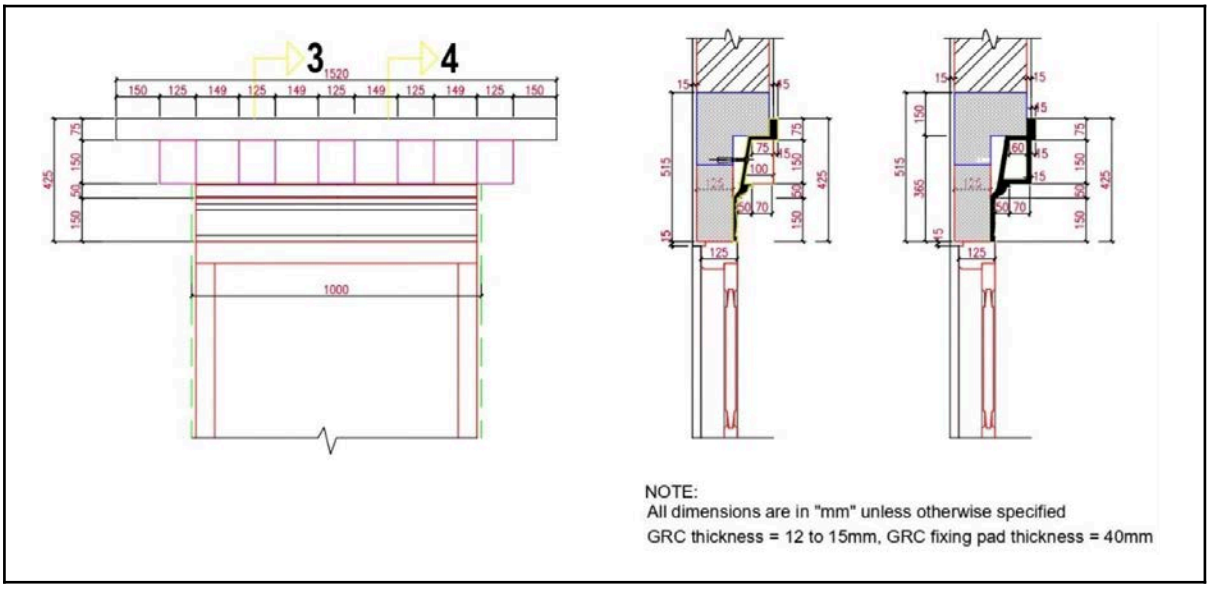



**Fig 5.11.2 GRC Door Cornice 1000mm dhung length**

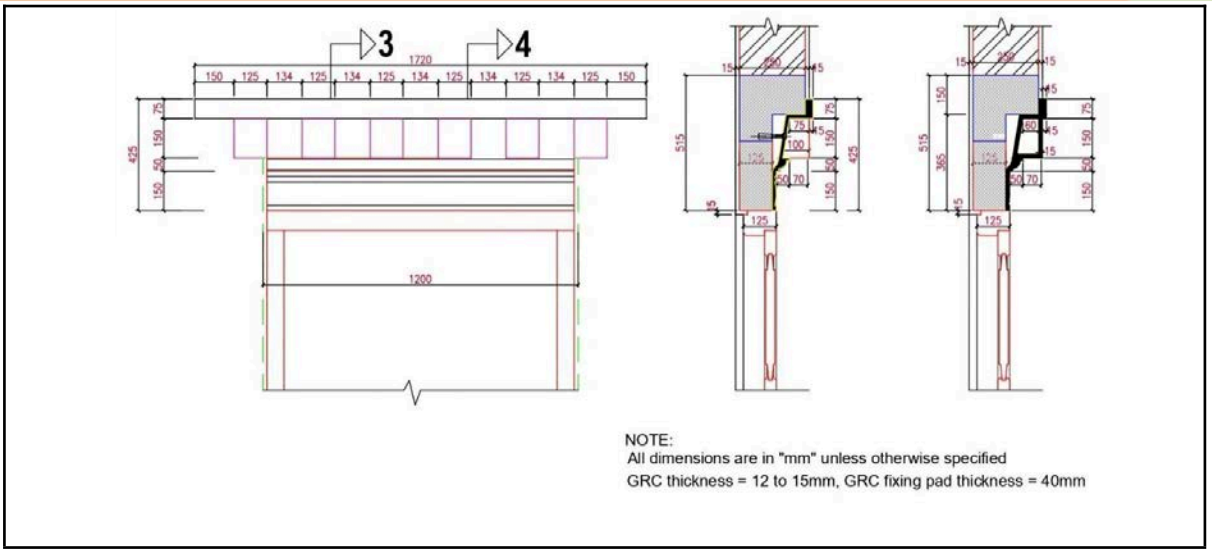



**Fig 5.11.3 GRC Door Cornice 1200mm dhung length**

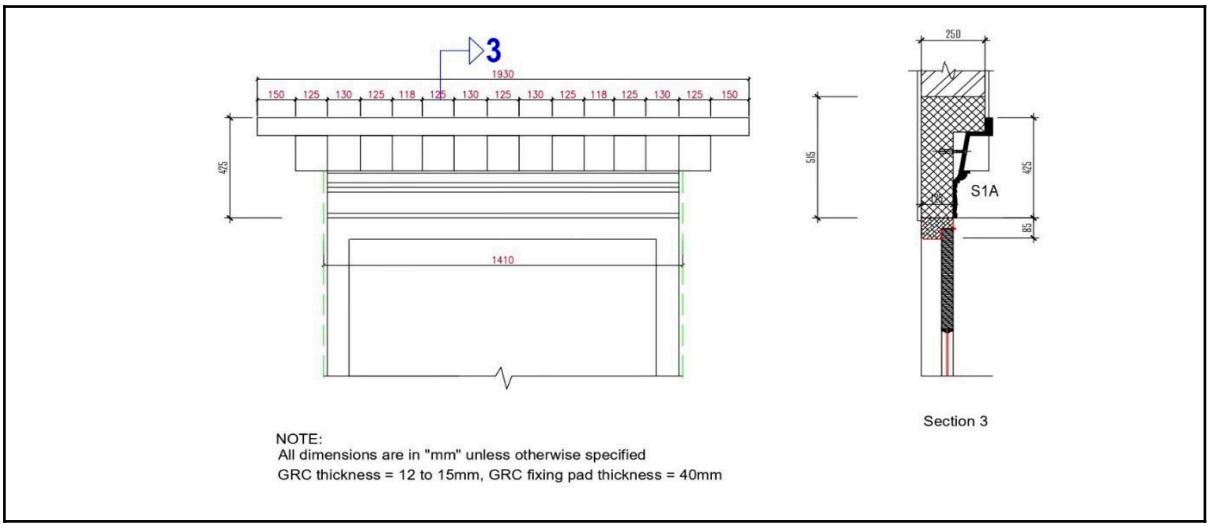



**Fig 5.11.4 GRC Door Cornice 1410mm dhung length**

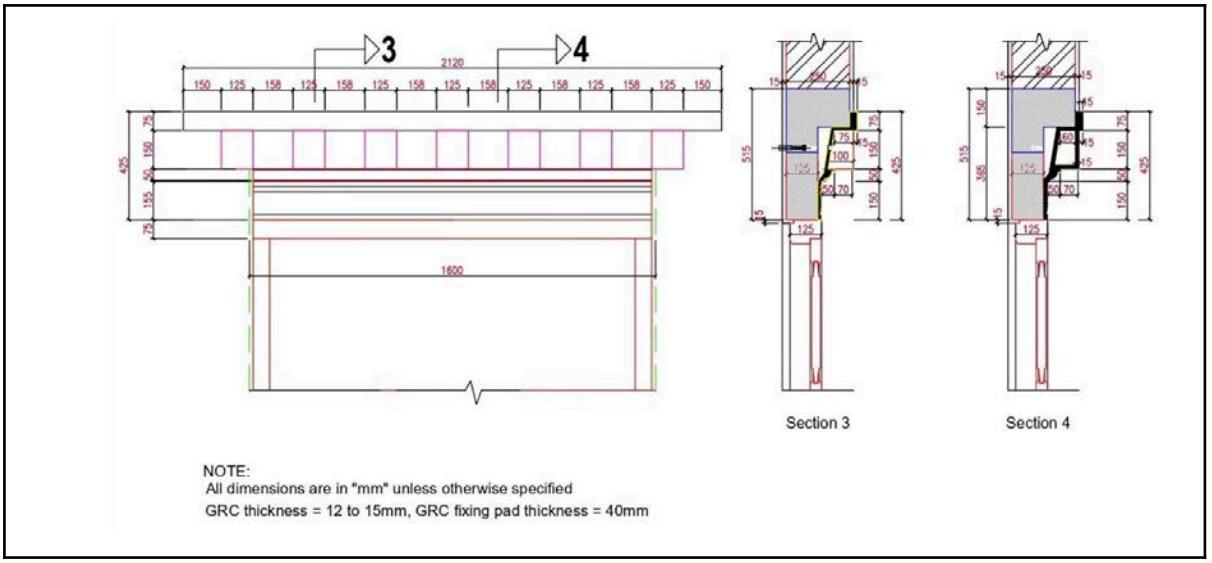



**Fig 5.11.5 GRC Door Cornice 1410mm dhung length**

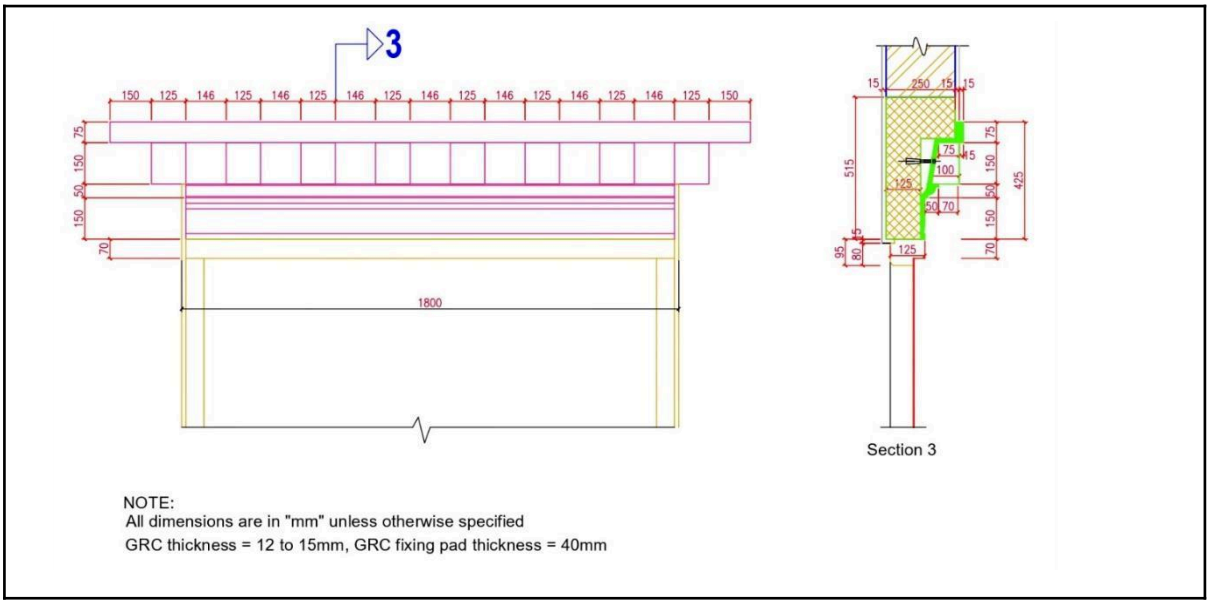



**Fig 5.11.6 GRC Door Cornice 1800mm dhung length**

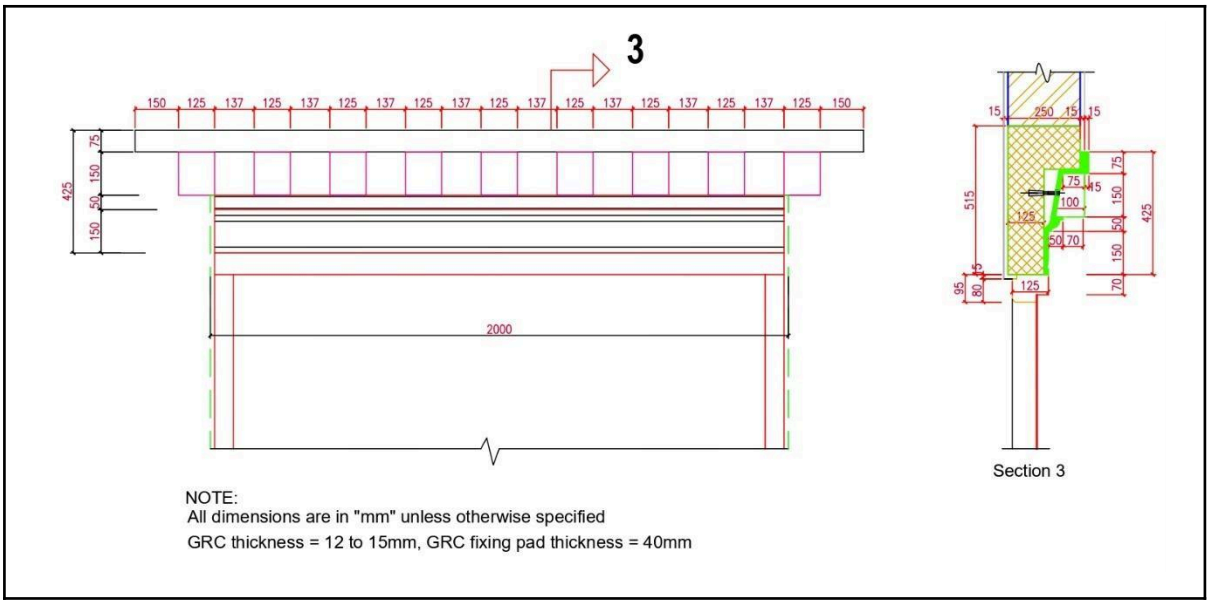



**Fig 5.11.7 GRC Door Cornice 1800mm dhung length**

**Pre installation Examination**

**1.Structural Assessment**: Conduct a structural assessment to evaluate the concrete surfaces to support the GRC cornice. Engage structural engineers, if necessary, to ensure the installation maintains structural integrity.

**2.Design and Measurement**: Accurately determine the placement of the GRC cornice. Take precise measurements and mark the exact location for installation according to the building's architectural design.

**3. Wall Reinforcement**: Reinforced concrete cement is required within the wall to provide adequate structural support for the cornice.

**4. Level and Straight RCC Provision**: Ensure that the RCC (Reinforced Concrete Cement) provision for the GRC cornice is level and straight. Any irregularities in this provision can cause significant alignment problems during installation. Therefore, thoroughly check and correct the RCC provision to establish a solid and level foundation for the cornice.

**Installation**

**1. Embedded Anchors**: During the initial construction or renovation phase, integrate embedded anchors or brackets into the concrete structure. These anchors will provide secure attachment points for the GRC cornice.

**2. Angle rods**: Use angle rods to reinforce the cornice to the RCC wall

**3. Joints and Finishing**: The final step involves filling the joints with GRC mortar and performing necessary finishing touches. All cornices will be covered with cement board.

**Measurement:** GRC Door cornices shall be measured in numbers (each) of door cornice installed at the site.

**Rate:** The rate includes the cost of materials and labour involved in all the operations described above, except painting works.

**5.11.3 Undressed Timber Framing**

WW0055 Providing & fixing Class 'B' (conif*er) (undressed) in frames etc. framed and fixed in position.*

*WW0056 Providing & fixing Class 'B' (broad leaf) (undressed) in frames etc. framed and fixed in position.*

The **specification**, **measurement** and **rates** for this work shall be the same as for dressed wood works in frames except that the scantling need not be planned unless otherwise specified.

- *Providing & fixing roof framing, in trusses, purlins, rafters, posts, post plates etc (excluding s*traps, bolts, plates, holding down bolts and priming, painting, polishing*)*

*WW0060 Class 'B' (conifer)*

*WW0061 Class 'A' (conifer)*

*WW0062 Class 'A' (broad leaf)*

*WW0063 Class 'B' (broad leaf)*

The work shall be carried out as per detailed drawing. A full truss size diagram shall first be drawn on a levelled platform. From this full-size diagram, templates of all joints as for tenons, mortises, scarf etc shall be made for use in the fabrication. The template shall be made to correspond to each member and plate hole for screws and bolts shall be marked

accurately. Specified timber shall be used and sawn truly straight and square in the directions of the grains. The scantlings shall be accurately planed smooth to the full dimensions and rebates, before the same are framed. Patching and plugging of any kind shall not be allowed. The Engineer at his discretion may allow a tolerance of up to +/-2 mm in the finished cross-sectional dimensions.

**Joints:** Joints shall be simple, neat and strong. All mortise and tenon joints, mitred joints, scarf etc shall fit in fully and accurately without wedging or fillings. The joints shall be as per detailed drawings. Holes of correct size shall be drilled before inserting screws/bolts. Holes for bolts shall be uniform in diameter. The wood sections as specified shall be measured with a steel tape and accurately fabricated as per template of each member, so that the fabricated members can be assembled without packing, and without forcing or straining into position. When built up the truss shall be of accurate dimensions and true to shape and free from twists, kinks, buckles or open joints or defects of any type. Likewise, any MS components like straps, king posts etc shall be fabricated accurate to the correct dimensions and without defects of any kind.

**Hoisting and placing in position:** The trusses shall be hoisted and placed in position carefully without any damage to itself and other building work and injury to workmen. Mechanical appliances such as lifting tackle, winch etc. shall be used where necessary. The contractor shall provide these unless specified otherwise in the contract. The trusses shall be stayed temporarily till they are permanently secured in position and connected to each other by means of purlins.

Woodwork shall not be painted, or otherwise treated before the Engineer has approved it. All portions of timber built into or against or close to masonry or concrete or buried in ground shall be given two coats of boiling coal tar. All junctions of rafters, purlins, beams and wall plates shall be painted with approved primer.

**Measurement:** Wood work shall be measured for finished dimensions. No allowance shall be made for dimensions supplied beyond those specified. Length of each piece shall be measured overall nearest to 10mm so as to include projections. Width and thickness shall be measured to the nearest mm. Cubical contents shall be worked out to nearest 0.01 cu.m. Steel items such as straps, bolts, plates, holding down bolts shall be measured separately.

**Rate:** The rate includes cost of materials and labour involved in all the operations described. Unless otherwise specified all M.S items such as straps, bolts, plates, holding down bolts and priming, painting and polishing work shall be paid for separately.

### *5.11.4* Pre-fabricated Board

- *Providing & fixing gussets for timber trusses including wood preservative (coal tar)*

*WW0070 12 mm phenolic plywood*

Plywood gusset shall be fabricated accurate to the correct dimensions as per the requirement for a particular truss connection and without defects of any kind. Holes of correct size shall be drilled before inserting screws/bolts. Holes for bolts shall be uniform in diameter. The size as specified shall be measured with a steel tape and accurately fabricated as per template of each truss member.

**Measurements**: The length and breadth shall be measured correct to 10 mm, and area worked out in square metres nearest to two places of decimal.

**Rate:** The rate includes cost of materials and labour involved in all the operations described above including cost of preservative.

- *Providing & fixing to frames (wall or ceiling) Gypsum plaster board including finishing of joints smooth complete (excluding cost of frame)*

*WW0080 10 mm*

*WW0081 12 mm*

*WW0082 15 mm*

The Gypsum plaster board (wall board) shall confirm to IS:2095. The boards shall be kept dry in transit and stored flat in a clean dry place.

**Fixing:** The supporting walls and framework for the coverings shall be completed. Assembled components, such as, frames of doors, windows, etc, shall be installed in position before the wall covering work is commenced.

The fixing of coverings shall reasonably permit the adjustment of the coverings to thermal and moisture movements without cracking or appreciable distortion. Spacing of support and fixing of gypsum wall coverings shall be as shown below:

**Table 5.11.1** SPACING OF SUPPORT AND FIXING OF GYPSUM WALL COVERINGS

| Sl. No | Thicknes s (mm) | Spacing of supports (mm) | Minimum clearance for nails from edges (mm) | Nail spacing c/c at edges and at other supports |
|---|---|---|---|---|
| 1 | 10 | 400 | 10 | |
| 2 | 12 | 500 | 10 | 100 to 150 |
| 3 | 15 | 600 | 10 | |

During fixing, the nailing shall be done starting from the centre of the row, working outwards. The nails with a shank diameter of 2, 2.24 or 2.5 mm shall be used.

**Jointing:** The boards shall be fixed with a joint thickness of about 6 mm. All vertical joints shall be staggered particularly where both sides of the wall are covered.The joints shall be filled with gypsum plaster or other materials specified by the manufacturers of the boards. After filling the joints, a thick skin of finishing materials shall be spread about 50 mm wide on either sides of the joint and on to it shall be trowelled dry a reinforcing scrim cloth about 100 mm wide. When metal scrim is used a stiffer plaster will be necessary to enable the trowelling of the scrim down to the board.

**Measurement:** The length and width of the work shall be measured correct to 10 mm. The area shall be calculated in square metres correct to two places of decimal.

**Rate:** It shall include all materials and labour involved in all operations described above.

- *Providing and fixing to frames mineral fibre board ceiling of size 595X595 mm of approved texture, design and pattern including Galvanized Steel interlocking grid frame of 24mmx38mm T sections and wall angle of 24mmx24mm with all accessories such as 6mm dia fully threaded hanger rod, anchor fasteners, and S.S. screws complete*

*WW0086 16 mm*

*WW0087 19 mm*

**Materials**

**Ceiling Tiles**

Mineral Fiber Ceiling tiles shall be made from granulated high-density mineral wool and should have superior sound absorption, heat insulation, fire resistance, and sag resistance properties.

Unless otherwise stated in the item description or indicated in the drawings, the tiles shall have a minimum dimension of 595 x 595 mm. They must feature an approved texture, design, and pattern and shall have a beveled, tegular edge or square lay-in edge with a 16 mm or 19 mm thickness as required.

**Suspension System**

**Interlocking T- Grid:** The ceiling tiles shall be laid on a suspended frame made of interlocking metal T-grids of hot-dipped all-around galvanized steel.

It shall consist of main T runners of size 24 x 38mm of length 3600mm, cross T of size 24 x 38mm of length 1200mm, and secondary intermediate cross T of size 24 x 38mm of length 600mm to form grid modules of size 600mm x 600mm. The end details of the cross tee shall be made of pre-hardened steel and fixed to the ends of the cross tee to provide double locking between “cross T to cross T” and “cross T to main T”.

**Perimeter Wall Angle**: The frame shall also consist of galvanized steel perimeter wall angle of size 24 x 24 mm of length 3000mm to be fixed on the periphery wall/ partition with the help of plastic rawl plugs and 40mm long drywall SS screws at 450mm center to center.

**Hanger rod/wire**: This grid shall be suspended from the structural slab/ceiling using 6 mm diameter fully threaded galvanized steel hanger rod, 50mm long M6 Anchor fasteners, and L-shaped level adjuster of size 85 x 25 x 2mm.

Alternatively, pre-straightened galvanized iron hanger wire of minimum diameter 2.5 mm can be used as hanger material if the false ceiling is suspended at a distance equal to or less than 600mm from the structural slab/ceiling. However, if the distance is more than 600mm, a 6mm diameter fully threaded hanger rod is recommended.

**Installation Steps**

**1. Levelling and marking**: The required height and level for the ceiling shall be marked on the periphery wall.

**2. Fixing of Wall angle**: The outer wall angle shall be fixed on the wall using stainless steel screws at 450mm center to center maximum. The T runners shall then be placed and fixed carefully to form the grid.

**3**. **Fixing of Frame and Hanger rod**: The grid shall consist of main T-runners at 1200mm center to center securely fixed to the structural slab/ceiling with approved hanger rod/wire at 1200mm center to center maximum and not more than 150mm from spliced joints of main T-runners. The last hanger at the end of each runner should not be greater than 600mm from the adjacent wall. Similarly, cross T-runners (primary cross T) of 1200mm long shall be placed at 600mm center to center. Finally, 600x600mm modules shall be formed by fitting 600mm long cross T-runners (secondary cross T) centrally between 1200mm cross T-runners.

The same pattern shall be maintained consistently throughout the room or corridor, wherever possible. In cases where the width of the room or corridor is not a multiple of the standard tile size, appropriately sized border panels shall be incorporated. The design of these borders must be approved by the engineer in charge and uniformly maintained throughout the length and width of the room or corridor.

**4. Placing of Ceiling tiles**: The ceiling tiles shall be placed properly in the grids, carefully avoiding damage to the edges.

**5. Finishing:** Care should be taken while placing ceiling tiles into the grid to avoid displacement, and ensure no stains are left on the ceiling tiles. If required, the level of the false ceiling grid shall be checked after placing the ceiling tiles, and necessary adjustments shall be made.

**Measurements:** The length and breadth shall be measured correct to 10 mm. The area shall be calculated in square meters correct to two places of decimal.

**Rate:** It shall include all the materials and labour involved in the operations described above.

- *Providing & fixing to frames (wall or ceiling) Class 'A' (conifer) plain lining, tongued and grooved, including necessary fixtures, wooden plugs and priming coat on unexposed surfaces (excluding cost of frames)*

*WW0090* *12 mm thick*

*WW0091* *20 mm thick*

- *Providing and fixing to frames (wall or ceiling) Plain Particle Board Lining with necessary nails etc. complete (excluding cost of frames)*

*WW0100* *6 mm*

*WW0101* *10 mm*

*WW0102* *12 mm*

*WW0103* *18 mm*

- *Providing and fixing Pre-laminated Particle Board Lining with necessary nails etc. complete (excluding cost of frame)*

*WW0110* *8 mm*

*WW0111* *10 mm*

*WW0112* *12 mm*

*WW0113* *18 mm*

- *Providing and fixing bison panel (Pre-laminated both sides for wall/ceiling) Lining with necessary nails etc. complete (excluding cost of frame)*

*WW0120* *6 mm*

*WW0121* *8 mm*

*WW0122* *10 mm*

*WW0123* *12 mm*

*WW0124* *16 mm*

*WW0125 20 mm*

- *Providing and fixing Plywood lining with necessary nails etc. complete (excluding cost of frame)*

*WW0130 4 mm, commercial*

*WW0131 4 mm, teak*

- *Providing and fixing Pre-fabricated wall panelling profiles with necessary nails etc. complete but excluding the cost of frame)*

*WW0140 19 mm, Class 'A' (conifer)*

*WW0141 19 mm, Class 'B' (conifer)*

*WW0142 15 mm, Class 'A' (conifer)*

- *Providing and fixing wooden skirting in Class 'B' (conifer) with necessary nails or screws complete*

*WW0150 20 mm*

*WW0151 25 mm*

Specified Timber shall be used and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimension rebates rounding and mouldings as shown in the drawings made before assembly. Patching of any kind shall not be permitted.

Grounds, consisting of battens and plugs, shall be used if specified. Battens of 50 x 25 mm or as specified shall be fixed over wooden plugs spaced at 45 to 60 cm depending upon the nature of work, with 50 mm long wooden screws.

The planks for wall lining shall be tongued and grooved unless otherwise specified. The lining shall be painted with priming coat on the unexposed surfaces and fixed to true line and level with screws, which shall be sunk with the woodwork, and their tops covered with putty. The work shall be true and accurate to the dimensions shown in the working drawing.

**Measurements:** The length and breadth shall be measured correctly to 10 mm, and area worked out in square metre nearest to two places of decimal. Grounds shall be measured on cubical contents of battens and paid for separately. Plugs are deemed to be included in the rate.

**Rate:** It shall include the materials and labour involved in all operations described above.

**5.11.5 Bamboo Walling**

- *Providing and fixing 75 mm thick split bamboo wall including grooving frames, 20mm plaster both sides (excluding cost of frame)*

*WW0160 with cement mortar 1:4*

*WW0161 with cement mortar 1:5*

*WW0162 with cement mortar 1:6*

*WW0163 mud plaster*

*WW0164 Providing and fixing 150mm thick split bamboo wall including grooving frames, 60mm mud plaster both sides (excluding cost of frame)*

*WW0165 Providing and fixing split Bamboo matting (excluding the cost of framing and beading)*

The split bamboo of 25x6mm shall be used which shall be slipped into the grooves of vertical timber members of specified size. The panels shall then be plastered from both sides with 20mm thick cement or mud plaster as per the directives of the Engineer. The plastering shall not be commenced unless instructed by the Engineer.

**Measurements:** The length and breadth shall be measured correctly to 10 mm, and area worked out in square metre nearest to two places of decimal. Grounds shall be measured on cubical contents and paid for separately. Plugs are deemed to be included in the rate.

**Rate:** It shall include the materials and labour involved in all operations described above.

**5.11.6 Partition**

*- Providing and fixing panelled or Panelled-&-Glazed partition, single-central-panelling including frame etc complete*

*WW0170 100mm framing, 38mm thick, Class 'B' (conifer)*

*WW0171 75mm framing, 38mm thick, Class 'B' (conifer)*

*WW0172 100mm framing, 38mm thick, Champ or Class 'A' (conifer)*

*WW0173 75mm framing, 38mm thick, Champ or Class 'A' (conifer)*

*- Providing and fixing panelled or Panelled-&-Glazed, Plywood panelling from both sides including frame in Class 'B' (conifer)*

*WW0180 100mm framing, 4mm Commercial Ply*

*WW0181 75mm framing, 4mm Commercial Ply*

*WW0182 100mm framing, 4mm Teak Ply*

*WW0183 75mm framing, 4mm Teak Ply*

*- Providing and fixing Panelled with Pre-fabricated profiles from both sides including the frame and prime coat on concealed face*

*WW0190 100mm framing, 12mm Class 'A' (conifer)*

*WW0191 75mm framing, 12mm Class 'A' (conifer)*

*WW0192 100mm framing, 12mm Class 'B' (conifer)*

*WW0193 75mm framing, 12mm Class 'B' (conifer)*

Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, rounding, and mouldings as shown in the drawings made before assembly. Patching or plugging of any kind shall not be permitted except as provided. All members shall be straight without any warp or bow and shall have smooth, well-planed faces at right angles to each other. All plywood shall be as specified and shall be free from defects.

The size of frame and panels shall be as specified in the items and spacing of framing shall be as shown in the drawing. However, frame spacing in both horizontal and vertical direction shall not exceed 1.2m in each direction.

**Joints:** Joints shall be mortise and tenon type, simple, neat and strong. Mortise and tenon joints shall fit in fully and accurately without wedging or filling. The joints shall be glued, framed, put together and pinned with hard wood or bamboo pins not less than 10mm dia. after the frames are put together pressed in position by means of a press.

**Surface Treatment**: Woodwork shall not be painted, oiled or otherwise treated before the Engineer has approved it. All portions of timber abutting against masonry or concrete or embedded in ground shall be painted with approved wood primer or with boiling coal tar.

**Gluing of Joints**: The contact surfaces of mortise and tenon shall be treated before putting together with bulk type synthetic resin adhesive of a make approved by the Engineer.

**Fixing in position**: Before the frames are fixed in position these shall be inspected and approved by the Engineer. The frames shall be placed in proper position, and secured to walls or columns as the case may be, with metallic fastener, iron hold fasts or as directed by the Engineer.

**Measurements**: Length and width shall be measured nearest to 10mm of the partition. All work shall be measured net as fixed. No extra payment shall be made for shape, joints etc. except for circular or segmental portions, which shall be measured separately. The area shall be calculated in square metres nearest to two places of decimal.

**Rate:** It includes the cost of materials and labour involved in all the operations described above including frame.

**5.11.7 Shutters**

- *Providing and fixing 25mm thick Panelled or glazed Shutters for cup-boards etc. complete including the hinges*

*WW0200 Class 'A' (conifer)*

*WW0201 Class 'B' (conifer)*

- *Providing and fixing 35mm thick Panelled or glazed doors and windows Shutters etc. complete including the hinges*

*WW0210 Class 'A' (conifer)*

*WW0211 Class 'B' (conifer)*

- *Providing and fixing 38mm thick Panelled or glazed doors and windows Shutters etc. complete including the hinges*

*WW0220 Class 'A' (conifer)*

*WW0221 Class 'B' (conifer)*

- *Providing and fixing 44mm thick Panelled or glazed doors and windows Shutters etc. complete including the hinges*

*WW0230 Class 'A' (conifer)*

*WW0231 Class 'B' (conifer)*

- *Providing and fixing 50mm thick Panelled or glazed doors and windows Shutters etc. complete including the hinges*

*WW0240 Class 'A' (conifer)*

*WW0241 Class 'B' (conifer)*

The frames shall be wrought, framed and fixed in position as per detailed drawing and as directed by the Engineer. Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, rounding, and mouldings as shown in the drawings made before assembly. Patching or plugging of any kind shall not be permitted except as provided.

**Panelling**: Timber panels shall be preferably made of timber of larger width, the minimum thickness of panel being 16 mm. When made from more than one piece, the pieces shall be joined with a continuous tongued and grooved joint glued together and reinforced with metal dowels. The grains of timber shall run along the longer dimensions of these panels. No single panel shall exceed 0.5 sq.m in area. The panels shall be framed into grooves to the full depth of the groove leaving an air space of 1.5 mm and the faces shall be closely fitted to the sides of the grooves.

**Joinery work:** All pieces shall be accurately cut and planed smooth to the full dimensions without any patching or plugging of any kind. The thickness of styles and rails shall be as specified for the shutters.

All members of the door shutters shall be straight without any warp or bow and shall have smooth, well-planed faces at right angles to each other. The corners and edges of panels shall be finished as shown in drawings, and these shall be feathers tongued into styles and rails. Sash bars shall have mitred joints with the styles. Styles and rails shall be properly and accurately mortised and tenoned. Rails, which are more than 180 mm in width, shall have two tenons. Styles and end rails of shutters shall be made out of one piece only. The tenons shall pass through styles for at least 3/4th of the width of the style. When assembling a leaf, styles shall be left projecting as a horn till the joinery work is approved by the Engineer. The styles and rails shall have 12 mm grooves in panelled portions for the panel to fit in.

The depth of rebate for housing the shutters shall in all cases be 1.25 cm and the rebate in shutters for closing in double shutter doors or windows shall not be less than 2.0 cm. The joinery work shall be assembled and passed by the Engineer, and then the joints shall be pressed, and secured by bamboo pins of about 6 mm diameter. The horns of styles shall be sawn off.

**Tolerance**: The finished work with a tolerance of + 1 mm in thickness and +2 mm in width of styles and rails shall be accepted.

**Gluing of joints**: The contact surfaces of tenon and mortise joints shall be treated before putting together with bulk type synthetic resin adhesive of a make approved by the Engineer. Shutters shall not be painted, oiled or otherwise treated, before these are fixed in position and passed by the Engineer. Mountings and glazing bars shall be stub- tenoned to the maximum depth, which the member would permit or to a depth of 25 mm whichever is less. Thickness of each tenon shall be approximately one third the finished thickness of the members and the width of each tenon shall not exceed five times its thickness.

**Beading:** Timber, plywood, hard board and particle board panels shall be fixed only with grooves but additional beading may be provided either on one side or on both sides. In so far as glass and asbestos panels are concerned, beading shall always be provided without grooves. Where beading is provided without grooves, the beading shall be only on one side, the other side being supported by rebate from the styles. For external doors and windows beading shall be fixed on the outside.

**Glazing:** The glass shall conform to the specifications given under materials. The glass panes shall be so cut that they fit slightly loose in the frame. A thin layer of putty (prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste) shall be drawn along the inner edge of the rebate for bedding the back of the glass pane. The glass pane shall then be put in position pressed home against the thin layer of putty and secured in rebate by new brads (small nails). The brads shall not be spaced at more than 7.5 cm from each corner and not more than 15 cm apart. The putty shall then be applied in the rebate uniformly sloping from the inner edge of the rebate, taking care to keep the putty a little within the inner edge of the rebate and surplus putty removed so that none of it may show through the glass from the inside. The putty so filled shall be levelled smooth and finished in a straight line. When dried the putty shall be covered with a coat of paint of approved quality and shade to match finish of joining work.

The glass panes shall be cleaned with spirit. Where moulded fillets are used for fixing of glass, the fillets shall be of wood as specified in the item of work. They shall be cut and planed smooth to the required shape and dimensions. The fillets shall either be fixed flush or projected uniformly as specified. The fixing is done with brads as before. The glass is cleaned after the fillets are finished to match the joining work.

**Fittings:** Details of fittings to be provided shall be as per the schedule of fittings supplied by the Engineer in each case. The cost of providing and fixing shutters shall include the cost of hinges and necessary screws for fixing the same. All other fittings shall be enumerated and paid for separately. Screws used for fittings shall be of the same metal and finish as the fittings. Fittings shall be fixed in proper positions as shown in the drawings or as directed by the Engineer. These shall be truly vertical or horizontal as the case may be screws shall be driven home with screwdriver and not hammered in. Recess shall be cut to the exact size and depth for countersinking of hinges. Where fittings are stipulated to be supplied by the department free of cost, screws for fixing the fittings shall be provided by the contractor and nothing extra will be paid for the same. Wooden cleats and blocks shall be fixed to doors and windows as directed by the Engineer. The size and shape of cleats and blocks shall be as approved by the Engineer.

**Measurements:** Length and width of the shutters shall be measured to the nearest 10 mm. in closed positions covering the rebates of the frame but excluding the gap between the shutter and the frame. Overlap of two shutters shall not be measured. All work shall be measured net as fixed. No extra payment shall be made for shape, joints etc. except for circular or segmental portions, which shall be measured separately. The area shall be calculated in square metres nearest to two places of decimal.

**Rate:** It includes the cost of materials and labour involved in all the operations described above.

- *Providing and fixing Wire-mesh Shutters 25mm thick for doors & windows using galvanised MS wire-gauze of I.S gauze designation 85G with wire 0.56mm dia. wire including the hinges*

*WW0250 Class 'A' (conifer)*

*WW0251 Class 'B' (conifer)*

- *Providing and fixing Wire-mesh Shutters 35mm for doors & windows using galvanised MS wire-gauze of I.S gauze designation 85G with wire 0.56mm dia. wire including the hinges*

*WW0260 Class 'A' (conifer)*

*WW0261 Class 'B' (conifer)*

- *Providing and fixing Wire-mesh Shutters 38mm for doors & windows using galvanised MS wire-gauze of I.S gauze designation 85G with wire 0.56mm dia. wire excluding the cost of hinges*

*WW0270 Class 'A' (conifer)*

*WW0271 Class 'B' (conifer)*

Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, rounding and mouldings as shown in the drawing made, before assembly. Patching or plugging of any kind shall not be permitted except as provided.

**Styles and Rails**: The specification shall be as described above. The styles and rails shall be given a rebate to receive the wire gauze, which shall form the panels.

**Wire gauze**: This shall unless otherwise specified, be of galvanised MS wire of I.S gauze designation 85G with wire of diameter 0.56 mm. The wire gauze shall be bent at right angles in the rebates of styles and rails, turned back, and fixed tight with blue tacks at about 75 mm centre, fixed alternately in two faces of the rebates. Over this, wooden beading shall be fixed with brads or small screws at about 75 mm centres. The space between the beading and rebates, where the wire gauze is bent, shall be neatly finished with putty, so that the end of the wire gauze may not be visible.

**Fittings, wooden cleats, Blocks** and **Measurement** shall be as specified under item described above for fixing of doors & windows shutters.

**Rate:** It includes the cost of materials and labour involved in all the operations described above excluding the cost of frames.

- *Providing and fixing Battened door & window shutters 20mm, with ledges and braces (25 mm), including the hinges*

*WW0280 Class 'A' (conifer)*

*WW0281 Class 'A' (Broad leaf)*

*WW0282 Class 'B' (conifer)*

*WW0283 Class 'B' (Broad leaf)*

*WW0290 Providing and fixing 22mm thick battened garage door with ledges and braces (38mm) in Class 'B' (conifer), including mountings etc complete*

Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, rounding, and mouldings as shown in the drawings made before assembly. Patching or plugging of any kind shall not be permitted except as provided. The thickness of the doors shall be the thickness of the battens only and not the combined thickness of battens and braces.

**Battens:** Planks for battens shall be as specified in the item and of uniform width of 125 to 175 mm. These shall be planed and made smooth and provided with minimum 12 mm rebated joints. The joint shall be chamfered. The finished work with a tolerance of +/-1 mm in thickness and +/-2 mm in width of battens etc. shall be accepted.

**Ledges and Braces**: The battens shall be fixed together by 25/38 mm thick (as specified) ledges and braces on the inside face of the door shutter with minimum two numbers 50 mm long wood screws per batten. The ledges shall be 225 mm wide and braces of 175 mm wide for garage doors and 175 mm and 135 mm respectively for other doors unless otherwise specified. The braces shall incline downwards towards the side on which the door is hung. Edges and ends of ledges and braces shall be chamfered.

**Fittings and fixing Garage door**: This shall be fixed to the wall masonry with six pintle sets. Each set shall consist of a pin clamp of 50 x 6 mm flat 45 cm long, bent and forked at one end and provided with 20 mm dia. MS pin 65 mm long on the other end and 50 x 6 mm double strap 60 cm long. The pin shall be firmly riveted or welded to the pin clamp, the other end of which shall be embedded in masonry by means of cement concrete block 40 x 20 x 20 cm 1:3:6 mix (1 cement: 3 coarse sand: 6 graded stone aggregate 20 mm nominal size). This shall be so placed that the bottom pin shall face upwards and the top pin down wards, in order that the gate may not be removed by lifting over pins. The fixing shall be so done that the door shutter can open on the outside by 180 degrees.

The double strap shall fit in the pin on one side and shall be fixed to the shutter at ledge on the other side with 4 bolts and nuts of 12 mm diameter. One hook and eye, 450 mm size of mild steel shall be provided for each shutter to keep it fixed in open position. A cement concrete block of 15 x 10 x 20 cm in 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) shall be embedded in the floor at junction of two shutters so that the door shutter opens only on the outside and not on the inside. An iron-sliding bolt of 450 mm long x 16 mm in diameter shall be provided and fixed.

**Measurement:** Length and width of the shutters shall be measured nearest to 10mm in closed positions covering the rebates of the frame but excluding the gap between the shutter and the frame. Overlap of two shutters shall not be measured. All work shall be measured net as fixed.

**Rate:** It includes the cost of materials and labour required for all the operations described above. Concrete shall be paid for separately as per relevant concrete item.

*WW0295 Providing and fixing 38mm thick battened and framed door shutters, Class 'B' (conifer) including the cost of hinges*

Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, rounding, and mouldings as shown in the drawings made, before assembly. Patching or plugging of any kind shall not be permitted except as provided.

Planks for battens shall be 20 mm thick unless otherwise specified and of the uniform width of 75 mm to 100 mm. These shall be planed and made smooth and provided with minimum 12 mm rebated joints. The battens shall be fixed together by 25 mm thick ledges. The ledge shall be 175 mm wide. Edges and ends of ledges shall be chamfered. Tee hinges shall be provided in ledges only. The finished work with a tolerance of +/1 mm in thickness and +/-3 mm in width of battens etc. shall be accepted. The ends of battens shall be feather tongued into styles and rails, which shall be provided with a 12 mm groove to fit in the battens.

The specifications for wooden cleats and blocks, fittings shall be as described above for doors & windows shutters.

**Measurement:** Length and width of the shutters shall be measured nearest to 10mm in closed positions covering the rebates of the frame but excluding the gap between the shutter and the frame.

**Rate:** It includes the cost of materials and labour involved in all the operations described above including hinges

**5.11.8 Venetian Works**

*WW0300 Providing and fixing 38mm thick louvered shutters for windows, doors with fixed 12 mm Venetian in Class 'B' (conifer) including the cost of hinges*

*WW0301 Providing and fixing Class 'B' (conifer) venetian 50 mm wide, 10 mm thick at 45 mm apart in ventilators above doors (excluding frame)*

Specified timber shall be used and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, rounding and mouldings as shown in the drawings made, before assembly. Patching and plugging of any kind shall not be permitted except as provided.

**Frames:** Where the shutters have been provided in the same frame as for the ordinary door or window the thickness of the frame shall be increased by the specified thickness of the shutters, which shall be paid for separately under the relevant items of work.

**Venetian:** The panel space shall be fitted with Venetian, which shall be 12 mm thick. The Venetian blades shall slope down towards the outside at angle as shown in the drawings and shall be fixed in styles. These shall overlap each other by about half of their widths. The finished work with a tolerance of +/-1 mm in thickness and +/-2 mm in width of battens etc. shall be accepted.

The specifications for fittings, wooden cleats and blocks and measurements shall be as specified above for doors & windows shutters.

**Measurement:** Measurements shall be as specified above for doors & windows shutters.

**Rate:** It includes the cost of materials and labour involved in all the operations described above including hinges.

**5.11.9 Trellis**

*WW0310 Providing & fixing plain trellis of 38x12 mm laths with 38 mm gap (excluding frames) including fixing beading 50x12mm with Class 'B' (conifer)*

*WW0311 Providing & fixing Door & window shutters of plain trellis of 38x12mm laths with 38mm gap (excluding frame) including fixing beading 50x12mm with Class 'B' (conifer)*

Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed, smooth and accurate to the full dimensions, rebates, rounding, and mouldings as shown in the drawings made, before assembly. Patching or plugging of any kind shall not be permitted except as provided.

**Plain Trellis**: This shall consist of wooden strips or laths 38 mm x 12 mm section, planed and nailed together at every alternate crossing. The strips shall cross each other at right angles and shall be spaced 38 mm apart, so as to form a 38 x 38 mm square opening or as shown in the drawing. These shall be fixed with nails to the frame. To cover the ends of strips, 50 x 12 mm beading shall be fixed to the frame with screws. The finished work with a tolerance of +/-1 mm may be accepted.

**Trellis Doors and windows Shutters:** Shutter frame shall consist of two styles and top, lock and bottom rails, each of section 75 x 38 mm. The styles and rails shall be properly mortised and tenoned. The tenon shall pass through the styles for at least 3/4th of the width of the style. Shutter frames shall be assembled and passed by the Engineer- in-charge before jointing. The joints shall be pressed and secured by bamboo pins of about 6 mm diameter. To this frame plain trelliswork shall be fixed as shown in the drawing or as directed by the Engineer. The fittings, wooden cleats and blocks shall be provided as specified under fixing doors & windows shutters.

**Measurement:** Width and height of plain trellis work and trellis shutters shall be measured correct to 10mm. The area shall be calculated in square metres nearest to two places of decimal. In case of shutters, the measurements shall be specified above.

**Rate:** It includes the cost of materials and labour required in all the operations described above.

### 5.11.10 Compound Gate

*WW0320 Providing and fixing Compound Gate including hinge-supports complete as per standard design in Class 'B' (conifer)*

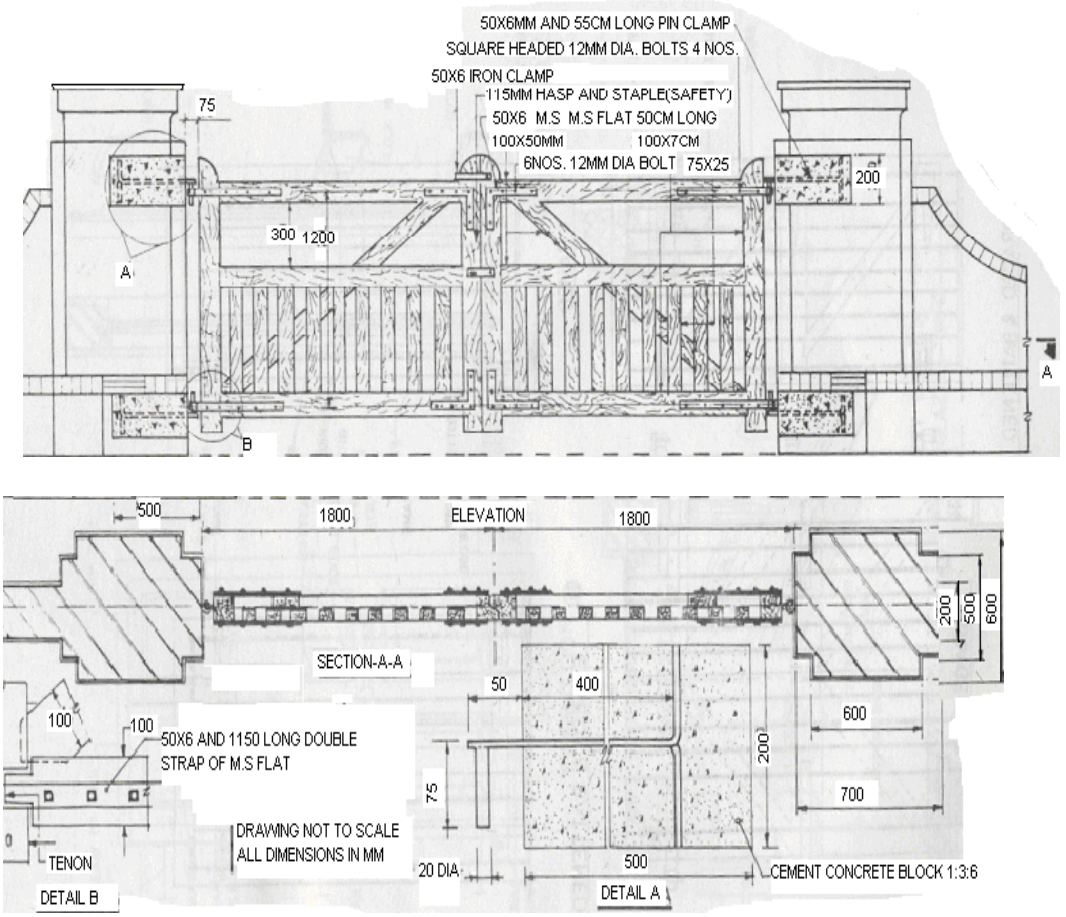



**Figure 5.11.8** Details of compound gate

Specified timber shall be used and it shall be sawn in the direction of the grains. Sawing shall be truly straight, square and free from waves. The scantlings shall be accurately planed smooth to the full dimensions, and rounding as shown in the drawing made, before framing. The joints shall be simple, neat and strong. All mortise and tenon joints shall fit in fully and accurately without wedging or filling. The joints shall be pressed and secured by means of iron straps of 50 x 6 mm flat iron and bolts and nuts of 12 mm in diameter as shown in the drawing, and where iron straps and bolts are not indicated the joints shall be pinned with hardwood or bamboo pins 10 to 12 mm diameter. Necessary holes shall be made in the frame members to fit in vertical wooden strips 75 x 25 mm. Vertical and horizontal (outside) members for frames shall be 100 x 75 mm whereas horizontal and diagonal (inside) members shall be 100 x 50 mm in section). A tolerance of +2 mm and -3 mm shall be allowed on the size of the section.

**Fixing:** Compound gate shall be fixed to the masonry pillars with four pintle sets. Detail shall be as per paragraph in Fittings and Fixing for Garage Door except that (a) length of flat iron for pintel shall be 55 cm, (b) length of double strap shall be 115 cm and (c) concrete block of cement concrete 1:2:4 shall not be provided in the floor.

**Measurement:** The width of the gate shall be measured from out to out of the verticals on the sides and height from bottom to the top of the outer horizontals, correct to 10mm. The gate shall be measured in square metres nearest to two places of decimal.

**Rate:** It includes the cost of materials and labour required for all the operations described above. Cement concrete blocks shall be paid for separately under the relevant concrete item.

**5.11.11 Windows Accessories**

*WW0325 Providing and fixing MS round or square bars in window frames*

*WW0326 Providing and fixing MS round or square bars with MS flats in window frames*

*WW0327 Providing and fixing ornamental steel grills in frames with MS flats & bars including round headed bolts and nuts etc.*

MS bars/grills shall be fixed as per detailed drawing or as directed by the Engineer.

**Fixing:** For fixing MS bars in wooden frames of windows etc. through holes shall be drilled in one side of the frame and in the other side of the frame, holes shall be drilled 5 cm deep. The bars shall be passed into the frame from one side and these shall be of correct length to fit in at one end and to flush with outside of the frame at the other end. Where there are MS flats provided along with the bars, these shall be fixed at the ends to the wooden frame with wooden screws. Holes for passing MS bars shall be punched in the flats at proper position. The grills shall be fabricated as per design and fixed to the frame by round headed bolts and nuts in new work, and by wooden screws in old work.

**Measurement:** The length of MS bars and flats shall be measured correct to 10 mm. and their weight calculated in kg from standard tables.

**Rate:** The rate includes the cost of labour and materials required for all the operations described above.

*WW0328 Providing and fixing expanded metal 20x60mm strands 3.25x1.6mm including 60x20mm beading of Class 'B' (conifer)*

Expanded metal shall be fixed to the window frames on the outside or inside as per detailed drawings or as directed by the Engineer. These shall be cut in one piece to the size of the frame (out to out). Expanded metal shall be fixed on to the frame with staples, over which wooden beading 60 x 20 mm shall be fixed with wood screws.

**Measurement**: The length and breadth shall be measured correctly to 10 mm, the area from outside to outside of beading shall be calculated in square metre nearest to two places of decimal.

**Rate:** It includes the cost of labour and materials required for all the operations described above.

**5.11.12 Pre-fabricated Shutters**

- *Providing and fixing Flush Door shutters with pre-laminated Cement Bonded Particle board*

*WW0335 25 mm*

*WW0336 30 mm*

- *Providing and fixing Flush Door shutters (pre-fabricated), block-board core with commercial ply veneer including the hinges*

*WW0345 25 mm*

*WW0346 30 mm*

*WW0347 35 mm*

*WW0348 40 mm*

- *Providing and fixing flush door shutters (pre-fabricated), block-board core with teak ply veneer including the hinges*

*WW0355 25 mm*

*WW0356 30 mm*

*WW0357 35 mm*

*WW0358 40 mm*

- *Providing and fixing flush door shutters (pre-fabricated), block-board core with ply veneer, chemically treated including the hinges*

*WW0365 25 mm*

*WW0366 30 mm*

*WW0367 35 mm*

*WW0368 40 mm*

**Measurement:** Length and width of the shutter shall be measured to the nearest 10 mm in closed position covering the rebates of the frame but excluding the gap between the shutter & the frame. Overlap of two shutters shall not be measured. All work shall be measured net as fixed.

**Rate:** It includes the cost of materials and labour involved in the work.

*5.11.13* **WPC (Wood Plastic Composite) Door Shutter**

*WW0801 Providing & fixing 30mm Thick WPC (Wood Plastic Composite) flush door shutter complete including hinges - Standard*

*WW0802 Providing & fixing 30mm Thick WPC (Wood Plastic Composite) moulded door shutter complete including hinges – Standard*

**Material:** Wood plastic Composite (WPC) Door shutter is made of WPC sheet which is extruded from WPC compound. The various additives like, stabilizers, lubricants, fillers, blowing agent etc. as added to virgin PVC Resin (K value 57-60 Suspension Grade) and Natural Fiber (Wood Flour) are fed to a high-speed mixer and heated to approximately 120°C using frictional heat. At this temperature the various additives blend and convert into WPC compounds. WPC shutter is highly resistant to moisture, rot, and warping which makes it suitable for both interior and exterior applications.

The WPC shutters should be water and moisture-resistant with good insulation properties.

Types of WPC shutter

1. Solid WPC Flush Door

2. Solid WPC Moulded Door

**Fixing of Shutter**

WPC door shutter shall be side hung on four bolt hinges of size 100 mm. The flat of the hinges shall be neatly counter sunk into the recesses cut out to the exact dimensions of the hinge flap. The door shall be drilled on the thickness to fit hinges. Screws for fixing the hinges shall be screwed in with screwdrivers and not hammered. The length of the screws should be 8 mm/30 mm. The hinges used should be of stainless steel.

**Measurements:** Length and width of the shutters shall be measured to the nearest mm and the area is calculated to the nearest 0.01 sqm.

**Rate:** It includes the cost of materials and labour involved in the work. Fittings and fixtures on the door shutter except hinges & screws shall be paid extra as provided.

### 5.11.14 WPC Frame

*WW0803 Providing & fixing WPC (Wood Plastic Composite) doors frame (size 75mm x 50mm thick) complete*

*WW0804 Providing & fixing WPC (Wood Plastic Composite) doors frame (size 100mm x 50mm thick) complete*

WPC door frame is made of wood powder, plastic and other additives as the main raw materials, through high temperature extrusion molding of a new type of environmentally friendly building materials. It combines the natural texture of wood with the waterproof and corrosion-resistant characteristics of plastic, not easy to deform, not easy to crack & suitable for home, office, hotel and other indoor space.

**Fixing of Frames**

The frames are to be fixed in prepared openings in the walls. All civil work and tiling should be completed before the fixing of the frames. The frames are to be fixed directly on the plastered wall. In case tiling is to be done in the place the frames are to be fitted; a 50 mm strip should be left un-tiled at the location where the frames are to be fitted. The frames are erected in the prepared opening such that the vertical members of the door frame are embedded 50 mm in the floor. The frame shall be fitted truly in plumb. A minimum of three anchor bolts or screws of size 65/100 shall be used to fix each vertical member. One bolt shall be fixed at 200 mm from the top member and one bolt shall be fixed at 200 mm from the floor. The third anchor bolt shall be fixed in the center. The top horizontal member shall be fixed using two 65/100 size anchor bolts or screws at a distance of 200 mm from both the corners.

**Measurements:** The outer length of the vertical and horizontal members of WPC door frame shall be measured in running meters including embedded length in floor correct up to 1cm.

**Rate:** The rate includes the cost of the materials and labour involved in all the operations described above.

### 5.11.15 PVC DOOR SHUTTER

*WW0810 Providing & fixing 30mm Thick PVC (polyvinyl chloride) flush door shutter complete including hinges - Standard*

*WW0811 Providing & fixing 30mm Thick PVC (polyvinyl chloride) moulded door shutter complete including hinges - Standard*

Shutters shall be factory-fabricated using PVC material conforming to IS 10151, as per item description and instructions of Engineer-in-Charge. If required the material shall be tested as per IS 4020 (Parts 1 to 16).

**Fixing of Shutter**

PVC door shutter shall be side hung on four bolt hinges of size 100 mm. The flat of the hinges shall be neatly counter sunk into the recesses cut out to the exact dimensions of the hinge flap. The door shall be drilled on the thickness to fit hinges. Screws for fixing the hinges shall be screwed in with screwdrivers and not hammered. The length of the screws should be 8 mm/30 mm. The hinges used should be of stainless steel.

**Measurements:** Length and width of the shutters shall be measured to the nearest mm and the area is calculated to the nearest 0.01 sqm.

**Rate:** It includes the cost of materials and labour involved in the work. Fittings & fixtures on the door shutter except hinges & screws shall be paid extra as provided.

### 5.11.15 PVC Door Frames

*WW0812 Providing & fixing PVC (polyvinyl chloride) doors frame (size 75mm x 50mm thick) complete*

*WW0813 Providing & fixing PVC (polyvinyl chloride) doors frame (size 100mm x 50mm thick) complete*

**Material**

PVC compound shall be made using suspension-grade PVC resin mixed with additives like calcium stearate, hydrocarbon wax, titanium dioxide, calcium carbonate, acrylic processing aids, impact modifiers, UV stabilizers, pigments, plasticizers, lubricants, and blowing agents. The compound shall provide cellular structure, strength, surface finish, and UV resistance, ensuring smooth extrusion of profiles.

Frames shall be factory-made from extruded PVC sections conforming to IS 10151. Corners shall be mitered, plastic welded, and jointed with galvanized M.S. brackets.

**Installation**

Frames shall be fixed in plastered wall openings after completion of civil and tiling works. A 50 mm tile-free margin shall be left if tiling is pending. Each vertical member shall be embedded 50 mm into the floor and secured with three anchor bolts/screws (65/100 mm): one each 200 mm from top and bottom, and one in the center. Two anchor bolts shall fix the top member, placed 200 mm from corners.

**Measurements:** The outer length of the vertical and horizontal members of WPC door frame shall be measured in running meters including embedded length in floor correct up to 1cm.

**Rate:** The rate includes the cost of the materials and labour involved in all the operations described above.

- **Shelving & Cupboards**

*WW0470 Providing and fixing 38 mm thick wooden shelves supported on 40 x 40 x 6 mm `T' or `L' iron brackets fixed at suitable distance but not exceeding 75 cm apart in 7.5 x 7.5 x 15 cm blocks of cement concrete 1:3:6, 20 mm aggregate with Class 'B' (conifer)*

The planks for shelves shall be planed on all faces and edges. These shall be supported on tees or angle iron, which shall be built in the walls at least 15 cm deep in cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 graded stone aggregate 20 mm nominal size). When the shelves are up to 30 cm width, the supports shall be spaced not more than 75 cm apart. When the shelves are wider, the spacing shall be suitably decreased, as directed by the Engineer. The shelves shall be grooved to rest squarely on the supports, to which these shall be fixed with iron wood screws from below. The finished work with a tolerance of +/- 1 mm in thickness and + 3 mm and - 2 mm in width may be allowed.

**Measurement:** Length and breadth shall be measured correct to 10 mm. The area shall be calculated in square metre nearest to two places of decimal.

**Rate:** Rate includes the cost of materials and labour required for all the operations described above.

- *Providing and fixing 25 mm thick Cupboard (90x200x45cm...LxHxD) with glazed, panelled shutters, 25 mm thick partitions and shelves supported on 25x25mm wooden runners, 50x20mm architraves and 25mm dia. curtain rod mounted on wooden brackets, including with Anodised Aluminium Hinges and frame in Class 'B' (conifer)*

*WW0475 Class 'B' (conifer)*

*WW0476 Class 'A' (conifer)*

The quality and thickness of the shutter shall be as specified. The shutter shall be panelled, glazed or panelled and glazed as directed by the Engineer. Specifications for panelled, glazed or panelled and glazed shutters shall be as specified above.

**Shelves**: The number, size and thickness of the shelves shall be as specified. The planks for shelves shall be of specified timber and planed on all faces and edges. The shelves shall rest on wood supports, 25x25 mm, for their full depth. The wooden supports shall be fixed in the masonry by means of wooden plugs and screws, at suitable intervals. The shelves shall be fixed to the supports with wood screws of suitable size at 10 cm centre to centre. The shelves, when fixed, shall be truly horizontal.

**Hanger rod:** The hanger rod, as shown in the drawings, or as directed by the Engineer, shall be provided at the top of the cupboard. The clear gap above the rod shall be not less than 8 cm. The rod shall be of single piece. The diameter of the wooden rod shall be 25 mm. The end support shall consist of wooden brackets of specified timber and shall be fixed to the side masonry of the cupboard with suitable plugs and screws.

**Fittings:** Two iron tower bolts of 200 mm size (one for inside and one on outside) and one 100 mm iron hasp and staple shall be provided.

**Finishing:** All woodwork shall be painted or polished as directed by the Engineer. After fixing the plugs for supports, the plaster should be neatly repaired with cement mortar 1:4 (1 cement: 4 sand). The inside plaster portion shall be finished with two coats of oil bound distemper or flat wall paint of approved colour, as directed.

**Measurement:** The cupboards shall be measured in numbers.

**Rate:** The rate shall include the cost of all materials and labour involved in all the operations.

- *Extras, for Cupboards including frame of Class 'B' (conifer)*

*WW0485* *For additional depth of 50 mm or part thereof*

**Measurement:** These shall be measured in numbers.

**Rate:** The rate includes the cost of all additional materials and labour involved in the work.

**5.11.16 Railing**

- *Providing and fixing railing including 90x60 mm top & bottom rails, trellis 60x45 mm including 2 coats of paint etc. all complete*

*WW0495* *900 mm high, Class 'A' (conifer)*

*WW0496* *900 mm high, Class 'B' (conifer)*

*WW0497* *1000 mm high, Class 'A' (conifer)*

*WW0498* *1000 mm high, Class 'B' (conifer)*

*WW0499* *1200 mm high, Class 'A' (conifer)*

*WW0500* *1200 mm high, Class 'B' (conifer)*

The work shall be done as per standard design or as directed by the Engineer. The planing, joinery and tolerance shall be as specified for items under doors & windows frame. The height of railing shall be measured from out to out of top and bottom rails.

**Measurement:** The item shall be measured in running metre correct to 10 mm.

**Rate:** The rate shall include all material and labour involved in the work.

**5.11.17 Pelmets**

- *Providing and fixing 100x12mm, with 25mm dia. wooden curtain rod and brackets including MS flats 25x3x100mm and plugs etc. complete*

*WW0505* *Class 'A' (conifer)*

*WW0506* *Class 'B' (conifer)*

- *Providing and fixing 150x12mm, with 25mm dia. wooden curtain rod and brackets including M.S flats 25x3x100mm and plugs etc. complete*

*WW0515* *Class 'A' (conifer)*

*WW0516* *Class 'B' (conifer)*

Sides, front and top of the pelmets shall be of 12mm planks or boards of specified width unless otherwise stated. These shall be projected from the wall face by 15 cm or as

specified, and shall be securely fixed to walls with wood screws by means of wooden plugs and 10 cm long 25 x 3 mm MS flat bent in the form of angle or by any other device approved by the Engineer. The pelmets shall be provided with curtain rods and brackets. Intermediate wooden brackets shall be provided, if the front length of pelmets exceed 1.5 metres.

**Measurement:** The pelmet shall be measured in running metres along the face planking correct to 10 mm.

**Rate:** The rate includes the cost of labour and materials required for all the operations described above.

**5.11.18 Shutters' Fittings**

- *Providing and fixing MS pressed butt hinges with necessary screws etc. complete*

*WW0525 100mm*

*WW0526 75mm*

*WW0527 50mm*

- *Providing and fixing MS tower bolt (barrel type) with necessary screws etc. complete*

*WW0535 250mm*

*WW0536 150mm*

*WW0537 100mm*

- *Providing and fixing MS sliding door bolt, bright finished, enamelled with necessary screws etc. complete*

*WW0545 300mm*

*WW0546 250mm*

*WW0547 200mm*

- *Providing and fixing MS handle with necessary screws etc. complete*

*WW0555 150mm*

*WW0556 125mm*

*WW557 100mm*

*WW0558 75mm*

- *Providing and fixing MS hook-and-eye with necessary screws etc. complete*

*WW0565 300mm*

*WW0566 200mm*

*WW0567 150mm*

*WW0568 100mm*

*WW0575 Providing and fixing MS door stopper with nuts and necessary screws complete*

- *Providing and fixing anodised aluminium butt hinges with necessary aluminium screws etc. complete*

*WW0580 100mm*

*WW0581 75mm*

- *Providing and fixing anodised aluminium tower bolt (barrel type) with aluminium screws etc. complete*

*WW0590 200mm*

*WW0591 150mm*

*WW0592 100mm*

- *Providing and fixing anodised aluminium sliding door bolts with nuts and aluminium screws etc. complete*

*WW0600 300mm*

*WW0601 250mm*

*WW0602 200mm*

- *Providing and fixing anodised aluminium handle with necessary aluminium screws etc. complete*

*WW0610 150mm*

*WW0611 125mm*

*WW0612 100mm*

*WW0613 75mm*

- *Providing and fixing anodised aluminium hook-and-eye with necessary screws etc complete*

*WW0620 300mm*

*WW0621 200mm*

*WW0622 150mm*

*WW0623 100mm*

- *Providing and fixing brass pressed butt hinges with necessary screws etc. complete*

*WW0635 100mm*

*WW0636 75mm*

*WW0637 50mm*

- *Providing and fixing brass tower bolt (barrel type) with necessary screws etc. complete*

*WW0645 250mm*

*WW0646 150mm*

*WW0647 100mm*

- *Providing and fixing brass sliding door bolt with nuts necessary screws etc. complete*

*WW0655 300mm*

*WW0656 250mm*

*WW0657 200mm*

- *Providing and fixing brass handle with necessary screws etc. complete*

*WW0665 150mm*

*WW0666 125mm*

*WW0667 100mm*

*WW0668 75mm*

*WW0675 Providing and fixing bright finish brass 100 mm mortise latch & pair of levers, handles with necessary screws etc. complete*

*WW0676 Providing and fixing bright finish brass spring-loaded, hinged door-closer with necessary screws etc. complete*

*WW0677 Providing and fixing bright finish brass hydraulic door-closer*

- *Providing and fixing bright finished brass hook-and-eye with necessary screws etc. complete*

*WW0685 150mm*

*WW0686 100mm*

*WW0678 Providing and fixing bright finished brass door stopper with nuts and necessary screws etc. complete*

**5.11.19 Kicking Plate**

*WW0630 Providing and fixing anodised aluminium kicking plate, 4 mm thick with necessary aluminium screws etc. complete*

The fittings to be provided in a particular work shall be as directed by the Engineer. The cost of providing and fixing fittings shall include the cost of hinges and necessary screws for fixing the same. Where fittings are stipulated to be supplied by the department free of cost, screws for fixing the fittings shall be provided by the contractor and no extra will be paid for the same.

The screws used for fittings shall be of the same metal and finished as the fittings. Fittings shall be fixed in proper position as shown in the drawings or as directed by the Engineer. These shall be truly vertical or horizontal as the case may be. Recesses shall be cut to the exact size and depth for the countersinking wherever required. Appropriate length of screws and numbers shall be used for each fitting. Screws shall be driven home with screwdriver so those headrests snugly in the countersunk provided. Screws shall not be hammered in. The fixing of the fittings shall be done so that the fittings operate smoothly and perform the functions for which they are intended without any constraint, nor should they hamper the functions of the doors, windows etc in any way.

**Measurement:** All fittings listed above except the kicking plates shall be measured in numbers. The kicking plate shall be measured correct to 10 mm and area calculated in sq.m corrects to two decimal places.

**Rate:** The rate includes the cost of labour and materials required for all the operations described above.

### 5.11.20 Frame Hold Fast

*WW0695 Providing and fixing 40x3mm MS hold fast 400mm long including fixing to frame with 10mm bolts & nuts, wooden plugs, & concrete blocks 300x100x150mm with 1:3:6 concrete mix, 20mm aggregate*

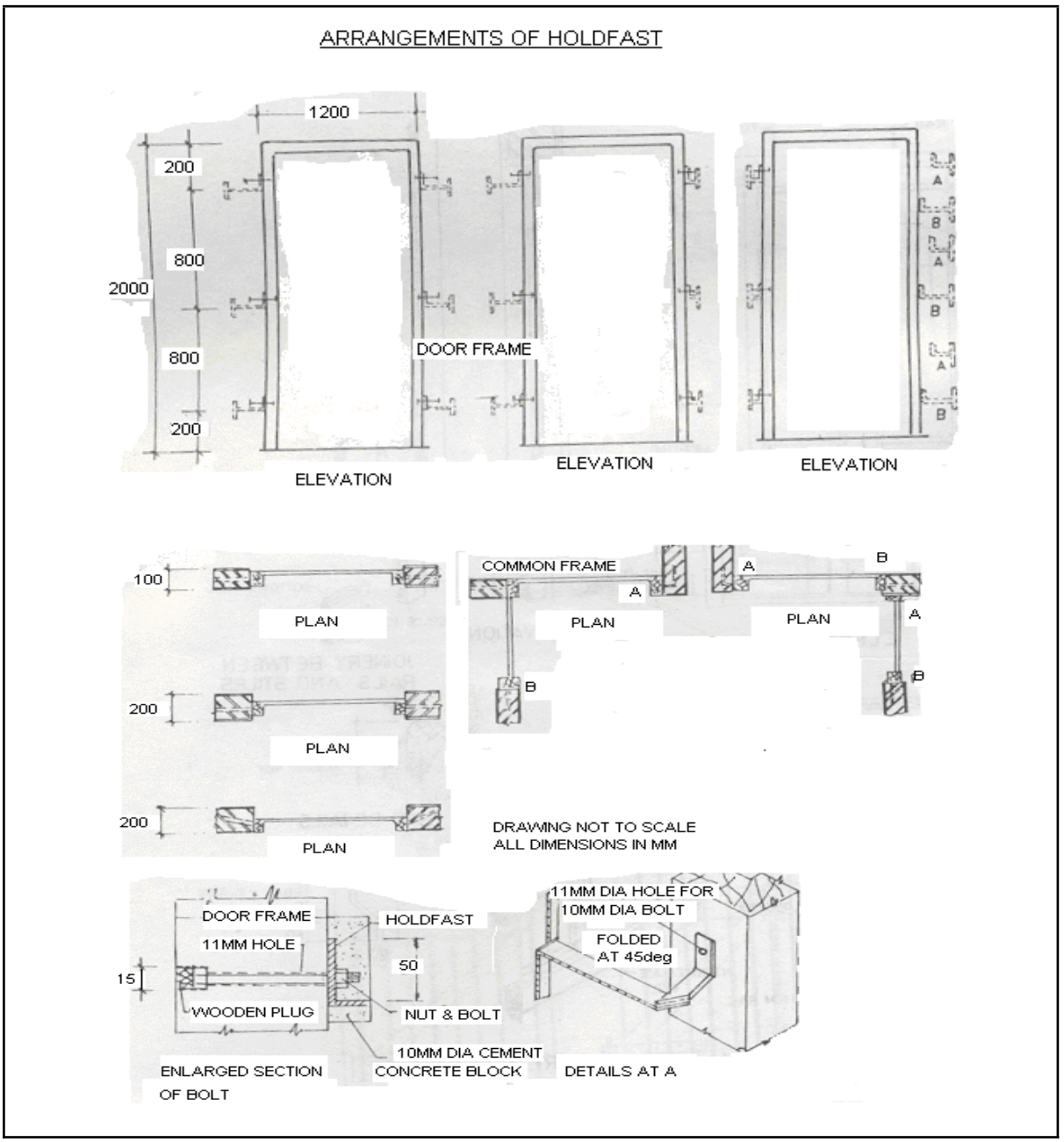



**Fig 5.11.9** Arrangement of holdfast

These shall be made from mild steel flat iron of specified size. Five cm length at one end of the hold fast shall be bent at right angles and one hole of 11 mm diameter shall be made in it for fixing to the frame with 10 mm diameter bolt. The bolt head shall be sunk into the frame and covered with a wooden plug 10 mm long. At the other end, the hold fast shall be forked and bent at right angles in opposite directions and fixed in a cement concrete block of specified size.

**Measurement:** The hold fast shall be measured in numbers.

**Rate:** The rate for each hold fast includes the cost of materials and labour required in all the operations described above.

### 5.11.21 Ceiling Insulation

*WW0700 Providing & laying dry earth in ceilings including providing and laying of plastic sheet barrier*

Prior to laying the earth, proper bedding shall be prepared and approved by the engineer. It shall be made sure that mud does not fall from the ceiling. 200 micro-metre plastic sheets shall be provided as bed to the dry mud.

The mud used shall be sun dried and shall be free from green organic materials, stone, etc. Perfectly dry earth shall then be mixed with straw or hay where the percentage of straw mixed does not exceed 20% of the earth by weight. The earth shall be rammed with iron/wooden ramming tools.

**Measurements:** Volume of consolidated filling shall be measured. The dimensions shall be measured correct to the nearest 10mm and cubical contents worked out in cubic metre correct to two places of decimal.

**Rate:** The rate includes the cost of materials and labour involved in all the operations described above. If a plastic sheet is not used, the cost of the same shall be deducted.

### 5.11.22 Skylight

*WW0705 Providing and fixing polycarbonate skylight translucent diffuser panel including 50x12 beading etc. complete.*

### 5.11.23 Timber Carving

*WW0710 Providing and fixing Decorative Traditional Timber Carving*

**Measurement:** The work shall be measured in sq.m correct to two places of decimal.

***Rate:*** The rate includes the cost of materials and labour involved in all the operations described above.

- *Bhutanese Traditional timber carving in cornice elements, rabsey, kachen, zhathri, tashi dargay, etc including drawing paints (chapa Zhomi) complete ( excluding traditional painting)*

*WW0711 Rab*

*WW0712 Ding*

*WW0713 Thama*

**Preparation of surface:** Wooden Surface: The woodwork to be carved shall be dry and free from moisture. The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sandpaper and shall be well dusted. Knots, if any, shall be avoided within the area of carving.

**Classification**: Traditional Bhutanese timber carvings are classified into three categories namely rab, ding and thama. Bill of quantities shall be based on these three categories unless stated otherwise.

Usually timber carving is carried out in the following members unless stated by the client:

1. **Cornices:** Boh, Pem, Pedhen and Dung are the elements of cornice for carving.
2. **Rabsey:** Zhurkha/Zeko, Thangcho, gochu Zing, Kachung. Zhutse, Zhu langtho and Drar are the important elements of carving in Rabsey.
3. **Kachen:** Chang Khep, Geb Dezhu, Kachen Pem, Thangwa and Reb, Kachen zhing, Zhungtshe and Ghenchu are the elements in Kachen for carving.
4. **Zhathri:** Norbu- to , Pem, Zhuden, Tshegey, Zhutshe and Tashi Dargay elements of carving in railing, etc.
5. Tashi Dagey and other auspicious symbols, etc.

**Drawing Chapa**: Adjust the paper to the surface to be carved, draw the design on the paper, and prick the lines of design by a pin. Place the paper back to the surface to be carved and rub the powder soaked cloth on the design paper. When the paper is withdrawn, powder marks are left on the surface which is to be carved for specified carving. This process is continued for carving the required surface.

**Physical Checking:** Physical checking shall be carried out on the quality of carving. The following steps shall be used as thumb rule to check the quality of the completed works:

I. Measure the depth of the carving and compare with the specified carving depth.
II. Check for any loosely attached or broken piece of timber.
III. Check the location of the carving and proportioning with the timber member.

**Applicability:** Generally, the following types of carving shall be applicable against the type of structures specified unless otherwise directed and approved by the engineer.

1. Rab: Rab carving shall be used in offices, dzong and other important places.
2. Ding: Ding carving shall be used in institutional buildings such as school, hospital, etc.
3. Thamar: Thamar carving shall be used in residential, staff quarter, and other similar buildings.

**Measurements:** The length and breadth shall be measured correct to 10mm. The area shall be calculated as sq. m correct to two places of decimal. The measurement shall be as per the actual carved area only.

**Rate:** Rate shall include cost of all labour involved in all operations described above for carving in inbuilt members. In case of carving not in-built, the rate shall include cost of all labour and materials involved in the operations.

### 5.11.24 uPVC Window, Doors and Partitions

#### 5.11.24.1 uPVC Window (Unplasticised Polyvinyl Chloride)

- *Providing and fixing uPVC sliding window (2-track system) of approved make and manufacture, fabricated from multi-chamber uPVC profiles with minimum outer wall thickness of 2.5 mm, reinforced with galvanized steel sections wherever required, complete with sliding shutters, 5 mm thick toughen glass, including hardware, accessories, weather sealing and finishing.*

*WW0960 Plain white window*

*WW0961 Polished window*

*WW0162 Textured Window*

- *Providing and fixing uPVC sliding window (2.5-track system) of approved make and manufacture, fabricated from multi-chamber uPVC profiles with minimum outer wall thickness of 2.5 mm, reinforced with galvanized steel sections wherever required, complete with sliding shutters and integrated insect mesh shutter, 5 mm thick toughen glass, including hardware, accessories, weather sealing and finishing.*

*WW0965 Plain white window*

*WW0966 Polished window*

*WW0167 Textured Window*

- *Providing and fixing uPVC sliding window (3-track system) of approved make and manufacture, fabricated from multi-chamber uPVC profiles with minimum outer wall thickness of 2.5 mm, reinforced with galvanized steel sections wherever required, complete with sliding shutters, 5 mm thick toughened glass, including hardware, accessories, weather sealing and finishing.*

*WW0970 Plain white window*

*WW0971 Polished window*

*WW0972 Textured Window*

- *Providing and fixing uPVC casement window of approved make and manufacture, fabricated from multi-chamber uPVC profiles with minimum outer wall thickness of 2.5–2.8 mm, reinforced with galvanized steel sections wherever required, complete with openable shutters, 5 mm thick toughen glass, including hardware, accessories, weather sealing and finishing.*

*WW0975 Plain white window*

*WW0976 Polished window*

*WW0977 Textured Window*

#### 5.11.24.2 uPVC Doors/Partitions (Un plasticised Polyvinyl Chloride)

- *Providing and fixing uPVC sliding door/partition (2-track system) of approved make and manufacture, fabricated from multi-chamber uPVC profiles with minimum outer wall thickness of 2.5–2.8 mm, reinforced with galvanized steel sections wherever required, complete with sliding shutters, 8 mm thick toughen glass or panel infill as specified, including hardware, accessories, weather sealing and finishing.*

*WW0980 Plain white door*

*WW0981 Polished door*

*WW0982 Textured door*

- *Providing and fixing uPVC sliding door/partition (3-track system) of approved make and manufacture, fabricated from multi-chamber uPVC profiles with minimum outer wall thickness of 2.5–2.8 mm, reinforced with galvanized steel sections wherever required, complete with sliding shutters and integrated insect mesh shutter, 8 mm thick toughen glass or panel infill as specified, including hardware, accessories, weather sealing and finishing.*

*WW0985 Plain white door*

*WW0986 Polished door*

*WW0987 Textured door*

- *Providing and fixing uPVC sliding door/partition (3-track system) of approved make and manufacture, fabricated from multi-chamber uPVC profiles with minimum outer wall thickness of 2.5–2.8 mm, reinforced with galvanized steel sections wherever required, complete with sliding shutters, 8 mm thick toughen glass or panel infill as specified, including hardware, accessories, weather sealing and finishing.*

*WW0990 Plain white door*

*WW0991 Polished door*

*WW0992 Textured door*

- *Providing and fixing uPVC casement door of approved make and manufacture, fabricated from multi-chamber uPVC profiles with minimum outer wall thickness of 2.8–3.0 mm, reinforced with galvanized steel sections wherever required, complete with openable shutter, 8 mm thick toughened glass or panel infill as specified, including hardware, accessories, weather sealing and finishing.*

*WW0995 Plain white door*

*WW0996 Polished door*

*WW0997 Textured door*

**Installation**

I. There shall be a maximum gap of 3 to 5mm in between uPVC door / window frame and finished opening and the plastic packers shall be provided to maintain the level.
II. To maintain the exact dimension of the door or window, the opening shall be checked for dimension and orthogonally using a prefabricated template. Any defect shall be made good by the agency at his own cost before fixing the door or window.
III. The uPVC frames are to be fixed in a prepared opening in the walls. Window / door frame shall be fixed into the aperture by drilling through the outer frame to the existing structure and shall use 100x8mm fasteners of approved make.
IV. The gap between uPVC window / door and adjacent RCC/Brick/Stone cladding work shall be filled with weatherproof Silicon sealant of approved make to maximum 5mm depth and 5mm in width to allow expansion/contraction of uPVC profiles. Silicon sealant of matching colour of uPVC profile shall be applied over the backer rod.

**Precautions taken before installation of uPVC Window &Door**

I. Jambs, sills and soffits of the opening shall be finished with plaster / stone / tiles according to agreement where the uPVC window / door to be fixed.
II. Aperture shall be smooth in line and level as well as in plumb.
III. Flooring (where casement door is to be installed should be complete before installation of door).
IV. The grill where to be installed in the sliding / casement window should be provided after the installation of the window.
    (a) For sliding windows – The grill shall be provided on the outer face of the window.
    (b) For casement windows – The grill shall be provided on the inner face of the window.
V. Installation of uPVC door and window should be done before the last coat of the paint on the wall where window jambs, sills and soffits to be finished by paint. At least one coat of paint should be done before installation begins.
VI. The colour of the profile shall be same and uniform on any surfaces or part of the surfaces which may be visible after installation of the window/door fabricated from the profile, when viewed by the normal vision.
VII. The uPVC profiles manufacturer shall provide warranty of 10 years for colour fastness and any manufacturing defects in respect of uPVC profiles as well as water and air tightness in case of casement uPVC door/window unit.
VIII. uPVC door/windows hardware and fittings manufacturer shall provide warranty of 10 years for any manufacturing defects.

**Measurements:** The length and breadth shall be measured correct to 10 mm. The area shall be calculated as sq. m correct to two places of decimal.

**Rate:** The rate includes the cost of materials and labour involved in all the operations described above.

**5.11.25 GRC (Glass Fiber Reinforced Concrete) Window**

- *Providing and fixing of Traditional Bhutanese style GRC window frames with cornice, side borders, and sill as per the standard design and detailed drawing, including the cost of nuts, bolts, anchors, sealant, complete excluding decorative painting*

*WW0750 1 Bay with Window size 853X1385mm full set*

*WW0751 1 Bay with Window size 780X1000mm full set*

*WW0752 2 Bay with Window size 1416X1385mm full set*

*WW0753 3 Bay with Window size 1979X1385mm full set*

*WW0754 3 Bay with Window size 1979X1140mm full set*

*WW0755 4 Bay with Window size 2542X1385mm full set*

- *Providing and fixing of Traditional Bhutanese style GRC window frame for Rabsey as per the standard design and detailed drawing, including the cost of nuts, bolts, anchors, sealant, complete excluding cornice, side borders, sill and decorative painting*

*WW0756 3 Bay Rabsey window size 1785x1600 (frame only)*

*WW0757 4 Bay Rabsey window size 2350x1600 (frame only)*

**Materials**

**GRC Window Frame Components**

The GRC window frame and all its components shall be factory-cast using high-quality cement, fine aggregate, alkali-resistant glass fiber, admixtures, and water. All aspects of GRC production from raw materials, through production, curing, and storage to quality assurances and testing, should be carried out as per "Specification for the manufacture, curing and testing of glass fiber Reinforced Concrete (GRC) products" published by The International Glassfibre Reinforced Concrete Association (GRCA).

The full set shall consist of the main window frame, traditional cornice, loshog (side frames), and chidren (sill). The dimensions and design shall be according to the approved drawing and conform to Bhutanese Architectural Guidelines.

The surface must be smooth and free from cracks, bubbles, or other defects. The thickness of each component should not be less than 12mm.

**Anchors and Fasteners**

The window components shall be anchored to the wall or RCC structure using corrosion-resistant stainless steel (Grade 304 or better) anchor bolts. The anchoring system must be pre-approved and compatible with the structure and GRC material.

**Sealants and Fillers**

After the installation of the window components, the gaps and holes shall be sealed with GRC mortar.

**Handling and Storage**

GRC components shall be handled with care to avoid chipping or cracking. It should be stored on level ground with padded supports and covered to protect from moisture and dust.

**Installation Steps**

**1. Preparation of wall**: Ensure that the wall openings are prepared as per the dimensions given in the approved drawings. The surface for the opening shall be checked with a plumb level before installation.

**2. Fixing of Frame**: Position the main GRC window frame in the opening with uniform gaps all around. Use stainless steel brackets or dowels to anchor the frame to the wall. Insert non-corrosive packers to maintain position during fixing.

**3. Fixing of Cornice**: After fixing the main window frame, the GRC cornice shall be installed above the main frame. It shall be anchored to the RCC lintel using stainless steel brackets or dowels. Care should be taken to align the edges of the cornice with the main window frame.

**4. Fixing of Chiden (sill)**: The GRC sill shall be placed on a levelled surface and should be aligned with the edges of the main window frame. After checking the level with a plumb bob, the sill shall be anchored to the reinforced concrete sill using stainless steel brackets or dowels.

**5. Fixing of Loshog (side frames)**: The side frames shall be placed in position, and the level shall be checked with a plumb bob. After ensuring proper alignment, the frames shall be anchored to the wall using stainless steel brackets or dowels.

**6. Joints and Finishing**: Seal the holes and joints using GRC mortar and complete by sanding for a smooth finish wherever required.

**Measurements:** The measurement shall be in numbers (Each) of windows installed, complete in all respects.

**Rate:** It shall include all the materials and labour involved in the operations described above.

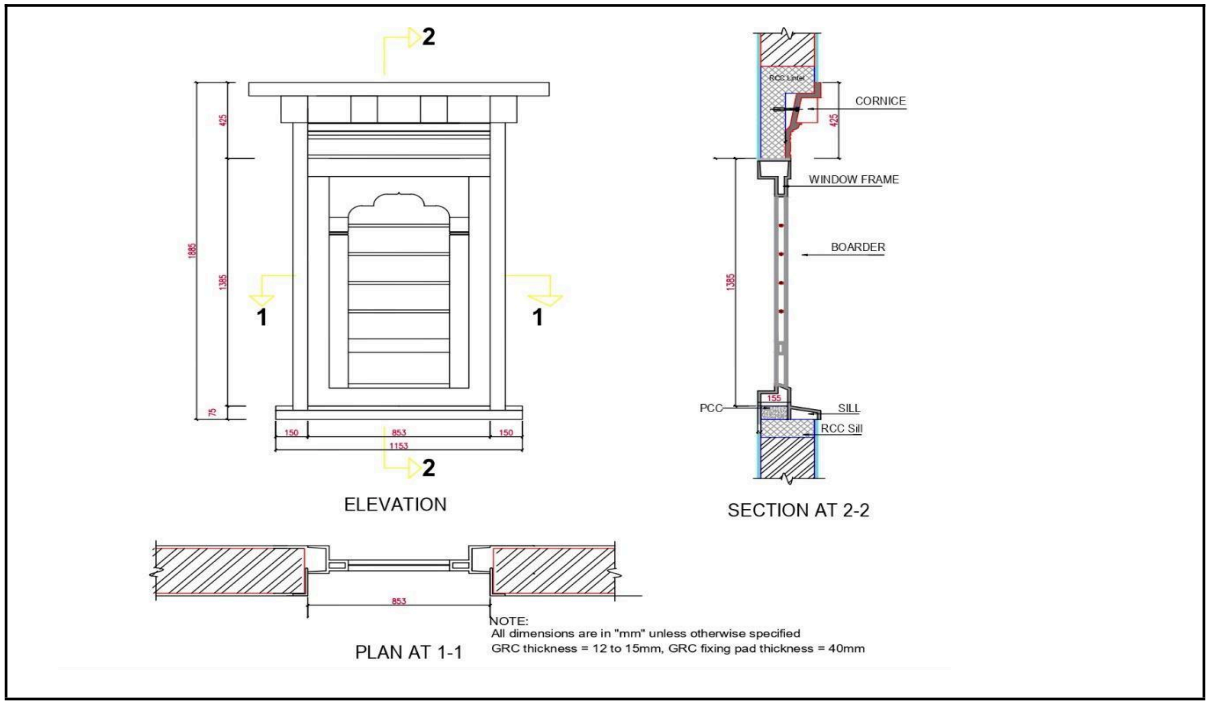



**Fig 5.11.10 GRC Window 1 Bay 853mmX1385mm (Full set)**

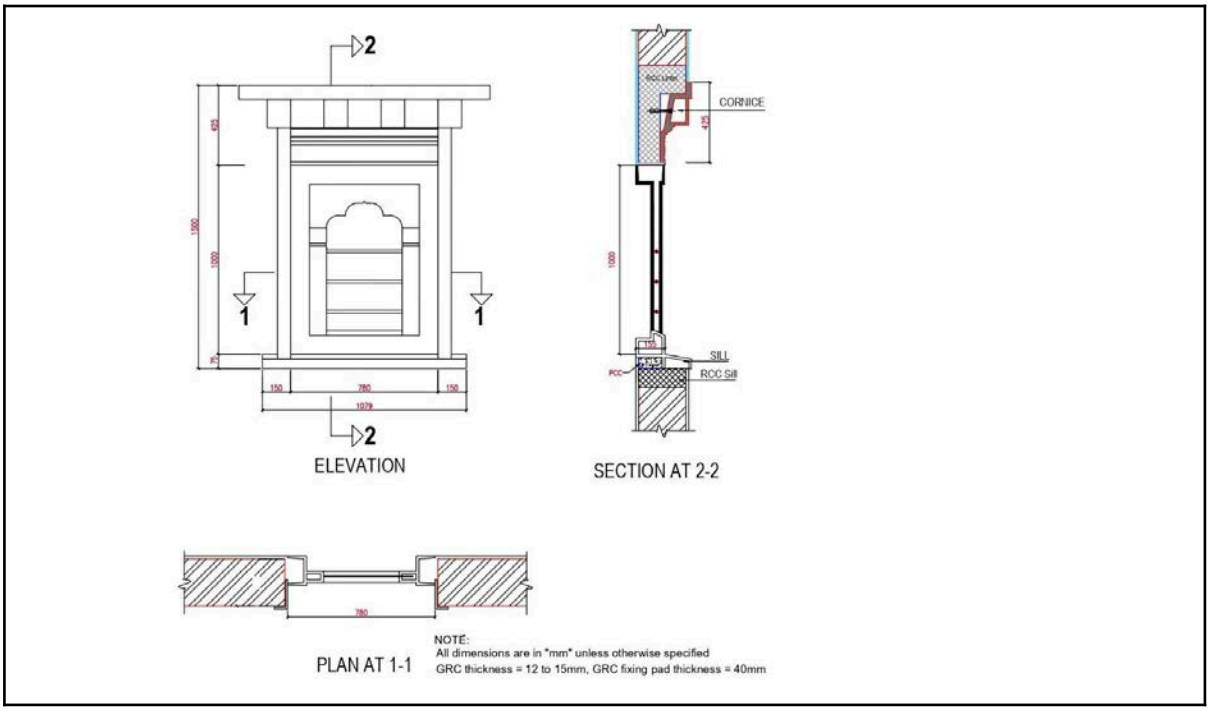



**Fig 5.11.11 GRC Window 1 Bay 780mmX1385mm (Full set)**

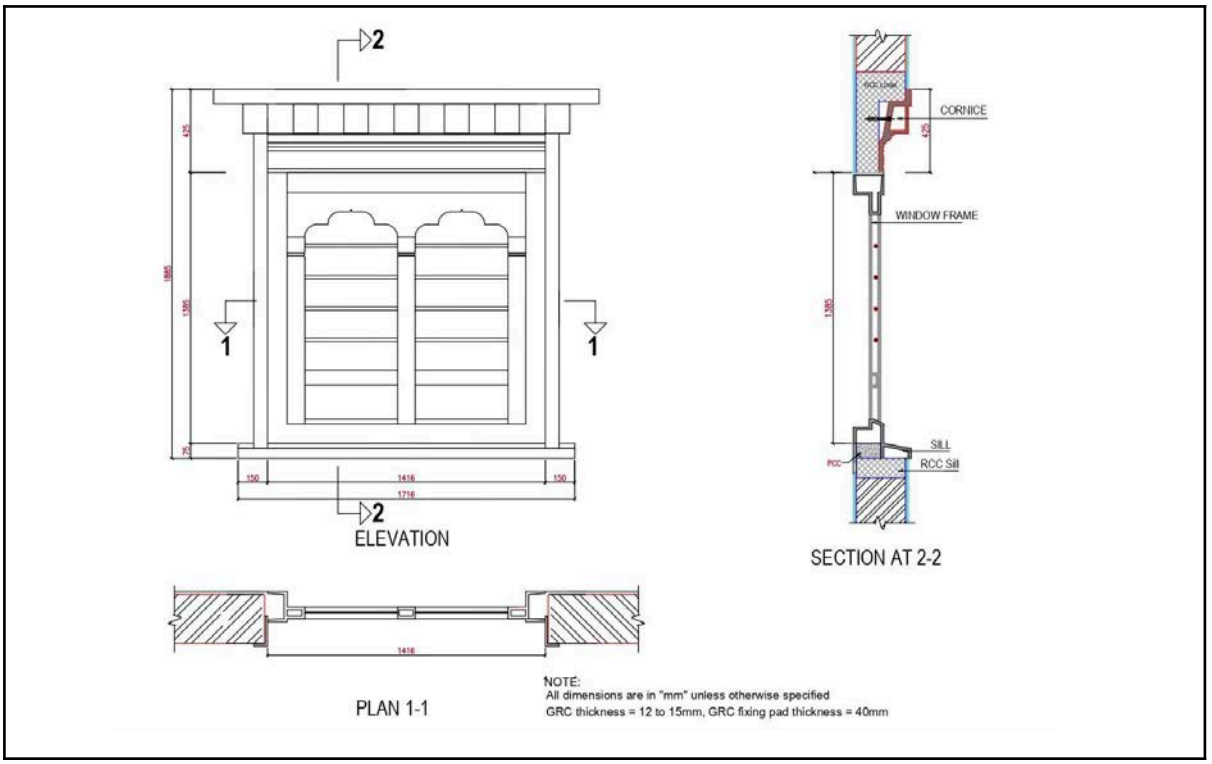



**Fig 5.11.12 GRC Window 2 Bay 1416mmX1385mm (Full set)**

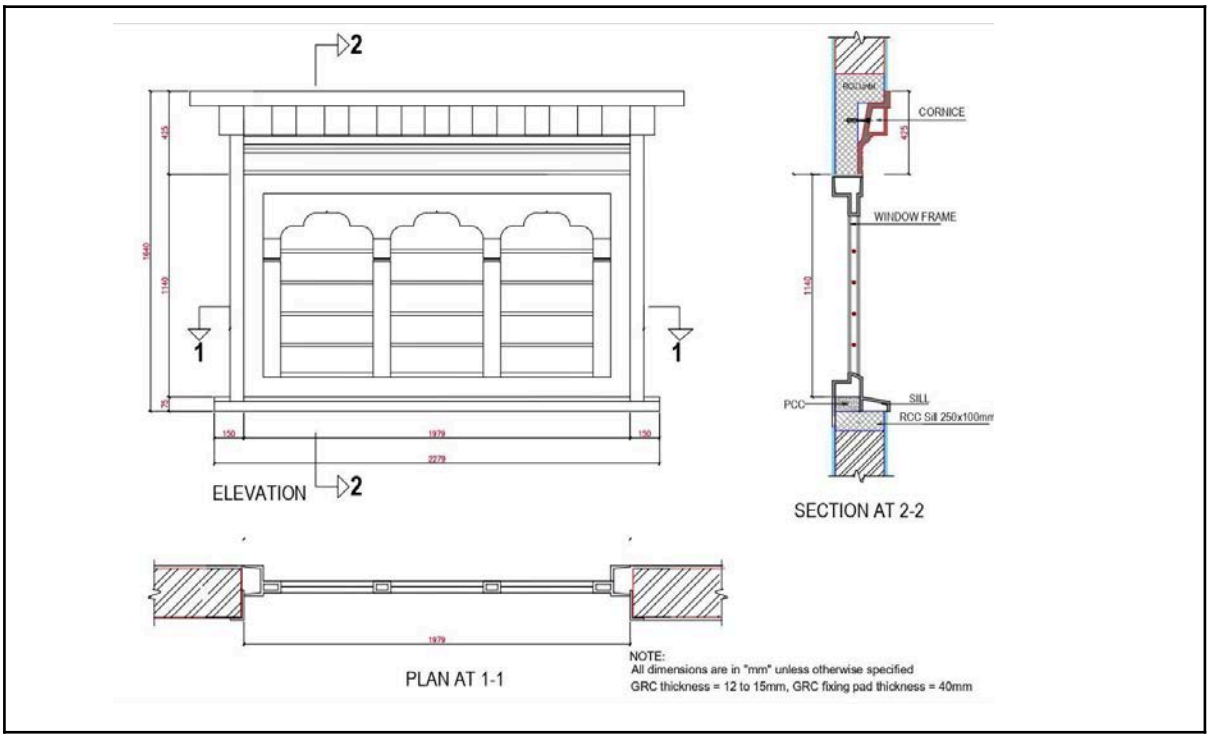



**Fig 5.11.13 GRC Window 3 Bay 1979mmX1140mm (Full set)**

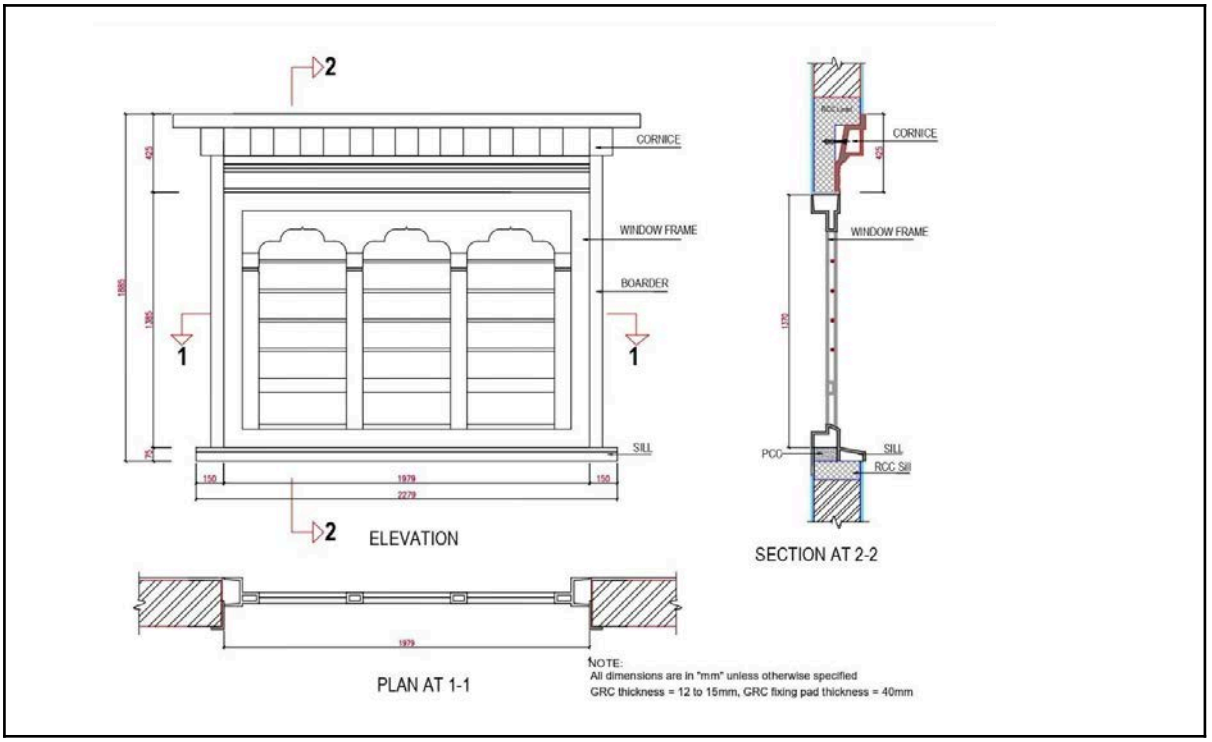



**Fig 5.11.14 GRC Window 3 Bay 1416mmX1385mm (Full set)**

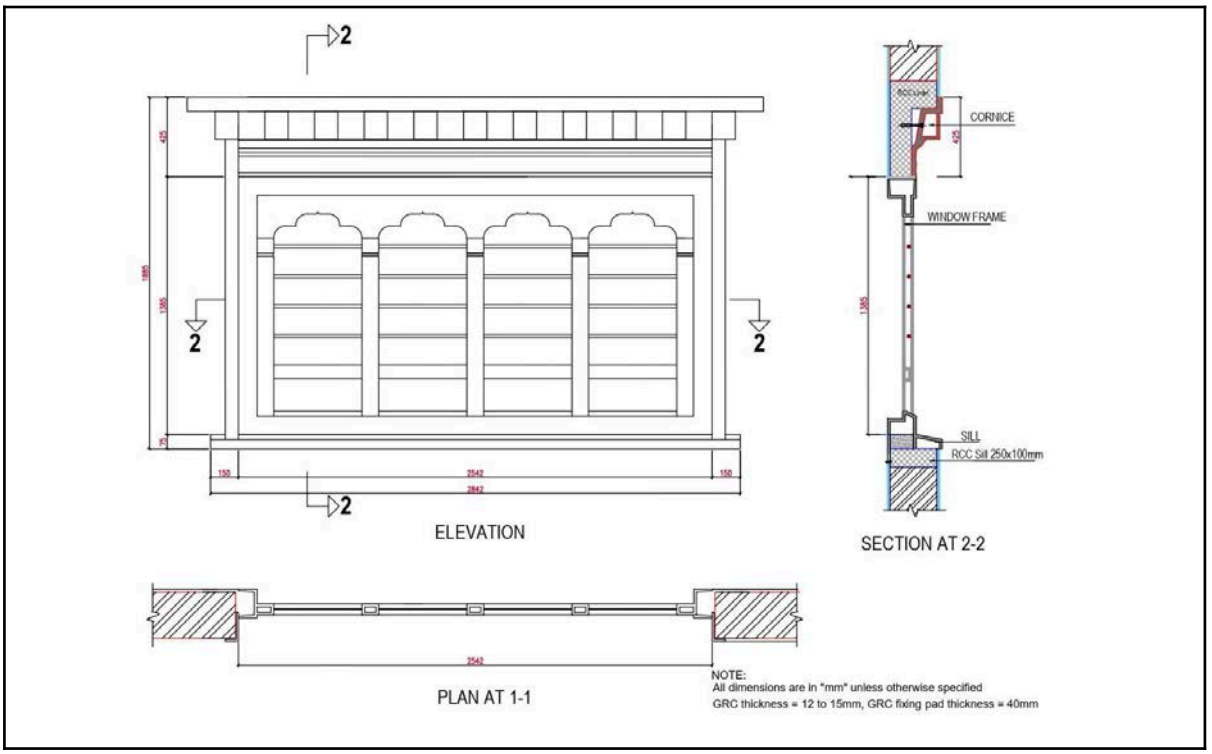



**Fig 5.11.15 GRC Window 4 Bay 2542mmX1385mm (Full set)**

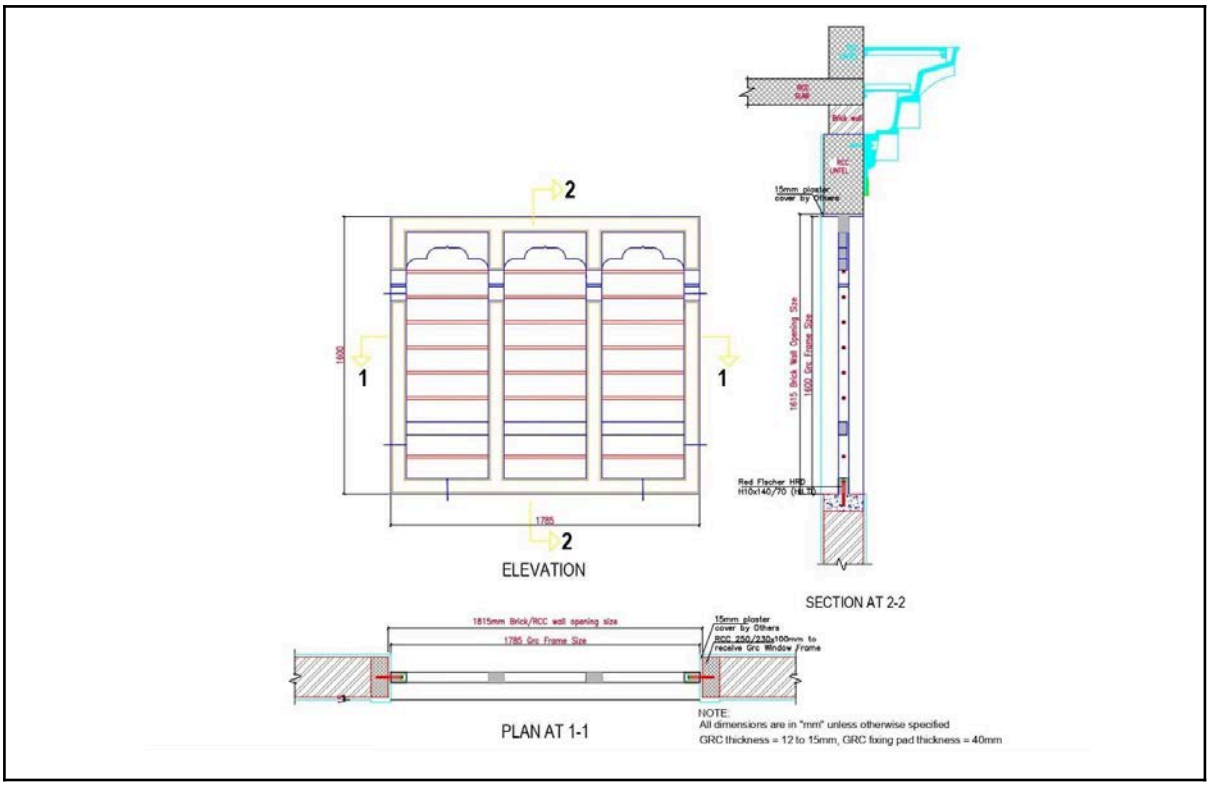



**Fig 5.11.16 GRC Rabsey Window 3 Bay 1785mmX1600mm (Frame Only)**

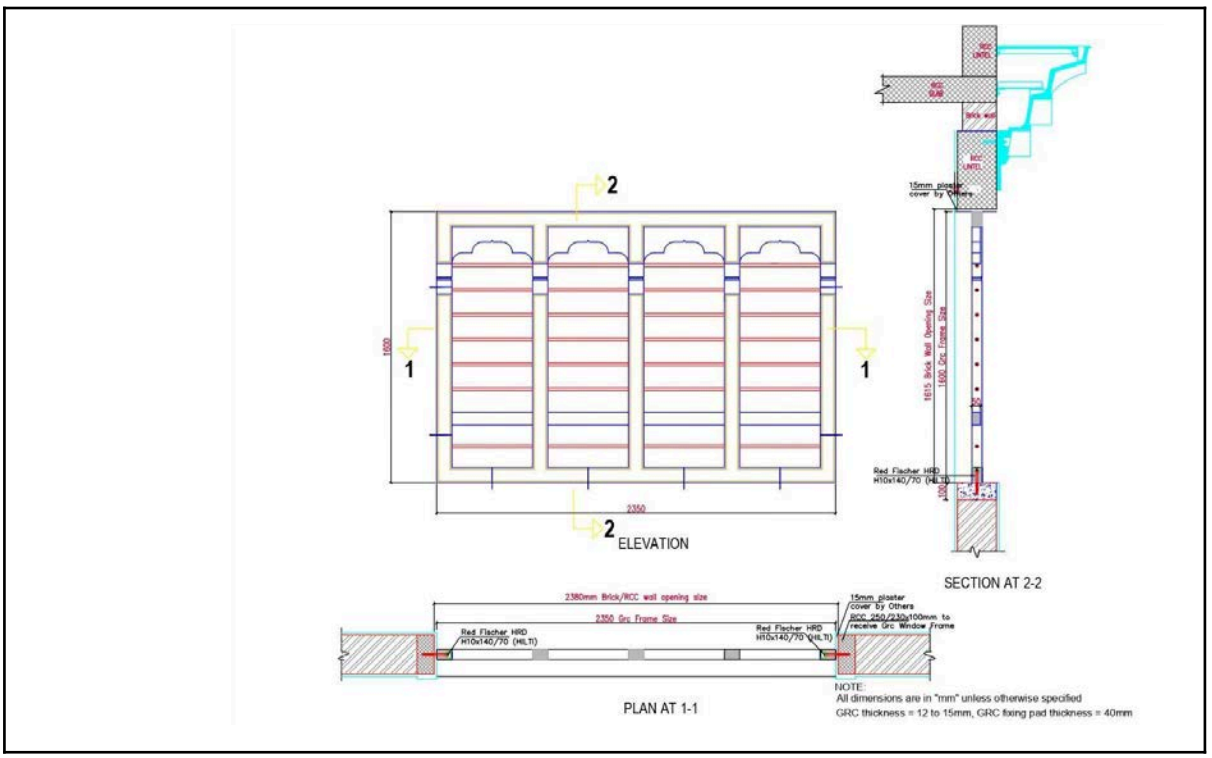



**Fig 5.11.17 GRC Rabsey Window 3 Bay 2350mmX1600mm (Frame Only)**

**5.11.26 SOFFIT CEILING**

**5.11.26.1 PVC Soffit Ceiling**

- *Providing and fixing to frames PVC soffit ceiling of approved texture, design and pattern including finishing of Joints complets (Excluding cost of Frame).*

*WW0830 PVC soffit board 8 mm thick*

*WW0831 PVC soffit board 9 mm thick*

*WW0832 PVC soffit board 12.5 mm thick*

**Applicable Standard:** The work shall generally conform to the relevant provisions of:

- IS 2441:1984 - Code of Practice for Fixing Ceiling Coverings
- IS 277:2003 - Galvanized Steel Sheets
- IS 6307:1985 - Specification for Rigid PVC Sheets.

**Installation:** PVC panels shall be cut accurately to required sizes and fixed securely to the supporting framework using approved screws, clips or fixing methods recommended by the manufacturer. Fixing shall be carried out without causing distortion, cracking, bending or damage to the panels.

Suitable expansion gaps shall be maintained at perimeters, joints, trims and abutments to allow thermal movement of PVC panels. Panels shall not be tightly restrained.Where ventilation is required for roof or eaves areas, perforated PVC soffit panels, vents or approved ventilation accessories shall be provided as shown in the drawings or as directed by the Engineer.

Necessary openings for light fittings, diffusers, access panels, electrical conduits and other services shall be neatly formed and reinforced where required. The finished ceiling surface shall be true to line and level and shall be free from sagging, gaps, waviness, undulations, stains, scratches, loose panels and visible defects.

PVC soffit ceiling shall not be used where fire-rated, non-combustible or high-temperature ceiling lining is required unless the product has certified fire performance approved by the Engineer and relevant authority.

**Measurement:** The PVC soffit ceiling shall be measured in square metres of finished surface area. Length and breadth shall be measured correct to 10 mm and area calculated correct to two decimal places. No deduction shall be made for openings up to 0.5 m² each. Openings exceeding 0.5 m² shall be deducted.

**Rate:** The rate shall include the cost of PVC panels, fasteners, anchorages, cutting, trimming, wastage, making openings for services, labour, tools and complete installation in all respects.

**5.11.26.2 PPGI Soffit Ceiling**

- *Providing and fixing to frames PPGI Sheet soffit ceiling of approved texture, design and pattern including finishing of Joints complets (Excluding cost of Frame)*

*WW0840 PPGI sheet- 0.3 mm*

*WW0841 PPGI sheet- 0.4 mm*

**Applicable Codes and Standards:** The work shall generally conform to the relevant provisions of the following standards:

| Code / Standard | Description |
|---|---|
| IS 14246 | Continuously pre-painted galvanized steel sheets and coils |
| IS 277 | Galvanized steel sheets and strips |
| IS 15965 | Pre-painted aluminium-zinc alloy metallic coated steel sheets and coils |
| IS 513 | Cold reduced low carbon steel sheets and strips |
| IS 2441 | Code of practice for fixing ceiling coverings |
| IS 800 | General construction in steel |
| IS 1367 series | Technical supply conditions for threaded steel fasteners |
| IS 875 series | Design loads for buildings and structures |
| IS 101 series | Methods of testing paints, varnishes and related products |

**Installation:** Before installation, the soffit area shall be checked for line, level, dimensions, structural support and clearance for services. Any uneven surface or unsuitable fixing location shall be reported to the Engineer before proceeding.

The panels shall be fixed true to line and level using approved corrosion-resistant screws, clips or concealed fixing system as recommended by the manufacturer. Panels shall be installed with proper side laps, end laps, joints and expansion allowance where required.

All panels shall be cut accurately to size using suitable tools. Cut edges shall be neat, straight and free from burrs. Damaged or distorted panels shall not be used.

Joints shall be properly aligned and covered with approved joint strips, trims or cover profiles where required. Edge trims, corner trims, wall angles and finishing profiles shall be fixed neatly to provide a clean and uniform appearance.

Where ventilation is required, perforated or slotted soffit panels shall be used as shown in the drawings.

**Handling and Storage:** PPGI panels shall be handled carefully to avoid bending, scratching, denting or damage to the paint coating. Panels shall be stored on raised supports in a dry, covered and well-ventilated area.

Panels shall not be stored directly on the ground or exposed to standing water. Protective film, if provided, shall be removed after installation within the manufacturer's recommended time.

**Inspection and Quality Control:** The contractor shall submit the manufacturer's technical data sheet, material test certificate, coating details, colour samples, panel profile and shop drawings for approval before commencement of work.

The Engineer shall inspect the materials before installation. Materials not conforming to the approved specification, sample or technical data shall be rejected.

After installation, the soffit ceiling shall be inspected for alignment, level, fixing, joint treatment, finish, cleanliness and overall appearance. Any defective work shall be rectified or replaced as directed by the Engineer.

**Measurement:** Measurement shall be taken in square metres of finished soffit ceiling area actually installed, unless otherwise specified. No separate measurement shall be made for laps, wastage, screws, trims, wall angles, fasteners, accessories, supporting framework or other incidental items unless specifically stated in the Bill of Quantities.

**Rate:** The rate shall include the cost of PPGI soffit panels, screws, fasteners, accessories, cutting, fixing, wastage, tools, labour, transportation, handling, storage, cleaning and all other works necessary to complete the soffit ceiling in accordance with the drawings, specifications.

**5.11.26.3 PPGL Soffit Ceiling**

- *Providing and fixing to frames PPGL Sheet soffit ceiling of approved texture, design and pattern including finishing of Joints complets (Excluding cost of Frame)*

*WW0850 PPGL sheet- 0.35 mm*

*WW0851 PPGL sheet- 0.4 mm*

**Applicable Codes and Standards:** The work shall generally conform to the relevant provisions of the following standards:

| Code / Standard | Description |
|---|---|
| **IS 14246** | Continuously pre-painted galvanized steel sheets and coils |
| IS 277 | Galvanized steel sheets and strips |
| IS 15965 | Pre-painted aluminium-zinc alloy metallic coated steel sheets and coils |

| | |
|---|---|
| IS 513 | Cold reduced low carbon steel sheets and strips |
| IS 2441 | Code of practice for fixing ceiling coverings |
| IS 800 | General construction in steel |
| IS 1367 series | Technical supply conditions for threaded steel fasteners |
| IS 875 series | Design loads for buildings and structures |
| IS 101 series | Methods of testing paints, varnishes and related products |

**Installation:** Before installation, the soffit area shall be checked for line, level, dimensions, structural support and clearance for services. Any uneven surface or unsuitable fixing location shall be reported to the Engineer before proceeding.

The panels shall be fixed true to line and level using approved corrosion-resistant screws, clips or concealed fixing system as recommended by the manufacturer. Panels shall be installed with proper side laps, end laps, joints and expansion allowance where required.

All panels shall be cut accurately to size using suitable tools. Cut edges shall be neat, straight and free from burrs. Damaged or distorted panels shall not be used.

Joints shall be properly aligned and covered with approved joint strips, trims or cover profiles where required. Edge trims, corner trims, wall angles and finishing profiles shall be fixed neatly to provide a clean and uniform appearance.

Where ventilation is required, perforated or slotted soffit panels shall be used as shown in the drawings.

**Handling and Storage:** PPGL panels shall be handled carefully to avoid bending, scratching, denting or damage to the paint coating. Panels shall be stored on raised supports in a dry, covered and well-ventilated area.

Panels shall not be stored directly on the ground or exposed to standing water. Protective film, if provided, shall be removed after installation within the manufacturer’s recommended time.

**Inspection and Quality Control:** The contractor shall submit the manufacturer's technical data sheet, material test certificate, coating details, colour samples, panel profile and shop drawings for approval before commencement of work.

The Engineer shall inspect the materials before installation. Materials not conforming to the approved specification, sample or technical data shall be rejected.

After installation, the soffit ceiling shall be inspected for alignment, level, fixing, joint treatment, finish, cleanliness and overall appearance. Any defective work shall be rectified or replaced as directed by the Engineer.

**Measurement:** Measurement shall be taken in square metres of finished soffit ceiling area actually installed, unless otherwise specified. No separate measurement shall be made for laps, wastage, screws, trims, wall angles, fasteners, accessories, supporting framework or other incidental items unless specifically stated in the Bill of Quantities.

**Rate:** The rate shall include the cost of PPGL soffit panels, screws, fasteners, accessories, cutting, fixing, wastage, tools, labour, transportation, handling, storage, cleaning and all other works necessary to complete the soffit ceiling in accordance with the drawings, specifications.

### 5.11.27 WALL PANELLING

#### 5.11.27.1 PVC Wall Panelling

- *Providing & fixing PVC wall panelling profiles with necessary screws, etc., complete (Excluding the cost of frame)*

*WW0870* *PVC panelling 10 mm thick*

*WW0871* *PVC panelling 12 mm thick*

**Code:** The work shall conform to IS 1414:1989 – Code of Practice for Fixing of Wall Coverings. Where supporting framework forms part of panel construction, principles of jointing and stability shall follow IS 11447:1985. PVC soffit/ceiling panel material properties conform to IS 6307:1985-Specification for Rigid PVC Sheets.

**Installation:** The wall surface shall be cleaned, prepared and checked for plumb and alignment before installation. PVC panels shall be stored flat and acclimatized at site for at least 24 hours prior to fixing.

Panels shall be installed vertically or horizontally as shown on the Drawings and fixed using grooves, concealed clips or approved fixing systems to minimize visible fasteners. The fixing and jointing system shall allow thermal and moisture movement in accordance with IS 1414:1989, with expansion gaps of 3 mm to 5 mm at joints, perimeter edges and abutting surfaces, unless otherwise recommended by the manufacturer.

Internal and external corners, cut edges, openings and service penetrations shall be neatly finished using matching PVC trims, edge profiles, corner sections and joining strips. All exposed cut edges shall be sealed or protected to prevent moisture ingress and deterioration.

The supporting framework shall be plumb, level, rigid and securely anchored at intervals not exceeding 600 mm centre to centre. It shall comprise preservative-treated timber battens of minimum 40 mm × 20 mm conforming to IS 401 where applicable, or galvanized steel sections of adequate rigidity. Additional supports shall be provided around openings, corners, junctions and service penetrations.

Fasteners shall be stainless steel screws, corrosion-resistant fasteners or approved concealed fixing clips compatible with the panel system and supporting framework. The completed surface shall be true to line, plumb and level, and free from waviness, bulging, visible gaps, scratches or surface distortion.

**Measurement:**The PVC wall paneling shall be measured in square metres of finished surface. Length and height shall be measured correct to 10 mm and area calculated to two decimal places. No deduction shall be made for openings up to 0.5 sq.m each.

**Rate:**The rate shall include supply of PVC panels, trims, fasteners, cutting, wastage, making openings and complete installation in all respects.

**5.11.27.2 WPC Wall Panelling**

- *Providing & fixing WPC wall panelling profiles necessary screws, etc., complete (Excluding the cost of frame)*

*WW0880* *WPC panelling 18 mm thick*

*WW0881* *WPC panelling 22 mm thick*

*WW0882* *WPC panelling 24 mm thick*

**Applicable standard:** The work shall conform to IS 1414:1989 – Code of Practice for Fixing of Wall Coverings. Structural stability and joint detailing principles shall comply with IS 11447:1985 where applicable.

**Installation:** WPC panels shall be installed vertically or horizontally as per drawings.

Expansion gaps shall be provided as per manufacturer's recommendations to accommodate thermal movement. Panels shall be fixed using concealed clip systems wherever specified. Joints shall be properly aligned to allow movement and avoid cracking. Cut edges shall be neatly finished and concealed with trims wherever required.

The supporting framework shall be plumb, level, rigid and securely anchored at intervals not exceeding 600 mm centre to centre. It shall comprise preservative-treated timber battens of minimum 40 mm × 20 mm conforming to IS 401 where applicable, or galvanized steel sections of adequate rigidity. Additional supports shall be provided around openings, corners, junctions and service penetrations.

Fasteners shall be stainless steel screws or approved concealed fixing clips. PVC or aluminium trims, corner profiles and jointing strips shall be provided where required. Additional supports shall be provided around openings. The framework shall be true to line, level and plumb and securely fixed to wall using approved anchor fasteners at intervals not exceeding 600 mm.

**Measurement:** WPC wall paneling shall be measured in square metres of finished surface area. Length and height shall be measured correct to 10 mm and area calculated to two decimal places. No deduction shall be made for openings up to 0.5 sq.m each.

**Rate:** The rate shall include supply of WPC panels, trims, fasteners, clips, cutting, wastage, making openings and complete installation.

### 5.11.28 INSULATION

#### 5.11.28.1 Resin Bonded Rockwool

- *Providing and fixing thermal insulation with Resin bonded rock wool conforming to IS: 8183, wrapped in 200 G virgin Polythene bags placed over existing false ceiling and held in position by criss-crossing Gl wire.*

*WW0900* *Resin Bonded Rock wool 43 kg/m³ 75 mm thick*

*WW0901* *Resin Bonded Rock wool 75 kg/m³ 75 mm thick*

**Installation:** Before installation, the false ceiling area shall be inspected and cleaned. The existing false ceiling shall be checked for stability and any loose dust, debris or unwanted material shall be removed.

The polythene-wrapped resin bonded rock wool shall be carefully placed over the existing false ceiling in continuous layers. The insulation shall be laid closely butted together, without gaps, sagging, compression or displacement.Joints shall be staggered where possible to avoid thermal gaps. The insulation shall be neatly cut and fitted around light fittings, ducts, pipes, conduits, hangers and other services without leaving voids.

The insulation shall be held firmly in position by criss-crossing GI wire over the rock wool at suitable spacing. The GI wire shall be securely tied to the ceiling framework or approved supports to prevent movement, sagging or displacement of the insulation

**Fire Performance:** Rockwool insulation shall be non-combustible and suitable for use in fire-rated assemblies. The insulation shall not adversely affect the fire resistance rating of the structural element. Sealants used at joints and penetrations where specified shall be intumescent type compatible with the fire-rated system.

**Health and Safety:** Handling and installation shall comply with manufacturer's safety recommendations. Workers shall wear appropriate personal protective equipment including gloves, goggles and dust masks during installation. Waste materials shall be collected and disposed of in accordance with local regulations.

The insulation shall be installed in a neat and workmanlike manner. It shall remain dry, intact and uniformly distributed over the ceiling area. The polythene wrapping shall not be torn or

punctured during installation. Any damaged wrapping shall be replaced or sealed with approved adhesive tape. Care shall be taken not to overload or damage the existing false ceiling, electrical fittings, air-conditioning ducts, sprinkler lines or other services.

**Measurement:** Rockwool soffit insulation shall be measured in square metres of finished surface area. Length and breadth shall be measured correct to 10 mm and area calculated to two decimal places. No deduction shall be made for openings not exceeding 0.5 m².

**Rate:** The rate shall include supply and installation of bonded mineral wool slabs conforming to IS 8183, mechanical anchor fixings, retaining washers, drilling of holes, cutting, alignment, sealing of joints, scaffolding, labour, tools, wastage and all incidental works necessary for complete installation as shown on drawings or specifications.

### 5.11.29 Scaffolding and Propping Work

- *Providing, preparing, erecting, maintaining, bamboo scaffolding (dia > 75 mm), including removal from site upon completion, for building renovation and maintenance works only. (Not Applicable for new construction works)*

*WW0890 Upto 10m Height*

*WW0891 Multistorey Building*

- *Providing, hoisting/installation of bamboo Platform scaffoldings - (Dia > 75mm), and complete dismantling & removal on completion, only for renovation and maintenance work of hall ceiling, height > 4.5m, area > 25 sqm on plan. (Not Applicable for new construction works) –*

*WW0895 Hall Ceiling*

**Design and Load Capacity:** Scaffolding and propping shall be designed and erected to safely carry all expected loads, including self-weight, workers, tools, materials, equipment, wind loads, impact loads and any temporary construction loads.

The scaffold shall have adequate strength, stiffness and stability for the intended use. It shall not settle, sway, overturn, slip or collapse under working conditions. Where the scaffold is high, heavily loaded, specially shaped, suspended, cantilevered or used for structural support, the arrangement shall be checked and approved by a competent person or engineer before use.

Scaffolds shall not be overloaded beyond their safe working capacity. Heavy materials such as blocks, bricks, stones, reinforcement, formwork panels or equipment shall not be stored on working platforms unless the scaffold has been designed for such loading.

**Erection of Scaffolding:** Scaffolding shall be erected by trained and experienced workers under the supervision of a competent person. The scaffold shall be erected true to line, level and plumb.

The foundation shall be firm, level and capable of carrying the imposed load. Base plates and sole plates shall be provided under standards where required, especially on soil, filling, paving, slabs or weak surfaces. Loose bricks, blocks, stones, barrels or unstable supports shall not be used as scaffold bases.

Standards, ledgers, transoms, putlogs, braces and ties shall be fixed securely. Bracing shall be provided in both longitudinal and transverse directions as necessary to prevent sway and lateral movement. Scaffolds adjacent to buildings shall be tied securely to the structure at suitable intervals, unless designed as an independent scaffold.

Working platforms shall be properly supported, closely boarded or decked, and kept free from tripping hazards. Planks shall be secured against displacement and shall not be cracked, excessively deflected or overloaded.

Safe access shall be provided by ladders, stair towers, ramps or other approved means. Cross-braces shall not be used as access ladders.

**Working Platforms, Guardrails and Toe Boards:** Working platforms shall be of adequate width for the type of work being carried out and shall allow safe movement of workers and handling of tools and materials.

Open sides and ends of platforms from which persons or materials may fall shall be provided with guardrails, midrails and toe boards, unless other approved fall protection is provided. Toe boards shall be provided where falling tools or materials may endanger persons below.

Platforms shall be kept clean and free from loose debris, mortar, oil, water, protruding nails, waste materials and other slipping or tripping hazards.

**Inspection and Maintenance:** Scaffolding and propping shall be inspected before first use, after erection, after alteration, after severe weather, after impact or disturbance, and at regular intervals during use.

Any defective, loose, damaged, corroded, unstable or unsafe part shall be repaired or replaced immediately. No worker shall be permitted to use unsafe scaffolding or propping.

The contractor shall maintain the scaffold and propping in safe working condition throughout the period of use. Any unauthorized removal of braces, ties, guardrails, planks, access ladders or props shall not be permitted.

**Safety Requirements:** All scaffold users shall be instructed in safe use of scaffolds, access arrangements, load limitations and fall hazards. OSHA Subpart L includes requirements for scaffold training and general scaffold safety.

Workers shall use appropriate personal protective equipment, including helmets, safety shoes, gloves and safety harnesses where required. Where persons are working above or below scaffold areas, suitable barricading, warning signs, toe boards, screens or catch platforms shall be provided to protect against falling objects.

Adequate clearance shall be maintained from live electrical lines. Where work is near electrical hazards, suitable isolation, protection or safe working clearance shall be arranged before erection or use of scaffolding.

Scaffolds shall not be used during unsafe weather conditions such as strong winds, lightning, heavy rain or any condition likely to affect stability or worker safety.

**Dismantling:** Scaffolding and propping shall be dismantled only by trained workers under supervision. Dismantling shall be carried out in a safe sequence from top to bottom, ensuring that the stability of the remaining scaffold is maintained at all times.

Materials shall not be thrown from height. Tubes, boards, couplers, fittings, props and other components shall be lowered safely, sorted, stacked and removed from site. Damaged or unserviceable materials shall be separated and disposed of as directed.

**Measurement:** Unless otherwise stated, measurement shall be in square metres of scaffolded face area or working platform area, as applicable.

For wall or facade scaffolding, the measured area shall generally be the length multiplied by the height of the scaffolded surface. For platform scaffolding, measurement shall be based on the plan area of the working platform.

No separate measurement shall be made for bracing, ties, ladders, platforms, guardrails, toe boards, base plates, sole plates, couplers, fittings, erection, maintenance, shifting, dismantling or removal unless specifically stated.

**Rate:** The rate shall include the cost of all labour, materials, tools, equipment, transport, loading and unloading, erection, bracing, tying, platforms, guardrails, toe boards, access ladders, base plates, sole plates, inspection, maintenance, shifting where required, dismantling, stacking and removal from site. The rate shall also include all incidental works necessary to provide a safe and complete scaffolding or propping system for the proper execution of the work.

**5.11.30 Toughened Glass**

*WW0930 Providing and installation of 12 mm thick frameless toughened glass door shutter of approved brand and manufacture, including providing and fixing top & bottom pivot & double acting hydraulic floor spring type fixing arrangement and making necessary holes etc. for fixing required door fittings, all complete as per specification. (Door handle, lock and stopper to be paid separately).*

*WW0935 Providing and installation of vision glass panels (IGUs) comprising of hermetically- sealed 6-12-6 mm insulated glass (double glazed) vision panel units of size and shape as required and specified, comprising of an outer heat strengthened float glass 6mm thick, of approved colour and shade with reflective soft coating on surface, an inner Heat strengthened clear float glass 6mm thick, spacer tube 12mm wide, dessicants, including primary seal and secondary seal (structural silicone sealant) etc. all complete for the required performances as specified, as per technical specification.*

*WW0940 Providing and installation of Spandrel Glass Panels comprising of 6 mm thick heat strengthened monolithic float glass of approved colour and shade with reflective soft coating on surface, all complete for the required performances as specified, as per technical specification.*

*WW0945 Providing & installation of toughened glass with Spider Fittings of SS-316 Grade Steel of approved manufacturer with glass panel having 12 mm thick clear toughened glass held together with SS-316 Grade Stainless steel Spider & bolt assembly with laminated glass fins 21 mm thick. The Glass fins and glass panel assembly shall be connected to Slab/ beams by means of SS- 316 Grade stainless steel brackets & Anchor bolts and at the bottom using SS channel of 50x25x2mm using fastener & anchor bolts, non staining weather sealants of approved make, Teflon/ nylon bushes and separators to prevent bi-metallic contacts, all complete to perform as per specification and approved drawings. The complete system to be designed to accommodate thermal expansion & seismic movements etc. The joints between glass panels (6 to 8 mm) and gaps at the perimeter & in U channel of the assembly to be filled with non staining weather sealant, so as to make the entire system fully water proof & dust proof. all fitting fixers nut bolts, washer, Buffer plates, fastener, anchors, SS channel laminated glass etc. all complete.*

**Handling and Storage:** Glass panels shall be transported, handled and stored vertically on padded supports. Glass shall not be dragged, dropped, struck, leaned directly against hard surfaces or allowed to come into direct contact with concrete, stone, steel or abrasive materials.

Protective corner guards, separators and packing materials shall remain in place until installation. Large glass panels shall be lifted using approved suction lifting equipment and adequate manpower.

Damaged, chipped, cracked, scratched, distorted or defective glass shall not be installed.

**Fabrication:** Glass dimensions shall be verified from actual site measurements before fabrication.

All holes, notches, cut-outs, drilling, edge polishing and edge processing required for patch fittings, pivots, spider fittings, rotules, handles, locks and other accessories shall be completed before toughening.

No cutting, drilling, grinding, edge modification or surface alteration shall be permitted after toughening.

Holes and cut-outs shall be accurately positioned and sized to suit the approved fittings without inducing localized stress concentration. All exposed edges shall be machine polished or finished as specified and shall be free from chips, sharp arises or edge defects.

Glass exhibiting scratches, edge damage, roller wave distortion, optical distortion, coating damage, visible blemishes or manufacturing defects beyond accepted tolerances shall be rejected.

**General Installation Requirements:** All toughened glass, heat-strengthened glass, laminated glass, insulated glass units, spandrel glass panels, frameless glass doors and suspended spider glazing systems shall be installed strictly in accordance with approved shop drawings, manufacturer's recommendations, relevant standards.

Before installation, all openings, frames, channels, rebates, mullions, transoms, pressure plates, substrates, structural supports and fixing locations shall be checked for line, level, plumb, alignment, dimensional accuracy and structural adequacy.

Supporting members shall be complete, rigid and capable of resisting dead loads, wind loads, impact loads, service loads, thermal movement, seismic movement where applicable and other design loads without excessive deflection, vibration or distortion.

Glass shall be installed using approved setting blocks, location blocks, packers, sleeves, gaskets, washers, bushes and isolators. Setting blocks shall be of neoprene, EPDM or other approved resilient material and shall be positioned to distribute dead loads uniformly and prevent edge damage or stress concentration.

Direct glass-to-metal, glass-to-concrete, glass-to-masonry or glass-to-hard surface contact shall not be permitted. Approved isolation materials shall be provided at all interfaces between glass and metal fittings, channels, brackets, rotules, bolts, spider fittings and supporting members.

Adequate edge clearance, face clearance and joint spacing shall be maintained to accommodate thermal expansion, solar heat gain, temperature differentials, building movement, structural deflection, seismic movement where applicable, installation tolerances and differential movement between adjoining materials.

Glass shall not be forced into openings or fixed in a manner that causes localized restraint, uneven bearing, hard contact or concentrated stress.

For frameless toughened glass doors, the floor spring recess shall be accurately formed and set out in proper alignment with the top pivot. The hydraulic floor spring shall be securely fixed using an approved fixing arrangement and finished flush with the floor level. Top and bottom pivots shall be accurately aligned to ensure smooth and balanced door operation. Patch fittings and pivot fittings shall be fixed using approved sleeves, gaskets and packers to prevent direct glass-to-metal contact. Door shutters shall maintain uniform clearance at the top, bottom and sides and shall operate smoothly in both directions without binding, scraping, vibration, impact or misalignment. Door stoppers shall be provided where specified to prevent over-swinging and edge damage.

For insulated glass units and spandrel glass panels, the glazing rebates, pressure plates, mullions, transoms, framing members, gaskets, setting locations and weather sealant grooves shall be checked for alignment, cleanliness and dimensional accuracy before installation. Coated glass surfaces shall be correctly oriented as shown on the approved drawings, including reflective soft coating on surface No. 2 where specified. Care shall be taken to avoid damage to coated surfaces, edge seals, spacers and corners. IGU panels and spandrel glass panels shall be supported on approved setting blocks and isolated from metal framing using suitable gaskets, packers and spacers. Any IGU with broken seal, internal condensation, displaced spacer, damaged coating, cracked glass, chipped edge or visible defect shall be rejected.

For openable side-hung or top-hung IGU panels, the openable frame, sash, friction hinges, locking points, handles, buffers, cremone locking sets and associated hardware shall be checked for correct size, alignment and operation before fixing. Hinges and hardware shall be securely fixed using approved stainless-steel screws and fasteners. The openable panel shall operate smoothly without binding, rattling, sagging, excessive friction or misalignment. Weather seals and gaskets shall be continuous and properly compressed to ensure watertightness and air tightness when the panel is closed.

For suspended spider glazing systems, the supporting slab, beam or structural frame shall be checked for alignment, stability, anchorage capacity and dimensional accuracy before installation. SS 316 brackets, anchor bolts and bottom stainless-steel channel shall be securely fixed as per approved structural details. Glass fins shall be installed first, accurately aligned and stabilized before installation of the main glazing panels. Glass panels shall be lifted using approved suction lifting equipment and positioned carefully to avoid impact,

edge damage or stress concentration. Spider fittings, rotules and bolt assemblies shall be provided with Teflon, nylon, neoprene or approved bushes, washers and separators to prevent direct metal-to-glass contact. Bolts shall be tightened uniformly using calibrated torque tools in accordance with manufacturer-recommended torque values. The joints between glass panels shall generally be maintained between 6 mm and 8 mm, or as shown on the approved shop drawings.

Sealants shall be approved neutral-cure, non-staining weather silicone and shall be compatible with glass, coatings, IGU edge seals, interlayers, metal framing and adjoining materials. Sealant shall be applied only to clean, dry and dust-free surfaces in continuous, uniform beads free from voids, air pockets, contamination and incomplete adhesion. Backing rods shall be provided where required to maintain proper sealant geometry. Joints, perimeter gaps and gaps within channels shall be sealed neatly to provide watertight and dust-tight performance.

The completed installation shall be true to line, level and plumb. Joint widths shall be uniform and aligned. Glass panels shall be free from cracks, chips, scratches, edge damage, coating damage, bowing, rattling, leakage, stress marks, visible misalignment or other defects.

Completed glass works shall be protected from impact, welding sparks, cement slurry, paint, sealant contamination, staining and damage by subsequent trades until final handover.

Any glass panel, fitting, sealant joint or installation work found defective, damaged, misaligned, improperly fixed or exceeding permissible tolerances shall be rectified or replaced by the Contractor at no additional cost.

**Design Responsibility:** The Contractor shall be fully responsible for the structural adequacy, detailing, fabrication and installation of frameless glass doors, insulated glass units, openable IGU panels, spandrel glass panels, suspended spider glazing systems and all associated supports and accessories.

Detailed shop drawings and structural calculations prepared by a qualified Structural Engineer shall be submitted for approval before fabrication, wherever structural performance is involved.

The design shall consider dead loads, wind loads, impact loads, thermal effects, seismic movement where applicable, deflection limits and load transfer mechanisms.

Approval by the Engineer-in-Charge shall not relieve the Contractor of responsibility for safety, stability, serviceability or long-term performance.

Any defect, instability, leakage, misalignment or failure arising from inadequate design, detailing, fabrication, materials or installation shall be rectified by the Contractor at no additional cost to the Employer.

**Tolerances:** Unless otherwise specified, installation tolerances shall be consistent with accepted architectural glazing practice, approved shop drawings and relevant installation principles of AS 1288.

| Item | Permissible Tolerance |
|---|---|
| Plumbness of installed glass panels | Not more than 3 mm in 3 m height |
| Level of channels, patch fittings, spigots and supports | ±2 mm |
| Variation in joint width | ±2 mm from approved joint dimension |
| Offset between adjacent glass panels at butt joints | Not more than 1.5 mm |
| Frameless glass doors | Smooth operation without binding, impact or uneven perimeter clearance |
| Spider glazing systems | Uniform joint spacing and alignment throughout the installed façade |

**Heat Soak Testing:** Where specified in the Drawings or BOQ, fully tempered glass panels intended for façades, spider glazing systems, overhead glazing or other critical applications shall undergo Heat Soak Testing to reduce the risk of spontaneous breakage caused by nickel sulphide inclusions.

Heat Soak Testing shall be carried out in accordance with recognized international practice and manufacturer's recommendations after the toughening process.

Glass panels exhibiting breakage, distortion or defects during Heat Soak Testing shall be rejected and replaced.

Manufacturer's certificates confirming completion of Heat Soak Testing shall be submitted before delivery to site.

**Quality Control, Testing and Acceptance:** All glass and hardware supplied to site shall be accompanied by manufacturer's certificates confirming compliance with specified standards.

Toughened safety glass shall exhibit fragmentation characteristics complying with IS 2553 Part 1.

Installed glazing shall be inspected for plumbness, alignment, joint uniformity, edge clearance, fitting tightness, anchor installation, sealant workmanship, scratches, distortion, edge damage and overall installation quality.

Glass exhibiting roller wave distortion, optical distortion, scratches, shelling, edge chips, cracks, inclusions, coating damage, sealant contamination, surface blemishes, fitting misalignment or visible manufacturing defects beyond accepted tolerances shall be rejected.

Bolts, patch fittings and spider fittings shall be tightened using calibrated torque tools in accordance with manufacturer-recommended torque values to prevent stress concentration, fitting distortion or glass fracture.

Sealant joints shall be continuous, uniform and free from voids, air pockets, contamination, incomplete adhesion and uneven finishing.

Doors shall be tested for smooth operation and self-closing action where specified. Openable IGU panels shall be checked for smooth operation, locking performance, gasket compression, watertightness and air tightness. Spider glazing systems shall be inspected for secure anchorage, watertightness, dust-tightness, joint uniformity and structural alignment.

Any chipped, cracked, scratched, distorted or improperly installed glass shall be removed and replaced at the Contractor's cost.

**Measurement:** Glass works shall be measured in square metres based on the actual installed area of glass, including grooves and weather silicone sealant areas, the actual elevation area of glazing, including the thickness of joints and the portion of glass panel inside the stainless-steel channel, shall be measured.

Holes, cut-outs, edge polishing, fittings, anchors, sealants, gaskets and accessories shall be deemed included in the item rate unless separately itemized in the BOQ.

**Rate:** The rate shall include the cost of glass, toughening, heat strengthening, lamination where specified, IGU assembly where applicable, edge polishing, drilling, cut-outs, fittings, brackets, patch fittings, pivots, floor springs, spider fittings, glass fins, anchors, sealants, gaskets, spacers, desiccants, lifting equipment, transportation, installation, alignment, testing, cleaning, protection of completed works, labour, tools, equipment and all incidental works necessary to complete the installation in accordance with this specification, approved drawings.

### 5.11.31 FRP Dengri and Lungzay

*WW1100 Providing and installation of decorative Fibre Reinforced Polymer (FRP) Dengri members of manufactured sizes at roof gables, eaves projections, fascia locations and other architectural features as shown on the drawings.*

*WW1110 Providing and installation of decorative Fibre Reinforced Polymer (FRP) Lungzay members of manufactured sizes at roof gables, eaves projections, fascia locations and other architectural features as shown on the drawings.*

**Applicable Standards:** The materials and workmanship shall conform to good engineering practice applicable to FRP architectural components and exterior cladding systems. Installation shall be carried out in accordance with manufacturer's recommendations regarding fixing arrangement, support spacing, joint treatment and thermal movement allowance.

Where steel supporting members are used, fabrication and corrosion protection shall conform to relevant Standards for structural steel and protective coatings.

**Preparation and Supporting Framework:** The supporting structure shall be checked for dimensional accuracy, alignment and adequacy before installation of FRP members. Any defects affecting line, level or fixing stability shall be rectified prior to commencement of work.

Supporting brackets and framework shall be securely anchored to the roof structure, truss members, fascia framing or wall system as shown on the drawings. The framework shall be properly aligned to ensure uniform spacing and symmetry of exposed decorative members. Where steel supports are used, all exposed surfaces shall receive approved anti-corrosion treatment prior to installation.

**Installation of FRP Dengri and Lungzay**

Members shall be accurately cut, positioned and fixed to the supporting framework in accordance with approved shop drawings and manufacturer's recommendations.

All joints, intersections and exposed edges shall be neatly finished to achieve a clean architectural appearance. Mechanical fixing shall be carried out using approved screws, bolts, concealed brackets or proprietary fixing systems.

Fasteners shall not be over-tightened so as to avoid cracking or deformation of FRP members. Adequate allowance shall be made for thermal expansion and contraction.

The installation shall ensure proper rigidity, alignment and resistance against wind uplift, vibration and weather exposure. Exposed members shall be installed symmetrically and consistently along the roof projection. Any visible gaps, misalignment, waviness or distortion shall not be accepted.

**Workmanship and Finish:** The completed FRP work shall be true to line, level and profile with uniform alignment and finish. The exposed surfaces shall be smooth and consistent in colour and texture.

Members having visible cracks, chips, edge damage, deformation or improper fixing shall be removed and replaced at the Contractor's cost. Protective coverings shall remain in place until completion of adjacent works where applicable.

**Quality Control:** The Contractor shall ensure that all FRP sections, fasteners and support systems conform to approved specifications and manufacturer's recommendations.

Fixing stability, alignment, spacing and finish shall be inspected during installation. The Engineer-in-Charge may reject any improperly fixed, damaged or visually defective member.

The completed installation shall remain stable and free from loosening, rattling, excessive movement or surface deterioration under normal service conditions.

**Measurement:** The work shall be measured in running metres for linear decorative members unless otherwise specified in the Bill of Quantities. All brackets, fasteners, trims, supports and accessories necessary for complete installation shall be deemed included in the rate.

**Rate:** The rate shall include supply of members, supporting framework, brackets, fasteners, cutting, fabrication, fixing, finishing, protection and cleaning together with all labour, tools, equipment and incidental works necessary to complete the work in accordance with the specification.

# 5.12 Chapter 12: STEEL & OTHER METAL WORK

### *5.12.1* Single Section

- *Steel work in single section including cutting, hoisting, fixing and applying priming coat of red lead paint*

*SW0001* *In R.S. joists*

*SW0002* *In Flats*

*SW0003* *In Tees, angles and channels*

**Fabrication:** The steel sections shall be straightened and cut square or otherwise as required to correct lengths, measurement being done with a steel tape. The cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of a member. All straightening and shaping to form shall be done by pressure. Bending or cutting shall be carried out in such a manner as not to impair the strength of the metal.

**Holing:** The locations of the holes shall be carefully marked by measuring with steel tape and holes drilled. Finished holes shall be not more than 1.5 mm (in case of rivets/bolts passing through them being dia. 25 mm or less) or 2.0 mm (in case of rivet/bolts dia. being more than 25 mm). Holes may be punched if permitted by the Engineer. Gas cutting shall not be used to form the holes unless otherwise specified as gas cutting diminishes the strength of the metal.

**Painting:** All surfaces, which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and rust. Surface not in contact but inaccessible after shop assembly, shall receive the full-specified protective treatment before assembly. This does not apply to the interior of sealed hollow sections. Parts to be encased in concrete shall not be painted or oiled.

**Erection:** Steelwork shall be hoisted and placed in position carefully without any damage to itself and other building work and injury to workmen. Where necessary mechanical appliances such as lifting tackles, winch etc. shall be used. The suitability and capacity of all plant and equipment used for erection shall be to the satisfaction of the Engineer.

**Measurement:** The work as fixed in place shall be measured in running metres correct to a millimetre and their weights calculated on the basis of standard tables.

**Rate:** The rate includes the cost of labour and materials required for all the operations described above.

### *5.12.2* Built-up Section

- *Steel work riveted or bolted, in built up sections, trusses, frame-works, including cutting, hoisting, fixing in position and applying priming coat of red lead paint*

*SW0010* *In R.S. joists*

*SW0011* *In Tees, angles, flats and channels*

**Laying Out**: Steel structure shall be laid out on a level platform to full scale. This may be done to full size or in parts, as shown on drawings or as directed by the Engineer. A steel tape shall be used for measurements.

**Fabrication:** Fabrication shall generally be done as specified below or as specified by the Engineer in special cases having complicated structures.

**Straightening, Shaping to Form and Cutting:** The steel sections as specified or required, shall be straightened and cut, square or otherwise as required and to correct lengths, and measurement being done with a steel tape. The cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of a member. All straightening and shaping to form shall be done by pressure. Bending or cutting shall be carried out in such a manner as not to impair the strength of the metal. In major work or where so specified, shop drawings giving complete information for the fabrication of the component parts of the structure including the location, type, size, length and details of rivets, bolts or welds, shall be prepared in advance of the actual fabrication and approved by the Engineer. The drawings shall indicate the shop and field rivets, bolts and welds. The steel members shall be distinctly marked or stencilled with paint with the identification marks as given in the shop drawings.

Great accuracy shall be observed in the fabrication of various members, so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true and free from twist, kinks, buckles or open joints. Wooden or metal sheet templates shall be made to correspond to each member, and rivet holes shall be marked accurately on them and drilled. The templates shall be laid on the steel members, and holes for riveting and bolting marked on them. The ends of the steel members shall also be marked for cutting. The base of steel columns and the position of anchor bolts shall be carefully set out. All stiffeners shall be formed by pressure, and where practicable the metal shall not be cut and welded in making these.

**Making Holes:** Holes through more than one thickness of material for members, such as compound stanchion and girder flanges shall, where possible, be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, provided the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall be not greater than 16 mm.

**Rivet holes:** The diameter for rivets and black bolts shall be taken as the nominal diameter of a rivet plus 1.5 mm for rivets of nominal diameter less than or equal to 25 mm, and 2.0 mm for rivets of nominal diameter exceeding 25 mm, unless specified otherwise. Holes for turned and fitted bolts shall be drilled or reamed large by 0.2 to 8 mm depending upon the dia. of bolts.

Holes shall have their axis perpendicular to the surface bored through. The drilling or reaming shall be free from burrs, and the holes shall be clean and accurate. Holes for rivets and bolts shall not be formed by gas cutting process. Holes for counter-sunk bolts shall be made in such a manner that their heads sit flush with the surface after fixing.

**Assembly:** Before making holes in individual members, for fabrication the steel work intended to be riveted or bolted together shall be assembled and clamped properly and tightly so as to ensure close abutting, or lapping of the surfaces of the different members. All stiffeners shall bear tightly both at top and bottom without being drawn or caulked. The abutting joints shall be cut or dressed true and straight, and fitted close together. Web plates of girders, which have no cover plates, shall have their ends flush with the tops of angles unless otherwise required. The web plates, when spliced, shall have clearance of not more

than 5 mm. The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 1.5 mm. The erection clearance at the ends of beams without web cleats shall not be more than 3 mm at each end but where for practical reasons, greater clearance is necessary, suitably designed seating shall be provided.

Column splices and butt joints of struts and compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels, etc. after riveting together shall be accurately machined so that the parts connected, butt against each other over the entire surfaces of contact. Connecting angles or channels shall be fabricated and placed in position with great accuracy so that they are not unduly reduced in thickness by machining. The ends of all bearings stiffeners shall be machined or ground to fit tightly both at top and bottom.

**Preliminaries before riveting:** Riveted members shall have all parts firmly drawn and held together before and during riveting, and special care shall be taken in this respect for all single-riveted connections. For multiple riveted connections, a service bolt or drift shall be provided in every third or fourth hole.

**Process of riveting**: The riveting shall be carried out by using steady pressure type machines. However, Engineers may permit hand riveting where such facilities are not available. The rivets shall be heated red-hot, care being taken to control the temperature of heating so as not to burn the steel. Rivets of diameter less than 10 mm may be driven cold. Rivets shall be finished neat, with heads full and of equal size. The heads shall be central on shanks and shall grip the assembled members firmly. All loose, burnt, or badly formed rivets with eccentric or deficient heads shall be out and replaced. In cutting out rivets, care shall be taken so as not to injure the assembled members. Caulking and re-cupping shall not be permitted.

For testing rivets, a hammer weighing approximately 0.25 kg shall be used. Both heads of the rivet (specially the machine head) shall be tapped. When so tested the rivets shall not give a hollow sound and/or a jar. Where so specified, further tests shall be carried out to ensure the soundness of rivets. All rivet heads shall be painted with approved steel primer paint within a week of their fixing.

**Bolting:** The nominal length of the bolt shall be the distance from the underside of the head to the further end of the shank. The nominal diameter of the bolt shall be the diameter at the shank above the screwed threads. Bolts, nuts and washers shall be thoroughly cleaned and dipped in double boiled linseed oil, before use. All bolts heads and nuts shall be hexagonal unless specified otherwise. The screwed threads shall conform to IS:1363 and the threaded surface shall not be tapered. The bolts shall be of such length as to project at least two clear threads beyond the nuts when fixed in position, and these shall fit in the holes without any shake. The nuts shall fit in the threaded ends of bolts properly.

Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads and nuts of bolt a satisfactory bearing. The threaded portion of each bolt shall project through the nut at least one thread. In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. Where there is risk of the nuts being removed or becoming loose due to vibration

or reversal of stresses, these shall be secured from slackening by the use of lock-nuts, spring washers or cross-cutting as directed by the Engineer.

**Erection:** Steelwork shall be hoisted and erected in position carefully, without any damage to itself, other structure and equipment and injury to workmen. The method of hoisting and erection, proposed to be adopted by the contractor, shall be approved by the Engineer. The contractor, however, shall be fully responsible for the work being carried out in a safe and proper manner without unduly stressing the various members. Proper equipment such as derricks, lifting tackles, winches, ropes, etc. shall be used.

The work may be erected in suitable units as may be directed by the Engineer. Fabricated members shall be lifted at such points as to avoid the deformation or excessive stress in members. The structure or the part of it placed in position shall be secured against overturning or collapse by suitable means. During execution the steelwork shall be securely bolted or otherwise fastened and when necessary, temporarily braced to provide for all loads to be carried safely by the structure during erection including those due to erection equipment and its operations. The steelwork shall be placed in proper position as per approved drawing. Final riveting or permanent bolting shall be done only after proper alignment has been obtained.

Trusses shall be lifted only at nodes. The trusses above 10 m in span shall not be slinged at the apex, as it will develop compression stresses in the bottom tie member. They shall be lifted by slinging at two mid points of rafters, which shall be temporarily braced by a wooden member of a suitable section. After the trusses are placed in position, purlins and wind bracing shall be fixed as soon as possible.

The end of the truss, which faces the prevailing winds, shall be filled with holding down bolts, and the other end kept free to move. In case of trusses of spans up to 10 m the free end of the truss shall be laid on lead sheet or steel plate as per design, and the holes for holding down bolts shall be made in the form of oblong slots, so as to permit the free movement of the truss end. For larger spans, the truss shall be provided with bearing as per design.

Columns and stanchions shall be erected truly vertical with the necessary cross bracing etc. as per drawing and the base shall be properly fixed with the foundation concrete by means of anchor bolts etc. as per design. Anchor bolts shall be placed in the concrete foundation. These should be held in position with a wooden template. The anchor bolts shall be provided with suitable timber mould or pipe sheeve to allow for adjustment. The timber mould or pipe shall be removed after the initial set of concrete. The spaces left around anchor bolts shall have a sloping channel leading to the side of the pedestal and on the underside of the base plate to allow the spaces being grouted up after the base plate is fixed in the position along with the column footing. Grouting shall be of cement mortar 1:3 (1 cement: 3 coarse sand) or as specified.

**Bedding of Column, Stanchions etc.:** Bedding shall not be carried out until the steelwork has been finally levelled, plumbed and connected together. The stanchion shall be supported on steel wedges and adjusted to make the column plumb. For multi-storeyed buildings, the bedding shall not be done until sufficient numbers of bottom lengths of stanchions have been properly lined, levelled and plumbed and sufficient floor beams are fixed in position. The base plates shall be wedged clear of the bases by MS wedges and adjusted where necessary to plumb the columns. The gaps under the base plates up to 25 mm shall then be

pressure grouted with cement grout. With small columns, if permitted by the Engineer, the column base shall be floated on a thick cement grout on the concrete pedestal. The anchor-bolt holes in the base plate may be made about 10 to 15 mm larger than the bolts. In such cases suitable washers shall be provided.

**Painting:** Before the members of the steel structure are placed in position or taken out of the workshop, these shall be painted as specified.

**Measurement:** The work as fixed in place shall be measured in running metres correct to a millimetre and their weights calculated on the basis of standard tables in kilogram correct to two places of decimal.

Unless otherwise specified, weight of cleats, brackets, packing pieces, bolts, nuts, washers, distance pieces, separators, diaphragms, gussets taking overall square dimensions, fish plates, etc. shall be added to the weight of respective items. No deductions shall be made for skew cuts. In riveted work, allowance is to be made for the weight of rivet heads. Unless otherwise specified an addition of 2.5% of the weight of structure shall be made for shop and site rivet heads in riveted steel structures. No deduction shall be made for rivet or bolt holes (excluding holes for anchor or holding down bolts). Deduction in case of bolt hole shall, however, be made if its area exceeds 0.02 sqm.

The weight of steel sheet, plate and strip shall be taken from relevant standards. For rolled sections, steel rods and steel strips, weight given in relevant Standards shall be used.

**Rate:** The rate shall include the cost of all materials and labour involved in all the operations described above with the exception noted in the relevant paragraphs.

- *Steel work welded, in built up sections, trusses, frame-works including cutting, hoisting, fixing and applying priming coat of red lead paint*

*SW0020* *In R.S. joists*

*SW0021* *In Tees, angles, flats and channels*

**Laying out**: It shall be as specified in the riveted and bolted built-up section above.

**Fabrications**: Straightening, shaping to form, cutting and assembling shall be as for riveted and bolted as far as applicable, except that the words "riveted or bolted" shall be read as "welded" and holes shall only be made for the bolts used for temporary fastening as shown in drawings.

**Welding:** Welding shall generally be done by electric process. The electric arc method is usually adopted and is economical. Where public electricity is not available, generators shall be arranged. Gas welding shall be resorted to using oxyacetylene flame with specific prior approval of the Engineer. Gas welding shall not be permitted for structural steel work. Gas welding requires heating of the members to be welded along with the welding rod and is likely to create temperature stresses in the welded members. Precautions shall therefore be taken to avoid distortion of the members due to these temperature stresses. The work shall be done as shown in the shop drawings, which should clearly indicate various details of the joint to be welded, type of welds, shop and site welds as well as the types of electrodes to be used. Symbols for welding on plans and shop drawings shall be according to IS:813.

As far as possible every effort shall be made to limit the welding that must be done after the structure is erected so as to avoid the improper welding that is likely to be done due to heights and difficult positions on scaffolding etc. apart from the aspect of economy. The

maximum dia. of electrodes for welding any work shall be as under unless otherwise specified.

**Table 5.12.1** MAXIMUM DIAMETER OF ELECTRODES FOR WEILDING

| Average thickness of plate or section | Maximum diameter of electrodes to be used |
|---|---|
| Less than 5 mm | 3.2 mm |
| 5mm to 7 mm | 4 mm |
| 8mm to 9 mm | 5 mm |
| 10mm to 15 mm | 6 mm |
| 16mm to 24 mm | 9 mm |
| 25mm and over | 9 mm |

Surfaces, which are to be welded together, shall be free from loose mill scale, rust, paint, grease or other foreign matter. A coating of boiled linseed oil may be permitted.

**Precautions:** All operations connected with welding and cutting equipment shall conform to the safety requirements given in IS:818 for Safety requirements and Health Provision in Electric and gas welding and cutting operations.

**Assembly**: Before welding is commenced the plate shall first be brought together and firmly clamped or spot-welded at specified distance. This temporary connection has to be strong enough to hold the parts accurately in place without any disturbance.

**Erection:** The specifications shall be as described above in riveted and bolted sections except that while erecting a welded structure adequate means shall be employed for temporarily fastening the members together and bracing the framework until the joints are welded. Such means shall consist of erection bolts, tack welding or other positive devices imparting sufficient strength and stiffness to resist all temporary loads and lateral forces including wind. Owing to the small number of bolts ordinarily employed for joints which are to be welded, the temporary support of heavy girders carrying columns shall be specially examined and provisions made to cater for such forces. Different members that are to be fillet welded shall be brought into as close contact as possible. The gap due to faulty workmanship or incorrect fit if any shall not exceed 1.5 mm. If a gap exceeding 1.5 mm or more occurs locally, the size of fillet weld shall be increased at each position by an amount equal to the width of the gap.

**Measurements:** The method of measurement shall be as described above in the riveted and bolted section except that the weight of welding material shall not be added to the weight of members for payment. Nothing extra shall be paid for making and filling holes for temporary fastening of members during erection before welding.

**Rate:** The rate shall include the cost of all labour and materials involved in all the operations described above.

- *Steel work welded, in built up sections, trusses, frame-works including cutting, hoisting, fixing and applying priming coat of red lead paint*

*SW0022 In Tubular sections*

**Fabrication:** The component parts of the structure shall be assembled in such a manner that they are neither twisted nor otherwise damaged and is so prepared that the specified cambers, if any, are maintained.

**Straightening:** All material before being assembled shall be straightened, if necessary, unless required to be of a curvilinear form and shall be free from twist.

**Bolting:** Washers shall be specially shaped where necessary, or other means used, to give the nuts and the heads of bolts a satisfactory bearing. In all cases where the full bearing area of the bolt is to be developed, the threaded portion of the bolt shall not be within the thickness of the parts bolted together, and washers of appropriate thickness shall be provided to allow the nut to be completely tightened.

**Welding:** Where welding is adopted, it shall be done as per the relevant Indian standard.

**Caps and Bases for Columns**: The ends of all the tubes for columns, transmitting loads through the ends, should be true and square to the axis of the tube and should be provided with a cap or base accurately fitted to the end of the tube and screwed, welded or shrunk on. The cap or base plate should be true and square to the axis of the column.

**Sealing of tubes:** When the end of a tube is not automatically sealed by virtue of its connection by welding to another member, the end shall be properly and completely sealed. Before sealing, the inside of the tube should be dry and free from loose scales.

**Flattened Ends:** In tubular construction the ends of tubes may be flattened or otherwise formed to provide that the methods adopted for such flattening do not injure the material. The change of sections shall be gradual.

**Hoisting and Erection:** Tubular trusses shall be hoisted and erected in position carefully, without damage to themselves, other structure, equipment and injury to workmen. The method of hoisting and erection proposed to be adopted shall be approved by the Engineer. The contractor shall however be fully responsible, for the work being carried out in a safe and proper manner without unduly stressing the various members. Proper equipment such as derricks, lifting tackles, winches, ropes, etc. shall be used.

**Measurement:** The work as fixed in place shall be measured in running metres correct to 10 mm and their weights calculated on the basis of standard tables in kilogram correct to two places of decimal, unless otherwise specified. Weight of cleats, brackets, packing pieces, bolts, nuts, washers, distance pieces, separators, diaphragm gussets (taking overall square dimensions) fish plates, etc. shall be added to the weight of respective item unless otherwise specified. No deductions shall be made for skew cuts.

**Rate:** The rate shall include the cost of labour and materials involved in all the operations described above including one coat of approved steel primer.

### 5.12.3 Collapsible/ rolling Shutters

*SW0030 Providing & fixing in position collapsible steel shutters with vertical channels 20x10x2mm and braced with flat iron, diagonals 20x5mm with top and bottom rails of T-iron 40x40x6mm with 38mm dia. steel pulleys complete with bolts, nuts, locking arrangement, stoppers handles including applying a priming coat of red lead paint*

These shall be of approved manufacture and shall be fabricated from the mild steel sections. The gates shall consist of double or single collapsible gates depending on the size of the

opening. These shall consist of vertical double channels each 20 x 10 x 2mm at 10 cm centres braced with flat iron diagonals 20 x 5mm and top and bottom rails of T-iron 40 x 40 x 6mm @ 3.5 kg/m with 40 mm dia ball bearings in every fourth double channel, unless otherwise specified. Wherever a collapsible gate is not provided within the opening and is fixed along the outer surface T-iron at the top may be replaced by flat iron 40 x 10mm.

The collapsible gate shall be provided with necessary bolts and nuts, locking arrangement, stoppers, handles. Any special fittings like spring, catches and locks, shall be so specified in the description of item where so required. The gate shall open smoothly and easily.

**Fixing:** T-iron rails shall be fixed to the floor and to the lintel at top by means of anchor bolts embedded in cement concrete of floor and lintel.

The anchor bolts shall be placed approximately at 45cm centres alternatively in the two flanges of the T-iron. The bottom runner (T-iron) shall be embedded in the floor and a proper groove shall be formed along and under the runner for the purpose. The collapsible shutter shall be fixed at sides by fixing the end double channels with T-iron rails and also by hold-fasts bolted to the end double channel and fixed in the masonry of the sidewalls on the other side.

In case the collapsible shutter is not required to reach the lintel, beam or slab level, a Tee-section suitably designed may be fixed at the top, embedded in masonry and provided with necessary clamps and roller arrangement at the top. All the adjoining work damaged in fixing the gate shall be made good to match the existing work, without any extra cost.

**Painting:** All the members of the collapsible gate including T-iron shall be thoroughly cleaned of rust, scales, dust etc. and given a priming coat of approved steel primer, before fixing them in position.

**Measurements:** The height and breadth shall be measured correct to 10 mm. The height of the gate shall be measured as the length of the double channels and breadth from outside to outside of the fixed double channels in open position of the gate. The area shall be calculated in square metres correct to two places of decimal.

**Rate:** The rate shall include the cost of materials and labour involved in all the operations described above.

*SW0035 Providing & fixing in position Aluminium Rolling shutters of 0.57mm thickness, including all accessories complete*

Aluminium Rolling Shutters shall be supplied with necessary locking arrangements, handles, guide channels, brackets, top cover, and all fixing accessories. They shall be suitable for installation inside or outside the opening, either on or below the lintel or between jambs, as specified. Shutters up to 10 sqm in area shall generally be manually operated (push and pull type), while those above 10 sqm shall be provided with mechanical gear or motorized operation, as required. If motorized, the motor and electrical components shall be paid for separately.

The shutter curtain shall be made of cold-rolled aluminium laths, extruded from high-strength aluminium alloy. Laths shall be at least 0.57 mm thick and around 80 mm wide, interlocked throughout their length, and fitted with end locks to prevent lateral movement. The surface shall be anodized or powder-coated for corrosion resistance. Each lath shall be a single, continuous piece. The bottom rail shall be reinforced with an

aluminium section and provided with locking arrangement. Weather seals may also be included.

Guide channels shall be of extruded aluminium with a minimum thickness of 2 mm and a depth of 60 mm for shutters up to 3.5 m wide and 75 mm for wider openings. These shall be fixed securely to the wall at intervals not exceeding 0.75 m using anchor bolts. Soft inserts like PVC strips or brushes may be used to reduce noise and ensure smooth operation.

The shutter shall be mounted on a shaft of aluminium or steel, which may house coiled spring mechanisms to balance the shutter. The shaft and spring shall be supported on strong brackets fixed with anchor fasteners. A protective top cover box made of aluminium shall enclose the roller assembly.

Brackets and guide channels shall be fixed accurately to ensure smooth and rattle-free operation. All visible fasteners shall be neatly concealed, and fixing shall be done in a workmanlike manner.

**Measurement:** Clear width and clear height of the opening for rolling shutter shall be measured correct to 10 mm. The clear distance between the two jambs of the opening shall be the clear width and the clear distance between the sill and the soffit (bottom of lintel) of the opening shall be the clear height. The area shall be calculated in square metres correct to two places of decimal.

**Rate:** The rate shall include the cost of materials and labour involved in all the operations described above including spring and ball bearing except top cover and mechanical device of chain and crank operation, which shall be paid for separately.

**5.12.4 Doors/Windows (Aluminium)**

- *Providing & fixing Aluminium section for doors, windows, ventilators, partitions and false ceiling of specified sections including all accessories such as U-rubber gasket for glass panes, weather strip fibre glass or weather seals, roller, etc complete (excluding cost of providing & fixing glass panes, ceiling boards)*

*SW0045* *Sliding, openable, fixed and pivoted windows*

*SW0046* *Sliding, openable doors*

*SW0047* *Partition framing*

*SW0048* *False ceiling framing*

- *Extra for providing and fixing plain glass panes on aluminium sections complete (excluding the cost of aluminium frame & accessories)*

*SW0055* *4mm thick plain glass*

*SW0056* *5mm thick plain glass*

*SW0057* *5mm thick frosted glass*

All Aluminium sections for doors, windows, ventilators, partitions and false ceiling shall be of specified sections and anodised to international standards.

Windows and ventilators shall be fully weather sealed using high quality weather seals/strips to reduce ingress of air and water as well as the escape of interior atmosphere.

All glass panes shall be 4 mm thick clear transparent sheet glass. All such glazing shall be firmly secured with matching aluminium glazing beads and gaskets of PVC (ethylene-propylene).

**Tolerances:** The sizes of doors, windows or ventilator frames shall not vary by more than ± 1.5 mm.

**Designation:** Doors, windows and ventilators shall be designated by standard symbols denoting width, type and height in succession. For details refer to the aluminium section under "*Material Specification*" or refer IS:1948 for further details and illustrations.

**Fixing of frame:** Outer frames will be provided with fixing holes centrally in the web. The frame shall be fixed to the wall or other base by using the screws and lugs. Any steel lug coming in contact with aluminium shall be either galvanised or given one coat of bituminous paint.

**Table 5.12.3** FIXING SCREWS AND LUGS

| Place of fixing | Size of screw or lug |
|---|---|
| **i.** To wooden frames rebated on the outside | 30mm x No. 10 galvanised wood-screws |
| ii. To plugs in concrete, stone or brick work rebated on the outside | 30mm x No. 10 galvanised wood-screws |
| iii. To plugs in concrete, stone or brick work not rebated on the outside | 45mm x No. 10 galvanised wood-screws |
| iv. Direct to brick work or masonry (that is plain or square jambs) | |
| v. To steel work | Slotted steel adjustable lugs not less than 100x16x3mm countersunk galvanised machine screws and nuts 19x6.3mm Standard clips and 8mm galvanised bolts with hexagonal nuts |

**Measurement:** The work as fixed in place shall be measured in running metres correct to 10 mm and their weights calculated on the basis of standard tables/weights in kilogram correct to two places of decimal, unless otherwise specified. Weight of cleats, brackets, bolts, nuts, fish plates, etc. shall be added to the weight of respective items unless otherwise specified.

**Rate:** The rate shall include the cost of labour and materials involved in all the operations described above excluding the cost of glass and ceiling boards.

### 5.12.5 Steel Fasteners

*SW0080 Providing & fixing MS round hold-down bolts with nuts and washer plates*

The holding down bolts shall be placed in the concrete foundation. These should be held in position with a wooden template. The bolts shall be provided with a suitable timber mould or pipe sheeve to allow for adjustment. The timber mould or pipe shall be removed after the initial set of concrete. The spaces left around holding down bolts shall have sloping channels leading to the side of the pedestal and on the underside of the base plate to allow the spaces being grouted up after the base plate is fixed in the position along with the column. Grouting shall be of cement mortar 1:3 (1 cement: 3 coarse sand) or as specified.

**Measurement**: The holding down bolts shall be measured in kg.

**Rate:** The rate shall include the cost of materials and labour involved in all the operations.

*SW0081 Providing & fixing bolts of various sizes including nuts & washers.*

Bolts, nuts and washers shall be thoroughly cleaned and dipped in double boiled linseed oil, before use. All bolts heads and nuts shall be hexagonal unless specified otherwise. The screwed threads shall conform to IS:1363 and the threaded surface shall not be tapered. The bolts shall be of such length as to project at least two clear threads beyond the nuts when fixed in position, and these shall fit in the holes without any shake. The nuts shall fit in the threaded ends of bolts properly.

**Measurement:** The bolts, nuts and washers shall be measured in kg as per actual weight.

**Rate:** The rate shall include cost of material and labour involved in the work.

*SW0082 Providing & fixing MS rivets of various sizes*

All loose, burnt, or badly formed rivets with eccentric or deficient heads shall be out and replaced. In cutting out rivets, care shall be taken so as not to injure the assembled members. Caulking and re-cupping shall not be permitted.

**Measurement:** The rivets shall be measured in kg as per actual weight.

**Rate:** The rate shall include all materials and labour involved in the work.

*SW0090 Providing, making and fixing MS straps, flats, sole plates etc.*

The MS straps, flats & sole plates shall be from flats and MS sheets. Steel shall be free from excessive rust, scaling and pitting and shall be well protected.

**Fabrication:** The steel sections as specified or required, shall be straightened and cut, square and to correct lengths and measured with a steel tape. The cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of a member. All straightening and shaping to form shall be done by pressure. Bending or cutting shall be carried out in such a manner as not to impair the strength of metal. The holes of required diameter shall be done with a drilling machine.

**Painting:** All surfaces, which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and loose rust. Surfaces to be encased in concrete shall not be painted or oiled.

**Erection:** Steelwork shall be hoisted and placed in position carefully without any damage to itself and other building work and injury to workmen.

**Measurements:** The work as fixed in place shall be measured in running metres correct to a millimetre and their weights calculated on the basis of standard tables.

**Rate:** The rate includes the cost of labour and materials required for all the operations described above.

**5.12.6 Fan Clamps**

*SW0095 Providing & fixing MS fan clamps of 16 mm dia. in R.C. slabs, including painting with red lead paint*

The fan clamp shall be of the following types.

(a) Fan clamp to be fixed during the laying of R.C.C. slab, shall be of type I. This shall be made of 16 mm dia. MS bar bent to shape with its ends hooked. The overall height of the clamps shall be made to suit the depth of the slab.

(b) Fan clamp for beams shall be of type II. It shall be similar to fan clamp type I, except that its height shall be greater depending on the depth of the beam rib.

**Fixing**: Holes for inserting the fan clamps in the positions shown in the drawing or as instructed by the Engineer shall be made in the shuttering after the latter has been fixed in position. After steel reinforcement is tied, fan clamps shall be fixed with their loops truly vertical and at the correct depth from the underside of the slab or beam. The hooked arms and the loop shall be tied to the reinforcement, either directly or through cut pieces of MS bars with annealed steel wire 1.6 mm or 1.00 mm thick. The clamp shall neither be disturbed out of position during concreting nor shall they be bent out of shape when shuttering of slabs or beams is removed. The exposed portion of loops of the clamp shall be given two or more coats of paint, including a priming coat, of shade as ordered by the Engineer.

**Measurements:** Clamps shall be counted in numbers.

**Rate:** The rate per fan clamp shall include the cost of labour and materials involved in all the operations described above.

*SW0110 Providing and fixing stainless steel (Grade 304) railing made of Hollow tubes, channels, plates etc…including welding, grinding, buffing, polishing and making curvature New items for BSR 2017 (wherever required) and fittings the same with necessary stainless steel nuts and bolts complete, i/e fixing railing with necessary accessories and stainless steel dash fasteners, stainless steel bolts etc, of required size on the top of the floor or the side of waist slab with suitable arrangement as per approval of engineers in charge*

**Fabrication:** Fabrication of all stainless steels should be done only with tools dedicated to stainless steel materials. Tooling and work surfaces must be thoroughly cleaned before use. These precautions are necessary to avoid cross contamination of stainless steel by easily corroded metals that may discolour the surface of the fabricated product.

**Welding:** Fusion welding performance for type 304 stainless steel is excellent both with and without fillers. Recommended filler rods and electrodes for stainless steel 304 is grade 308 stainless steel. For 304L the recommended filler is 308L. Heavy welded sections may require post-weld annealing. This step is not required for 304L. Grade 321 may be used if post-weld heat treatment is not possible. Welding shall be executed from the non-exposed side, as far

as possible and in each case the welds shall be ground smooth and finished with a texture matching the parent metal. All welds shall be finished smooth and square.

**Measurement:** The stainless steel shall be measured in kg. F*or payment purpose only weight of stainless steel members shall be considered excluding fixing accessories such as nuts, bolts, fasteners etc*

**Rate:** The rate shall include the cost of all materials and labour involved in all the operations.

# 5.13 Chapter 13: FLOORING

### 5.13.1 Concrete Flooring

- Providing & laying cement concrete flooring 1:2:4, finished with floating coat of neat cement

*FL0050* *12mm aggregate, 25mm thick*

*FL0051* *20mm aggregate, 40mm thick*

*FL0052* *20mm aggregate, 50mm thick*

*FL0053* *20mm aggregate, 75mm thick*

*FL0054* *20mm river gravel, 40mm thick*

*FL0055* *20mm river gravel, 50mm thick*

- *Providing & laying cement concrete flooring 1:3:6, finished with a floating coat of neat cement*

*FL0060* *20mm aggregate, 50mm*

*FL0061* *20mm river gravel, 50mm*

**Cement concrete:** Cement concrete of specified mix shall be used. The concrete shall conform to specifications given under the head **"Concrete work"**.

**Sub-grade:** Flooring shall be laid on concrete sub-grade where so provided. The sub-grade shall be provided with the slopes required for the flooring. Flooring in veranda, kitchens, baths, water closets and courtyards shall invariably be provided with suitable slope to drain off washing and rain water. Plinth masonry off-set shall be depressed so as to allow the sub-grade concrete to rest on it. If the sub-grade consists of lime concrete, it shall be allowed to set for seven days and the flooring shall be laid in the next three days. If the sub-grade is of lean cement concrete, the flooring shall be commenced preferably within 48 hours of the laying of sub-grade. The surface of the sub-grade shall be roughened with steel wire brushes without disturbing the concrete. Before laying the flooring the sub-grade shall be wetted and smeared with a coat of cement slurry at 2 kg of cement spread over an area of one sq.m so as to get a good bond between the sub-grade and concrete floor.

If the cement concrete flooring is to be laid directly on the R.C.C. slab, the surface of R.C.C. slab shall be cleaned and the laitance shall be removed and a coat of cement slurry at 2 kg of cement per sq. m shall be applied, so as to get a good bond between R.C.C. slab and concrete floor.

**Thickness:** The thickness of floor shall be as specified in the description of the item.

**Laying:**

***Panels:*** Flooring of specified thickness shall be laid in the pattern as given in the drawings or as directed by the Engineer. The border shall have mitred joints at the corners of the room and intermediate joints shall be in straight line with the panel joints. The panels shall be of uniform size and no dimension of a panel shall exceed 2 m and the area of a panel shall not be more than 2 sq. m.

***Laying with strips:*** Normally cement concrete flooring shall be laid in one operation using glass/plain asbestos sheet strips at the junction of two panels. This method ensures uniformity in colour of all the panels and straightness at the junction of the panels.

*Strips fixing:* Aluminium strips, Glass strips or plain asbestos sheet/strips shall be fixed with their top at proper level, giving required slopes.

*Concreting:* Cement concrete shall be placed in position, in one operation, in the panels. It shall then be levelled with the help of straight edge and trowel and beaten with a wooden rammer or mason's trowel. The blows shall be fairly heavy in the beginning but as consolidation takes place, light but rapid strokes shall be given. Beating shall cease as soon as the surface is found covered with cream of mortar. The surface shall be tested with a straight edge and made true to required slopes. While laying concrete care shall be taken to see that the strips are not damaged/disturbed by the labourers. The top of strips shall be visible clearly after finishing with cement slurry.

***Laying without Strips****:* Laying of cement concrete flooring in alternate panels may be allowed by Engineer in case strips are not to be provided.

*Shuttering:* The panels shall be bounded by wooden/angle iron battens. The battens shall have the same depth as the concrete flooring. These shall be fixed in position, with their top at proper level, giving required slopes. The surface of the battens or flats, to come in contact with concrete, shall be smeared with soap solution or non-sticking oil (form oil or raw linseed oil) before concreting. The flooring shall butt against the masonry wall, which shall not be plastered.

*Concreting:* The concreting shall be done in the alternate panels. The battens used for shuttering shall be removed on the next day of the laying of cement concrete. The ends thus exposed shall be repaired, if damaged, with cement mortar 1:2 (1 cement: 2 coarse sand) and allowed to set for a minimum period of 24 hours. The alternate panels shall then be cleaned of dust, mortar, droppings etc. and concrete laid. While laying concrete, care shall be taken to see that the edges of the previously laid panels are not damaged and fresh mortar is not splashed over them. The joints between the panels should come out as fine and straight lines. The concrete levels in the panels should be uniform. The junction line between panels shall not come out a ridge or a valley.

**Finishing:** The finishing of the surface shall follow immediately after the cessation of beating. The surface shall be left for some time, till moisture disappears from it. Excessive trowelling shall be avoided. Use of dry cement or cement and sand mixture sprinkled on the surface to stiffen the concrete or absorb excessive moisture, shall not be permitted.

Fresh quantity of cement at 2.0 kg of cement shall be mixed with water to form thick slurry and spread over an area of one sq. m of flooring while the concrete is still green. The cement slurry shall then be properly pressed and finished smooth. The edges of sunken floors shall be finished and rounded with cement mortar 1:2 (1 cement: 2 coarse sand) and finished with a floating coat of neat cement. The junctions of floor with wall plaster, dado, or skirting shall be rounded off where specified. The men engaged in finishing operations shall be provided with raised wooden platforms to sit on, so as to prevent damage to new work.

**Curing:** The curing shall be done for a minimum period of ten days. Curing shall not be commenced until the top layer has hardened. Covering with empty cement gunnies shall be

avoided, as the colour is likely to be bleached with the remnants of cement matter from the bags.

**Precautions:** Flooring in lavatories and bathrooms shall be laid after fixing of water closet and squatting pans and floor traps. Traps shall be plugged, while laying the floors and opened after the floors are cured and cleaned. Any damage done to W.C squatting pans and floor traps during the execution of work shall be made good. During cold weather, concreting shall not be done when the temperature falls below 5 °C (See section on "Concrete work"). The concrete placed shall be protected against frost by suitable coverings. Concrete damaged by frost shall be removed and work redone. During hot weather, precautions shall be taken to see that the temperature of wet concrete does not exceed 38 °C. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer. The floor shall be protected from any damage during the execution of work.

**Measurement:** Length and breadth shall be measured correct to 10 mm and its area as laid shall be calculated in sq. m correct to two places of decimal. Length and breadth shall be measured before laying skirting, dado or wall plaster. No deduction shall be made or extra paid for any opening in the floor of an area up to 0.10 sq. m. The flooring done with strips (in one operation) and without strips (in alternate panels) shall be measured together.

**Rate:** The rate shall include the cost of all materials and labour involved in all the operations described above excluding application of cement slurry on R.C.C. slab or on sub-grade including roughening and cleaning the surface and cost of glass sheet or asbestos sheet strips. Nosing of steps where provided shall be paid for separately in running metres. Nothing extra shall be paid for laying the floor at different levels in the same room or courtyard and rounding of edges of sunk floors. In case the flooring is laid in alternate panels, it includes the cost of shuttering.

### 5.13.2 Red Oxide Flooring

*FL0070 Providing & laying 40 mm thick red oxide flooring under layer 30 mm thick cement concrete 1:2:4 12.5mm aggregate (down gauge) and top layer of 10 mm thick plaster of cement red oxide mix (using 3.5 kg of red oxide of iron per 50 kg of cement) 1:3 finished with a coat of neat cement-red oxide mix of the same proportion including cement slurry, rounding of edges and strips etc. but excluding the cost of nosing of steps complete.*

**Cement concrete:** Cement concrete of specified mix shall be used and it shall conform to the specification given under section "Concrete Work".

**Under layer:** The under layer shall be of the concrete grade specified and shall be laid as specified for concrete flooring above except that:

(a) The wooden batten/angle iron shuttering shall be to the full depth of the flooring i.e. under layer + top layer

(b) The under layer shall be left roughened with 2 mm deep diagonal cuts.

(c) The shuttering shall only be removed 24 hours after the top layer has been laid.

**Top layer**: This shall consist of a uniform and smooth layer of plaster of specified thickness and of mix 1:3 (1 cement: 3 sand) finished with a coat of neat cement. In both plaster and floating coat, 3.5 kg of red oxide of approved quality shall be mixed with every 50 kg of

cement. This ratio may be adjusted to get the tinge ordered by the Engineer. The full quantity of dry mortar required for a room shall be prepared in one lot in order to ensure uniform colour.

**Laying**: The top layer shall be laid the following day after the under layer has been laid. The plaster shall be done to a uniform thickness of 10 mm and finished smooth with cement slurry (2 kg of cement - red oxide mix- mixed in the ratio used per square metre of flooring). The surface shall then be brought to a fine polish by using polishing stones. In laying alternate panels and coloured plaster on top, care shall be taken that the concrete and coloured matter droppings do not disfigure the coloured topping previously finished. The junctions of floor with wall plaster, dado or skirting shall be rounded off neatly upto 25 mm radius or as required. Persons engaged in finishing operations shall be provided with raised platforms to sit so as to prevent damage to new work.

**Thickness:** Thickness of under layer shall be as specified correct to 1 mm. The thickness of the top layer shall not be less than specified.

**Curing:** The curing shall be done for a minimum of ten days commencing after hardening of the top layer.

**Measurement** and **rate** will be same, as under concrete flooring except that where red oxide proportion used is different from that described in the item, a corresponding adjustment shall be made in the rate.

### 5.13.3 Surface Hardening

*FL0075 Providing & laying 62mm thick flooring with 50mm thick sub-layer cement concrete 1:2:4 20mm aggregate; 12mm metallic cement hardener topping consisting of mix 1:2(1 cement hardener mix: 2 stone aggregate, 6mm) by volume with which metallic hardening compound is mixed in the ratio 1:4 (1 metallic hardener: 4 cement) including cement slurry*

Wherever floors are required to withstand heavy wear and tear, 12 mm thick metallic hardener topping shall be used.

**Metallic hardening compound:** The compound shall be of approved quality consisting of uniformly graded iron particles, free from non-ferrous metal particles, oil, greases, and soluble alkaline compound.

**Under layer:** Cement concrete flooring of specified thickness and mix shall be laid as under layer. The top surface shall be roughened with brushes while the concrete is still green and the form shall be kept projecting up 12mm over the concrete surface to receive the metal hardening compound topping.

**Top layer:** This shall consist of a 12mm thick layer of mix 1:2 *(1 cement hardener mix: 2 stone aggregate, 6mm)* by volume with which metallic hardening compound is mixed in the ratio 1:4 (1 metallic hardener: 4 cement). The concrete hardener shall be dry mixed thoroughly with cement on a clean and dry platform. This dry mixture shall be mixed with 6mm aggregate in the ratio 1:2 (1 cement hardener mix: 2 stone aggregate, 6mm) by volume and add just enough water to make the concrete.

The concrete so prepared shall be laid in 12 mm thickness on cement concrete floor (within 2 to 4 hours of its laying). The topping so laid shall be firmly pressed into the bottom

concrete so as to have a good bond with it. After the initial set has started, the surface shall be finished smooth and true to slope with steel floats.

The specification for curing, precautions, measurements and rates shall be the same as for cement concrete floor.

*FL0080 Extra for making chequers on concrete floors, steps, landings, pavements etc.*

The chequers shall be made according to the patterns as approved by the Engineer.

**Measurement:** Length and breadth shall be measured correct to 10 mm and its area as laid shall be calculated in sq. m correct to two places of decimal. No deduction shall be made or extra paid for any opening in the floor of area up to 0.10 sq. m

**Rate:** The rate shall include all labour and materials involved in the work.

### 5.13.4 Terrazzo-Marble Chips Flooring

- *Providing & laying 40mm thick marble chips flooring top layer 6mm thick with white, black or black and white marble chips of nominal size 1.5-3mm in proportion 1:2 (cement: chips), on 34mm thick concrete base in cement concrete 1:2:4, 12.5mm aggregate*

*FL0085 In grey cement*

*FL0086 In white cement*

- *Providing & laying 40mm thick marble chips flooring top layer 10mm thick with white, black or black and white marble chips of size 6mm in proportion 1:2 (cement: chips), on 30mm cement concrete 1:2:4 base, 12.5mm aggregate*

*FL0105 In grey cement*

*FL0106 In white cement*

**Thickness:** The thickness of the under layer shall be measured correct to a mm. The thickness of the top layer shall not be less than that specified.

**Under layer:** Cement concrete of specified mix shall be used and the specifications given under cement concrete work shall apply. The panels shall be of uniform size, not exceeding 2 sq. m in area and 2 m in length in inside situations. In exposed situations the length of any side of the panel shall not be more than 1.2 metres. Cement slurry @ 2.00 kg per sq. m shall be applied before laying of under layer over the cement concrete/R.C.C. surface.

**Strip fixing:** 4 mm glass strips or 2 mm aluminium strips shall be fixed with their top at proper level, giving slopes.

**Top Layer:** The mix for terrazzo topping shall consist of cement with or without pigment, marble powder, marble aggregate (marble chips) and water. The cement and marble powder shall be mixed in the proportion of three parts cement to one part marble powder by weight. For every part of cement marble powder mix, the proportion of aggregate by volume shall be as follows:

**Table 5.13.1** PROPORTION OF AGGREGATES BY VOLUME

| Size of aggregate | proportion of aggregate to binder mix |
|---|---|
| Grade 00, 0 and 2 | 1.75 parts |
| Grade 2 and 3 | 1.50 parts |
| For grade 4 and 5 | 1.25 parts |
| Mixed size aggregate | 1.50 parts |

The marble chips shall be hard, sound, dense and homogeneous in texture with crystalline and coarse grains. They shall be uniform in colour and free from stains, cracks, decay and weathering. Before starting the work, the contractor shall get the sample of marble chips approved by the Engineer. The cement to be used shall be ordinary grey cement or white cement, or cement with admixture of colouring matter of approved quality in the ratio specified in the description of the item or in the ratio to get the required shade as ordered by the Engineer. Colouring matter where specified, shall be mixed dry thoroughly with the cement and marble powder and then marble chips added and mixed as specified above. The full quantity of dry mixture of mortar required for a room shall be prepared in order to ensure a uniform colour. The mixtures shall be stored in a dry place and well covered and protected from moisture. The dry mortar shall be mixed with water in the usual way as and when required. The mixed mortar shall be homogeneous and stiff and contain just sufficient water to make it workable.

The terrazzo topping shall be laid while the under layer is still plastic, but has hardened sufficiently to prevent cement from rising to the surface. This is normally achieved between 18 to 24 hours after the under layer has been laid. Cement slurry preferably of the same colour as the topping shall be brushed on the surface immediately before laying is commenced. It shall be laid to a uniform thickness slightly more than that specified in order to get the specified finished thickness after rubbing. The surface of the top layer shall be trowelled over, pressed and brought true to required level by a straight edge and steel floats in such a manner that the maximum amount of marble chips come up and are spread uniformly over the surface.

**Polishing, Curing and Finishing:** Polishing shall be done by machine. About 36 hours after laying the top layer, the surface shall be watered and ground evenly with a machine fitted with a special rapid cutting grit block (carborundum stone) of coarse grade (No.60) till the marble chips are evenly exposed and the floor is smooth. After the first grinding, the surface shall be thoroughly washed to remove all grinding mud and covered with a grout of cement or/and colouring matter in the same mix and proportion as the topping in order to fill any pin holes that appear. The surface shall be allowed to cure for 5 to 7 days and then ground with a machine fitted with fine grit blocks (No.120). The surface is cleaned and repaired as before and allowed to cure again for 3 to 5 days. Finally the third grinding shall be done with a machine fitted with fine grade grit blocks (No.320) to get an even and smooth surface without pinholes. The finished surface should show the marble chips evenly exposed.

Where use of machine for polishing is not feasible or possible, rubbing and polishing shall be done by hand, the same manner as specified for machine polishing except that carborundum stone of coarse grade (No.60) shall be used for the first rubbing, stone of medium grade (No.80) for second rubbing and stone of fine grade (No.120) for final rubbing and polishing.

After final polish, oxalic acid shall be dusted over the surface @ 33 gm. per sq. m sprinkled with water and rubbed hard with a pad of Woollen rags. The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

**Curing:** Curing shall be done by suitable means such as laying moist sawdust or ponding water.

**The specification for** precautions, measurements **and** rates **shall be the same as for cement concrete floor.**

*FL0095 Extra, for coloured chips instead of black, white or black and white chips in top 6mm layer of marble chips flooring*

*FL0096 Extra, for coloured chips instead of black, white or black and white chips in top 10mm layer marble chips flooring*

The rate shall include the extra cost as involved in using coloured marble chips instead of black, white or black & white chips.

*FL0115 Extra, for providing and fixing glass strips in joints of terrazzo floors*

The glass strip shall be of 40 x 4mm. It shall be fixed with their top at proper level giving required slope.

**Measurement**: The strips shall be measured in running metres.

**Rate:** The rate shall include all materials and labour involved in the item.

*FL0116 Extra, for terrazzo flooring laid as floor borders, margins, bands, 75 < width > 300mm*

*FL0117 Extra, for laying terrazzo flooring on staircase treads, width < 300mm, including forming nosing*

**Measurement**: The work shall be measured in running metres.

**Rate:** The rate shall include all the additional labour involved in the item.

*FL0118 Extra, for laying terrazzo in narrow bands width <75mm*

*FL0119 Extra, for making moulded nosing in terrazzo, including moulded returns, ends, and angles*

**Measurement**: The work shall be measured in running metres.

**Rate:** The rate shall include all the additional materials & labour involved in the item and measurement shall be taken in running metres.

*FL0120 Providing & fixing aluminium strip 40x1.6mm in joints of terrazzo floor*

Aluminium strip shall be of 40 x 1.6mm. It shall be fixed with their top at proper level giving required slope.

**Measurement**: The strips shall be measured in running metres.

**Rates:** The rate shall include all materials and labour involved in the item.

**5.13.5 Skirting**

- *Providing & laying Cement plaster skirting upto 300mm height with cement mortar 1:3 with a floating coat of neat cement including rounding off junctions with floor*

*FL0130 20mm*

*FL0131 22mm*

A band of plaster at the bottom of the wall not exceeding 30 cm in height above the floor shall be classified as skirting. It shall be flush with wall plaster or projecting out uniformly from the wall plaster, as specified. The work shall be preferably carried out simultaneously with the laying of floor. Its corners and junctions with floor shall be finished neatly as specified.

**Thickness:** The thickness of the plaster specified shall be measured exclusive of the thickness of key i.e. grooves or open joints in brickwork. The average thickness shall not be less than the specified thickness. The average thickness should be regulated at the time of plastering by keeping suitable thickness "gauges". Extra thickness required in daubing behind rounding of corners at junctions of wall shall be ignored.

**Preparation of wall surface:** The joints shall be raked out to a depth of at least 15 mm in masonry walls, while the masonry is being laid. In case of concrete walls, the surface shall be roughened by hacking. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

**Application:** Skirting with specified mortar and specified thickness shall be laid immediately after the surface is prepared. It shall be laid along with the border or adjacent panels of floor. The joints in skirting shall be kept true and straight in continuation of the line of joints in borders or adjacent panels. The skirting shall be finished smooth and true, with top truly horizontal and joints truly vertical except where otherwise indicated.

**Finishing:** The finishing of the surface shall be done simultaneously with the borders of the adjacent panels of floor. The cement to be applied in the form of slurry for smooth finishing shall be at the rate of 2 kg of cement per litre of water applied over an area of 1 sq. m. Where skirting is flush with plaster, a groove 10 mm wide and upto 5 mm deep shall be provided in the plaster at the junction of skirting with plaster.

**Curing:** Curing shall be commenced on the next day of plastering when the plaster has hardened sufficiently. It shall be continued for a minimum period of 7 days.

**Measurement:** Length and height shall be measured correct to 10 mm and its area shall be calculated in sq. m correct to two places of decimal stating the thickness. Length shall be measured as the finished length of skirting. Height shall be measured from the finished level of floor correctly to 5 mm where the height of skirting does not exceed 30 cm and where the height exceeds 30 cm it shall be measured correctly to 10mm.

**Rates:** The rate shall include the cost of all materials and labour involved in all the operations described above.

- *Providing & fixing Terrazzo or Marble chips skirting upto 300mm height, top layer 6mm thick with white or black, black and white marble chips size 4mm in proportion 1:2, laid on 12.5mm thick cement plaster 1:3 base*

*FL0140 In grey cement*

*FL0141 In white cement*

**Under coat:** The under coat of skirting shall be of cement plaster of the thickness and mix as specified in the item. Specification shall be the same as for cement plaster skirting except that the under coats shall be finished rough with a scratching tool to form a key for the top coat.

**Top coat**: Specifications for top coat shall be as described above for marble chips flooring and shall include cutting to line and fair finish to top edges of terrazzo and polishing.

**Measurement:** Length and height shall be measured correct to 10 mm and its area shall be calculated in sq. m correct to two places of decimals stating the thickness. Length shall be measured as the finished length of skirting. Height shall be measured from the finished level of floor correctly to 5 mm where the height of skirting does not exceed 30 cm and where the height exceeds 30 cm it shall be measured correctly to 10mm.

**Rates:** The rate shall include the cost of all materials and labour involved in all the operations described above.

### 5.13.6 Marble/Kota Stone/Granite Flooring

- *Providing & laying marble stone flooring over 20mm thick base of cement mortar 1:4, jointed with grey cement slurry mixed with pigment where necessary, rubbing & polishing complete*

*FL0150 20mm thick black marble*

*FL0151 20mm thick white marble*

*FL0152 20mm thick black and white marble*

*FL0153 20mm thick coloured marble*

*FL0154 40mm thick black marble*

*FL0155 40mm thick white marble*

*FL0156 40mm thick black and white marble*

*FL0157 40mm thick coloured marble*

- *Providing & laying Kota stone flooring over 20mm thick base of cement mortar 1:4, jointed with grey cement slurry mixed with pigment where necessary, rubbing & polishing complete*

*FL0160 20mm thick*

*FL0161 40mm thick*

**Thickness:** The thickness of the slab shall be as specified in the item. Tolerance of ± 2 mm shall be allowed in the thickness.

**Laying:** Sub-grade concrete or the R.C.C slab on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be with cement mortar 1:4 (1 cement: 4 sand) as given in the item. The average thickness of the bedding mortar under the slab shall be 20 mm.

The slab shall be laid as follows: Mortar shall be spread under the area of each slab, roughly to the average thickness specified in the item. The slab shall be washed clean before laying.

It shall be laid on top, pressed, tapped with a wooden mallet and brought to level with the adjoining slabs. It shall be then lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar is allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg of cement per sq. m. The edges of the slabs already paved shall be buttered with grey cement (or white cement as specified). The slab to be paved shall then be lowered gently back in position and tapped with a wooden mallet till it is properly bedded in level with and close to the adjoining slab with as fine a joint as possible. Subsequent slabs shall be laid in the same manner. After each slab is laid surplus cement on the surface shall be cleaned off. The flooring shall be cured for a minimum period of seven days. The surface of the flooring as laid shall be true to levels and slopes as instructed by the Engineer. The slabs shall be matched as shown in drawings or as instructed by the Engineer. Slabs, which are fixed in the floor adjoining the wall, shall enter not less than 12 mm under the plaster skirting or dado. The junction between wall plaster and floor shall be finished neatly and without waviness.

**Polishing and finishing:** Slight unevenness at the meeting edges of the slabs shall then be removed by fine chiselling. The surface, after curing for seven days, shall be ground evenly with a machine fitted with coarse grade grit blocks (No.60) water shall be used profusely while grinding. It shall then be thoroughly washed to remove all grinding mud cleaned and mopped. The surface shall be cured again. The second grinding shall then be carried out with a machine fitted with fine grade grit blocks (No.120). The final grinding with finest grade grit blocks (No.320) shall be carried out the day after second grinding. For small areas where circumstance so requires, hand polishing may be permitted in lieu of machine polishing. For hand polishing the following carborundum stones shall be used:

| | |
|---|---|
| 1st grinding: | Coarse grade stone No.60 |
| 2nd grinding: | Medium grade stone No.80 |
| Final grinding: | Fine grade stone No.120 |

In all other respects, the process shall be similar to machine polishing.

After final polish oxalic acid shall be dusted over the surface at the rate of 33 gm per square metre sprinkled with water and rubbed hard with a pad of Woollen rags. The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

**Measurements**: Marble/kota stone flooring shall be measured in square metres (separately for different kinds of marble/kota stone used) correct to two places of decimal. Length and breadth shall be measured between the finished faces of skirting, dado or wall plaster as the case may be correct to 10 mm. No deduction shall be made nor extras paid for opening in the floor of an area up to 0.05 sq. m. Steps and treads paved with marble stone slabs shall also be measured under the item. Nosing for treads shall be paid for extra in running metres.

**Rate:** The rate shall include the cost of the materials and labour involved in all the operations described above.

*FL0170 Extra, for marble stone flooring for laying in step-treads, width < 300 mm*

*FL0171 Extra, for marble stone flooring for nosing in step-treads*

The work shall be executed as per drawing and as directed by engineer.

**Measurement:** The work shall be measured in running metres correct to 10mm.

**Rate:** The rate shall include the extra labour involved in the work

- *Providing and laying Pre-Polished/ Polished Granite of approved quality and source in flooring using necessary cement bedding in C.M. 1:4 upto 20 mm thick average cement slurry for fixing the tiles with required slopes, curing, cleaning, filling the joints with pigments of similar colour and at all levels with all leads and lifts etc. complete as per directions of site in-charge and as per pattern required*

*FL0175 18mm Thick granite stone flooring over 18mm thick base of cement mortar 1:4*

*FL0176 20mm Thick granite stone flooring over 20mm thick base of cement mortar 1:4*

*FL0177 Extra, for granite stone flooring for laying in step-tread, width <300 mm*

*FL0178 Extra, for granite stone flooring for nosing in step-treads*

Stone slabs for flooring, skirting, dado, treads, risers, counter slab etc. shall be selected of quality from an approved quarry and of thickness, finish and colour as approved. Stone slab shall be hard, sound, dense, homogenous in texture, free from cracks, decay, weathering and flaws.

For polished stone flooring the slabs shall have the top (exposed) face machine polished before being brought to site. The edge of stone shall be machine cut on all sides to a minimum depth of 15mm. so that a straight edge laid along the side of the stone shall be fully in contact with it. The edges of stone slab for counters, stair treads, risers and steps shall also be machine cut and polished to full depth and chamfered or round. The slabs shall conform to the sizes called for on the drawings. All angles and edges of the slabs shall be true, square and free from chippings and the surface shall be true and plain.

**Site Storage:** Upon receipt at the site or storage yard, the granite shall be stacked on timber or platforms at least 75mm above the ground, and extreme care shall be taken to prevent staining during storage. If storage is to be for a prolonged period, polyethylene or other suitable plastic film shall be placed between any wood and finished surfaces, and shall be used also as an overall protective covering. All holes shall be plugged during freezing weather to prevent the accumulation of water. Salt shall not be used for melting of ice formed on pieces, or for any purpose involving its contact with the granite.

**Laying:** The RCC slabs or sub-grade concrete or over the insulation layer over which the tiles/slabs are to be laid shall be cleaned, wetted and mopped. The cement mortar shall be spread over a small area to an average thickness of 20 mm. The slab shall be washed clean before laying. It shall be laid on the mortar pressed, tapped, with a wooden mallet, and brought to required level .It shall then be removed and laid aside. The top of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar is then allowed to harden and a cement slurry of paste-like consistency shall be spread over the same at the rate of 4.4 kg of cement per sq. m. The edges of the slab already laid shall be buttered with a slurry of cement and pigment to match the shade of slabs. The slab to be laid shall then be placed back in position, pressed and properly bedded in level with adjoining slab with as fine a joint as possible. Other slabs are also laid in similar manner to correct levels with fine joints. The surplus slurry on the surface shall be cleaned off. Slabs which are fixed in the floor adjoining the wall shall enter under the skirting of dado as shown on the details. The junction between floor and wall finish shall be finished neatly as directed. The flooring

unevenness at the meeting of the slabs shall be removed by fine chiseling and grinding. The completed floor shall be cured for a minimum period of seven days. The slabs shall be matched as shown in drawings or as instructed by the Engineer. The junction between wall plaster and floor shall be finished neatly and without waviness.

**Grinding:** The grinding and polishing shall be commenced about seven days after the slabs are laid. The surface shall be watered and ground evenly with a grinding machine using carborundum stone grade 60. The surface shall then be washed clean and joints grouted with a grout of cement and appropriate pigment mixed in suitable proportion to match the shade of stone. It shall then be allowed to dry for four hours and wet-cured for seven days. The grinding and grouting operation shall be repeated using carborundum stone grade 80 and 120 till a smooth finished surface is obtained. After thoroughly cleaning the surface, grouting and curing as described earlier, the final grinding shall be carried out using carborundum stone grade 320. The surface shall again be washed clean, dusted over with oxalic acid at 32 grams per square meter sprinkled with water, rubbed hard with cotton waste and wiped clean the following day. Where use of a machine for grinding is not feasible rubbing and polishing shall be done by hand in the same manner as described above.

**Metal Cramps:** Granite stone cladding to walls, columns, etc. shall additionally be held in position by means of stain steel/gun metal cramps, which shall be of size of shape as shown in the drawing. The cramps anchored into the backing wall/column in adequate manner shall insert into holes drilled in the granite slabs at appropriate position and grouted with appropriate mortar. The number and position of metal cramps shall be as directed by the site engineer. Absolute Protection of Adjoining Work Care shall be taken to protect adjoining works including walls and other elements from staining or damage by cement slurry. Any openings through which slurry can escape shall be temporarily but properly sealed and slurry removed without staining adjoining work.

**Measurements:** Granite stone flooring shall be measured in square meters (separately for different kinds of granite used) correct to two places of decimal. Length and breadth shall be measured between the finished faces of skirting, dado or wall plaster as the case may be correct to 10 mm. No deduction shall be made or extras paid for opening in the floor of an area up to 0.05 sq. m. Steps and treads paved with granite stone slabs shall also be measured under the item. Nosing for treads shall be paid for extra in running meters.

**Rate:** The rate shall include the cost of the materials and labour involved in all the operations described above.

### 5.13.7 Timber Flooring

- *Providing and fixing bison panel flooring including necessary nails/screws etc. complete, excluding cost of frame*

*FL0180 25mm*

*FL0181 30mm*

- *Providing and fixing Plain Particle-Board Flooring including necessary screws etc. complete, excluding cost of frame*

*FL0190 25mm*

*FL0191 35mm*

*- Providing and fixing Mixed Conifer Flooring including iron screws etc. complete, excluding the cost of frame*

*FL0200 25mm thick, T&G*

*FL0201 25mm thick, half-lapped*

*FL0202 40mm thick, T&G*

*FL0203 40mm thick, half-lapped*

*FL0204 45mm thick, T&G*

*FL0205 45mm thick, half-lapped*

*- Providing and fixing Pre-Fabricated Flooring Profiles mixed conifer including necessary screws etc. complete*

*FL0215 25mm thick*

*FL0216 38mm thick*

**Supporting Joists**: Main beams and joists of the class of wood and sections specified in the description of the item for beams and joists, or as instructed by the Engineer shall be fixed to position to dead levels. The width of the joists shall not be less than 50 mm. The arrangement and spacing of beams, joists, etc. shall be as per design furnished. The beams, joists etc shall be painted or treated with wood preservative as directed by the Engineer.

**Boards:** It shall be of the class of timber and thickness specified in the description of the item. Only selected boards of uniform width shall be used. Unless otherwise specified or shown in the drawings, the width of boards selected shall not be less than 100 mm nor more than 150 mm. The same width of boards shall be maintained throughout except where the width of the room is not an exact multiple of the width of boards. In the latter case the difference shall be equally adjusted between the two end boards (adjacent to walls). The length of the boards shall not exceed three metres anywhere. Ordinarily the minimum length of boards shall be such that the boards shall rest at least on three supports, except where otherwise required by the pattern specified in the drawings or as directed by the Engineer.

**In case of timber plank:** The boards shall be planed true on the top face only unless otherwise specified in the description of the item. Where the bottom face is exposed and it is also required to be planed, then such planning shall be paid for extra. The longitudinal joints of planks shall be tongued and grooved to a minimum depth of 12 mm or half lapped for 12 mm width while the heading joints shall be of the square butt type and shall occur over the centre line of the supporting joints. Heading joints in adjacent boards shall not be placed over the same joists.

**Iron Screws:** Iron screws shall be of the slotted counter-sunk head type, of length not less than the thickness of planks plus 25 mm subject to a minimum of 40 mm, and of designation No. 9 conforming to IS: 451.

**Fixing:** The joist on which the planks shall be fixed, shall be checked and corrected to levels. The end boards shall be accurately fixed with the sides parallel and close to the walls. Each adjoining board shall be carefully jointed and shall be tightened in position and fixed with screws. For fixing the boards to the joists, two screws shall be used at each end of the boards and one screw at each of the intermediate joists in a zigzag manner. The screws shall

be counter- sunk and screw holes filled with approved stopping. The junction between timber flooring and adjacent flooring shall be formed by inserting a metal strip (brass or aluminium) at the junction. The metal strip shall be fixed to the end of the planks by screws. The strip shall be paid for extra.

The flooring shall be truly level and plane. The joints shall be truly parallel and or perpendicular to the walls, unless otherwise specified. The floor shall be planned in both directions and made perfectly even, true and smooth.

**Note:** No woodwork of any kind shall be placed within 60 cm of any fireplace or flue. Provision shall be made for ventilating the space below the floor in case of ground floor and between floor and ceiling in the case of upper floors. Such arrangements shall be paid for separately.

**Finishing:** The surface of the floor shall be bees waxed or finished otherwise as directed by the Engineer. The lower face shall be painted or treated with wood preservative as directed. The finishing shall be paid for separately.

**Measurement:** Length and breadth of superficial area of the finished work shall be measured correct to 10 mm. The area shall be calculated in square metre correct to two places of decimal. No deduction shall be made or any extras paid for any opening in the floor upto 0.1 square metres in area.

**Rate**: The rate shall include the cost of the labour and materials involved in all the operations described above, with the exceptions noted in the relevant sub-paras. The beams and joists and the painting shall be paid for separately unless specifically included in the description of the item

### 5.13.8 Parquet Flooring

*FL0210 Providing and fixing Parquet (wood block) flooring including blown bitumen and iron screws etc. complete, excluding cost of frame- 38mm thick, champ wood.*

**Wood blocks (Parquet):** The wood blocks shall be of selected wood of the class of timber specified in the item and shall be in accordance with the general specifications for wood. The size of blocks shall be as shown in the drawings. The longitudinal edges of the blocks shall be dovetail grooved near the bottom. The blocks shall be truly rectangular in shape with clean sharp edges and true faces. The thickness of blocks shall be 38 mm unless otherwise specified.

**Levelling Concrete**: The levelling layer shall be of cement concrete 1:2:4 (1 cement: 2 sand: 4 stone aggregate 12.5 mm). Its thickness shall be 25 mm. Cement concrete shall be placed in position and levelled with the help of a straight edge and trowel. It shall be beaten with the trowel till the cream comes up. The surface shall be finished with a wooden float to give a sand paper finish, plane and true to level. The finished level of the concrete shall be lower than the proposed finished level of the flooring by the specified thickness of the wooden blocks plus a minimum of 1.5 mm. The levelling layer shall be cured for a week and then allowed to dry thoroughly before paving with wood blocks.

**Laying:** The wood blocks shall be first laid `dry' to the margin and pattern shown in the drawings or as directed by the Engineer. The blocks shall fit closely and sides and ends shall be corrected by further planning if necessary to get closed and even joints. After the blocks have been fitted and matched they shall be removed and stacked in a suitable way to

facilitate their relaying in the same order. The levelling course surface shall be thoroughly cleaned and the surface coated with a thin layer of hot bitumen (blown type petroleum bitumen or equivalent) applied at a temperature of 180 °C and at the rate of 2.45kg/sq.m. The wood blocks shall then be taken in turn serially and be dipped in the same hot bitumen for about half their depth so as to coat thoroughly the bottom and part of the sides and quickly set and pressed into place to required patterns on the previously coated levelling concrete surface so that dovetailed grooves get filled up with bitumen. The joints of the work shall be very thin and fine. When all the blocks have been set in position, the surface shall be cleaned of any bitumen droppings and planed or machined level and smooth. The floor shall be given a final smooth finish by rubbing down with sand paper.

**Finishing:** The floor shall be bees-waxed or polished with ready-made wax polish or given any other finish as required.

**Measurements:** Length and breadth of the superficial area of the finished work shall be measured correct to 10mm. The area shall be calculated in square metre correct to two places of decimal. No deduction shall be made or any extra paid for any opening in the floor upto 0.1 sq.m in area.

**Rate:** The rate shall include the cost of all labour and materials involved in all the operations described but shall not include the cost of levelling course/frame, or sub-grade or bees waxing etc.

### 5.13.9 Linoleum Flooring

- *Providing and fixing 2mm thick Vinyl or Linoleum sheet laid with special adhesive, including 2 coat of bitumen applied over subfloor on prepared surface @ 1.5kg/sq. m each coat including the cost of base concrete.*

*FL0225 over base 25mm thick cement concrete 1:2:4, 12.5mm aggregate*

The vinyl tile shall be of a make, manufacture colour and pattern as approved by the Engineer. The adhesive to be used shall also get approved.

Care shall be exercised in laying the vinyl tile floor and the work shall be done by skilled and experienced tile layers. The sub-floor concrete shall be finished smooth and to the proper level. It shall be allowed to dry thoroughly. This may take 4 to 8 weeks, but it is essential to have a dry floor.

Bitumen is applied on the dry sub-floor in two coats each at the rate of 1.5 kg/sq. m. Over this bitumen layer the base concrete of the specified proportion is laid to a thickness of 25 mm and finished smooth and level, and cured for 7 days. This base shall be perfectly dry and even before any laying work is started. After the base is dry, the tile layout shall be finalised and guidelines marked on the base. It is preferable to avoid laying of tiles under high humidity conditions.

The adhesive shall be applied by using a notched travel to the base as well as to the back of the tiles. In approximately half an hour, by which time the adhesive will be tacky to touch but will not mark the fingers, the tiles will be ready for laying. (The adhesive should not be left for setting too long as the properties may be lost due to dust and other causes).

The laying shall start at the centre of the area. The tiles shall be lowered in position and pressed firmly onto the adhesive. Care should be taken not to slide them as this may result

in the adhesive being squeezed up between joints. The tiles shall be laid close to each other with minimum gap between joints. The tiles after laying shall be rolled with a light wooden roller of about 5 kg to ensure full contact with the base. Any undulation, if any, noticed shall be rectified by removing and relaying the tiles after cleaning the underside of the adhesives by using proper solvents and then cleaning the tiles of the solvents. The work shall be constantly checked to ensure that all four edges of each tile meet accurately. Any adhesive, which may squeeze up between tiles, shall be wiped off immediately with a wet cloth.

A period of 24 hours shall be given after laying of the floor for developing proper bond of the adhesive. When the flooring has been fixed securely it shall be cleaned with a wet cloth soaked in warm soap solution (two spoons of soap in 5 litres of warm water).

**Measurement:** Length and breadth shall be measured correct to 10 mm and its area shall be calculated in sq. m correct to two places of decimal. No deduction shall be made or extra paid for any opening in the floor upto 0.1 sq. metre in area.

**Rate:** The rate shall include the cost of the materials and labour involved in all the operations described above. The rate shall include the cost of 25mm base concrete and bitumen coating but not sub-floor.

### 5.13.10 Mud Flooring

*FL0230 Providing & laying rammed mud flooring complete*

Only selected dry earth (clay) shall be taken or as approved by the Engineer. It should be free from any organic matters, grits, stones chips/boulder, etc unless approved otherwise. Normally, the earth from the same area shall be used. All clods of earth shall be broken or removed before laying.

The earth shall be laid in layers not exceeding 50 mm in each layer. It shall then be rammed with wooden planks or iron rammers if feasible.

**Measurement:** The measurement shall be taken in cubical contents correct to two places of decimal.

**Rate:** The rate shall include the cost for all operations described above.

### 5.13.11 Laminated Flooring

- *Providing and laying laminated flooring over prepared subfloor surfaces complete with underlay, moisture barrier, skirting, trims and accessories in accordance with the Drawings, manufacturer's recommendations .*

*FL0235 12mm Laminated Floor Planks*

**Applicable Standards:** Materials and workmanship shall conform to good engineering practice consistent with the principles of timber flooring installation described in IS 5389:1969 relating to preparation of base, moisture protection and finishing of floor systems.

Installation shall also comply with manufacturer-specified requirements for laminated flooring systems including floating floor construction and expansion provisions.

**Preparation of Subfloor:** The base floor shall be clean, dry, level and free from dust, grease, loose particles or previous floor coverings. Any bumps, depressions or irregularities shall be corrected before installation. Concrete subfloors shall be allowed sufficient curing time and shall have moisture content within acceptable limits prior to installation.

All building services passing through the floor shall be completed beforehand to avoid disturbance after installation. The subfloor shall be prepared to provide a smooth and stable surface as required for flooring works, consistent with accepted flooring practices described in IS 5389:1969.

**Moisture Protection and Underlay:** A continuous vapour barrier shall be laid over concrete subfloors with adequate overlaps at joints to ensure complete moisture protection. The barrier shall extend over the entire flooring area without gaps.

A resilient underlay shall then be placed over the vapour barrier with edges properly butted together without overlapping. The underlay shall provide acoustic insulation and accommodate minor floor unevenness while allowing free movement of the floating floor system.

**Installation of Laminated Flooring**

Laminated flooring shall generally be installed as a floating floor system in which the planks are interlocked with each other but not fixed to the base floor. The flooring shall be acclimatized within the installation area for a minimum period of forty-eight hours prior to laying to allow adjustment to room temperature and humidity conditions.

Installation shall commence along a straight wall using spacers to maintain expansion gaps between flooring and walls. Planks shall be connected by inserting the tongue into the groove or click system at the specified angle and lowering into position to achieve tight joints.

The direction of laying shall preferably follow the direction of natural light or along the longer dimension of the room to improve appearance and minimize visible joints. Care shall be taken to maintain alignment of rows and avoid damage to locking edges during installation.

Expansion gaps ranging from approximately 8 mm to 15 mm shall be maintained along walls, columns and fixed elements to allow expansion and contraction due to temperature and humidity variation. These gaps shall remain free from rigid fillers and shall be concealed by skirting or trims.

Where large rooms exceed recommended dimensions, expansion joints or transition profiles shall be provided to prevent buckling of flooring.

**Cutting and Finishing:** Laminate boards shall be cut using suitable tools to avoid chipping of decorative surfaces. Cutting shall preferably be carried out with the decorative face oriented appropriately depending on the cutting equipment to ensure clean edges.

After installation, skirting boards and edge trims shall be fixed without restricting movement of the floating floor. The finished floor surface shall be clean, level and free from gaps, uneven joints or visible damage.

**Quality Control:** The Contractor shall ensure that laminate planks are properly interlocked and that joints remain tight and uniform. Flooring shall be checked for levelness, alignment and surface finish. Any damaged or defective planks shall be replaced before final acceptance. The installed floor shall remain free from excessive movement, squeaking or joint separation under normal walking conditions.

**Measurement:** Laminated flooring shall be measured in square metres based on the net finished floor area. Openings, cut-outs, wastage, trims and accessories required for complete installation shall be deemed included unless separately specified.

**Rate:** The rate shall include supply of laminate flooring boards, underlay, vapour barrier, trims, skirting, cutting, laying, alignment, finishing, protection and cleaning, together with all labour, tools, equipment and incidental works necessary to complete the flooring in accordance with this specification.

# 5.14 Chapter 14: TILING - WALL & FLOOR

## 5.14.1 Tiles

*GL0001 Providing and fixing vitrified tiles in skirting, step risers, dado and wall in different sizes (Sizes and thickness to be specified by the engineer / as per design) in all colours and shade, on 12mm thick cement mortar 1:3 (1 cement: 3 sand) finished with flush-pointing in white cement.*

*GL0010 Providing and fixing Vitrified Wall Tiles -full body in skirting, step risers, dado and wall in different sizes (Sizes and thickness to be specified by the engineer/as per design) in all colours and shade, on 12 mm thick cement mortar 1:3 (1 cement:3 sand) finished with Tiles grout flush-pointing.*

*GL0011 Providing and fixing Vitrified Wall Tiles -full body 3D tiles in skirting, step risers, dado and wall in different sizes (Sizes and thickness to be specified by the engineer/as per design) in all colours and shade, on 12 mm thick cement mortar 1:3 (1 cement:3 sand) finished with Tiles grout flush-pointing.*

**Preparation of surfaces**: The joints shall be raked out to a depth of at least 15 mm in masonry walls, while the masonry is being laid. In case of concrete walls, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned, thoroughly washed with water and kept wet before skirting is commenced.

**Laying:** 12 mm thick plaster of cement mortar 1:3 (1 cement: 3 coarse sand) shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonally at close intervals. The tiles should be soaked in water, washed clean, and a coat of cement slurry applied liberally at the back of tiles and set in the bedding mortar. The tiles shall be tamped and correct to proper plane and lines. The tiles shall be set in the required pattern and butt jointed. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size and their edges rubbed smooth.

**Curing and Finishing**: The joints shall be cleaned off the grey cement grout with wire brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement with pigments added if required to match the colour of tiles. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished work shall not sound hollow when tapped with a wooden mallet.

**Measurement:** Length shall be measured correct to 10 mm. Height shall be measured correct to 10 mm in the case of dado and 5 mm in the case of riser and skirting. The area shall be calculated in square metre, correct to two places of decimal. Length and height shall be measured along the finished face of the skirting or dado including curves where specials such as coves, internal and external angles and beads are used. Where cornices are used the area of dado shall be measured excluding the cornices.

**Rate:** The rate shall include the cost of the materials and labour involved in all the operations described above. The specials such as coves, internal and external angles and

boards shall be measured and paid for separately in running metres. The rate shall not include the cost of cornices which shall be measured and paid for separately. Raking of joints in masonry and hacking of RCC are not included in the rate.

*GL0002 Providing and laying vitrified tiles in flooring, treads of steps and landings in different sizes (Sizes and thickness to be specified by the engineer / as per design) in all colours and shade, on 20mm thick cement mortar 1:4 (1 cement: 4 sand) finished with flush-pointing in white cement.*

*GL0005 Providing and laying tactile floor tiles in different sizes (Sizes and thickness to be specified by the engineer/as per design) in all colours and shade, laid on 20 mm thick cement mortar 1:4 (1 cement: 4 coarse sand) finished with tiles grout flush pointing.*

*GL0015 Providing and laying Vitrified floor Tiles - full body in flooring, treads of steps and landings in different sizes (Sizes and thickness to be specified by the engineer/as per design) in all colours and shade, laid on 20 mm thick cement mortar 1:4 (1 cement: 4 coarse sand) finished with tiles grout flush pointing.*

*GL0016 Providing and laying Vitrified floor Tiles - full body 3D in flooring, treads of steps and landings in different sizes (Sizes and thickness to be specified by the engineer/as per design) in all colours and shade, laid on 20 mm thick cement mortar 1:4 (1 cement: 4 coarse sand) finished with tiles grout flush pointing.*

**Preparation of surface and laying:** Sub-grade concrete or the R.C.C slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:4 (1 cement: 4 coarse sand). The average thickness of bedding shall be 20mm under any portion of the tiles.

Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it. Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square metre. Tiles shall be soaked in water, washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints. Tiles, which are fixed in the floor adjoining the wall, shall enter not less than 10 mm under the plaster, skirting or dado. After tiles have been laid surplus cement grout shall be cleaned off.

**Pointing and finishing**: The joints shall be cleaned off the grey cement grout with wire brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement with pigment added if required to match the colour of tiles. The floor shall then be kept wet for 7 days. After curing, the surface shall be

washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

**Measurement:** Length and breadth shall be measured correct to 10 mm between the exposed surfaces of skirting or dado, where the junction of floor with skirting or dado is square and its area as laid shall be calculated in square metre, correct to two places of decimal. Where coves are used at the junctions, the length and breadth shall be measured between the lower edges of the coves.

**Rate:** The rate for flooring shall include the cost of the materials and labour involved in all the operations described above. No extra shall be paid for the use of cut (sawn) tiles in the work. No deduction shall be made or extra paid for any opening in the floor of an area up to 0.1 square metres. Nothing extra shall be paid for laying the floor at different levels in the same room.

*GL0003 Extra, for laying tiles in treads of steps, width <300mm, skirting and risers of steps, height <300mm*

**Measurement:** The area shall be calculated in square metre, correct to two places of decimal.

**Rate:** The rate shall include the cost of additional labour required in the work.

# 5.15 Chapter 15: ROOFING

### 5.15.1 Roofing Sheet

- *Providing & fixing Corrugated Galvanised Iron (CGI) sheeting, including bolts, hooks and nuts 8mm dia. with bitumen and G.I limpet washers filled with white lead for connection, excluding the cost of purlins, rafter and trusses*

*RF0001 24g*

- *Providing & fixing Pre - Painted Galvanised Iron (PPGI) sheets, including bolts, hooks and nuts 8mm dia. with bitumen and G.I limpet washers filled with white lead for connection, excluding the cost of purlins, rafter and trusses.*

*RF0003 25g (0.50 mm)*

- *Providing & fixing Pre - Painted Galvalume (PPGL) sheeting, including necessary accessories for fixing sheet (excluding the cost of purlins, rafter and trusses) - 25g*

*RF0004 25g (0.50 mm)*

**C.G.I sheets:** C.G.I sheets shall be of the thickness specified in the item. The C.G.I sheets shall conform to IS: 277; P.P.G.I and P.P.G.L shall confirm to IS 15965 in all respects.

- *Providing & fixing Corrugated Galvanised Iron (CGI) sheeting, including bolts, hooks and nuts 8mm dia. with bitumen and G.I limpet washers filled with white lead for connection, excluding the cost of purlins, rafter and trusses - 25g*

*RF0225 Corrugated Galvanised Iron Sheets 25G (0.50mm)*

*RF0226 Corrugated Galvanised Iron Sheets 25G (0.45mm)*

**Purlins:** Wooden purlins of the specified wood or MS rolled sections of requisite size shall be fixed over the principle rafters. Maximum spacing of purlins shall not exceed 1.60 metre

The top surfaces of the purlins shall be uniform and plane. They shall be painted before fixing on top. Embedded portions of wooden purlins shall be coal tarred with two coats.

**Slope:** Roof shall not be pitched at a flatter slope than 1 vertical to 5 horizontal.

**Laying and fixing:** The sheets shall be laid and fixed in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer. The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

The sheets shall be laid with a minimum lap of 20 cm at the ends and two ridges of corrugation at each side. The above end lap of 20 cm shall apply to slopes of 1 vertical to 3 horizontal and flatter slopes. For steeper slopes the minimum permissible end lap shall be 15 cm. The minimum lap of sheets with ridge, hips and valleys shall be 20 cm measured at right angles to the line of the ridge, hip and valley respectively. These sheets shall be cut to suit the dimensions or shape of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge and chisel to give a smooth and straight finish.

Lapping in C.G.I. sheet shall be painted with a coat of approved steel primer and two coats of painting with approved paint for steelwork before fixing in place. Sheets shall not generally be built into gables and parapets. They shall be bent up along their side edges close to the

wall and the junction shall be protected by suitable flashing or by a projecting drip course, the later to cover the junction by at-least 7.5 cm. The laying operation shall include all scaffolding work involved.

Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with galvanised J or L hook bolts and nuts, 8 mm diameter, with bitumen and G.I. limpet washers or with a limpet washer filled with white lead as directed by the Engineer. The length of the hook bolt shall be varied to suit the particular requirements. The bolts shall be sufficiently long so that after fixing they project above the top of the nuts by not less than 10 mm. The grip of the J or L hook bolt on the side of the purlin shall not be less than 25 mm. There shall be a minimum of three hook bolts placed at the ridges of corrugations in each sheet on every purlin and their spacing shall not exceed 30 cm. Coach screws shall not be used for fixing sheets to purlins.

Where slopes of roofs are less than 21.5 degrees (1 vertical to 2.5 horizontal) sheets shall be joined together at the side laps by galvanised iron bolts and nuts 25 x 6 mm size, each bolt with bitumen and a G.I. limpet washer or a G.I. limpet washer filled white lead. As the overlap at the sides extends to two corrugations, these bolts shall be placed zigzag over the two overlapping corrugations, so that the ends of the overlapping sheets shall be drawn tightly to each other. The spacing of these seam bolts shall not exceed 60 cm along each of the staggered rows. Holes for all bolts shall be drilled and not punched in the ridges of the corrugations from the underside, while the sheets are on the ground. Sheets with wrongly drilled holes shall be rejected. The holes in the washers shall be of the exact diameter of the hook bolts or the seam bolts. The nuts shall be tightened from above to give a leak proof roof.

**Wind Ties:** Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified. These shall be fixed at the eaves ends of the sheets. The fixing shall be done with the same hook bolts, which secure the sheets to the purlins.

**Finish:** The roof when completed shall be true to lines, and slopes and shall be leak proof.

**Measurement:** The length and breadth shall be measured correct to 10 mm. Area shall be worked out in sq.m correct to two places of decimal. The superficial area of roof coverings shall be measured on the flat without allowance for laps and corrugations. Portions of roof coverings overlapping ridge or hip etc. shall be included in the measurements of the roof. Roofs with curved sheets shall be measured and paid for separately. Measurements shall be taken on the flat and not girth. No deduction in measurement shall be made for opening up to 0.4 sq.m. For any opening exceeding 0.4 sq.m in area, deduction in measurements for the full openings shall be made and in such cases the labour involved in making these openings shall be paid for separately. Cutting across corrugation shall be measured on the flat and not girth.

**Rate:** The rate shall include the cost of all the materials and labour involved in all the operations described above including a coat of approved steel primer and two coats of approved steel paint on overlapping of C.G.I. sheets. This includes the cost of roof sheets, galvanised iron J or L hooks, bolts and nuts, galvanised iron seam bolts and nuts bitumen and (galvanised iron) limpet washers. The ties shall be paid for separately.

- *Providing & fixing 600 mm ridges or hips in plain G.I. including bolts, hooks and nuts 8 mm dia G.I limpet and bitumen washers for connection*

*RF0005 24g.*

- *Providing & fixing 600 mm ridges or hips in Pre - Painted Galvanised Iron (PPGI) sheets, including bolts, hooks and nuts 8mm dia G.I limpet and bitumen washers for connection.*

*RF0007 25g (0.50 mm)*

- *Providing & fixing 600 mm ridges or hips in Pre-Painted Galvalume (PPGL) sheets, including necessary accessories for fixing sheet*

*RF0008 25g (0.50 mm)*

**Ridges and Hips:** Ridges and hips of C.G.I/P.P.G. I/P.P.G. L roofs shall be covered with ridge and hip sections with a minimum lap of 20.0 cm on either side over the sheets. The end laps of the ridges and hips, and between ridges and hips shall also be not less than 20.0 cm. The ridges and hips shall be of 60 cm overall width plain G.I. sheets and shall be properly bent to shape.

**Fixing:** Ridges shall be fixed to the purlins below with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to the purlins. Similarly, hips shall be fixed to the roof members below such as purlins, hip and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members. At least one of the fixing bolts shall pass through the end laps of ridges and hips, on either side. If this is not possible extra hook bolts shall be provided. The end laps of ridges and hips shall be joined together by galvanised iron seam bolts 25 x 6 mm size each with a bitumen and G.I. washer or as directed by the Engineer. There shall be at least two such bolts in each end lap.

**Finish:** The edges of the ridges and hips shall be straight from end to end and their surfaces shall be plane and parallel to the general plane of the roof. The ridges and hips shall fit in squarely on the sheets.

**Measurement:** The measurements shall be taken for the finished work in length along with the centre line of ridge or hip, as the case may be, correct to 10 mm. The laps in ridges and hips, and between ridges and hips shall not be measured.

**Rate:** The rate shall include the cost of all labour and materials specified above, including the cost of seam bolts and any extra G.I. hook bolts, nuts and washers required for the work.

- *Providing & fixing 450mm over all semi-circular plain G.I gutter, including brackets, bolts, nuts, washers & rain water pipes connections, excluding the cost of pipes*

*RF0010 24g sheet*

- *Providing & fixing 600 mm overall width Pre - Painted Galvanised Iron (PPGI) gutter, including brackets, bolts, nuts, washers & rain water pipes connections, excluding the cost of pipes - 25 g sheet*

*RF0011 25g sheet*

- *Providing & fixing 600 mm overall width Pre-Painted Galvalume (PPGL) gutter, including brackets, bolts, nuts, washers & rain water pipes connections, excluding the cost of pipes - 25 g sheet*

*RF0012 25g sheet*

- *Providing & fixing semi circular/half round Poly Vinyl Chloride (PVC) roof gutter of 140mm dia 3.04m long, including fittings (brackets, bolts, nuts, washer, end cap, tee end cap etc) excluding the cost of pipes.*

*RF0013 140mm*

- *Providing & fixing semi circular/half round Poly Vinyl Chloride (PVC) roof gutter of 180mm dia 3.04m long, including fittings (brackets, bolts, nuts, washer, end cap, tee end cap etc) excluding the cost of pipes.*

*RF0014 180mm*

**Gutters:** Gutters shall be fabricated from plain G.I. sheets 24g or Poly Vinyl Chloride (PVC). The overall width of the sheet referred to shall mean the peripheral width of the gutter including the rounded edges. The longitudinal edges shall be turned back to the extent of 12 mm and beaten to form a rounded edge. The ends of the sheets at junctions of pieces shall be hooked into each other and beaten flush to avoid leakage.

**Slope:** Gutters shall be laid with a minimum slope of 1 in 120.

**Laying and fixing:** Gutters shall be supported on and fixed to M.S. flat iron brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1.20 metres. Where these brackets are to be fixed to the sides of rafters, they shall be of 40 x 3 mm section bent to shape and fixed rigidly to the sides of rafters with 3 Nos. 10 mm dia bolts, nuts and washers. The brackets shall overlap the rafter not less than 30 cm and the connecting bolts shall be at 12cm centres.

Where the brackets are to be fixed to the purlins, the brackets shall consist of 40 x 3 mm M.S. flat iron bent to shape, with one end turned at right angle and fixed to the purlin-face with a 10 mm dia. bolt, nut and washer. The perpendicular over hung portion of the 40 x 3 mm flat bent to right angle shape with its longer leg connected to the bracket with 2 Nos. 6 mm dia M.S. bolts, nuts and washers and its shorter leg shall be fixed to face of purlin with 1 No. 10 mm dia, bolt, nut and washer. The overhang of the vertical portion of the flat iron bracket from the face of the purlins shall not exceed 20 cm with this arrangement. The gutters shall be fixed to the brackets with 2 Nos. G.I. bolts and nuts 6 mm dia, each fitted with a pair of G.I. and bitumen washers. The connecting bolts shall be above the water line of the gutters.

For connection to down take pipes, a proper drop end or funnel shaped connecting piece shall be made out of G.I. sheet of the same thickness as the gutter and riveted to the gutter, the other end tailing into the socket of the rain-water pipe. Wherever necessary stop ends, angles, etc. should be provided.

**Finish**: The gutters when fixed shall be true to line and slope and shall be leak proof.

**Measurement**: Measurement shall be taken for the finished work along the centre line of the top width of the gutter correct to a 10 mm. The hooked lap position in the junctions and gutter lengths shall not be measured.

**Rate:** The rate shall include the cost of all labour and materials specified above, including all specials such as angles, junctions, drop ends etc., flat iron brackets and bolts and nuts required for fixing the latter to the roof members.

*RF0015 Extra, for providing & fixing curved C.G.I/P.P.G. I/ P.P.P.G.L sheet in roofing*

*RF0016 Extra, for providing & fixing C.G.I/P.P.G. I/ P.P.P.G.L sheets vertically or to a pitch >60 degrees*

*RF0017 Extra, for making straight-cut openings for chimney, sky lights*

- *Extra, for making opening or recess in C.G.I/P.P.G. I/ P.P.P.G.L roofing of girth <1 m*

*RF0025 Area ≤ 0.01 sq.m*

*RF0026 0.01 < Area < 0.04 sq.m*

*RF0027 Area ≥ 0.04 sq.m*

**Measurement:** Measurement shall be taken in area correct to 0.01sq.m

**Rate:** The rate shall include the additional labour involved in bending, cutting the opening, wastage to the required shape and fixing.

### *5.15.2* Wind Bracing

*RF0060 Providing & fixing wind tie of 40 x 6 mm MS flats*

Wind ties shall be of 40 x 6 mm flat iron section. These shall be fixed at the eave end of the sheets. The fixing shall be done with the same hook bolts, which secure the sheets to the purlin.

**Measurements:** Wind ties shall be measured in running metres correct to 10mm.

**Rate:** Rate shall include the cost of materials and labour involved in all the operations.

### 5.15.3 Slate Roofing

*RF0075 Providing & fixing single slate roofing including bitumen felt water-proofing etc complete, excluding the cost of wooden reepers, trusses*

**Laying:** The reepers shall be fixed after laying bitumen felt on wooden plank 20 mm thick. The wooden planks shall rest on rafters of trusses. The horizontal lap in bitumen felt shall be 75 mm and vertical lap 150 mm. Nails shall be fixed in drilled holes of slates having minimum edge distance 75 mm. The minimum lap in slates shall be horizontal 75 mm and vertical 50 mm. Wood work of reepers shall be paid separately in quantity of trusses.

**Measurements:** The length and width of finished work shall be measured correct to 10mm. The area shall be calculated nearest to two places of decimal.

**Rate:** The rate shall include all materials and labour involved in the operations described above.

### 5.15.4 Shinglep Roofing

*RF0130 Providing & fixing shinglep roofing with standard shinglep (3 layers) including tying, uplift protection*

The shinglep shall be of size 1.35 m long, 125 mm wide and 12.5 mm thick. The trusses are erected in the usual manner. The purlin spacing shall be at 60 cm. The shinglep shall be laid with the long side parallel to the slope of the roof. They shall be laid side by side in each abutting against the next so as not to leave any gap. The next length of shinglep is laid with an overlap of 150 mm with the previous length, the laying being commenced from the eaves level and proceeding towards the ridge. After one layer is laid in this fashion, the second layer is laid so that the transverse joints in the new layer lie in the middle of the bottom

layer of shinglep exactly. Thus the transverse joints of the bottom layer and those second layer will be staggered to the extent of half the width of the shinglep. The third layer is now laid again with the transverse joints being staggered as before.

After the completion of the third layer, wind ties are provided over the roofing coinciding length-wise with every alternate purlin. Over this wind tie stones of average diameter 250 mm are placed at a spacing of 600 mm to hold the roof against wind. Care must be taken while placing the stone to see that it lies on its flattest side.

**Measurements:** Length and breadth shall be measured correct to 10 mm, and superficial areas in square metre correct to two places of decimal.

**Rate:** The rate shall include all materials and labour involved in the operations described above.

### 5.15.5 Corrugated Polycarbonate Roofing

*RF0150 Providing & fixing 2 mm Polycarbonate transparent sheet including 8 mm G.I J or L hooks, bitumen & G.I limpet washers etc complete, excluding the cost of trusses, purlins, rafter*

The transparent sheet should be corrugated matching to the corrugation of other roofing materials. The transparent sheet shall be of a thickness 2 mm. The sheet shall be free from cracks, split edges, twists and surface flaws etc. The corrugations shall be uniform in depth, pitch and parallel with the sides. The sheet shall be drilled and not punched. Such holes shall always be made through the crowns of corrugation and never on the flats or valleys.

For **laying** and **fixing** shall be as same as the C.G. I sheeting

**Measurement:** The length and breadth shall be measured correct to 10 mm. Area shall be worked out in sq.m correct to two places of decimal. The superficial area of roof coverings shall be measured on the flat without allowance for laps and corrugations. Portions of roof coverings overlapping ridge or hip etc. shall be included in the measurements of the roof. Roofs with curved sheets shall be measured and paid for separately. Measurements shall be taken on the flat and not girth. No deduction in measurement shall be made for opening up to 0.4 sq.m. For any opening exceeding 0.4 sq.m in area, deduction in measurements for the full openings shall be made and in such cases the labour involved in making these openings shall be paid for separately. Cutting across corrugation shall be measured on the flat and not girth.

**Rate:** The rate shall include the cost of all the materials and labour involved in all the operations described above including overlapping of sheets.

### 5.15.6 Rain Water Pipe

- *Providing and fixing on wall face single socketed rigid PVC ( Working Pressure 4kgf per sq.cm) rain water pipes including jointing with seal ring leaving 10 mm gap for thermal expansion- complete*

*RF0190 75 mm dia*

*RF0191 50 mm dia*

*RF0192 110 mm dia*

- *Providing and fixing on wall face PVC coupler for rigid rain water pipes including jointing with seal ring leaving 10 mm gap for thermal expansion - complete*

*RF0195* *75 mm dia*

*RF0196* *50 mm dia*

*RF0197* *110 mm dia*

- *Providing and fixing on wall face PVC Single tee with door for rigid rain water pipes including jointing with seal ring leaving 10 mm gap for thermal expansion - complete*

*RF0200* *75 mm dia*

*RF0201* *50 mm dia*

*RF0202* *110 mm dia*

- *Providing and fixing on wall face PVC plain Single tee for rigid rain water pipes including jointing with seal ring leaving 10 mm gap for thermal expansion - complete*

*RF0205* *75 mm dia*

*RF0206* *50 mm dia*

*RF0207* *110 mm dia*

- *Providing and fixing on wall face PVC bend for rigid rain water pipes including jointing with seal ring leaving 10 mm gap for thermal expansion - complete*

*RF0210* *75 mm dia*

*RF0211* *50 mm dia*

*RF0212* *110 mm dia*

- *Providing and fixing on wall face PVC shoe for rigid rain water pipes including jointing with seal ring leaving 10 mm gap for thermal expansion - complete*

*RF0215* *75 mm dia*

*RF0216* *50 mm dia*

*RF0217* *110 mm dia*

**Providing and fixing, measurement and rate shall conform to the same specifications, workmanship, and installation procedures as specified for plumbing pipework**.

### 5.15.7 Insulated PUF Roofing Panels

- *Providing & fixing PUF sheeting (PPGI), including necessary screws, excluding the cost of frames*

*RF0230* *40 mm thick PUF sheets (0.50 mm Top & 0.40 mm bottom sheet.)*

*RF0231* *50 mm thick PUF sheets (0.50 mm Top & 0.40 mm bottom sheet.)*

*RF0232* *60 mm thick PUF sheets (0.50 mm Top & 0.40 mm bottom sheet.)*

*RF0233* *80 mm thick PUF sheets (0.50 mm Top & 0.40 mm bottom sheet.)*

**Installation:** The panels shall be fixed to steel purlins using suitable self-drilling/self-tapping fasteners complete with EPDM washers. Holes for fixing shall be drilled and not punched. The panels shall be laid true to line, level and slope in accordance with approved drawings and manufacturer's recommendations. The panels shall be laid from eaves towards the ridge with proper side laps and end laps.

The panels shall be securely fixed to steel purlins using suitable self-drilling/self-tapping fasteners complete with EPDM washers. Holes for fixing shall be drilled through the crown of corrugation/profile and not punched.

Side laps, end laps and joints shall be properly sealed with approved sealant to ensure weatherproof and watertight roofing. Ridge pieces, flashings and closures shall be properly fixed and aligned.

For laying and fixing, the work shall generally conform to the specifications for CGI/profile (code to be mentioned) sheet roofing unless otherwise specified. Damaged panels shall not be used

**Measurement:** The length and breadth shall be measured correct to 10 mm. Area shall be worked out in sq.m correct to two places of decimal.

The superficial area of roof covering shall be measured on the flat without allowance for laps, corrugations, ribs or interlocks. Portions overlapping ridges, hips, valleys and similar surfaces shall be included in the measurements. Roofs with curved panels shall be measured and paid for separately. Measurements shall be taken on the flat and not on girth.

No deduction in measurements shall be made for openings up to 0.4 sq.m. For openings exceeding 0.4 sq.m, deduction shall be made for the full openings and labour involved in forming such openings shall be measured and paid separately. Cutting across corrugations/ribs shall be measured on the flat and not on girth.

**Rate:** The rate shall include the cost of all materials and labour involved in all the operations described above including transportation, loading, unloading, handling, hoisting, cutting, drilling, fastening, overlaps, sealants, ridge pieces, flashings, EPDM washers, accessories and all incidental charges necessary for completion of the work.

# 5.16 Chapter 16: PLUMBING - INDOOR WORK

## 5.16.1 Water Supply (General)

**General Requirements:** All water supply installation work shall be carried out through skilled plumbers. It is most important that a wholesome water supply provided for drinking and culinary purposes shall not be liable to contamination from any less satisfactory water. There shall, therefore, be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for conveying or containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose.

No piping shall be laid or fixed so as to pass into, through or adjoining any sewer, scour outlet or drain or any manhole connected therewith nor through any ash-pit or manure-pit or any material of such nature that would be likely to cause undue deterioration of the pipe. Where the laying of any pipe through fouled soil or previous material is unavoidable, the piping shall be properly protected from contact with such soil or material by being carried through an exterior cast iron tube or by some other suitable means. Any piping or fitting laid or fixed, which does not comply with the above requirements, shall be removed and re-laid in conformity with the above requirements.

All pipe work shall be so laid or fixed, and maintained as to be and to remain completely watertight, thereby avoiding waste of water, damage to property and the risk of contamination of the water conveyed. Due attention shall be given to the maximum rate of discharge, protection against damage and corrosion, protection from frost, and to avoidance of airlocks, noise transmission and unsightly arrangement.

To reduce frictional losses, piping shall be as smooth as possible inside. Methods of jointing shall be such as to avoid internal roughness and projection at the joints, whether of the jointing materials or otherwise. Change in diameter and in direction shall preferably be gradual rather than abrupt to avoid undue loss of head. No bend or curve in piping shall be made so as to materially diminish or alter the cross-section.

Underground piping shall be laid at such a depth that it is unlikely to be damaged by frost or traffic loads and vibrations. It shall not be laid in ground liable to subsidence, but where such ground cannot be avoided; special precautions shall be taken to avoid damage to the piping. Where piping has to be laid across recently disturbed ground, the ground shall be thoroughly consolidated so as to provide a continuous and even support. Where the service pipe is of diameter less than 50 mm, the stop valves shall be of the screw-down type and shall have loose washer plates to act as non-return valves. Other stop valves in the service line may be of the gate type.

## 5.16.2 Pipe works

- *Providing and fixing G.I. pipes including G.I. fittings & clamps & repair walls (internal works)*

| | |
|---|---|
| *PI0001* | *15mm* |
| *PI0002* | *20mm* |
| *PI0003* | *25mm* |

*PI0004 32mm*

*PI0005 40mm*

*PI0006 50mm*

- *Providing and fixing H.D.P.E pipes, PN 10, including fittings and repairing walls etc. complete*

*PI0010 20mm*

*PI0011 25mm*

*PI0012 32mm*

*PI0013 40mm*

*PI0114 50mm*

- *Providing and fixing 3-layer PP-R (Polypropylene Random Copolymer) PN-16 pipes, SDR 7.4 UV Stabilized and anti microbial fusion welded, having thermal stability for hot and cold water supply including all PP-R plain and brass Threaded Polypropylene random fittings including fixing pipe with clamps at 1.0m spacing. This includes testing of joints, cutting chases and making good the wall complete as per direction of Engineer-in- Charge.*

*PI0290 16mm*

*PI0291 20mm*

*PI0292 25mm*

*PI0293 32mm*

*PI0294 40mm*

*PI0295 50mm*

- *Providing and fixing Chlorinated Polyvinyl Chloride (CPVC) pipes - class 1 (SDR11), having thermal stability for hot & cold water supply, including all CPVC plain & brass threaded fittings, including fixing the pipe with clamps at 1.00 m spacing. This includes jointing of pipes & fittings with one step CPVC solvent cement and testing of joints complete as per direction of Engineer in Charge. Internal work - Exposed on wall*

*PI0300 15 mm*

*PI0301 20 mm*

*PI0302 25 mm*

*PI0303 32 mm*

*PI0304 40 mm*

*PI0305 50 mm*

- *Providing and fixing Chlorinated Polyvinyl Chloride (CPVC) pipes - class 1 (SDR11), having thermal stability for hot & cold water supply, including all CPVC plain & brass threaded fittings, including fixing the pipe with clamps at 1.00 m spacing. This includes jointing of pipes & fittings with one step CPVC solvent cement and the cost of cutting chases*

*and making good the same including testing of joints complete as per direction of Engineer in Charge. Concealed work, including cutting chases and making good the walls etc.*

*PI0315 15 mm*

*PI0316 20 mm*

*PI0317 25 mm*

*PI0318 32 mm*

For internal work, the pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm clear of the wall. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts or recess etc., provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage and where so required joints are not buried. Where directed by the Engineer, a M.S. tube sleeve shall be fixed at a place where the pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion and contraction and other movements. In case the pipe is embedded in walls or floors it should be painted with anticorrosive bitumastic paint of approved quality. The pipe shall not come in contact with lime mortar or lime concrete as the pipe is affected by lime. Under the floors the pipes shall be laid in a layer of sand filling as done under concrete floors.

**Cutting and Threading**: Where the pipes have to be cut or rethreaded, the ends shall be carefully filed out so that no obstruction to bore is offered. The end of the pipes shall then be carefully threaded with pipe dies and taps in such a manner as not to result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening screw threads which have become bent or damaged and shall not be used for turning of the threads so as to make them slack as the later procedure may not result in a water tight joint. The screw threads of pipes and fittings shall be protected from damage until they are fitted.

**Jointing:** The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of pipes shall be oiled and rubbed with a white lead and a few turns of spun yarn wrapped round the screwed end of the pipe. The end shall then be screwed in the socket, tee etc, with pipe wrench. Care shall be taken that all pipes and fittings are kept at all times free from dust and dirt during fixing. Burr from joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern holder bat clamps of required shape and size as to fit tightly on the pipes when tightened with screw bolts. The clamps shall be embedded in brickwork in cement mortar 1:3 (1 cement: 3 coarse sand), and shall be spaced at regular intervals in straight lengths as shown in table 5.16.1.

**Table 5.16.1** INTERVALS IN STRAIGHT LENGTH

| Diameter of pipe (mm) | Horizontal length (m) | Vertical length (m) |
|---|---|---|
| 15 | 2.0 | 2.5 |
| 20 | 2.5 | 3.0 |
| 25 | 2.5 | 3.0 |
| 32 | 2.5 | 3.0 |
| 40 | 3.0 | 3.5 |
| 50 | 3.0 | 3.5 |

The clamps shall be fixed at shorter lengths near the fittings as directed by the Engineer. The pipes shall be tested as follows.

**Testing the joints:** After laying and jointing the pipes and fittings shall be inspected under working conditions of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost.

The pipes and fittings after they are laid shall be tested to hydraulic pressure of 6 kg/cm$^2$ (60 metres of head of water). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock and water hammer. The draw off taps and stopcocks shall then be closed and hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least half an hour. The pipes and fittings shall be tested in section as the work of laying proceeds, keeping the joints exposed for inspection during the testing.

**Measurements**: The lengths shall be measured in running metre correct to 10 mm for the finished work, which shall include G.I. pipe and G.I. fittings such as bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, but exclude brass or gun metal taps (cocks), valves, lead connection pipes and shower rose. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance, quality and finish. In case of fittings of an equal bore the pipe shall be described as including all cuttings and waste. In case of fittings of unequal bore, the largest bore shall be measured. Pipes laid in trenches (or without supports) shall be measured separately.

**Rate:** The rate shall include the cost of labour and material involved in all the operations described above. The rate shall include the cost of cutting holes in walls and floors and making good the same. It shall not include painting of pipes and providing sleeves.

**5.16.3 Storage Tank**

- *Providing and fixing storage tank of M.S. sheet welded all round, including. 40mm G.I scour pipe, 25mm G.I overflow pipe, 15mm ball valve, pads for inlet and outlet pipes, red lead primer & two coats of bitumastic paint*

*PI0020* *270 litre capacity of 2mm steel sheet*

*PI0021* *810 litre capacity of 2.8mm steel sheet*

*PI0022* *1620 litre capacity of 3.15mm steel sheet*

The tanks shall be made from the best quality M.S sheet of thickness specified above. The sheets shall be welded to form a tank as per standard welding practice.

The tanks shall have net capacity as specified. The various sizes of tanks with their net capacities are given below.

**Table 5.16.2** VARIOUS SIZES OF STORAGE TANKS WITH NET CAPACITIES

| Net capacity of tank | Size of tank |
|---|---|
| 270 liters | 90 x 60 x 60 cm |
| 810 liters | 120 x 90 x 90 cm |
| 1620 liters | 120 x 120 x 120 cm |

**Fittings:** Each tank shall be provided with 40 mm dia G.I scour pipe, which shall terminate into a socket and a plug, 25 mm G.I over flow pipe with fittings and brass mosquito proof coupling conforming to the municipal design and approved by the Engineer and ball valve with copper or plastic float of specified size and pressure. The ball valve shall be securely fixed to the tank independent of the inlet pipe and set in such a position that the body of the ball valve does not submerge when the tank is full up to the waterline. Each tank shall be provided with 40 cm dia standard mosquito proof C.I hinged cover weighing 8.15 kg and frame weighing 6.80 kg with locking arrangements.

**Hoisting**: The hoisting of tanks into position as directed by the Engineer shall be carried so that no part of the tank or structure is damaged in the operation. The tank shall be installed in position truly level and secure to concrete members with necessary bolts and nuts.

**Painting:** A priming coat of red lead shall be applied both internally and externally. On the inside, two coats of bitumastic paint shall be applied and on the exterior two coats of paint of approved make and tint shall be applied.

**Measurements:** Water storage tanks shall be counted in numbers for complete job.

**Rate:** The rate shall include the cost of materials and labour involved in all the operations described above except the cost of external painting.

- *Providing and fixing plastic tank with accessories complete*

*PI0030* *300 litre capacity*

*PI0031* *500 litre capacity*

*PI0032* *1000 litre capacity*

*PI0033* *2000 litre capacity*

*PI0034* *3000 litre capacity*

**Fittings:** Each tank shall be provided with 40 mm dia G.I scour pipe, which shall terminate into a socket and a plug, 25 mm G.I over flow pipe with fittings and brass mosquito proof coupling conforming to the municipal design and approved by the Engineer and ball valve with copper or plastic float of specified size and pressure. The ball valve shall be securely fixed to the tank independent of the inlet pipe and set in such a position that the body of the ball valve cannot become submerged when the tank is full up to the waterline.

**Hoisting**: The hoisting of tanks into position as directed by the Engineer shall be carried so that no part of the tank or structure is damaged in the operation. The tank shall be installed in position truly level and secure to concrete members with necessary bolts and nuts.

**Measurements:** Water storage tanks shall be counted in numbers for complete job.

**Rate:** The rate shall include the cost of materials and labour involved in all the operations described above.

**5.16.4 Sanitation (General)**

**General Requirements for Installation:** The work shall be carried out, complying in all respects with the requirements of relevant byelaws of the local body in whose jurisdiction the work is situated. Any damage caused to the building or to electric, sanitary water supply or other installations etc therein either due to negligence on the part of the contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the contractor. Nothing extra shall be paid for it except where otherwise specified.

In all the above operations the damaged portion shall be cut in regular geometric shape and cleaned before making good the same. All exposed G.I., C.I. or lead pipes and fittings shall be painted with approved quality of paint and shade as specified.

**5.16.5 Pans & Cisterns**

- *Providing and fixing Indian-type vitreous china w.c squatting pan, including 100 mm. P or S trap, 10 litres vitreous china cistern & fittings, repair walls complete.*

*PI0041* *580mm, white Orissa-model*

- *Providing and fixing Indian-type vitreous china w.c squatting pan, including 100 mm. P or S trap, 10 litres PVC cistern & fittings, repair walls complete.*

*PI0042* *580mm, white Orissa-model*

**Flushing Cistern:** The cistern shall be fixed on C.I. cantilever brackets, which shall be firmly embedded in the wall in cement concrete (1:2:4) block 100 x 75 x 150 mm. The cistern shall be provided with 20mm nominal bore overflow pipe. The outlet or flush pipe from the cistern shall be connected to the pan by means of cement or putty joint. The flush pipe shall be fixed to the wall by using holder bat clamps of required shape and size so as to fit tightly on the pipes when tightened with screwed bolts. The clamps shall be embedded in brickwork in cement mortar 1:3 (1 cement: 3 sand). The connection between the cistern and the closet shall be made by means of 40 mm flush bend with an inlet connection as specified.

**Painting:** The cistern, brackets, overflow and flush pipe etc. shall be painted with two or more coats of paint of approved shade and quality.

**Squatting pan:** The pan shall be sunk into the floor and embedded in a cushion of average 15 cm thick cement concrete 1:5:10 (1 cement: 5 fine sand: 10 graded brick ballast 40 mm nominal size). The concrete shall be left 115 mm below the top level of the pan so as to allow flooring and its bed concrete. The pan shall be provided with a 100 mm 'P' or 'S' type trap with an approximately 50mm seal and 50 mm dia. vent horn, where required by the Engineer. The joint between the pan and the trap shall be made leak proof with cement mortar 1:1 (1 cement: 1 sand). The cost of concrete shall be paid separately.

**Measurements:** Measurement shall be counted in numbers for complete job.

**Rate:** The rate shall include the cost of materials and labour involved in all the operations described above.

- *Providing and fixing European-type vitreous china w.c pedestal including seat and lid with c.p brass hinges, 15 litres white vitreous china low level cistern with flush pipe, fittings, brackets, repairing walls complete.*

*PI0050* *White, with plastic seat & lid*

- *Providing & fixing European-type vitreous china w.c One piece Toilet with seat cover, repairing walls complete*

*PI0051* *White, with plastic seat & lid*

**W.C. pan with white plastic seat and lid**.

**Seat and Cover:** The seat shall be fixed to pan by means of two 8 mm diameter corrosion resistant hinge bolts with a minimum length of shank of 65 mm and threaded to within 25 mm of the head. Each bolt shall be provided with two suitably shaped washers of rubber or other similar materials for adjusting the level of the seat while fixing it to the closet. In addition, one non-ferrous or stainless steel 8mm washer shall be provided with each bolt. The maximum external diameter of the washer fixed on the underside of the pan shall not be greater than 25mm. One arm of the hinge in each bolt shall be fixed to the underside of the seat by three Nos. 20mm long, 6 gauge wood screws. The other arm of the hinge shall be fixed to the underside of the cover, flush with the surface by means of three 10mm long 6 gauge wood screws.

**Water closet:** The closet shall be fixed to the floor by means of 75 mm long 6.5 mm diameter counter sunk bolts and nuts embedded in floor concrete.

The low level cistern shall be fixed as per specifications given above for Indian type W.C.

**Measurements**: The squatting pan shall be measured in numbers.

**Rates:** The rate shall include the cost of the materials and labour involved in all the operations described above.

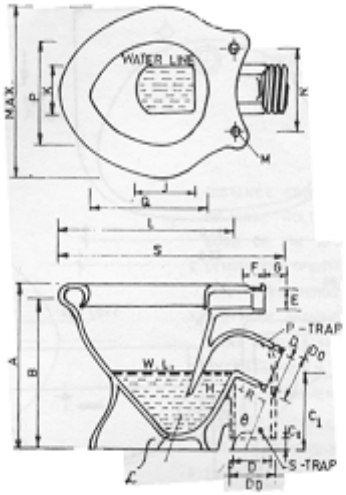



**Figure 5.16.1** Water closet

**Table 5.16.3** DIMENSION OF WATER CLOSET

| | A | B | $C_1$ | $C_2$ | D | $D_0$ | E | F | G |
|---|---|---|---|---|---|---|---|---|---|
| S - trap | 390 | 350 | | 20 | 80 | 110 | 55 | 30 | 45 |
| P – trap | 390 | 350 | 185 | 20 | 80 | 110 | 55 | 30 | 45 |

| | J | H | K | L | M | N | O | P |
|---|---|---|---|---|---|---|---|---|
| S - trap | 150 | Not < 50 water surface | 150 | 430 | 13 | 165 | 175 | 240 |
| P – trap | 150 | < 50 cu. cm | 150 | 430 | 13 | 165 | 175 | 240 |

| | Q | R | S | α | θ | T |
|---|---|---|---|---|---|---|
| S - trap | 230 | 40 | 630 | $90^0$ to $135^0$ | - | 75 |
| P – trap | 230 | 40 | 630 | $90^0$ to $135^0$ | $104^0$ | 75 |

**5.16.6 Urinals**

*- Providing and fixing white vitreous china flat back, lipped front urinal basin 430x260x350mm including all fittings, painting and repairing walls complete*

*PI0065 One bowl-5 litres C.I. cistern*

The installation shall consist of lipped urinal (single or range) automatic flushing cistern, G.I flush and waste pipes. The size of the flushing pipe shall be 15mm.

Urinals shall be fixed in position by using wooden plugs and screws. It shall be at a height of 65 cm from the standing level to the top of the lip of the urinal, unless otherwise directed by the Engineer. The plugs shall be fixed in the cement mortar 1:3. After the plugs are fixed the mortar shall be cured until it is set. Each urinal shall be connected to a 32mm dia waste pipe, which shall discharge into the channel or a floor trap. The connection between the urinal and the flush or waste pipe shall be made by means of putty or white lead mixed with chopped hemp.

**Measurement:** Urinals shall be measured in numbers.

**Rate:** The rate shall include the cost of all materials and labour involved in all the operations described above.

**5.16.7 Bath Tub**

*PI0075 Providing and fixing Porcelain, white enamelled Bath Tub with fittings and accessories complete - CP mixer, 40mm C.P brass waste, 32mm C.P brass over flow, rubber plug, 40mm C.P trap etc.*

*PI0076 Providing and fixing Fibreglass Bath Tub white with fittings and accessories complete - CP mixer, 40mm C.P brass waste, 32mm C.P brass over flow, rubber plug, 40mm C.P trap etc.*

*PI0077 Providing and fixing PVC P-Trap, heavy duty, for bath-tub complete*

The installation shall consist of an assembly of the bath-tub, pillar taps, chain with stay plug and waste arrangements. The tub shall be connected to a waste pipe and anti-siphon stack unless it discharges into a floor trap or in a channel.

**Measurement:** The item shall be measured in numbers.

**Rate:** The rate shall include the cost of all materials and labour involved in all the operations described above.

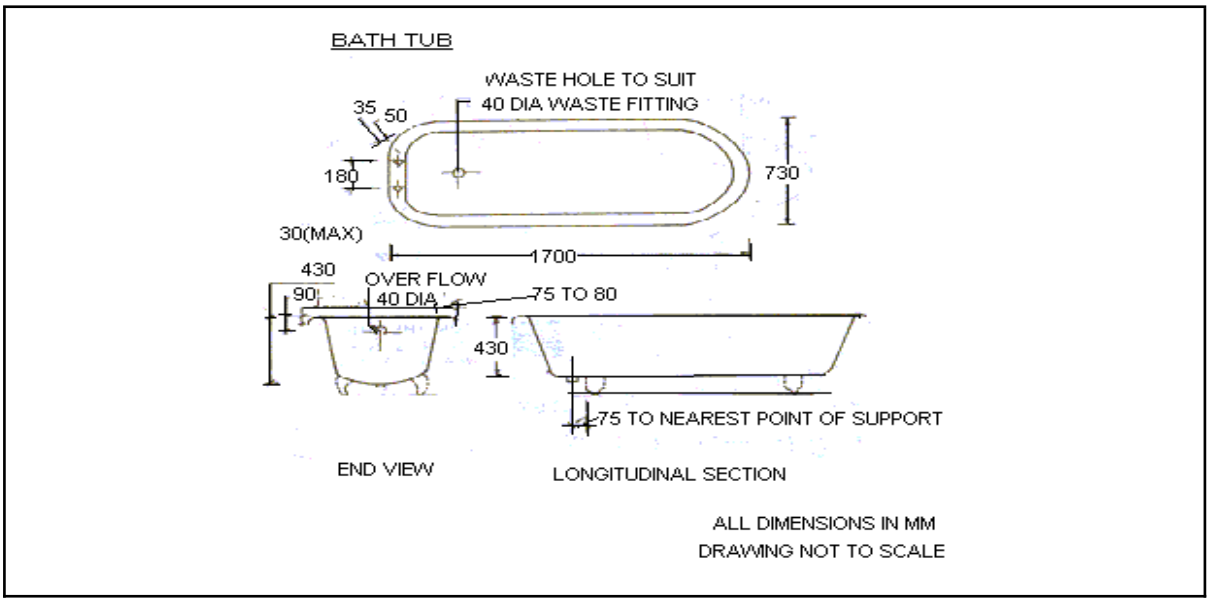



**Figure 5.16.2** Details of a bathtub

### 5.16.8 Wash Basin

- *Providing and fixing white vitreous china wash basin, including C.I brackets, 15mm C.P. brass pillar taps, c.p. chain & rubber plug, 32mm p.v.c. waste, 32mm dia. trap & union, repair walls*

*PI0085* *Flat back wash basin 630x450mm with a pair of 15mm c.p. brass pillar taps*

*PI0086* *Flat back wash basin 630x450mm with single 15mm c.p. brass pillar tap.*

*PI0087* *Flat back wash basin 550x400mm with a pair of 15mm c.p. brass pillar taps*

*PI0088* *Flat back wash basin 550x400mm with single 15mm c.p. brass pillar tap*

- *Providing and fixing white vitreous china angle back wash basin 400x400mm including brackets, 15mm c.p. brass pillar taps, c.p. brass chain & rubber plug, 32mm c.p. brass waste (waste coupling), 32mm dia c.p. brass trap and G.I. union and repair walls*

*PI0095* *With single 15 mm c.p. brass pillar tap*

*PI0096* *With a pair of 15 mm c.p. brass pillar taps*

The wash basin shall be provided with one or two taps as mentioned in the item. The front edge of the wash basin from the floor level shall be 80 cm.

**Fixing:** The basin shall be supported on a pair of R.S. or C.I. cantilever brackets embedded in concrete (1:2:4) block of 100 x 75 x 150 mm size. The brackets shall be fixed in position before dado work is done. The wall plaster on the rear shall be cut so that overhang of the top edge of the basin can rest on it. After fixing the basin, the plaster shall be made good and the surface finished to match with the existing one. The union shall be connected to 32 mm dia waste pipe which shall be suitably bent towards the wall and which shall discharge into an open drain leading to gully trap or direct into the gully trap on the ground floor; and shall be connected to waste pipe stack through a floor trap on upper floors. The C.P. brass trap and union shall not be provided when the waste pipe is discharged through a floor trap or a surface drain leading to a floor trap. Where so specified C.P. brass trap and union shall be paid for separately. Where so specified a G.I. puff 20 mm terminating with perforated brass cap screwed on it on the outside of the wall or connected to the anti-syphon stack, will be provided.

**Measurement:** Wash basin with specified fittings shall be measured in numbers.

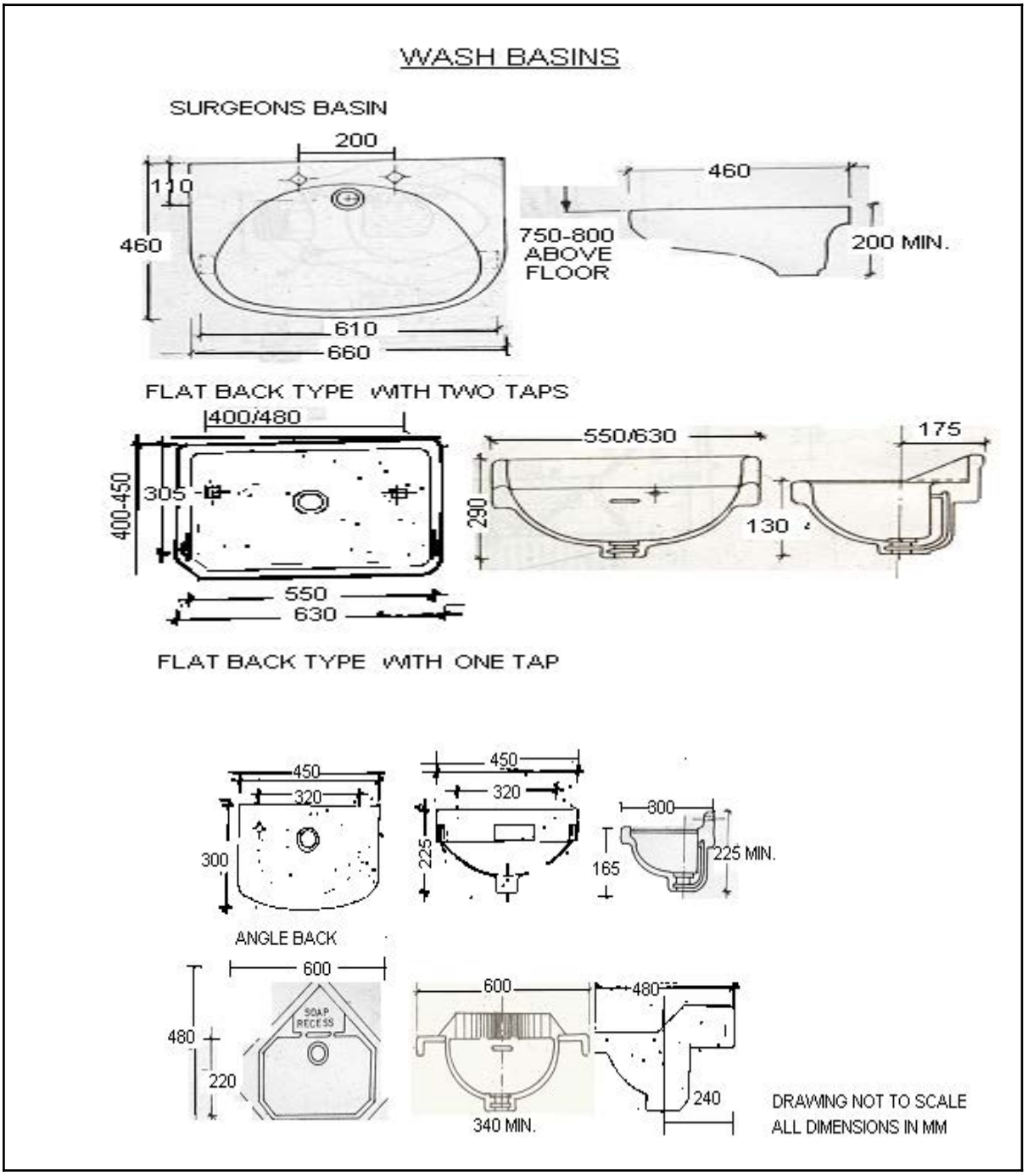



**Figure 5.16.3** Types of wash basin

*PI0115 Providing & fixing pedestals for basins, white vitreous china, recessed back for pipes and necessary fittings*

White vitreous china pedestal for wash basins, where specified, shall be provided. The quality of the pedestal shall be exactly the same as that of the wash basin with which it is to be installed. It shall be completely recessed at the back to accommodate supply and waste pipes and fittings. It shall be capable of supporting the basin rigidly and adequately and shall be so designed as to make the height from the floor to top of the rim of basin 75 to 80 cm.

**Measurement:** The pedestal shall be measured in numbers.

**Rate:** The rate includes the cost of all materials and labour involved in all the operations described above.

*PI0105 Providing and fixing c.p. flush valve, 32mm with 40mm outlet*

*PI0106 Providing and fixing c.p. concealed flush valve, 32mm with 40mm outlet*

*PI0107 Providing and fixing c.p. flush bend, long*

*PI0108 Providing and fixing c.p. flush valve elbow*

**Measurement:** The fitting shall be measured in numbers.

**Rate**: The rate includes the cost of all materials and labour involved in all the operations.

**5.16.9 Kitchen Sinks**

- *Providing and fixing Kitchen Sinks including all connections and fittings*

*PI0120 White glazed vitreous china 600 x 450 x 250 mm including accessories and repairs to walls etc.*

*PI0121 Stainless steel, 450 x 400 x 150 mm, single bowl*

*PI0122 Stainless steel, 580 x 480 x 175 mm, single bowl*

*PI0123 Stainless steel, 940 x 460 x 160 mm, single bowl & drain-board*

*PI0124 Stainless steel, 1080 x 520 x 175 mm, single bowl & drain-board*

*PI0125 Stainless steel, 1150 x 515 x 175 mm, single bowl & drain-board*

*PI0126 Stainless steel, 1740 x 520 x 200 mm, single bowl & double drain-board*

*PI0127 Stainless steel, 940 x 460 x 160 mm, double bowl*

*PI0128 Stainless steel, 1150 x 520 x 160 mm, single bowl*

*PI0129 Stainless steel, 1740 x 520 x 200 mm, double bowl & single drain-board*

*PI0130 Stainless steel, 1740 x 520 x 200 mm, double bowl & double drain-board*

The installation shall consist of assembling the sink, the brackets, trap, unions and waste pipe.

**Fixing:** The sink shall be supported on C.I. or R.S. brackets embedded in cement concrete 1:2:4 block of size 100 x 75 x 150 mm. Brackets shall be fixed in position before dado work is done. The C.P. brass (or P.V.C) union shall be connected to 40 mm nominal bore G.I. or P.V.C. waste pipe which shall be suitably bent towards the wall and shall discharge into a floor trap.

**Measurement:** The sinks shall be measured in numbers.

**Rate**: The rate shall include all the specials mentioned in the description of the item and the labour involved in the operation but will not include the cost of waste pipe which shall be paid separately.

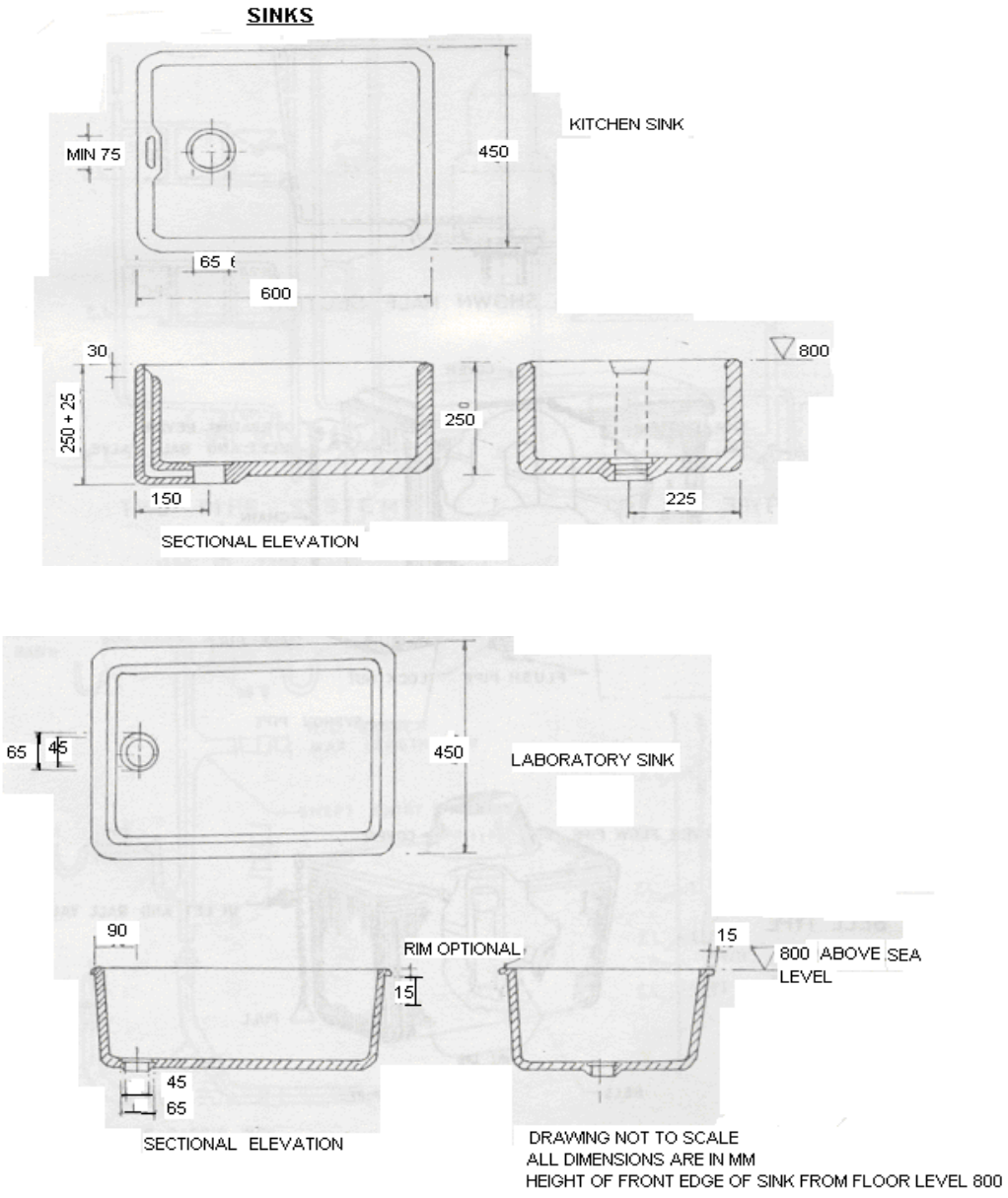



**Figure 5.16.4** Kitchen sink

*PI0140 Providing and fixing stainless steel drain-board, 610 x 460 mm with all necessary fittings*

*PI0141 Providing and fixing c.p. brass chain & rubber plug for basin and sink*

**Fixing**: The board shall be of the size specified. One end of the board shall rest on the sink and the other end shall be supported on C.I. (or R.S.) bracket embedded in cement concrete (1:2:4) block 100 x 75 x 150 mm. The bracket shall be of cantilever type or wall fixed type as for the sink.

**Measurement:** The sinks shall be measured in numbers.

**Rate**: The rate shall include the cost of all materials and labour involved in all operations for the items.

**5.16.10 Waste Pipes**

*PI0150 Providing and fixing 32mm dia p.v.c. waste*

*PI0151 Providing and fixing 32mm c.p. brass waste (waste coupling)*

*PI0152 Providing and fixing 40mm c.p. brass waste (waste coupling)*

**Measurement:** The items shall be measured in numbers.

**Rate**: The rate shall include cost of materials and the labour involved in the operation.

**5.16.11 Water Heaters**

- *Providing and fixing electric water heater including necessary fittings*

*PI0160 10 litres*

*PI0161 15 litres*

*PI0162 25 litres*

*PI0163 35 litres*

*PI0164 50 litres*

*PI0165 70 litres*

*PI0166 100 litres*

The water heaters shall be fixed on C.I cantilever brackets, which shall be embedded in the wall in cement concrete 1:2:4. The other fitting as specified shall be provided as per the directives of the Engineer. The brackets shall be painted with synthetic red lead primer or as directed by the Engineer.

**Measurement:** The water heater shall be measured in numbers.

**Rate**: The rate shall include the cost of all materials and labour involved in all operations for the items.

**5.16.12 Bathroom Fittings**

- *Providing and fixing C.P. Brass shower fittings*

*PI0175 Shower with revolving joint, 15mm,*

*PI0176 Adjustable shower, with locking key, 15mm*

*PI0177 Shower arm, standard 15mm*

*PI0178 Shower arm, heavy duty 15mm*

*PI0179 Flexible shower tube & shower*

- *Providing and fixing c.p. brass stop cock*

*PI0185 15mm, standard, c.p knob*

*PI0186 20mm, standard, c.p knob*

*PI0187 20 mm heavy-duty, c.p knob*

*PI0188 15mm, concealed, c.p knob*

*PI0189 15mm, angle, c.p knob*

*- Providing and fixing c.p. brass pillar-cock*

*PI0195 15mm, standard, c.p knob*

*PI0196 15mm, swan neck, c.p knob*

*- Providing and fixing c.p. brass bibcock*

*PI0205 15mm, standard vertical, c.p knob*

*PI0206 15mm, inclined, c.p. knob*

*PI0207 15mm, long nose, c.p. knob*

*PI0208 15mm, long body, c.p. knob*

*- Providing and fixing c.p. brass mixers, 15mm*

*PI0215 For basin, Single – hole, casted spout*

*PI0216 For basin, close hole*

*PI0217 For basin, elbow action, surgical*

*PI0218 For basin, elbow action, surgical with shower*

*PI0219 For sink, with spout J-pipe*

*PI0220 For sink, with casted spout swinging*

*PI0221 For sink, with swivel spout*

*PI0222 For wall, non – telephonic type*

*PI0223 For wall, telephonic type with crutch and telephonic shower*

*PI0224 For wall, telephonic type without crutch, and with telephonic shower*

*PI0225 For wall, telephonic type with crutch, and without telephonic shower*

*PI0226 For wall, telephonic type with C.P bend and flanges*

*PI0227 For wall, with telephonic shower arrangement with 115 mm long bend pipe for overhead shower connection*

*PI0228 Three hole mixer without pop - up*

*PI0229 Three hole mixer with pop - up*

*PI0230 For bath, with exposed adjustable legs with telephonic shower arrangement with crutch*

*PI0231 For shower, three in one, with bend flexible tube, and shower & hook*

*- Providing and fixing Wall Spouts*

*PI0240 c.p., standard, 15mm*

*PI0241 With diverter, for use with single lever mixers*

Only Government approved brands of fittings shall be used. The fittings of the type specified in the item shall be fully examined and cleared of all the foreign matters before being fixed. The fitting shall be fitted in the pipelines in workmen like manner. The joints between fittings and pipe shall be leak proof when pressure tested. The defective fittings and joints shall be replaced or redone.

**Measurement:** The items shall be measured in numbers.

**Rate:** The rate shall include all labour and materials involved in the work.

**5.16.13 Bathroom Accessories**

*PI0250 Providing and fixing 600x450mm bevelled edge mirror (superior glass) including 4mm A.C sheet base fixed to wooden cleats with C.P brass screws and washers*

The mirror shall be mounted on 4 mm thick plain asbestos sheet ground and shall be fixed in position by means of 4 C.P. brass screws and C.P. brass washers, over rubber washers and wooden plugs firmly embedded in walls. C.P. brass clamps with C.P. brass screws may be an alternative method of fixing, where so directed. Unless specified otherwise the longer side shall be fixed horizontally.

**Measurement:** Mirror shall be measured in numbers.

**Rate:** Rate shall include the cost of all the materials and labour involved in all the operations described above.

*PI0251 Providing and fixing 450x120mm glass shelf, including. c.p. brass brackets fixed to wooden cleats*

**Measurement:** The glass shelf shall be measured in numbers.

**Rate:** The rate shall include all labour and materials involved in the work.

*PI0252 Providing and fixing c.p. towel rail 750 x 20mm with c.p brass brackets fixed to wooden cleats*

*PI0253 Providing and fixing c.p. towel rail 600 x 20mm with c.p brass brackets fixed to wooden cleat*

*PI0254 Providing and fixing c.p. towel rail 450 x 20mm with c.p brass brackets fixed to wooden cleats*

*PI0255 Providing and fixing c.p. towel ring*

The towel rail shall be of the type as specified. The thickness of the rail shall be of 1.25mm. Chromium plating shall be of grade B type. The brackets shall be fixed by means of C.P. brass screws to wooden plugs firmly embedded in the wall.

**Measurement:** The towel rails shall be measured in numbers.

**Rate:** Rate shall include the cost of all the materials and labour involved in all the operations described above.

- *Providing and fixing toilet paper holder*

*PI0260 C.P. brass*

*PI0261 Recessed ceramic, 200 x 100 mm, coloured,*

*PI0262 Recessed ceramic, 200 x 100 mm, white*

*PI0263 Recessed ceramic, roll-type, 150 x 150 mm*

The toilet paper holder shall be of the type as specified and size and design as approved by the Engineer. It shall be fixed in position by means of screws and rawl plugs embedded in the wall. In case of C.P. brass toilet paper holder C.P. brass screws shall be used for fixing the holder to the rawl plugs.

**Measurement**: Holder shall be measured in numbers.

**Rate**: Rate shall include the cost of all the materials and labour involved in all the operations described above.

*PI0270 Providing and fixing Liquid soap containers, c.p, including. c.p. brass lid & brackets, wooden cleats, c.p. brass screws*

It shall be fixed in position by means of screws and rawl plugs embedded in the wall.

**Measurement**: Holder shall be measured in numbers.

**Rate:** Rate shall include the cost of all the materials and labour involved in all the operations described above.

- *Providing and fixing soap dish*

*PI0275 Including brackets, wooden cleats, c.p. brass screws*

*PI0276 Recessed, ceramic, 150x150 mm*

*PI0277 Recessed, ceramic, 200x100 mm*

- *Providing and fixing c.p. coat hook*

*PI0285 Single*

*PI0286 Double*

The item shall be of the type as specified and size and design as approved by the Engineer. It shall be fixed in position by means of screws and rawl plugs embedded in the wall. In case of C.P. brass, C.P. brass screws shall be used for fixing the holder to the rawl plugs.

**Measurement**: Measurement shall be taken in numbers.

**Rate:** Rate shall include the cost of all the materials and labour involved in all the operations described above.

# 5.17 Chapter 17: PLUMBING - OUTDOOR WORK

## 5.17.1 Water Supply

- *Providing and laying G.I. pipes including G.I. fittings (excluding trenching, refilling and thrust block)*

| | |
|---|---|
| *PO0001* | *15mm* |
| *PO0002* | *20mm* |
| *PO0003* | *25mm* |
| *PO0004* | *32mm* |
| *PO0005* | *40mm* |
| *PO0006* | *50mm* |
| *PO0007* | *65mm* |
| *PO0008* | *80mm* |
| *PO0009* | *100mm* |
| *PO0010* | *150mm* |

- *Providing, laying, jointing, and testing High-Density Polyethylene (HDPE) Double Wall Corrugated (DWC) pipes SN 4/8/16/ conforming to IS 16098 (Part 2). The scope includes lowering the pipes into trenches, aligning, and jointing with matching DWC couplers and elastomeric rubber sealing rings (gaskets) using manufacturer-approved food-grade lubricants to ensure a watertight joint. The item includes all necessary fittings such as bends, tees, Y-Junctions (Wyes), End Caps and reducers as per drawings, hydraulic testing (water/smoke test) for leakage as per standards, and neat finishing, complete in all respects. (Excluding trenching, bedding, refilling & thrust block)*

| | |
|---|---|
| | *75mm* |
| | *100mm* |
| | *125mm* |
| | *135mm* |
| *PO0800* | *150mm* |
| | *170mm* |
| *To* | *200mm* |
| | *225mm* |
| *PO0875* | *250mm* |
| | *300mm* |
| | *400mm* |
| | *500mm* |

*600mm*

*800mm*

*1000mm*

*1200mm*

- *Providing, laying, jointing, testing, and commissioning of HDPE pipe (High-Density Polyethylene) PN 2.5/4/6/8/10/12.5/16/20/, conforming to IS 4984: 2016, jointing by butt-fusion/electrofusion methods, including HDPE fittings such as coupler, bends, tees, Y-Junctions (Wyes), and reducers, complete in all respects. (Excluding trenching, bedding, refilling & thrust block)*

*16mm*

*20mm*

*25mm*

*32mm*

*40mm*

*50mm*

*63mm*

*75mm*

*90mm*

*110mm*

*125mm*

*140mm*

*PO1000* *160mm*

*180mm*

*To* *200mm*

*225mm*

*PO1293* *250mm*

*280mm*

*315mm*

*355mm*

*400mm*

*450mm*

*500mm*

*560mm*

*630mm*

*710mm*

*800mm*

*900mm*

*1000mm*

*1200mm*

*1400mm*

*1600mm*

*1800mm*

*2000mm*

- *Providing, laying, jointing, testing, and commissioning of HDPE pipe (High-Density Polyethylene) PN 4.0/6.0/8.0/10.0/12.5/16/20, conforming to ISO 4427-2:2019 , jointing by butt-fusion/electrofusion methods, including HDPE fittings such as coupler, bends, tees, Y-Junctions (Wyes), and reducers, complete in all respects. (Excluding trenching, bedding, refilling & thrust block)*

*16mm*

*20mm*

*25mm*

*32mm*

*40mm*

*50mm*

*63mm*

*75mm*

*90mm*

*110mm*

*125mm*

*140mm*

*PO1400* *160mm*

*180mm*

*To* *200mm*

*225mm*

*PO1653* *250mm*

*280mm*

*315mm*

*355mm*

*400mm*

*450mm*

*500mm*

*560mm*

*630mm*

*710mm*

*800mm*

*900mm*

*1000mm*

*1200mm*

*1400mm*

*1600mm*

*1800mm*

*2000mm*

- *Providing and fixing 3-layer PP-R (Polypropylene Random Copolymer) PN 16 pipes, SDR 7.4 UV Stabilized and anti microbial fusion welded, having thermal stability for hot and cold water supply including all PP-R plain and brass Threaded Polypropylene random fittings excluding trenching, refilling but including testing of joints complete as per direction of Engineer-in- Charge.*

*PO0700* *16mm*

*PO0701* *20mm*

*PO0702* *25mm*

*PO0703* *32mm*

*PO0704* *40mm*

*PO0705* *50mm*

*PO0706* *63mm*

*PO0707* *75mm*

*PO0708* *90mm*

- *Providing and fixing 3-layer PP-R (Polypropylene Random Copolymer) PN 10 pipes, SDR 7.4 UV Stabilized and anti - microbial fusion welded, having thermal stability for hot and cold water supply including all PP-R plain and brass Threaded Polypropylene random fittings excluding trenching, refilling but including testing of joints complete as per direction of Engineer-in- Charge.*

*PO0709* *110mm*

*PO0710* *160mm*

The specified pipes and fittings shall be laid in trenches. The width and depths of the trenches of different diameters of the pipes shall be as shown in the table below.

**Table 5.17.1** WIDTH AND DEPTHS OF THE TRENCHES OF DIFFERENT DIAMETERS OF THE PIPES

| Diameter of pipe | Width of trench (cm) | Depth of trench (cm) |
|---|---|---|
| 15 mm to 50 mm | 30 | 60 |
| 65 mm and above | 45 | 75 |

*Note: Refer 5.3.7 for specification on excavation for pipes/cables etc.*

At joints, trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earthwork in trenches. In case of GI pipes, the pipes shall be painted with two coats of anticorrosive bitumastic paint of approved quality. The pipes shall be laid in a layer of 7.5 cm sand and filled up to 20 cm above the pipes. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be disposed of as directed by the Engineer.

When excavation is done in rock, the bottom shall be cut deep enough to permit the pipes to be laid on a cushion of sand of minimum 7.5 cm. In case of bigger diameter pipes where the pressure is very high thrust blocks of cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate of 20 mm nominal size) shall be constructed on all bends to transmit the hydraulic thrust without impairing the ground and spreading it over a sufficient area.

**Testing the joints:** After laying and jointing, the pipes and fittings shall be inspected under working conditions of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost. The pipes and fittings after they are laid shall be tested to hydraulic pressure of 6kg/cm$^2$ (60 metres). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw off takes and the stop-cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least half an hour. The pipes and fittings shall be tested in sections as the work of laying proceeds, keeping the joints exposed for inspection during the testing.

**Measurements:** The lengths shall be measured in running meter correct to 10 mm for the finished work, which shall include pipe and fittings such as bends, tees, elbows, reducers, crosses, plugs, sockets, nipples, flanges, nuts, etc. but exclude brass or gun metal taps (cocks), valves, lead connection pipe and shower rose. The length shall be taken along the central line of the pipe and fittings. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance, quality and finish. The diameter shall be the nominal diameter of the internal bore. The pipe shall be described as including all cuttings and waste. In case of fittings of equal bore, the largest bore shall be measured. Digging and refilling of trenches shall be measured separately.

**Rate:** The rate shall include the cost of labour and material involved in all operations described above (excluding the cost for excavation in trenches, refilling of trenches, thrust block, painting of pipes and sand filling all round the pipes).

### 5.17.2 Ductile Iron Pipes for Water Supply

- *Providing and Laying Ductile Iron K-9 pipes with push-on joints, including fittings (excluding trenching, refilling and thrust block)*

*PO0065* *80 mm*

*PO0066* *100 mm*

*PO0067* *150 mm*

*PO0068* *200 mm*

*PO0069* *250 mm*

*PO0070* *300 mm*

*PO0071* *350 mm*

*PO0072* *400 mm*

*PO0073* *450 mm*

*PO0074* *500 mm*

*PO0075* *600 mm*

- *Providing and Laying Ductile Iron K-7 pipes with push-on joints including fittings (excluding trenching, refilling and thrust block)*

*PO0078* *100 mm*

*PO0079* *150 mm*

*PO0080* *200 mm*

*PO0081* *250 mm*

*PO0082* *300 mm*

*PO0083* *350 mm*

*PO0084* *400 mm*

*PO0085* *450 mm*

*PO0086* *500 mm*

*PO0087* *600 mm*

- *Providing and Laying Double Flanged (Screwed or Welded) Centrifugally Spun ductile iron K-9 Pipes including fittings (excluding trenching, refilling and thrust block)*

*PO0090* *100 mm*

*PO0091* *150 mm*

*PO0092* *200 mm*

*PO0093* *250 mm*

*PO0094 300 mm*

*PO0095 350 mm*

*PO0096 400 mm*

*PO0097 450 mm*

*PO0098 500 mm*

*PO0099 600 mm*

- *Providing and Laying Ductile Iron K - 9 Restrained Joint Pipe including fittings with Locking Bar/Plate Device along with fixing of EPDM Rubber Gasket, excluding trenching, refilling & thrust block*

*PO0750 80 mm*

*PO0751 100 mm*

*PO0752 150 mm*

*PO0753 200 mm*

*PO0754 250 mm*

*PO0755 300 mm*

*PO0756 350 mm*

*PO0757 400 mm*

*PO0758 450 mm*

*PO0759 500 mm*

*PO0760 600 mm*

Use and laying of DI pipes shall conform to IS 12288:1987.

Transportation, handling and inspection: Pipes should be transported in such a way that damage to the protective coating and brushing or damage of jointing surfaces although they are less susceptible to cracking and breaking on impact. Pipes should be offloaded with cranes. The pipes should be arranged in stacks before usage and the stacking should either be one of the following:

(a) Square Stacking
(b) Parallel stacking with timbers
(c) Nested Stacking ( pyramid stacking)
(d) Stringing

Bitumen sheathed pipes should be laid in a single layer supported on timbers placed under the uncoated portions of the spigots and sockets. Sheathed pipes should be lifted by means of properly designed hooks.

Excavation and Trenching: The width of trench at the bottom between faces of sheeting shall be such as to provide not less than 200mm clearance on either side of the pipe except where rock excavation is involved. In agricultural land, the depth must not be less than 900mm, while it may be necessary to increase the depth of pipeline in the vicinity of land drains, roads, railways and other crossings.

When pipes are directly bedded on the bottom of the trench, it should be trimmed and leveled, and where excavation is through rocks or boulders, the pipeline should be bedded on concrete bedding or on at least 150mm or fine grained soil or other means to protect the pipe and the coating.

Laying of pipes: Pipes should be lowered into the trench with a tackle suitable for the weight of pipes. For pipes up to 250mm nominal bore, the pipe may be lowered by the use of ropes but for heavier pipes either a well designed set of shear legs or mobile cranes should be used.

All construction debris should be cleared from the inside of the pipe either before or just after a joint is made. When the laying is not in progress, a temporary end closure should be securely fitted to the open end of the pipeline. All persons should vacate any section of the trench where the pipe is being lowered. Partial backfilling may be done in order to secure the pipe in place.

When the pipe is laid over ground, the ground should be dressed to match the curvature of the pipe shell for an arch length subtending an angle of 120º at the centre of the pipes. Pipes may be allowed to rest on ground if the soil is non- aggressive. Pipes with spigot and socket, should be supported at the rate of one support per pipe and they should be tied to the supports by mild steel straps so that axial movement due to expansion and contraction resulting from temperature change is adjusted in the individual joints.

The maximum unsupported length for flanged pipes is 8 m, and the supports should be stable and unyielding due to movements in the pipeline. Straps should fix the pipes to the supports and should prevent lateral or lifting movements while allowing expansions and contractions.

The pipes should be cut using suitable equipment in a neat and workmanlike manner without any damage to the pipe of lining so as to leave a smooth end at right angles to the axis of the pipe.

All pipelines having unanchored flexible joints require anchorage at changes in direction and at dead ends to resist static thrusts developed by internal pressure. Anchorages should be designed taking into account maximum pressure the main is to carry in service and in test, and the safe bearing capacity of the surrounding soil. Concrete hollow blocks of suitable shape should be used.

Joints and the jointing procedure shall conform to IS 12288:1987.

Hydraulic Testing: After a new pipeline is laid and jointed, testing shall be done for

(a) Mechanical soundness and leak tightness of pipes and fittings
(b) Leak tightness of joints
(c) Soundness of any construction works particularly the anchorages.

The hydraulic testing may be done in either one length or in sections. Length of test sections may vary but after gaining experience the test section may be as long as 1.5 Kms. The test section should be properly sealed off. The section under test should be filled with water taking that all air bubbles are displaced. After filling, the pipeline is pressurized to the specified operating pressure and left for a period of time to achieve stable conditions. The duration depends on many factors. Then the pipeline is pressurized to the full test pressure and the section under test completely closed off. The test should be maintained over 10 minutes to reveal any defeat in the pipes, joints and the anchorages. Test pressure should be

measured at the lowest section or alternatively an allowance should be made to the static head between the lowest point and the point of measurement to ensure that the required test pressure is not exceeded at the lowest point.

If the test is not satisfactory, the fault should be found and rectified. Where there is difficulty in finding the fault, the sections may be further sub-divided and tested again. After all the sections have been tested, tests on the complete pipeline should be carried out.

Before commissioning of the pipeline, it should be disinfected.

**Measurement**: The net length of the pipes as laid or fixed, shall be measured in the running metres correct to a cm.

**Rate**: The rate shall include the cost of materials and labour involved in all the operations described above (excluding the cost for excavation in trenches, refilling of trenches, thrust block, and sand filling all round the pipes)

**5.17.3 Brass Fittings**

- *Providing and fixing brass stopcock*

*PO0100* *15mm*

*PO0101* *20mm*

*PO0102* *25mm*

- *Providing and fixing brass full way valve with wheel*

*PO0105* *32mm*

*PO0106* *40mm*

*PO0107* *50mm*

*PO0108* *65mm*

*PO0109* *80mm*

- *Providing and fixing non-return valve*

*PO0110* *50mm*

*PO0111* *65mm*

*PO0112* *80mm*

- *Providing and fixing brass bibcock*

*PO0114* *15mm, brass*

**5.17.4 H.D.P.E Fittings**

- *Providing and fixing, Equal Tee butt-welded-type fittings*

*PO0115* *20mm*

*PO0116* *25mm*

*PO0117* *32mm*

*PO0118* *50mm*

*PO0119* *63mm*

*PO0120 90mm*

*PO0121 110mm*

*PO0122 160mm*

- *Providing and fixing Elbow*

*PO0125 32mm*

*PO0126 50mm*

*PO0127 63mm*

*PO0128 90mm*

*PO0129 110mm*

- *Providing and fixing Reducer*

*PO0130 90 x 50mm*

*PO0131 90 x 63mm*

*PO0132 110 x 63mm*

*PO0133 110 x 90mm*

- *Providing and fixing Blank End (Cap)*

*PO0140 50mm*

*PO0141 63mm*

*PO0142 90mm*

*PO0143 110mm*

*PO0144 160mm*

The fittings of the type specified in the items shall be fully examined and cleared of all foreign matters before being fixed. The fitting shall be fitted in the pipeline in a workman-like manner. The joints between fittings and pipes shall be leak proof when pressure tested to the extent specified by the Engineer. The defective fittings and joints shall be replaced or redone.

**Measurement:** The item shall be measured in numbers.

**Rate:** The rate shall include the cost of labour and material involved in all operations described above.

### 5.17.5 Push on Jointing for DI pipes

- *Providing and fixing push - on joints to Centrifugally Spun D.I pipes including the cost of rubber Gaskets.*

*PO0150 80 mm*

*PO0151 100 mm*

*PO0152 150 mm*

*PO0153 200 mm*

*PO0154 250 mm*

*PO0155 300 mm*

*PO0156 350 mm*

*PO0157 400 mm*

*PO0158 450 mm*

*PO0159 500 mm*

*PO0160 600 mm*

At joints, trench width shall be widened where necessary. The joints should satisfy the following basic requirements:

(a) Cleanliness of all parts
(b) Correct location of components
(c) Centralization of spigot with socket, and
(d) Strict compliance with the manufacturer's jointing instructions

The inside of sockets and the outside of spigots should be cleaned and wire brushed for a distance of 150 to 225 mm. Glands and Gaskets should be wiped clean and inspected for damage. When lifting gear is used to place the pipe in the trench, it should also be used to assist in centralizing the spigot in the socket.

Where the pipeline is likely to be subjected to movement due to subsidence or temperature variations, the use of flexible joints is recommended. A gap should be left between the end of the spigot and the back of the socket to accommodate such movement.

Flexible Joint: The spigot and socket flexible joint should be designed to permit angular deflection in direction and axial movement to compensate for ground movement and thermal expansion and contraction. They incorporate a gasket of elastomeric materials and the joints may be of the simple push-on-type or the type where the seal is effected by the compression of a rubber gasket between a seating on the inside of the socket and the external surface of the spigot. Joints of the latter type are referred to as mechanical joints. Both push in and mechanical joints are flexible joints. Flexible joints required to be externally anchored at all changes in direction such as at bends, etc. and at blank end to resist the thrust created by internal pressure and to prevent the withdrawal of spigots.

Flanged Joints: Flanged joints are made on pipes having a machined flange at each end of the pipe. The seal is usually affected by means of a flat rubber gasket compressed between two flanges by means of bolts which also serve to connect the pipe rigidly. Gaskets of other materials, both metallic and non-metallic are used for special applications

**Measurement**: The items shall be measured in numbers.

**Rate**: The rate shall include the cost of labour and material involved in all the operations described above.

### 5.17.6 PVC Soil Waste Pipes & Fittings

- *Providing and fixing PVC soil waste and vent pipes, single or double socketed including clips complete but excluding PVC fittings.*

*PO0370 75 mm dia.*

*PO0371 50 mm dia.*

*PO0372 110 mm dia.*

- *Providing & fixing PVC Pipe connector*

*PO0380 110mm dia*

- *Providing & fixing PVC Coupler*

*PO0385 75mm dia*

*PO0386 50mm dia*

*PO0387 110mm dia*

- *Providing & fixing PVC Reducer*

*PO0395 90x75mm*

*PO0396 110x75mm*

*PO0397 110x90mm*

- *Providing & fixing PVC plain bend*

*PO0405 75mm dia*

*PO0406 50mm dia*

*PO0407 110mm dia*

- *Providing & fixing PVC door bend*

*PO0415 75mm dia*

*PO0416 50mm dia*

*PO0417 110mm dia*

- *Providing & fixing PVC Long arm bend with door*

*PO0425 75mm dia*

*PO0426 50mm dia*

*PO0427 110mm dia*

- *Providing & fixing PVC Single Tee plain*

*PO0435 75mm dia*

*PO0436 50mm dia*

*PO0437 110mm dia*

- *Providing & fixing PVC Single Tee with door*

*PO0445 75mm dia*

*PO0446 50mm dia*

*PO0447 110mm dia*

- *Providing & fixing PVC Double Tee plain*

*PO0455 75mm dia*

*PO0456 50mm dia*

*PO0457 110mm dia*

- *Providing & fixing PVC Double Tee with door*

*PO0465 75mm dia*

*PO0466 50mm dia*

*PO0467 110mm dia*

- *Providing & fixing PVC Single Y, plain*

*PO0475 75mm dia*

*PO0476 50mm dia*

*PO0477 110mm dia*

- *Providing & fixing PVC Single Y, with door*

*PO0485 75mm dia*

*PO0486 50mm dia*

*PO0487 110mm dia*

- *Providing & fixing PVC Double Y, plain*

*PO0495 75mm dia*

*PO0496 50mm dia*

*PO0497 110mm dia*

- *Providing & fixing PVC Double Y, with door*

*PO0505 75mm dia*

*PO0506 50mm dia*

*PO0507 110mm dia*

- *Providing & fixing PVC Offset, 75mm dia*

*PO0515 With 75mm projection*

*PO0516 With 150mm projection*

- *Providing & fixing PVC Offset, 90mm dia*

*PO0525 With 75mm projection*

*PO0526 With 150mm projection*

- *Providing & fixing PVC Offset, 110mm dia*

*PO0535 With 75mm projection*

*PO0536 With 150mm projection*

- *Providing & fixing PVC Floor Trap*

*PO0545 75mm dia*

*PO0546 50mm dia*

*PO0547 110mm dia*

- *Providing & fixing PVC P-Trap, without air vent*

*PO0555 Big*

*PO0556 Small*

- *Providing & fixing PVC Nahani Trap*

*PO0565 110mm inlet & 75mm outlet*

**5.17.7 uPVC Soil Waste Pipes**

- *Providing & laying uPVC Pipes including fittings pressure class 4 kg/sq.cm (excluding trenching, refilling & thrust block)*

*PO720 110 mm*

*PO721 160 mm*

*PO722 180 mm*

*PO723 200 mm*

*PO724 225 mm*

*PO725 250 mm*

*PO726 280 mm*

*PO727 315 mm*

*PO728 400 mm*

*PO729 450 mm*

*PO730 560 mm*

**Underground installation:** For laying PVC and uPVC pipes in trenches, trench width shall not be less than pipe diameter plus 125mm on each side.

**Concealed installation:** For concealing the drain lines, slots shall be made in the wall or concrete. The slot size shall be such that the system remains stress free at the time of installation. Sharp edges should be avoided. All PVC pipes and fittings shall be cleaned and a light coat of solvent cement applied externally before they are inserted in the slots. Leakage test shall be carried out before concealing the system.

**Storage:** To avoid damages to the pipes and fittings following precautions shall be taken when intended for storage of PVC pipes:

i. Pipes shall be stacked on an even surface, the staking height not exceeding 1.5m
ii. Pipes and fittings shall not be kept on sharp objects
iii. All fittings shall be stored in cartons or bags
iv. Pipes and fittings shall not be dragged
v. Rubber rings shall be kept tension free
vi. Lubricants and solvent cement shall be stored in a cool place, away from direct sunlight.

**Jointing:** The commonly used joints are as follows:

a) Solvent welded joints,
b) Flanged joints
c) Screwed or treaded joints, and
d) Rubber ring joints.

a) **Solvent welded joints:** The solvent welded joint may be achieved either by heat application method or non-heat application method.

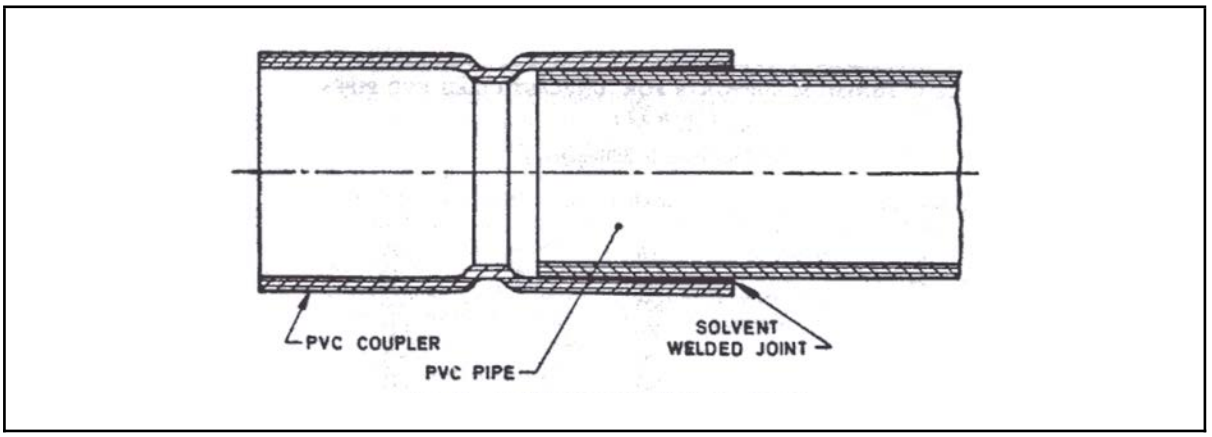



**Figure 5.17.1** PVC solvent welded joint

**Non-heat application method**: In this method, the pipe shall be cut perpendicular to the axis of the pipe length with a saw. The pipe ends have to be bevelled slightly with bevelling tool at an angle of about 30-degree. The total length of insertion of socket shall be marked on pipe and checked how far the pipe end should go into the fitting socket up to 1/3 to 2/3 of the socket length. After cleaning, the coating of solvent cement shall be applied evenly on the inside of the fitting for full length of insertion and then on the outside of the pipe end up to the marked line. For hot and dry climate thicker coatings shall be applied. The pipe shall be pushed into the fitting socket and held for 1 to 2 minutes as otherwise the pipe may come out of the fitting due to the slippery quality of cement and the tapering inside bore of the fitting. The surplus cement on the surface shall be wiped out. In hot climates it is recommended to join the pipe early in the morning or in the evening when it is cooler. After making the joints, the trench shall be covered immediately.

**Heat application method:** This method of jointing makes use of spigot and socket shapes of pipes. The female end is bevelled on the bore. The other pipe end to be inserted is bevelled at an angle of 20 to 30 degrees on the outer periphery. The female end of the pipe is expanded by heating a length of 1.5 times the pipe diameter to a temperature of about 130-degree C by blowtorch or any other suitable medium. The male end is inserted inside the softened female end. A plug gauge may be used to prevent distortion. A little before heating is complete, a thin coat of slow drying solvent cement is applied evenly on the inside surface of the female end of pipe, and outside surface of the male end of pipe. After the insertion is complete, the joint is cooled with water or a wet cloth.

b) **Flanged joints:** Flanged joints are preferred for larger diameter pipes. The joint shall be made by the compression of a gasket or a ring seal set in the face of the flange.

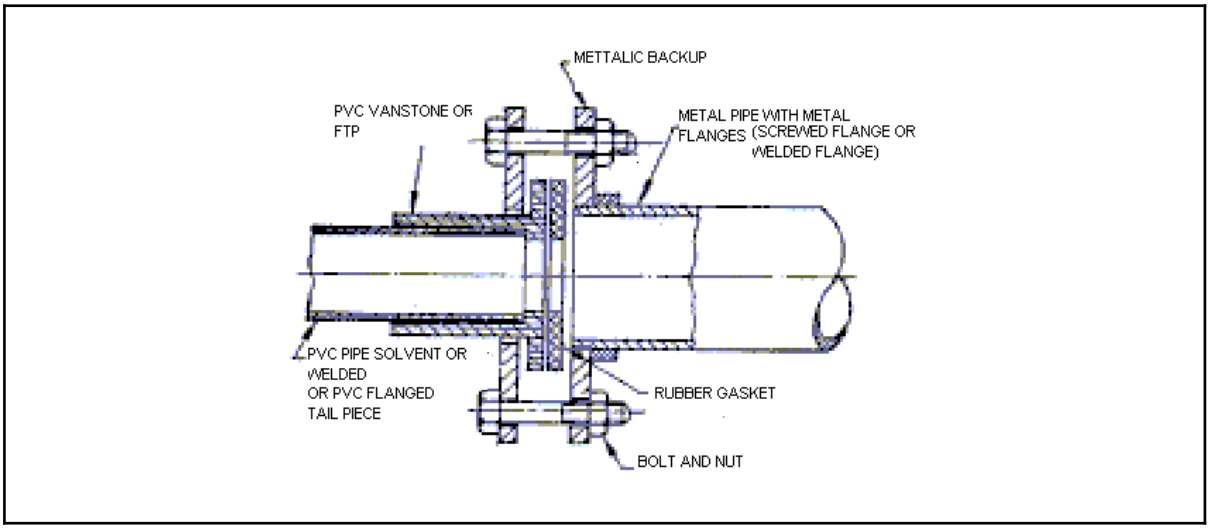



**Figure 5.17.2** PVC solvent welded joint

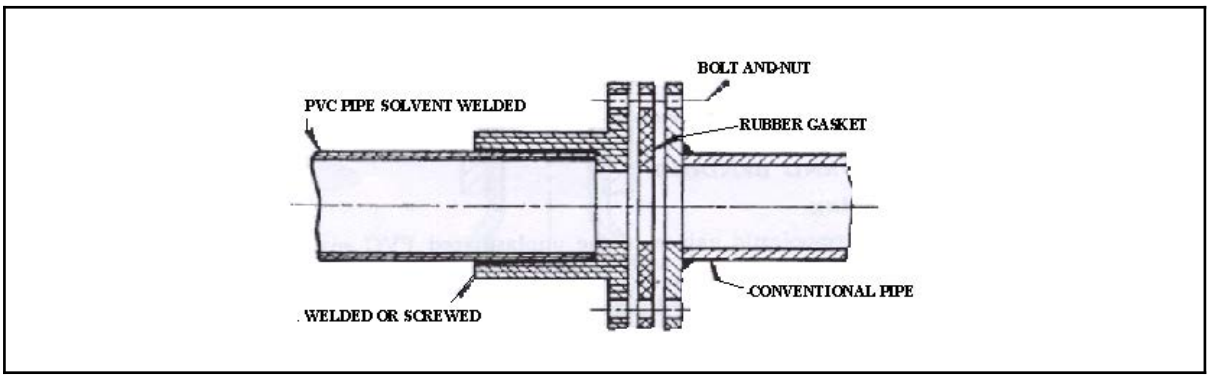



**Figure 5.17.3** Flange joints (jointing PVC pipes and other)

c) **Screwed or treaded joints:** These are similar to the joints used with GI pipes. Screwed or treaded joints shall not be used unless otherwise the situation demands.

d) **Rubber ring joints:** Rubber ring joints are not recommended for pipes in tension. The following steps may be followed if such joints are provided:

Cut the PVC pipe to the required length. Chamfer the edge of the pipe to be inserted at an angle of about 15-degree to 1/3$^{rd}$ the wall thickness using a coarse file. After cleaning the pipe ends to be connected, insert the pipe into the socket without the seal ring and mark along the pipe when it is fully inserted. Fix the rubber ring into the groove without twisting it. Apply manufacturer's recommended lubricant to the chamfered end of pipe up to the mark made on the spigot or socket end. Push the pipe firmly into the socket.

**Support Spacing:** The minimum support spacings for PVC pipes shall be as given below:

**Table 5.17.3** MINIMUM SUPPORT SPACINGS FOR PVC PIPES

| Outside diameter (mm) | Horizontal spacing (mm) |
|---|---|
| 50 mm | 1200 |
| 90 mm | 1200 |
| 110 mm | 1500 |

For vertical runs support spacing may be increased by 50%.

**Measurement:** The pipes shall be measured in running meters and the fittings shall be measured in numbers

**Rate:** The rate shall include the cost of labour and materials involved in all the operations described above.

**5.17.8 Painting of Pipes**

- *Painting GI pipes and fittings including primer & white coat, for new work*

*PO0570* *15mm dia pipe*

*PO0571* *20mm dia pipe*

*PO0572* *25mm dia pipe*

*PO0573* *32mm dia pipe*

The primer shall be of approved brand and manufacture and the final paint anticorrosive bitumastic, aluminium or other type of paint as specified.

**Preparation of Surface**: All rust and scales shall be removed by scraping or brushing with steel wire brushes. All dust and dirt shall be thoroughly wiped away from the surface. If the old surface is to be painted, it shall be rubbed with wire brushes and any loosened paint taken off. All dust shall be thoroughly wiped away. The surface shall then be wiped finally with mineral turpentine to remove grease etc and then allowed to dry.

**Application:** The number of coats of painting over the priming coat shall be as stipulated in the description of the item. The paint shall be laid on evenly and smoothly. The painted surface shall present a uniform appearance and glossy finish free from streaks, blisters etc.

**Measurement:** For pipes, measurement will be taken over the finished line of pipe including specials etc in running metres correct to 10 mm including fittings.

**Rate:** The rate shall include cost of the materials and labour involved in all the operations described above.

**5.17.9 Soak Pits**

- *Constructing Soak Pit*

*PO0600* *Size 1200x1200x1200mm, filled with brick bats including 110 dia H.D.P.E (PN 4) drain pipe x1200mm long*

*PO0601 Size 2500 dia. x 3000mm depth including 450x450mm dry brick honeycomb shaft and 110 dia H.D.P.E (PN 4) drain pipe x 1800mm long*

The earthwork excavation shall be as per general specifications given under "Earthwork". After the excavation is complete, the soak pit shall be filled with brickbats. The brickbats shall be from properly burnt bricks.

**Circular soak pit:**

The earthwork excavation shall be carried out to the exact dimensions as given in the description of the item. In this pit, a honeycomb dry brick shaft 45x 45 cm and 292.5 cm high shall be constructed centrally. Round this shaft and within a radius of 60 cm shall be placed well-burnt brickbats. Around the brickbats up to a radius of 90 cms brick ballast of size from 50 to 80 mm nominal size shall be packed. The remaining portion shall be filled with brick ballast of 40 mm nominal size. The construction of the shaft filling of the bats and ballast shall progress simultaneously.

Over the filling shall be placed single matting, which shall be covered with a minimum layer of 7.5 cm earth. The shaft shall be covered with 7.5 cm thick stone or R.C.C slab.

Brick edging 10 cm wide 10 cm deep shall be provided round the pit. The connection of the open surface drain to the soak pit shall be made by means of a 100 mm dia. S.W. pipe with open joints.

**Measurements:** The soak pits shall be measured in numbers.

**Rate**: The rate shall include the cost of labour and material involved in all the operations described above.

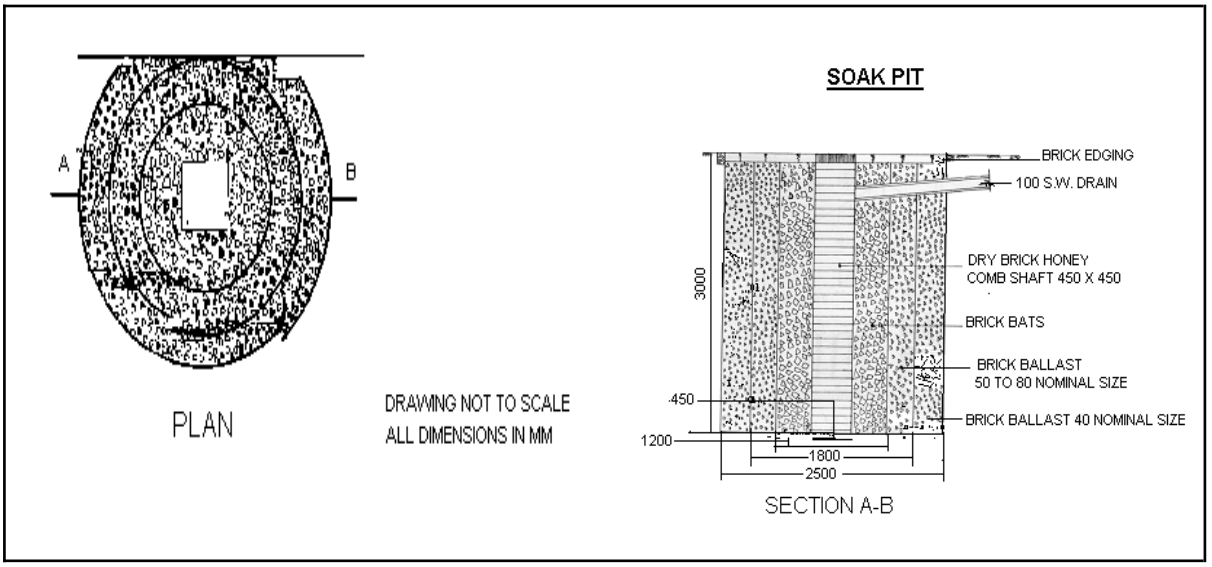



**Figure 5.17.4** Soak pit

### 5.17.10 Septic Tanks

- *Constructing Septic Tanks, in R.R. Masonry in cement mortar 1:6, including fittings, CI cover with frame, 40mm thick concrete flooring (1:4:8, 40mm aggregate) with 12 mm thick cement plaster in C. M 1:4 etc. complete as per standard design*

*PO0610 15 users*

*PO0611 25 users*

*PO0612 50 users*

*PO0623 75 users*

*PO0614 100 users*

- *Constructing Septic Tanks, in brick masonry in cement mortar 1:4, including fittings, CI cover with frame, 40mm thick concrete flooring (1:4:8 40 mm aggregate) cement plaster concrete base in C.C etc. complete as per standard design*

*PO0620 15 users*

*PO0621 25 users*

*PO0622 50 users*

*PO0623 75 users*

*PO0624 100 users*

- *Constructing Septic Tanks, in reinforced concrete 1:2:4 (20mm aggregate) including fittings, CI cover with frame, 40mm thick concrete flooring (40mm aggregate) cement plaster concrete base in C.C 1:4:8 etc. complete as per standard design*

*PO0630 15 users*

*PO0631 25 users*

*PO0632 50 users*

*PO0633 75 users*

*PO0634 100 users*

Every septic tank shall be provided with PVC ventilating pipe of at least 50 mm dia. and extended to a height of 2m. The top of the pipe shall be provided with a suitable cage of mosquito proof wire mesh. Septic tank shall be located away from the nearest building as per the regulations of the local implementing authority.

The septic tank shall have a minimum width of 750mm, and minimum liquid capacity of one $cm^3$. Length of the tank shall be 2 to 4m. However, the actual sizes of the tank shall be as per the standard size based on the number of users.

The minimum size for different number of users for cleaning interval of 2 years is as shown below:

**Table 5.17.4** SIZES OF SEPTIC TANK FOR VARIOUS NUMBER OF USERS

| No. of users | Length (m) | Width (m) | Height (m) |
|---|---|---|---|
| 15 | 2.00 | 0.90 | 2.00 |
| 25 | 2.60 | 1.30 | 1.80 |
| 50 | 4.00 | 1.40 | 2.00 |

| | | | |
|---|---|---|---|
| 75 | 5.00 | 1.50 | 2.00 |
| 100 | 5.70 | 2.10 | 1.70 |

Before the tank is commissioned for use, it shall be tested for water-tightness by filling it with water and allowing it to stand for 24 hours. It shall then be topped up, if necessary, and allowed to stand for a further period of 24 hours, during which time the fall in the level of water shall not be more than 15mm.

**Measurement:** The measurement shall be made in numbers.

**Rate:** The rate shall include all operation as described above for construction of septic tank including necessary pipe fitting in position.

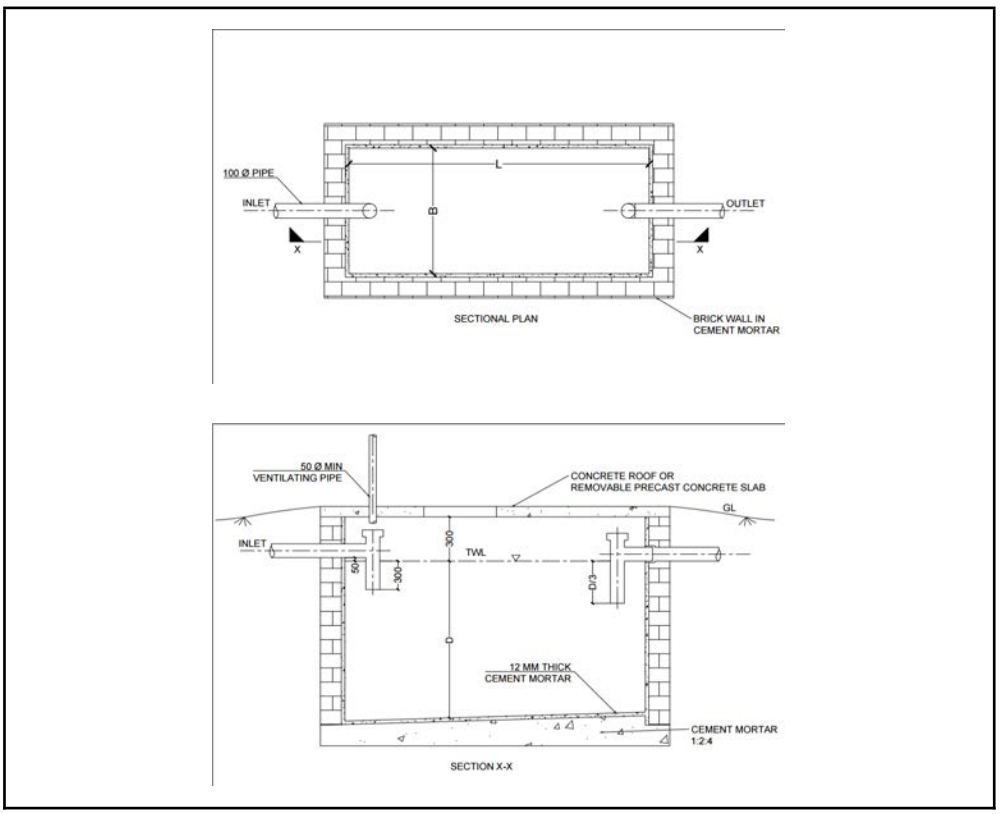



**Figure 5.17.5** Typical sketch of single compartment septic tank up to 20 users

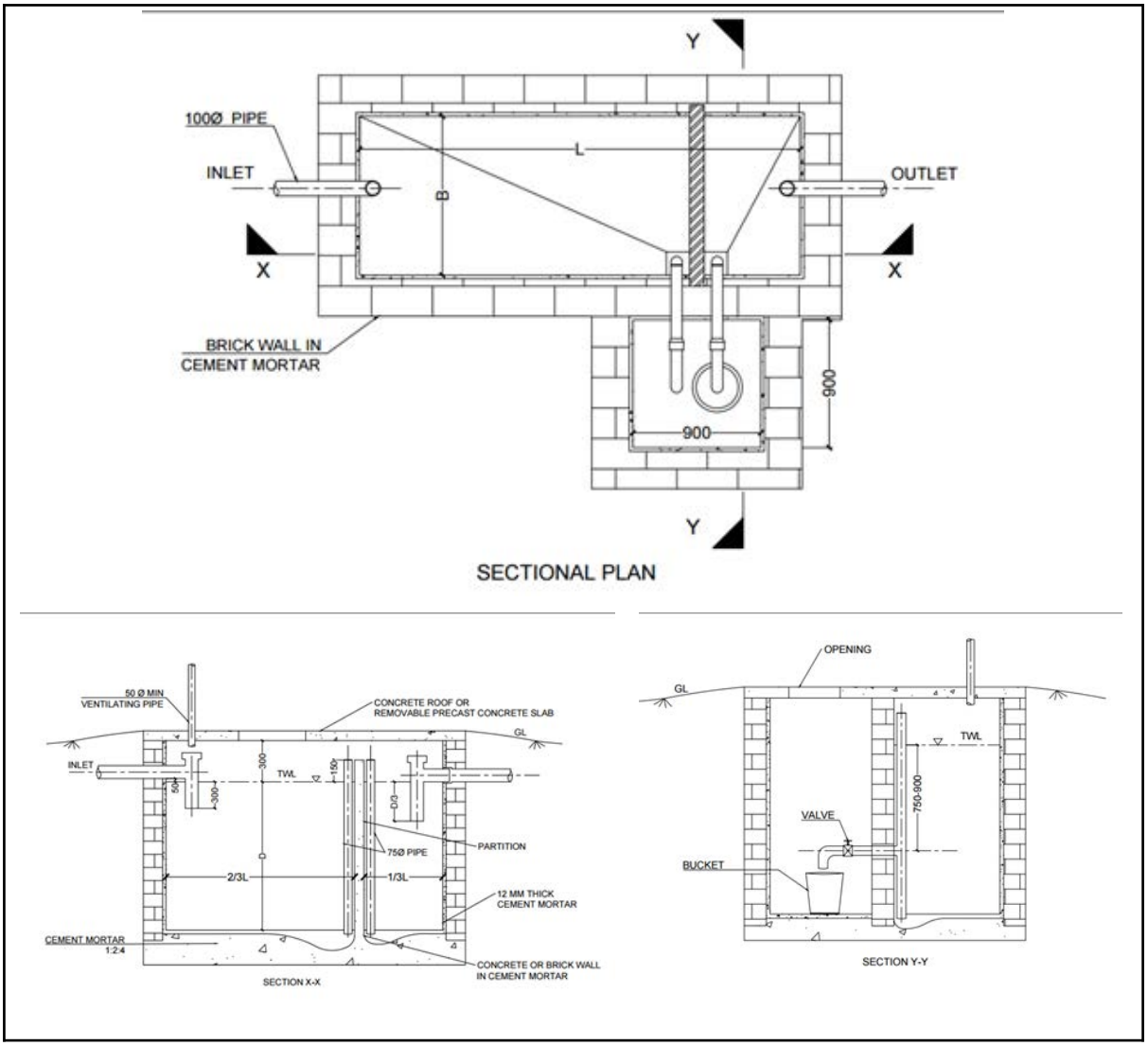



**Figure 5.17.6** Typical sketch of two compartment septic tank for population up to 50

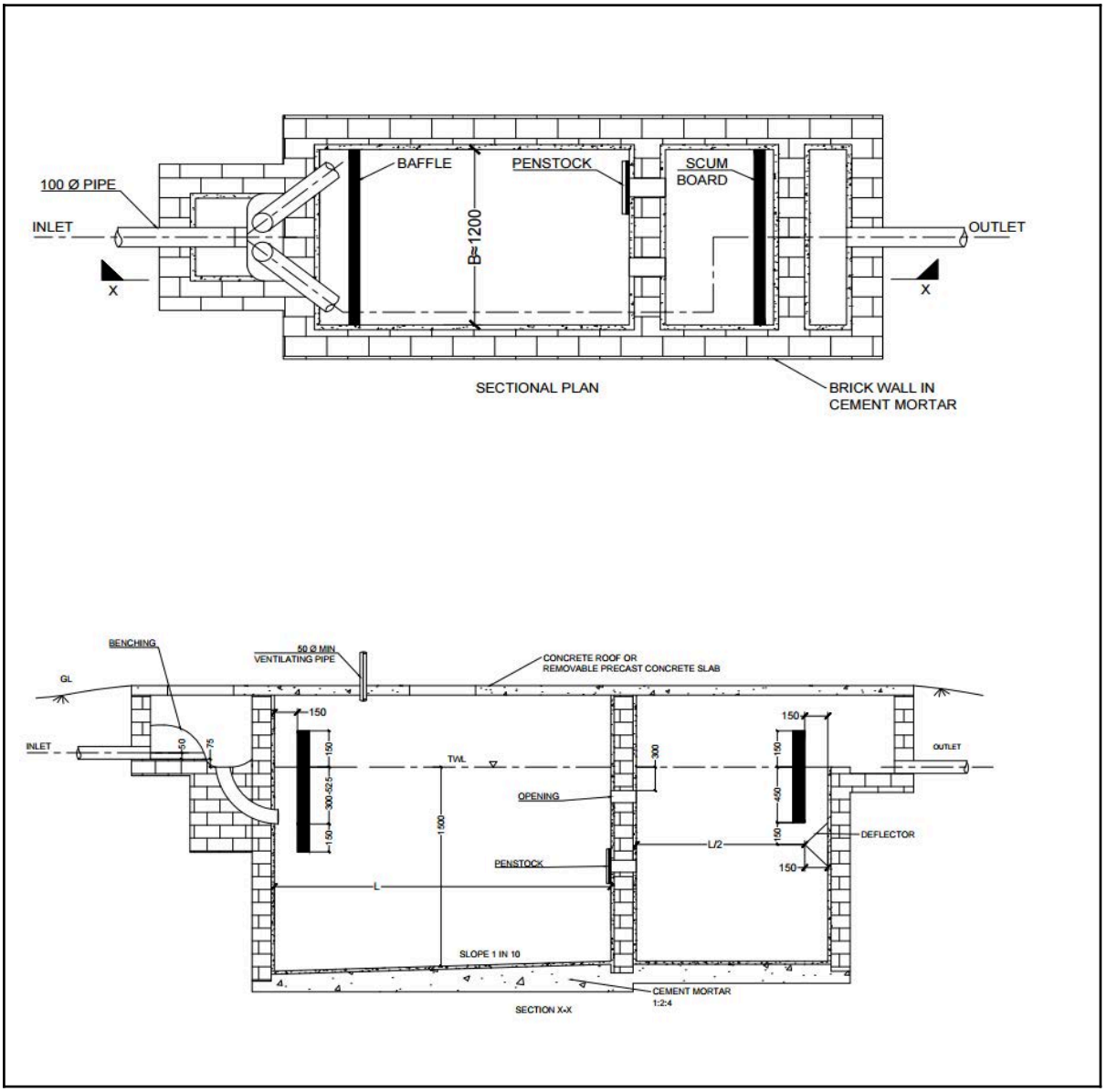



**Figure 5.17.7** Typical sketch of two compartment septic tank for population over

### 5.17.11 Water Stopper

- *Providing & fixing of PVC Water stopper for Structural Joints of water retaining structures.*

*PO0790 250mm- 300mm width.*

**Measurement**: Measurement shall be taken in numbers.

**Rate:** Rate shall include the cost of all the materials and labour involved in all the operations described above.

# 5.18 Chapter 18: PLASTERING

### 5.18.1 Mud Plaster

- *Providing and laying mud plaster incl. neat finish*

*PL0001* *15mm*

*PL0002* *20mm*

### 5.18.2 Cement Plaster

- *Providing and laying 6mm cement plaster (in ceilings)*

*PL0010* *CM 1:3*

*PL0011* *CM 1:4*

*PL0012* *Extra, for plaster to ceiling height > 5m ...per additional meter height*

- *Providing and laying 12mm cement plaster*

*PL0020* *CM 1:3*

*PL0021* *CM 1:4*

*PL0022* *CM 1:5*

*PL0023* *CM 1:6*

- *Providing and laying 15mm cement plaster on rough side of single or half-brick wall*

*PL0030* *CM 1:3*

*PL0031* *CM 1:4*

*PL0032* *CM 1:5*

*PL0033* *CM 1:6*

- *Providing and laying 20mm cement plaster*

*PL0040* *CM 1:3*

*PL0041* *CM 1:4*

*PL0042* *CM 1:5*

*PL0043* *CM 1:6*

**Preparation of surface:** The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced. In case of concrete surface, if a chemical retarder has been applied to the formwork, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarder is left on the surface. The joints of masonry shall be raked out properly so that the plaster is well keyed with the masonry.

**Mortar:** The mortar of the specified mix described in the item shall be used.

**Scaffolding:** For all exposed brickwork or tile work, double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together

with horizontal pieces over which scaffolding planks shall be fixed. For all other masonry in buildings, single scaffolding shall be permitted. In such cases, the inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not be allowed in pillars/columns less than one metre in width, or immediately near the skewbacks of arches. The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering.

**Note:** In case of a special type of brickwork, scaffolding shall be approved by the Engineer.

**Application of Plaster:** Ceiling plaster shall be completed before commencement of wall plaster. Plastering shall be started from the top and worked down towards the floor. All putlog holes shall be properly filled in advance of the plastering as the scaffolding is taken down. To ensure even thickness and true surface, plaster about 15 x 15 cm, shall be first applied, horizontally and vertically, at not more than 2 metres intervals over the entire surface to serve as gauges. The surfaces of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall then be laid on the wall, between the gauges with a trowel. The mortar shall be applied in a uniform surface slightly more than the specified thickness. The surface shall be brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upward and sideways movements at a time. Finally the surface shall be finished off true with trowel or wooden float accordingly as a smooth or a sandy granular texture is required. Excessive trowelling or over working the float shall be avoided. All corners, rises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, junctions etc. where required shall be done without any extra payment. Such rounding or chamfering shall be carried out with proper templates to the sizes required. In suspending work at the end of the day, the plaster shall be left, cut clean to line both horizontally and vertically, when recommencing the plastering, the edge of the old work shall be scraped cleaned and wetted with lime putty or cement grout before plaster is applied to the adjacent areas, to enable the two to properly join together. Plastering work shall be closed at the end of the day on the body of the wall and not nearer than 15 cm to any corners or rises. It shall not be closed on the body of the features such as plasters, bands and copings, as these invariably lead to leakages. No portion of the surface shall be left out initially to be patched up later on. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

**Finish:** The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

**Precaution:** Any cracks which appear in the surface and all portions, which sound hollow when tapped, or are found to be soft or otherwise defective, shall be cut out in rectangular shape and redone as directed by the Engineer.

**Thickness:** The thickness of the plaster specified shall be measured exclusively of the thickness of the key. The average thickness of the plaster shall not be less than the specified thickness and the minimum thickness over any portion of the surface shall not be less than specified thickness by more than 3 mm. Where the thickness required as per description of the item is 20 mm the average thickness of the plaster shall not be less than 20 mm whether

the wall treated is of brick or stone. In the case of brickwork, the minimum thickness over any portion of the surface shall not be less than 15 mm while in the case of stonework the minimum thickness over the bushings shall be not less than 12 mm.

**Curing:** Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered. The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the contractor's expense by such means as the Engineer may approve. The dates on which the plastering is done shall be legibly marked on the various sections plastered so that curing for the specified period thereafter can be watched.

**Measurement:** Length and breadth shall be measured correct to 10 mm and its area shall be calculated in square metres correct to two places of decimal. Thickness of the plaster shall be exclusive of the thickness of the key i.e. grooves, or open joints in brick works. The measurements of wall plaster shall be taken between the walls or partitions (the dimensions before plastering shall be taken) for the length, and from the top of the floor or skirting to the ceiling for the height. Depth of coves or cornices if any shall be deducted.

The following shall be measured separately from wall plaster:

(a) Plaster bands 30 cm wide and under.

(b) Cornices, beadings and architraves or architraves moulded wholly in plaster.

(c) Circular work not exceeding 6 m in radius.

Plaster over masonry pilasters will be measured and paid for as plaster only. A coefficient of 1.63 shall be adopted for the measurement of one side plastering on honeycomb work.

(a) Moulded cornices and coves:

(b) Length shall be measured at the centre of the girth.

(c) Moulded cornices and coves shall be given in square metres the area being arrived at by multiplying length by the girth.

(d) Flat or weather-top cornices when exceeding 15 cm in width shall not be included in the girth but measured with the General Plaster work.

(e) Cornices, which are curved in their length, shall be measured separately.

Exterior plastering at a height greater than 10m from average ground level shall be measured separately in each storey height. Patch plastering (in repairs) shall be measured as plastering new work, where the patch exceeds 2.5 sq.m, extra payment being made for preparing old wall, such as dismantling old plaster, raking out the joints and cleaning the surface. Where the patch does not exceed 2.5 sq.m in area, it shall be measured under the appropriate item under sub-head "Repairs to Buildings".

Deductions in measurements for openings etc. will be regulated as follows:

(a) No deduction will be made for openings or ends of joists, beams, posts, girders, steps etc. upto 0.5 sq.m in area; no additions shall be made either, for jambs, soffits and sills of such openings. The above procedure will apply to both faces of the wall.

(b) Deduction for openings exceeding 0.5 sq.m but not exceeding 3 sq.m each shall be made for reveals, jambs, soffits, sills etc. of these openings.

(i) When both faces of walls are plastered with the same plaster, deductions shall be made for one face only.

(ii) When two faces of walls are plastered with different types of plaster or if one face is plastered and other is pointed, or one face is plastered and other is un-plastered, deduction shall be made from the plaster or pointing on the side of the frame for the doors, windows etc. on which width of reveal is less than that on the other side but no deduction shall be made on the other side. Where width of reveals on both faces of wall are equal, deduction of 50% of area of opening on each face shall be made from area of plaster and/or pointing as the case may be.

(iii) For an opening having a door frame equal to or projecting beyond thickness of wall, full deduction for opening shall be made from each plastered face of wall.

(iv) For openings exceeding 3 sq.m in area, deduction will be made in the measurements for the full opening of the wall treatment on both faces, while at the same time, jambs, sills and soffits will be measured for payment. In measuring jambs, sills and soffits, deduction shall not be made for the area in contact with the frame of doors, windows etc.

**Rate:** The rate shall include the cost of the labour and materials involved in all the operations described above.

**5.18.3 Plaster Band**

- *Providing and laying 12mm plain cement mortar band in CM 1:4*

*PL0050* *Flush band*

*PL0051* *Sunk band*

*PL0052* *Raised band*

- *Providing and laying 20mm plain cement mortar band in CM 1:4*

*PL0060* *Flush band*

*PL0061* *Sunk band*

*PL0062* *Raised band*

Plain band is a plaster strip of uniform width not exceeding 30 cm and of uniform thickness, provided for decorative or other purposes flush with, sunk below or projecting beyond, the wall plaster. A flush band is one where due to the difference in mix or shade of the mortar, the band is executed as a separate and distinct operation from the wall plaster.

**Thickness:** The thickness of a raised band is the thickness of the projection beyond the plane of the wall plaster. In the case of a flush or a sunk band, the thickness will be the thickness of the wall plaster measured from the untreated wall-surface.

**Preparation of Surfaces and Application:** In the case of flush or sunk bands the joints shall be raked out properly. Dust and loose mortar shall be brushed out.

Efflorescence if any shall be removed by brushing and scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced. In case of concrete surface if a chemical retarder has been applied to the form work, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface. In case

of raised band the surface shall be prepared as specified for plastering works. The surface of the wall plaster behind the band shall be left rough and furrowed 2 mm deep with a scratching tool, diagonally both ways to form a key for the band. No reduction in the rate for the above backing wall plaster shall, however, be made for not finishing the same smooth.

**Mortar:** Mortar of the mix and type of sand specified in the description of the item shall be used.

**Finish:** The bands shall be finished exactly to the size as shown in the drawings. The horizontal or vertical lines of bands shall be truly parallel and straight and the surfaces shall be finished truly plane and smooth. The lines and surfaces shall be checked with fine threads for straightness and accuracy.

Scaffolding, Curing and Precaution shall be as described in plastering items.

**Measurements**: Length will be measured in running metres correct to 10 mm. The length shall be taken along the finished face. The width shall not be measured by girthing. For width of band 30 cm or below, the width shall be measured in cm correct to 25 mm. The quantity shall be calculated in metres in 2.5 cm units.

**Rate:** The rate shall include the cost of the labour and materials involved in all the operations described above. Nothing extra shall be paid for mitres, stops or for bands on curved surfaces of whatever radius, they may. The rate is also inclusive of all rounding or chamfering at corners, arises etc.

### *5.18.4* Cement Plaster with Floating Coat

- *Providing and laying cement plaster, finished with floating coat of neat cement*

*PL0070* *12 mm plaster in CM 1:3*

*PL0071* *15 mm plaster in CM 1:3*

*PL0072* *20 mm plaster in CM 1:3*

*PL0073* *12 mm plaster in CM 1:4*

*PL0074* *15 mm plaster in CM 1:4*

*PL0075* *20mm plaster in CM 1:4*

The cement plaster shall be 12, 15 or 20 mm thick, finished with a floating coat of neat cement, as described in the item.

Specifications for this item of work shall be the same as described in plastering items above except for the additional floating coat, which shall be carried out as below.

When the plaster has been brought to a true surface with the wooden straight edge, it shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quantity of cement applied for floating coats shall be 1 kg per sq.m. Smooth finishing shall be completed with a trowel immediately and in no case later than half an hour of adding water to the plaster mix.

Thickness, curing, measurements **and** rate **shall be as specified above in the plastering items.**

*PL00766mm cement plaster in CM 1:3 finished with a floating coat of neat cement, including lime wash on top of wall when dry for bearing of R.C slabs and beams*

Cement plaster shall be 6 mm thick finished with a floating coat of neat cement and thick coat of lime wash on top of walls for bearing of slabs.

**Application:** The plaster shall be applied over the cleaned and wetted surface of the wall. When the plaster has been brought to a true surface with the wooden straight edge, it shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quantity of cement applied for floating coats shall be 1 kg per sq.m. Smooth finishing shall be completed with a trowel immediately and in no case later than half an hour of adding water to the plaster mix. The rest of the specifications described in "plastering works with floating coats of neat cement" shall apply.

**Lime Wash:** This shall be applied in a thick coat after curing the plaster for three days.

**Measurement:** Length and breadth shall be measured correct to 10 mm and area worked out in sq.m correct to two places of decimal.

**Rate:** The rate shall include the cost of the labour and materials involved in all the operations described above.

**5.18.5 Decorative Plaster**

- *Roughcast plaster with a mixture of sand and gravel or crushed stone 2-12mm including plaster in two layers with under layer 12mm in CM 1:4, & top layer 10mm in CM 1:3 hydrated lime cement*

*PL0080* *Grey cement*

*PL0081* *White cement*

Roughcast finish comprises a mixture of sand and crushed stone (or gravel) in specified proportions dashed over a freshly plastered surface. Scaffolding shall be done as specified above in ordinary plastering works.

**Preparation of surface:** The joints shall be raked out; dust and loose mortar shall be brushed out. The surface shall be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

**Mortar:** Mortar of specified mix using the type of sand described in the item shall be used.

The plaster base over which rough cast finish is to be applied shall consist of two coats, under layer 12 mm thick and top layer 10 mm. The under layer shall be applied in the same manner as specified above in ordinary plastering works. The top layer shall be applied a day or two after the under layer has taken the initial set. The latter shall not be allowed to dry out before the top layer is laid on. The mortar used for applying top layer shall be sufficiently plastic and of mix 1:3 (1 cement: 3 fine sand) so that the mix of sand crushed stone (or gravel) gets well pitched with the plaster surface. In order to make the base plastic about 10% of finely ground lime by volume of cement shall be added.

**Finish:** It shall be ensured that the base surface, which is to receive roughcast mixture, is in plastic state. The roughcast mixture shall consist of sand and crushed stone (or gravel) of uniform colour from 2 mm to 12 mm as specified to get the effect required. The mixture shall be wetted and shall be dashed on the plaster base in plastic state by hand scoop so that the mix gets well pitched with the plaster base. The mix shall again be dashed over the

vacant spaces, if any, so that the surface represents a homogeneous surface of sand/stone (or gravel). A sample of the plaster shall be approved by the Engineer.

Measurement and rate shall be the same as for general plastering.

*PL0090 Pebble dash plaster with a mixture of washed pebble or crushed stone 6-12mm including plaster in 2 layers*

Pebble dash plaster with a mixture of washed pebble or crushed stone 6 mm to 12 mm nominal size dashed over and including fresh plaster in the layers, the under layer 12 mm cement plaster 1:4 (1 cement: 4 sand) and top layer 10 mm cement plaster 1:3 (1 cement: 3 sand) mixed with finely ground hydrated lime by volume of cement.

The specifications shall be the same as under "Rough cast plaster" except that the washed pebble or crushed stone graded from 6 mm to 12.5 mm shall be dashed over the plastic base and the vacant spaces if any shall be filled in by pressing pebbles or crushed stone as specified, by hand so that the finished surface is homogeneous.

Specifications, Measurements, rate shall be the same as given under item "Rough cast plaster".

**5.18.6 Cement Plaster in Two coats**

*PL009118 mm cement plaster in two coats; under layer 12 mm C.P 1:5 (1 cement : 5 sand) and top layer 6 mm thick C.P 1:4 (1 cement : 6 sand) finished even and smooth and curing etc. complete*

*PL009218 mm cement plaster in two coats; under layer 12 mm C.P 1:5 (1 cement : 5 sand) and top layer 6 mm thick C.P 1:3 (1 cement : 6 sand) finished even and smooth and curing etc. complete*

The Specification for scaffolding and preparation of surface shall be as described in 18.2.

*Mortar* - The mix and type of the fine aggregate specified in the description of the item shall be used for the respective coats. Generally the mix of the finishing coat shall not be richer than the under coat unless otherwise described in the item. Generally coarse sand shall be used for the under coat and fine sand for the finishing coat, unless otherwise specified for external work and under coat work, the fine aggregate shall conform to grading zone IV. For finishing coat work the fine aggregate conforming to grading zone V shall be used.

*Application* - The plaster shall be applied in two coats i.e. 12 mm under coat and then 6 mm finishing coat and shall have an average total thickness of not less than 18 mm.

12 mm *Under Coat:* This shall be applied as specified in 18.2 except that when the plaster has been brought to a true surface a wooden straight edge and the surface shall be left rough and furrowed 2 mm deep with a scratching tool diagonally both ways, to form key for the finishing coat. The surface shall be kept wet till the finishing coat is applied.

6 mm *Finishing Coat:* The finishing coat shall be applied after the under coat has sufficiently set but not dried and in any case within 48 hours and finished in the manner specified in 18.2.

Specifications for Curing, Finishing, Precautions, Measurements and Rate shall be as described under 18.2.

**5.18.7 Cement Lime Plaster**

*PL009512 mm cement lime plaster of mix on fair side of brick work - 1:1:6 (1 cement: 1 lime: 6 sand) finished even and smooth and curing etc., complete*

*PL009612 mm cement lime plaster of mix on rough side of brick work - 1:1:6 (1 cement: 1 lime: 6 sand) finished even and smooth and curing etc., complete*

The cement lime plaster shall be 12 mm or 15 mm as specified in the item.

*Mortar* - The mortar of the mix and types of sand specified in the description of the item shall be used. The cement lime mortar shall be as specified in specifications for mortars

*Application* - It shall be as specified under 18.2 except that the plastering and finishing shall be completed within half an hour of adding slurry of lime putty to the dry cement sand mixture or mixing cement to ground lime mortar.

Specifications for scaffolding, Preparation of surface, Finish, Thickness, Curing, Precautions, measurements and Rate shall be as described under 18.2.

***5.18.8* Extra for Plaster**

- *Extra, for providing and mixing water-proofing materials in proportion recommended by the manufacturers*

*PL0100* *12mm plaster in CM 1:3*

*PL0101* *12mm plaster in CM 1:4*

*PL0102* *15mm plaster in CM 1:3*

*PL0103* *15mm plaster in CM 1:4*

*PL0104* *20mm plaster in CM 1:3*

*PL0105* *20mm plaster in CM 1:4*

The water-proofing compound shall be mixed in the proportion and in the way as recommended by the manufacturers.

**Measurement:** The measurement shall be in square metres correct to two places of decimal.

**Rate:** The rate shall include the cost of water proofing compound and labour involved in mixing the compound with cement Mortar.

*PL0110* *Extra for neat cement punning*

When the plaster has been brought to a true surface with the wooden straight edge it shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quantity of cement applied for floating coats shall be 1 kg per sq.m. Smooth finishing shall be completed with a trowel immediately and in no case later than half an hour of adding water to the plaster mix.

**Curing:** Curing shall be started as soon as the plaster has hardened sufficiently so as not be damaged when watered. The work shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the contractor's expense by such means as the Engineer may approve. The dates on which the work is done shall be legibly marked on the various sections plastered so that curing for the specified period

thereafter can be watched. Specifications for scaffolding, finish and precautions to be taken for the work shall be as described under ordinary plastering works.

**Measurement:** The measurements for cement punning shall be taken over the finished work. The length and breadth shall be measured correct to 10 mm. The area shall be calculated in sq.m correct to two places of decimal. Punning over plaster on bands, skirting, coving, cornices, drip courses, stringcourses, etc. shall not be measured separately. In these cases the measurements shall be taken girthed over the above features. Punning over plaster on circular work also, of any radius shall be measured only as wall surfaces and not separately. Cement punning in patch repairs irrespective of the size of the patch shall be measured as new work, and in this case the rate shall include for cutting the patch to rectangular shape before cement punning. Deductions in measurements for openings shall be regulated generally as described under item for ordinary plastering works.

**Rate:** The rate shall include the cost of the labour and materials involved in all the operations described above.

### 5.18.9 Putty finishes

*PL0125 Providing & applying putty of 2mm or more thickness over plastered surface to prepare the surface even and smooth complete.*

**Application of Putty finishes:** Apply putty of 2mm thick over finished cement plaster surface.

**Finish:** The putty shall be finished to a true and plumb surface and to the proper degree of smoothness as required.

**Measurement:** Length and breadth shall be measured correct to 10 mm and its area shall be calculated in square metres correct to two places of decimal. The measurements of wall putty plaster shall be taken between the walls or partitions (the dimensions before plastering shall be taken) for the length, and from the top of the floor or skirting to the ceiling for the height.

**Rate:** The rate shall include the cost of the labour and materials involved in all the operations described above.

### 5.18.10 Plaster of Paris (POP) Finish

*PL0126 Providing and applying plaster of paris of 2 mm thickness over plastered surface to prepare the surface even and smooth complete*

**Application of POP Finish:**
Apply Plaster of Paris (POP) of average 2 mm thickness over the finished cement plaster surface after properly cleaning the surface of dust, loose particles, oil, grease or other foreign matter. The POP shall be mixed in approved proportion and applied uniformly to obtain a smooth and even surface. The surface shall be finished by rubbing and trowelling to the required line, level and finish.

**Finish:** The finished surface shall be true, even and plumb and shall be smooth without undulations, cracks, blistering or other defects and suitable for receiving paint or other decorative finish.

**Measurement:** Length and height shall be measured correct to 10 mm and the area shall be calculated in square metres correct to two places of decimal. The measurements of POP finish shall be taken between the walls or partitions (the dimensions before application shall be taken) for the length, and from the top of the floor or skirting to the ceiling for the height.

**Rate:** The rate shall include the cost of the labour and materials involved in all the operations described above.

# 5.19 Chapter 19: PAINTING & WALL PAPER

## 5.19.1 General

Painting shall not be started until the Engineer has inspected the items of work to be painted and satisfied himself about their proper quality and given his approval to commence the painting work. Painting, except the priming coat, shall generally be taken in hand after practically finishing all other builder's work. Painting of external surfaces should not be done in adverse weather conditions like hail or dust storms etc. The rooms should be thoroughly swept out and the entire building cleaned up at least one day in advance of the painting work being started. The contractor shall bring approved paints, oils and varnishes to the site of work, in their original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The empties shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer.

Wherever scaffolding is necessary, it shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. No ballies, bamboos or planks shall rest on or touch the surface being washed. For all exposed brick work or tile work, double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

In case of a special type of brickwork, scaffolding shall be approved from the Engineer in advance. Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damages or scratches to walls. For white washing the ceiling, the proper stage scaffolding shall be erected.

### 5.19.1.1 Preparation of surface:

**Wooden surface:** The woodwork to be painted shall be dry and free from moisture. The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sandpaper and shall be well dusted. Knots, if any, shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material with the same shade, as paint shall be used where specified. The surface treated for knotting shall be dry before painting is applied. After the priming coat is applied, the holes and indentation on the surface shall be stopped with a glazier's putty or wood putty. Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in the stopping and the latter is therefore liable to crack.

**Iron & Steel Surface:** All rust and scales shall be removed by scraping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling, which becomes loose by rusting shall be removed. All dust and dirt shall be thoroughly wiped away from the surface. If the surface is wet, it shall be dried before priming coat is undertaken.

**Plastered surface:** The surface shall ordinarily not be painted until it has dried completely. Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall then be taken in hand. Before primer is applied, holes and undulations shall be filled up with plaster of paris and rubbed smooth.

**Measurements**

The length and breadth shall be measured correct to 10 mm. The area shall be calculated in sq.m correct to two places decimal, except when otherwise stated. Small articles not exceeding 0.1 sq.m of painted surfaces where not in conjunction with similar painted work shall be enumerated. Painting up to 15 cm in width or in girth and not in conjunction with similar painted work shall be given in running metres. Components of trusses, compound girders, stanchions, lattices and similar work shall, however be given in sq. metres irrespective of the size or girth of members. In measuring painting, varnishing oiling etc., of joinery, and steel work etc. the coefficients as in tables 5.19.1 shall be used to obtain the area payable.

The following coefficients shall be applied to the areas measured flat and not girth.

**Table 5.19.1** COEFFICIENTS FOR PAINTING MEASUREMENT

| Sl. No | Description of work | How measured | Multiplying coefficients |
|---|---|---|---|
| | Wood work – Doors, windows, etc. | | |
| 1 | Panelled or framed and braced doors, windows, etc. | Measured flat (not girthed) including frame | 1.3 (for each side) |
| 2 | Flush doors etc. | -do- | 1.20 (for each side) |
| 3 | Part panelled and part glazed or gauzed doors, windows, etc. | -do- | 0.8 (for each side) |
| 4 | Fully glazed or gauzed doors, windows, etc. | -do- | 0.5 (for each side) |
| 5 | Fully venetianed or louvered doors, windows, etc. | -do- | 1.80 (for each side) |
| 6 | Railing (Jadhang Tazi) | Measured flat over all on one side, no deduction shall be made for open spaces, supporting members shall not be measured separately. | 2.00 (for painting all over) |
| 7 | Traditional Cornices | Measured flat | 2.00 (for each side) |
| 8 | Wood shingle roofing | Measured flat (not girthed) | 1.10 (for each side) |
| 9 | Tile and slate battening | Measured flat over all, no deduction shall be made for open spaces | 0.80 (for painting all over) |

| | | | |
|---|---|---|---|
| II | STEEL: WORK-DOORS, WINDOWS, ETC. | | |
| 10 | Plain sheeted steel doors or windows | Measured flat (not girthed) including frame edges etc. | 1.10 (for painting all over) |
| 11 | Fully glazed or gauzed steel doors and windows | -do- | 0.50 (for each side) |
| 12 | Partly panelled and partly glazed or gauzed doors and windows | -do- | 0.80 (for each side) |
| 13 | Corrugated sheeted steel doors or windows | -do- | 1.25 (for each side) |
| 14 | Collapsible gates | Measured flat | 1.50 (for each side) |
| 15 | Rolling shutters of interlocked laths | Measured flat (size of opening) all over jamb, guides, bottom rails and locking arrangements etc. shall be included in the item (top cover shall be measured separately) | 1.10 ( For each side) |
| III | General | | |
| 16 | Expanded metal, hard drawn steel wire fabric of approved quality grill works and gratings in guard bars, balustrades, railings, partitions and m.s bars in window frames | Measured flat over all, no deductions shall be made for open spaces, supporting members shall not be measured separately | 1.0 for painting all over |
| 17 | Corrugated iron sheeting in roofs, side cladding, etc. | Measured flat (not girthed) | 1.14 (for each side) |
| 18 | Wire gauze shutters including painting of wire gauze | -do- | 1.0 (for each side) |

**EXPLANATORY NOTE FOR THE TABLE**

1. Measurements for doors windows etc., shall be taken flat (and not girth) overall including frames, where provided. Where frames are not provided, the shutter measurements shall be taken.
2. Where doors, windows etc., are of composite types other than those included in Table -1 the different portion shall be measured separately with their appropriate coefficients, the centre line of the common rail being taken as the dividing line between the two portions.

3. The coefficients for doors and windows shall apply irrespective of the size of the frames and shutters members.
4. In case steel frames are used the area of doors, windows shutters shall be measured flat excluding frames.
5. When two faces of a door, window etc. are to be treated with different specified finishes, measurable under separate items, the edges of frames and shutters shall be treated with the one or the other type of finish as ordered by the Engineer, and measurement of this will be deemed to be included in the measurement of the face treated with that finish.
6. In the case where shutters are fixed on both faces of the frames, the measurement for the doorframe and shutter on one face shall be taken in the manner already described. While the additional shutter on the other face will be measured for the shutter area only excluding the frame.
7. Where shutters are provided with clearance at top or/ and bottom each exceeding 15 cm height, such openings shall be deducted from the over-all measurements and relevant co-efficient shall be applied to obtain the area payable.
8. Collapsible gates shall be measured for width from outside to outside of the gate in its expanded position and for height from bottom to top of channel verticals. No separate measurements shall be taken for the top and bottom guide rails rollers, fittings etc.
9. Co-efficient for sliding doors shall be the same as for normal types of doors in the table. Measurements shall be taken outside to outside of shutters, and no separate measurements shall be taken for painting guides, rollers, fittings etc.
10. Measurements of painting as above shall be deemed to include painting all iron fittings in the same or different shades for which no extra will be paid.
11. The measurements of guard bars expanded metal, hard drawn steel wire fabric of approved quality grill work and gratings, when fixed in frame work, painting of which is once measured elsewhere shall be taken exclusive of the frames. In other cases the measurements shall be taken inclusive of the frames.

Painting of rain water, soil, waste, vent and water pipes etc. shall be measured in running metres of the particular diameter of the pipe concerned. Painting of specials such as bends, heads, branches, junctions, shoes etc. shall be included in the length and no separate measurements shall be taken for these or for painting brackets, clamps etc.

Measurements of wall surfaces and wood and other work not referred to already shall be recorded as actual. Flag staffs, steel chimneys, aerial masts, spires and other such objects requiring special scaffolding shall be measured separately.

**Precautions:** All furniture, fixtures, glazing, floor etc. shall be protected by covering and stairs, smears, splashing, in any shall be removed and any damage done shall be made good by the contractor at his cost.

### 5.19.2 Surface Preparation

- *Surface preparation removing by scraping, sand papering, including scratch repairs*

*PT0001* *White colour-wash*

*PT0002* *Dry oil bound distemper*

**Preparation of Surface:** Before new work is white washed, the surface shall be thoroughly brushed free from mortar dropping and foreign-matter. In the case of old work, all loose pieces and scales shall be scraped off and shaded in plaster as well as patches of less than 50 sq.cm area shall be filled up with mortar of the same mix. The surface shall then be allowed to dry for at least 48 hours. Where so specifically ordered by the Engineer, the entire surface of old white wash shall be thoroughly removed by scraping. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulation and then sand papering the same after it is dry.

**Measurement:** Length and breadth shall be measured correct to 10 mm and area shall be calculated correct to two places of decimals. Corrugated surface shall be measured flat as fixed and the area so measured shall be increased by 20% to allow for the girth area. Cornices and other such wall or ceiling features shall be measured along the girth and included in the measurements. The item shall include removing nails, making good holes, cracks, patches etc. not exceeding 0.1 sq.m each with material similar in composition to the surface to be prepared. Work on old treated surfaces shall be measured separately and so described. Measurement for jambs, soffits, sills, etc. shall be the same as for plastering works.

**Rate:** The rate shall include the labour and materials involved in the work.

### 5.19.3 Primers

- *Providing & applying one coat of primer*

*PT0010* *Cement primer*

*PT0011* *Metal work - synthetic red oxide primer*

*PT0012* *Wood work - pink primer*

*PT0013* *Wood work - white primer*

*PT0014* *Red lead primer*

Cement primer coat is used as a base coat on wall finish of cement, lime or lime cement plaster or on asbestos cement surfaces before oil emulsion distemper paints are applied on them. The cement primer is composed of a medium and pigment which are resistant to the alkalis present in the cement, lime or lime cement in wall finish and provides a barrier for the protection of subsequent coats of oil emulsion distemper paints. Primer coat shall be preferably applied by brushing and not by spraying. Hurried priming shall be avoided particularly on absorbent surfaces. New plaster patches in old work should also be treated with cement primer before applying oil emulsion paints etc.

**Application:** The cement primer shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for atleast

48 hours, before oil emulsion paint is applied. The specifications in respect of scaffolding protective measures, measurements and rate shall be as described above for surface preparation.

The primer for woodwork, ironwork shall be as specified in the description of the item. The primer shall be applied with brushes, worked well into the surface and spread even and smooth. Primers for plaster/wood/iron & steel/aluminium surfaces shall be as specified in the Table below:

**Table 5.19.2** PRIMERS FOR PLASTER/WOOD/IRON & STEEL/ALUMINIUM SURFACES

| Sl. No | Surfaces | Primer to be used |
|---|---|---|
| 1 | Wood works (hard and soft wood) | Pink confirming to (IS 3536) |
| 2 | Resinous wood and ply wood | Aluminium primer |
| 3 | Aluminium steel and galvanised steel work | Zinc chromate primer conforming to (IS:104) |
| 4. | Cement, brick work, plaster surface, Asbestos surface for oil bound distemper and paint | Cement primer |

The primer shall be ready mixed primer of approved brand and manufacture.

**Measurement:** The measurement shall be taken as described under the section 19.1.2

**Rate:** The rate shall include the cost of the materials and labour involved in all the operations described above.

### 5.19.4 Wall Washing

- *Providing & applying white or colour washing*

*PT0020* *White washing with lime, new work, three coats*

*PT0021* *White washing with lime, old work, two coats*

*PT0022* *White washing with lime, old work, one coat*

*PT0023* *Colour washing new work, two coats, including base coat of white wash with lime*

*PT0024* *Colour washing with lime, old work, two coats*

*PT0025* *Colour washing with lime, old work, one coat*

**Preparation of lime wash:** The wash shall be prepared from fresh stone white lime. The lime shall be thoroughly slaked on the spot, mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 40 gm of gum dissolved in hot water shall be added to each 0.01 cubic metre of the cream.

The approximate quantity of water to be added in making the cream will be 5 litres of water to 1 kg of lime. Blue up to 3 gm per kg of lime dissolved in water shall be added and wash stirred well. Water then shall be added @ about 5 litres per kg of lime to produce a milky solution.

**Application:** The specified number of coats of the white wash shall be applied with the brushes. The operation for each stroke shall consist of a stroke of the brush given from the top downwards, another from the bottom upward over the first stroke and similarly one stroke horizontally from the right and another from left before it dries. Each coat shall be allowed to dry before the next one is applied. Further each coat shall be inspected and approved by the Engineer before the subsequent coat is applied. No portion of the surface shall be left out to be patched up later on.

For new work, three or more coats shall be applied till the surface presents a smooth and a uniform finish through which the plaster does not show. The finished dry surface shall not show any signs of cracking and peeling nor shall it come off on the hand when rubbed. For old work, after the surface has been prepared as described above, a coat of white wash shall be applied over the patches and repairs. Then a single coat or two or more coats of white wash as stipulated in the description of the item shall be applied over the entire surface. The white washed surface should present a uniform finish through which the plaster patches do not appear. The washing on the ceiling should be done prior to that on the walls.

The mineral colours, not affected by lime, shall be added to white wash. Blue (Neel) shall, however, not be added. No colour wash shall be done until a sample of the colour washes of the required tint or shade has been got approved from the Engineer-. The colour shall be of even tint or shade over the whole surface. If it is blotchy or otherwise badly applied, the contractor shall redo it. For new work, the priming coat shall be of white wash with lime or with whiting as specified in the description of the item. Two or more coats shall then be applied on the entire surface till it represents a smooth and uniform finish. For old work, after the surface has been prepared a coat of colour wash shall be applied over the patches and repairs. Then a single coat, or two or more coats of colour wash, as stipulated in the description of the item shall be applied over the entire surface. The colour washed surface shall present a uniform finish. The finished dry surface shall not be powdery and shall not readily come off on the hand when rubbed.

Note: In case of Hessian ceiling, on no account, lime shall be used as it rots cloth and hessain.

**Protective Measures:** Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be white washed shall be protected from being splashed upon. Splashing and droppings if any, shall be removed by the contractor at his own cost. Damages if any to furniture or fittings and fixtures shall be recoverable from the contractor.

**Measurement:** The measurement shall be taken as described under the section 19.1.2

**Rate:** The rate shall include the cost of the materials and labour involved in all the operations described above.

### 5.19.5 Cement Paint

- *Finishing wall with Water-Proof Cement Paint*

*PT0030* *New work, three coats*

*PT0031* *Old work, one coats*

**Material:** The cement paint shall be (equivalent to IS 5410) of approved brand and manufacture.

**Preparation of Surface:** For new work, the surface shall be thoroughly cleaned of all mortar dropping, dirt, dust, algae, grease and other foreign matter by brushing and washing. The surface shall be thoroughly wetted with clean water before the cement paint is applied. In the case of old work, all loose pieces and scales shall be removed and the surface shall be cleaned of all dirt, dust, algae, oil etc. by brushing and washing. Pitting in plaster shall be made good and a coat of water proof cement paint shall be applied over patches after wetting them thoroughly.

**Preparation of mix:** Cement paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Cement paint shall be mixed with water in two stages. The first stage shall comprise two parts of cement paint and one part of water stirred thoroughly and allowed standing for 5 minutes. Care shall be taken to add the cement paint gradually to the water and not vice versa. The second stage shall consist of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer's instructions shall be followed meticulously. The lids of cement paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement paint rapidly becomes air set due to its hygroscope qualities.

**Application:** The solution shall be applied on the clean and wetted surface with brushes or a spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface, which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The method of application of cement paint shall be as per manufacturer's specification. The completed surface shall be watered after the day's work. The second coat shall be applied after the first coat has set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted. For new work, the surface shall be treated with three or more coats of waterproof cement paint as found necessary to get a uniform shade. For old work, the treatment shall be with one or more coats as found necessary to get a uniform shade.

**Precaution:** Water cement paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, paints etc. It shall not be applied on gypsum, wood and metal surfaces.

**Measurement:** The measurement shall be taken as described under the section 19.1.2

**Rate:** The rate shall include the cost of the materials and labour involved in all the operations described above.

### 5.19.6 Distemper

- *Providing and applying finishing coats, with*

*PT0040* *Dry distemper, two coats on new work, incl. white priming coat*

*PT0041* *Dry distemper, one coat on old work*

**Materials:** Dry distemper of required colour and (IS:427) of approved brand and manufacture shall be used. The shade shall be approved from the Engineer before application of the distemper. The dry distemper colour as required shall be stirred slowly in clean water using 0.6 litre of water per kg of distemper or as specified by the makers. Warm water shall preferably be used. The mixture shall be allowed to stand for at least 30 minutes (or if practicable over night) before use. The mixture shall be well stirred before and during

use to maintain an even consistency. Distemper shall not be mixed in larger quantities than is actually required for one day's work.

**Priming coat:** A priming coat of whiting shall be applied over the prepared surface in case of new work, if so stipulated in the description of the item. No white washing coat shall be used as a priming coat for distemper. The treated surface shall be allowed to dry before a distemper coat is given.

**Application:** In the case of new work, the treatment shall consist of a priming coat of whiting followed by the application of two or more coats of distemper till the surface shows an even colour. For old work, the surface prepared shall be applied one or more coats of distemper till the surface attain an even colour. The application of each coat shall be as follows:

The entire surface shall be coated with the mixture uniformly, with proper distemper brushes (ordinary white wash brushes shall not be allowed) in horizontal strokes followed immediately by vertical ones, which together shall constitute one coat. The subsequent coats shall be applied only after the previous coat has dried. The finished surface shall be even and uniform and shall show no brush marks. Enough distemper shall be mixed to finish one room at a time. The application of a coat in each room shall be finished in one operation and no work shall be started in any room, which cannot be completed the same day. After each day's work, the brushes shall be washed in hot water and hung down to dry. Old brushes, which are dirty or caked with distemper, shall not be used.

**Measurement** and **rate** shall be the same as described under item X above**.**

- *Providing and applying finishing coats, with*

*PT0042* *Acrylic washable distemper, two coats on new work, incl. cement primer coat*

*PT0043* *Acrylic washable distemper, one coat on old work*

**Materials:** Oil emulsions (Oil Bound) distemper (IS-428) of approved brand and manufacture shall be used. The primer where used, as on new work, shall be cement primer or distemper primer as described in the item. These shall be of the same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day's work shall be prepared. The distemper and primer shall be brought by the contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight's work, and the same shall be kept in the joint custody of the contractor and the Engineer. The empty tins shall not be removed from the site of work, till this item of work has been completed and passed by the Engineer.

**Application: Priming coat:** The priming coat shall be with distemper primer or cement primer, as required in the description of the item. The application of the distemper primer shall be as described above. Oil bound distemper is not recommended to be applied, within six months of the completion of wall plaster. For old work no primer coat is necessary.

**Distemper coat:** For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitute one coat. The subsequent coats shall be applied in

the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade. A time interval of at least 24 hours shall be allowed between consecutive coats to permit for the proper drying of the preceding coat.

For old work the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade. 15 cm double bristled distemper brushes shall be used. After each day's work, brushes shall be thoroughly washed in hot water with soap solution and hung down to dry. Old brushes, which are dirty and caked with distemper, shall not be used on the work.

**Measurement:** The measurement shall be taken as described under the section 19.1.2

**Rate:** The rate shall include the cost of the materials and labour involved in all the operations described above.

### 5.19.7 Finishing Paints

- *Providing and applying finishing coats, with*

*PT0044* *Bituminastic enamel, for steel work, two coats on new work*

*PT0045* *Bituminastic enamel, for steel work, one coat on old work*

*PT0046* *Synthetic enamel, for steel & wood work, one coat on old work*

*PT0047* *Synthetic enamel, for steel & wood work, two coats on new work*

Synthetic Enamel paint (conforming to IS:1932) of approved brand and manufacture and of the required colour shall be used for the top coat and an undercoat of shade to match the top and as recommended by the manufacturer shall be used.

**Painting on New Surface:**

**Preparation of Surface for Wood work:** The surface shall be cleaned and all unevenness removed. Knots if visible, shall be covered with a preparation of red lead. Hole and indentations on the surface shall be filled in with glazier's putty or wood putty and rubbed smooth before painting is done. The surface should be thoroughly dry before painting.

**Preparation of Surface for Iron and steelwork:** The priming coat shall have dried up completely before painting is started. Rust and scaling shall be carefully removed by scraping or by brushing with steel wire brushes. All dust and dirt shall be carefully and thoroughly wiped away.

**Application:** The number of coats including the undercoat shall be as stipulated in the item.

**Under Coat**: One coat of the specified paint of shade suited to the shade of the topcoat shall be applied and allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface, free from brush marks and all loose particles dusted off.

**Topcoat:** Topcoats of specified paint of the desired shade shall be applied after the undercoat is thoroughly dry. Additional finishing coats shall be applied if found necessary to ensure a properly uniform glossy surface.

Other details shall be as specified after item 54 as far as they are applicable.

**Painting on old surface:**

**Preparation of surface**: Where the existing paint is firm and sound it shall be cleaned of grease, smoke etc. and rubbed with sand paper to remove all loose paint and loose particles dusted off. All patches and cracks shall then be treated with stopping and filler prepared with the specified paint. The surface shall again be rubbed and made smooth and uniform. If the old paint is blistered and flaked it will be necessary to completely remove the same. Such removal shall be paid for separately and the painting shall be treated as on new surface.

**Painting:** The number of coats as stipulated in the item shall be applied with the specified paint. Each coat shall be allowed to dry and rubbed down smooth with very fine wet abrasive paper, to get an even glossy surface. If, however, the surface is not satisfactory additional coats as required shall be applied to get correct finish.

**Measurement:** The measurement shall be taken as described under the section 19.1.2

**Rate:** The rate shall include the cost of the materials and labour involved in all the operations described above.

- *Providing and applying finishing coats, with*

*PT0048* *High gloss synthetic enamel, for steel & wood work, two coats on new work*

*PT0049* *High gloss synthetic enamel, for steel & wood work, one coat on old work*

Ready mixed paints of approved brand and manufacture and of the required shades shall be used. They shall conform in all expects to the relevant IS specifications.

**Painting on New Surface:** The surface which has not been painted earlier, or the paint has been removed by paint remover, burning, caustic soda etc. shall be considered to be new surface.

**Preparation of Surface:**

**Wood Work:** The surface shall be cleaned and all unevenness removed as specified under items 57 to 60. Knots if visible, shall be covered with a preparation of red lead. Holes and indentations on the surface shall be filled in with glazier's putty or wood putty and rubbed smooth before painting is done. The surface should be thoroughly dry before painting.

**Iron and Steel work:** The priming coat shall have dried up completely before painting is started. Rust and scaling shall be carefully removed by scraping or by brushing with steel wire brushes. All dust and dirt shall be carefully and thoroughly wiped away.

**Plastered surface:** The priming coat shall have dried up completely before painting is started. All dust or dirt that has settled on the priming coat shall be thoroughly wiped away before painting is started.

**Application:** The specifications described below shall hold good as far as applicable. The number of coats to be applied will be as stipulated in the item. The painted surface shall present a uniform appearance and glossy finish, free from streaks, blisters etc. The general specifications described after item 54 shall hold good in so far as they are applicable.

**Painting an old surface:** The surface, which has been painted earlier, shall be considered to be an old surface.

**Preparation of Surface:**

**Wood work:** If the old paint is sound and firm and its removal is considered unnecessary, the surface shall be rubbed down with pumice stone after it has been cleared of all smoke and grease by washing with lime and rinsing with water and drying. All dust and loose paint shall be completely removed. The surface shall then be washed with soap and water. If the old painted surface is blistered or flaked badly, old paint shall be completely removed and such removal shall be paid for separately. Holes and cracks if any shall be stopped with glazier's putty or wood putty. Further the painting itself shall be treated as on new surface and paid for, accordingly.

**Iron and Steel Work:** If the old paint is sound and firm and its removal is considered unnecessary, it shall be rubbed with wire brushes and any loosened paint taken off. All dust shall then be thoroughly wiped away. This surface shall then be wiped finally with mineral turpentine to remove grease and perspiration of hand marks etc. and then allowed drying. If the old painted surface is in bad condition and blistered and flaked, the old paint shall be completely removed and such removal shall be paid for separately. The painting including the priming coat shall be treated as on new work and paid for accordingly.

**Plastered surface:** If before painting any portion of the wall shows signs of dampness, the causes shall be investigated and the damp surface shall be properly treated. Such treatment shall be paid for separately. A thin coat of white lead if so required shall be applied on the wet or patchy portion of the surface, before painting is undertaken and this shall be paid extra. The number of coats to be given shall be as stipulated in the description of the item.

**Measurement:** The measurement shall be taken as described under the section 19.1.2

**Rate:** The rate shall include the cost of the materials and labour involved in all the operations described above.

- *Providing and applying finishing coats, with*

*PT0050* *Red corrugal, ready mixed|on G.I. sheets, two coats on new work*

*PT0051* *Red corrugal, ready mixed, on G.I. sheets|one coat on old work*

Ready mixed paint, suitable for painting over GI sheets, of approved brand and manufacture and of the required shade shall be used. New or weathered GI sheets shall be painted with a priming coat of one coat of red oxide zinc chromate paint. Primer shall be applied before fixing sheets in place.

**Preparation of Surface:**

**Painting New Surface:** The painting of new GI sheets shall not usually be done till the sheets have weathered for about a year. When new sheets are to be painted before they have weathered they shall be treated with a mordant solution prepared by mixing 38 gm of copper acetate in a litre of soft water or 13 gm hydrochloric acid in a solution of 13 gm each of copper chloride, copper nitrate & ammonium chloride dissolved in a litre of soft water. This quantity of solution is sufficient for about 235 sq.m to 280 sq.m of area and is applied for ensuring proper adhesion of paint. The painting with the mordant solution will be paid for separately. Before painting on new or weathered GI sheets, rust patches shall be completely cleaned with coarse emery paper and brush. All grease marks also shall be removed and the surface washed and dried and rusted surface shall be touched with red mixed paint of red lead.

**Painting Old Surface:** If the old paint is firm and sound, it shall be cleaned of grease, smoke etc. The surface shall then be rubbed down with sandpaper and dusted. Rusty patches shall be cleaned up and touched with red lead. If the old paint is blistered and flaked, it shall be completely removed. Such removal shall be paid for separately and painting shall be treated as on new work.

**Application:** The number of coats to be applied shall be as in the description of the item. In the case of C.G.I. sheets, the crowns of the corrugations shall be painted first and when these get dried the general coat shall be given to ensure uniform finish over the entire surface without the crowns showing signs of thinning. The second or additional coats shall be applied when the previous coat has dried.

**Measurement:** The measurement shall be taken as described under the section 19.1.2

**Rate:** The rate shall include the cost of the materials and labour involved in all the operations described above.

- *Providing and applying finishing coats, with*

*PT0052 Vinyl plastic emulsion paint, for cement, masonry, plaster, two coats on new work*

Plastic emulsion paint is not suitable for application on external wood and iron surface and surfaces, which are liable to heavy condensation, and are to be used on internal surfaces except wood and steel which is liable for condensation. Plastic emulsion paint as per IS 5411 of approved brand and manufacture and of required shade shall be used.

**Preparation of surface:** The plaster surfaces shall be allowed to dry thoroughly. A thin layer of plaster of Paris shall be used to make the wall surface perfectly plane and wall junction lines perfectly straight and neat. This surface shall be finished smooth. Care must be taken to keep this layer as thin as possible. This shall be inspected by the engineer before the application of the plastic emulsion paint.

**Application of paint:** The paint will be applied in the usual manner with brush or roller. The paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surfaces to 2 to 3 hours on non-absorbent surfaces. The thinning of emulsion is to be done as per manufacturer's recommendation. Turpentine should not be used for this purpose. The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

**Precautions:** Old brushes, if required to be used, shall be thoroughly cleaned by washing in warm soap water. Brushes shall be washed immediately after use and kept immersed in water during break periods to prevent paint drying on the brush and hardening. No oil-based putties shall be used in preparation of walls. Splashes of paint shall be cleaned out without delay, as it will be difficult to remove after hardening. Washing of surfaces treated with plastic emulsion paint shall not be done within 3 to 4 weeks of application.

**Measurement:** The measurement shall be taken as described under the section 19.1.2

**Rate:** The rate shall include the cost of the materials and labour involved in all the operations described above.

- *Providing and applying finishing coats, with*

*PT0053 Acrylic emulsion, one coat*

*PT0054 Aluminium paint, one coat on old work*

*PT0055 Aluminium paint, two coats on new work*

Aluminium paint shall be (conforming to IS: 2339) of approved brand and manufacture. The paint comes in compact dual containers with the paste and the medium separately. The two shall be mixed together to proper consistency before use.

**Preparation of Surfaces:**

**Steel Work (New Surfaces):** All rust and scales shall be removed by scraping or brushing with steel wire brushed and then smoothened with sandpaper. The surface shall be thoroughly cleaned of dust.

**C.G.I. Sheets (New surface):** The painting of new G.I. Sheets shall not usually be done till the sheets have weathered for about a year. When new sheets are to be painted before they have weathered, they shall be treated with a mordant solution prepared by mixing 38 gm of copper acetate in a litre of soft water or 13 gm of hydro chloric acid in a solution of 13 gm each of copper chloride, Copper nitrate and ammonium chloride dissolved in a litre of soft water. This quantity of solution is sufficient for about 235 sq.m of area and is applied for ensuring proper adhesion of paint. The painting with the mordant solution will be paid for separately. Before painting on new or weathered G.I. sheets, rust patches shall be completely cleaned with coarse emery paper and brush. All grease marks also shall be removed and the surface washed and dried and rusted surface shall be touched with ready mixed paint of red lead.

**Steel work or CGI sheets (old surface):** The specifications shall be as described above.

**Application:** The number of coats to be applied shall be as given in the item. Each coat shall be allowed to dry for 24 hours and lightly rubbed down with fine grade sandpaper and dusted before the next coat is applied. The finished surface shall present an even and uniform appearance. As aluminium paste is likely to settle in the container, care shall be taken to frequently stir the paint during use. Also the paint shall be applied and laid off quickly, as the surface is otherwise not easily finished.

**Measurement and rate shall be the same as described under item X above.**

### 5.19.8 Stains, Varnishes & Polishes

- *Providing and applying wood stains, varnishes & polishes*

*PT0060 Wood stain (various colours), one coat (Black Japan paint of approved brand shall be used).*

*PT0061 Synthetic varnish (clear) - one coat, on old work*

*PT0062 Synthetic varnish (clear) - two coats, incl. coat of wood filler on new work*

*PT0063 French polish - one coat, on old work*

*PT0064 French polish - two coats, on new work*

Pure shellac varying from pale orange to lemon yellow colour, free from resin or dirt shall be dissolved in methylated spirit at the rate of 140 gm of shellac to 1 litre of spirit. Suitable pigment shall be added to get the required shade.

**Polishing New Surface:**

**Preparation of Surface:** The surface shall be cleaned. All unevenness shall be rubbed down smooth with sand paper and well dusted. Knots if visible shall be covered with a preparation of red lead and glue size laid on while hot. Holes and indentations on the surface shall be stopped with glazier's putty. The surface shall then be given a coat of wood filler made by mixing whiting (ground chalk) in methylated spirit at the rate of 1.5 kg of whiting per litre of spirit. The surface shall again be rubbed down perfectly smooth with glass paper and wiped clean.

**Application:** The number of coats of polish to be applied shall be as described in the item. A pad of woollen cloth covered by a fine cloth shall be used to apply the polish. The pad shall be moistened with the polish and rubbed hard on the wood, in a series of overlapping circles applying the mixture sparingly but uniformly over the entire area to give an even level surface. A trace of linseed oil on the face of the pad facilitates this operation. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cotton cloth slightly damped with methylated spirit and rubbed lightly and quickly with circular motions. The finished surfaces shall have a uniform texture and high gloss.

**Polishing Old Surface:**

**Preparation of surface:** If the old polished surface is not much soiled it shall be cleaned of grease and dirt by rubbing with turpentine and then rubbed with fine sandpaper. If the old polished surface is much soiled then it will be necessary to remove the entire polish with patent paint remover or with caustic soda solution, as suitable and such removal shall be paid for separately outside the rate of polishing. Further the polishing itself will have to be done like new work and will be paid for as such.

**Measurement:** The measurement shall be taken as described under the section 19.1.2

**Rate:** The rate shall include the cost of the materials and labour involved in all the operations described above.

### 5.19.9 Wood Preservatives

- *Providing and applying wood preservatives*

*PT0070* *Brown, two coats on new work*

*PT0071* *Brown, one coat on old work*

*PT0072* *Coal tar, two coats on new work*

*PT0073* *Coal tar, one coat on old work*

Oil type wood preservative, of specified quality and approved make conforming to IS-218, shall be used. Generally, it shall be creosote oil type-I or anthracene oil.

**Painting on New Surface:** Painting shall be done only when the surface is perfectly dry to permit good absorption. All dirt, dust or other foreign matter shall be removed from the surface to be painted. All roughness shall be sand papered and cleaned.

**Application:** The preservative shall be applied liberally with a stout brush and not daubed with rags or cotton waste. It shall be applied with a pencil brush at the joints of the woodwork. The first coat shall be allowed at least 24 hours to soak in before the second (the final) coat is applied. The second coat shall be applied in the same manner as the first coat.

The excess of preservative which does not soak into the wood shall be wiped off with a clean dry piece of cloth.

**Painting on old surface:** The work shall be done in the same manner as on new surface except that only one coat shall be done. Such of the specifications given below, in so far as they are applicable shall also hold good.

**Materials:** Paints, Oils, and Varnishes etc of approved brand and manufacture shall be used. Ready mixed paint as received from the manufacturer shall be used without any admixture. If for any reason, thinning is necessary in case of ready mixed paint, the brand of thinner recommended by the manufacturer or as instructed by the Engineer, shall be used.

**Preparation of Surface:** The surface shall be thoroughly cleaned and dusted. All rust and dirt scales, smoke and grease etc shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Engineer after inspection, before painting is commenced.

**Application:** The paint shall be stirred thoroughly in its containers before pouring into containers for use and also while applying so that its consistency is uniform. The paint shall be laid on evenly and smoothly by means of "crossing and laying off" the latter in the direction of the grain of wood. In this process, no brush marks shall be left after the laying off is finished. The full process of "crossing and laying off" will constitute one coat. Where so stipulated painting shall be done by spraying. Spray machines used may be a) high-pressure (small air aperture) type, or b) a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding suitable thinner. Spraying should only be done when dry conditions prevails. Each coat shall be allowed to dry out thoroughly and rubbed smooth before the next coat is applied. This should be facilitated by thorough ventilation. Each coat except the last coat shall be lightly rubbed with sandpaper or fine pumice stone and cleaned off dust before the next coat is laid. No left over paint shall be put back into the stock tins. When not in use, the containers shall be kept properly closed. No hair marks from the brush or clogging of paint puddles in the corner of panels, angles of mouldings etc shall be left on the work. In painting doors and windows, the putty round the glass panes must also be painted; but care must be taken to see that no paint stains etc, are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting. In painting steelwork, special care shall be taken while painting over bolts, nuts, rivets, overlaps etc.

**Brushes and Containers:** After work, the brushes/shall be completely cleaned of paint and linseed oil by rinsing with turpentine. A brush in which paint has dried up is ruined and shall on no account be used for painting work. The containers, when not in use, shall be kept closed and free from air so that paint does not thicken and also shall be kept safe from dust. When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean, and can be used again.

**Coal Tarring:** Coal tar of approved manufacture shall be used. The tar, to every litre of which 200 gm of unslaked lime has been added, shall be heated till it begins to boil. It must then be taken off the fire and kerosene oil added to it slowly at the rate of one part of kerosene oil to six or more parts by volume and stirred thoroughly. The addition of lime is for preventing the tar from running.

**Coal Tarring New Surface:** The work to be painted shall be dry and free from moisture. The surface shall be thoroughly cleaned. Knots, if any, shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material with the same shade, as paint shall be used where specified. The surface treated for knotting shall be dry before painting is applied, the holes and indentation on the surface shall be stopped with glaziers putty or wood putty. Stopping shall not be done before the priming coat is applied, as the wood will absorb the oil in the stopping and the latter therefore liable to crack. Where ironwork is to be painted it shall be free from scales and rust before painting.

**Application:** The mixture shall be applied as hot as possible with a brush. The second coat shall be applied only after the first coat has thoroughly dried up. Where possible, the article to be tarred shall be dipped in the hot mixture for better results. The quantity of tar to be used for the first or second coat shall be not less than 0.16 and 0.12 litre per sq.m respectively. Thinning with kerosene oil shall be suitably done to ensure this.

**Coal Tarring old Surface**: The work shall be done in the same manner as specified above except that only one coat using 0.12 litre per sq.m area shall be done.

**Measurement:** The length and breadth shall be measured correct to 10 mm. The area shall be calculated in sq.m correct to two places of decimal.

**Rate:** Rate shall include cost of all labour and materials involved in all the operations described above and in the particular specifications given under the several items.

### 5.19.10 Wall Paper

- *Providing & fixing wallpaper*

*PT0080* *Standard Quality*

*PT0081* *High Quality*

Quality of wallpaper shall be as specified.

**Measurement:** Length and breadth shall be measured correct to 10 mm and area shall be calculated correct to two places of decimal. The item shall include removing nails, making good holes, cracks, patches etc. Work on old treated surfaces shall be measured separately. Measurement for jamps, soffits, sills, etc. shall be the same as for plastering works.

**Measurement:** The measurement shall be taken as described under the section 19.1.2

**Rate:** The rate shall include the cost of the materials and labour involved in all the operations described above.

### 5.19.11 Traditional Painting

- *Providing, preparing and applying Sumdang painting*

*PT0090* *Rab*
*PT0091* *Ding*
*PT0092* *Thamar*

- *Providing, preparing and applying Dangtshon painting*

*PT0100* *Rab*
*PT0101* *Ding*

*PT0102 Thamar*

- *Providing, preparing and applying Sumdang washable painting*

*PT0110 Rab*
*PT0111 Ding*
*PT0112 Thamar*

- *Providing, preparing and applying Dangtshon washable painting*

*PT0120 Rab*
*PT0121 Ding*
*PT0122 Thama*

- *Providing, preparing and applying Yutshon painting (plain)*

*PT0130 Washable*
*PT0131 Not washable*

- *Providing, preparing and applying flower natural painting for wall decoration design such as Tashi-tagey symbols, Tashi-Zeegay, Za-Tshering, etc., etc.*

*PT0140 Dangtshon - Rab*
*PT0141 Sumdang - Rab*

Traditional Painting shall not be started until the Engineer has inspected the items of work to be painted and satisfied himself about their proper quality and given his approval to commence the painting work. Painting, except the priming coat, shall be started after practically finishing all other builder's work. Traditional painting of external surfaces should not be done in adverse weather conditions like hail or dust storms etc. The rooms should be thoroughly swept out and the entire building cleaned up at least one day in advance of the painting work being started. The contractor shall bring approved painting materials to the site of work, in their original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The empties shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer.

Wherever scaffolding is necessary, it shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. No ballies, bamboos or planks shall rest on or touch the surface being painted. For all exposed brick work or tile work, double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed. Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damages or scratches to walls.

**Classification**: Traditional Bhutanese paintings are classified into four categories namely *Rab*, *Ding*, *Thamar* and Yu*tshon*. Bill of quantities shall be based on these categories.

**Note: The labeling given in the figures in the following pages are not meant to depict/imply the Traditional Bhutanese painting nomenclatures but they are for the structural members only.**

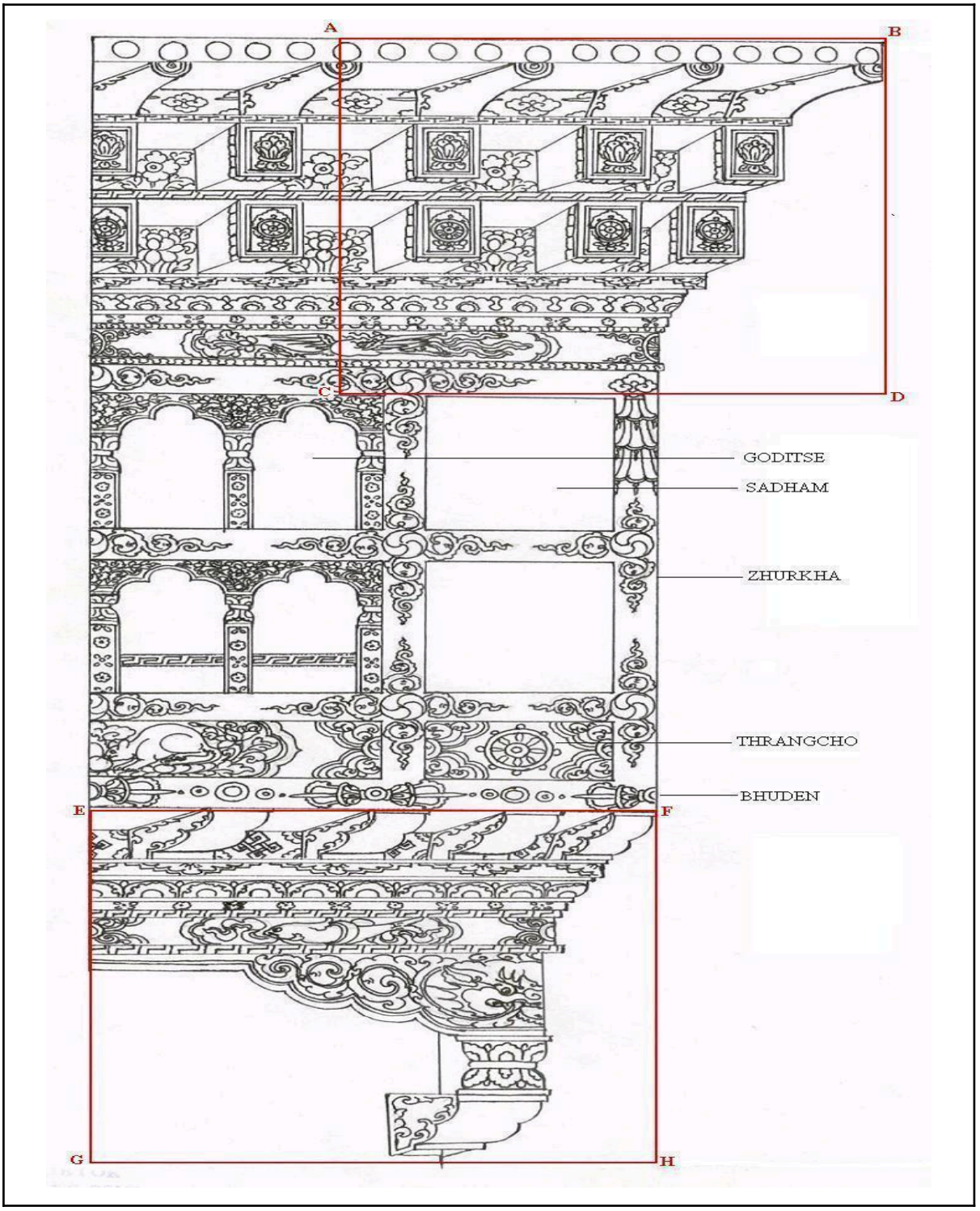



**Figure 5.19.1** Rabsey (Rab)

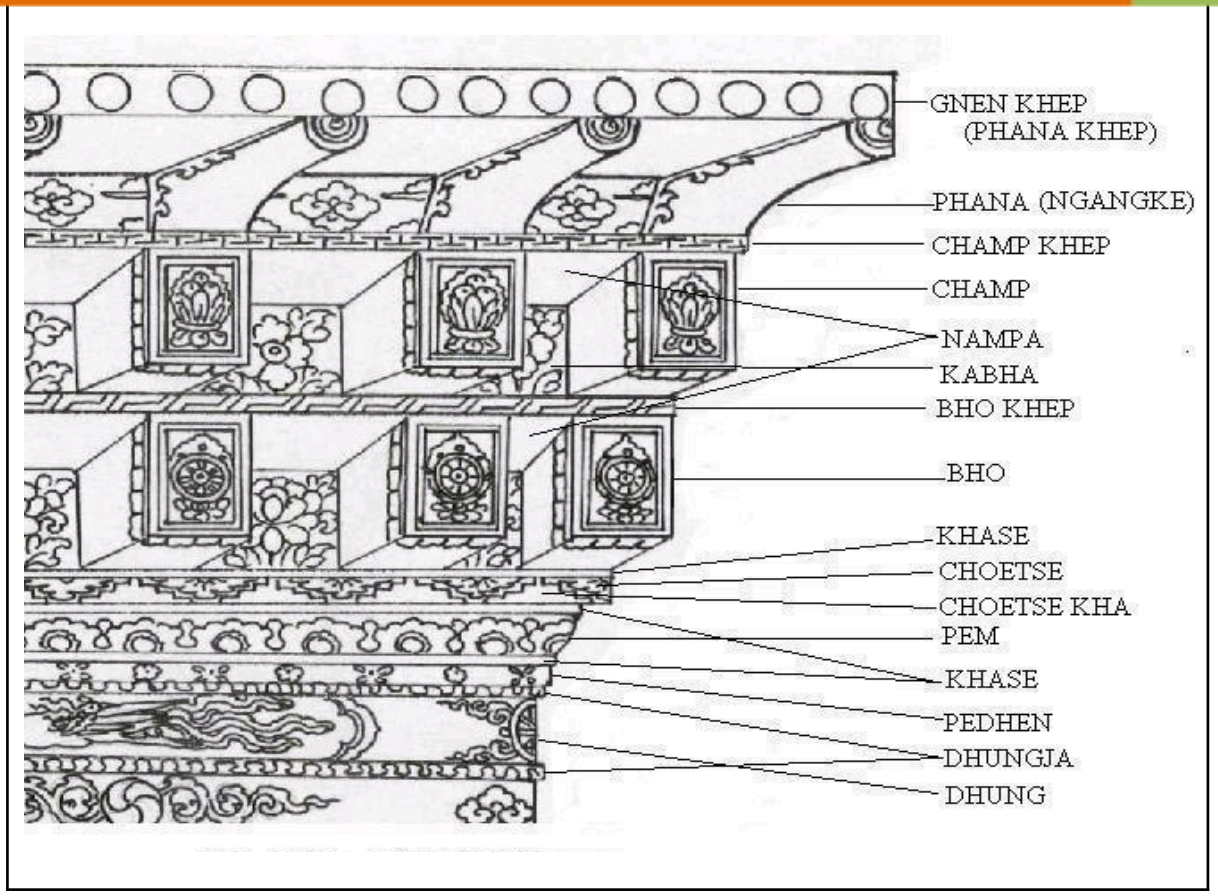



**Figure 5.19.2** Enlarged part ABCD

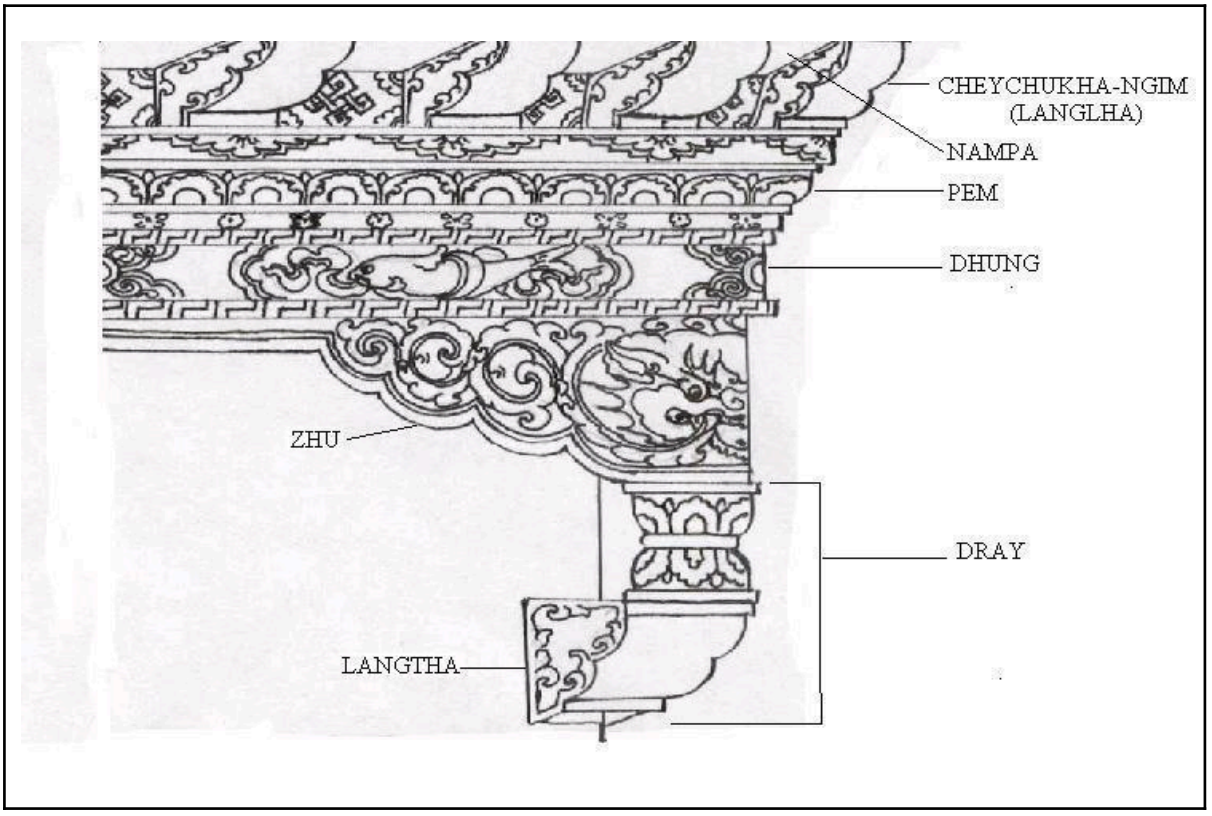



**Figure 5.19.3** Enlarged part EFGH

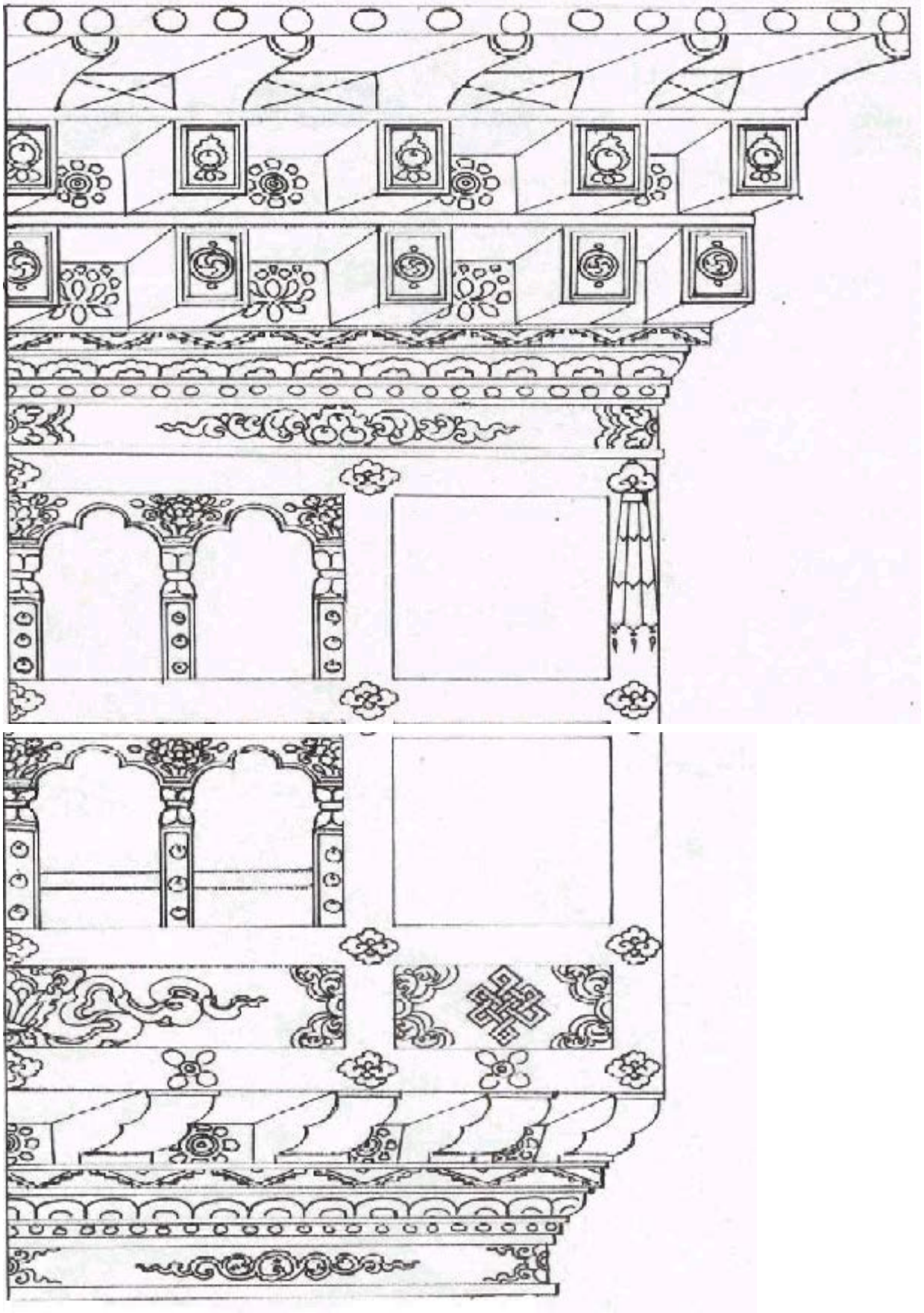


**Figure 5.19.4** Rabsey (Dring)

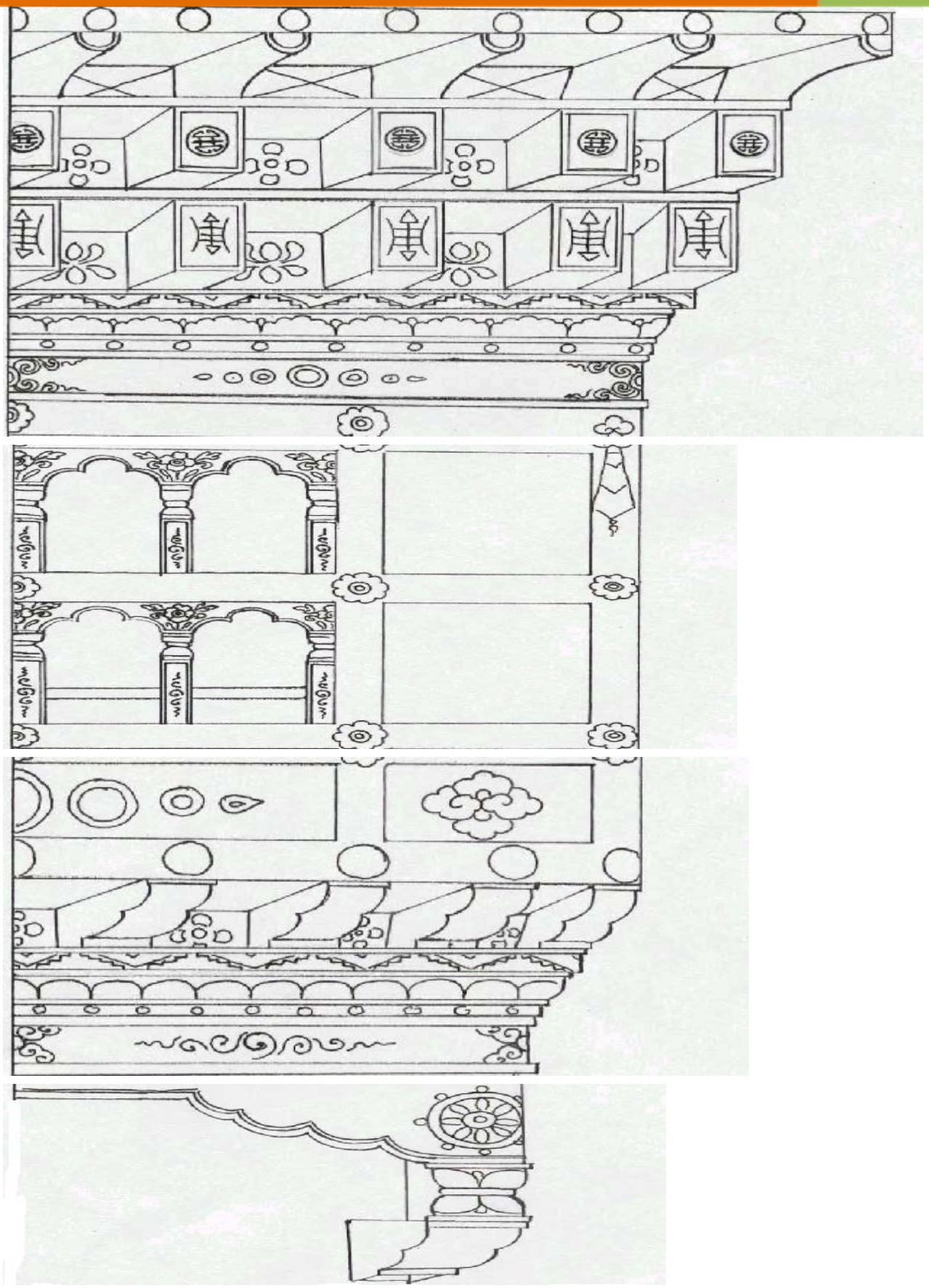


**Figure 5.19.5** Rabsey (Thama)

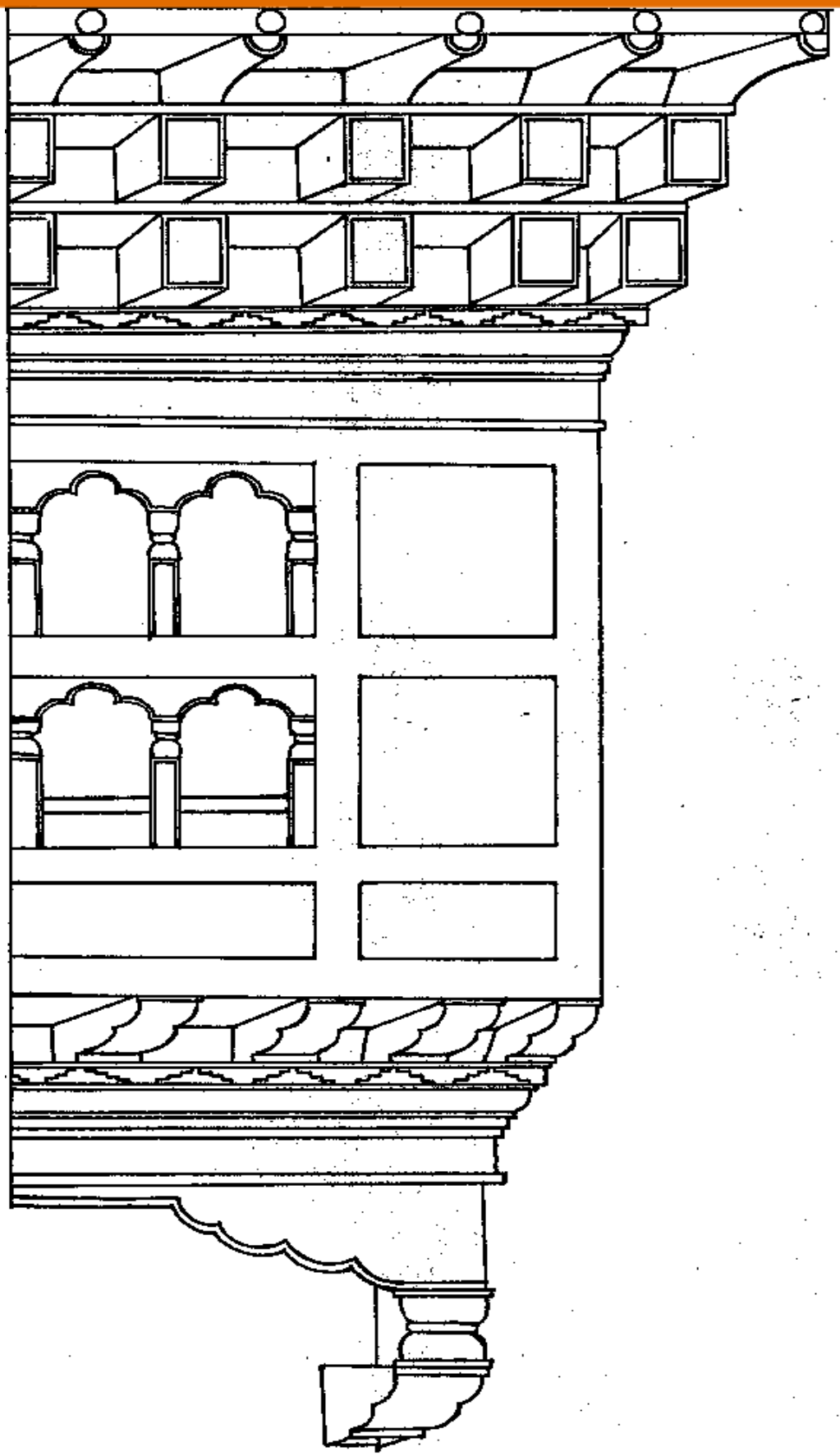


**Figure 5.19.6** Yutshon

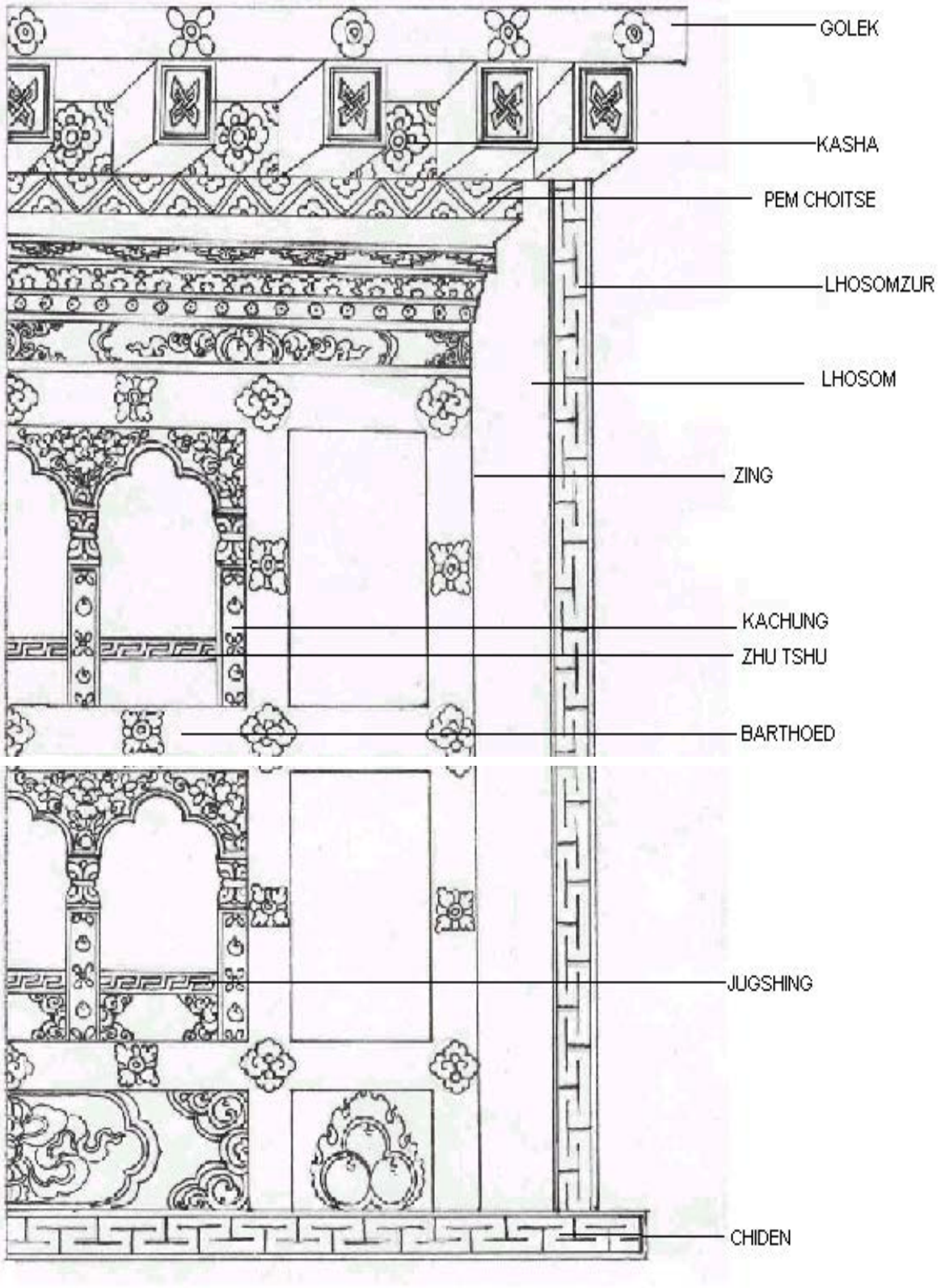



**Figure 5.19.7** Payab (Rab)

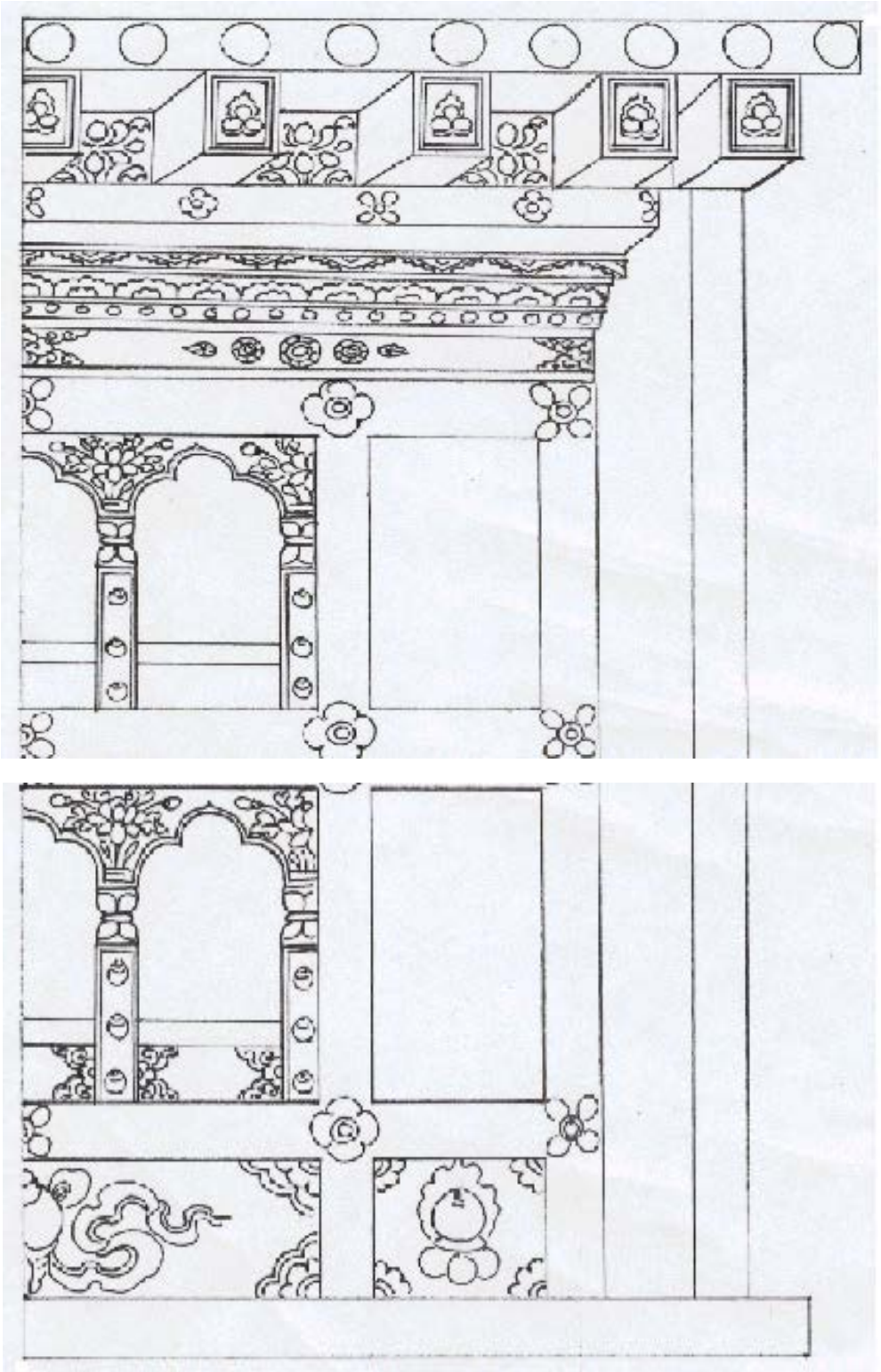


**Figure 5.19.8** Payab (Ding)

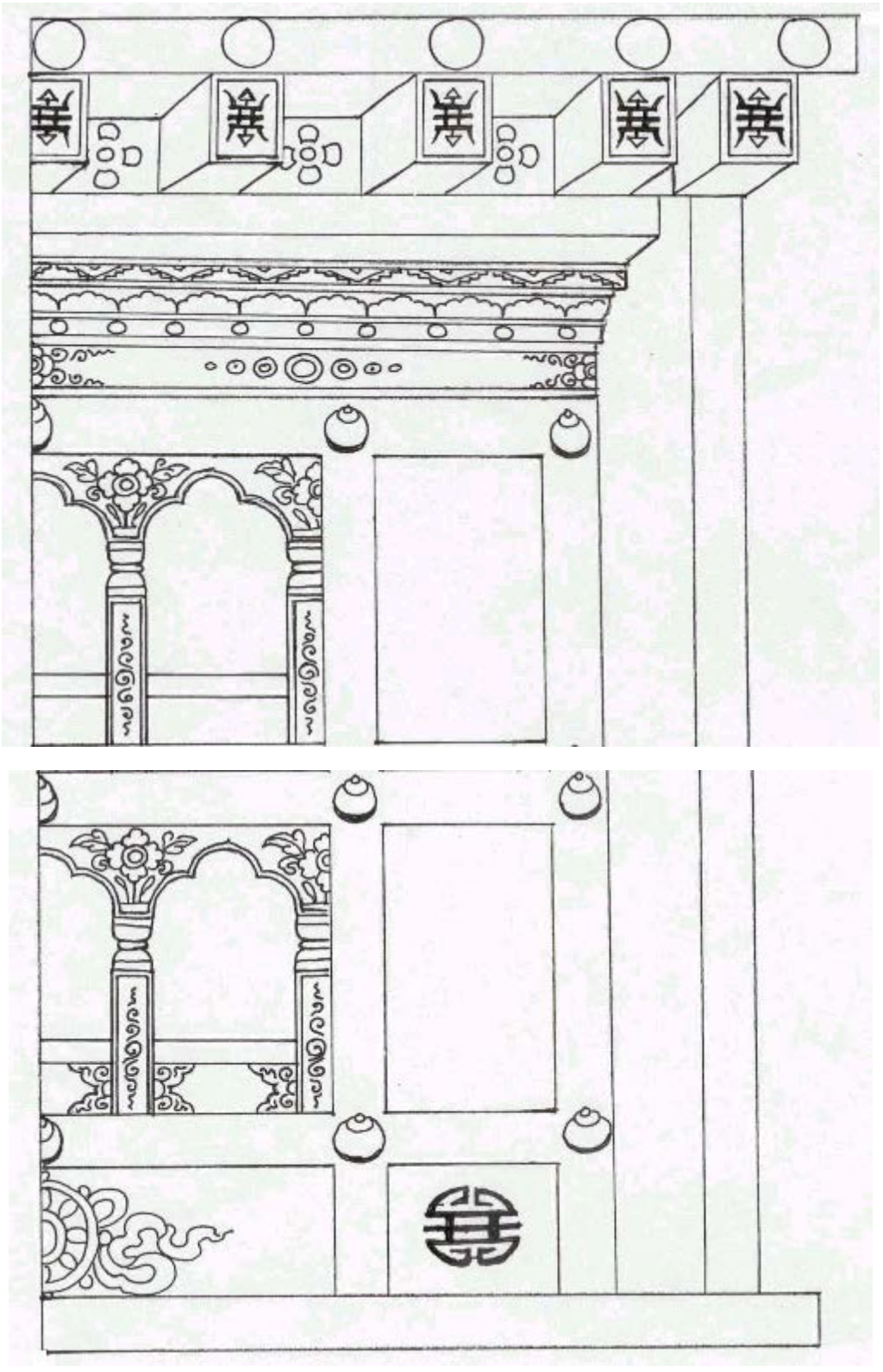


**Figure 5.19.9** Payab (Thama)

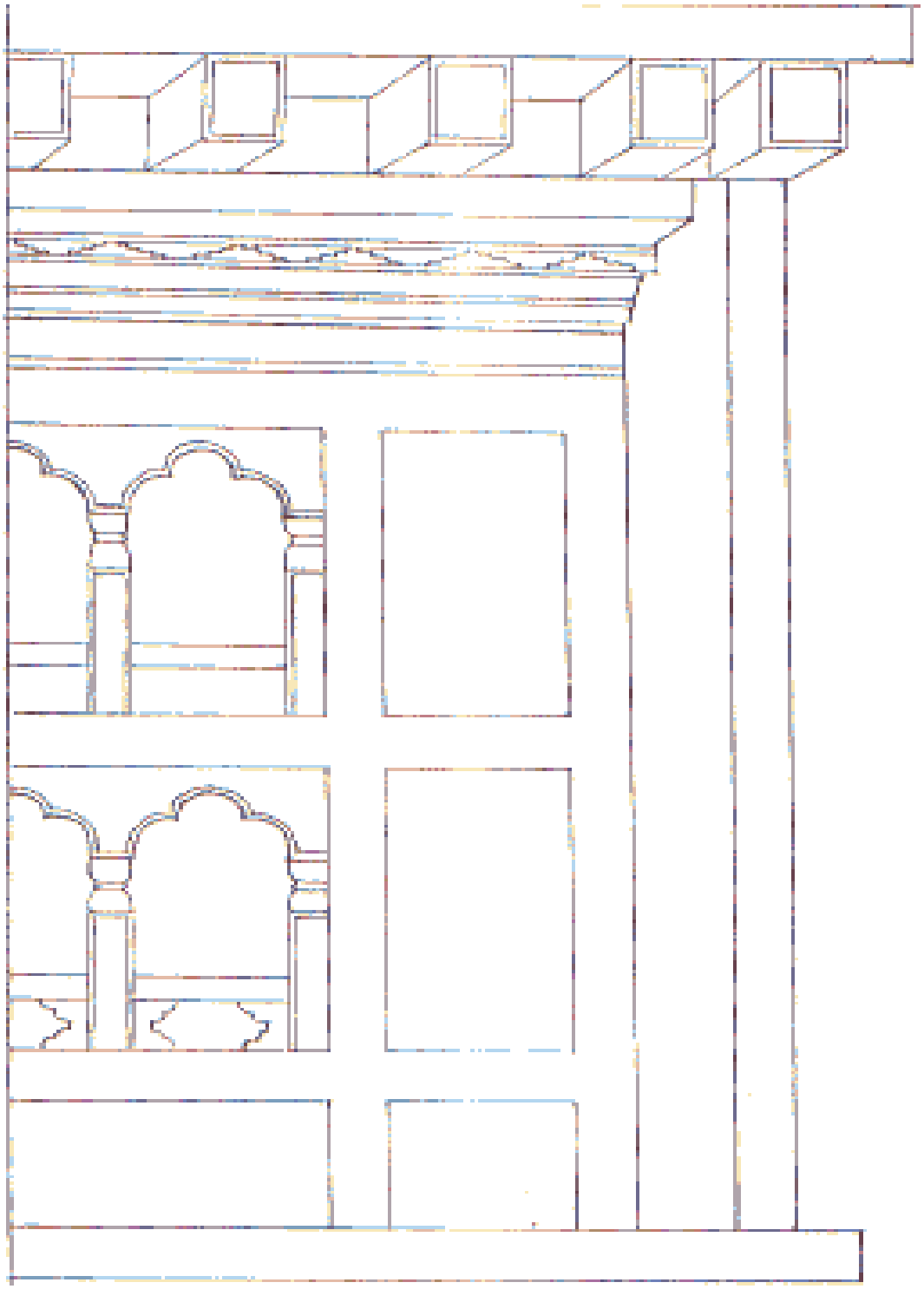


**Figure 5.19.10** Payab (Yutson)

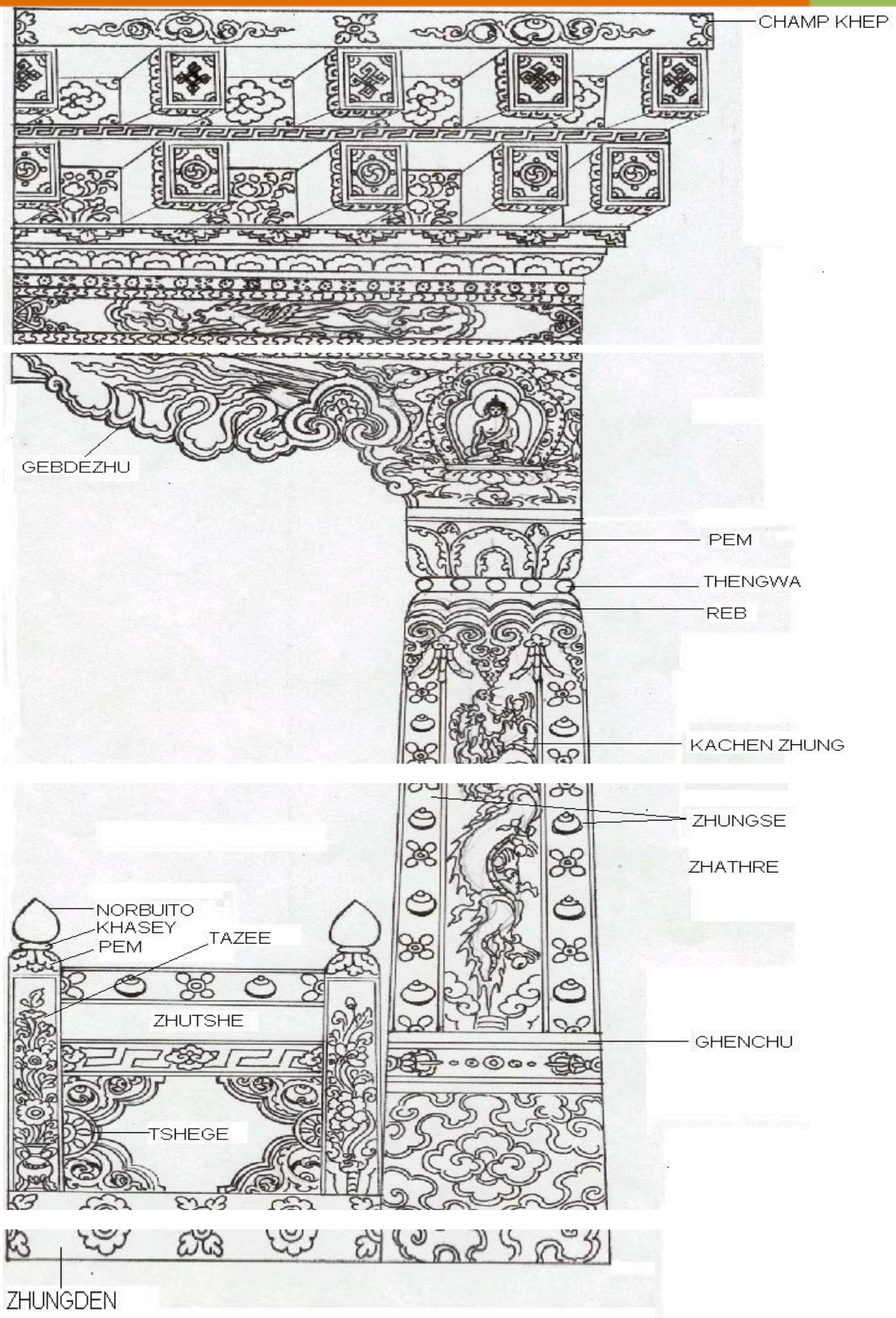



**Figure 5.19.10** Kachen (RAB)

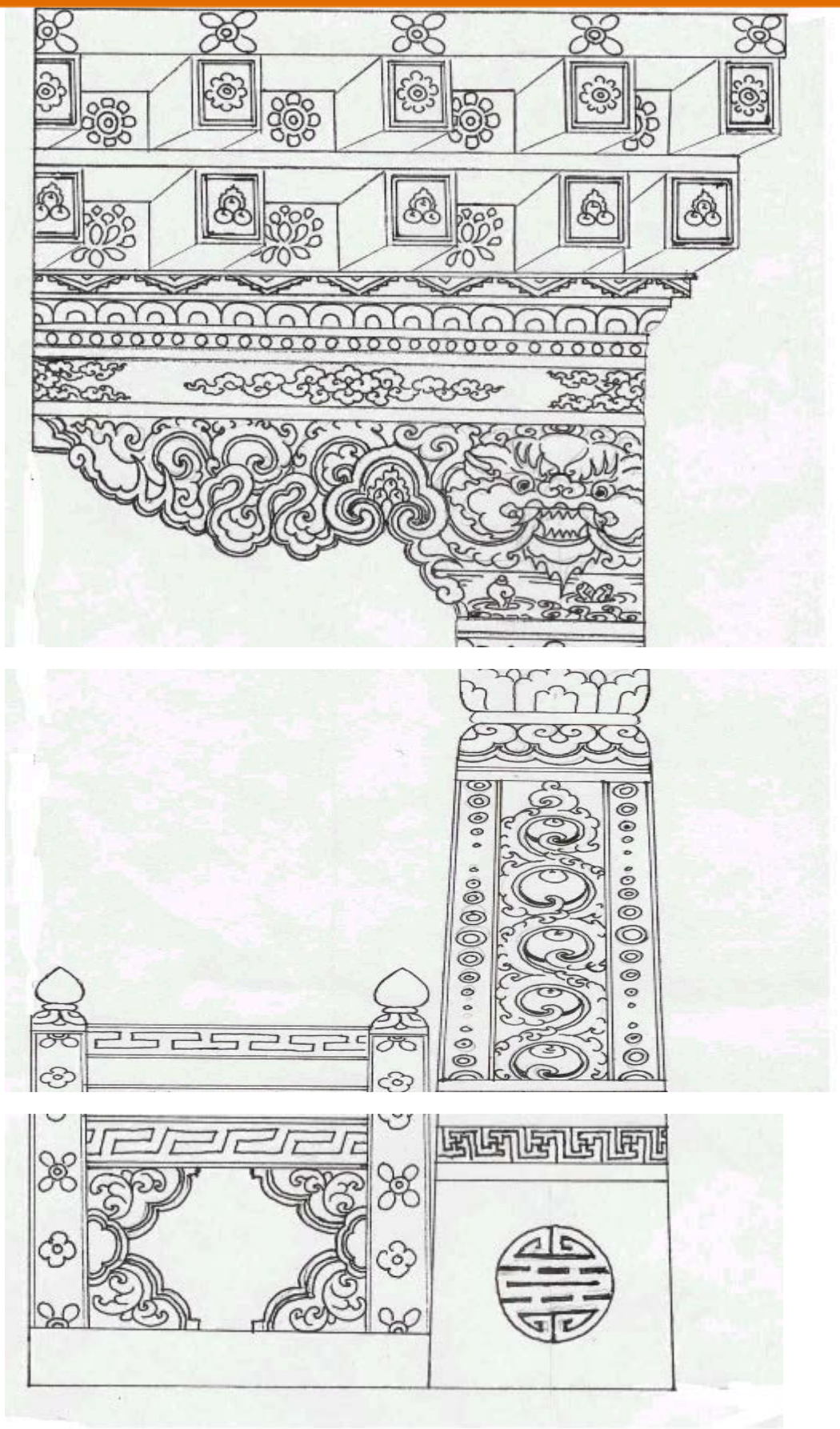


**Figure 5.19.11** Kachen (Ding)

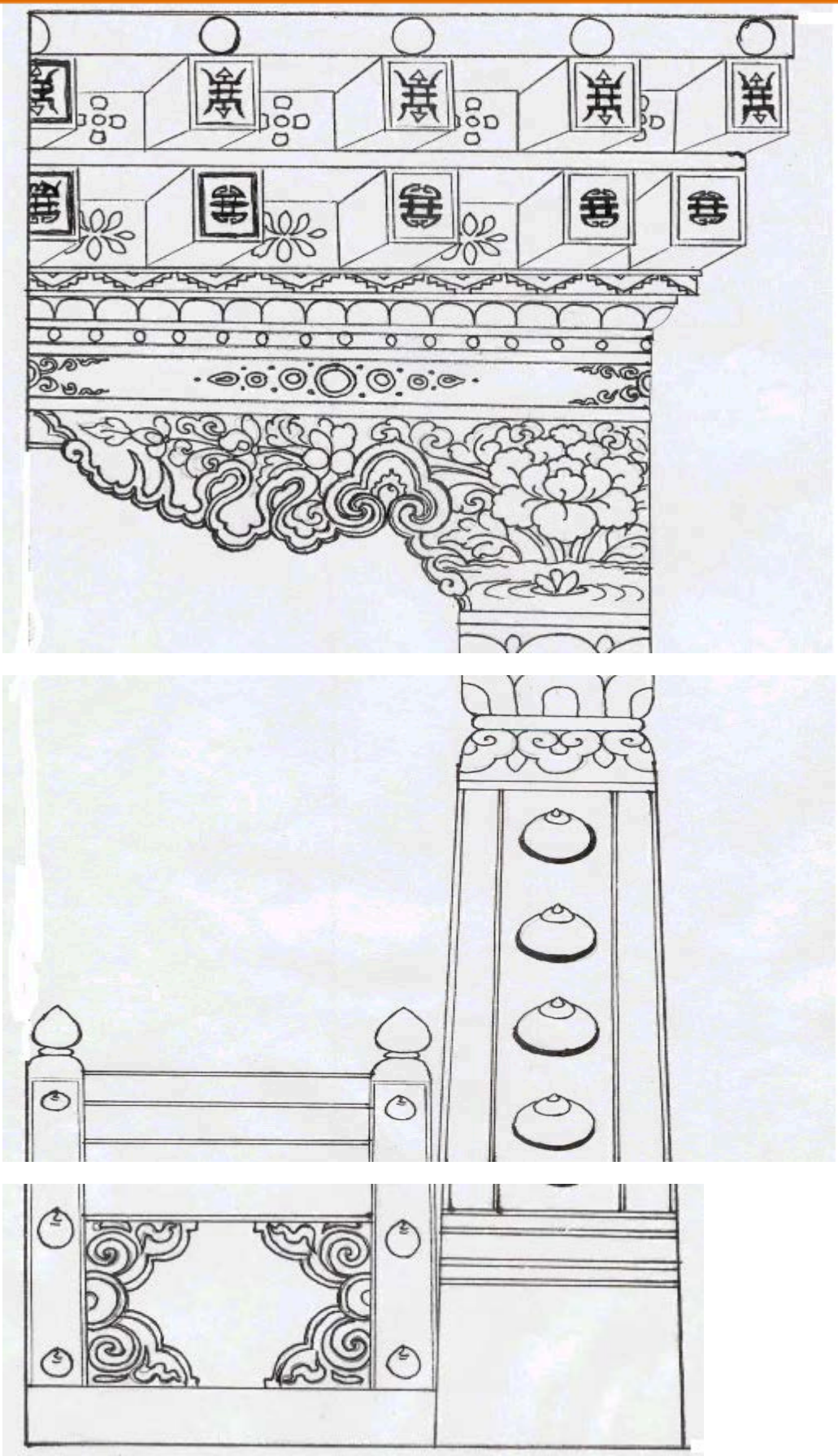


**Figure 5.19.12** Kachen (Thama)

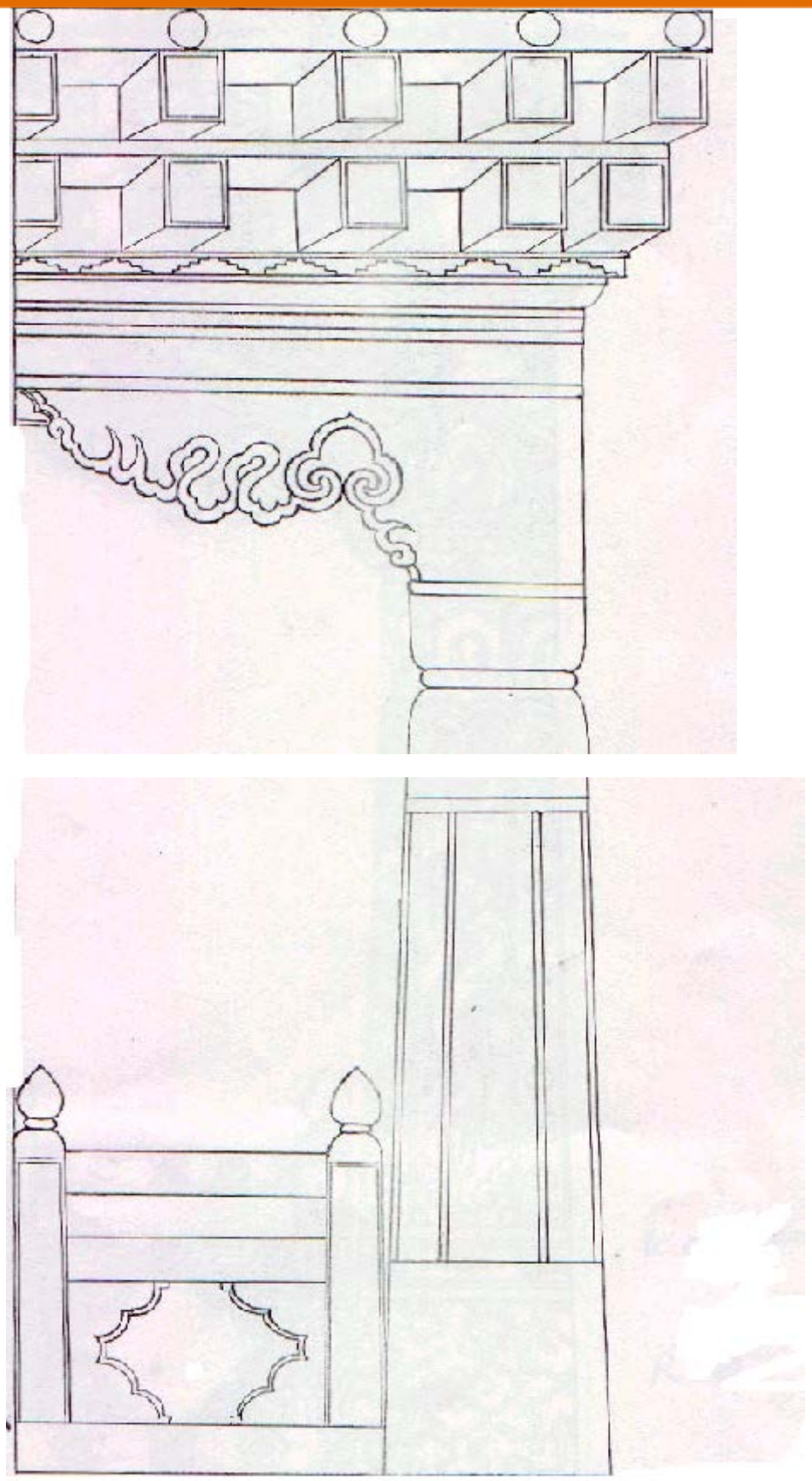


**Figure 5.19.13** Kachen (Yutshon)



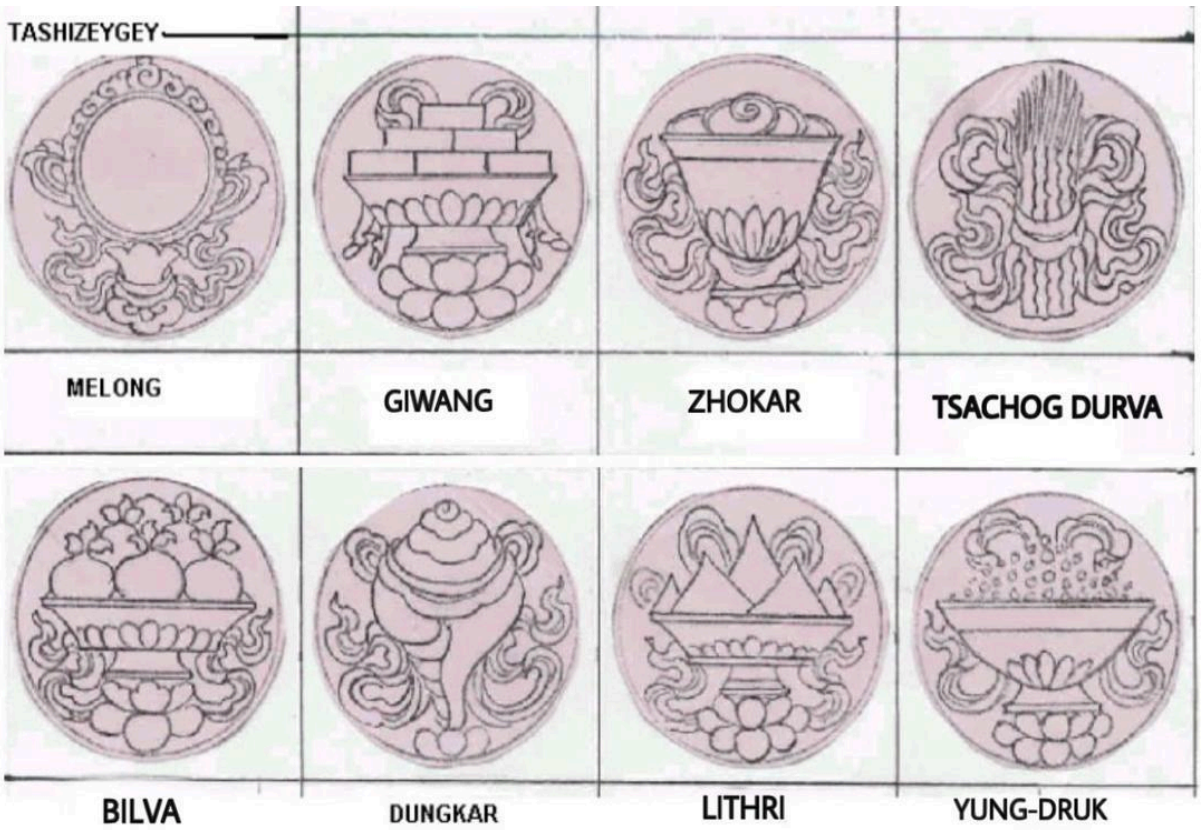




**Figure 5.19.14** Tashi Dzegye

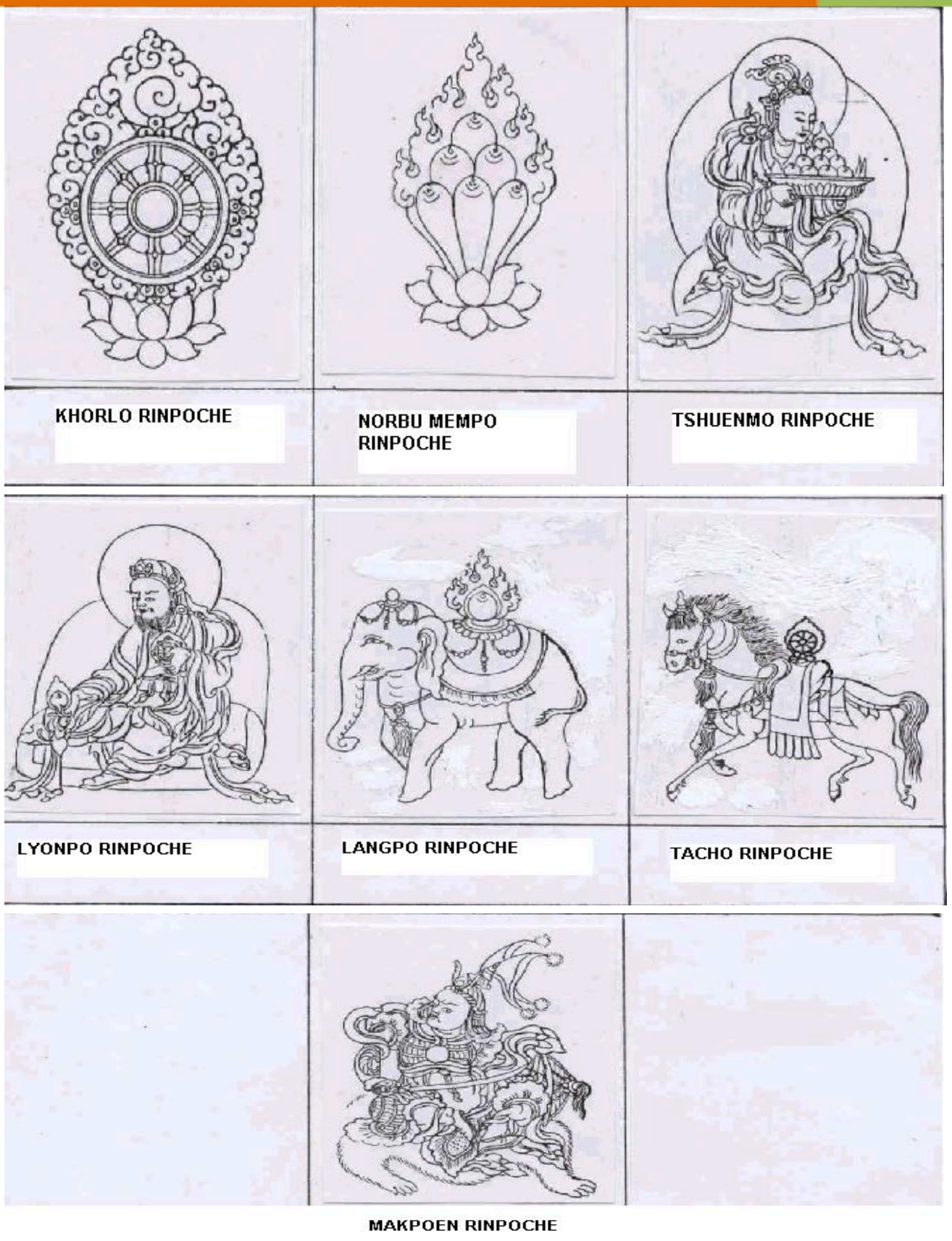



**Figure 5.19.15** Gyelse Nadhuen

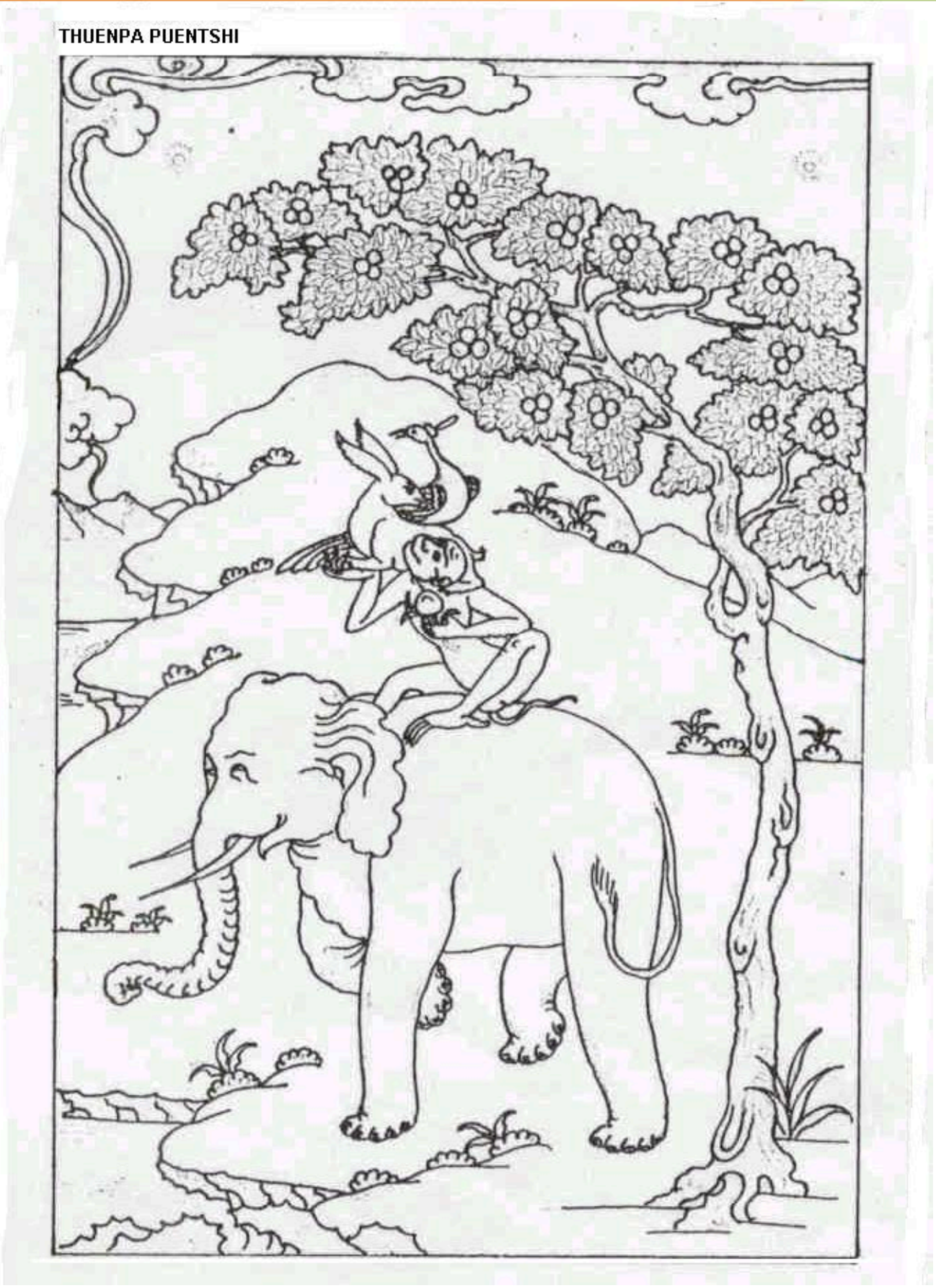



**Figure 5.19.16** Thuenpa Puenzhi

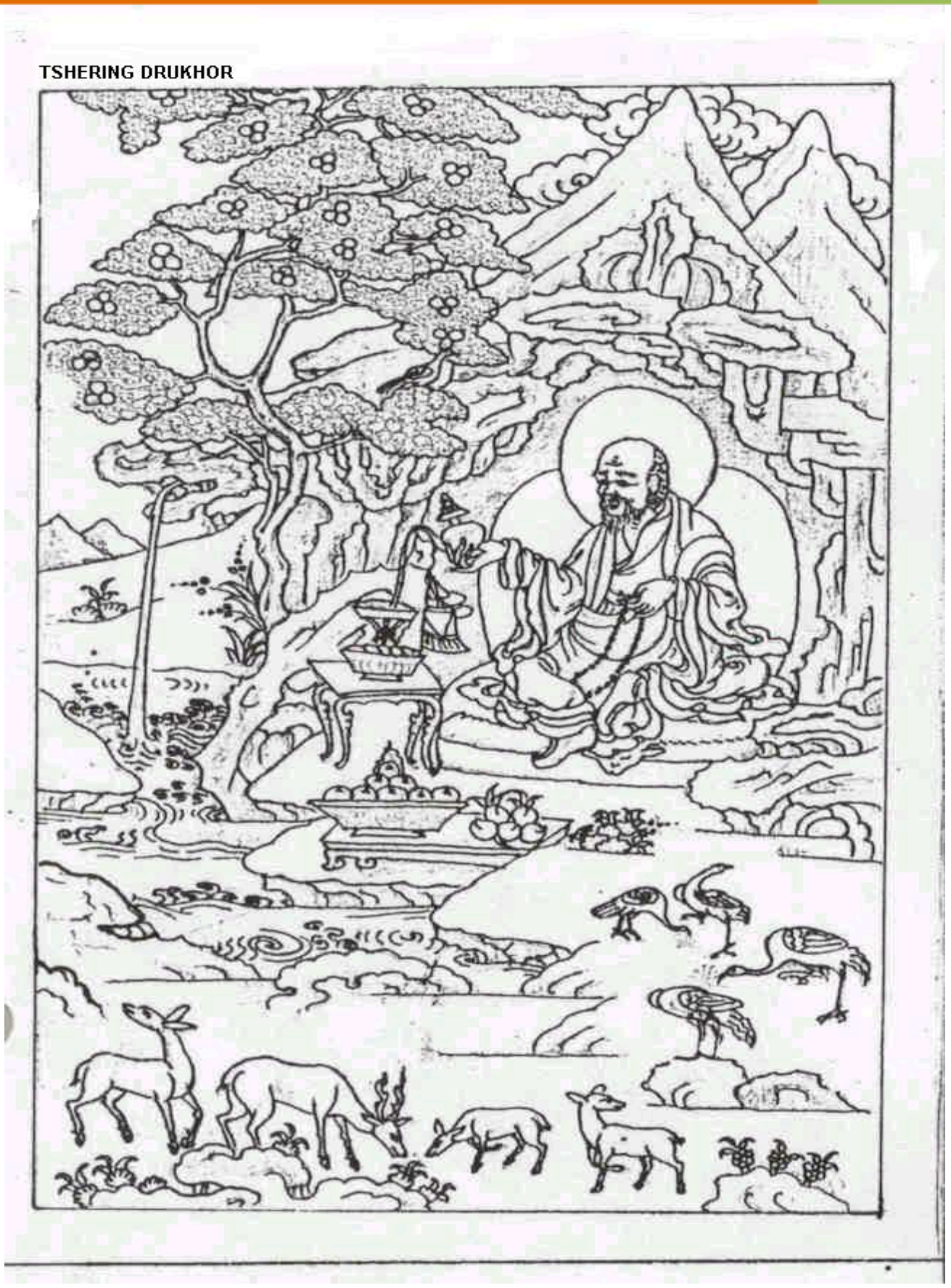



**Figure 5.19.17** Tshering Drukhor

**Preparation of Traditional paint**: Round mud paint (Sa-tshoen) as available in the market shall be put in a tin, filled with water and kept for about 25 to 30 minutes. Water shall then be poured out taking care that the mud ball is not shaken / distributed. When the water is completely drained out, either animal glue or fevicol shall be mixed with the soaked mud ball as follows:

**a) Mixing with animal glue: A**nimal glue and water shall be mixed in the ratio of 1:2 (1 animal glue: 2 water) and boiled until the whole of the glue is melted and it becomes sticky. The prepared gum shall then be mixed with a mud ball already soaked in water in the ratio 1:1 (1 gum: 1 soaked mud) and the paint is ready for painting.

**b) Mixing with fevicol: F**evicol shall be mixed with cold water and stirred well in the ratio 1:1 (1 water: 1 fevicol). The fevicol solution shall then be mixed with mud soaked in water in the proportion of 1:1 and stirred well. The paint is ready for painting.

**Brush for painting:** Selection of brush for painting shall be based on the painters' judgement. For design painting, a round brush is recommended.

**Mud colour:** Four primary mud paint colours are Red, Yellow, White and Black or grey. Supplementary colour, if required may be prepared by mixing the four primary colours as follows:

| | | |
|---|---|---|
| Pink | - | Red and white |
| Green | - | Black/blue and yellow |
| Sky-blue | - | Black and white |
| Aquamarine | - | Black, yellow and white |
| Brown | - | Black and red |

All the above 10 colours shall be used for medium and ordinary painting. The ready-made packet powder colours shall not be used for traditional paintings unless otherwise allowed by the Engineer. For

special painting, a special paint called Chomur or distemper shall be added to the prepared paint to raise the thickness of the design.

**Washable paint:** The following steps shall be followed to prepare the washable paint:

1. Dry mud ball paint shall be ground to fine powder;
2. Fine powder shall be Sieved by a thin cloth;
3. The sieved powder shall then be mixed with synthetic enamel paint in the proportion one litre of synthetic paint with one kilogram of mud powder and kept for about 30 minutes to get a thick paint;
4. A small quantity of turpentine oil shall be added to the thick solution and stirred; and
5. Packet colours shall not be added.

**Precautions:** All furniture, fixtures, glazing, floor etc. shall be protected by covering and stains, smears, splashing, in any shall be removed and any damage done shall be made good by the contractor at his cost.

**Preparation of surface:**

**a) Wooden surface:** The woodwork to be painted shall be dry and free from moisture. The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sandpaper and shall be well dusted. Appropriate filler material shall be used where

specified. The surface treated for knotting shall be dry before painting is applied. Apply two coats of yutshon painting as primer on the surface to be painted.

**b) Iron & Steel Surface:** All rust and scales shall be removed by scraping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling, which becomes loose by rusting shall be removed. All dust and dirt shall be thoroughly wiped away from the surface. If the surface is wet, it shall be dried before the priming coat (yutshon) is undertaken.

**c) Plastered surface:** The surface shall ordinarily not be painted until it has dried completely. Trial patches of primer (yutshon) shall be laid at intervals and where drying is satisfactory, painting shall then be taken in hand. Before primer is applied, holes and undulations shall be filled up with plaster of paris and rubbed smooth.

**Drawing Chapa:** Adjust the paper to the surface to be painted, draw the design on the paper, and prick the lines of the design by a pin. Place the paper back to the surface to be painted and rub the powder soaked cloth on the design paper. When the paper is withdrawn, powder marks are left on the surface, which is to be painted for specified painting. This process is continued for painting the required surface.

**Painting on old surface**: If the old paint is firm and sound, it shall be cleaned of grease, smoke etc. The surface shall then be rubbed down with sandpaper and dusted. Rusty patches, etc shall be cleaned up. If the old paint is blistered and flaked, it shall be completely removed. Chadam (Bangchang + animal glue together) shall be boiled and applied on the surface to be painted. Drawing Chapa shall be the same as for the new work.

**Physical checking:** Physical checking shall be carried out on the quality of painting only after two days after painting. The following steps shall be used as thumb rule to check the quality of the completed works:

1. Rub the surface already painted with palm and feel for smoothness.
2. When rubbed with the palm, the colour should not be seen in the palm. If the colour comes when rubbed, the mixture is not proper and vice versa.

**Applicability**: Generally, the following types of painting shall be applicable against the type of structures specified unless otherwise directed and approved by the Engineer.

I. **Sumdang**:

- Rab painting shall be used in office, Dzong and other important places;
- Ding painting shall be used in institutional buildings such as schools, hospitals, etc.
- Thama painting shall be used in residential, staff quarter, and other similar buildings

II. **Dangtshon:**

- All the three types of paintings (Rab, Ding, Thama) may be used for internal decoration of all types of buildings only and external decoration for Royal cottages

**Measurements:** The length and breadth shall be measured correct to 10 mm. The area shall be calculated in sq.m, correct to two places of decimal. The co-efficient in Table 5.19.1 above shall be applied to the areas measured flat and not girth for all the items listed in the table wherever applicable. For railings either for staircase or balcony, the area shall be measured flat and equivalent area calculated for payment using 0.5 co-efficient for each side.

Measurement of areas for all types of cornices including at lintel level shall be measured flat. Length of the cornices being measured along with junction of wall and cornice (separate measurement for boh, kah, etc. shall not be allowed). For wall decoration design such as *Tashi-tagey symbols, Tashi-Zeegay, Za-Tshering, and alike,* the area shall be measured flat as squire or rectangle and equivalent area calculated for payment using 0.8 as the co-efficient or actual painted area calculated using appropriate method of area measurement.

**Rate:** Rate shall include cost of all labour and materials involved in all the operations described above.




**Figure 5.19.18** Types of Bhutanese traditional painting

## 5.20 Chapter 20: ADDITIONS, ALTERATIONS & REPAIRS

*AA0001 Repair to plaster, patch area < 2.5 sq.m including cutting to shape, surface preparation, proving and applying cement plaster to the surface, disposal of rubbish within 50m lead*

The work includes cutting the patch and preparing the wall surface. Patches of 2.50 sq.m and less in area shall be measured under this item. Plastering in patches over 2.50 sq.m in area shall be paid for at the rate as applicable to new work under head "Plasterer".

**Scaffolding:** Scaffolding as required for the proper execution of the work shall be erected. If work can be done safely with the ladder these will be permitted in place of scaffolding.

**Cutting:** The mortar of the patch, where the existing plaster has cracked, crumbled or sounds hollow when gently tapped on the surface shall be removed. The patch shall be cut out, to a square or rectangular shape at position marked on the wall as directed by the Engineer. The edges shall be slightly under cut to provide a neat joint.

**Preparation of Surface**: The masonry joints which become exposed after removal of old plaster shall be raked cut to a minimum depth of 10 mm in the case of brick work and 20 mm in the case of stone work. The raking shall be carried out uniformly with a raking tool and loose mortar dusted off. The surface shall then be thoroughly washed with water, and kept wet till plastering is commenced. With regard to concrete surfaces, the same shall be thoroughly scrubbed with wire brushes after the plaster has been cut out and pock marked za pointed tool, at spacing of not more than 5 cm centres, the pocks being made not less than 3 mm deep. Pock is being made to ensure proper key for the plaster. The surface shall be washed and cleaned and kept wet till plastering is commenced.

**Application of Plaster:** Mortar of specified mix shall be used. The surface shall be finished even and flush and matching with the old surrounding plaster. All rounding necessary at junctions of walls, ceilings etc. shall be carried out in a tidy manner. All dismantled mortar etc. shall be disposed off as directed by the Engineer.

**Protective measures:** Doors, windows, floors, articles of furniture etc. and such other parts of the building shall be protected from being splashed upon. Splashing and droppings if any, shall be removed by the contractor at his own cost and the surface cleaned. Damages if any to furniture or fittings and fixtures shall be recoverable from the contractor.

**Curing:** Curing shall be as for plasterwork described under the section "Plasterer".

**Finishing:** After the plaster is thoroughly cured and dried the surface shall be white washed or colour washed to suit the existing finishing as required.

**Measurement:** Length and breadth shall be measured correct to 10mm. The area shall be calculated in square metres correct to two places of decimal. Patches below 0.05 square metre in area shall not be measured for payment. Pre-measurements of the patches to be plastered shall be recorded after the plaster is cut and wall surface prepared.

**Rate:** The rate includes the cost of all the labour involved in all the operations described above including lead for disposal of old dismantled plaster.

*- Providing & fixing glass panes with putty, nails including removal of broken glass panes*

*AA0005 3mm thick plain*

*AA0006 4mm thick plain*

*AA0007 5.5mm thick plain*

*AA0008 3mm thick frosted*

*AA0009 5.5mm thick frosted*

**Removing Broken Glass Panes:** Old putty shall be raked out with a hack knife. The brads (small nails without head) and pieces of broken glass shall be removed from the rebates of the sash-bars. The pieces of glass panes as found useful shall be handed over to the Engineer. No glass shall be inserted in frames until they have been primed and prepared for painting so that the wood may not draw oil out of the putty.

**Fixing:** The glass panes shall be so cut that it fits slightly loose in the frame. A thin layer of putty (prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding the boiled linseed oil to the mixture to form into a stiff paste) shall be drawn along the inner edge of the rebate, for bedding the back of the glass pane. The glass pane shall then be put in position, pressed home against the thin layer of the putty, and secured in rebate by new brads. The brads shall not be spaced more than 7.5 cm from each corner and not more than 15 cm apart. The putty shall then be applied in the rebate uniformly, sloping from the inner edge of the rebate, in doing this care shall be taken, to keep the putty a little within the inner edge of the rebate and surplus putty removed so that none of it may show through the glass from the inside. The putty so filled in the rebates shall be levelled smooth and finished in a straight line. When dried the putty shall be covered with a coat of paint of approved quality and shade to match the existing, finishing of joinery work. The glass panes shall be cleaned with methylated spirit. All splashing or dropping of washing and paints shall be removed. All rubbish and unserviceable materials shall be disposed of to the dumping ground.

**Measurement:** Length and breadth of glass panes shall be measured correct to 10mm. The area of the glass panes as fixed shall be calculated in square metre correct to two places of decimal.

**Rate:** The rate shall include the cost of labour and materials involved in all the operations described above.

*AA0015 Cutting holes < 300x300mm in brick walls including repair of wall*

Due care shall be taken while cutting the holes, not to disturb the adjoining masonry and the masonry under the bearings of lintels and arches etc. spanning the holes. Special care shall be taken when holes are made in load bearing pillars or wall portions separated by openings to ensure that beams etc. supported by them are properly propped up. In such portions cutting holes shall be done on one side at a time. The sides of holes shall be truly paralleled and perpendicular to the plane of the wall. The holes shall be cleaned of all dust, mortar and brickbats or stone pieces and thoroughly wetted.

**Measurement:** The holes shall be counted in numbers.

**Rate:** The rate shall include all labour and tools involved in the operation described above.

*AA0016 Cutting holes < 150x150mm in R.C. floors or roof including making leak proofing with concrete 1:2:4, 20mm aggregate*

The cutting of holes shall be done carefully. If any reinforcement is seen in the hole, the same shall be cut if so desired by the Engineer. The cuttings should be done without damaging the adjacent portions of the slab. After the cutting is over, loose chips and dirt shall be removed and watered. After insertion of pipe etc. the hole shall be repaired with C.C. 1:2:4. The top and bottom shall be finished to match the adjoining finish.

**Measurement:** The holes shall be enumerated.

**Rate:** The rate shall include all materials, labour and tools involved in all operations described above.

*AA0017 Making chases < 75x75mm in walls including repair after fixing G.I. pipe etc.*

The work shall be done carefully without causing any damage. After cutting the chase the same shall be cleaned and watered. After insertion of the pipe etc., the chase shall be repaired with the same mortar used in plastering and the surface finished smooth to match the surface. The surface shall be white or colour washed as required.

**Measurement:** The chase cutting shall be measured in running metres correct to one cm.

**Rate:** The rate shall include all labour and materials involved in above operation.

- *Providing & fixing Aluminium strip edging to staircases including rawl plugs and screws, a thin layer of cement mortar 1:3*

*AA0025 57mm x 12mm x 3mm*

*AA0026 38mm x 12mm x 3mm*

The size and shape of the strip shall be as specified.

**Fixing:** A suitable recess shall be provided in the step both in the tread and riser portions to receive the edging so that after fixing the top surface of the edging and the top surface of the stair tread shall be perfectly in one level. Similarly, the outer face of the vertical leg shall be flush with the surface of the riser.

The strips shall be fixed after the finish of the treads/risers is complete. Recess to receive the strip shall be thoroughly cleaned of all foreign material, mortar droppings etc. It shall then be given a thin layer of cement mortar 1:3 (holes shall be drilled in the portion of edging coming in the concrete tread). The edging shall be kept in position, gently tapped to seat it in the mortar and fixed in position with screws of 25 mm size. After the mortar is set and work is complete, no hollow sound shall emanate when the edging is tapped.

**Measurement:** The edging will be measured in metres correct to 3 mm.

**Rate:** The rate shall include all labour and materials involved in above operation.

# 5.21 Chapter 21: ROAD WORKS

## 5.21.1 General

### 1. Introduction

These specifications cover the construction of the Works, as shown in the Bill of Quantities, Drawings and in the General Conditions of Contract, and shall be read in conjunction with all other contract and tender documents including the Environmental Codes of Practice.

### 2. Scope of Works

The work to be carried out under the Contract is as specified in the contract data and drawings and shall include the following:

- **Earthwork**
- **Structures**
- **Permanent works**
- **Base course/layer works**
- **Water Management & slope stabilisation including Bio-Engineering.**

All works shall be undertaken on the basis of an item rate contract.

### 3. Quality of Materials and Workmanship

The materials and workmanship shall be of the best of their respective kinds and shall be to the approval of the Employer or his representative on Site, the Engineer. In reading these Specifications, the words to the approval of the Engineer shall be deemed to be included in the description of all materials incorporated in the works, whether manufactured or natural, and in the description of all operations for the due execution of the works.

All works or parts thereof shall be in accordance with the latest edition of the Indian Standards (IS), or International Standards Organisation (ISO) Specification and the Environmental Codes of Practice (ECP), Highways and Roads.

The contractor shall carry out modifications in the procedure of work, if found necessary, as directed by the Engineer during inspection. Substandard quality of work shall be rectified/redone by the contractor at his own cost, and defective work/material shall also be removed from the site of works by the contractor at his own cost.

The Engineer may ask to carry out the field/Laboratory tests mentioned in the specification and the cost of carrying out such tests which include equipment charges, tools, materials, labour and incidentals to perform tests and other operations of quality control according to the specification requirements shall be deemed to be incidental to the work and no extra payment shall be made for the same. Sampling and testing procedure to be used shall be as approved by the Engineer and his decision shall be final and binding on the contractor.

### 4. Equivalency of Standards and Codes

Wherever reference is made in the Contract to specific standards and codes to be met by the goods and materials to be furnished and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly stated in the Contract. Where such standards and codes are

national, or relate to a particular country or region, other authoritative standards that ensure a substantially equal or higher quality than the standards and codes specified will be accepted subject to the Engineer's prior review and written consent. Differences between the standards specified and the proposed alternative standards shall be fully described in writing by the Contractor and submitted to the Engineer at least 28 days prior to the date when the Contractor desires the Engineer's consent. In the event the Engineer determines that such proposed deviations do not ensure substantially equal or higher quality, the Contractor shall comply with the standards specified in the documents.

All materials shall be of approved manufacture and origin, equal to sample and delivered to the site a sufficient period before they are required to be used in the works to enable the Contractor to take such samples as the Engineer may require for testing or approval, and the Contractor shall provide any information required by the Engineer as to the quality, weight, strength, constituents, description, etc., of the materials.

No materials of any description shall be used without prior approval by the Engineer and any condemned as unfit for use in the works, shall be removed immediately from the site by, and without recommendation to, the Contractor.

If these specifications do not cover these items then the relevant IS codes shall be applicable. Where no reference is found in the above specifications for an item of work then sound engineering practice as decided by the Engineer shall be applicable and the decision of the Engineer in respect to all such matters relating to specifications shall be final and binding on the contractor.

**5. Temporary Roads and Traffic Control**

The Contractor shall provide, maintain, remove and bring back in original condition on completion all temporary roads, bridges and other work required for the construction of the works including access to quarries, borrow-pits, accommodation, etc. All temporary access facilities need to be kept trafficable (for 4WD cars) during the construction and liability period in order to monitor the construction activities and to assess maintenance requirements during the Defects Liability Period.

The Contractor shall provide and allow in his rates for all necessary temporary traffic control signs, barricades, beacons, flagmen, lighting and watching required for the normal control of traffic.

**6. Signboards**

The Contractor shall erect signboards in prominent positions adjacent to the works to the satisfaction of the Engineer.

**7. Office for Contractor**

The Contractor shall erect an office near the works at the site to be approved by the Engineer. The office shall be kept open all hours during which the work is in progress. The standard of the contractor's Office shall be at least as described in the Project Office/accommodation below, the space and the size shall depend upon the contractor's requirement.

Any notice to be given to or served upon the Contractor shall be deemed and taken to be effectually given or served upon by the delivery thereof at such office.

**8. Project Office/accommodation**

The contractor shall construct and furnish Project Office/accommodation for the use by the Department and Technical Assistant team as per the enclosed drawings. The accommodation shall be reasonable and economic with materials specified in the drawings. Local materials shall be used as far as possible with good workmanship. The Office site shall be identified by the Engineer. The contractor shall construct and hand over the said office within 3 months after the award of the work. The Office shall remain as the property of the Department of Roads after completion of the work for future use. The contractor shall arrange to maintain the site office, furniture and watch & ward of the site office compound during the day & night time until the issue of taking over certificate for the complete work. The contractor cannot claim any materials after it is handed over to the Engineer. Nothing extra shall be paid for this work; therefore the contractor shall keep this provision in his rates in the BoQ items for other works.

**9. Environmental Management Plan**

The Contractor's bid shall contain an Environmental Management Plan, where the Contractor explains how the site shall be organized, how he shall proceed with the works, and how the activities shall be executed to comply fully with the rules explained in the Bhutanese Environmental Codes of Practice.

**10. Classification of material**

(a) All Kinds of Soil: Generally any strata, such as sand, gravel, loam, clay, mud, black cotton moorum, shingle, river or nallah bed boulders, soiling of roads, paths etc. and hard core macadam surface of any description (water bound, grouted tarmac etc.), lime concrete, mud concrete and their mixtures which for excavation yields to the application of picks, shovels, jumpers, scarifiers, ripper and other manual digging implements.

(b) Ordinary Rock: Generally any rock which can be excavated by splitting with crow bars or picks and does not require blasting, wedging or similar means of excavation such as lime stone, sand stone, hard laterite, hard conglomerate and un-reinforced cement concrete below ground level.

If required light blasting may be resorted to, for loosening the materials but this will not in any way entitle the material to be classified as "Hard Rock"

(c) Hard Rock : Generally any rock or boulder for the excavation of which blasting is required such as quartzite, granite, basalt, reinforced cement concrete ( reinforcement to be cut through but not separated from concrete) below ground level and the like.

(d) Hard Rock ( blasting prohibited) : Hard rock requiring blasting as described under (c) but where the blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging or any other agreed method

(e) Marshy Soil: This shall include soils like soft clays and peat excavated below the original ground level of marshes and swamps and soils excavated from other areas requiring continuous pumping or bailing out of water.

**Authority for classification:** The Engineer or his representative shall decide the classification of excavation and his decision shall be final and binding on the contractor. Merely the use of explosives in excavation shall not be considered as a reason for higher classification unless

blasting is clearly necessary in the opinion of the Engineer. All the above-mentioned blasting shall be controlled blasting as described in the 'use of explosives and blasting' under excavation. All excavation shall be deemed to be ordinary soil until agreed upon the classification with the Engineer. The contractor shall immediately upon encountering the different types of soil shall inform in writing to the Engineer for the request for classification.

### 5.21.2 Earthwork

#### 5.21.2.1 Definitions and Use of Earthwork Materials

**1. Definitions**

The following definitions of Earthwork Materials shall apply to this and other clauses of the Specifications in which reference is made to the defined materials:

**Topsoil**

It shall mean the top layer of soil (thickness approximately 200 mm) that is of a fertile composition and can support vegetation growth. It shall include all turf, which has been cut too long to be acceptable for turfing (bioengineering).

**Suitable Material**

It shall comprise all that which is acceptable such as moorum, sandy gravels, hard stones etc., in accordance with the technical specification for use in the Works and which is capable of being compacted to form a stable fill having side slopes as indicated in the Drawings.

**Unsuitable Material**

It shall mean other than suitable material and shall include:

a. Material from swamps, marshes or bogs;
b. Peat, logs, stumps and Perishable Material;
c. Material susceptible to spontaneous combustion;
d. Soft or loose boulders which does not meet the technical specification
e. Material in a frozen condition; Materials classified as such, if otherwise suitable, shall be classified as suitable when unfrozen;
f. Clay of liquid limit exceeding 80 and/or plasticity index exceeding 55;
g. Materials having moisture content greater than the maximum permitted for such materials in the Contract, unless otherwise permitted by the Engineer.

**Rock**

It shall mean masses of hard material, which necessitate the use, or partly use, of blasting for their removal.

**Rock Fill**

It shall consist of hard material of suitable size for deposition and compaction and may comprise rock as defined above, broken stone, hard brick, concrete or other comparable hard inert material.

**Soft Material**

It shall mean suitable material with the exception of rock fill.

**Cohesive Soil**

It includes clays and marls with up to 20% of gravel and having a moisture content not less than the value of the plastic limit (determined in accordance with IS 2720, Part V); also chalk having a saturation moisture content of 20% or greater.

**Well Graded Granular and Cohesive Soils**

They include clays and marls containing more than 20% of gravel and/or having moisture content less than the value of the plastic limit (determined in accordance with IS 2720, Part V); Well graded sands and gravels with a uniformity coefficient exceeding 10; chalk having a saturation moisture content within the range 15-20% and all shale, clinker ash, and approved spent domestic refuse.

**Uniformly Graded Material**

It includes sands and gravels with a uniformity coefficient of 10 or less, and all silts and pulverized fuel sheds. Any soil containing 80% or more material in the particle size range 0.06-0.002 mm will be regarded as silt for this purpose.

**2. Use of Earthwork Materials**

The use of *topsoil* shall be restricted to surface layers in positions not subject to loading by pavements or structures.

Unless otherwise described in the Contract, *turf* not required for re-laying and all *topsoil* shall be removed from the areas of cuttings, and unless surplus to requirements, stockpiled for re-use for the soiling of slopes of cuttings and embankments, shoulders, verges, central reserves and for provision of beds for the cultivation of trees and shrubs.

The Contractor shall make his own arrangements for the *stockpiling* of topsoil and/or suitable material and for the provision of sites for the purpose.

No excavated *suitable material* other than surplus to requirements of the Contract shall be removed from the site except on the direction of the Engineer who may require material, which is unsuitable only by reason of being frozen to be retained on site in that condition. Should the Contractor be permitted to remove suitable material from the site to suit his operational procedure, then he shall make good at his own expense any consequent deficit of filling arising there from.

If any *suitable material* excavated at site is, with permission of the Engineer, taken by the Contractor for purposes other than the forming of embankments and other areas of fill, sufficient quantities of suitable filling material to occupy after full compaction a volume corresponding to that which the excavated material occupied, shall, unless otherwise directed by the Engineer, be provided by the Contractor from his own resources.

Suitable material and top soil *surplus* to the total requirements of the works, and all *unsuitable material*, shall, unless the Engineer permits otherwise, be transported to spoil disposal sites as indicated on the Drawings or directed by the Engineer.

Where the excavation reveals a *combination of suitable and unsuitable materials* the Contractor shall, unless otherwise agreed by the Engineer, carry out the excavation in such manner that the suitable materials are excavated separately for use in the works without contamination by the unsuitable materials. Suitable materials stacked on the road side shall

be allowed to be used for the works. However, the contractor shall not be allowed to lift the suitable materials from the project sites.

#### 5.21.2.2 Excavation

**1. General**

All excavations shall be carried out to such lengths, depths and inclinations as are shown on the Drawings or as may be ordered by the Engineer.

The Contractor shall open up excavation sites in stages as ordered by the Engineer. No further excavation works shall commence until the Engineer has inspected and approved the completed excavation site.

All excavations shall be carried out by excavator, unless otherwise indicated by the Engineer.

The Contractor shall take all precautions necessary to preserve the material or existing structures below and beyond any line of excavation in the soundest possible condition.

Any damage to the Works due to the Contractor's operations, including shattering of material and existing structures beyond the required excavation lines, shall be repaired at the expense of and by the Contractor. Any and all excess excavation for the convenience of the Contractor for any purpose or reason, except as may be ordered in writing by the Engineer, and whether or not due to the fault of the Contractor, shall be at the expense of the Contractor. Where required to complete the work, all such excess excavation and over-excavation shall be filled and compacted with suitable material supplied and placed at the expense of and by the Contractor.

All excavation shall be carried out during dry weather. The Contractor shall supply and operate all necessary pumping plants to remove all water from any source whatsoever which may enter the excavation whether these are in progress.

If excavations are carried out within 5 m of buildings, the Contractor shall execute the work in a way that will minimize damage and disturbances. In general, vertically sided excavation will be required in such places and all necessary timbering or other support shall be provided. Under-excavation of excavation sides will not be permitted.

Excavations shall be finished to the lines and dimensions shown on the Drawings or directed by the Engineer.

The Engineer reserves his right to direct the Contractor as to the lengths of trenches or parts of bulk excavations, which may be opened at any one time.

In the case of excavations likely to cause interference to the public, the Contractor shall organise his operations in such a way as to reduce to a minimum the interval between opening up and back-filling the excavations.

Prior to the commencement of any excavation, the Contractor shall satisfy himself as to the circumstances at the site and of all the various materials, obstructions, strata, water streams including the possibility of floods, etc., and of all other items and things liable to affect or be encountered in the excavations necessary for the proper construction of the works. The rates entered in the Bill of Quantities shall provide for these circumstances.

Cutting work shall be executed true to levels, slope, shape and pattern as per the drawing or as indicated by the Engineer. The sides of excavation shall be dressed or trimmed and bottom shall be levelled or graded and rammed as directed by the Engineer. Under no

circumstances shall undermining or under cutting be allowed during excavation, the contractor shall maintain the natural/man-made drainage of the area.

When the cutting has reached the formation width the contractor shall immediately construct and maintain V-shaped temporary earth drain of size 600mm wide and 500mm deep as per the drawing. No extra payment shall be made for the construction and maintenance of the drain, the rate shall be deemed to be covered by excavation of road formation/trace/box cutting.

**1. Manual Excavation:**

- *Earth work in excavation over areas, exceeding 300 mm in depth 1.5 m in width as well as 10 sqm. On plan, including disposal of excavated earth, (disposed earth to be levelled and neatly dressed).*

*RW0007* *All types of soil*

*RW0008* *All types of rock with or without blasting*

*RW0009* *All types of rock requiring blasting*

*RW0010* *All types of rock requiring chiseling (where blasting is prohibited)*

**2. Excavation by Excavator**

- *Excavation of road formation/trace/box cutting, with rock breaker including separate deposition of soil, rocks and stones within 50m for reuse*

*RW0011* *All types of rock*

- *Excavation of road formation/trace/box cutting, with excavator including separate deposition of soil, rocks and stones within 50m for reuse.*

*RW0013* *All types of soil*

*RW0014* *All types of rock*

**Excavation in different types of soil/rock**

The Contractor shall notify the Engineer on each occasion when he considers that he is entitled to payment for excavation of rock and shall not fill in any rock excavation until it has been inspected by the Engineer and the excavated material has been classified into ordinary rock or hard rock.

In case of excavation by earthmoving machinery/equipment, only two categories of soil shall be classified, which are:

1. All Types of soil: Excavation by equipment where no blasting is required
2. All types of rock : Excavation by equipment where blasting is required

Similarly the contractor shall notify the Engineer in writing when he encounters the excavation in hard soil for inspection and classification of excavation by the Engineer. Unless the contractor informs the Engineer in advance and the type of soil is classified all excavation shall be deemed to be ordinary soil and shall be paid at the rate only.

No payment for excavation of rock shall be made unless the Engineer has inspected the excavation and certified in writing the quantities involved.

**Use of Explosives and Blasting**

Training: All blasting works shall have to be carried out exclusively in a controlled manner. It has been experienced that the blasters do not have adequate knowledge on control blasting. Therefore the contractor shall make arrangements to organise control blasting training for a period of one week before starting the blasting operation.

The contractor shall prepare the site for practical demonstrations and training, make arrangements of all equipment and explosives well in advance and inform the Engineer at least two weeks in advance after finalizing the date. The Department of Roads will provide the resource person and the contractor shall make arrangements for accommodation and logistics for the resource person. The contractor shall have provision included in the contract to meet the above expenses and nothing extra shall be paid.

On any work requiring the use of explosives, the Contractor shall employ blasters experienced in controlled blasting and these blasters must be in possession of a current blasting certificate or should recently have participated in a training for Controlled Blasting organised by the Department of Roads.

The purchase, transport, storage and use of explosives shall be carried out in accordance with DoR "Blasting Manual" [Reini Schrämli, Switzerland, 1999], which is available at DoR Head Office and the by-laws issued by the Ministry of Home and Cultural Affairs and the Contractor shall allow in his rates for excavation and quarrying for all expenses incurred in meeting these requirements, including the provision of suitable stores.

Blasting operations shall be carried out in a controlled manner, as bench blasting using detonating cords of 5, 10 and 40gm/m depending upon the site requirements without overcharging the holes and in advance by the Engineer approved drilling pattern. Delay detonators of delay time of 20 milliseconds shall be used to increase the interval of blasting between two rows of holes. No blasting shall be carried out without using delay detonators. To attain the maximum output, the size of the hole shall be drilled appropriately with different rod size, for 3 feet 34mm dia, 5 feet 32mm dia and for 8 feet 30mm dia. The minimum capacity of the compressors shall be 7.50 cum of air/min. for two jack hammers. Blasting shall take place with as little interference as possible to traffic or persons. Shot hole blasting is not allowed except when explicitly approved as an exception by the Engineer. The rates shall include for all flagging, watching, barricades and clearance of debris, and the Contractor shall take all precautions for the protection of persons, properties and the Works.

For horizontal drilling the contractor shall have a minimum of two pusher legs.

Slopes shattered or loosened by blasting shall be taken down at the expense of and by the Contractor.

The Contractor's controlled blasting and other operations in excavation shall be such that they will yield as much material as possible suitable for use in the Works. The Contractor shall limit falling down of blasted material along the valley slope to the maximum. The Contractor shall in this respect take all measures reasonably possible and shall mitigate any damages caused by blasted material to the extent possible.

The contractor shall immediately request the Engineer to inspect upon arrival of new consignment of explosives. Only the approved explosives after inspection shall be permitted to use. Any explosives which are more than one year from the date of manufacture shall not be used.

### 3. Excavation for Structures

- *Earth work in excavation in foundation trenches or drains including dressing of sides and ramming of bottom, disposal of surplus excavated soil within 50m lead.*

*RW0016* *All types of soil*

*RW0017* *All types of rock with or without blasting*

*RW0018* *All types of rock requiring blasting*

Excavation for structures shall be carried out to the levels and dimensions shown on the Drawings or as directed. Excavation will be carried out to the least dimensions required to accommodate all parts of the works and will include only the minimum working space necessary for their execution.

When the foundation level as shown on the Drawings, or as directed, is exposed by the Contractor the Engineer shall approve the foundation prior to the start of structure construction.

All excavation will be carried out in such a manner that the surrounding materials receive the minimum amount of disturbance. Any damage or disturbance caused to materials, whether or not within the area of operations, will be made good by the Contractor at his own expense, as directed.

Excavations will be kept free from water and the Contractor shall make all necessary arrangements to dispose of any water, which enters the excavation.

Suitable material removed from foundation excavations, which are required for subsequent backfilling of the excavation will be stockpiled at an approved location adjacent to the excavation. All other material excavated will be disposed off to spoil tips provided by the Engineer.

All soft or loose material will be removed and any cavities backfilled with compacted rock fill as directed.

**Trench Excavations**

Trench excavations shall be carried out with great care, true to line and gradient and as near as practicable to the size required for construction of the Permanent Works. Nowhere shall the external dimensions of the excavations be less than the required dimensions shown on the Drawings or ordered by the Engineer.

Any excavated materials stored on Site for back filling or other purposes shall be deposited along the excavation at a minimum distance of 0.5m in such a manner that it will cause no damage or inconvenience. The surface shall be dressed properly. If the excavation is done to a depth greater than that shown in the drawings or greater than that required by the Engineer, the excess depth shall be made good at the cost of the contractor. The subsequent disposal of the excavated material shall either be as directed by the Engineer under a separate item or as included in this item disposal up to 50 meters lead.

**Timbering of Excavations.**

For the purpose of this section the words “timber” and “timbering” shall be construed to include trench sheeting and or concrete sheet piling or any other means adopted by the Contractor for supporting excavations.

The contractor shall be responsible for support of all excavations during the construction of the Works.

The Contractor shall supply and fix all timber necessary for the support of sides and bottoms of the excavations, for the security of adjacent structures and properties and for every other purpose for which it may be required in connection with or caused by the execution of the works. The Contractor shall maintain such supports until the works are sufficiently advanced to permit their withdrawal. Such withdrawal shall be executed only under the personal supervision of a competent staff of the contractor.

The Contractor shall be responsible for any injury to the work and any consequential damage caused by or arising out of the insufficiency of the support he provides for his excavations or caused by or arising out of the removal of that support.

The Engineer may order excavations to be timbered to be close timbered or may order timbering to be driven ahead of the excavation, or may order the adoption of any other method of supporting the sides and bottoms of the excavations as may appear to be necessary, and the Contractor shall adopt and shall make no additional charge for executing the adopted method.

Any instruction given by the Engineer will be directed to the provision of stronger support than that proposed by the Contractor, and will be given only when, in the opinion of the Engineer, the support proposed by the Contractor is insufficient.

Any advice, permission, approval or instruction given by the Engineer relative to any timbering or removal thereof shall not relieve the Contractor of any responsibility under the Contract.

All timber etc. used in the support of excavations shall be removed by the Contractor on completion unless otherwise approved by the Engineer.

**Finishing**

All excavations shall be carried out in conformity with the lines, grades, side slopes and levels shown on the drawings or as directed by the Engineer. The contractor shall not excavate outside the limits of excavation subject to the permitted tolerances, any excess depth/width excavated beyond the specified levels/dimensions on the drawings shall be made good at the cost of the contractor.

All debris and loose materials on the slopes of cutting and the formation width shall be removed. After excavation the sides of excavated areas shall be trimmed and the required slopes/gradient shall be maintained uniformly to minimise erosion and ponding. The excavated area shall be neatly dressed and all overhanging soil shall be removed.

The formation width shall be finished to the final level with the given cross fall, neatly dressed surface free from depressions and projections and at gradients given in the drawing.

**QA/QC**

- Gradient: Check the gradient whether it complies with the drawing

- Cross fall: Measure and check the cross fall as specified
- Compaction: Ensure that the work is compacted as specified, check cracks, splits or any other failure
- Dressing: Visual inspection, no over hanging soil or loose materials, the surface should look uniform and neat.
- Blasting: Check that drilling patterns and charges are approved before blasting. Ensure that all statutory laws, regulations, rules for acquisition, transport, storage, handling and use of explosives as per the guidelines of the Ministry of Home Affairs are followed strictly.
- Finishing: The final finishing of the formation shall satisfy all the requirements of specification and shall be prepared to receive sub base/base course, with the tolerance of +20mm and –25mm

**Measurements:** The length, breadth and depth shall be measured correct to 10 mm. In case the measurements are taken with staff and level, the level shall be recorded correct to 5 mm and depth of cutting and heights of filling calculated correct to 5 mm. In the formation cutting the measurement shall be done by taking cross sections at suitable intervals, where it is not feasible to compute volumes by this method because of erratic surfaces, the volumes shall be computed by other accepted methods. For rock excavation, the over burden shall be removed first so that necessary cross sections could be taken for measurement. Where cross sectional measurements could not be taken due to irregular configuration or where the rock is mixed with other classes of materials, the volumes shall be computed on the basis of stacks of excavated rubble after making 35% deduction there from. When volumes are calculated in this manner for excavated material other than rock, deduction made will be to the extent of 16% of stacked volumes. The cubical contents shall be worked out to the nearest two places of decimal in cubic meters.

**Rates:** The rates shall cover the cost for carrying out all the required excavation and banking operations within 50m lead including cost of labour, materials, equipment hired/owned, tools and plants, blasting materials and incidentals necessary to complete the work. In case of rock, the rate shall include the cost of all operations of blasting with explosives, machineries and other accessories or other means as mentioned above. The filling & embankment within the formation width on the valley side shall be measured and paid as per specification under **filling and embankment.**

**4. Disposal of Spoil Materials**

- *Transportation of excavated materials from excavation sites to designated locations, including loading, unloading, dressing of dump sites, and environmental restoration*

*RW0019 Beyond 50 m:*

The free and indiscriminate disposal of any surplus materials is strictly prohibited. Spoil materials shall only be disposed of to sites approved by the Engineer.

It is the Contractor's responsibility to select suitable spoil disposal sites (ranging from 50 metres to 1000 metres lead) such as suitable gullies, natural depressions, abandoned quarries, degraded land. Enough care shall be taken not to trigger instability on such disposal sites to avoid the destruction of property, vegetation, irrigation and drinking water supply systems. The deposited materials shall be properly stacked by benching using an excavator and compacting with boom to accommodate more materials. After the

completion of the disposal the surface shall be neatly dressed and plantation shall be done after applying top soil. The plantations shall be fast growing plants or turfing as directed by the Engineer.

The contractor shall identify small disposal sites along the road on the valley side where slope is gentler and risk of destruction is minimum. These disposal sites shall be improved by construction log and boulder barriers. The dumping shall be done by benching with the excavator releasing the material from the bucket at a very low height to prevent the material from rolling down. For dumping the boulders or rocks the space shall be created first to place them firmly. The contractor shall notify these identified areas for Engineer's inspection and approval. These dumping areas shall be optimally used to reduce time and long distance transport.

Wetland shall not be used as spoil disposal site unless drained properly on forehand, to the discretion of the Engineer**.**

**QA/QC**

- Dump sites: Check that the dump sites are optimally used levelled and grass planted. Ensure that no erosion or gully formation will take place.
- Stacking of useful material: Ensure that the contractor stacks the useful material obtained from excavation. Check that they are stacked in the proper place; it should not block the road or drain. Ponding or diversion of water should not occur due to stacking.

**Measurement:** The length, breadth and depth of the loose volume (excavated material) shall be measured correct to 10 mm. In case of rocks/boulders 10% deduction for voids for the measured quantity shall be done. The cubical contents shall be worked out to the nearest two places of decimal in cubic meters.

**Rates:** The rates shall cover the cost for carrying out all the operations described above including labour charges, loading, unloading, engaging of excavator for levelling and compacting the spoil deposits, spreading of top soil, plantations and other incidentals involved in the operation.

### 5.21.3 Filling and Embankments

#### 1. Embankments

*RW0030 Construction of embankment by providing and laying dry earth in horizontal layers not exceeding 200 mm in depth (compacted), including watering, power rolling, dressing and preparation of site with selected excavated earth within 50m lead (Excluding cost of Selected Earth Transportation beyond 50 m Lead).*

***General***

Filling and embankment construction includes the preparation of areas for embankments to be constructed.

All materials used by the Contractor for the construction of fillings and embankments shall be approved by the Engineer. Approved materials shall normally be rock and slightly weathered rock passing a 150 mm ring and other excavated material, defined as suitable material, free from vegetable matter or top-soil and having a liquid limit of not more than 65.

***Preparation of Surface for Filling***

Areas to receive fillings and embankments shall be cleared and grubbed, and all existing structures and other obstruction shall be demolished and cleared away, in accordance with Section C of this Technical Specification.

Where groundwater or seepage is encountered, the Contractor shall notify the Engineer and any action to be taken shall, unless otherwise specified, be submitted to the Engineer for review.

Where the existing ground has an inclination steeper than 4 (horizontally) to 1 (vertically), benches shall be cut progressively over the full area to be covered by the fill. The width of each bench shall be such as to permit safe and effective operation of the plant but shall be not less than 1 m.

Prior to the placing of fill, the sub grade shall be compacted to 95% of the maximum dry density. The Contractor shall not commence placing any fill on the prepared areas until the Engineer has inspected these areas and has given consent to proceed.

***Construction of Road Embankment***

Embankments shall be built up evenly over the full width in layers of not more than 200 mm compacted thickness and shall be maintained at all times with a sufficient cross-fall to valley side and a surface sufficiently even to enable surface water to drain readily from them.

All materials used in embankments shall be compacted as soon as practicable after deposition. Each layer shall be compacted to a density of not less than 98% of the maximum dry density as determined by the Modified Standard Proctor Test. Earthmoving plants shall not be accepted as compaction equipment.

During the construction of embankments, the Contractor shall control and direct constructional traffic uniformly over their full width. Damage to compacted layers by constructional traffic shall be made good by the Contractor.

If the condition of the material deposited as fill is such that it cannot be compacted in accordance with the requirements of the Contract the Contractor shall either:

**Make good by removing the material off the embankment either to top or elsewhere until it is in a suitable physical condition for re-use and replacing it with suitable material; or**

**Make good the material by mechanical or chemical means to improve its stability; or**

**Cease work on the material until its physical conditions are again such that it can be compacted as described in the Contract.**

The finishing of the road embankment shall be in accordance with the levels and dimensions provided in the design, including the provision of the temporary side drain. The finishing, including road shoulders, shall be smooth with a cross fall to the mountain side of 4%, allowing controlled surface water run-off into the temporary side drain.

**Slopes**

The finishing of mountain and valley side slopes shall be in accordance with the levels and dimensions provided in the design. The finishing shall be smooth to the extent that bio-engineering works can be taken up if needed slopes shall be trimmed where necessary.

**QA/QC**

- Material: Materials from swamps, marshes, bogs, peat, log, stump and perishable materials are considered unsuitable for filling/embankment.
- The materials for embankment/filling shall be obtained from approved sources with preference given to materials becoming available from nearby excavation or any other excavation under the same contract.
- Surface area: Check the surface area for filling to comply with the specification (Preparation of surface for Filling & Construction of Road Embankment).
- Sub grade compaction: Check whether the sub grade is compacted as per specification (CBR not less than 5).
- Sub grade: If the sub grade is weak, conduct a field density test by DCP apparatus.
- Moisture content: Moisture content of the material shall be checked at the site of placement prior to commencement of compaction; if found to be beyond the tolerance of optimum moisture content, the same shall be made good.
- If the materials are brought from borrow pits following tests may be conducted: Grid the borrow area at 25m c/c (or closer if the variability is high) to full depth of proposed working. These pits shall be logged and plotted for proper identification of suitable sources of material.
    1. Sand content as per IS 2720 part 4, 2 tests per 3000 cum of soil
    2. Plasticity test as per IS 2720, part 5, 2 tests per 3000 cum of soil
    3. Density test as per IS 2720, part 8, 2 tests per 3000 cum of soil
    4. Deleterious content as per IS 2720, part 27, as and when required.
    5. Moisture content test as per IS 2720, part 2, one test per 250 cum of soil.
- Control shall be exercised on each layer by taking at least one measurement of density for each 1000 sqm of compacted area or closer. The determination of density shall be in accordance with IS: 2720 (part-28) & (CBR not less than 5).
- Finishing: All finishing works like shaping and dressing the shoulders/roadbed and side slopes conform to the alignment, levels, cross sections and dimensions shown on the drawings or as directed by the Engineer.

**Measurement:** The length, breadth and depth of the compacted layer shall be measured correct to 10 mm. The cubical contents shall be worked out to the nearest two places of decimal in cubic meters.

**Rates:** The rates shall cover the cost of transporting of earth, labour involved for screening, laying of the useful material and disposing the spoil material, preparation of site, watering, power rolling and dressing and any other incidentals involved in the operation.

*2.* **Backfilling of Structures**

*RW0035 Providing and laying filter material (600 mm wide) in trenches, sides of foundations, walls, etc. with 100 to 200 mm stones wherever applicable.*

No fill shall be placed until the foundation for the fill has been reviewed by the Engineer. Backfilling of structures shall be done with two hand-packed filter layers of stone aggregates of size 100 to 200 mm 600 mm thickness along the structure wherever possible.

**Measurement:** The length, breadth & depth of the finished work shall be measured correct to 10 mm & the cubical contents shall be worked out to the nearest two places of decimal.

**Rates:** The rates shall cover the cost of carrying out all the required filling operations including cost of labour, materials, equipment hired/owned, tools and plants and incidentals necessary to complete the work.

### 5.21.4 Extraction, supply and stacking of materials

#### 5.21.4.1 Extraction of Materials

**1. Quarries**

*RW0040 Opening, running and restoration of quarries according to Environmental Code of Practice (ECP) and as per technical specification*

Quarry site locations, which if shown in the Drawings, are provided as a guide only. It is the Contractor's responsibility to verify the suitability of the site, and to obtain the approval of the Engineer.

Quarry sites shall be located in geologically stable areas and away from populated centres, cultural sensitive sites, drinking water intake points, potential croplands, and protected biological areas.

When opening the site, care should be taken to keep the vegetation clearing at the minimum possible. Topsoil, if any, shall be removed and deposited for re-use after closing of the quarry.

The blasting operations shall be conducted in accordance with DoR "Blasting Manual" and the by-laws issued by the Ministry of Home Affairs. Blasting shall be executed as per the chapter: se of Explosives and Blasting. For stone quarrying, the operation shall begin from the crown of the slope and then move gradually downward. No shot hole blasting shall be executed. Blasting shall be conducted only during the day hours.

Labourers working in the quarry shall be equipped with safety gadgets such as helmets, ear protectors, nose/mouth protection, boots, goggles and gloves. In case of failure by the contractor to provide the safety gadgets as mentioned above to the labourers Nu. 500.00 per instance shall be debited from the contractor's payables.

Quarries and its access shall be restored after the termination of the works. The site shall be left in a stable condition and shall be properly drained to avoid stagnant water. Too steep slopes shall be trimmed. Deposited topsoil shall be spread before applying bioengineering measures to re-vegetate the whole site.

**Stone Crushing Plant**

The same is valid for the location of stone crushing plants as for the location of quarries. Ideally, if feasible, the crushing plant shall be located closest possible to the quarry site.

The plant shall be operated according to the manufacturer's specifications and only during the day hours. The labourers shall be equipped with safety gadgets such as helmets, ear protectors, nose/mouth protection, goggles and gloves.

**QA/QC**

- Site: The site shall be located at stable areas and away from human habitats, cultural sites, drinking water intake points, potential crop lands and protected Biological areas.
- Quality of stones: The quality of stone shall meet the requirement. Conduct tests on crushing, impact and abrasion.
- Operation: Ensure that the operation complies fully with ECP.
- Restoration: Ensure that the quarry site is restored as specified

**Measurement:** The complete work irrespective of the number of quarries shall be treated as an item of work.

**Rates:** The rate shall include the cost of all installation, operations of quarry, plant and equipment hired/owned, labour charges including the restoration of quarries as per the direction of the Engineer. This includes also the construction and closure of access roads, if any.

**2. Sand / Gravel Extraction Sites**

*RW0041 Opening, running and restoration of sand quarries according to Environmental Code of Practice (ECP) for Highways & Roads and as per technical specification*

Sand/gravel extraction site locations, which may be shown in the Drawings, are provided only as a guide. It is the Contractor's responsibility to verify the suitability of the site, and to obtain the approval of the Engineer.

The extraction of gravel and sand from small rivers or streams shall be minimized as far as possible. If extraction is necessary, the extraction points shall be spread out along the length of the river to minimize disruption in the river flow pattern and to prevent instability of embankments. Furthermore, disturbance of aquatic life and their habitats is to be prevented.

Extraction points shall not be near bridges or river training structures. The depth of material removal at any one location shall be limited, and extraction areas shall be selected where there is little fine material to be carried downstream.

Local residents and water users shall be consulted to ensure that irrigation intakes and bunds do not adversely impact. Land utilized for riverbed extraction shall be restored with bioengineering measures after the construction activities have ended.

**QA/QC**

- Site: The site shall be located at stable areas if it is from quarry. If it is from the river ensure that no erosion takes place. The aquatic life should not be disturbed.
- Quality of sand: The quality of sand shall meet the requirement.
- Operation: Ensure that the operation complies fully with ECP.
- Restoration: Ensure that the site after extraction is restored as specified

**Measurement:** The complete work irrespective of the number of quarries shall be treated as an item of work.

**Rates:** The rate shall include the cost of all installation, operations of quarry, plant and equipment hired/owned, labour charges including the restoration of quarries as per the direction of the Engineer. This includes also the construction and closure of access roads, if any.

**5.21.4.2 Aggregate Collection**

- *Supplying and stacking stone aggregates*

*RW0044 100mm*

*RW0045 75 mm*

*RW0046 50 mm*

*RW0047 63 - 40 mm*

*RW0048 20 mm*

*RW0049 12 - 6 mm*

*RW0050 50 - 20 mm*

**Stacking:** The size and quantities of aggregates to be supplied shall so be selected by the Engineer that the grading requirements set forth in the specifications for which the supply is intended are satisfied. Only the aggregates satisfying the specific requirements shall be conveyed to the roadside and stacked. Ground where the stacks are proposed to be made shall be cleared, levelled or dressed to a uniform slope and all lumps, depressions etc. shall be removed. The stacked metal shall be free from vegetation and other foreign matter. Coarse aggregate stack shall be made at places as directed by the Engineer. All rejected stone metal shall be removed from site. Each size of aggregate shall be stacked separately. Like wise, materials from different quarry shall be stacked separately.

The aggregate shall be stacked in convenient units of 1m top width, 2.2 m bottom width, and 60 cm height and of length in multiples of 3 m for new roads. Where berm width is limited or for repair works it shall be stacked in units of 40 cm top width, 1.4 m bottom width, 50 cm height and length in multiples of 3 m. Templates of wood or steel shall be used for making the stacks and shall always be kept at site for checking measurements. The Engineer may permit stacking in different sizes and heights ranging between 45 to 75 cm for new roads and 40 to 60 cm for repair work, in case the site conditions demand.

The stack shall be uniformly distributed along the road and shall be numbered serially. The number plate shall be in position until the stack is used in the work. A register showing daily consumption of stacks shall be maintained at site of work. The collection of stone metal shall be for a completed length of one km (for each layer of W.B. Macadam) or as directed by the Engineer in writing.

**Measurement:** Length, breadth and height shall be measured correct to 10mm. The total quantity so arrived shall be reduced by 7.5% to arrive at the net quantity for payment. Unless otherwise directed, measurement shall not be taken until sufficient materials for use on the road have been collected and stacked.

**Rate:** The rate shall include the cost of all materials and labour involved in all the operations described above including all royalties, fees, rents where necessary; all leads and lifts; tools, equipment and incidentals to complete the work to the specifications.

*RW0055 Extraction/collection and stacking of blinding materials*

*RW0056 Extraction/collection and stacking of coarse sand*

**Stacking:** The size and quantities of blinding materials to be supplied shall so be selected by the Engineer that the grading requirements set forth in the specifications for which the supply is intended are satisfied. Only the materials satisfying the specific requirements shall be conveyed to the roadside and stacked. All rejected materials shall be removed from site. Materials from different quarry shall be stacked separately and shall be in dry state. Such materials shall be protected from deterioration in quality.

Materials shall not be stacked in locations liable to inundation or floods. Ground where stacks are proposed to be made shall be dressed to a uniform slope and all lumps, depressions etc. shall be removed. Quarry dust or earth shall be stacked in convenient units of one cubic metre. The stacks shall be made with wooden boxes open at both ends and of 2 x 2 x 0.25 m dimensions. These shall always be kept at site for stacking and check measurement.

The stacks shall be uniformly distributed along the road. The supply of quarry dust or earth shall be completed for the entire work or for a complete length of one km or as directed by the Engineer in writing.

**Measurement:** Length and breadth of boxes shall be measured correct to a cm. Volume shall be calculated in cubic metres, correct to two places of decimal. The total quantity so arrived shall be reduced by 5% to arrive at the net quantity for payment. Unless otherwise directed, measurement shall not be taken until sufficient materials for use on the road have been collected and stacked.

**Rate:** The rate shall include the cost of all materials and labour involved in all the operations described above including all royalties, fees, rents where necessary; all leads and lifts; tools, equipment and incidentals to complete the work to the specifications.

*RW0057 Extraction/collection and stacking stone boulder at site*

Ground where stacks are proposed to be made shall be cleared, levelled or dressed to a uniform slope and all lumps, depressions etc. shall be removed. The stone shall be stacked in convenient units of 1 to 1.25 m heights and of uniform width and length as directed by the Engineer. The stacks shall be uniformly distributed along the road. The supply shall be completed for the entire work or for a complete length of one km or as directed by the Engineer.

Stone brought to the site shall be broken to the specified sizes with hammers and while stacking all rejected stones shall be separated out and removed from the site before measurements are made.

**Measurement:** Length, breadth and height shall be measured correct to a cm. The total quantity so arrived shall be reduced by 15% to arrive at the net quantity for payment. Unless otherwise directed, measurement shall not be taken until sufficient materials for use on the road have been collected and stacked.

**Rate:** The rate shall include the cost of all materials and labour involved in all the operations described above including all royalties, fees, rents where necessary; all leads and lifts; tools, equipment and incidentals to complete the work to the specifications.

### 5.21.5 Structures/slope stabilisation

**Geotextile in structures and drains**

*RW0060* *Providing and laying Non-woven Geotextile filter on compacted surface that can sustain a load of not less than 10 kN/m with grab tensile strength of more than 0.4kN/m and a minimum tear resistance of 150N excluding earthwork and compaction.*

**Scope**

This specification covers the various applications of Geotextiles materials in road and bridge works including supplying and laying. The laying shall be done as per the location shown in the drawing or as directed by the Engineer.

**Geotextile:** Geotextile shall be made of polyethylene or polypropylene or polyester or similar fibres, either woven or nonwoven in variety, through machine made process of heatbonding or needle punching or weaving techniques. These fabrics are required to pass water through but retain the particles, which require specific cross-plane permeability or permittivity and apparent opening size or equivalent opening size or 095. The above two requirements along

with the requirement of strength and durability denote general characteristics of geotextiles to be used.

(a) Sustain a load of not less than 10 kN/m at break and have a minimum failure strain of 10 per cent when determined in accordance with BS:6906 (Part 1) or shall have a grab tensile strength more than 0.4kN/m and elongation corresponding to this limit in accordance with ASTM D 4632.

(b) The apparent opening size shall satisfy the following †*

**Table 5.21.1** OPENING SIZE OF GEOTEXTILE

| Test method | Units | Requirements percent in – situ passing 0.75 | | |
|---|---|---|---|---|
| ASTM D4751 | mm | <15 | 15 to 50 | >50 |
| | | 0.43 | 0.25 | 0.22** |

*These default filtration property values are based on the predominant particle size of in-situ soil. In addition to the default permittivity value, the Engineer may require geotextile permeability and/or performance testing based on engineering design for drainage systems in problematic soil environments.

†Site specific geotextile design should be performed especially if one or more of the following problematic soil environments are encountered; unstable or highly erodible soils such as non-cohesive silts; gap graded soils; alternating sand/silt laminated soils; dispersive clays; and/or rock flour.

**For cohesive soils with a plasticity index greater than 7, geotextile maximum average roll values for apparent opening size is 0.30mm.

(c) Allow water to flow through it at right angles to its principal plane, in either direction at a rate of not less than 10 liters/m2/sec. Under a constant head of water of 100mm, determined in accordance with BS: 6906 (Part 3) or ASTM D 4491 or as stated in the design drawing. The flow rate determined in the test shall be corrected to that applicable to a temperature of 15°C using published data on variation in viscosity of water with temperature.

(d) Have a minimum puncture resistance of 200N when determined in accordance with BS: 6906 (Part 4) or ASTM D 4833.

(e) Have a minimum tear resistance of 150N when determined in accordance with ASTM Standard D 4533.

The composite drain shall have a flow rate through each face of the drain of more than 75 per cent of the value determined by direct measurement of the composite drain using BS: 6906 (Part 3). The composite drain shall have values of long-term in-plane flow rates as stated in the design drawing.

**Testing and acceptance:** Geotextiles shall be tested in accordance with tests prescribed by BIS. In absence of IS Codes, tests prescribed either by ASTM or British Standards or International Standards Organization, shall be conducted.

**QA/QC**

- Provide suppliers test certificate of geotextile materials: tensile and tear requirements before mass supply to BS 6906 part 3 or ASTM D4491. Check the samples to meet the tensile and tear requirements before mass supply.
- Ensure all the geotextile is free of tears or perforations
- Ensure all laps between adjacent sheets are the minimum 150mm
- Ensure all backfill immediately on geotextile is placed with care prior to mass fill

**Measurements for payment:** The fabric of geotextile shall be measured in $m^2$ for the finished area of work (as per drawing).

**Rate:** The rate shall include the cost of geotextile material including overlaps of 15 to 30 cm, transportation, storage and incidentals.

**5.21.5.1 Construction of Walls**

**1. Gabion Walls**

**1.1 Double Twisted Woven Gabion**

- *Construction of gabion wall as per drawings with dry stone masonry (hammer dressed facing) including excavation of foundation in all types of soils, sides and backfilling, delivery of machine woven gabion mesh (Hexagonal mesh of size 100mm x 120mm with a minimum of doubly twisted) with GI wire 2.70 mm dia including diaphragm, fixing of selvedge wire 3.4 mm dia, binding/lacing wire 2.40 mm dia complete.*

| | |
|---|---|
| *RW0065* | *Height up to 1.0m* |
| *RW0066* | *Height up to 2.0m* |
| *RW0067* | *Height up to 3.0m* |

*RW0068 Height up to 4.0m*

*RW0069 Height up to 5.0m*

*RW0070 Height up to 6.0m*

*RW0071 Height up to 7.0m*

*RW0072 Height up to 8.0m*

*RW0073 Height up to 9.0m*

- *Construction of gabion wall as per drawings with dry stone masonry (hammer dressed facing) including excavation of foundation in all types of soils, sides and backfilling, delivery of machine woven gabion mesh (Hexagonal mesh of size 100mm x 120mm with a minimum of doubly twisted) with GI wire 3mm dia including diaphragm, fixing of selvedge wire 4.06mm (8 swg) dia, binding/lacing wire 2.64mm (12 swg) dia complete.*

*RW0245 Height up to 1.0m*

*RW0246 Height up to 2.0m*

*RW0247 Height up to 3.0m*

*RW0248 Height up to 4.0m*

*RW0249 Height up to 5.0m*

*RW0250 Height up to 6.0m*

*RW0251 Height up to 7.0m*

*RW0252 Height up to 8.0m*

*RW0253 Height up to 9.0m*

The space (excavated for construction purposes) between the side of the finished walls and the road embankment needs to be filled with dry masonry in order to create a smooth finishing from the wall to the road embankment/slope as per site condition and the site engineer's instruction.

### 1.1.1 Materials

#### I. Stone

Stones used for filling for gabion boxes shall be clean, hard, sound, unweathered and angular rock fragments or boulders. The smallest dimension of any stone shall be at least twice that of the longer dimension of the mesh of the crate.

Before filling any gabion boxes, the Contractor shall submit representative samples of the rock he proposes to use in the gabions for approval by the Engineer. Further representative samples shall be submitted for approval each time whenever there is a change in the type or strength of the rock that the Contractor proposes to use in gabion work.

#### II. Gabion Crates (woven wire mesh)

Gabions shall consist of steel wire mesh crates. The steel wire shall be mild steel wire complying with IS 280. All wire used in the manufacture of the crates and for use as diaphragms, binding and connecting wire shall be galvanised with an extra heavy coating of zinc by an electrolytic galvanising process. The weight of deposition of zinc shall be in accordance with IS 4826. Zinc coating shall be uniform and shall be able to withstand a

minimum number of dips and adhesion test specified as per IS 4826. Tolerance on diameter of wire shall be 2.5 percent. The tensile strength shall be between 300 to 550 N/mm$^2$.

The wire shall be mechanically woven into a hexagonal mesh of standard size with tolerance of +16 and -4. The tightness of the twisted joints shall be such that a force of 7 KN is required to pull on one wire to separate it from the other wire provided that each wire is prevented from turning and the whole process is done in one plane. All edges of the crates shall be finished with a selvedge wire. Gabions shall be manufactured in the standard sizes shown in the following table.

**Table 5.21.2** STANDARD SIZES OF GABIONS

| **Dimensions** (m) | **Diaphragms** (No) | **Dimensions of Diaphragms** (m) | **Volume of Crate**(m$^3$) |
|---|---|---|---|
| 1 x 1 x 1 | 1 | 1 x 1 | 1 |
| 1.5 x 1 x 1 | 1 | 1 x 1 | 1.5 |
| 2 x 1 x 1 | 1 | 1 x 1 | 2 |
| 3 x 1 x 1 | 2 | 1 x 1 | 3 |
| 2 x 1 x 0.5 | 1 | 1 x 0.5 | 1 |

Diaphragms shall be manufactured of the same materials as the parent gabion and shall have selvedge wire throughout their perimeter. The number and size of diaphragms to be provided with each crate shall be as in the table 5.21.2. All crates shall be supplied with binding and connecting wire.

### 1.1.2 Installation Methodology of Gabions

#### I. General Requirements

Before filling any gabion boxes, the Contractor shall also submit samples of gabion boxes assembled for approval and shall be retained for reference and comparison with the gabions built. The size, type and location of the samples shall be as directed by the Engineer.

Gabion boxes shall be assembled and erected including filling in the dry on prepared surfaces except as may be otherwise approved. Approval for assembling and erecting gabions in water will be given only if in the Engineer's opinion such a method will produce work, which is otherwise in accordance with the Specification.

#### II. Preparation of Foundation and Surface for Bedding

1. Excavate the foundation to the required level as shown in the drawings. If good bearing stratum is not observed after the excavation up to mentioned levels, then, the same should be brought to the notice of Engineer-in-charge for further advice. The surface of the foundation should be free from any deleterious material and unwanted foreign objects. Loose pockets, if any, should be excavated and filled with suitable granular or backfill material.
2. If there is standing water, the place should be cleared of to ensure proper placement of gabions. In case, dewatering is not possible then gabions shall be installed underwater. The installation of the gabion underwater is not covered by this specification. The method of installation shall be referred to IRC: SP 116.

3. Compact the foundation. Density of compacted foundation should be greater than or equal to 95% of the modified Proctor value.

### III. Assembly

Gabions are delivered at the work site in bundles along with the lacing wire. Bundles must be unloaded using any available machine and stored close to the site where they are to be installed. While unloading, care shall be taken that Gabion bundles are not damaged. Maximum 4 bundles shall be stacked over each other. Gabion bundles shall be stacked on a levelled ground with wooden rafters/sleepers in between them for easy in handling and preventing any damage to the mesh and other components like the selvedge wire. Storage can be outdoors as long as the bundles are not laid over abrasive or chemically aggressive surfaces (corrugated asphalt, oils, grease, chemicals, etc.).

The following are the steps in the basic procedure for erection and installation of structures. At the work site bundles should be opened and gabions assembled according to the following instructions:

1. The outer alignment of the gabion facia should be marked as per the requirements in the drawings.
2. The gabions are unfolded and laid over an even, level and hard surface (compact ground). One or two persons may be deployed for the straightening of mesh panel activity depending on the size of gabions. The gabions should be properly assembled and wired together, so that all four corners match and form an exact rectangular shape and size as designed. Refer Figure 1 (a) and (b).
3. The side panels are opened up to form a box by tying the upper corner of each pair of side panels using the thick selvedge wires (Figure 2).
4. The edges are laced together, starting from top corner, in a continuous operation using alternate single and double loops at the spacing of one mesh length i.e., 100 mm to 125 mm. The ends of the lacing wire are secured at each corner and turned into the gabions. Alternatively, steel rings mentioned IS16014 can be used which are attached using mechanical tools (Figure 3 and Figure 4).
5. Similarly, all the other sides are tied up and the box structure made, with the top end open to fill the boxes.

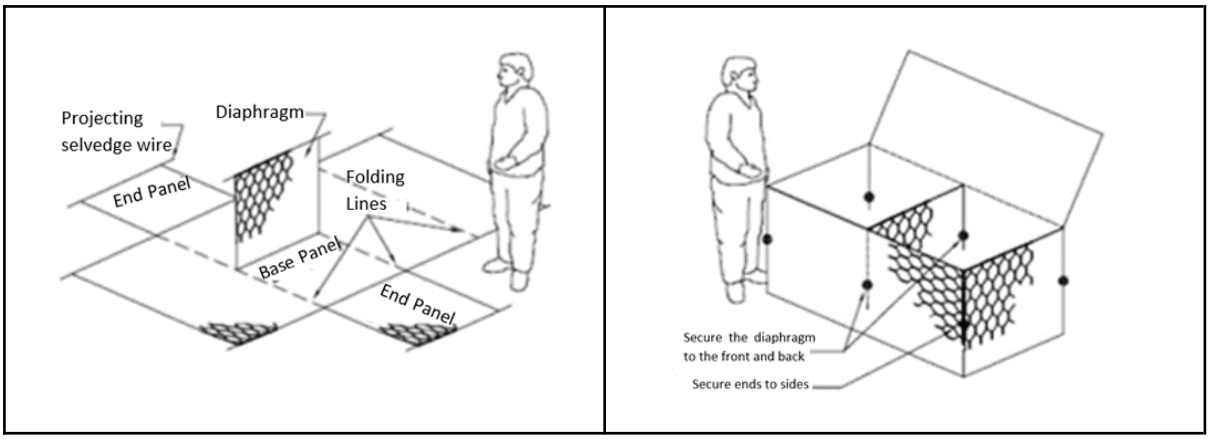



**Figure 1 (a) and (b)** Gabion installation steps

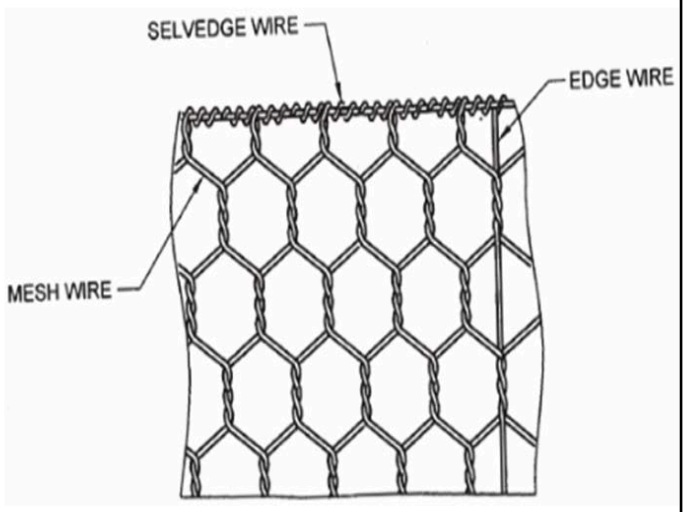



**Figure 2** Mesh wire, Selvedge and Edge wire

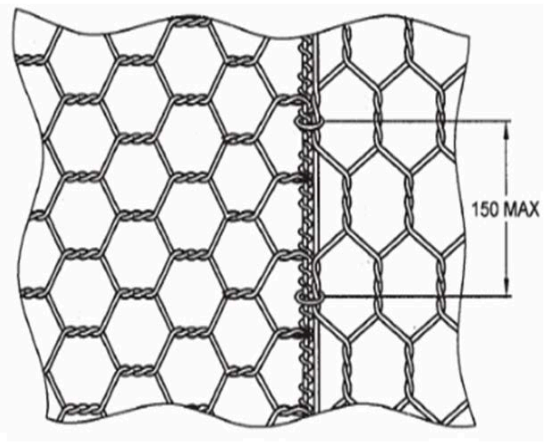



**Figure 3** Lacing Wire for tying adjacent panels in single and double loop fashion

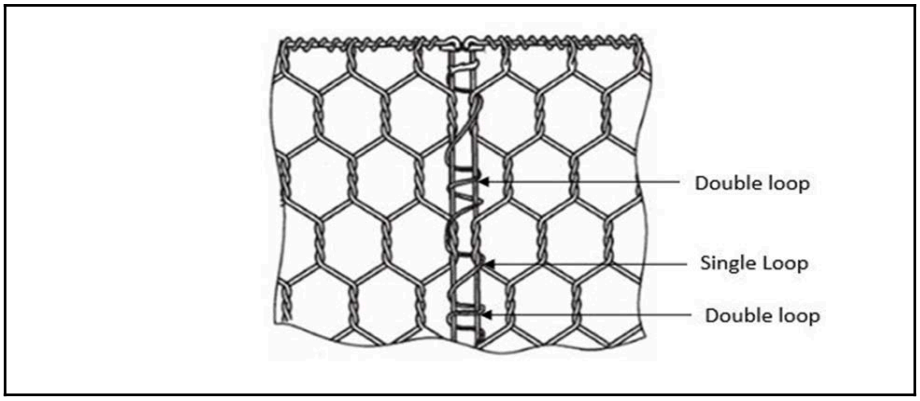



**Figure 4** Rings for joining adjacent panels instead or with lacing wire

**IV. Filling**

1. The crates shall be placed in their final position before filling commences. The selvedges of the crate will be bound to the selvedges of adjacent crates with lacing wire. They shall be stretched to their full dimension and securely pegged to the ground or wired to adjacent gabions and stretched from the opposite end or side by inserting temporary bars and levering them forward before filling. The top and bottom shall be kept stretched by tensioning with tie wires attached to an anchorage or equivalent approved method until the gabion has been filled. The gabions shall be inspected at this stage but before filling with stone to ensure that the tie wiring has been properly carried out and the gabion boxes are not pulling apart. Gabion boxes may be tensioned either singly or in the case of a long straight structure by straining a number of units together using an approved tensioning system.

   The vertical corners shall be kept square and to full dimension by inserting a steel bar of at least 20 mm diameter at each vertical corner maintaining it in the correct final position throughout the filling process. The steel bars will have to be removed when the crate is full.

2. Mild Steel pipe/frame formwork shall be provided at the gabion facia for achieving a good aesthetic appearance and keeping the bulges within the specified tolerances (Figure 7). The formwork enables to achieve uniformity in the gabion box dimensions during the filling and placement of stones.

   The filling will be carried out by placing individual stones into the gabion by hand in such a manner that the stones are bedded on each other and bonded as in dry stone masonry to achieve proper bonding and minimize void. For better finish, the stone fill to the external faces is hammer dressed and placed carefully to give the best appearance. No loose stones shall be tipped into the crate. And the practice of coursing and bonding the outer layer and filling the interior with un-laid stones will not be permitted. As far as possible a fair face of large flat stone should be placed at the exposed faces. The Gabion is over-filled by approximately 25 mm to 50 mm, to allow for settlement of the infill (due to self-weight).

   All 1 m deep gabions shall be filled in three equal layers and 0.5 m depth gabions in two equal layers. Horizontal bracing wires made with the same lacing wires as used for lacing shall be fixed directly above each layer of the stone in the compartments. The bracing wires are looped round two adjoining meshes in each side of the compartment and joined together to form a double tie which shall be tensioned by winding the bracing wires together with a flat stone in order to keep the face of the gabions even and free from bulges. Bracing wires shall be spaced horizontally along and across the gabions at distances not greater than 0.33 m (Figure 5).

3. The filled layer should never be more than 300 mm higher than any adjoining cell. To avoid such circumstances the filling pattern shown in below (Figure 6) should be followed.

4. The gabion box compartments shall be filled slightly over-full to allow for subsequent settlement. The lids shall then be laced down with binding wire to the tops of all partition panels. The lids shall be stretched to fit the sides exactly by means of a suitable tool but due care shall be taken to ensure that the gabions are not so full that the lids are over stretched. The corners shall be laid so that the hinge of the lid is

on the lower side on slopes and on the outer side in walls. Where laid horizontally, hinges for retaining walls shall be placed on the valley side and for breast walls on the mountain side.

On completion the crates shall be completely and tightly filled, square, true to dimensions and the line and level shown on the Drawings.

5. The Gabions should be covered on the inner face with a non-woven geotextile before placing and compacting the backfill.
6. The backfill shall be placed and compacted to 95% of modified Proctor density in the area behind the gabion units.
7. In walls, gabion boxes shall be placed such that vertical joints are not continuous but staggered. Aprons shall be formed of headers. If more than one unit is required to obtain the necessary width, units of unequal length shall be used and the joints between them should be staggered. The adjoining boxes shall be joined together with the selvedge wire.

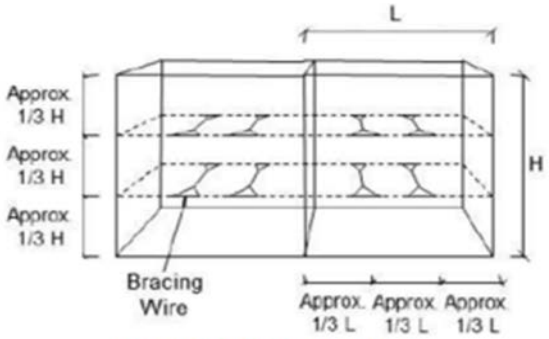



Fig. 32: Bracing wire details

Figure 5 Bracing wire details for 1 m deep gabion crates

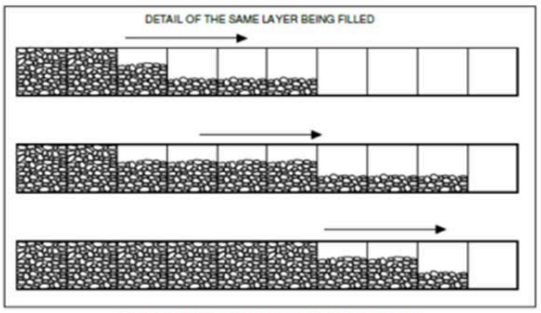
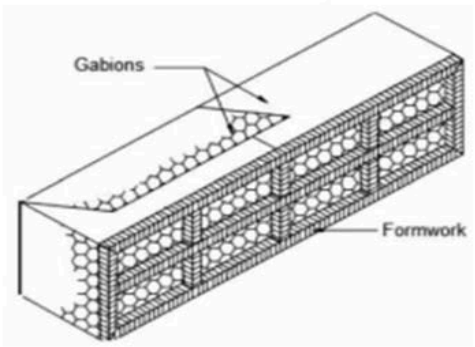



Fig. 33: Filling Pattern of Gabion Boxes

Figure 6 Filling pattern of gabion boxes




a) Temporary Formwork



b) Use of pipes

Fig. 34: Use of steel frame or pipes to avoid gabion bulging during filling operation

Figure 7 Use of steel frame or pipes to avoid gabion bulging during filling operation



Figure 8 Lid closing procedure at site

### 1.1.3 Testing

The testing of the shall be done in accordance with IS 16014.

### 1.1.4 Measurement

1. In case of gabion retaining and breast walls, the length of the wall shall be measured in running metre correct to 10 mm and the quantity shall be calculated nearest to two places of decimal.

### 1.1.5 Rates

1. In case of gabion retaining walls and breast walls, the rate shall include the cost of excavation to foundation level, back and side filling and providing and delivering stones from quarry and their preparation to use for gabion walls, as well as the providing, delivery and filling and closing of the gabion boxes, materials, including all testing, labour, equipment, tools, and incidentals necessary to complete the works as specified.

## 1.2 Welded Wire Gabion

- *Construction of gabion wall, as per drawing with dry stone masonry (hammer dressed facing) including excavation of foundation in all types of soils, sides and backfilling, delivery of welded wire gabion mesh conforming IS 16013 (50mm x 100 mm) with GI wire 4 mm dia including diaphragm, fixing of Spiral binder 3 mm (minimum) dia, stiffener wire 4 mm (minimum) dia, lacing wire 3 mm (minimum) dia complete*

| | |
|---|---|
| *RW0270* | *Height up to 1.0m* |
| *RW0271* | *Height up to 2.0m* |
| *RW0272* | *Height up to 3.0m* |
| *RW0273* | *Height up to 4.0m* |

*RW0274* *Height up to 5.0m*

*RW0275* *Height up to 6.0m*

*RW0276* *Height up to 7.0m*

*RW0277* *Height up to 8.0m*

*RW0278* *Height up to 9.0m*

### 1.2.1 General

Welded gabions are mostly used in architectural applications, free standing retaining walls, cladding or low height structures. It should not be used where there is risk of differential settlement.

### 1.2.2 Materials

#### I. Stone

The stones used shall be the same as described under 1.1.1.

#### II. Welded Gabion Crates

The wire used in the manufacture of welded wire fabric shall be manufactured from zinc-coated steel wire conforming to IS 4826 (heavy coated) or IS 12753 (heavy coated). Gabions and gabion mattresses shall be manufactured with all components mechanically connected at the production facility with the exception of the mattress lid which may be supplied separately. Specification of welded gabions such as classifications, manufacture and materials, mechanical properties, physical properties and dimensions should be as per IS 16013.

**Table 5.21.3** STANDARD SIZES OF GABIONS TYPICAL GABION SIZE

| Sl. No | Length (m) | Height (m) | Width (m) | Number of cells | Capacity ($m^3$) |
|---|---|---|---|---|---|
| i) | 1.8 | 0.9 | 0.9 | 2 | 1.46 |
| ii) | 2.7 | 0.9 | 0.9 | 3 | 2.19 |
| iii) | 3.6 | 0.9 | 0.9 | 4 | 2.92 |
| iv) | 1.2 | 1.2 | 1.2 | 1 | 1.73 |
| v) | 2.7 | 0.9 | 0.3 | 3 | 0.73 |
| vi) | 2.7 | 0.9 | 0.45 | 3 | 1.09 |

**Table 5.21.4** WIRE DIAMETERS

| SL. No | Mesh Opening (mm) | Minimum Nominal Diameter metallic-coated wire (mm) | Minimum Diameter, PVC coated (Including Coating) Wire (mm) |
|---|---|---|---|
| i) | 75 x 75 / 38 x 75 | 3.0 | 3.80 |
| ii) | 100 x 100 / 50 x 100 | 4.0 | 4.80 |
| iii) | 150 x 150 / 75 x 150 | 4.0 | 4.80 |
| iv) | Lacing Wire | 3.0 | 3.80 |
| v) | Preformed wire spiral binders | 3.0 | 3.80 |
| vi) | Stiffeners | 4.0 | 4.80 |

The metallic-coated wire shall have the size tolerances in accordance with IS 4826 (heavy coated) or IS 12753 (heavy coated) or IS 432 (part 2) for class B.

The minimum thickness of the PVC overcoats which covers the wire shall be 0.40 mm measured radically at any cross-section transverse to the wire length

**Tensile Strength**

The tensile strength of the welded fabric, spiral binders, lacing wire, and stiffeners shall be in accordance with the requirements of IS 4826 (heavy coated) or IS 12753 (heavy coated).

**Weld Shear Strength**

The minimum shear value, in Newton, shall be 70 percent of the tensile strength of the wire or as indicated in Table below, whichever is greater.

| Sl. No | Minimum Wire Diameter (mm) | Minimum Strength (N) | Breaking Shear Strength (N) |
|---|---|---|---|
| (i) | 3.0 | 2520 | 1760 |
| (ii) | 4.0 | 4480 | 3140 |
| (iii) | 5.0 | 7000 | 4900 |

The material shall be deemed to conform with the requirements for weld shear strength, if the average of the test results of the first four specimens tested complies with the value above or if the average of the test results for all welds tested complies with the value.

**Panel to Panel Joint Strength**

The minimum strength of the joined panels, when tested shall be as specified in the Table below.

| Sl. No | Mesh Size (mm) | Exterior Panels kN/m | Diaphragm Panels (kN/m) |
|---|---|---|---|
| (i) | 75 x75 Mesh/ 38 x75 Mesh | 20.4 | 8.7 |
| (ii) | 100 x 100 Mesh/ 50 x 100 Mesh | 27.2 | 11.6 |
| (iii) | 150 x 150 Mesh/ 75 x 150 Mesh | 18.1 | 7.7 |

### 1.2.3 Installation Methodology of Welded Wire Gabions

#### I. General Requirements

The requirements shall be as described under 1.1.2.

#### II. Preparation of Foundation and Surface for Bedding

The foundation on which the gabions are to be placed shall be cut or filled and graded to the lines and grades shown on the drawings. Surface irregularities, loose material, vegetation, and all foreign matter shall be removed from foundation surface area. The foundation should then be compacted to prevent settlement. When fill is required, it shall consist of materials conforming to the specified requirements. Gabions and bedding or specified geotextiles shall not be placed until the foundation preparation is completed, and subgrade surfaces have been inspected and approved by the site engineer. The surface of the finished material shall be to grade and free of mounds, dips or windrows. Extra care should be taken with foundation preparations in order to ensure a level and smooth surface. Geotextile shall be installed in accordance with the requirements of the plans and specifications.

#### III. Assembly and Placement

The assembly and placement of gabions shall be in accordance with the following procedures:

1. The outer alignment of the gabion facia should be marked as per the requirements in the drawings.
2. Rotate the gabion panels into position and join the vertical edges with fasteners for gabion assembly. Lacing wire, spiral binder or ring type fasteners are used for gabion assembly. Where lacing wire is used, first double loop and/or twist the lacing wire to the wire mesh. Then wrap the wire with alternating single and double loops at intervals between 100 to 130 mm similar to double twisted woven gabion (Figure 3). Pull each loop tightly and finally secure the end of the lacing wire to the wire mesh with a double loop and twist. Where spiral fasteners are used, crimp the ends to secure the spirals in place (Figure 9). Where ring type alternate fasteners are used for basket assembly, install the fasteners at a maximum spacing of 150 mm (Figure 10).
3. Use the same fastening procedures to install interior diaphragms where they are required. Interior diaphragms will be required where any inside dimension exceeds 91 cm for gabion baskets thicker than 300 mm. Diaphragms will be installed to assure

that no open intervals are present that exceed 91 cm. For baskets 300 mm or less, rectangular cells are allowed with dimensions 91 cm in one direction and not to exceed 183 cm in the perpendicular direction.

4. Place the empty gabions on the foundation. To interconnect the adjacent gabions boxes along the top, bottom, and vertical edges, use spiral binder if the joints of the individual boxes are connected with either lacing wire or ring type fasteners. And use lacing wires when individual gabion box joints are connected using spiral binders. The process of joining shall be the same as described in step 2 above.
5. To lay the subsequent layers, interconnect each layer of gabions to the underlying layer of gabions along the front, back, and sides (Figure 11) using lacing wire. Stagger the vertical joints between the gabions of adjacent rows and layers by at least one-half of a cell length.

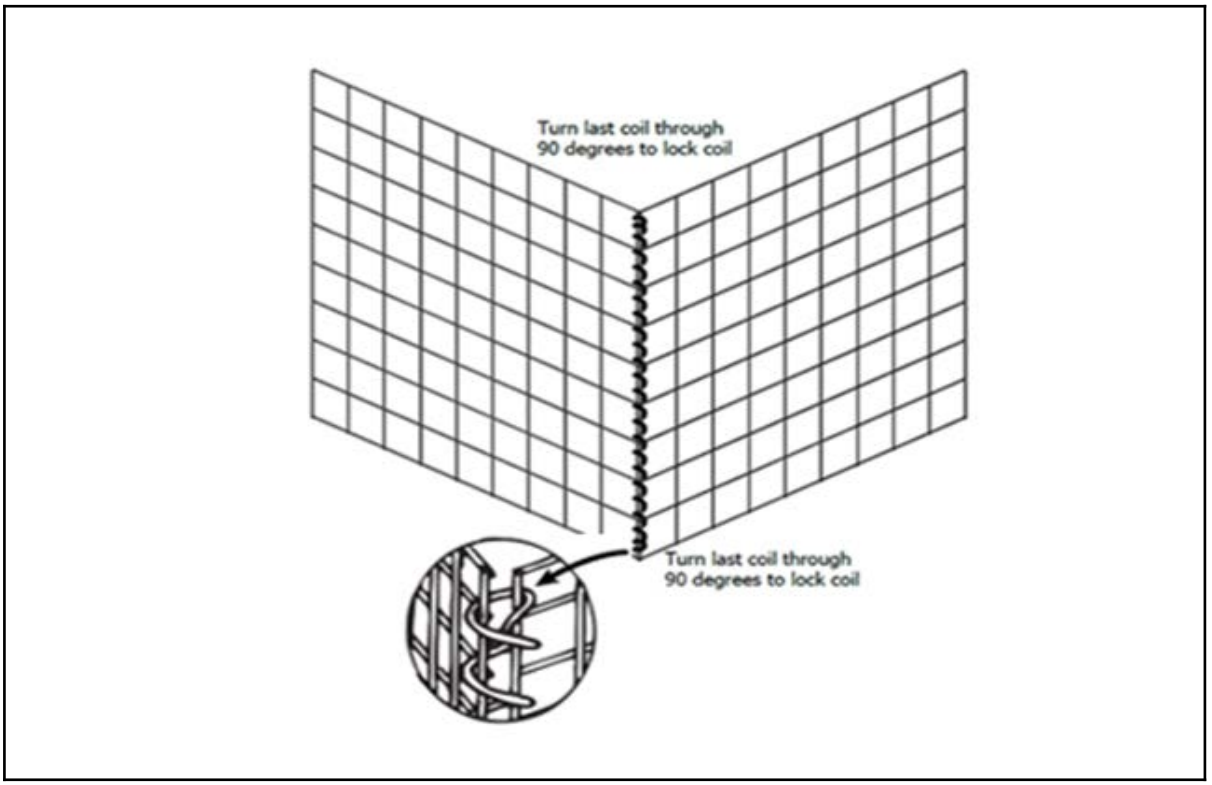



**Figure 9** Spiral fastener

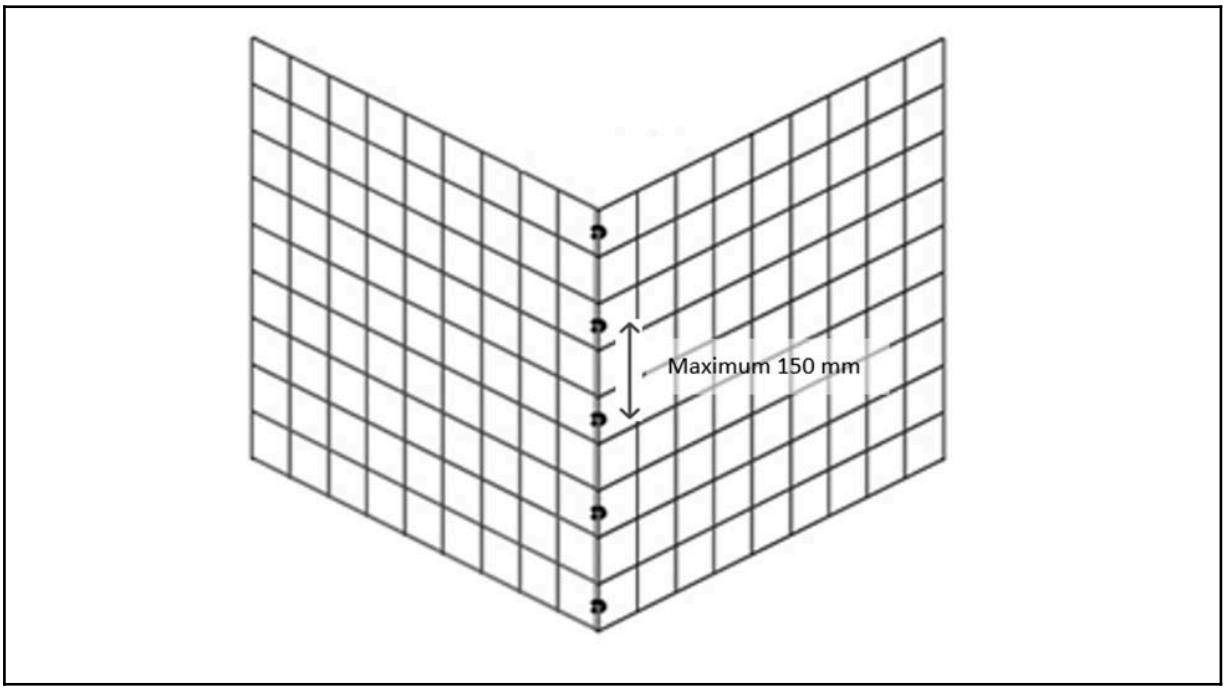



**Figure 10** Ring type fasteners

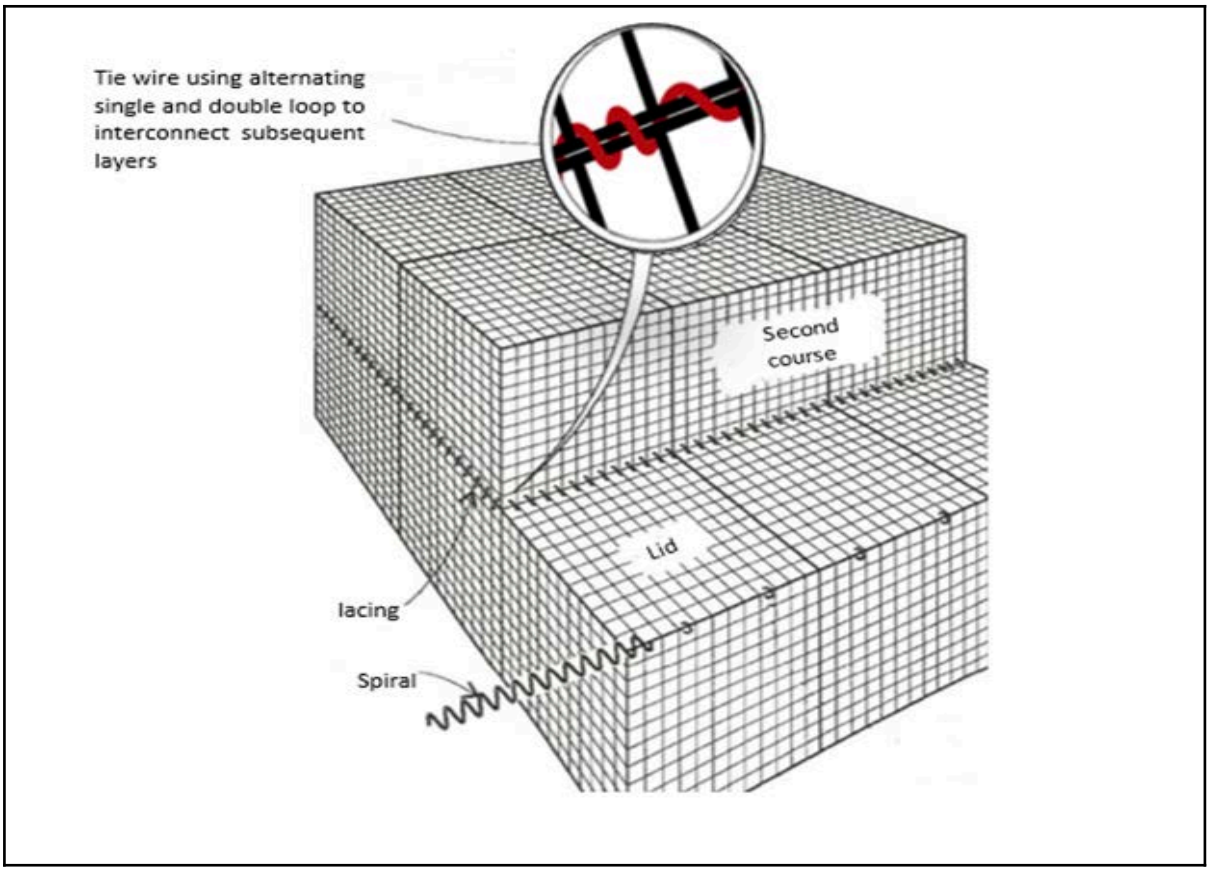



**Figure 11** Connection of subsequent layers of gabions

### IV. Filling

The filling of the gabion units shall be done described in 1.1.2 (IV) under Double Twisted Woven Gabion with the following additions:

1. Internal connecting cross-tie wires shall be placed in cells greater than 500 mm in height. Two internal connecting wires shall be placed concurrently with rock placement, at each 330 mm interval of depth for 1 meter height as shown for welded wire gabions. In addition to these crossties or stiffeners, in welded mesh gabions, corner stiffeners will be placed across all the corners of exterior sides of the structure of the gabions providing diagonal bracing as shown in Figure 12 and Figure 13. Alternatively, lacing wire or preformed wire stiffeners may be used.
2. The last layer of rock shall be uniformly levelled to the top edges of the gabions. Lids shall be placed over the rock filling using only approved lid closing tools as necessary. The use of crowbars or other single point leverage bars for lid closing is prohibited due to the potential for damage to the baskets.
3. The gabion lid shall then be secured to the sides, ends, and diaphragms with spiral binders, approved alternate fasteners, or lacing wire wrapped with alternating single and double loop in the mesh openings (Figure 11). Lacing may be used as needed to supplement the interconnection of welded mesh gabions, and the closing of lids.
4. Place the next course of empty gabions on top of the filled ones. Interconnect each layer of gabions to the underlying layer of gabions along the front, back, and sides as shown in Figure 11 using lacing wire. Courses are staggered along the vertical and horizontal joints. The stone filling is done as in the previous layers.
5. Any damage to the wire or coatings during assembly, placement and filling shall be repaired promptly in accordance with the manufacturer's recommendations or replaced with undamaged gabion baskets.

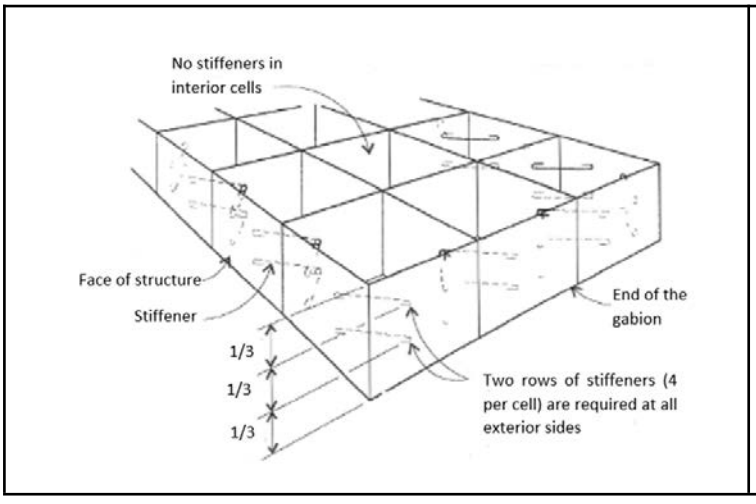



Figure 12 corner stiffener details

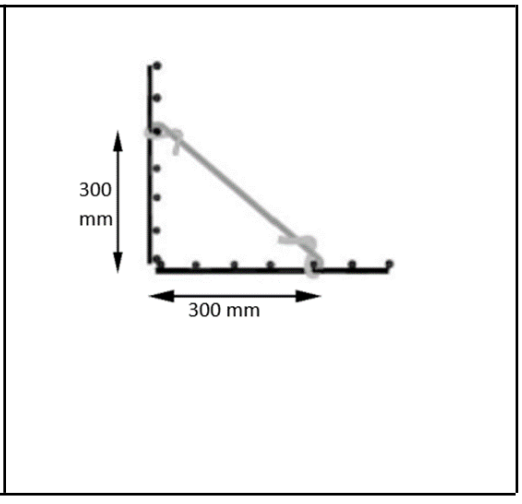



Figure 13 Layout of exterior corner stiffeners. Should be properly crimped

### 1.2.4 Testing

The testing of the welded wire gabions shall be done in accordance with IS 16013.

### 1.2.5 Measurement

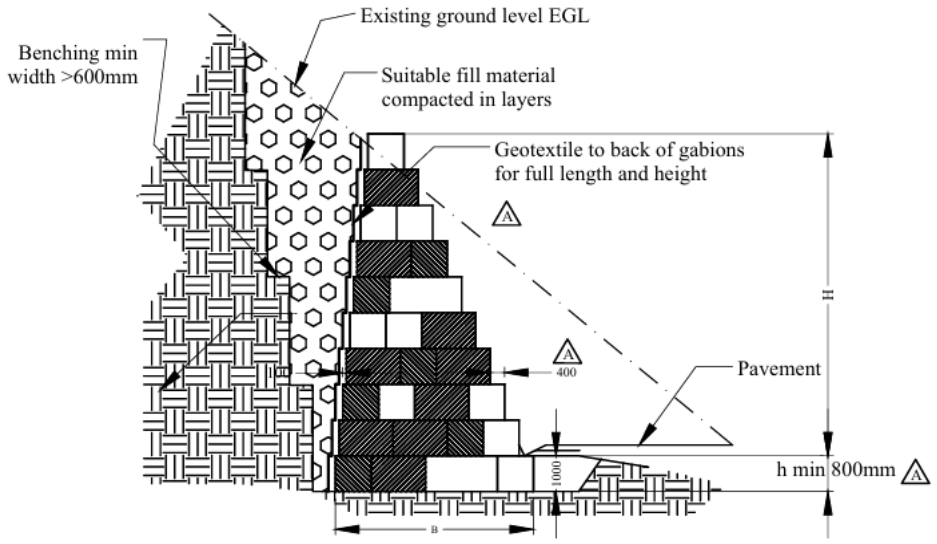
As described under Double Twisted Woven Gabions.

### 1.2.6 Rates

As described under Double Twisted Woven Gabions.

## 1.3 Precautions

1. Welded gabions are mostly used in architectural applications, free standing retaining walls, cladding or low height structures. It should not be used where there is risk of differential settlement.
2. Improper foundation and placing of gabion layers without the required preparation can lead to excessive settlements and thereby deformation of the structure.
3. Use of improper graded aggregate or rock and improper filling may lead to post construction deformations of the boxes and settlements.
4. While these structures can be constructed with local labours including skilled and unskilled labour, minimum machinery and equipment, construction of Gabion wall is highly quality conscious. It needs to be constructed as a monolithic structure with simultaneous backfilling and compaction which is often not followed at site due to poor workmanship.
5. Improper galvanisation of the wires (mesh, fastening, lacing, stiffening etc.). Improper galvanising leads to the premature degradation of wires/gabions, causing the failure of the structure.




BREAST WALL CROSS SECTION

A

| Total Height H+h | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Base Width B | 1.50 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 5.50 | 6.00 | 6.50 |

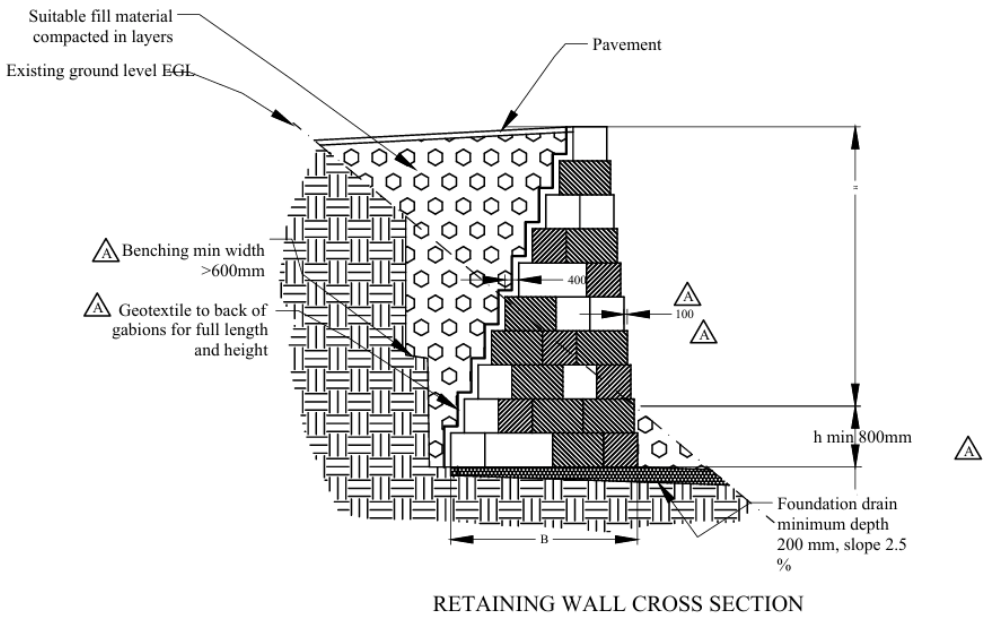
1m x 1m x1.5m gabion

1m x 1m x 2m gabion

1.5m x 1m x 1m gabion

2m x 1m x 1m gabion

**Figure 5.21.1** Breast wall

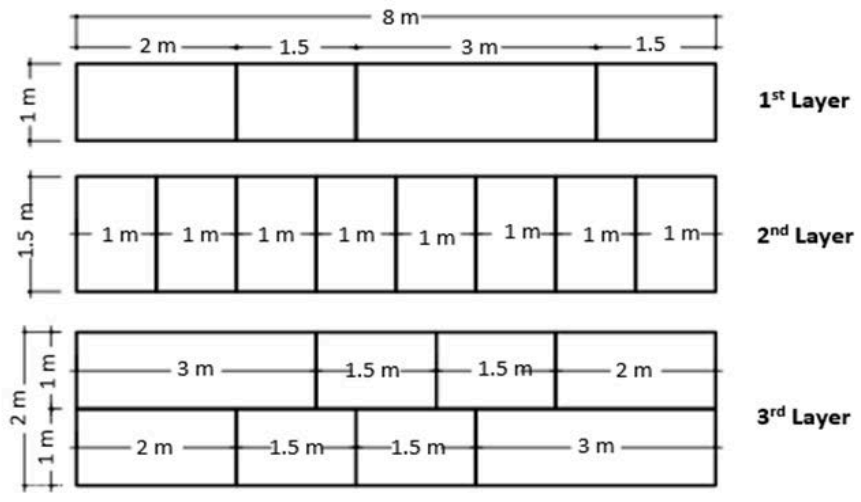


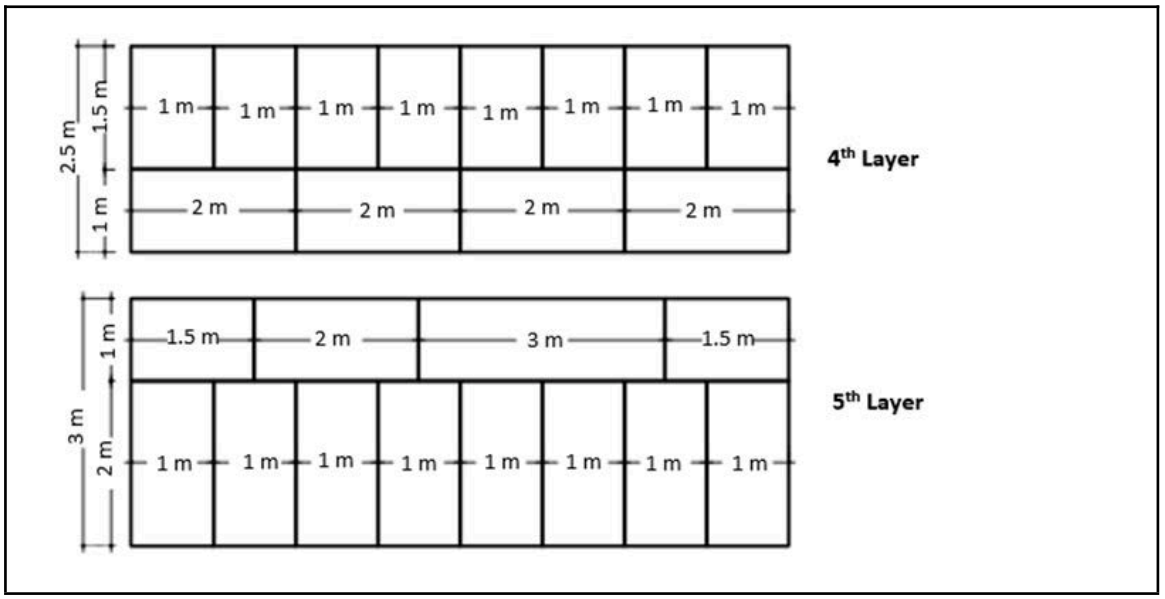

RETAINING WALL CROSS SECTION

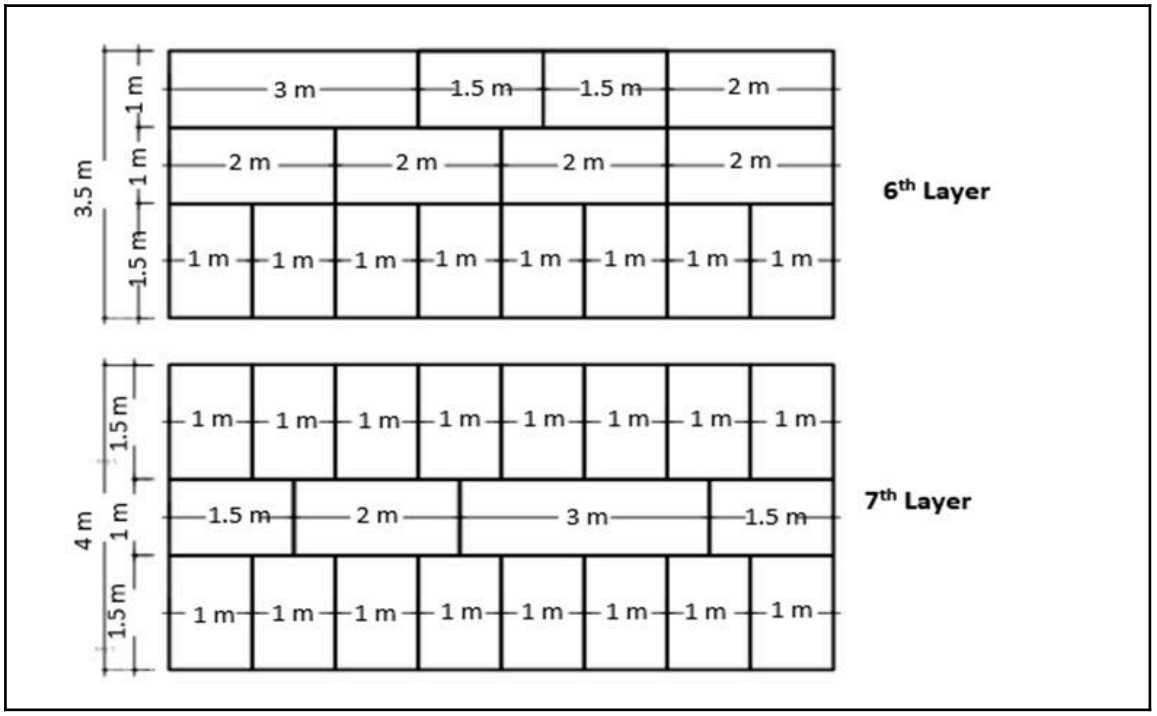
Note

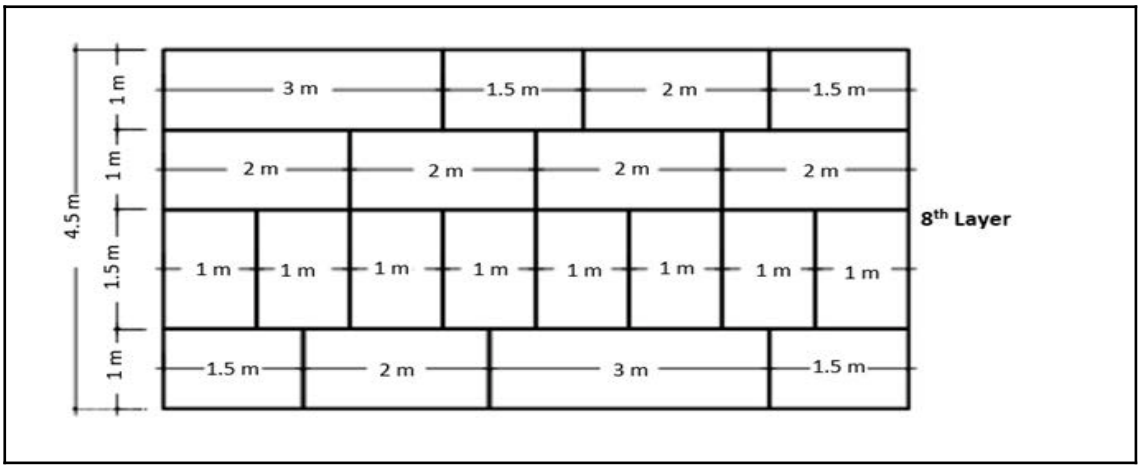
1. All dimensions in millimetres unless otherwise specified
2. Foundation surfaces are to be approved by the Project Manager
3. Suitable fill shall conform to the Technical Specification Section D9 and D10
4. All gabions shall conform to Technical Specification Section E4
5. All geotextiles shall conform to Technical Specification Section G13
6. Any gap remaining between the edge of the excavation and the last gabion basket at either end, shall be filled with hand packed Dry Rubble Masonry to prevent scouring/ erosion at the ends of the wall.

**Figure 5.21.2** Retaining wall




2.5 m
1.5 m
1 m
1 m 1 m 1 m 1 m 1 m 1 m 1 m 1 m
2 m 2 m 2 m 2 m
4th Layer
3 m
1 m
2 m
1.5 m 2 m 3 m 1.5 m
1 m 1 m 1 m 1 m 1 m 1 m 1 m 1 m
5th Layer


3.5 m
1 m
1 m
1.5 m
3 m 1.5 m 1.5 m 2 m
2 m 2 m 2 m 2 m
1 m 1 m 1 m 1 m 1 m 1 m 1 m 1 m
6th Layer
4 m
1.5 m
1 m
1.5 m
1 m 1 m 1 m 1 m 1 m 1 m 1 m 1 m
1.5 m 2 m 3 m 1.5 m
1 m 1 m 1 m 1 m 1 m 1 m 1 m 1 m
7th Layer



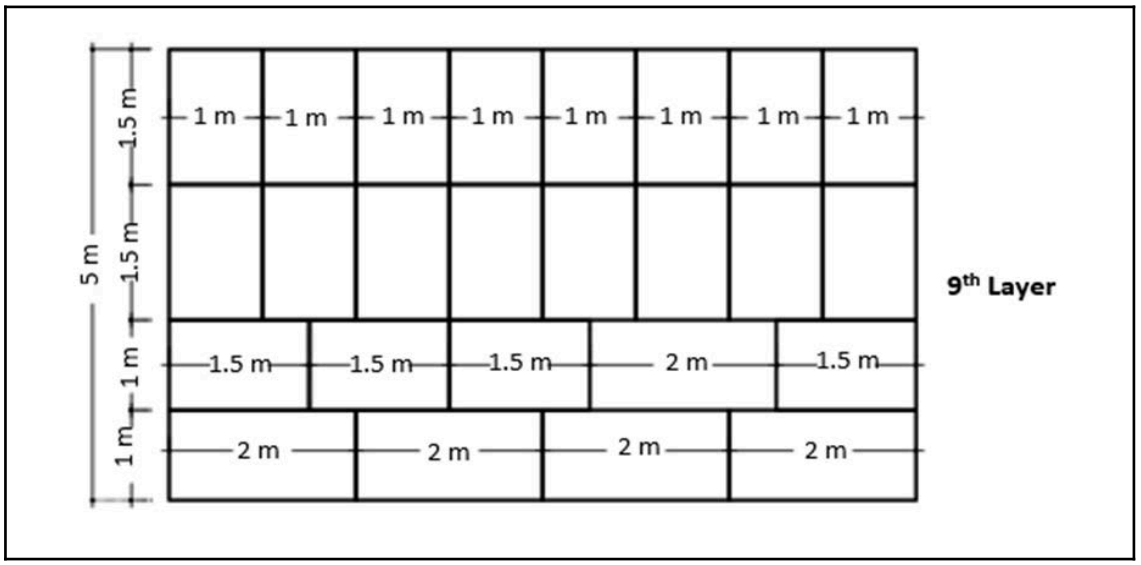




**Figure 5.21.3** Wall Plan

**Note:** The above plan is for up to 8-meter length wall. The vertical joints shall be staggered depending on the length and height of the wall to achieve a discontinuous vertical joint.

**2. Crib walls:**

- *Providing and constructing of light timber crib walls*

*RW0075* *With a timber section of 100 to 150mm diameter including excavation in all types of soil and backfilling.*

*RW0076* *With a timber section of 250 to 300mm diameter including excavation in all types of and backfilling.*

Crib walls provide a limited but flexible support function. They can be used for armouring as a revetment and they also catch moving debris.

Crib walls shall be constructed where the slope does not exceed 45°. The crib walls shall be constructed with timber sections 100 to 150mm diameter for light crib wall and 250 to 300mm for heavy crib walls laid perpendicularly. The height of the crib walls in any case shall not exceed: Light crib = 1.50 metres and Heavy crib = 5.00 m. Excavation shall be done as per the requirement. Lay the timber section in the trench at right angles to the line of the trench; they shall be spaced at intervals shown in the drawing. Lay two long sections of timber on top of the short sections, running parallel to the line of the trench. Fix the long sections with nails/reinforcement bar 16 mm dia, 800 mm long for heavy crib wall and 12 mm dia. 250mm long for light crib wall on each cross. Back fill and compact excavated debris up to the top of the long sections. Repeat the procedure until the required height is obtained. Step each layer into the slope, so that the face of the wall is at an angle of 45° to 60° from horizontal. Backfill above the wall with additional suitable material at 35° to meet the slope as high up as possible. Carry out bioengineering works in the front and at the top.

QA/QC

- Only waste timber branches shall be used for construction of crib walls.
- The timber branches shall be 100mm to 150mm for light crib walls and 250 to 300 mm dia for heavy crib walls at least 3m long.
- Crib walls shall be constructed in slopes up to a maximum of 45 deg.
- The logs shall be of hard wood, durable species with barks removed.

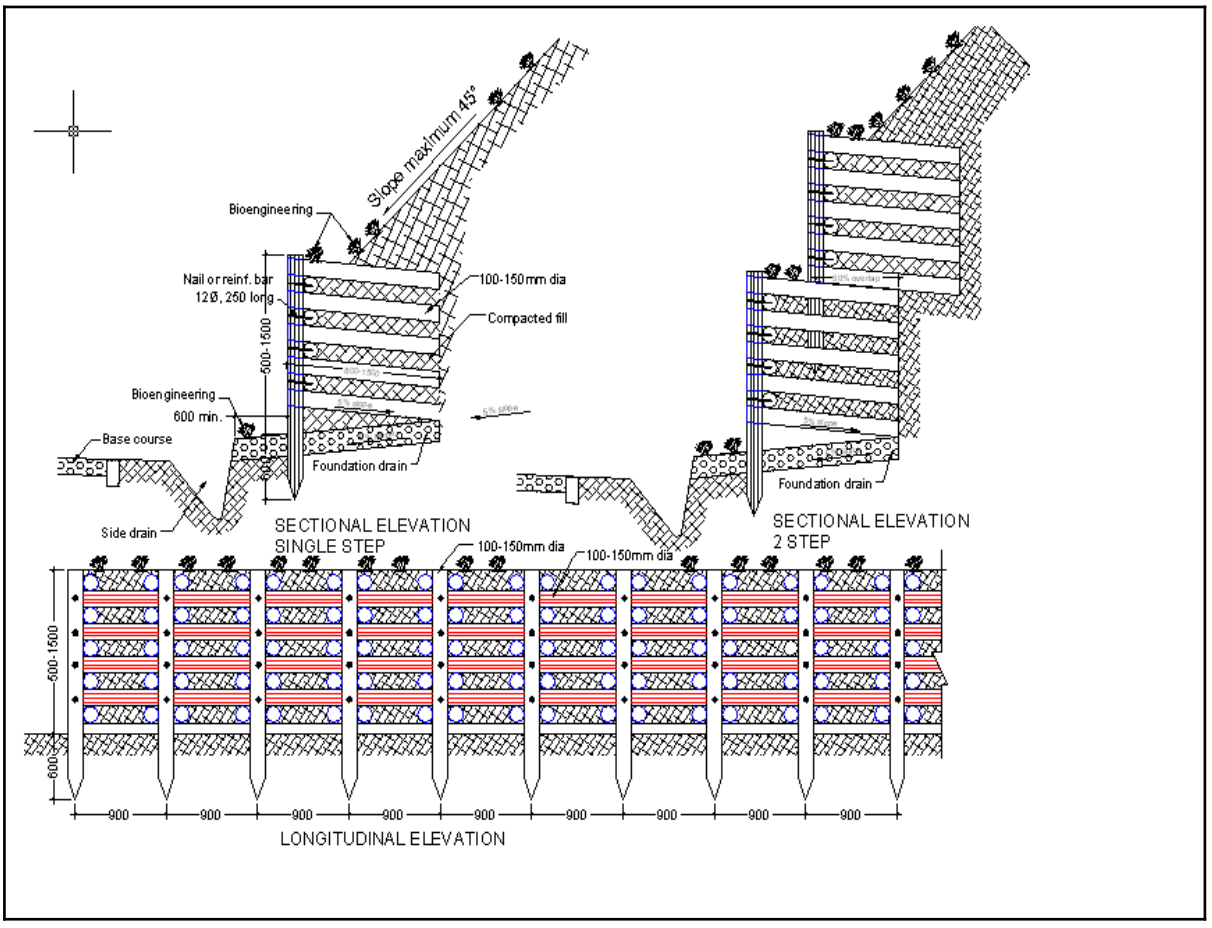



**Figure 5.21.3** Crib wall

**Measurements:** The length and height of the finished works shall be measured correct to 10mm and area calculated correct to two places of decimal.

**Rates:** The rate shall, unless otherwise stated, include for excavation to foundation level, disposal of surplus excavated materials within 50 m lead where necessary, providing, laying timber sections as specified back filling with compaction, reinstatement of (road) surfaces works, bioengineering as well as all labour, equipment, tools and incidentals necessary to complete the works.

**Construction of Barriers**

Barriers are to be constructed on the valley side of the road in advance of the formation cutting. The purpose of barriers is to stop material from falling further down the valley side slopes. As such the barriers need to be constructed as and where possible at distances of about 5-10 below the road edge. The barriers have no permanent retaining function and their function needs therefore to be taken over in time by bio-engineering works (e.g. deep rooting vegetation), which will have to be taken up on the slopes above the barriers. In principle two different types of barriers are taken up in the contracts, the log barrier and the bolder barrier.

***1. Log Barriers***

*RW0080 Providing and constructing log barriers with logs fell from the alignment of the road, girth not less than 300 mm, height not exceeding 1.0 m, 20 deg. maximum inclination to the road alignment within 50m lead.*

Log barriers are ideal support structures in forest covered areas to withhold side carted spoil material. Log barriers consist of logs laid onto each other maximum 2 logs and will be held by placing them against two standing trees. Logs with girth minimum 300 mm shall be used and the total height shall not exceed 1.0 meter. Their inclination against the road alignment shall not exceed 20º.

Log barriers shall be built wherever useful in pairs. The first barrier shall be 5-10 m below the road edge. The same distance shall be kept between the first and second barrier. The exact position of the barrier will depend on the actual site conditions and will be determined by the Engineer. The barriers must form a closed line along the road slope so that all material dipped over the road edge will be withheld by the barriers.

QA/QC

- Construct log barriers only where it is useful i.e. the spoil material is available.
- If the first barrier is not sufficient to accommodate the backfill, construct the second one to prevent the spill over.
- Construct barriers with the trees that have fallen from the road alignment.
- Provide adequate support to the logs to prevent collapse.
- Carry out Bioengineering after completion.

**Measurement:** The length shall be measured in the running meter correct to 10 mm and the quantity calculated nearest to two places of decimal.

**Rates:** The rate shall include the cost of obtaining, transporting and placing of the logs at the indicated place of use including cost of materials, labour plants and equipment required for the complete operation.

### *1. Boulder barrier*

*RW0081* *Providing and constructing boulder barriers, height not exceeding 1.5 m, maximum inclination of 20 deg. to the road alignment and width not less than 900 mm within 50m lead.*

In places where boulders are available a rough type of "dry wall" can be constructed by placing boulders in a row and on top of each other. Boulder barriers shall be built where possible in pairs. The first barrier shall be 5-10 m below the road edge. The same distance shall be kept if possible between the first and second barrier. The exact position of the barrier will depend on the actual site conditions and will be determined by the Engineer.

The barriers must form a closed line along the road slope so that all material dipped over the road edge will be withheld by the barriers. The boulders will be placed in such a way that larger boulders will form the first layer and smaller boulders the layer(s) above. The packing of the boulders shall be done in such a way that the barrier can withstand the future pressure of the throw material.

The maximum height of the boulder barrier will depend on the size of available boulders and the amount of throw material estimated and will in principle not exceed 1.5 meters. The inclination of the row against the road alignment shall not exceed 20º.

QA/QC

- Construct boulder barriers only where it is useful.
- If the first barrier is not sufficient to accommodate the backfill, construct the second one to prevent the spill over.
- Restrict the height of the wall as specified to prevent failures.
- Carry out bioengineering works to replace these structures in future.

**Measurement:** The length,width and height shall be measured in cubic metres correct to 10 mm and quantity calculated nearest to two places of decimal.

**Rates:** The rate shall include the cost of obtaining, transport and placing of the boulders at the indicated place of use and to the necessary dimensions of the barrier, including the cost of labour, plants and equipment required for the complete operation.

### *2. Trench barrier*

*RW0082* *Trench Barrier - excavate 600mm wide trench 2-2.5m deep, Form compacted earth bund immediately adjacent and downhill of trench. 20-45 degree maximum inclination to the horizontal line as per drawings and technical specifications.*

In places where neither standing trees nor boulders are available a trench barrier can be constructed below the formation cut. The first barrier shall be 5-10 m below the road edge. A trench not less than 600mm shall be dug parallel to the road, between 2-2.5m deep. The material arising from this trench shall be used to construct a bund on the downhill side of the trench to increase the effective height of the barrier. The exact position of the barrier will depend on the actual site conditions and will be determined by the Project Manager.

Additional barriers may be dug within 10-15m of the first if large quantities of spoil are expected.

**QA/QC**

- Identify areas where trench barriers can be constructed and where slope will cause falling spoil
- Construct a second parallel barrier below the first before undertaking the cut, if spill over or barrier collapse is a risk
- Place excavated material on the downhill side of the trench and compact to provide additional effective height of the barrier
- Carry out Bioengineering after completion

**Measurement:** The length shall be measured in running metre correct to 10 mm and quantity calculated nearest to two places of decimal.

**Item Coverage:** The rate shall include the cost of obtaining, transport and placing of the boulders at the indicated place of use and to the necessary dimensions of the barrier, including the cost of labour, plants and equipment required for the complete operation

**5.21.6 Water management Structures**

**Construction of Pipe Culverts**

**RC Hume pipes**

- *Providing and laying NP2 class RC pipes, including Collars, jointing in cement mortar 1:2 including visual inspection of joints etc. Including excavation, supply and placing of gravel bedding and suitable trench backfill as per the contract drawings*

*RW0085 900 mm dia*

*RW0086 1050 mm dia*

*RW0087 1200 mm dia*

The quantities and unit rates for the provision and laying of Hume pipes specified in the Bill of Quantities are for culverts under the road embankment as well as for provision of drainage of spoil disposal sites, as per design and instructions of the Engineer.

**Excavation**

The ground shall be excavated to the lines and depths shown on the Drawings or to such other lines and depths as the Engineer may direct. Trenches shall be of sufficient width to enable the pipes to be properly laid, jointed and haunched. Should the Contractor desire to use a mechanical plant for excavating trenches or for laying pipes he shall submit his proposals for approval by the Engineer, but such approval will not relieve the Contractor from responsibility for damage to pipes.

**Water in Pipe Excavations**

Trenches shall be kept free from water, until, in the opinion of the Engineer, the works will not suffer any deleterious effect from water. The Contractor shall, at his own expense, construct any sumps or temporary drains that the Engineer may consider necessary. The Contractor shall make good at his own expense, any damage caused by prolonged and excessive pumping, and shall take all precautions necessary for the safety of adjoining structures and buildings by shoring or otherwise, during the time the trenches are open.

**Laying of Concrete Pipes**

Concrete pipes shall comply with the requirements of I.S. 458-1971. The pipes shall be laid true to line and level, commencing at the outfall, each pipe being separately boned between sight rails. Laying of pipes shall proceed with the upgrade of a slope. Before placing the pipe culverts, the bottom width of the excavation shall be covered with a drainage layer of stones of specification and depth as noted on the contract drawings.

Where the required pipe length (as determined by the carriageway width, shoulder width etc) is not a multiple of the standard pipe size, then the contractor shall not be paid for any additional length of pipe that he installs.

In the event that the pipe is installed over the design length which results in the need for scour or other water protection measures deemed necessary by the Engineer, then these shall be provided at the contractor's own cost.

**Table 5.21.5** PHYSICAL REQUIREMENT OF REINFORCED CONCRETE LIGHT DUTY NON-PRESSURE PIPE CLASS NP2

| Internal Diameter (mm) | Min Wall Thickness of Pipe (mm) | Caulking Space (mm) | Wall Thickness of Collar (mm) | Width of Collar (mm) |
|---|---|---|---|---|
| 900 | 50 | 19 | 50 | 200 |
| 1200 | 65 | 19 | 65 | 200 |

Loading, transporting and unloading of concrete pipes shall be done with care. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain block is recommended. All pipe sections and connections shall be inspected carefully before being laid. Broken or defective pipes or connections shall not be used. Pipes shall be lowered into the trenches carefully. Mechanical appliances may be used.

In cases where the foundation conditions are unusual such as in the proximity of trees or holes, under existing or proposed tracks, manholes etc. the pipe shall be encased all round in compacted sand or gravel for its full length.

In cases where the natural foundation is inadequate the pipes shall be laid either in a concrete cradle supported on proper foundations or on any other suitable designed structure. If concrete cradle bedding is used, the depth of concrete below the bottom of the pipe shall be at least $1/4^{th}$ of the internal diameter of pipe subject to the minimum of 10 cm and a maximum 30 cm. The concrete shall extend up the side of the pipe at least to a distance of $1/4^{th}$ of the outside diameter of the pipe. The pipe shall be laid in this concrete bedding before the concrete has set. Pipes laid in trenches in earth shall be bedded evenly and firmly in compacted sand or gravel at least to a distance of $1/3^{rd}$ of the outside diameter of the pipe. Necessary provision shall be made for joints wherever required.

When the pipe is laid in a trench in rock hard clay, shale or other hard materials the space below the pipe shall be excavated and replaced with an equalising bed of concrete, sand, gravel or compacted earth. In no place shall pipe be laid directly on such hard materials.

When the pipes are laid completely above the ground, the foundations shall be made even and sufficiently compacted to support the pipeline without any materials settlement. Alternatively the pipe line shall be supported on rigid foundations at intervals. Suitable arrangements shall be made to retain the pipe line in the proper alignment, such as by

shaping the top of the supports to fit the lower part of the pipe. The distance between the supports shall be by a max of 2.5m centres, and not more than 300mm either side of any joints. In no case shall the joint come in the centre of the span. Care shall be taken to see that superimposed loads greater than the total load equivalent to the weight of the pipe when running full shall not be permitted.

Where joints are to be made with loose collars, the collars shall be slipped on before the next pipe is laid. Adequate and proper expansion joints shall be provided where directed.

Special care shall be taken to see that any excess of cement mortar is neatly cleaned off while each joint is being made and any earth, cement or other material thoroughly cleansed out of the pipes. A properly fitted plug shall be well secured at the ends of each pipe already laid and shall be removed only when the next pipe is being laid or on completion of the culvert or pipe line. The excavations shall be kept free from water until the joints are thoroughly set.

**Jointing of Concrete Pipes**

Joints are generally of rigid type. Where specified flexible type joints may also be provided. Cement mortar for jointing pipes shall consist of 1 (cement):2 (sand) by volume. The materials shall be accurately gauged and mixed in an approved manner. Cement mortar shall be made in suitable small quantities only as and when required, and any motor, which has begun to set, or which has been mixed for a period of more than one hour shall be rejected.

**Rigid Collar Joint**

This is a rigid joint. The two adjoining pipes shall be butted against each other and adjusted in correct positions. The collar shall then be slipped over the joint, covering equally both the pipes. The annular space shall be filled with a stiff mixture of cement mortar 1 (cement):2 (sand) by volume), which shall be rammed with a caulking tool. After day's work any extraneous materials shall be removed from the inside of the pipe and the newly made joint shall be cured.

***Semi Flexible Collar Joint***

This is made up of a loose collar, which covers two specially shaped pipe ends. Each end shall be fitted with a rubber ring which when compressed between the spigot and the collar, seal the joint. A stiff mixture of cement mortar 1 (cement):2 (sand) shall then be filled into the remaining work, any extraneous materials shall be removed from the inside of the pipe and the newly made joints shall be cured.

***Socket and spigot joint***

The spigot of each pipe shall be placed home in the socket of the one previously laid, and the pipe then adjusted and fixed in the correct position with the spigot of the pipe accurately centred in the socket. A ring of gaskin or tarred rope yarn shall be inserted in the socket of each pipe previously laid and driven home with a wood caulking tool and wooden mallet; such yarn when in position shall not occupy more than one quarter of the total depth of the socket. The socket shall then be completely filled with cement mortar 1 (cement):2 (sand) and a fillet shall be bevelled off and extend for a length not less than 50 mm from the face of the socket. The newly made cement fillet shall be protected by means of a cover of damp hessian, which shall be kept moist for at least 24 hours after forming.

**Pipe to be Left Clean on Completion**

On completion, all pipe lines shall be flushed from end to end with water and left clean and free from obstructions.

**Pipes Bedded and Haunched With Concrete**

Where shown on the Drawings or directed by the Engineer, pipes shall be bedded, surrounded and/or haunched with PCC M5:40. In carrying out this work the Contractor shall take care to pack the concrete under the around the pipes to ensure even bedding and solidity in the concrete in no instance shall the concrete be thrown directly on the pipes. The upper surface of the concrete shall be struck off with a wooden screed and neatly finished off.

**Refilling Trenches**

Backfill to depth of D/3mm of the pipe from its base shall be with filter material as **Section G14.** All remaining backfill shall comply with **Section D9** to at least 600mm or D/2 above the pipe. (where D is the nominal internal diameter of the pipe). Backfill for concrete pipes and minor drainage structures shall be obtained from the material excavated in forming the excavation and in the event of there being insufficient excavated material or the culvert is laid close to or above existing ground level then selected backfill shall be obtained from borrow pits.

The remainder of the trench shall then be backfilled with best selected material available, placed in layers not exceeding 150 mm loose thickness, mixed, watered or dried as necessary and compacted.

All backfilling material shall be compacted to a minimum dry density of 95% of MDD (Heavy Compaction).

For pipe culverts which have been constructed close to, above or where the culverts protrude above the existing ground the backfilling under the flanks and alongside and over the culverts shall be placed and compacted in layers not exceeding 150 mm after compaction to 95% MDD. The width of backfilling along the flanks of the culvert shall be at least (2 + 1.5h) metres from each side of the culvert (Where 'h' is the height from the underside of the layer being compacted to the crown of the pipe in metres). All existing ground under this backfill shall be compacted to 95% MDD (Heavy Compaction) to a depth of 150 mm.

The material used for filling alongside the culvert above existing ground shall be the same material as will be used for the adjacent fill and no additional payment will be made than that provided for the fill in **Section D10** of this Specification.

Backfilling shall be carried out simultaneously and equally on both sides of the culvert to avoid unequal lateral forces.

In all cases there shall be cover of at least 600mm or D/2 mm over the crown of the culvert before construction equipment is driven over it unless other protective measures approved by the Project Manager have been provided.

**Measurement**

All measurement will be done in accordance with the specific item coverage for the works as noted elsewhere

**5.21.6.1 Drains**

***1. Lined Catch Drains***

*RW0090 Construction of lined catch drains as per drawings including excavation and delivery of materials.*

**Materials**

**Stone**

The stones shall be of durable nature from quarry or excavation and be angular in shape. If boulders are used, they shall be broken into angular pieces. The stone shall be sound, hard, and free from iron bands, spots, sand holes, flaws, shakes, cracks or other defects. At least 80% of the stones shall have individual volumes of more than 0.01 m3. Representative samples of stone intended for use in the Works shall be submitted for the Engineer's prior approval. Further representative samples shall be submitted for approval whenever there is a change in the type or strength of rock that the Contractor intends to use in masonry work.

**Mortar**

Mortar for masonry shall comply with IS 2250 Code of Practice for preparation and use of mortar. Mortar shall be of mix ratio 1:3 (I Cement: 3 Sand) by volume. For field conditions the mortar strength shall be at least 30 percent higher than the laboratory strength.

Cement and sand may also be mixed in specified proportions. Cement shall be proportioned only by weight, by taking its unit weight as 1.44 tonne/m3 and sand shall be proportioned by volume after making due allowance for bulking. The required quantity of water shall then be added and the mortar mixed to produce workable consistency.

Sand shall comply with IS 2116.

If hand mixing is done, the operation shall be carried out on a clear water tight platform, cement and sand shall be first mixed dry in the required proportion to obtain a uniform colour and then the mortar shall be mixed for at least two minutes after addition of water.

Only sufficient mortar that can be used before it becomes unworkable shall be mixed. Any mortar that has become unworkable shall not be used in the Works. On no account shall mortar be re-wet to make it workable.

Where mortared masonry faces will remain exposed the mortared joints shall be pointed to a consistent style to the satisfaction of the Engineer, and excess mortar shall not be unnecessarily plastered over exposed stonework.

**Excavation**

The excavation for the drain shall be done according to the Drawings provided and the cut material placed without compaction as a bund immediately on the valley side of the cut. The bottom of the excavation shall be levelled carefully. Any pockets of soft material or loose rock in the bottom of the excavation shall be removed and the resulting cavities filled with suitable material and compacted.

**Construction**

Construction shall be carried out generally in accordance with IS 1597-1967, Code of Practice for construction of stone masonry.

The length of any stone shall not exceed three times its height. The breadth on the bed shall be not less than 150 mm nor greater than ¾ the thickness of the wall. All stratified stone possessing bedding planes shall be laid with its natural bed as nearly as possible at right angles to the direction of load.

All stones shall be carefully shaped to obtain as close a fit as possible at all beds and joints, any interstices between the stones being filled with selected stone spalls. The stone courses shall be laid perpendicular to the face batter. The exposed tops shall be formed as shown on the Drawings.

After the stones have been laid, all spaces between them shall be filled with clean rock fragments, crushed rock or gravel of which not more than 15% shall pass through a 19 mm sieve. The material shall be carefully hand tamped into place. The grout shall consist of 1 part Portland cement in 3 parts sand measured volumetrically and mixed with sufficient water to produce the desired consistency. The interstices between the stones shall be completely filled with grout throughout the entire thickness of the dry stone masonry after which the surface shall be swept with a stiff broom. Grouting operations on slopes shall progress from the bottom of the slope towards the top.

For lined catch drains a 50 mm bed of mortar shall first be placed on the prepared ground surface. The dry stone masonry shall be bedded in the mortar and the method of laying completed as described above such that after grouting there shall be no voids in the completed layer.

As shown on the Drawings, the upper half of the mountainside wall of the catch drain shall be provided with weep holes.

QA/QC

- The surface where the drain needs to be constructed shall be prepared to the required levels/slopes with full compaction of the base to prevent future settlement.
- Ensure that the drain has a uniform slope with no ponding. The surface of the drain shall be smooth finish.
- The water shall be allowed to run only when the concrete work is fully set to avoid scouring of the concrete surface.

**Measurement:** The length shall be measured in the running meter correct to 10 mm.

**Rates:** The cost of excavation to foundation level, back filling and providing and delivery of stones, sand from quarry and their preparation to use for the completion of the works as well as all labour, equipment, tools, cement and incidentals necessary to complete the works as specified must be included in the concerned contract rate.

***2. French Drains***

- *Construction of French drain, including jungle clearance, earth work in excavation, levelling of excavated earth to the sides, filling drain with 50-100 mm stones, complete as per the design.*

*RW0095* *Drain size 0.6 X 1.0 m*

*RW0096* *Drain size 1.0 X 1.5 m*

**Materials**

*The stones used for the filling of the French drain shall be of a size between 50 - 100 mm*.

**Excavation and Filling**

The excavation for the drain shall be done according to Drawings and the cut material must be equally distributed to the left and right of the drain over an area of about 1-2 m, without

compaction. For the filling of the drain, the stones may be thrown into the drain at random, careful stacking is not required.

QA/QC

- The excavation for the main and tributary drain shall be to the required depth as mentioned in the specification.
- The sides of the trench shall be excavated slightly inclined to give more stability and to prevent collapse of the vertical trench sides.
- The excavated earth shall be placed towards the downhill of the drain not to block the water. The excavated earth shall be placed uniformly avoiding heaps and lumps.
- The stone used for filling shall be 50 to 100 mm, filled randomly.
- The alignment of the drain shall be in herringbone pattern for quick collection and drainage of water.

**Measurement:** The length of the French drain shall be measured in running metres correct to 10mm.

**Rate:** The rate shall include for all the operation involved above to complete the work including labour, material, excavation, filling, equipment hired/owned, tools and plants and other incidentals.

***2. Construction of Foundation Drains***

*RW0100 Construction of foundation drains of minimum size 200 mm wide & 250 mm deep with stone fill of average size 50-100 mm as per drawing or as directed by the Engineer including excavation and delivery of materials.*

**Materials**

*The stones used for the filling of the foundation drains shall be of size between 50 - 100 mm*.

**Excavation and Filling**

The excavation for the foundation drains shall be done according to Drawings and the cut material deposited outside the foundation for re-use. For the filling of the drains, the stones may be thrown into the drain at random, careful stacking is not required.

QA/QC

- The foundation drain shall be sufficiently sloped and filled with stones of 50 to 100 mm. The drain shall be provided both length and cross wise.

**Measurement:** The length shall be measured in the running meter correct to 10 mm.

**Rates:** The rate shall include cost of all labour and material required for the complete operation described above.

**3. Construction of a V-shaped drain.**

*- Construction of V-shaped stone pitched drain including excavation, levelling and disposal of surplus earth within 50m.*

*RW0105 depth 300 mm and width 600 mm*

*RW0106 depth 300 mm and width 450 mm*

*RW0107 depth 500 mm and width 600 mm.*

*RW0108 Construction of lined V-shaped drain 600X300 with 50mm thick PCC 1:2:4, 150mm thick stone soling, RRM in CM 1:5 on sides, finished with 20mm thick 1:4 cement plaster including excavation, levelling and disposal of surplus earth within 50m*

Trenches shall be made along the edge of the road where the drain is to be constructed. The excavation shall be done exactly to the required profile giving specified slope. The surface shall be levelled to uniform grade/level and rammed. The drain shall be maintained throughout the construction and defect liability period therefore the contractor shall keep provision in his rates for such maintenance and nothing extra shall be paid.

For the lined drain the relevant specification for concreting, soling and plastering shall be followed. The surface of the concrete shall be finished smooth. Any rough surface shall be made smooth by adding a dry mix of cement and sand 1:3 (1 cement: 3 sand) on the surface immediately after concreting when the concrete is still green. No extra shall be paid for such finishes. All work shall be carried out as per the drawing and specification or as directed by the Engineer.

QA/QC

- Check the slope of the drain; it should be uniform to avoid ponding.
- The size of the drain shall not be more than the specified size.
- In case of earth drain, it shall be made by excavation and compaction of sides and bottoms, neatly finished. If the drain is made by filling, the filled earth shall be compacted as per the specification for embankment and filling.
- In case of lined drain sufficient time should be given to set and hardened the concrete before allowing the water to flow.
- All concrete and masonry work shall be thoroughly cured not less than 28 days.

**Measurement:** The length shall be measured in the running meter correct to 10mm.

**Rates:** The rates shall include the cost of all material and labour involved in the above operation.

### 5.21.6.2 Other Water Management Structures

#### *1. Vented Causeways*

*RW0110 Providing and constructing vented cause ways as per design including delivery of materials.*

**Excavation**

The ground shall be excavated to the lines and depths shown on the Drawings with a gradient of 5% in the flow direction or to such other lines and depths as the Engineer may direct. Trenches shall be kept free from water, until, in the opinion of the Engineer, the works will not suffer any deleterious effect from water. The Contractor shall, at his own expense, construct any sumps or temporary drains that the Engineer may consider necessary.

**Laying & Jointing of Concrete Pipes**

Laying and Jointing of pipes shall be as for NP2 class RC pipes in chapter 4

**Refilling of Trenches**

Refilling of trenches shall be as for NP2 class RC pipes in chapter 4

**Preparation of Surface for Bedding**

The bed on which the stone pitching is to be laid as a basis for the concrete causeway slab shall be with an even surface. If necessary cavities between rock protrusions shall be filled with material similar to that specified for gabion filling

**Temperature Reinforcement**

The temperature reinforcement shall confirm to Indian Standards IS: 1786 – 1985. The reinforcement shall be laid on top allowing a minimum cover of 40 mm.

**QA/QC**

- The slope of the causeway shall be not more than 1 in 20 (5% in flow direction) and cross slope of 10:1 (Span: Depth).
- The causeway shall not contract the stream and shall be built at right angles to prevent scouring.
- Protection work shall be done in the upstream and the down stream as per the specification.
- The temperature reinforcement of specified diameter shall be laid at spacing mentioned in the drawing.

**Measurement:** The length and breadth of completed causeway shall be measured correctly to 10 mm and the area calculated nearest to two places decimal.

**Rates:** The rate shall include the cost of all the materials and labour involved in the complete completion of causeway including delivery of materials, laying of RC pipes & other incidentals involved in the above operation to complete the work.

***2. Submersible Causeway***

**Excavation**

The slope of the causeway shall be not more than 7% in flow direction and cross slope of 10:1. The actual length of the causeway will be determined by the natural FRL-IL depth

The ground shall be excavated to the lines and depths shown on the Drawings with a gradient of 7% in the flow direction or to such other lines and depths as the Project Manager may direct. Trenches shall be kept free from water, until, in the opinion of the Project Manager, the works will not suffer any deleterious effect from water. The Contractor shall, at his own expense, construct any sumps or temporary drains that the Project Manager may consider necessary.

The approach to the causeway shall be at 5% for not less than 10m.

**Preparation of Surface for Bedding**

The bed on which the stone pitching is to be laid as a basis for the concrete causeway slab shall be with an even surface. If necessary cavities between rock protrusions shall be filled with material similar to that specified for gabion filling.

**Reinforcement**

The reinforcement shall conform to Indian Standards IS :1786 – 1985. The reinforcement shall be laid allowing a minimum cover of 40 mm, 10mm dia at 200mm spacing top and bottom

**Measurement:** All measurement will be done in accordance with the specific item coverage for the works as noted elsewhere

**Table 5.21.6** SAMPLE ITEM COVERAGE OF SUBMERSIBLE CAUSEWAY

| | |
|---|---|
| Excavation – all soil and rock | RRM 1:6 (walls) |
| Provision of geotextile and 600mm width of filter material for full height and width of structure. | Plain Concrete M10 (foundation to walls) |
| Backfilling of structures | RCC slab M20:20 |

**Item Coverage:** The rate shall include the cost of all the materials and labour involved in the complete completion of causeway including protection works and walls.

***3. Check Dams***

*- Construction of check dams using gabion boxes as per drawing including excavation of foundations, side and back filling and delivery of materials.*

*RW0111 Check dams for height 1m*

*RW0112 Check dams for height 2m*

Because check dams need to be flexible and free draining they are generally constructed in gabion. Check dams should normally be placed to protect weak parts of a gully from scour, natural nick points and the foot of the debris heaps. The base of the dam should be at least 60 cm thick if it is 1m high, for every additional meter of height increase the base width by 30 cm. An apron shall be provided below the dam to ensure that energy is dissipated and that flow continues in the centre of the gully below the check dam. The wings and the sides shall be back filled and compacted thoroughly.

For the materials to be used and other details refer to specification on gabion walls.

QA/QC

- Select the best location of the wall for maximum effect.
- Use local and best draining material for construction of check dams.
- If a masonry wall is used, provide adequate weep holes.
- Provide protection works if necessary below the dam to avoid scouring.
- Back fill the trenches after construction.

**Measurements:** The length, breadth and height of the wall shall be measured correct to 10mm and volume calculated nearest to two places of decimal.

**Rates:** The rate shall include all the cost of material, labour, equipment hired/owned, tools and plants and other incidentals involved in the above operation to complete the work.

### *4. Rip Raps*

*RW0113 Providing and constructing rip-rap with boulders weighing not less than 35 kgs including cost of material, labour, excavation and backfilling.*

If the amount of runoff water in perennial or seasonal water streams has been increased due to discharge water from side drains, bed scouring or erosion may occur. In case of moderate increase of velocity, ripraps may be a suitable solution to prevent such damages.

Ripraps consist of the placement of heavy boulders into the stream bed in the form of steps to reduce the water velocity back to the original intensity.

The boulders to be used must be of angular form and have a weight of at least 35 kg.

QA/QC

- In case of vegetated rip-rap, the vegetation should not obstruct the flow.
- The rip-raps shall be constructed with the stones keeping the flattest sides on the surface.
- All voids in between shall be filled with soil.

**Measurements:** The length of the completed works shall be measured in running metre correct to 10mm and quantity calculated nearest to two places of decimal.

**Rates:** The rate shall include surface preparation, providing and placing of stones, boulders as well as all labours, equipment, tools and incidentals necessary to complete the work.

### *5. Chute*

*RW0114 Providing and constructing of chute as per drawing including delivery of materials.*

Chutes are suitable for small streams only (width not more than 3.00 meters). They are usually provided to reduce the velocity of stream water by constructing a series of steps (gabion) across the stream bed. The steps are linked together with a gabion mat. Gabion mats and steps are protected by a concrete layer of 50 mm thickness.

Between two gabion steps, the length of the gabion mats should be 3 m and their gradient should not exceed 10%.

For the construction of gabion steps and mats refer to technical specifications E2, Clause 2.

QA/QC:

- Check the samples to meet the requirements before mass supply.
- Check the diameter of wire used for the gabion boxes; it shall not be less than specified diameters.
- The galvanizing shall be with extra heavy coating to comply with the weight of deposition with IS 4826-1979.
- Conduct adhesion test, zinc coating, tensile strength and bending test as per IS 280 and IS4826-1979.
- The tolerance on diameter of wire shall be 2.5% with the tensile strength of 300 to 550 N/sqmm.

- The hexagonal mesh size shall be 100mmX120mm with minimum of doubly twisted.
- The gabion box compartments shall be filled slightly over-full to allow for subsequent settlement.
- The vertical joints shall be staggered and should not be continuous.
- The diaphragms shall be of same materials as that of parent gabion and shall have selvedge wire throughout the perimeter.
- All the filled stones shall be bedded on each other as in dry rubble masonry on all sides.
- All edges of the crates shall be finished with selvedge wire.
- Inspect all the laid boxes before and after the fill on each layer.
- The concrete layer must be as specified in the drawing.

**Measurement:** The length of the completed works shall be measured in the running meter correctly to 10mm and the quantity calculated nearest to two places of decimal.

**Rates:** The rates shall include excavation, surface preparation, providing, transportation and placing of all materials as well as all labour, equipment, tools and incidentals necessary to complete the works.

### *6. Sub-surface Drains*

Sub-surface drains shall be of close-jointed perforated pipes, open-jointed unperforated pipes, surrounded by granular material laid in a trench or aggregate drains to drain the pavement courses. Sub-surface drains designed using Geotextiles and approved by the Engineer can also be used.

**Other Materials:**

**A.** **Pipe:** Perforated pipes for the drains may be of cement, cement concrete or PVC, and unperforated pipes of vitrified clay, cement concrete or asbestos cement. The type, size and grade of the pipe to be used shall be as specified in the Contract. In no case, however, shall the internal diameter of the pipe be less than 100 mm. Holes for perforated pipes shall be on one half of the circumstance only and conform to the spacing indicated on the drawings. Size of the holes shall not ordinarily be greater than half of $D_{85}$ size of the material surrounding the pipe, subject to being minimum 3 mm and maximum 6 mm $D_{85}$ stands for the size of the sieve that allows 85 per cent of the material to pass through it.

B. **Backfill material:** Backfill material shall consist of sound, tough, hard durable particles of free draining sand-gravel material or crushed stone and shall be free of organic material, clay balls or other deleterious matter. Unless the Contract specifies any particular grading envelope for the backfill material or requires these to be designed on inverted filter criteria for filtration and permeability to the approval of the Engineer, the backfill material shall be provided on the following lines:

(i) Where the soil met with in the trench is of fine, grained type (e.g., silt, clay or a mixture thereof), the backfill material shall conform to **Class I** grading set out in-Table below.

(ii) Where the soil met within the trench is of coarse silt to medium sand or sandy type, the backfill material shall correspond to **Class II** grading of Table below.

(iii) Where soil met with in the trench is gravely sand, the backfill material shall correspond to **Class III** grading of Table below.

Thickness of backfill material around the pipe shall be as shown on the drawings subject to being at least 150 mm all around in all cases.

**Trench Excavation:** Trench for sub-surface drain shall be excavated to the specified lines, grades and dimensions shown in the drawings provided that width of trench at pipe level shall not be less than 450 mm. The excavation shall begin at the outlet end of the drain and proceed towards the upper end. Where unsuitable material is met with at the trench bed, the same shall be removed to such depth as directed by the Engineer and backfilled with approved material which shall be thoroughly compacted to the specified degree.

**Table 5.21.7** GRADING REQUIREMENTS FOR FILTER MATERIAL

| Sieve Designation | Per cent passing by weight | | |
|---|---|---|---|
| | Class I | Class II | Class III |
| 53 mm | - | - | 100 |
| 45 mm | - | - | 97-100 |
| 26.5 mm | - | 100 | - |
| 22.4mm | - | 95-100 | 58-100 |
| 11.2 mm | 100 | 48-100 | 20-60 |
| 5.6 mm | 92-100 | 28-54 | 4-32 |
| 2.8 mm | 83-100 | 20-35 | 0-10 |
| 1.4 mm | 59-96 | - | 0-5 |
| 710 micron | 35-80 | 6-18 | - |
| 355 micron | 14-40 | 2-9 | - |
| 180 micron | 3-15 | - | - |
| 90 micron | 0-5 | 0-4 | 0-3 |

**Laying of pipe and backfilling:** Laying of pipe in the trench shall be stared at the outlet end and proceed towards the upper end, true to the lines and grades specified. Unless otherwise provided, the longitudinal gradient of the pipe shall not be less than 1 in 100.

Before placing the pipe, backfill material of the required grading (s) shall be laid for full width of the trench bed and compacted to a minimum thickness of 150 mm or as shown on the drawings. The pipe shall then be embedded firmly on the bed.

Perforated pipes shall be placed with their perforations upwards to ensure that water flows within the pipe to the discharge point. The pipe sections shall be joined securely with appropriate coupling fittings or bands.

Non-perforated pipes shall be laid with joints as close as possible with the open joints wrapped with suitable previous material (like double layer of hessian, suitable Geotextiles or some other material of not less than 150 mm width) to permit entry of water but prevent fines entering the pipes. In the case of non-perforated pipes with bell ends, the bell shall face upgrade.

Upgrade end sections of the pipe installation shall be tightly closed by means of concrete plugs or plugs fabricated from the same material as the pipe and securely held in place to prevent entry of soil materials.

After the pipe installation has been completed and approved, backfill material of the required grading(s) shall be placed over the pipe to the required level in horizontal layers not exceeding 150 mm in thickness and thoroughly compacted. The minimum thickness of material above the top of the pipe shall be 300 mm.

Excavated material shall be reused to create bunds to the downhill side of any trench. The material shall have any objects larger than 200mm removed before compaction.

**Use of geotextiles in laying of pipe and backfilling**: After excavating the trench for subsurface drain, the filter fabric shall be placed, the pipe installed and the trench backfilled with permeable material according to dimensions and details. Surfaces to receive filter fabric prior to placing shall be free of loose or extraneous material and sharp objects that may damage the filter fabric during installation. Adjacent rolls of the fabric shall be overlapped a minimum of 450 mm. The adjacent roll shall overlap the following roll in the direction the material is being spread.

*Any fabric that is damaged during construction shall be replaced or repaired by the Contractor at his expense.*

**Drain outlet:** The outlet for a sub-drain shall not be under water or plugged with debris but should be a free outlet discharging into a stream, culvert or open ditch. The bottom of the pipe shall be kept above high water in the ditch and the end protected with a grate or screen. For a length of 500 mm from the outlet end, the trench for pipe shall not be provided with granular material but backfilled with excavated soil and thoroughly compacted so as to stop water directly percolating from the backfill material around the pipe. The pipe in this section shall not have any perforations.

**Measurements for Payment**

Measurement for surface and sub-surface drains shall be per running metre length of the drain. Disposal of surplus material shall be included in the rate.

**Item Coverage**

The Contract unit rates for surface and sub-surface drains shall be payment in full for all items such as excavation, dressing the sides and bottom; providing geo-textile, providing, laying and joining pipes; providing, laying and compacting backfill and bed of granular material including all materials, labour, tools, equipment and other incidentals to complete the work with all leads and lifts except for removal of unsuitable material for which the lead shall be 1000m. The Contract unit rate for disposal of surplus and unsuitable material beyond the initial 1000 m lead.

### 5.21.7 Layer Works

#### 5.21.7.1 Hammer dressed stone edging

*SM00120* *Providing and laying Hammer dressed stone edging 150 x 250 mm with stones including excavation, refilling and disposal of surplus earth within lead 50 m lead*

Trenches shall first be made as directed by the Engineer. The stones shall be laid true to line and gradient. The joints shall not be more than 1 cm thick.

**QA/QC**

- Check the quality & size of the stones used for the edging.
- The gaps in between stones shall not be more than 10mm
- The stones shall be laid true to line and gradient with neat finish, its base properly compacted to make the stone stable.
- The edging stone must be bedded on the subgrade and reach the top of Basecourse. Therefore if subgrade layer is required, the edging stone should retain it

**Measurement:** The stone edging shall be measured in running metre correct to 10 mm.

**Rate:** The rate shall include all materials and labour involved in the work.

#### 5.21.7.2 Sub grade

**1. Preparation**

- *Preparation of sub grade by excavating earth to depth equal to the pavement thickness, consolidation with roller, disposal of surplus earth up to 50m*

*RW0121* *All kinds of soil*

*RW0122* *Blasted Rock*

*RW0123* *Consolidation of sub grade with roller and making good the undulation with earth and re-rolling the sub grade*

**Preparation of sub-grade:** The surface of the formation for a width of sub-base, which shall be 15 cm more on either side of base course, shall first be cut to a depth equal to the combined depth of sub-base and surface courses below the proposed finished level (due allowance being made for consolidation). It shall then be cleaned of all foreign substances. Any ruts or soft yielding patches that appear due to improper drainage conditions, traffic hauling or from any other cause, shall be corrected and the sub-grade dressed off parallel to the finished profile.

If a sub-grade composed of clay, fine sand or other soils that may be forced up into the coarse aggregate during rolling operations, an insulation layer of granular materials or over size brick aggregate not less than 10 cm thick of suitable thickness shall be provided for blanketing the sub-grade.

In slushy soil or in areas that are water logged, special arrangements shall be made to improve the sub-grade and the total pavement thickness shall be designed after testing the properties of the sub-grade soil. Necessary provision for the special treatment required shall be made in the project and paid for separately.

**Consolidation**: The sub-grade shall be consolidated with a power road roller of 8 to 12 tonnes. The roller shall run over the sub-grade till the soil is evenly and densely consolidated and behaves as elastic mass (the roller shall pass a minimum of 5 runs on the sub-grade). All the undulations in the surface that developed due to rolling shall be made good with material or quarry spoils as the case may be and the sub-grade is re-rolled.

**Surface Regularity:** The finished surface shall be uniform and conform to the lines, grades and typical cross-sections shown in the drawings. When tested with the template and straight edge, the variation shall be within the tolerances specified in the table below:

**Table 5.21.8** PERMISSIBLE TOLERANCES OF SURFACE REGULARITY

| Longitudinal profile | Cross profile |
|---|---|
| Maximum permissible undulation when measured with a 3 m straight edge<br><br>24 mm | Maximum permissible variation from specified profile when measured with a camber template<br><br>15 mm |

When the surface irregularity of the sub-grade falls outside the specified tolerances, the contractor shall rectify these with fresh material or quarry spoils as the case may be, and the sub-grade re-rolled to the satisfaction of the Engineer.

**Measurement:** The length and width shall be measured correct to a cm. The area shall be worked out in square metre, correct to two places of decimal.

**Rate:** The rate shall include the cost of materials and labour required for all the operations mentioned above, unless specified otherwise.

*RW0124 Extra for compaction of earth in embankments under suitable moisture conditions to give at least 95% of the proctor density*

In the case of earthwork consolidated under optimum moisture conditions, each layer of earth shall be carefully moistened to give field moisture content of about +1% to -2% of the optimum content (OMC). Each layer of uniform thickness not exceeding 200mm shall then be compacted by rolling with 8 to 10 tonnes power road roller and a sheep-foot roller if required. The required amount of water shall be added during consolidation to keep the moisture content of the soil at the optimum as per test. The density to be achieved shall not be less than 95% of the density obtained in the laboratory.

Each compacted layer shall be tested in the field for density and accepted before the operations for the next layer are begun. Control on compaction in the field shall be exercised through frequent moisture content and density determinations. A systematic record of these shall be maintained. At all times during construction the top of the embankment shall be maintained at such cross fall as will shed water and prevent ponding.

**Density Measurement and Acceptance Criteria:** One measurement of density shall be made for each 500 sq.m of compacted area or for a smaller area as directed by the Engineer. Each measurement shall consist of at least 5 density determinations and the average of these 5 determinations shall be treated as the field density achieved. In general the control at the top 40 cm thickness of the formation shall be stricter with density measurements being

done at the rate of one measurement for 250 sq.m of compacted area. Further for the determination of the mean density the number of tests in one measurement shall not be less than 10 and the work will be accepted if the mean dry density equals or exceeds the specified density.

When density measurements reveal any soft areas in the embankment, the Engineer shall direct that these be compacted further. If in spite of that the specified compaction is not achieved the material in the soft areas shall be removed and replaced by approved materials and compacted to the satisfaction of the Engineer. Should circumstances arise, owing to wet weather the moisture content cannot be reduced to the required amount by above procedure, compaction work shall be suspended.

**Control Tests on Borrow Material**: Soil suitable for consolidation under O.M.C. conditions should preferably have the following characteristics:

| | | |
|---|---|---|
| (a) | Minimum percentage of clay | 10% |
| b) | Liquid Limit | 14 |
| (c) | Plasticity index | 4 |
| (d) | Percentage of silt should not exceed | 50% |
| (e) | Peat, muck and organic soils are unsuitable. | |

The Engineer may, however, relax these requirements taking into account availability of materials, cost of transportation and other relevant factors. Various tests required to be conducted on the borrowed material with their recommended frequency are indicated below. All the tests need not be stipulated on every project. Depending upon site conditions etc. only some may be found necessary at a particular project. The frequency of testing indicated refers generally to the minimum number of tests to be conducted. The rate of testing must be stepped up as found necessary depending upon the variability of the materials and compaction methods employed at a project.

(a) Gradation: At least one test for each kind of soil. Usual rate of testing shall be 1 to 2 tests per 8000 cu.m of soil.

(b) Plasticity: At least one test for each kind of soil. Usual rate of testing shall be 1 to 2 tests per 8000 cu.m of soil.

(c) Proctor Tests: At the rate of 1 to 2 per 8000 cu.m of soil.

(d) Deleterious Contents: As required.

(e) Moisture Contents: One test for every 250 cu.m of soil.

**Measurement:** The filling shall be measured and the quantity of earthwork computed from cross-sections of filling or the embankment. No deduction shall be made for voids.

**Rate:** The rate shall include the testing, additional rolling to obtain required density in addition to the cost of materials and labour required for all the operations mentioned above.

**5.21.7.3 Sub-base/ Base**

**1. Granular Sub-base**

*RW0130 Providing and laying Granular sub-base course (GSB) to required degree of compaction with proper formation of cross fall using motor grader for laying and compacted to required density as per material gradation and aggregate quality specified.*

**Scope**: This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the engineer.

**Materials**: The material to be used for the work shall be natural sand, moorum, gravel, crushed stone, or combination thereof depending upon the grading required. Materials like crushed slag, crushed concrete, brick metal and kankar may be allowed only with the specific approval of the Engineer. The material shall be free from organic or other deleterious constituents and conform to one of the three gradings given in table 5.21.9 below.

**Table 5.21.9** GRADING FOR CLOSE GRADED GSB MATERIALS

| IS sieve Designation | % by weight passing the IS sieve | | |
|---|---|---|---|
| | **Grading I** | **Grading II** | **Grading III** |
| 75.0 mm | 100 | - | - |
| 53.0 mm | 80 – 100 | 100 | - |
| 26.5 mm | 55 – 90 | 0 – 100 | 100 |
| 9.50 mm | 35 – 65 | 0 – 80 | 65 – 95 |
| 4.75 mm | 25 – 55 | 0 – 65 | 50 – 80 |
| 2.36 mm | 20 – 40 | 0 – 50 | 40 – 65 |
| 0.425 mm | 10 – 25 | 5 – 25 | 20 – 35 |
| 0.075 mm | 3 – 10 | 3– 10 | 3 – 10 |
| in. CBR Value | 30 | 25 | 20 |

**Table 5.21.10** GRADING FOR COARSE GRADED GSB MATERIALS

| IS sieve Designation | % by weight passing the IS sieve | | |
|---|---|---|---|
| | **Grading 1** | **Grading II** | **Grading III** |
| 75.0 mm | 100 | - | - |
| 53.0 mm | | 100 | |
| 26.5 mm | 55 – 75 | 50 – 80 | 100 |
| 9.50 mm | | | |
| 4.75 mm | 10 – 30 | 15 – 35 | 25 - 45 |

| | | | |
|---|---|---|---|
| 2.36 mm | | | |
| 0.425 mm | | | |
| 0.075 mm | <10 | <10 | <10 |
| Min. CBR Value | 30 | 25 | 20 |

*Note: The material passing 425 micron sieve shall for all the three gradings when tested shall have liquid limit and plasticity index not more than 25 and 6 % respectively*

While the grading in table 5.21.9 are in respect of close-graded granular sub-base materials, one each for maximum particle size of 75 mm, 53 mm and 26.5 mm. The corresponding grading for the coarse graded materials for each of the three maximum particle sizes are given at table 5.21.10. The grading to be adopted for the project shall be as specified in the contract.

**Physical Requirements**: The materials shall have a 10 percent fines value of 50 KN or more (for sample in soaked condition) when tested in compliance with BS: 812(Part 111). The water absorption value of the coarse aggregate shall be determined as per IS: 2386 (Part 3); if this value is greater than 2 percent, the soundness test shall be carried out on the material delivered to the site as per IS: 383. For grading II and III materials, the CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions which shall be taken as being the density relating to a uniform air voids content of 5 percent.

**Strength of sub-base**: It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies the requirements of CBR and other physical requirements when compacted and finished.

When directed by the Engineer, this shall be verified by performing CBR tests as required on specimens remolded at field dry density and moisture content and any other tests for the “quality” of the materials, as may be necessary.

**Construction operations**

Preparation of subgrade: Immediately prior to the laying of the sub-base, the subgrade shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water if necessary, and rolled with two passes of an 80–100 kN smooth-wheeled roller.

Spreading and Compacting: The sub-base material of grading specified in the contract shall be spread on the prepared subgrade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and the grade during the operation or other means as approved by the engineer.

When the sub-base materials consist of a combination of materials mentioned above, mixing shall be mechanically done by the mix-in place method.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small sized jobs. The equipment used for mix-in-place construction shall be a rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, Trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS: 2720(Part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water for uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS: 2720 (Part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means like disc harrows, rotavators until the layer is uniformly wet.

Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 KN weigh may be used. For a compacted single layer up to 225 mm the compaction shall be done with the help of a vibratory roller of a minimum 80 to 100 KN static weight with plain drum or pad foot drum or heavy pneumatic tyred roller of minimum 200 to 300 KN weight having a minimum tyre pressure of 0.7 MN/m2 or equivalent capacity roller capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional cross fall and super-elevation and shall commence at the edges and progress towards the centre for portions having cross fall on both sides.

Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and cross fall (camber) shall be checked and any high spots or depressions, which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 Km per hour.

Rolling shall be continued till density is at least 98% of the maximum dry density for the material determined as per IS: 2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

**Measurements for payment:** GSB shall be measured as finished work in position in cubic meters. The protection of edges of granular sub-base extended over the full formation as shown in the drawing shall be considered incidental to the work of providing granular sub-base and as such no extra payment shall be made for the same.

**Rate:** The contract unit rate for granular sub-base shall be payment in full for carrying out the required operations.

**2. Wet Mix Macadam**

*RW0131* *Providing and laying wet mix macadam graded aggregate base course to required degree of compaction with proper formation of cross fall by using well graded crushed aggregates premixed with OMC using suitable mixer, motor grader as per material gradation and aggregate quality specified*

**Scope:** This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premised with water, to a dense mass on a prepared subgrade/sub-base/base or existing pavement as the case may be in accordance with the requirements of these specifications. The material shall be laid in one or more layers as

necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the engineer.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub-base course may be increased to 200mm upon approval of the engineer.

**Materials:**

*Aggregates:*

Physical Requirements: Coarse aggregates shall be crushed stone. If Gravel/shingle is used, not less than 90% by weight of the gravel/shingle pieces retained on 4.75mm sieve shall have at least two fractured faces. The aggregate shall conform to the physical requirements set forth in the table 5.21.11 below.

**Table 5.21.11**: PHYSICAL; REQUIREMENTS OF COARSE AGGREGATE FOR WMM FOR THE SUB-BASE BASE COURSE

| Test | Requirements |
|---|---|
| *Los Angeles abrasion value test or<br>An aggregate impact value test | 40 percent maximum<br>30 percent maximum |
| Combined flakiness and elongation indices(combined) | 30 percent maximum** |

**Aggregates may satisfy the requirements of either of the two tests*
***To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone divided by weight of stone sample. Only the elongated particles be separated out from the remaining non-flaky stone metal. Elongation index is the weight of elongated particles divided by total non-flaky particles. The value of flakiness index and elongation index so found are added up.*

If the water absorption value of the coarse aggregates is greater than 2 percent, the soundness test shall be carried out on the material delivered in the site as per IS: 2386 (part 5)

Grading Requirements: The aggregates shall conform to the grading given in the table 5.21.12

**Table 5.21.12** GRADING REQUIREMENTS OF AGGREGATES FOR WMM

| IS sieve Designation | % by weight passing the IS sieve |
|---|---|
| 53.00 mm | 100 |
| 45.00 mm | 95-100 |
| 26.50 mm | - |
| 22.40 mm | 60 – 80 |
| 11.20 mm | 40 – 60 |

| | |
|---|---|
| 4.75 mm | 25 – 40 |
| 2.36 mm | 15 – 30 |
| 600 micron | 8 – 22 |
| 75 micron | 0 – 8 |

Materials finer than 425 micron shall have plasticity index (PI) not exceeding

6.The final gradation approved within these limits shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve and vice-versa.

The aggregates can also conform to the grading given in the table below:

**Table 5.21.13** GRADING REQUIREMENTS OF AGGREGATES

| **Percentage by mass of total aggregate passing test sieve Nominal maximum particle size** | | |
|---|---|---|
| **37.5 mm** | **28 mm** | **20 mm** |
| 100 | - | - |
| 95-100 | 100 | - |
| - | - | - |
| 60-80 | 70 -85 | 90-100 |
| 40-60 | 50 – 65 | 60-75 |
| 25 – 40 | 35 – 55 | 40 – 60 |
| 15 – 30 | 25 – 40 | 30 – 45 |
| 7-19 | 12 – 24 | 13 – 27 |
| 5 – 12 | 5 – 12 | 5- 12 |

*Note: 1. For paver laid materials lower fines content may be accepted*

**Construction Operations**

Preparation of Base: The base of the sub-grade/sub-base/base shall be prepared to the specified lines and cross fall (camber) and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by sprinkling water.

Preparation of lateral confinement of aggregates: While constructing WMM, arrangement shall be made for the lateral confinement of wet mix. This shall be done laying materials in adjoining shoulders along with that of the WMM layer.

Preparation of Mix: WMM shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement like pug mill or pan type mixer of concrete batching plant. For small quantities of wet mix work, the engineer may permit the mixing to be done in concrete mixers.

Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part 8) after replacing the aggregate fraction retained on 22.4mm sieve with material of 4.75mm to 22.4mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

Spreading of mix: Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared sub-grade/sub-base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread by motor grader. For portions where mechanical means cannot be used, manual means as approved by the engineer shall be used. The motor grader shall be capable of spreading the material uniformly all over the surface. Its blade shall have hydraulic control suitable for initial adjustments and maintaining the same so as to achieve the specified slope and grade.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

Compaction: After the mix has been laid to the required thickness, grade and cross fall/camber the same shall be uniformly compacted, to the full depth with suitable roller. If the thickness of a single compacted layer does not exceed 100 mm, a smooth wheel roller of 80 to 100 KN weight may be used. For a compacted single layer up to 200 mm, the compaction shall be done with the help of vibratory roller of minimum static weight of 80 to 100 KN or equivalent capacity roller. The speed of the roller shall not exceed 5km/h.

In portions having a unidirectional cross fall/super-elevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, the roller should progress parallel to the center line of the road, uniformly overlapping each preceding track by at least one-third width until the entire surface had been rolled. Alternate trips of the roller shall be terminated in stops at least 1 m away from any preceding stop.

In portions in camber, rolling should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the center parallel to the centerline of the road uniformly overlapping each of the preceding track by at least one third width until the entire surface has been rolled.

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.

Along forms, kerbs, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching on an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

Rolling shall not be done when the subgrade is soft yielding or when it causes a wave like motion in the sub-base/base course or subgrade. If irregularities develop during rolling which exceeds 123 mm when tested with a 3 m straight edge, the surface should be

loosened and premixed material added or removed as required before rolling again as to achieve a uniform surface conforming to the desired grade and cross fall. In no case should the use of unmixed materials be permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 98% of the maximum dry density for the material.

After completion, the surface of any finished layer shall be well-closed, free from movement under compaction equipment or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and re-compacted.

Setting and Drying: After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hrs.

Opening to traffic: No vehicular traffic of any kind should be allowed on the finished wet mix macadam surface till it has dried and the wearing course laid.

**Measurement for payment**

WMM shall be measured as finished work in position in cubic meters.

**Rates:** The unit rate for WMM shall be payment in full for carrying out all the required operations.

**3. Prime Coat**

- *Providing and applying prime coat using bitumen emulsion conforming to IS: 8887, using asphalt/bitumen sprayer including preparing the surface and cleaning with a road broom.*

*RW0280 On W.M.M @0.75 kg/sq.m*
*RW0281 On W.B.M @0.4 kg/sq.m*

A prime coat means a thin layer of low viscosity bituminous binder applied to an absorbent non bituminous surface. If the prime coat is to be trafficked, it shall be covered with blinding material.

**Materials**

The primer shall be cationic bitumen emulsion SS1 grade conforming to 1S:8887

**Weather and seasonal limitations**

Primer shall not be applied during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 1O$^{o}$C. Surfaces which are to receive emulsion primer should be damp, but no free or standing water shall be present. The surface can be just wet by very light sprinkling of water.

**Equipment**

The primer shall be applied by a self-propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at specified rates and temperatures. Hand spraying shall not be allowed except in small areas, inaccessible to the distributor, or in narrow strips where primer shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

**Preparation of Road Surface**

The granular surface to be primed shall be swept clean by power brooms or mechanical sweepers and made free from dust. All loose material and other foreign material shall be removed completely. If soil/moorum binder has been used in the WBM surface, part of this should be brushed and removed to a depth of about 2 mm so as to achieve good penetration.

**Application of Bituminous Primer**

After preparation of the road surface, the primer shall be sprayed uniformly at the specified rate. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

No heating or dilution of SS1 bitumen emulsion shall be permitted at site. Temperature of bitumen shall be high enough to permit the primer to be sprayed effectively though the jets of the spray and to cover the surface uniformly.

**Curing of Primer and Opening to Traffic**

A primed surface shall be allowed to cure for at least 24 hours or such other higher period as is found to be necessary to allow all the moisture/volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with a light application of sand, using the minimum quantity possible. A primed surface shall not be opened to traffic other than that necessary to lay the next course

**Testing**

The minimum testing frequency for the purpose of process control shall be as given below

**Table 5.21.14** MINIMUM TESTING FREQUENCIES

| **Type of Construction** | **Test** | **Frequency (min.)** |
|---|---|---|
| Prime Coat/Tack Coat/Fog Spray | i) Quality of binder ii) Binder temperature for application iii) Rate of spread of Binder | Number of samples per lot and tests as per IS:73, IS:217 and IS:8887 as applicable at regular close intervals |

**TOLERANCES**

The actual rate of application of bituminous binder across the width of each spray run shall not vary by more than ±5% of the rate ordered and the actual rate of application of binder for each single run of the spray shall not vary from this specified rate by more than 0.03 litre per square metre.

If, after the application of the prime coat, the bituminous material fails to penetrate within

the time specified or if the road must be used by traffic, blinding material shall be spread in the amount required to absorb any excess bituminous material and to protect the primed surface

Blinding material shall be spread from trucks in such a manner that no wheel shall travel on uncovered bituminous material.
Unless the Engineer permits otherwise, all loose material on the sprayed surface, including any blinding material, shall be removed before any further layer of the pavement is laid.

**Measurement**

Prime coat shall be measured in terms of surface area of application in square metres.

**Rate**

The rate shall include the cost of materials and labour required to carry out all the operations.

**4. Tack coat**

- *Providing and applying tack coat using bitumen emulsion conforming to IS: 8887, using asphalt/bitumen sprayer including preparing the surface and cleaning with road broom.*

*RW0282* *On DBM/Prime coat @0.3 kg/sq.m*

*RW0283* *On old bituminous surface (resurfacing work) @0.75 kg/sq.m*

*RW0284* *Providing and applying tack coat using bitumen emulsion conforming to IS: 8887, including preparing the surface and cleaning with broom. On old bituminous surface (resurfacing work) @ 1.00kg/sq.m (Manually)*

**Scope**

The section shall consist of the application of a single coat of low viscosity liquid bituminous material to existing bituminous, cement concrete or primed granular surface preparatory to the superimposition of a bituminous mix, when specified in the Contract or as instructed by the Engineer.

**Materials**

The binder used for tack coat shall be either Cationic bitumen emulsion (RS 1) complying with IS:8887 or suitable low viscosity paving bitumen of VG 10 grade conforming to IS:73. The type and grade of binder for tack coat shall be as specified in the Contract or as directed by the Engineer.

**Weather and seasonal limitations**

Bituminous material shall not be applied during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10°C. Where the tack coat consists of emulsion, the surface shall be slightly damp, but not wet.

**Equipment**

The tack coat shall be applied by a self-propelled or towed bitumen pressure sprayer, equipped for spraying the material uniformly at a specified rate. Hand spraying shall not be permitted except in small areas, inaccessible to the distributor, or narrow strips, shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

**Preparation of Base**

The surface on which the tack coat is to be applied shall be clean and free from dust, dirt, and any extraneous material. The granular or stabilized surfaces shall be primed.
Immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom, and high-pressure air jet, or by other means as directed by the Engineer.

**Application of Tack Coat**

The tack coat shall be applied uniformly. No dilution or heating at site of RS1 bitumen emulsion shall be permitted. Paving bitumen if used for tack coat shall be heated to appropriate temperature in bitumen boilers to achieve viscosity less than 2 poise. The normal range of spraying temperature for a bituminous emulsion shall be 20°C to 70°C. The method of application of tack coat will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar, and speed or forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

**Curing of Tack Coat**

The tack coat shall be left to cure until all the volatiles have evaporated before any subsequent construction is started. No plant or vehicles shall be allowed on the tack coat other than those essential for the construction.

**Measurement**

Tack coat shall be measured in terms of surface area of application in square metres.

**Rate**

The rate shall include the cost of materials and labour required to carry out all the operations.

**5. Dense Bituminous Macadam (DBM)**

- *Providing and Laying Dense Bituminous Macadam ( DBM) to required degree of compaction based on job mixture design ( job mix formula) approved by the supervising engineer, by mechanized method as per material gradation and materials quality specified using VG 10 complete*

*RW0132 50 mm*

*RW0133 60 mm*

*RW0134 70 mm*

*RW0135 75 mm*

*RW0136 80mm*

- *Providing and Laying Dense Bituminous Macadam ( DBM) to required degree of compaction based on job mixture design ( job mix formula) approved by the supervising engineer, by mechanized method as per material gradation and materials quality specified using VG20/VG30 complete.*

*RW0400 50 mm*

*RW0401 60 mm*

*RW0402 70 mm*

*RW0403 75 mm*

*RW0404 80mm*

**Scope**: This clause specifies the construction of dense graded bituminous macadam, (DBM), for use mainly, but not exclusively, in base/binder and profile corrective courses. DBM is also intended for use as a road base material. This work shall consist of construction in a single or multiple layers of DBM on a previously prepared base or sub-base. The thickness of a single layer shall be 50mm to 100 mm

**Materials**

Bitumen: The bitumen shall be paving bitumen of Penetration Grade complying with IS: 73.

Coarse Aggregates: The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm sieve. They shall be clean, hard, and durable, of cubicle shape, free form dust and soft or friable matter, organic or other deleterious substances.

Where crushed gravel is proposed for use as aggregate, not less than 90% by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces

**Table 5.21.15** PHYSICAL REQUIREMENTS FOR COARSE AGGREGATE FOR DBM

| Property | Test | Specifications |
|---|---|---|
| Cleanliness( dust) | Grain size analysis | Max 5% passing 0.075 mm sieve |
| Particle Shape | Flakiness and Elongation index ( combined) | Max 30% |
| Strength | Los Angeles Abrasion Value | Max 35% |
| | Aggregate Impact Value | Max 27% |
| Durability(Soundness) | Sodium Sulphate | Max 12% |
| | Magnesium Sulphate | Max 18% |
| Water Absorption | Water absorption | Max 2% |
| Stripping | Coating and Stripping of bitumen aggregate mixtures | Minimum retained coating 95% |
| Water Sensitivity | Retained tensile strength | Min 80% |

* The tests shall be carried out in accordance with the respective IS Specifications

Fine Aggregates: Fine aggregates shall consist of crushed or naturally occurring mineral material or a combination of the two, passing the 2.36 mm sieve and retained on the 75 micron sieve. They shall be clean, hard, durable, dry and free form dust, and soft or friable matter, organic or other deleterious matter. The fine aggregate shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS: 2720 (part 37). The plasticity index of the fraction passing the 0.425mm sieve shall not exceed 4 when tested in accordance with IS: 2720 (part 5). The plasticity index of the fraction passing the 0.425 mm sieve shall not exceed 4 when tested in accordance with IS: 2720 (part 5).

Filler: Filler shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement approved by the engineer. The filler shall be graded within the limits specified below

**Table 5.21.16** GRADING OF FILLER MATERIAL

| IS Sieve (mm) | Cumulative % by weight of total aggregate |
|---|---|
| 0.60 | 100 |
| 0.30 | 95 – 100 |
| 0.75 | 85 - 100 |

The filler shall be free from organic impurities and have a plasticity index not greater than 4. The plasticity requirement shall not apply if the filler is cement or lime. When the coarse aggregate is gravel, 2% by weight of the total aggregate, shall be Portland cement or hydrated lime and the % of fine aggregate reduced accordingly. Cement or hydrated lime is not required when the limestone aggregate is used. Where the aggregates fail to meet the requirements of the water sensitivity test, then 2% by total weight of aggregate, of hydrated lime shall be added without additional cost.

Aggregate Grading and Binder content: when tested in accordance with IS:2386 ( part 1) – wet sieving method, the combined grading of the coarse and fine aggregates and added filler for the particular mixture shall fall within the limits shown in the Table 5.21.17 below, for DBM grading 1 or 2 as specified in the contract. The type and quantity of bitumen, and appropriate thickness, are also indicated for each mixture type.

**Table 5.21.17** COMPOSITION OF DBM PAVEMENT LAYERS

| **Grading** | | |
|---|---|---|
| Nominal Aggregate Size | 40 mm | 25 mm |
| Layer Thickness | 80 – 100 mm | 50 – 75 mm |
| **IS Sieve[1] ( mm)** | **Cumulative % by weight of total aggregate** | |
| 45 | | - |
| 37.5 | | 100 |
| 26.5 | | 90-100 |
| 19 | | 71-95 |
| 13.2 | | 56 – 80 |

| | | |
|---|---|---|
| 9.5 | | - |
| 4.75 | | 38 – 54 |
| 2.36 | | 28- 42 |
| 1.18 | | - |
| 0.6 | - | - |
| 0.3 | 7 – 21 | 7 – 21 |
| 0.15 | - | - |
| 0.075 | 2- 8 | 2 – 8 |
| Bitumen content % by mass of total mix[2] | Min 4.0 | Min 4.5 |
| Bitumen grade | 65 or 90 | 65 0r 90 |

*Notes:*

1. *The combined aggregate grading shall not vary from the low limit on one sieve to the high limit on the adjacent sieve.*
2. *Determined by the marshall method*

**Mixture Design**

Requirement for the mixture: Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 5.21.18

**Table 5.21.18**: REQUIREMENTS FOR DENSE GRADED BITUMINOUS MACADAM

| | |
|---|---|
| Minimum stability (KN at $60^0$ C) | 9.0 |
| Minimum flow (mm) | 2 |
| Maximum flow (mm) | 4 |
| Compaction level (Number of blows) | 75 blows on each of the two faces of the specimen |
| Percent air voids | 3-6 |
| Percent voids in mineral aggregate | See Table 5.21.16 below. |
| Percent voids filled with bitumen (VFB) | 65-75 |

The requirements for minimum percent voids in mineral aggregate (VMA) are set out in Table below:

**Table 5.21.19** MINIMUM PERCENT VOIDS IN MINERAL AGGREGATE (VMA)

| **Nominal Maximum Particle Size** | **Minimum VMA, percent related to Design Air Voids, percent** | | |
|---|---|---|---|
| | **3.0** | **4.0** | **5.0** |
| 9.5 | 14.0 | 15.0 | 16.0 |
| 12.5 | 13.0 | 14.0 | 15.0 |

| | | | |
|---|---|---|---|
| 19.0 | 12.0 | 13.0 | 14.0 |
| 25.0 | 11.0 | 12.0 | 13.0 |
| 37.5 | 10.0 | 11.0 | 12.0 |

**Notes:** *1. The nominal maximum particle size is one size larger than the first sieve to retain more than 10 percent*

*2. Interpolate minimum voids in the mineral aggregate (VMA) for design air voids values between those listed.*

**Binder Content:**

The binder content shall be optimized to achieve the requirements set out in Table 5.21.15 and the traffic volume set out in the contract. The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2, replacing the aggregates retained on the 26.5 mm sieve by the aggregates passing the 26.5 mm sieve and retained on the 22.4 mm sieve, where approved by the engineer.

Where the 40mm DBM mixture is specified, the modified Marshall method described in MS-2 shall be used. This method requires modified equipment and procedures; particularly the minimum stability values in Table 5.21.15 shall be multiplied by 2.25 and the minimum flow shall be 3 mm.

**Job mix formula:**

The contractor shall inform the engineer in writing, at least 20 days before the start of the work, of the job mix formula proposed for use in the works. While establishing the job mix formula, the contractor shall ensure that it is based on a correct and truly representative sample of the materials that will actually be used in the work and that the mixture and its different ingredients satisfy the physical and strength requirements of these specifications.

Approval of the job mix formula shall be based on the independent testing by the engineer for which samples of all ingredients of the mix shall be furnished by the contractor as required by the engineer.

The approved job-mix formula shall remain effective unless and until a revised job mix formula is approved. Should a change in the source of materials be proposed, a new job mix formula shall be forwarded to the engineer for approval before placing of the material.

**Plant trials – permissible variation in job mix formula:**

Once the laboratory job mix formula is approved, the contractor shall carry out plant trials at the mixer to establish that the plant can be set up to produce a uniform mix conforming to the approved job mix formula. The permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used shall be within the limits as specified in the Table 5.21.20. These variations are intended to apply to individual specimens taken for quality control tests in accordance with section 900.

**Table 5.21.20**: PERMISSIBLE VARIATIONS FROM THE JOB MIX FORMULA

| Description | Permissible variation | |
|---|---|---|
| | Base/Binder course | Wearing course |
| Aggregate passing 19 mm sieve or larger | ± 8% | ± 7% |
| Aggregates passing 13.2 mm, 9.5 mm | ± 7% | ± 6% |
| Aggregate passing 4.75 mm | ± 6% | ± 5% |
| Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm | ± 5% | ± 4% |
| Aggregate passing 0.3 mm, 0.15 mm | ± 4% | ± 3% |
| Aggregate passing 0.075 mm | ± 2% | ± 1.5% |
| Binder content | ± 0.3% | ± 0.3% |
| Mixing temperature | ± 10ºc | ± 10ºc |

Once the plant trials have demonstrated the capacity of the plant, and the trials are approved, the laying operation may commence. Over the period of the first month of production for laying on the works, the Engineer shall require additional testing of the product to establish the reliability and consistency of the plant.

**Table 5.21.21** MANUFACTURING AND ROLLING TEMPERATURES

| Bitumen penetration | Bitumen mixing ($^0$C) | Aggregate mixing ($^0$C) | Mixed Material ($^0$ C) | Rolling ($^0$C) | Laying ($^0$C) |
|---|---|---|---|---|---|
| 35 | 160 – 170 | 160 – 175 | 170 Max. | 100 Min. | 130 Min. |
| 65 | 150 – 165 | 150 – 170 | 165 Max. | 90 Min. | 125 Min. |
| 90 | 140 – 160 | 140 – 165 | 155 Max. | 80 Min. | 115 Min. |

**Laying Trials:** Once the plant trials have been successfully completed and approved, the Contractor shall carry out laying trials, to demonstrate that the proposed mix can be successfully laid, and compacted all in accordance with clause 501. The laying trial shall be carried out on a suitable area which is not to form part of the works, unless specifically approved in writing, by the Engineer. The area of the laying trials shall be a minimum of 100 sq.m. of construction similar to that of the project road, and shall be in all respects, particularly compaction, the same as the project construction, on which the bituminous material is to be laid.

The contractor shall previously inform the Engineer of the proposed method for laying and compacting the material. The plant trials shall then establish if the proposed laying plant, compaction plant, and methodology is capable of producing satisfactory results. The density of the finished paving layer shall be determined by taking cores, no sooner than 24 hours after laying, or by other approved method.

Once the laying trials have been approved, the same plant and methodology shall be applied to the laying of the material on the project, and no variation of either shall be acceptable, unless approved in writing by the Engineer, who may at his discretion require further laying trials.

**Constructions Operations**

The methodology and plant to be used for the whole project should be based arrived after plant and laying trials for the job mix ratio, which should be based on a correct and truly representative sample of the materials that will actually be used in the work, and that its different ingredients satisfy the physical and strength requirements of these specifications.

Weather and Seasonal Limitations: Laying shall be suspended while free standing water is present on the surface to be covered, or during rain, fog and dust storms. After rain, the bituminous surface, prime or tack coat shall be blown off with a high pressure air jet to remove excess moisture, or the surface left to dry before laying shall start. Laying of bituminous mixture shall not be carried out when the air temperature at the surface on which it is laid is below 10degC, or when the wind speed at any temperature exceeds 40 km/h at 2m height unless specifically approved by the engineer.

Mixing and Transportation of the mixture: The premixed bituminous material for DBM shall be prepared in a hot-mix plant of adequate capacity and capability of yielding a mix of proper and uniform quality with thoroughly coated aggregates at appropriate mixing temperatures; the difference in temperature between the binder and the aggregate at no time should exceed 14 deg C. The hot mix plant should be calibrated from time to time in order to ensure the uniform quality of the mix and better coating of aggregates.

The bituminous material should be transported in clean insulated vehicles, and unless otherwise agreed by the engineer, shall be covered while in transit or waiting tipping. Subject to the approval of the Engineer, a thin coating of diesel or lubricating oil may be applied to the interior of the vehicle to prevent sticking and to facilitate the discharge of the material.

Spreading: Except in areas where a mechanical paver cannot access, bituminous materials shall be spread, leveled and tamped by an approved self-propelled paving machine. As soon as possible after arrival at site, the materials shall be supplied continuously to the paver and laid without delay. The rate of delivery of material to the paver shall be regulated to enable the paver to operate continuously. The travel rate of the paver, and its method of operations, shall be adjusted to ensure an even and uniform flow of bituminous material across the screed, free from dragging, tearing and segregation of the material. In areas with restricted space where a mechanical paver cannot be used, the material shall be spread, raked and leveled with suitable hand tools by experienced staff, and compacted to the satisfaction of the engineer. The maximum thickness of material laid in each paver pass shall be 150 mm. When laying binder course or wearing course approaching an expansion joint of a structure, machine laying shall stop 300 mm short of the joint. The remainder of the pavement up to the joint, and the corresponding area beyond it, shall be laid by hand, and the joint or the joint cavity shall be kept clear of surfacing material.

Bituminous material shall be kept clean and uncontaminated. The only traffic permitted to run on bituminous material to be overlaid shall be that engaged in laying and compacting the next course or, where a binder course is to be sealed or surface dressed, that engaged on such surface treatment. Should any bituminous material become contaminated the contractor shall make it good to the satisfaction of the engineer. Binder course shall not remain uncovered by either the wearing course or surface treatment, whichever is specified in the contract, for more than three consecutive days after being laid. The Engineer may extend the period by the minimum amount of time necessary, because of weather conditions or for any other reason.

Rolling: Bituminous materials shall be laid and compacted in layers which enable the specified thickness, surface level, regularity requirements and compaction to be achieved. Compaction of bituminous materials shall commence as soon as possible after laying. Compaction shall be substantially completed before the temperature falls below the minimum rolling temperature. Rolling of the longitudinal joints shall be done immediately behind the paving operation. After this, rolling shall commence at the edges and progress towards the center longitudinally except that on super-elevated and uni-directional cambered portions, it shall progress from the lower to the upper edge parallel to the center line of the pavement. Rolling shall continue until all roller marks have been removed from the surface. All deficiencies in the surface after laying shall be made good by the attendants behind the paver, before initial rolling is commenced. The initial or breakdown rolling shall be done with 8-10 tonnes dead weight smooth wheeled rollers. The intermediate rolling shall be done with 8 – 10 tonnes dead weight or vibratory roller or with a pneumatic tyred roller of 12 to 15 tonnes weight having nine wheels, with a tyre pressure of at least 5.6 kg/sq.cm. The finish rolling shall be done with 6 to 8 tonnes smooth wheeled tandem rollers. Bituminous materials shall be rolled in a longitudinal direction, with the driven rolls nearest the paver. The roller shall first compact material adjacent to joints and then work from the lower to the upper side of the layer, overlapping on successive passes by at least one-third of the width of the rear roll or, in the case of a pneumatic-tyred roller, at least the nominal width of 300 mm. Rollers shall move at a speed of not more than 5km/h. The roller shall not be permitted to stand on pavement which has not been fully compacted, and necessary precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign material on the pavement either when the rollers are operating or standing. The wheels of the rollers shall be kept moist with water, and the spray system provided with the machine shall be in good working order, to prevent the mixture from adhering to the wheels. Only sufficient moisture to prevent adhesion between the wheels of the rollers and the mixture should be used. Surplus water shall not be allowed to stand on the partially compacted pavement.

Where longitudinal joints are made, the materials shall be fully compacted and the joint made flush. All joints shall be offset by at least 300 mm from parallel joints in the layer beneath or as directed, and in a layout approved by the engineer. Joints in the wearing course shall coincide with either the lane edge or the lane marking, whichever is appropriate.

Opening to traffic: The newly laid surface shall not be open to traffic for at least 24 hrs after laying and completion of compaction, without the express approval of the Engineer in writing.

**Measurement:** The finished work shall be measured in sq.m at a specified thickness correct to two places of decimal.

**Rate:** The rate shall include the cost of materials and labour required to carry out all the operations.

**6. Asphalt/ Bituminous Concrete**

- *Providing and Laying Asphalt/Bituminous Concrete to required degree of compaction based on the job mixture design ( job mix formula) approved by the supervising engineer, by mechanized method as per material gradation and materials quality specified using VG 10 complete.*

*RW0139 25 mm*

*RW0140 30 mm*

*RW0141 35 mm*

*RW0142 40 mm*

*RW0143 50 mm*

- *Providing and Laying Asphalt/Bituminous Concrete to required degree of compaction based on the job mixture design ( job mix formula) approved by the supervising engineer, by mechanized method as per material gradation and materials quality specified using VG20/VG30 complete.*

*RW0410 25 mm*

*RW0411 30 mm*

*RW0412 35 mm*

*RW0413 40 mm*

*RW0414 50 mm*

**Scope:**

This clause specifies the construction of Bituminous Concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single or multiple layers of bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 25 mm to 100 mm in thickness.

**Materials**

**Bitumen:** The bitumen shall be paving bitumen of penetration grade complying with IS Specification for paving Bitumen, IS: 73 or otherwise as specified in item. Where modified bitumen is specified, it shall conform to the requirements of IRC:SP:53 and IS:15462.

**Coarse aggregates:** The coarse aggregates shall be generally as specified for DBM, except that the aggregates shall satisfy the physical requirements of Table 5.21.22.

**Table 5.21.22** PHYSICAL REQUIREMENTS FOR COARSE AGGREGATE FOR BITUMINOUS CONCRETE PAVEMENT LAYERS

| Property | Test | Specification |
|---|---|---|
| Cleanliness (dust) | Grain size analysis | Max. 5% passing 0.075 mm sieve |
| Particle shape | Flakiness and Elongation Index | Max. 30%(Combined) |
| Strength | Los Angeles Abrasion Value | Max. 30% |
| | Aggregate Impact Value | Max. 24% |
| Polishing | Polished Stone Value | Min. 55 |
| Durability(Soundness) | Sodium Sulphate | Max. 12% |
| | Magnesium Sulphate | Max. 18% |
| Water Absorption | Water Absorption | Max. 2% |

| | | |
|---|---|---|
| Stripping | Coating and Stripping of Bitumen Aggregate Mixtures | Minimum retained coating 95% |
| Water Sensitivity | Retained Tensile Strength | Min. 80% |

**Fine Aggregates:** The fine aggregates shall be as for DBM.

**Filler:** Filler shall be generally as specified for DBM. Where the aggregates fail to meet the requirements of the water sensitivity test, then 2 percent by total weight of aggregate, of hydrated lime shall be added without additional cost.

**Aggregate grading and binder content:** When tested in accordance with IS:2386 Part I (wet grading method), the combined grading of the coarse and fine aggregates and added filler shall fall within the limits shown in table 5.21.23 for grading 1 to 2 as specified in the contract.

**Table 5.21.23** COMPOSITION OF BITUMINOUS CONCRETE PAVEMENT LAYERS

| **Grading** | **1** | **2** |
|---|---|---|
| Nominal aggregate size | 19 mm | 13 mm |
| Layer thickness | 50 – 65 mm | 30 – 45 mm |
| **IS Sieve (mm)** | **Cumulative % by weight of total aggregate passing** | |
| 45 | - | - |
| 37.5 | - | - |
| 26.5 | 100 | - |
| 19 | 79 - 100 | 100 |
| 13.2 | 59 - 79 | 79 - 100 |
| 9.5 | 52 - 72 | 70 - 88 |
| 4.75 | 35 - 55 | 53 - 71 |
| 2.36 | 28 - 44 | 42 - 58 |
| 1.18 | 20 - 34 | 34 - 48 |
| 0.6 | 15 - 27 | 26 - 38 |
| 0.3 | 10 - 20 | 18 - 28 |
| 0.15 | 5 - 13 | 12 - 20 |
| 0.075 | 2 - 8 | 4 - 10 |
| Bitumen content % by mass of total mix | 5.0 - 6.0 | 5.0 - 7.0 |
| Bitumen Grade (pen) | 65 | 65 |

**Mixture Design**

**Requirements for the mixture:** Apart from the conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 5.21.15.

**Binder Content:** The binder content shall be optimized to achieve the requirements of the mixture set out in the following table 5.21.24, and the traffic volume as specified in the contract.

**Table 5.21.24** REQUIREMENTS FOR BITUMINOUS PAVEMENT LAYERS

| | |
|---|---|
| Minimum stability (KN at $60^0$C) | 9.0 |
| Minimum flow (mm) | 2 |
| Maximum flow (mm) | 4 |
| Compaction level (Number of blows) | 75 blows on each of the two faces of the specimen. |
| Percent air voids | 3-6 |
| Percent air voids in mineral aggregate (VMA) | see table 5.21.16 |
| Percent air voids filled with bitumen (VFB) | 65 - 75 |
| Loss of stability on immersion in water at $60^0$C (ASTMD 1075) | Minimum 75 percent retained strength. |

The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2, replacing the aggregates retained on the 26.5 mm sieve and retained on the 22.4 mm sieve, where approved by the Engineer.

**Job mix formula:**

The procedure for formulating the job mix formula shall be generally as specified in DBM and the results of tests enumerated in table 5.21.21 as obtained by the contractors.

**Plant trials – permissible variations in job mix formula:**

The requirements for the plant trials shall be all as specified for DBM, and permissible limits for variation as shown in Table 5.21.17 in DBM

**Laying trials:**

The requirements for laying trials shall be all as specified for DBM.

**Construction operations**

The methodology and plant to be used for the whole project should be based arrived after plant and laying trials for the job mix ratio, which should be based on a correct and truly representative sample of the materials that will actually be used in the work, and that its different ingredients satisfy the physical and strength requirements of these specifications.

Weather and seasonal limitations: The provisions as in DBM shall apply.

Mixing and transportation of the mixture: The provisions as specified in DBM shall be applied.

Spreading: The general provisions as in DBM shall apply, as modified by the approved laying trials.

**Measurement:** The measurement shall be as specified in DBM.

**Rate**: The contract unit rate shall be all as specified in DBM, except that the rate shall include the provision of bitumen at 5.0 percent, by weight of total mixture. The variance in actual percentage of bitumen used will be assessed and the payment adjusted up or down, accordingly.

**Asphalt/Bituminous Concrete with (6 to 8%) shredded plastic**

*Providing and Laying Asphalt/Bituminous Concrete with (6 to 8%) shredded plastic to required degree of compaction based on the job mixture design approved by the supervising engineer using asphalt plant, paver, steel roller, tyre roller etc. as per material gradation and aggregate quality specified*

| | |
|---|---|
| *RW0290* | *25 mm* |
| *RW0291* | *30 mm* |
| *RW0292* | *35 mm* |
| *RW0293* | *40 mm* |
| *RW0294* | *50 mm* |

**Scope**

This section deals with the specifications and use of waste plastic in the wearing course using dry process, application, manufacturing, transportation, storage, and quality testing requirements.

**Materials**

**Bitumen**

The bitumen for bituminous mixes for wearing course with waste plastic shall comply with the Indian Standard Specifications for viscosity graded paving bitumen IS 73 or otherwise specified in the item. Guidelines for selection for grade of viscosity graded paving bitumen shall be in accordance with the IRC:111-2009.

**Aggregates**

The aggregates shall comply with IRC:111-2009, for dense graded mixes and IRC:14-2004, IRC: SP:78-2008 and IRC:11 0-2005 for open graded mixes respectively.

**Filler**

**Waste Plastic**

Depending on the physical properties, plastics can be classified as Thermoplastic and Thermosetting materials. Thermoplastic materials can be formed into desired shapes under heat and pressure and become solids on cooling. When subjected to the same conditions of heat and pressure, they can be remolded. Thermosetting materials which once shaped cannot be softened/remolded by the application of heat. Thermosetting materials are not used in pavement construction.

The examples of some typical Thermoplastic and Thermosetting materials are tabulated below.

| Thermoplastic | Thermosetting |
|---|---|
| Polyethylene Teryphthalate (PET) | Bakelite |
| Polypropylene (PP) | Epoxy |
| Poly Vinyl Acetate (PVA) | Melamine |
| Poly Vinyl Chloride (PVC) | Polyester |
| Polystyrene (PS) | Urea – Formaldehyde |
| Low Density Polyethylene (LDPE) | Alkyd |
| High Density Polyethylene (HDPE) | |

Plastics can also be classified according to their chemical sources. According to sources of plastic, there are six general groups: Cellulose Plastics, Synthetic Resin Plastics, Protein Plastics, Natural Resins, Elastomers and Fibers. The table below gives the source of waste plastic generation. Only plastic conforming to Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE), PET and Polyurethane shall only be used in pavement construction.

| Waste Plastic | Origin |
|---|---|
| Low Density Polyethylene (LDPE) | Carry bags, sacks, milk pouches, bin lining, cosmetic and detergent bottles |
| High Density Polyethylene (HDPE) | Carry bags, bottle caps, household articles etc. |
| Polyethylene Teryphthalate (PET) | Drinking water bottles etc. |
| Polypropylene (PP) | Bottle caps and closures, wrappers of detergent, biscuit, wafer packets, microwave trays for readymade meal etc., |
| Polystyrene (PS) | Yoghurt pots, clear egg packs, bottle caps. Foamed polystyrene: food trays, egg boxes, disposable cups, protective packaging etc. |
| Polyvinyl Chloride (PVC) | Mineral water bottles, credit cards, toys, pipes and gutters; electrical fittings, furniture, folders and pens, medical disposables; etc. |

The following need to be ensured for the plastic used for bituminous concrete:

- The material shall consist of only Low-Density Polyethylene (LDPE) or High-Density Polyethylene (HDPE), PU (available in limited quantity as waste) and PET.
- Black coloured plastic waste is a result of repeated recycling and should not be used.
- PVC shall not be used since they release lethal levels of dioxins.
- The Thermo Gravimetric Analysis (TGA) of thermoplastics has revealed gas evolution and thermal degradation may occur beyond 180°C. Thus, misuse or wrong implementation of

this technology may result in release of harmful gases, premature degradation, if the temperatures are not maintained during construction.

- The waste plastic shall conform to the size passing 2.36 mm sieve and retained on 600-micron sieve.
- Dust and other impurities shall not be more than 1 percent. The process is indicated in Appendix-2. An easy method to determine the quantity of impurity is to determine the ash content at 600°C.
- To ascertain the ability of plastic to mix with the binder, the melt-flow value shall be tested as per ASTM D 1238-2010, for which the range shall be as follows:

  For LDPE: 0.14-58 gm/10 min

  For HDPE: 0.02-9.0 gm/10 min

**DESIGN OF MIX**

The requirements for waste plastic modified design and open graded mixes are as follows:

**Dense Graded Mixes**

The properties for denser graded mixes are indicated in the table below:

| | |
|---|---|
| Minimum stability (KN at 60°C) | 12.0 |
| Minimum flow (mm) | 2 |
| Maximum flow (mm) | 4 |
| Marshall Quotient (KN/mm) | 2.5 - 5 |
| Compaction level (number of blows) | 75 blows on each of the two faces of the specimen |
| Percent air voids | 3 - 5 |
| Retained Stability (%) | 98 |
| ITS (min) MPa | 0.9 |
| VMA | 16 |
| VFB | 65 – 75 |
| Quantity of waste plastic % by weight of bitumen | 6 to 8 depending on low rainfall or high rainfall areas |

**Open Graded Mixes**

Waste Plastic @ 6 to 8 percent of the weight of the bitumen can be used for Open-Grade Premix Surfacing and Mix Seal surfacing mix. The quantity of bitumen can be reduced correspondingly.

**MANUFACTURING OF BITUMINOUS MIX USING WASTE PLASTIC**

There are two processes namely dry process and wet process for manufacturing bituminous mixes using waste plastic. In the dry process, processed waste plastic is added after shredding in hot aggregates whereas in the wet process, processed waste plastic in the form of powder is added in the hot bitumen.

**Dry Process**

The dry process involves following steps:

I. The Plastic waste conforming to Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE), PET and Polyurethane which is cleaned is cut into a size between 2.36 mm and microns and of maximum size 2.36 mm length and 2.00 mm width using a shredding. Care should be taken that PVC waste should be eliminated before it proceeds into the next process.

II. **Mixing of shredded waste plastic, aggregate and Bitumen in Central mixing Plant:** The aggregate mix is heated to 140-175°C in Central mixing plant. The requisite percentage of waste plastic to the weight of bitumen is injected with a pipe under compressed air in the drum of a drum mix plant through a pipe at 2/3 length of the drum or through an opening over the pugmill in the case of a batch mix plant. The waste plastic initially coats the heated aggregates. In the next stage bitumen is added to the aggregates, the temperature of the binder shall conform to the temperature depending on the grade of binder and the type of mix. The plastics waste coated aggregate is mixed with hot bitumen for 15 seconds and the resulting mix transported for road construction. A central mixing plant helps to have better control of temperature and better mixing of this material thus helping to have a uniform coating and heated bitumen is also sprayed. At the mixing chamber, the shredded plastics waste is added over the hot aggregate. It gets coated uniformly over the aggregate within 30 to 45 seconds. It gives an oily coated look to the aggregate.

III. **Laying of bituminous mix:** The road laying temperature is between 110°C to 120°C for waste plastic bituminous mix. The roller used can be of any specified capacity.

**CONSTRUCTION**

Construction operation shall be in accordance with the IRC:111-2009, IRC:14-2004, IRC: 11 0-2005 and IRC:SP:78-2008 for dense graded and open graded mixes respectively.

**CONTROLS**

Controls shall be in accordance with the IRC:111-2009, IRC:14-2004 and IRC:110-2005 and IRC:SP:78-2008 for dense graded and open graded mixes respectively. Besides, plastic shall be tested for impurity and melt flow value. Three samples are tested for each day's work or when there is change in the source of plastic.

**Measurement**

The length and breadth shall be measured cored to a cm and the area calculated in square meter correct to two places of decimal.

**Rate**

The rate shall include the cost of labour, materials, equipment hired/owned, tools and plant, and incidentals necessary to complete the work specified above.

**21.7.3 Scarifying**

*RW0145* *Scarifying metalled (water bound) road surface including disposal of rubbish lead up to 50 meters and consolidation with road roller of the aggregate received from scarifying.*

*RW0450* *Stripping of existing bituminous (BT) road surface using machines. This includes stripping the old bituminous layer without disturbing the underlying base course, cleaning of the stripped surface to make it ready for subsequent operations, all complete as per technical specifications.*

**Preliminary Work:** All dirt, dust, cracked up mud, slush, animal droppings, vegetation and all other rubbish shall be removed from the water bound macadam surface.

**Scarifying:** The macadam surface shall be scarified to a depth of approximately 5 cm with such additional picking of high parts of the road as may be necessary to the required camber and gradient as directed by the Engineer. Any hollows that remain after picking shall be filled with new aggregate 50 mm nominal size and well consolidated to bring the surface to template.

**Finishing:** The scarified aggregate shall be raked to bring smaller stones on the top and surface brought to the required camber and gradient with tolerance of 12 mm longitudinally as well as transversely. All rubbish etc. shall be disposed off as directed by the Engineer. Scarifying operation will also include consolidation with road roller aggregate received from scarifying although this aggregate will be consolidated along with aggregate of new wearing course to be paid separately.

**Measurement:** The measurement of the finished work shall be taken in sq.m. Length and breadth shall be measured correct to 10mm between the kerb or channel stones or brick edging etc. as the case may be.

**Rate:** The rate shall include the cost of labour and materials involved in all the operations described above except the cost of stone aggregate which shall be paid for separately.

*RW0146* *Cutting and repairing water bound macadam road, including supply of required quantities of aggregate*

**Cutting:** All road crossings shall be cut in half the width at a time and repaired unless otherwise permitted by the Engineer. Cutting shall be straight and uniform in width. Soling stone and aggregate obtained from cutting macadam road shall be stacked separately clear of the road surface. Aggregate shall be screened and stones of smaller size below 20 mm and with rounded edges discarded and disposed off.

**Making good:** After the trenches have been filled in with excavated earth in layers of 15 cm thickness, watered, well consolidated with heavy iron rammers and brought to sub-grade

level, soling stone obtained from cutting shall be stacked as directed by the Engineer. Where the earth consolidation is well done no settlement need occur subsequently; for this, excess watering should be avoided.

New aggregate 50 mm nominal size, as required shall be added to old aggregate and spread over to a depth of 7.5 cm. This shall then be consolidated with hand roller or heavy iron rammers, as directed, first with light sprinkling then with sufficient application of water, till the aggregate has become adequately consolidated and does not get displaced. All undulations shall be loosened by hand picking surplus aggregate removed from high spots and depressions filled with surplus and new aggregate and the surface compacted again. When thoroughly consolidated, blinding materials, freshly collected, shall be spread over it in a 12 mm layer and consolidated with hand roller or heavy iron rammers, with sufficient application of water till a uniform surface is obtained.

The finished surface shall be in camber with and left a little proud of the adjoining road surface to all for any settlement on drying.

**Measurement:** The measurements shall be taken in sq.m. Length and width of cutting shall be taken correct to 10mm.

**Rate:** The rate shall include the cost of materials and labour involved in all the operations described above except stone soling, aggregate, blinding materials, if specified, shall be paid for separately.

**5.21.7.4 Wearing Course**

*RW0147* *Laying wearing course with stone aggregate and blinding materials including screening, sorting, spreading to template and consolidation (Payment to be made for the quantity of aggregate used, excluding blinding materials)*

**General:** For all-important roads, two wearing courses of stone metal each 7.5 cm thick or as specified, shall be provided. For service or back lanes, one wearing course of 11.5 cm thickness or as specified shall be provided. In case of two wearing courses, the first course shall be consolidated and thrown open to traffic at least for a period of 2 to 6 weeks, depending upon the intensity of traffic and the period available for completion of the work. The surface of the first course shall then be scarified, undulation filled up and the second course then laid according to profile and consolidated.

**Preparing surface:** The surface of soling or of old macadam shall be cleaned of caked mud, animal dung etc. All patches and ruts in the first wearing course or old macadam road surface shall be cut in rectangular shape with vertical sides, cleaned and filled with new metal. First wearing course or macadam surface shall be scarified to a depth of 4 cm and brought to the required camber and gradient with a tolerance of 12 mm longitudinally and 12 mm transversely.

**Shoulders:** Two parallel mud walls 20 x 15 cm shall be made along the outer edges of the wearing course. These shall be laid true and parallel having a clear distance between them equal to the width to be metalled.

**Spreading and packing stone aggregate:** Stone aggregate shall be raked off the stacks with the rakes so as to leave behind mud and dust. It shall be spread evenly over the prepared surface to the required depth, with a twisting motion to avoid segregation. Aggregate shall be carefully laid and packed, bigger size being placed at the bottom. The thickness of the

surface of the new aggregate shall be checked with templates of approved design (to be provided by the contractor), which shall be set perfectly horizontal on the prepared surface, at intervals of not more than 15 m and surface rectified if necessary. The bottom member of the template shall be of a depth equal to the unrolled thickness of the wearing course, where the aggregate is being spread. The aggregate when spread shall be correct to template. A small quantity of aggregate shall be retained for rectification.

The camber of the template shall not be flatter than 1 in 72 for roads to be carpeted or concreted. 1 in 48 if the road is to be painted and 1 in 36 if it is to remain water bound unless otherwise directed by the Engineer. In the super-elevated curves, the super-elevation on banking shall commence at the lower edge and progress towards the upper edge of the carriageway in one straight line. This shall be secured by gradually raising the outer edge above the inner edge of the carriageway at a uniform rate till the designed super-elevation is reached. The designed super-elevation shall be attained in the above manner gradually over the entire length of the transition curve, and thereafter the same rate of super-elevation shall be maintained over the circular arc.

**Consolidation:** The stone aggregate shall be consolidated by dry rolling and wet rolling with a power roller of 8 tonnes minimum weight. In case of straight reach of the road, the rolling shall be commenced at the edges and worked towards the centre. In case of a super-elevated curve, the rolling shall commence from the inside edge of the curve to the outside edge.

**Dry Rolling**: The stone aggregate shall first be rolled dry and then lightly sprinkled with water just sufficient quantity to moisten the earth cushioning below and to facilitate interlocking of aggregate. Rolling shall continue till the aggregate has become well consolidated and does not get displaced. During the process of rolling, camber and grade of the aggregate surface shall be checked. All undulations shall be loosened by hand packing or raking tools, surplus material removed from high spots and depressions filled with surplus and fresh material and the surface rolled again, small quantities of aggregate having been kept in stock for this purpose. When all the surface defects are removed dry rolling shall be stopped, as otherwise the edges of the aggregate may get crushed, which is not desirable.

**Wet Rolling:** After the dry rolling has been completed as described above, the road surface shall be watered copiously so as to keep the water level up to the top of the aggregate and rolling with power roller proceeded with, till the roller makes no visible impression on the surface and the interstices between the stone have been filled up by consolidation of aggregate and a piece of 25 mm size stone placed on surface gets crushed under the roller without being driven in.

**Rolling with blinding materials:** After wet rolling of the wearing surface each surface shall be tested with a 3 m straight edge laid parallel to the centre line of the road and any irregularity exceeding 12 mm shall be corrected by loosening the surface and re-compacting the same after adding or removing material as required. If further required by the Engineer, the surface shall be checked with a long string also.

Blinding materials shall then be spread evenly over the surface, copiously watered and rolled till the slurry, after filling all voids, shall form a wave before the wheel of the moving roller. Wet materials sticking to the wheels shall be removed simultaneously when the roller is moving, by a spade and sprinkling water on the wheels. The rolling shall be done a minimum of four passes or till a hard smooth solid surface is obtained. The finished surface shall give a uniform appearance and the road shall be closed to traffic till next day or lapse of 24 hours.

**Measurement:** The measurement shall be made for the finished work in cubic metres as per net measurements of the stacks of stone aggregate used in the work.

**Rate:** The rate shall include the cost of machinery and labour required for all the operations mentioned above, unless specified otherwise.

**5.21.7.5 Bitumen Emulsion**

*RW0150* *Cutting and repairing bituminous road, including supply of required quantities of aggregate, grit and bitumen emulsion*

*RW0151* *Cutting and repairing bituminous road along with W.B.M layer making good the same, including supply of required quantities of aggregate, grit and bitumen emulsion*

*RW0152* *Painting two coats with bitumen emulsion (coat 1 – 1.2 kg bitumen emulsion per sq.m, 1 cu.m, 12.5mm aggregates per 100 sq.m; coat 2 – 1.6 kg bitumen emulsion per sq.m, 0.6 cu.m, 10 mm aggregates per 100 sq.m) complete*

*RW0153* *Repainting one coat with bitumen emulsion @ 2.3 kg bitumen emulsion per sq.m; 2 cu.m, 10mm aggregates per 100 sq.m of road surface complete*

*RW0154* *20 mm premix carpet surfacing with 2.1 cu.m of aggregates, 10mm nominal size per 100 sq.m using 147 kg of bitumen emulsion 0f approved quality per cu.m of aggregates including a tack coat with bitumen emulsion of same quality @ 0.75 kg per sq.m of road surface complete.*

*RW0155* *25 mm premix carpet surfacing with 2.7 cu.m of aggregates, 10mm nominal size per 100 sq.m using 149 kg of bitumen emulsion 0f approved quality per cu.m of aggregates including a tack coat with bitumen emulsion of same quality @ 0.75 kg per sq.m of road surface complete.*

*RW0156* *50 mm premix carpet surfacing with 6 cu.m of aggregates, 10mm nominal size per 100 sq.m using 96 kg of bitumen emulsion 0f approved quality per cu.m of aggregates including a tack coat with bitumen emulsion of same quality @ 0.75 kg per sq.m of road surface complete.*

*RW0157* *Providing seal coat with bitumen emulsion using 1.3 kg of emulsion per sq.m with 0.8 cu.m of stone of 10mm aggregates per 100 sq.m of road surface.*

*RW0158* *Providing seal coat of premixed sand with bitumen emulsion using 53 kg of emulsion and 0.45 cu.m of coarse sand per 100 sq.m of road surface complete*

The **Specification, Precautions, Measurement** and **Rates** for bitumen emulsion shall be similar to that of Bitumen VG - 10 except for the following.

The Bitumen Emulsion shall be conforming to (IS: 8887, 1978) having bitumen content of 60 percent minimum by weight. The following points shall be noted and taken care while applying the bitumen emulsion:

(i) Before applying the emulsion tack coat, the surface shall be cleaned thoroughly with brushes, brooms, etc. and water shall be sprayed to clean away loose particles etc.

(ii) All potholes and depressions shall be compacted well in advance on the existing base.

(iii) No work shall be carried out while it is raining.

(iv) The drum containing the binder shall be rolled 5 to 6 times to-and-fro for a distance of about 10 m enabling the contents to mix properly.

(v) The spreading of emulsion shall be done with the help of a spray can with 6/8mm holes spaced at 30mm intervals or with the help of mechanical sprayer.

(vi) The barrels shall be properly tightened after drawing off emulsion.

(vii) If it rains before the emulsion has set, spread the aggregate immediately and wait until dry before rolling and opening to traffic.

(viii) No one shall be allowed to walk over uncovered bitumen emulsion applications.

(ix) The existing surface shall be cleaned thoroughly and washed with water before applying the bitumen emulsion.

Quantity of various materials used in Bitumen emulsion work shall be as given in the table below:

**Table 5.21.25** QUANTITY OF VARIOUS MATERIALS USED IN BITUMEN EMULSION WORK

| Sl. No | Item (for 10 $m^2$) | Aggregates/sand | Emulsion requirement |
|---|---|---|---|
| **(a)** | **Premix carpeting** | | |
| (i) | 20 mm | | |
| | Track coat | - | 07.50 kg |
| | Premix | 10 mm, 0.21 cu.m | 30.80 Kg |
| | Seal coat | 0.030 cu.m (sand) | 05.30 kg |
| (ii) | 25 mm | | |
| | Track coat | - | 07.50 kg |
| | Premix | 10 mm, 0.27cu.m | 40.20kg |
| | Seal coat | 0.045cu.m(sand) | 05.30 kg |
| (iii) | 50 mm | | |
| | Track coat | - | 07.50 kg |
| | Premix | 10 mm, 0.54 cu.m | 51.60 kg |
| | Seal coat | 0.045cu.m(sand) | 05.30 kg |
| **(b)** | **Pot-Holes/Patch** | | |
| | Track coat | - | 05.50 kg |
| | Premix | As required | 22.00 kg |
| **(c)** | **Surface dressing** | | |
| | Single coat | 10mm, 0.02cu.m | 23.00 kg |
| | Double coat | | |

| | | | |
|---|---|---|---|
| | First coat | 12mm, 0.10cu.m | 12.00 kg |
| | Second coat | 10mm, 0.06cu.m | 16.00 kg |
| **(d)** | **Seal coat** | 10mm, 0.08cu.m | 13.00 kg |

For the Premix Seal coat, the aggregates shall be first made wet with water and thereafter shall be mixed with emulsion until the aggregates are well saturated.

**5.21.7.6 Bitumen VG - 10**

*RW0160* *Cutting and repairing bituminous road, including supply of required quantities of aggregate, grit and bitumen*

*RW0161* *Cutting and repairing bituminous road along with W.B.M layer making good the same, including supply of required quantities of aggregate, grit and bitumen (Mechanized)*

**Surface preparation**: The area to be treated shall be marked out with chalk or any other suitable means by drawing a rectangle around the defect. All materials from within the marked out area shall be removed and increase the depth of the hole until firm material is found. Dress the walls of the hole so that they are vertical. The bottom of the holes shall be leveled and dressed and then shall be compacted.

**Back filling the holes:** After the bottom of the hole is levelled, compacted and cleaned, the materials in cold mix in case of emulsion and hot mix in the case of bitumen VG - 10 shall be placed and compacted in one or more layers of regular thickness depending on the depth involved. The last layer, prior to compaction shall have an excess thickness of about 1/5$^{th}$ depth of the excavation, in order to allow for settlement on compaction. Such compaction shall be carried out using either vibrating roller or a rammer until the surface is level.

**Measurement:** The measurements shall be taken in sq.m. Length and width of cutting shall be taken correct to 10mm.

**Rate:** The rate shall include the cost of materials and labour involved in all the operations described above except stone soling, blinding materials, if specified, shall be paid for separately.

*RW0165* *Painting two coats with bitumen VG - 10 (coat 1 - 2 kg bitumen per sq.m, 1.5 cu.m, 12.5mm aggregates per 100 sq.m; coat 2 - 1 kg bitumen per sq.m, 0.9 cu.m, 10 mm aggregates per 100 sq.m) complete (mechanised)*

*RW0166* *Painting two coats with bitumen VG - 10 (coat 1 - 2 kg bitumen per sq.m, 1.5 cu.m, 12.5mm aggregates per 100 sq.m; coat 2 - 1 kg bitumen per sq.m, 0.9 cu.m, 10 mm aggregates per 100 sq.m) complete (manually)*

**General:** This type of treatment is normally done for roads with medium density, rubber tyred traffic. It consists of cleaning the existing water bound macadam, gravel surface, applying a coat of hot bitumen and binding it with stone grit including consolidation with road roller and repeating this operation for a second coat.

**Preparation of surface:**

(A) **Repairs:** Pot holes or patches and ruts in water bound macadam base or surface course which is to be surface treated, shall be repaired by removal of all loose and defective material by cutting in rectangular patches and replacement with suitable material. For the

purpose of repairs, the area of potholes shall be taken up to 0.75 sq.m and depth up to 5 cm. All pot holes, patches and ruts 2.5 cm deep shall be repaired and brought to level with premix and properly consolidated while those of depths greater than 2.5 cm shall be repaired with similar specification as adopted originally.

(B) **Cleaning:** Prior to the application of the binder, all dust, dirt, caked mud, animal dung loose and foreign material etc. shall be removed. 30 cm on either side, beyond the full width to be treated, by means of wire brushes, small picks, brooms, etc. The material so removed shall be disposed of as directed by the Engineer.

For water bound macadam surface, the interstices between road metal shall be exposed up to a depth of about 12 mm by means of wire brushes. The surface shall then be brushed with soft brooms to remove all loose aggregate. Finally the traces of fine dust, which get accumulated while brushing, shall be thoroughly removed from the surface by blowing with gunny bags. The prepared surface shall be closed to traffic and maintained fully clean till the binder is applied.

**Applying binder:**

**Hot bitumen for first coat:** The binder shall be heated in a boiler to a temperature 149℃ to 177℃ and maintained at the temperature, the use of a thermometer being essential.

The binder shall be applied evenly to the cleaned dry surface by means of pressure sprayer at the rate of 2 kg per sq.m. An even and uniform distribution of binder shall be ensured from the calibration chart showing the relation between pumping pressures, height of nozzle above the road and the amount of binder of a given grade that will be deposited per minute at specific temperature.

The binder shall be applied longitudinally along the length of the road and never across it. The edges of the binder surface shall be defined by wire or chord line stretched in position. Heating in cut out drums and pouring from perforated tins, cans and by such other methods shall not be permitted, except in case of petty works and repairs with the specific approval of the Engineer. The binder shall not be applied when the air temperature is less than 16 degree C. or when weather conditions are rainy or otherwise unsuitable. In damp conditions special precaution, use of red soil, lime etc. may be necessary or bitumen emulsion may be used.

**Blinding or spreading grit over the surface for the first coat:** Immediately after the binder is applied and while it is still hot, stone grit free from dust, shall be spread evenly over the surface at the rate of 1.5 cu.m per 100 sq.m. Spreading shall be done with a twisting motion to avoid segregation which otherwise shall have to be removed by brushing the excess grit over the surface into hungry spots to obtain a uniform surface, free from waviness, depressions and other irregularities. The surface shall be checked by means of a camber board laid across the road and a 3 m straight edge laid parallel to the centre line of the road, and undulations if any, shall be corrected by addition or removal of blindage. If a uniform surface is thus assured at this stage, the completed surface should be normally free from undulations and unevenness.

**Consolidation of blindage for 1st coat:** Immediately following the application of the stone grit and light brooming, the road surface shall be compacted by power roller 6 to 8 tonnes, starting at edges and working towards centre (or to the outside edge in case of super-elevated curve). The roller shall be worked or started and stopped without jerks and shall not be stopped or reversed each time at the same location to cause the displacement

of stone and other irregularities. Consolidation shall be considered complete when the stone chippings are firmly embedded. Generally five to six trips shall be made for thorough compaction of the surface or as specified by the Engineer. Along kerbs, manholes and at all places not accessible to roller, the rough compaction shall be secured by means of steel rammers or hand rollers.

**Cleaning the road surface for the second coat:** Prior to application of 2nd coat of binder, the surface shall be examined and any loose material and foreign matter shall be removed by brooming or blowing off by fanning with gunny bags, care being taken not to loosen the blindage already set.

**Applying binder, hot bitumen for 2nd coat:** The second coat of binder shall be applied immediately after the binding has been set and the surface has been cleaned. The binder, at the rate of 1 kg per sq.m shall be applied in the manner indicated in the above for the first coat.

**Blinding or spreading grit over the surface for 2nd coat**: Immediately after the 2nd application of binder, the stone grit 10 mm nominal size shall be spread at the rate of 0.9 cu.m per 100 sq.m in the manner indicated in the above for first coat.

**Consolidation of blindage for 2nd coat:** The work shall be done as specified above para for first coat. Further the prepared finished surface shall be protected from traffic for 24 hours or such period as may be specified by the Engineer.

**Measurement:** The measurement shall be taken for the finished work in sq.m. Length and width shall be measured correct to a cm along the finished surface of the road. For record purposes, the measurements for stone grit and binder shall be taken before they are actually used on the work. Pre-measurements of materials taken for record purposes shall simply serve as a guide and shall not form basis for payment. Thickness of treatment shall be the ruling criterion for payment.

**Rate:** The rate shall include the cost of materials and labour involved in all the operations described above, except for repairs described.

*RW0167* *50 mm premix carpet surfacing with 6 cu.m of aggregates 10mm nominal size per 100 sq.m 64 kg of bitumen VG - 10 0f approved quality per cu.m of aggregates including a tack coat with bitumen of same quality @ 0.75 kg per sq.m of road surface complete (Mechanized).*

*R00168* *20 mm premix carpet surfacing with 2.4 cu.m of aggregates 10mm nominal size per 100 sq.m 64 kg of bitumen VG - 10 0f approved quality per cu.m of aggregates including a tack coat with bitumen of same quality @ 0.75 kg per sq.m of road surface complete (Mechanized).*

*RW0169* *25 mm premix carpet surfacing with 3 cu.m of aggregates 10mm nominal size per 100 sq.m 64 kg of bitumen VG - 10 0f approved quality per cu.m of aggregates including a tack coat with bitumen of same quality @ 0.75 kg per sq.m of road surface complete (Mechanized).*

*RW0170* *20 mm premix carpet surfacing with 2.4 cu.m of aggregates 10mm nominal size per 100 sq.m 64 kg of bitumen VG - 10 0f approved quality per cu.m of aggregates including a tack coat with bitumen of same quality @ 0.75 kg per sq.m of road surface complete (Manually).*

*RW0171* *25 mm premix carpet surfacing with 3 cu.m of aggregates 10mm nominal size per 100 sq.m 64 kg of bitumen VG - 10 0f approved quality per cu.m of aggregates including a tack coat with bitumen of same quality @ 0.75 kg per sq.m of road surface complete (Manually).*

**Premix carpets with binder:**

**General**: This type of treatment is normally applied on roads where the motor traffic of medium intensity, but cart traffic is fairly heavy. The consolidated thickness of the type of treatment shall be 2 cm or 2.5 cm as specified. This treatment consists of applying a tack coat on the prepared base followed immediately by spreading aggregates pre-coated with specified binder, to camber and consolidated.

**Materials:** The specifications given above (painting two coats) shall apply except that for the specified consolidated thickness of premix carpet viz. 20mm or 25mm or 50mm, the quantities of bitumen for tack coat and pre-coating the stone grit as well as the size and the quantity of stone grit shall be as given in the table below, unless otherwise directed by the Engineer.

**Table 5.21.26** QUANTITIES OF BITUMEN FOR TACK COAT AND PRE-COATING THE STONE GRIT AS WELL AS THE SIZE AND THE QUANTITY OF STONE GRIT

| Sl. No | Consolidated thickness of premix carpet | Binder hot, Track coat kg/sq.m | Bitumen carpet Kg/cu.m | Stone grit Cu.m/100 sq. m |
|---|---|---|---|---|
| 1 | 20 mm | 0.75 | 64 | 2.4 (10 mm nominal size) |
| 2 | 25 mm | 0.75 | 64 | 3.0 (10 mm nominal size) |
| 3 | 50 mm | 0.75 | 96 | 6.0 (10 mm nominal size) |

**Preparation of Surface (Repairs and cleaning):** The specifications under "painting two coats" above shall apply.

**Applying binder-hot bitumen for tack coat:** The hot bitumen shall be used at the rate of 0.75 kg per sq.m for the road surface unless otherwise directed.

**Preparation of mix and laying:** The stone grit (aggregate) shall be surface dry and contain not more than 2 percent moisture before use. It shall be first screened of dust and measured in boxes and then loaded into the drum mixer according to the capacity of the mixing drum in the proportion given in the table above. The aggregate shall be heated to facilitate mixing with the binder in cold weather, where so directed by the Engineer.

The binder heated in boilers to the temperature 149-degree C. to 177 degree C. and maintained at that temperature shall be drawn off from the boiler into a suitable container or in a bucket gauged to show the weight of bitumen in it. This shall then be poured over the aggregate into the mixer @ 64 kg per cu.m of aggregate or as directed and mixing started and continued till aggregate is uniformly coated with bitumen.

The hot mix shall be discharged from the mixer, carried to the road surface and spread to levels immediately after applying the tack coat, to a thickness sufficient to achieve after consolidation the specified thickness provided. The consolidated thickness shall in no place be less than the specified thickness by more than 25%. Rakes and drag spreaders shall be used for spreading the mixture.

**Consolidation of premix:** The specifications shall be as specified under "painting two coats" above except the number of trips of the roller shall not be less than two times. Any high spot or depression, which becomes apparent, shall be corrected by addition or removal of premix materials.

Further the prepared finished surface shall be protected from traffic for 24 hours or such period as may be specified by the Engineer.

**Measurement:** The specifications for measurement shall be as specified under "painting two coats" shall apply.

**Rate:** The rate shall include the cost of materials and labour involved in all the operations described above for the particular item.

*RW0175* *Repainting, one coat of bitumen VG - 10 @ 1 kg bitumen per sq.m; 0.9 cu.m, 10mm aggregates per 100 sq.m of road surface (Manually)*

*RW0176* *Repainting, one coat of bitumen VG - 10 @ 1 kg bitumen per sq.m; 0.9 cu.m, 10mm aggregates per 100 sq.m of road surface (Mechanized)*

**General:** This treatment consists of cleaning old painted surfaces and applying a coat of hot bitumen on the prepared base, blinding with stone grit and consolidation with road roller. For bitumen emulsion refer to the guidelines above.

**Preparation of Surface:**

(A) **Repairs:** The surface shall be prepared much in advance for re-painting operations. All patches, pot holes and ruts shall first be cut regularly in shape, with sides reasonably vertical to the required depth of not less than 2.5 cm. These shall be cleaned of all dust etc. painted with the binder and the surface brought to level as described above. The road shall then be opened to traffic for a few days. The repaired surface shall be so maintained till the binder is applied.

(B) **Cleaning:** Prior to the application of the binder, all dust, dirt, caked mud, animal dung, loose and foreign material etc. shall be removed 30 cm on either side, beyond the full width to be repainted, by means of wire brushes, small picks, brooms etc. The materials so removed shall be disposed of as directed by the Engineer. The prepared surface shall be closed to traffic and so maintained fully clean till the binder is applied. Applying binder, blinding the surface including consolidation of blindage.

**Measurement:** The measurement shall be taken for the finished work in sq.m. Length and width shall be measured correct to a cm along the finished surface of the road. For record purposes, the measurements for stone grit and binder shall be taken before they are actually used on the work. Pre-measurements of materials taken for record purposes shall simply serve as a guide and shall not form basis for payment. Thickness of treatment shall be the ruling criterion for payment.

**Rate:** The rate shall include the cost of materials and labour involved in all the operations described above, except for repairs described in the above.

*RW0177* *Providing seal coat with bitumen VG - 10 using 1.5 kg of bitumen per sq.m with 1.05 cu.m of stone of 10mm aggregates per 100 sq.m of road surface.*

**General:** Seal coats are applied to water proof the road, to seal the surface to prevent oxidation due to air circulation, to strengthen old bituminous surfaces, or to improve

texture, reduce porosity and tendency to disintegration. The seal coat treatment can be given either with hot bitumen or bitumen emulsion.

**Seal coat with Hot Bitumen:**

**General:** The treatment consists of applying a coat of hot bitumen on a prepared surface blinding with stone grit and consolidating with a road roller.

**Cleaning the road surface:** The specification described under "painting two coats" above shall apply.

**Applying binder:** The bitumen shall be applied at the rate of 1.5 kg per sq.m of road surface.

**Blinding the Surface:** Immediately after the application of binder and while it is still hot, the stone grit 10 mm nominal size shall be spread evenly over the surface at the rate of 1.05 cu.m per 100 sq.m.

**Consolidation of blindage:** The specification described under "painting two coats" above shall apply. The road shall be opened to traffic after 24 hours. After a period of seven days, surplus grit shall be swept and collected and shall be used for blinding the spots where bleeding occurs.

*RW0178* *Providing seal coat of premixed sand with bitumen VG - 10 using 96 kg of bitumen and 0.75 cu.m of coarse sand per 100 sq.m of road surface complete*

**Preparation of premix:** The sand shall be dry and suitably heated to temperature as directed by the Engineer. The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer avoiding local overheating and ensuring a continuous supply. The heated sand and bitumen are thoroughly mixed with the help of a mixer. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheelbarrows. The vehicles employed for transport shall be cleaned and be covered over in transit if so directed.

**Spreading and rolling:** The premixed sand shall be spread on the carpet to the required thickness and distributed evenly with the drag spreader, without any undue loss of time. The surface should then be rolled with a power roller 6 to 9 tonne capacity.

**Measurements:** The length and width of the finished work shall be measured correct to a cm along the finished surface of the road. The area shall be calculated in sq.m, correct to two places of decimal.

**Rate:** The rate shall include the cost of materials and labour involved in all the operations described above.

**Metal crash barrier**

*RW0260* *Providing and erecting "W" metal beam crash barrier (3mm thick w-metal beam of 4m length, width 310mm, wave height- 81-85mm, 1.8m long Channel post 150x75x5mm @ 2m c/c & 330mm long spacer 150x75x5mm) including excavation and PCC 1:1.5:3 for channel post, complete as per drawing.*

**Scope**

This section covers the materials required and construction of metal crash barriers. The barrier shall be single side single W-beam metal crash barrier with related accessories like beam, spacer, channel, post, end unit (fish tail, bull dog) and fastener. The W-metal beam crash barrier shall comprise of 3mm thick corrugated sheet metal beam rail, 312 mm minimum width, 70 cm above road/ground level, fixed on ISMC series channel vertical post, 150x 75 x 5mm spaced at 2 m center to center, 1.8 meter high, 1.1 m below the ground/road level. The W-beam rails should be fixed on the vertical post with a spacer of channel section 150x75x5mm, 330mm long.

**Materials**

Unless otherwise specified the materials for the metal crash barrier shall meet the following specifications:

W-Beam: It should be cold rolled formed section, minimum 3 mm thick, hot dip galvanized, 550g/sq.m and raw materials conforming to IS:5986 Gr. Fe 360(ST-37)/Fe.

Post and Spacer: It should be cold rolled formed section, minimum 5 mm thick, hot dip galvanized, 550g/sq.m and raw materials conforming to IS:5986 Gr. Fe 360(ST-37)/Fe.

**Construction**

The crash barrier shall be constructed at the locations shown on the Drawings or as instructed by the Engineer. The W-Beam spacer post shall be cast in M20 concrete block (400x400 mm), 700 mm deep.

After the concrete has fully set, the crash barrier shall be erected by assembling a beam, spacer channel and other accessories.

**Tests and Standards of Acceptance**

The materials shall be tested in accordance with the relevant standards specified and shall meet the prescribed criteria. The Contractor shall furnish necessary test certificates as required by the Engineer. The work shall conform to these Specifications and shall be true to the lines, levels and dimensions as indicated on the Drawing or as directed by the Engineer, subject to the tolerances as indicated in these Specifications.

**Measurement**

The measurement of the metal crash barrier shall be in linear metres.

**Rate**

The rate shall include the cost of labour, materials, equipment hired/owned, tools and plant, and incidentals necessary to complete the work specified above.

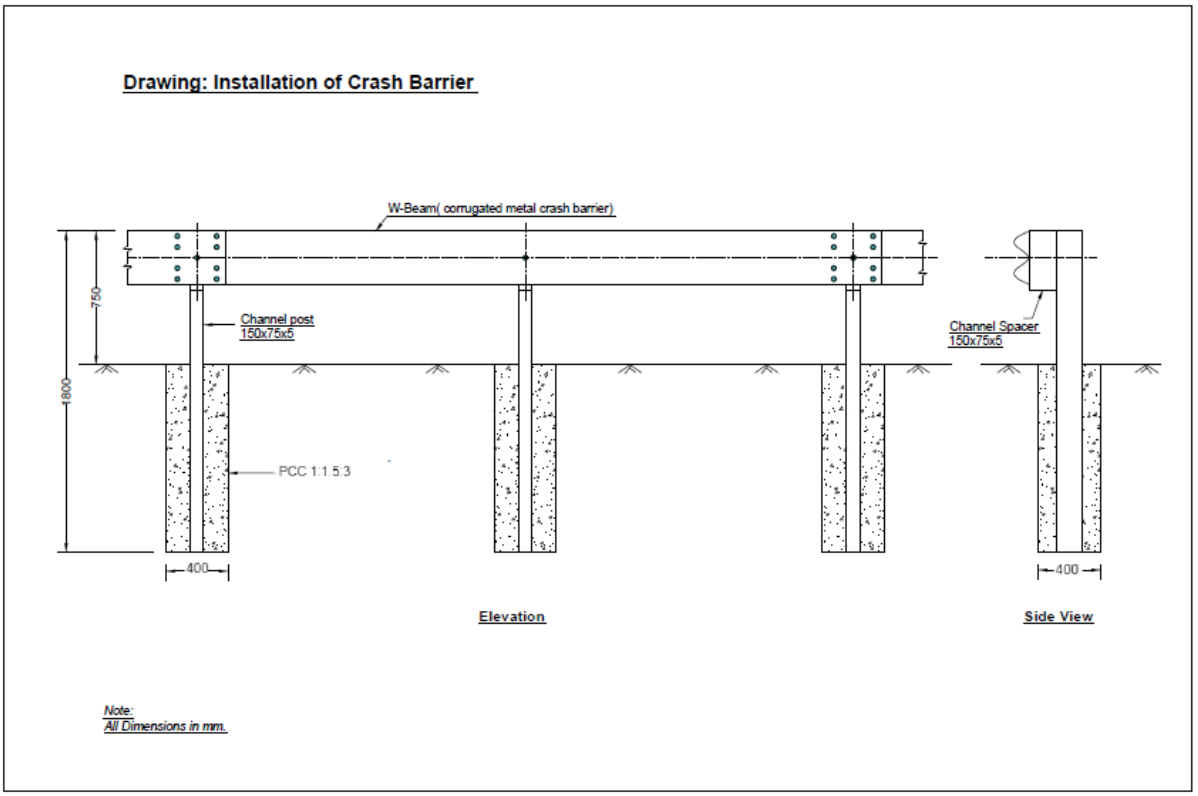



**Figure 5.21.4** Crash Barrier

### 5.21.8 Road Signs

- *Providing & fixing RC name board including primer and white zinc paint*

*RW0180* *Rectangular with post*

*RW0181* *Flat without post for one direction only*

*RW0182* *Flat without post for two directions only*

The sign boards shall be of standard design the dimension of the board proper only being the following:

"Keep Left" board- 450 x 450 x 450 mm

Rectangular Name board- 900 x 300 x 25 mm

Board for one direction- 1350 x 675 x 65 mm (over all)

Board for two direction- 1630 x 675 x 65 mm (over all)

The "Keep Left" board shall be firmly fixed in ground to the depth of 450 mm and the side filling shall be thoroughly compacted, watered and consolidated. The name board with post shall be likewise fixed to a depth of 750 mm. The flat boards shall be fixed in cement concrete 1:3:6 with 40 mm aggregate of size 1200/900 x 750 x 300 mm to a depth of 600 mm.

**Painting:** Exposed Surfaces shall be painted with two or more coats of white zinc paint over a primer as for new work. Lettering shall be done with black enamel with letters of size as directed by the Engineer.

**Measurement:** Items shall be enumerated.

**Rate:** The rate shall include the cost of materials described above.

*RW0183 Engraving letters on hard stone.....per letter per centimetre height.*

The Size of the letters shall be as specified. The engraving shall be done by cutting with snap incision in V shape 12 mm deep or as directed. The letters engraved, shall be painted in black enamel or as specified.

**Measurement**: The height of each letter shall be measured correct to 3 mm.

**Rate:** The rate is only for engraving the letters and painting and is exclusive of the cost of stones or paint.

*RW0185 Providing & fixing pre-cast boundary stone (150mm dia x 900mm high) of RC 1:2:4 (20mm aggregates) including finishing with mortar 1:3 (cost of excavation, refilling etc to be paid separately)*

The stone shall be to the standard design of concrete specified. It shall be fixed as per specification given under item "RCC name board".

**Measurement:** The item shall be enumerated.

**Rate:** The rate shall include materials and labour in casting the stone and fixing it in position except for items mentioned in the schedule.

- *Providing & fixing pre-cast kilometre stone of RC 1:2:4 (20mm aggregates) including finishing with mortar 1:3 complete as per standard design (cost of excavation, concreting, painting etc. shall be paid for separately)*

*RW0186 35cm x 111cm x 25cm*

*RW0187 50cm x 152.5cm x 25cm*

*RW0188 35cm x 93.5cm x 18cm*

The stones will be of standard design of the specified dimensions.

**Fixing:** Trenches 50 cm wide and 45 cm deep shall first be excavated to receive the kilometre stone. The lower 45 cm of the kilometre stone shall then be finally fixed in position in ground and the sides filled with earth, thoroughly watered and consolidated. Where so specified the kilometre stone shall be fixed in cement concrete 1:4:8 (1 cement: sand :8 stone aggregate 40 mm nominal size) so that there is 15 cm thick cement concrete in the bottom and 15 cm thick all round up to formation level. Trench excavation in this case will be made to the requirements.

**Finishing:** The exposed surfaces above ground shall be painted with two or more coats of required colour or as specified over a coat of primer as for new work. The colours shall be as specified, as also the scheme of painting and lettering.

**Measurements:** Kilometre stones shall be enumerated.

**Rate:** The rate shall include cost of materials and labour involved in all the operations but excluding the cost of excavation concrete foundations, painting and lettering for which payment shall be made separately.

*RW0189 Lettering with paint of approved brand and manufacture...per letter per centimetre height*

The paint, size of letters shall be as specified or as directed by the Engineer.

**Measurement:** The height of each letter will be measured correct to 3 mm.

**Rate:** The rate shall include cost of materials and labour involved in all the operations.

*RW0190 Re-lettering with paint of approved brand and manufacture...per letter per centimetre height*

Old lettering will be thoroughly cleaned and all dust removed before commencing re-lettering.

**Measurement:** The height of each letter will be measured correct to 3 mm.

**Rate:** The rate shall include cost of materials and labour involved in all the operations.

### 5.21.9 Traffic Signs

*Providing and fixing Mandatory/Regulatory sign boards of Circular shape made up of 2 mm thick aluminium sheet, fully covered with retro reflective sheeting in blue and silver white or other colour combination including subject matter, message, symbols and borders etc.with supporting post of approved size and length complete as per drawing, specification and direction of Engineer-in-charge excluding excavation and concreting for base.*

*RW0360 750mm diameter with 75mmX40mmX4.7mm post of length 3000mm*

*RW0361 600mm diameter with 75mmX40mmX4.7mm post of length 3000mm*

*RW0362 450mm diameter with 50mm dia post of length 3000mm*

*RW0363 300mm diameter with 50mm dia post of length 3000mm*

*Providing and fixing Mandatory/Regulatory sign boards of Hexagonal shape made up of 2 mm thick aluminium sheet, fully covered with retro reflective sheeting in blue and silver white or other colour combination including subject matter, message, symbols and borders etc.with supporting post of approved size and length complete as per drawing, specification and direction of Engineer-in-charge excluding excavation and concreting for base.*

*RW0364 900mmX900mm with 75mmX40mmX4.7mm post of length 3000mm*

*RW0365 750mmX750mm with 75mmX40mmX4.7mm post of length 3000mm*

*RW0366 600mmX600mm with 75mmX40mmX4.7mm post of length 3000m*

*Providing and fixing Cautionary/ Warning sign boards of Equilateral Triangular shape made up of 2 mm thick aluminium sheet, fully covered with retro reflective sheeting in blue and silver white or other colour combination including subject matter, message, symbols and borders etc.with supporting post of approved size and length complete as per drawing, specification and direction of Engineer-in-charge excluding excavation and concreting for base.*

*RW0367 900mm with 75mmX40mmX4.7mm post of length 3000mm*

*RW0368 750mm with 75mmX40mmX4.7mm post of length 3000mm*

*RW0369 600mm with 75mmX40mmX4.7mm post of length 3000mm*

*RW0370 450mm with 50mm dia post of length 3000mm*

The colour and size of all traffic signs shall conform to BTS 33:2017 while the configuration and location of all traffic signs placed along roadsides, over carriageways, at intersections, and other designated areas shall conform to the standards prescribed in the Code of Practice for Road Signs, IRC:67. Where applicable, the specifications shown in the drawings or as directed by the Engineer-in-Charge shall be followed.

**Materials**

**Aluminum Plate**

The aluminum plates used for traffic signs shall be manufactured from smooth, hard, and corrosion-resistant aluminum alloy conforming to IS: 736, with material designation 24345 or 19000. Unless otherwise specified, the plates shall be 2 mm thick. These plates shall be either welded or bolted to the mounting posts, in accordance with the construction drawings or as specified by the Engineer at site.

**Retro-Reflective Sheeting**

The reflective sheeting shall be of the enclosed lens type, containing microscopic lens elements embedded beneath the surface of a smooth, flexible, transparent, and waterproof plastic layer. The adhesive backing may either be of the pressure-sensitive type with aggressive tack, requiring no additional treatment such as heat or solvents, or a tack-free adhesive type that is activated by heat in a Heat Lamp Vacuum Applicator, as per the manufacturer's recommendations. In all cases, the adhesive must form a durable, weather-resistant bond with the smooth aluminum surface such that the sheeting cannot be removed without damage.

**Mounting Posts**

Mounting posts shall be fabricated from either 50 mm internal diameter steel tubes of the heavy category or 78 mm by 38 mm C-channels. The structural steel used for these posts shall conform to IS 2062, while steel tubes shall meet the requirements of IS 1161.

**Bolts, Nuts and Washers**

High-strength bolts shall comply with IS 1367, whereas precision bolts, nuts, and other fastening components shall conform to IS 1364.

**Plates and Supports**

The steel plates and structural supports used for mounting traffic signs shall conform to IS 226 and IS 2062, or any other relevant IS specification approved by the Engineer.

**Installation**

Prior to the application of retro-reflective sheeting, the sign surface shall be thoroughly prepared. The aluminum or aluminum composite panel (ACP) sheet shall be de-greased using acid or hot alkaline etching methods, and all dust, scale, and surface impurities shall be removed to achieve a clean and smooth surface. The retro-reflective material shall be applied uniformly without folds, twists, or cracks, ensuring full and even coverage of the sign face.

Sign posts, their foundations, and associated mounting elements shall be constructed to maintain the signs in proper alignment and position, ensuring resistance against normal storm wind loads or tampering. Sign supports shall be as specified in the item description or as directed by the Engineer-in-Charge. The foundation works for mounting the signposts shall conform to the relevant specifications, although excavation and concreting for the base are excluded from this scope.

The reverse side of the aluminum sheet shall be painted with two coats of epoxy paint to prevent corrosion. All other exposed steel parts and support frames shall be finished with two or more coats of synthetic enamel paint to provide long-term durability and aesthetic consistency.

**Measurement**

Traffic signs shall be measured by the number of signposts successfully installed at the site, in accordance with the drawings and specifications.

**Rate**

The rate shall cover the cost of all materials, labour, and equipment required for the complete execution of work as described above. However, it shall exclude the costs associated with excavation and concreting of the foundation base.

**Road Studs**

*RW0371 -Providing and fixing Glow studs of size 100x20 mm made of heavy duty body and shall be moulded ASA (Acrylic styrene Acryloretrite ) or HIP (High impact polystyrene) or ABS having electronically welded micro- prismatic lens with abrasion resistant coating with reflective panels on both sides with at least 12 cm of reflective area up each side. The studs shall be approved and fixed to the Road surface as per direction of the Engineer in charge.*

Reflective pavement markers (RPM) or road studs shall be securely bonded to the road surface and serve as lane marking and delineation aids to enhance visibility during night-time and adverse weather conditions.

**Materials**

The RPM/road stud body shall be moulded from ASA (Acrylic Styrene Acrylonitrile) or HIPS (Hi-impact Polystyrene) or ABS (Acrylonitrile Butadiene Styrene), or any other suitable material as approved by the Engineer.The road studs should be able to withstand a load of 13.635 kg, tested in accordance with ASTM D 4280.

Reflective panels on the studs shall comprise of lenses made of methyl methacrylate, conforming to ASTM D 786 or equivalent. Each lens shall contain single or dual prismatic cubes that provide total internal reflection. The retro-reflecting surface shall have a slope of 35° ± 5° to the base and the minimum area of each retro-reflective surface shall be 13.0 $cm^2$.

**Optical Performance**

**Unidirectional and Bi-directional Studs.**

Each reflector or combination of reflectors on each face of the stud shall have a Coefficient of Luminous Intensity (C.I.L.), as specified in the Table below:

**Minimum C.I.L. values for Road Studs**

| Entrance Angle | Observation Angle | Observation Angle | | |
|---|---|---|---|---|
| | | White | Amber | Red |
| 0º U 5º L&R | 0.3º | 220 | 110 | 44 |
| 0º U 5º L&R | 0.5º | 120 | 60 | 24 |

**Tests**

Co-efficient of luminance intensity can be measured by procedure described in ASTM E 809 “Practice for Measuring Photometric Characteristics” or as recommended in BS:873-Part 4: 1973**.**

Fixing of Road Studs

**General Requirements**

- The stud head shall have a smooth, rounded profile with no sharp edges.
- Reflective surfaces must be free from crevices or ledges where dirt may accumulate.
- Dimensions:
- Height: 10 mm to 20 mm
- Width: ≤ 130 mm
- The base must be flat within 1.3 mm. If contoured, no outer face should deviate more than 1.3 mm from a flat surface.

**Placement**

- Markers shall be affixed using manufacturer-recommended adhesives. No nails shall be used to affix the marker so that they do not pose a safety hazard on the roads.
- Markers must not be fixed if:
- The pavement surface is not dry.
- The pavement is newly surfaced and has not been opened to traffic for at least 14 hours.
- Surface preparation:
- Ensure areas are clean, dry, and free from contaminants (dirt, oil, curing compound, loose materials, etc.).

Application:

- Adhesive must be applied uniformly, ensuring full contact with no voids.
- A slight excess should be visible after placement.
- In epoxy applications, any excess adhesive must be immediately removed from the marker and road surface.

**Measurement:** Measurement shall be in the number of reflective markers/road studs supplied and fixed at the site.

**Rate:** The rate shall include the cost of all materials, labour, tools, equipment, and incidentals necessary to complete the work in accordance with these specifications.

**Delineators**

*Providing and fixing 48mm dia. mild steel round pipe delineators of approved length as per drawing and specifications with 3 nos of ABS round body high reflective reflectors with duly powder coated anti-rust and anti theft steel complete excluding excavation & concreting for base.*

*RW0372 750mm length*

*RW0373 1200mm length*

*RW0374 Providing and fixing 100mm rectangular mild steel post delineators of length 1200mm with 3 nos of ABS high reflective reflectors complete excluding excavation & concreting for base.*

The role of delineators is to provide visual assistance to drivers about alignment of the road ahead, especially at night. Delineators are particularly effective in the case of complex locations involving changes in horizontal / vertical geometry and severe weather conditions such as heavy rain, fog or snow. Normally reflectors are used on the delineators for better night time visibility. Road delineators may have a circular, rectangular or triangular cross-section, however the side facing the traffic should not be less than 10 cm wide.

In broad sense, Delineators stands for any device or treatment whose aim is to outline the road way.

**Material:**

The design, materials to be used and the location of the road delineators shall conform to recommended practice for road delineators, IRC:79, and to relevant drawings and as directed by the Engineer-in-charge.

The delineators are to be made of Acrylonitrile Butadiene Styrene (ABS) body with highly reflective reflectors mounted on M.S. pipe of size and shape as specified in the drawings and specifications. For delineators with tubular posts anti-rust and anti-theft grill shall be installed as per direction of Engineer-in-charge.

Road delineators may have a circular, rectangular or triangular cross-section based on the specified drawing.

**Placement and spacing:**

As a general rule, delineators posts should be erected at the edge of the usable shoulders, and in the case of kerbed sections at a distance of 0.6 to 1.5 m from the kerb face. On hill roads they may be placed either on the parapet or at the edge of the shoulders.

The delineator should be so positioned that the reflectorized face is perpendicular to the direction of travel.

**Measurement**

The measurement shall be made in numbers of delineators fixed at site.

**Rate**

The rate includes the cost of all the material, labour and equipment required in all the operations described above.

### 5.21.9 Fencing

- *Supplying posts & struts for fencing*

*RW0195* *Local ballies, 250 mm minimum girth*

*RW0196* *Local ballies,250mm minimum girth, 1.8 m long*

*RW0197* *Pre-cast R.C posts, 1.8 m long, minimum cross section 100x100*

*RW0198* *Pre-cast R.C struts 2.0 m long, minimum cross section 100x100*

*RW0199* *RCC posts and struts, 1.8m long,minimum cross section 100x100*

*RW0200* *RCC posts and struts, 2.0m long,minimum cross section 100x100*

**Ballies:** Ballies shall be as far as possible straight and uniform in section. The diameter shall be as specified in the item. Ballies shall be free from large and dead knots, cracks and wooden borer infection or decay.

**R.C.C Post:** All posts and struts shall be of standard size, the length of posts being 1.8 m or as specified and that of struts being minimum of 2.0 m. These shall be cast in reinforced cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 12.5 mm nominal size) reinforced with 4 nos. 6 mm diameter mild steel bars with 6mm dia. Stirrups @ 200 c/c or as directed and finished smooth with cement mortar 1:3 (1 cement: 3 fine sand). The posts shall have wooden plugs and M.S. bar ribs as shown in the drawing or as directed by Engineer. The posts and struts shall be free from cracks, twists and such other defects.

**Measurement:** The Ballies shall be measured in running metres correct to a cm. The RCC post and struts shall be enumerated.

**Rate:** The rate includes the cost of materials and labour required for all the operations described above.

- *Providing & fixing G.I barbed wire netting including fixing of post or struts, G.I staples, coal tarring in case of ballies complete but excluding the cost of posts, struts, earthwork, concrete which is to be paid for separately.*

*RW0202* *2.5mm dia., (12 SWG), 4 barbs formed by twisting two point wires, each two turns, pitch of barbs 75mm*

**Fencing with barbed wire and ballies posts:** The minimum girth of ballies shall be 30 cm, the length of posts being 1.8 m or as specified in the description of the item and that of struts being minimum 2.0 m. The spacing of posts shall be 2.50m centre to centre of the posts, unless otherwise specified or as directed by the Engineer to suit the dimensions of the area to be fenced.

**Fencing with barbed wire and RCC posts:** The spacing of posts shall be 3.0m centre to centre of the posts, unless otherwise specified. The minimum length of posts shall be 1.8 m or as specified in the description of the item and that of struts being minimum 2.0 m.

**Spacing of struts:** Every 15th, last but one end post and corner post shall be strutted on both sides and end post on one side only.

**Fixing of posts and struts:** Pits 45 x 45 cm and 75 cm deep or as directed shall first be excavated, true to line and level to receive the posts. In case of struts pits 70 x 45 x 75 cm deep or as directed shall be excavated to suit the inclination of the strut so that it is surrounded by concrete by not less than 15 cm at any point. The portion of the posts and struts to be embedded in concrete shall be coal tarred two coats before fixing while the visible portion shall also be coal tarred two coats unless otherwise specified after fixing barbed wire. Struts shall be fixed to posts by means of spikes of suitable size. The pits shall be filled with a layer of 15 cm thick cement concrete 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size). The posts and struts shall then be placed in the pits, the posts projecting 1.2 m or to the specified height above ground, true to line and position and cement concrete 1:5:10 filled in up to 15 cm for posts and 25 cm for struts below ground level to the top of the concrete so that the posts are embedded in the cement concrete block of size 45 x 45 x60 cm and struts in block of size 70 x 45x 50 cm. The concrete in foundations shall be watered for at least 7 days to ensure proper curing. The remaining portions of pits shall be filled up with excavated earth and the surplus earth disposed off as directed by the Engineer and site cleared.

**Fixing of barbed wire:** The barbed wire shall be stretched and fixed in the number of rows as specified and diagonals, the bottom row shall be 15 cm above ground and the rest at 20 cm centre to centre. The diagonals, if any, shall be stretched between adjacent posts from the top wire of one post to the bottom wire of the 2nd post. The barbed wire shall be fixed to posts by means of G.I. staples.

**Measurement:** The length of each wire shall be measured correct to a cm for the finished work, from centre to centre of the posts.

**Rate:** The rate shall be in running metres of barbed wire fixed, longitudinal/diagonal including fixing of post, coal tarring but excluding the cost of posts, struts, and excavation, concrete in foundations for which separate payments shall be made under respective items.

- *Providing & fixing G.I double knotted mesh excluding the cost of posts, struts, earthwork excavation, concrete which is to be paid for separately.*

*RW0205 4mm (8 SWG) x 100mm*

*RW0206 2.5mm (12 SWG) x 100mm*

*RW0207 4mm (8 SWG) x 150mm*

*RW0208 2.5mm (12 SWG) x 150mm*

- *Providing & fixing G.I chain-link excluding the cost of posts, struts, earthwork excavation, concrete which is to be paid for separately.*

*RW0209 4mm (8 SWG) x 50mm*

*RW0210 2.5mm (12 SWG) x 50mm*

*RW0211 4mm (8 SWG) x 75mm*

*RW0212 2.5mm (12 SWG) x 75mm*

*RW0213 4mm (8 SWG) x 100mm*

*RW0214 2.5mm (12 SWG) x 100mm*

**Fencing with RCC or iron angle posts:** The spacing of posts shall be 3.0m centre to centre of the posts, unless otherwise specified. The minimum length of posts shall be 1.8 m or as specified in the description of the item and that of struts being minimum 2.0 m.

**Spacing of struts:** Every 15th, last but one end post and corner post shall be strutted on both sides and end post on one side only.

**Fixing of posts and struts:** Pits 45 x 45 cm and 75 cm deep or as directed shall first be excavated, true to line and level to receive the posts. In case of struts pits 70 x 45 x 75 cm deep or as directed shall be excavated to suit the inclination of the strut so that it is surrounded by concrete by not less than 15 cm at any point. The portion of the posts and struts to be embedded in concrete shall be coal tarred two coats before fixing while the visible portion shall also be coal tarred two coats unless otherwise specified after fixing barbed wire. Struts shall be fixed to posts by means of spikes of suitable size. The pits shall be filled with a layer of 15 cm thick cement concrete 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size). The posts and struts shall then be placed in the pits, the posts projecting 1.2 m or to the specified height above ground, true to line and position and cement concrete 1:5:10 filled in up to 15 cm for posts and 25 cm for struts below ground level to the top of the concrete so that the posts are embedded in the cement concrete block of size 45 x 45 x60 cm and struts in block of size 70 x 45x 50 cm. The concrete in foundations shall be watered for at least 7 days to ensure proper curing. The remaining portions of pits shall be filled up with excavated earth and the surplus earth disposed off as directed by the Engineer and site cleared.

**Fixing of mesh:** The mesh shall be stretched and fixed to posts by means of G.I. staples in case of R.C.C posts and to the iron angle posts it shall be fixed by appropriate welding. The mesh shall be fixed at every 30 cm or as directed by the Engineer.

The mesh shall be painted with aluminium paints unless otherwise specified or directed. Before the paint is applied the mesh shall be cleaned off any rust, etc.

**Measurement:** The length and breadth of the mesh shall be measured correct to a cm for the finished work and area calculated correct to two places of decimal from centre to centre of the posts.

**Rate:** The rate shall be in sq.m of the wire mesh fixed to post including fixing of post, staples etc. complete but excluding the cost of posts, struts, and excavation, concrete in foundations for which separate payments shall be made under respective items.

*RW0215* *1.2 m high fencing with 1.8 m R.C.C posts of standard design placed every 3 m apart, embedded in cement concrete blocks, every 15th post, last but one end post and corner post shall be strutted on both sides and end post one side only, provided with nine horizontal lines and two diagonals of barbed wire 10 kg per 100 m ( min) between two posts fitted and fixed with GI staples on wooden plugs or GI binding wire tied to 6mm bars nibs fixed while casting the post ( cost of RCC posts, struts, earthwork and concrete to be paid for separately)*

*RW0216* *1.2 m high fencing with 1.8 m balli posts 250 mm girth (minimum) placed every 2.5 m apart, embedded in cement concrete blocks, every 15th post, last but one end post and corner post shall be strutted on both sides and end post one side only, provided with six horizontal lines and two diagonals of barbed wire 10 kg per 100 m ( min) between two posts fitted and fixed with GI staples*

*driven into the posts complete ( cost of posts, struts, earthwork and concrete to be paid for separately)*

*RW0217* *2.4 m high fencing with 3.3 m balli posts 250 mm girth (minimum) placed every 2.5 m apart, embedded in cement concrete blocks, every 15th post, last but one end post and corner post shall be strutted on both sides and end post one side only, provided with 12 horizontal lines and two diagonals of barbed wire 10 kg per 100 m ( min) between two posts fitted and fixed with GI staples driven into the posts complete ( cost of posts, struts, earthwork and concrete to be paid for separately)*

*RW0218* *1.3 m high concrete rail and pale fencing with 1.8 m R.C.C posts 2.2 m rails and 1.25 m pales, posts placed at 2.5 m apart, embedded in cement concrete blocks ( 450mm X 450 mm X 700mm) of mix 1:5:10 ( 1 cement : 5 sand : 10 graded stone aggregate 40mm nominal size) ( cost of earthwork in excavation, concrete work, posts, rails and pales to be paid for separately)*

*RW0219* *1.2 m high fencing with 1.2 m angle iron ( 40x 40 x 6 mm) posts placed every 3 m centre to centre , embedded in cement concrete blocks, every 15th post, last but one end post and corner post shall be strutted on both sides and end post one side only, provided with nine horizontal lines and two diagonals interwoven with horizontal wires of barbed wire 10 kg per 100 m ( min) between two posts fitted and fixed with GI staples, turn buckles complete ( cost of posts, struts, earthwork and concrete to be paid for separately)*

*RW0220* *1.8 m high fencing with 1.8 m angle iron ( 50x 50 x 6 mm) posts placed every 3 m centre to centre , embedded in cement concrete blocks, every 15th post, last but one end post and corner post shall be strutted on both sides and end post one side only, provided with nine horizontal lines and two diagonals interwoven with horizontal wires of barbed wire 10 kg per 100 m ( min) between two posts fitted and fixed with GI staples, turn buckles complete ( cost of posts, struts, earthwork and concrete to be paid for separately)*

*Barbed Wire and R.C.C. Posts*

*Materials:* R.C.C. posts and struts shall be as specified under supplying posts and struts. Barbed wire shall be as per 18:278.

*Spacing of Posts and Struts:* The spacing of posts shall be three metres center to center, unless otherwise specified, or as directed by the Engineer to suit the dimensions of the area to be fenced. Every 15th, the last but one end post and corner posts shall be strutted on both sides and end posts on one side only.

*Fixing of Posts and Struts:* Pits 45 x 45 cm and 75 cm deep or as directed shall first be excavated true to line and level to receive the posts. In the case of struts, pits 70 x 45 x 75 cm deep or as directed shall be excavated to suit the inclination of the strut so that it is surrounded by concrete by not less than 15 cm at any point. The pits shall be filled with a layer of 15 cm thick cement concrete 1:3:6 (1 cement: 3 fine sand: 6 graded stone aggregate 40 nominal size). The posts and struts shall then be placed in the pits, the posts projecting 1.2 m or to the specified height above ground, true to line and position. The cement concrete 1:3:6 shall be filled in up to 15 cm for posts and 25 cm for struts below ground level at the base of the concrete so that the posts are embedded in the cement concrete block of size 45x45x60 cm and strut in block of size 70x45x50 cm. The concrete in

foundations shall be watered for at least 7 days to ensure proper curing. The remaining portions of pits shall be filled up with excavated earth and the surplus earth disposed of as directed by the Engineer-in-Charge and site cleared.

*Fixing Barbed Wire:* The barbed wire shall be stretched and fixed in a specified number of rows and two diagonals. The bottom row shall be 14 cm above ground and the rest at 12.5 cm center to center. The diagonals shall be stretched between adjacent posts from the top wire of one post to the bottom wire of the second post. The diagonal wires will be interwoven with horizontal wires by fixing the odd-rows of wires, then the diagonal cross wires and lastly the even rows of wires. The barbed wire shall be held to the R.C.C. posts by means of G.I. staples fixed to wooden plugs or G.I. binding wire tied to 6 mm bar nibs fixed while casting the posts. Turn buckles and straining bolts shall be used at the end posts, if so specified.

**Measurements:** The length of fencing shall be measured correct to a cm for the finished work, from center to center of the posts.

**Rate:** The rate shall include the cost of labour and materials involved in all the operations described above but excluding the cost of posts, struts, turn buckle, straining bolts and excavation and concrete in foundations for which separate payments shall be made under respective items

*R.C.C. Posts, Rails and Pales*

*Materials:* R.C.C. posts, rails and pales shall be as described under supply of posts and struts.

*Spacing of Posts:* The spacing of post shall be 2.25 m center to center unless otherwise specified, or as directed by the Engineer to suit the dimensions of the area to be fenced.

*Fixing Posts:* Pits 45x45 cm and 70 cm deep or as directed shall first be excavated true to line and level to receive the posts.

*Fixing Rails and Pales:* The rails shall be slotted into the slots left in the posts, while the pales shall be simply dovetailed into the rails. The pales shall be fixed' by pouring a little grout of 1.2 mix (1 cement: 2 fine sand) into the dovetails. The fencing shall be so erected that on completion is truly in line and level and top of the fence shall then follow approximately the profile of the ground.

*Measurements:* The length of fencing shall be measured in meters correct to a cm for the finished work, from center to center of the posts.

*Rate:* The rate shall include the cost of labour and materials involved in all the operations described above, but excluding the costs of posts rails pales and excavation and concrete in foundation for which separate payment shall be made under respective items.

*Barbed Wire Fencing with Angle Iron Posts*

*Materials:* Barbed wire shall be as per IS: 278 and angle iron shall be 40 x 40 x 6 mm procured from a reputed brand confirming to IS 800.

*Spacing of posts and struts:* The spacing of posts shall be 3.00 m center to center, unless otherwise specified or as directed by the Engineer to suit the dimensions of the area to be fenced. Every 15th, the last but one end post and corner post shall be strutted on both sides and end post on one side only.

*Fixing of Posts and Struts:* This shall be as per given in barbed wire and RCC posts above. In addition, the angle iron post at bottom shall be split and banded at right angle in opposite

direction for 10 cm length to get proper grip.

*Fixing barbed wire:* The barbed wire shall be stretched and fixed in a specified number of rows and two diagonals. The bottom row should be 14 cm above ground and the rest @ 12.5 cm center to center. The diagonal shall be stretched between adjacent posts from the top wire of one post to the bottom wire of the 2nd post. The diagonal wire will be interwoven with horizontal wires by fixing the odd rows of wires, then the diagonal cross wires and lastly even rows of wires. The barbed wire shall be held by tearing the holes of 10 mm dia in the post and tied with G.!. wire, turn buckles and straining bolts shall be used at the end post, if so specified.

*Measurements:* This shall be as given for fixing barbed wire in RCC posts.

*Rates:* The rate shall include the cost of labour and materials involved in all the operations described above but excluding the cost of post struts turn buckle straining bolts and excavation and concrete in foundation for which separate payments shall be made under respective item. No extra payment shall be made for making holes in angle and nothing shall be deducted on account of holes.

### 5.21.10 Bioengineering

#### 1. Seeds collection, treatment and storage

*RW0230* *Grass and pioneer plant seed collection, including separation, drying in the sun and storing.*

Seed collection, treatment and storage are a skilled business. Utmost care has to be taken in order to ensure that you get material of good quality as it forms the basis to the success of any bio-engineering programme.

The quantity and species of grass/shrubs/trees whose seeds to be collected will be determined by the Engineer. The contractor will be responsible for safety measures and also making all necessary arrangements with landowners, farmers and the Forest Offices, as applicable, before the collection of seeds.

Collect seeds from most vigorous or healthy looking plants when they are fully ripe, from local areas/sources within 1 km of the road and from sites similar to the ones that you are going to use them.

Immediately after collection, seeds must be separated from flower heads, stems and other unwanted parts. Once separated the seeds must be thoroughly sun dried before storage.

Seeds must be stored in a cool dry, ventilated place/room with adequate precautions taken against pests. Containers should be raised above the floor. They should not be kept in the same place/room as cement, or any chemicals, fuels or lubricants. Seeds are best stored in bags made of Hessian (jute) or polythene bags. If polythene bags are used make sure that the seeds are completely dry or they will go mouldy. Seeds should be inspected on a weekly basis to ensure that there is no deterioration or mould formation or pest attacks. The seeds bags must be labelled (label tags) while storing. The label must contain the following information: (i) Name of the species, (ii) date of collection, and (iii) location (place & elevation).

**QA/QC**

- Collect seeds from the most vigorous and healthy looking plants, within a 1-2 km distance.
- Seeds shall be fully ripe during collection.
- Seeds shall be separated from flower heads, stems/leaves & other parts immediately and sun dried.
- Seeds shall be stored in Hessian (jute) bags, plastic bags/or containers. If plastic bags/containers are used ensure that the seeds are thoroughly dried or else they will get moldy.
- Store seeds on a raised platform in a cool dry well ventilated place/room.
- Seed bags/containers should be labeled/ have tags, indicating the species, date of collection and source of collection (place & Elevation).
- Ensure that the seeds are used within their viability period or else the germination rate/success will be nil.
- Seeds shall NEVER be kept/stored in the same place/room as cement, or any chemicals, fuels or lubricants.
- Inspect seeds on a weekly basis to ensure that there is no deterioration or mould formation or pest attacks.

**Measurement:** The payment for the seeds collection shall be according to the quantity in Kg.

**Rate:** The rate shall include collection, drying, storage, including the cost of labour, plants & equipment required for the complete operation.

### *2. Broadcasting*

*RW0231 Broadcasting of grass/pioneer plants seeds on slopes; seeding rate 25 gm per m2*

Prepare the slopes/sites before broadcasting. The surface should be trimmed and scarified to give a rough and looser surface to retain the seeds and to put roots into.

Spread top-soil on the slope and broadcast seeds over the entire slope. From top of the slope work downwards. Broadcast the seeds liberally over the slope, thus covering the whole surface with seeds. An application rate of 25 gm per square meter is normal. Broadcasting should be carried out before or during monsoon, preferably after pre-monsoon and monsoon.

If required, compact loose scarified surface with a plank and cover the seeds with a layer of mulch (decayed leaves or grass).

QA/QC

- Spread top soil over the scarified slope surface.
- Broadcast seeds liberally and evenly over the slope.
- Broadcast seeds from the top of the slope downwards.

- Broadcasting should be carried out during the rainy season, preferably after pre-monsoon.
- Ensure that the slopes are not destroyed/disturbed too much during the works.
- If required, tamp loose scarified surfaces and cover the seeds with a layer of mulch.
- Seeds shall be entire, undamaged, well dried and within the viability period.

**Measurement:** The length and breadth of the completed work shall be measured correctly to 10 mm area calculated in square meter nearest to two places decimal.

**Rates:** The rate shall include the cost of labour in preparation of the slopes/sites, spreading topsoil/mulching and broadcasting of seeds and also tools and plants required for the complete operation but excluding the cost of seeds.

***3. Direct Seeding***

*RW0232* *Direct seeding of shrubs or tree seeds at 30 cm spacing including digging holes up to 5 cm depth and covering with soil, with two seeds per planting hole*

Prior to sowing of seeds prepare the slopes/sites by clearing very loose debris/trimming slopes etc. Start from the top of the slope and work downwards.

Make small holes (5 cm depth and 30 cm apart) using a planting bar. The holes should be a little bigger than the seeds. Push two seeds into the hole and cover it with soil; if it is in a rocky crevice, check that it is right out of the direct sunlight. Make sure that the seed coat is not damaged in this process. Spread top soil on the whole slope.

Depending on the species, some pre-sowing treatment needs to be carried out such as soaking them in water for a period of 24 to 48 hours for hard coated seeds.

QA/QC

- Seeds shall be entire, undamaged, well dried and within the viability period.
- Place at least two seeds per hole.
- Ensure that the holes are not very deep and the seed coat is not damaged in the process.
- Spread top soil on the whole slope.

**Measurement:** The length and breadth of the completed work shall be measured correctly to 10 mm area calculated in square meter nearest to two places decimal.

**Rate:** The rate shall include the cost of labour in preparation of the slopes/sites sowing of seeds and also tools and plants required for the complete operation.

***4. Live staking/palisade***

*RW0233* *Collection and preparation of materials (woody cuttings 2-4 cm diameter and 50 cm length) and staking them ¾ of the cuttings in the soil*

*Collection*: Collection of stem/branches cuttings, (that have vegetative propagating properties) for planting from local areas/sources.

The cuttings should be 2-4 cm in diameter and 50 cm in length (for *Erythrina or phaledo* use 5-10 cm dia) with the tops cut at right angles and the bottoms at 45° to show which way the

cuttings should be inserted. The cuttings should be planted the same day. Use Hessian and water to keep the cuttings moist until planting.

Trim and clean the sites well in advance of the planting operation, by removing irregularities and loose debris.

*Planting*: Using a crowbar or a pointed bar, make holes in the slope that are slightly bigger than the cutting and deep enough to take at least three-fourth of its length. Carefully place the cutting, at least three-fourth, in the hole. Tamp the soil around the cutting to make it firm.

Spacing between palisades depends on the steepness of the slope. The following spacing is recommended.

Slope < 30° - 2-m interval

Slope 30° –60° - 1-m interval

Within the palisade lines, cuttings should be at 5-10 cm centre to centre.

QA/QC

- Use planting materials as per specification.
- Plant the materials within the same day.
- The stakings shall be at least 3/4th inside the soil and tamp the base to make it firm.
- Ensure the planting materials are not dried up, damaged during transportation and planting.

**Measurement:** The measurement of the completed work shall be taken in a running meter correct to 10 mm, i.e. one unit consists of 10 Nos/m).

**Rate:** The rate shall include the cost of collection, transportation, preparation and planting of the cuttings of the above specification and tools & plants required for the complete operation.

***5. Brush layer, Hedge-brush layer***

*RW0234 Collection and preparation of materials (woody cuttings 2-4 cm diameter and 60 cm length) and staking them ¾ of the cuttings in the soil*

*Collection*: Collection of stem/branches cuttings, (that have vegetative propagating properties) for planting from local areas/sources and also rooted cuttings/wildlings for hedge-brush layering.

The cuttings should be 2-4 cm in diameter and 60 cm in length with the tops cut at right angles and the bottoms at 45° to show which way the cuttings should be inserted. The cuttings should be planted the same day. Use Hessian and water to keep the cuttings moist until planting.

*Planting:* Using string, mark the lines to be planted, along the contour, 50 cm from the base of the slope and work upwards. Form a terrace, about 40-cm wide with a backward inclination of about 20°. Densely place the first layer of cuttings, about 3/4$^{th}$ in the terrace and 1/4$^{th}$ outside with the growing tips. Add wildlings or rooted cuttings for hedge-brush layering. Apply 20 mm of (top) soil in between the cuttings. Lay a second layer of cuttings on top of this. On scree slope cover with about 80 mm of topsoil. Backfill terrace with material

from the terrace above. Firmly compact the terrace. Mark a line 1-2 m above the first brush layer and continue with brush layering works following the same procedures.

Spacing between brush layers depends on the steepness of the slope. The following spacing is recommended.

Slope< 30° - 2-m interval

Slope 30° –60° - 1-m interval

Within the brush layers, cuttings should be at 5 cm centres or even denser.

QA/QC

- Use planting materials (cuttings) as per specification.
- Use plant materials/cuttings (add wildlings or rooted plants for hedge-brush layering) within the same day.
- The terrace shall be 40 cm wide with a backward inclination of 20°.
- The cuttings shall be at least 3/4$^{th}$ inside the soil and compact soil firmly with feet.
- Ensure the planting materials are not dried up, damaged during transportation and planting.
- Backfill the terrace from the above and compact the terrace with feet.
- For scree areas, apply 80 mm top soil in between the cuttings.
- Ensure that the terraces below are not damaged by the falling materials while working above.

**Measurement:** The measurement of the completed work shall be made in the running meter correct to 10 mm.

**Rate:** The rate shall include the cost of collection and transportation of cuttings, site preparation and planting of the cuttings of the above specification and tools & plants required for the complete operation.

***6. Planting of seedlings/wildlings***

*RW0235 Planting of seedlings or wildlings (including the collection of wildlings from the wild) and planting them in a pit size 30 cm x 30 cm.*

Collect wildlings from local areas using digging shovels, keeping the mud and roots intact, as far as possible and transport them in bamboo baskets.

Dig pits in advance of the planting programme. Pits should be 30 cm deep and 30 cm diameter. Carefully place the wildlings in the pits, filling the soil carefully around the plant and tamp the soils firmly around the plant. For seedlings, carefully remove the poly-pot by slicing it down the side with a razor or tear it carefully along the joint. Place the seedlings in the pits, fill with soils and tamp the soils firmly around the plants. Add mulch around the seedlings.

QA/QC

- The seedlings/wildlings shall be entire and healthy looking and not damaged or diseased.
- The roots shall be intact while planting.

- Fill the pits with soil (top/good soil) and tamp the soils firmly around the plants.

**Measurement:** The measurement of the completed work shall be based on the number of plants planted.

**Rate:** The rate shall include the collection of wildlings, cost of seedlings, transportation, pit digging and planting works including any other equipment required for the complete operation.

***7. Sodding/Turfing***

*RW0236* *Sodding of slopes with sods, eg lemon grass (30 cms centre to centre), titepati (1metre centre to centre) in contour lines. The sods should be placed even closer to each other if the slope is greater than 25 degree*

*RW0237* *Turfing of embankment with 30 x 30 cm turfs and fixed to the ground with wooden pegs, if slope is greater than 25°.*

Collected sods (shallow or rooted plants) by uprooting using shovels ensuring that the roots are intact. Well in advance of the sodding operation, thoroughly make the surface smooth. It is important to obliterate all irregularities. Place the sods closely in contour lines & apply a 5 cm layer of topsoil and compact by hand.

Cut turfs (30x30cm) with sharp-edged shovels. Use a khukuri/knife to cut the turfs to shape. Well in advance of the turfing operation, thoroughly make the surface to be covered. It is important to obliterate all irregularities. On gravel-filled embankment/slope apply 5 cm layer of topsoil and compact by hand.

Place the turfs closely, without gaps in between. On slopes greater than 25°, fix turfs with wooden pegs about 30 cm long and 3-5 cm dia hammered through the turfs to stop it from sliding. Once the slope has been satisfactorily covered, compact the turf with the wooden hammer. Finally, water the fresh turfs thoroughly.

QA/QC

- The sods and turfs shall not be damaged and the roots should contain sufficient parent soil.
- The turfs shall be placed closely, without any gap in between, fixed with wooden pegs to hold them from sliding.
- Water the sods/turfs if there is no prospect of rains within the next 1-2 days.

**Measurement:** The length and breadth of the completed work shall be measured correct to 10 mm and area calculated nearest to two places decimal. In case of sodding in contour the finished work shall be measured in the running meter.

**Rate:** The rate shall include the preparation, collection, and transportation of turfs/sods/wooden pegs to the site, preparation of the site and placing them and also including any other equipment required for the complete operation.

***8. Grass slips planting***

*RW0238* *Grass slips planting on slopes (random or in line) at 10 cm apart and 5 cm deep.*

Collect and transport grass plants from the locality in a bamboo basket or in Hessian. Wrap the plants in damp Hessian to keep them moist until they are planted. Split the plants to give two slip cuttings per drill (planting hole) if the grass is fibrous rooting type (e.g. lemon grass) but only one if it is rhizomatous (e.g. amliso).

With a planting bar, make holes just big enough for the roots, and place the slips into the hole, taking care not to tangle the roots or have them curved back to the surface. Fill the soil in around them, firming it gently with the fingers. Spacing for the slip planting should be average 10 cm centre to centre.

QA/QC

- The site shall be well prepared before planting.
- Grass slips must be wrapped in damp Hessian (preferably kept under the shade) to keep them moist before planting.
- There shall be two slips per planting hole.
- Ensure that the roots are well covered by the soil, firming it gently with your fingers.
- Use top soil, compost or manure wherever available/applicable with provision for watering if there is no prospects of rain within the next 1-2 days.

**Measurement:** The length and breadth of the completed work shall be measured correct to 10 mm and area calculated nearest to two places decimal.

**Rate:** The rate shall include the collection, preparation, and transportation of grass slips to the site, preparation of the site, digging holes and placing grass slips into them and also including any other equipment required for the complete operation.

### 5.21.11 Bridge works

#### 5.21.11.1 BEARINGS

**I. Arch Pin Bearing**

Pin bearing shall ensure fixity by arresting translator movement. The pin bearing shall not take any vertical load. It will take care of the longitudinal horizontal force of the entire superstructure unit as well as transverse horizontal force developed at the fixed end.

Pin bearing shall resist horizontal force from any direction and will permit rotation but will not bear any vertical load. The material of pin bearing including rocker plates shall be high tensile steel conforming to IS: 961

In general the pin bearing shall conform to BS: 5400, Parts 9.1 and 9.2 and all relevant clauses of this specification. Bearings shall be guaranteed for design loads and movements. The term bearing shall include the entire assembly covering all the accessories required for operation, erection and dismantling for replacement. All bearings shall be of replaceable type. These bearings should be based on their design to the specifications mentioned/international specifications. The manufacturer should get their design approved from appropriate authority and the manufacturer should be associated with installation of bearings.

**(a) Seating of Pin Bearing**

(i) Backing plate with studs welded on the face opposite to the seating of manufacture shall be delivered by the manufacturer.

(ii) This backing plate shall be accurately positioned on the reinforcement grid of the pedestal and leveled.

(iii) Studs shall be tack welded/tied to the reinforcement to keep the backing plate in proper location during casting.

(iv) Depth of embedment of the backing plate in the concrete shall be as per relevant drawing.

(v) The round base of the pot (bottom) of the pin bearing assembly shall be connected to the backing plated by anchor screws after concreting the pier cap/pedestal.

(vi) In order to ensure successful transfer of large horizontal forces to be resisted by the Pin bearing, great care shall be taken in detailing the reinforcement in the sub-structure and the super-structure adjacent to the studs in the backing plate.

**(b) Acceptance Test on Pin Bearings**

(i) All bearings shall be checked for overall dimensions.

(ii) All bearings shall be load tested (if required, for design horizontal load only)

**II. ELASTOMERIC BEARINGS**

The term “bearing” in this case refers to an electrometric bearing consisting of one or more internal layers of elastomer bonded to internal steel laminates by the process of vulcanization. The bearing shall cater for translation and/or rotation of the superstructure by elastic deformation.

**(a) Raw Material**

Chloroprene (CR) only shall be used in the manufacture of bearings.

Grades of raw elastomer of proven use in electrometric bearings, with low crystallization rates and adequate shelf life (e.g. Neoprene WRT, Bayprene 110, Skyprene B-5 and Denka S-40V) shall be used.

No reclaimed rubber or vulcanized wastes or natural rubber shall be used.

The raw elastomer content of the compound shall not be lower than 60 per cent by its weight. The ash content shall not exceed 5 per cent. (as per tests conducted in accordance with ASTM D-297, sub-section 10)

EPDM and other similar candidate elastomers for bridge bearing use shall not be permitted.

**(b) Properties**

The elastomer shall conform to the properties specified in Table below

**Table 5.21.27** PROPERTIES OF ELASTOMER

| S.No | Property | Unit | Test Method, IS Specification Reference | Value of Characteristic Specified |
|---|---|---|---|---|
| **1** | **Physical Properties** | | | |
| 1.1 | Hardness | IRHD | IS 3400 (Part II) | 60 + 5 |
| 1.2 | Minimum Tensile strength | Mpa | IS 3400 (Part I) | 17 |
| 1.3 | Minimum elongation at break | % | IS 3400 (Part I) | 400 |
| **2** | **Maximum compression set** | **%** | **IS 3400 (Part X)** | |
| | | Duration (h) | Temp (°C) | |
| | C.R | +0 to 24.2 | 100±1 | 35 |
| 3. | **Accelerated ageing** | IS 3400 (Part IV) | | |
| | | Duration (h) | Temp (°C) | |
| | C.R | 70 | 100±1 | |
| 3.1 | Maximum change in hardness | IRHD | | +15 |
| 3.2 | Maximum change in Tensile strength | % | | -15 |
| 3.3 | Maximum change in elongation | % | | -40 |

Shear modulus of the elastomeric bearing shall neither be less than 0. 80 MPa or greater than 1.20 MPa.

The adhesion strength of elastomeric to steel plates determined according to IS: 3400 (Part XIV) method A shall not be less than 7 kN/m.

No cracking detected by visual observation at the end of the test shall be considered satisfactory.

**(c) Fabricatio**n

Bearing with steel laminates shall be cast as a single unit in a mould and vulcanized under heat and pressure.

Casting of elements in separate units and subsequent bonding shall not be permitted, nor shall cutting from large size cast be permitted.

Bearings of similar size to be used in particular bridge projects shall be produced by identical process and in one lot as far as practicable. Phased production may only be resorted to when the total number of bearings is large enough.

The moulds used shall have standard surface finish adequate to produce bearings free from any surface blemishes.

Steel plates for laminates shall be sand blasted, clean of all mill scales and shall be free from all contaminates prior to bonding by vulcanization. Rusted plates with pitting shall not be used. All edges of plates shall be rounded.

Spacers used in mould to ensure cover and location of laminates shall be of minimum size and number practicable. Any hole at surface or in edge cover shall be filled in subsequently.

Care shall be taken to ensure uniform vulcanizing conditions and homogeneity of elastomer through the surface and body of bearings. The bearings shall be fabricated with the tolerances specified in Table 5.21.28.

The bearings shall be fabricated with the tolerance specified in table

**Table 5.21.28** TOLERANCE FOR BEARINGS

| Sl. No | Item | Tolerance |
|---|---|---|
| 1. | Overall plan dimensions | -0, + 6 mm |
| 2. | Total bearing thickness parallelism | 0, + 5 mm |
| 3. | Parallelism | |
| a. | Of top surface of bearing with respect to the bottom surface as datum | 1 in 200 |
| b. | Of one side surface with respect to the other as datum thickness internal layer of elastomer | 1 in 100 |
| 4. | | |
| a. | Thickness of individual internal layer of elastomer | ±20 per cent (max. of 2 mm) |
| b. | Thickness of individual outer layer | -0, + 1 mm |
| 5. | | |
| a. | Plan dimensions of laminates | -3 mm, +0 |
| b. | Thickness of laminates | ±10 per cent |
| c. | Parallelism of laminate with respect to bearing base as datum | 1 in 100 |

The vulcanizing equipment/press shall be such that between the platens of press the pressure and temperature are uniform and capable of being maintained at constant values as required for effecting a uniform vulcanization of the bearing.

The mounding dies utilized for manufacturing the bearings shall be so set inside the Patten of the press so that the pressure developed during vulcanization of the product is evenly distributed and the thickness maintained at all places are within acceptable tolerance limits taking into consideration the shrinkage allowance of vulcanized.

The raw compound which has been introduced inside the metal dies for vulcanization shall be accurately weighed each time and it must be ensured that sufficient quantity has been put inside the die for proper flow of material at every place so that a homogeneous and compact bearing is produced without any sign of sponginess or deficiency of material at any place.

Before any vulcanization of any batch of production is used for producing vulcanized bearings, test pieces in the form of standard slab and buttons shall be prepared in accordance with prescribed standards and salient properties tested and recorded regularly against each batch of production to monitor the quality of the products.

**(d) Tests & Acceptance**

The manufacturer shall have all the test facilities required for the process and acceptance control tests installed at his plant to the complete satisfaction of the Engineer. The test facilities and their operation shall be open to inspection by the engineer or demand.

All acceptance and process control tests shall be conducted at the manufacturer's plant. Cost of all materials, equipment and labor shall be borne by the manufacturer unless otherwise specified or specially agreed to between the manufacturer and Engineer.

Acceptance testing shall be commenced with the prior submittal of testing Programme by the manufacturer to the Engineer and after obtaining his approval.

Any acceptance testing delayed beyond 180 days of production shall require special approval of the engineer and modified acceptance specification, if deemed necessary by him.

All acceptance testing shall be conducted by the Inspector with aid of the personnel having adequate expertise and experience in rubber testing provided by the manufacturer, working under the supervision of the Inspector and to his complete satisfaction.

Lot by lot inspection and acceptance shall be made.

**(e) Certification and Marking**

Bearings shall be transported to bridge site after final acceptance by Engineer and shall be accompanied by an authenticated copy of the certificate to that effect.

An information card giving the following details for the bearings, duly certified by the manufacturer shall also be appended:

Name of manufacturer:

Date of manufacture:

Elastomer grade used:

Bearing dimensions:

Production batch no.:

Acceptance lot no.:

Date of testing:

Specific bridge location, if any:

Explanation of markings used on the bearing:

All bearings shall have suitable index markings identifying the information. The markings shall be made in indelible ink or flexible paint and if practicable should be visible after installation. The top of the bearing and direction of installation shall be indicated.

**(f) Storage and Handling**

Each elastomeric bearing shall be clearly labeled or marked. The bearing shall be wrapped in a cover. They shall be packed in timer crates with suitable arrangement to prevent movement and to protect corners and edges.

Care shall be taken to avoid mechanical damage, contamination with oil, grease and dirt, undue exposure to sunlight and weather to the bearings during transport and handling prior to and during installation.

**(g) Installation**

Installation of multiple bearings one behind the other on a single line of support shall be of identical dimensions.

Bearings must be placed between true horizontal surfaces (maximum tolerance 0.2 per cent perpendicular to the load) and at true plan position of their control lines marked on receiving surfaces (maximum tolerance $\pm$ 3 mm).

Concrete surfaces shall be free from local irregularities (maximum tolerance $\pm$ 1 mm in height)

Design shall be checked for the actual inclination in seating if larger inaccuracies than those specified are permitted.

For cast–in – place concrete construction of superstructure, where bearings are installed prior to its concreting, the forms around the bearings shall be soft enough for easy removal. Forms shall also fit the bearings shall be soft enough for easy removal. Forms shall also fit the bearings snugly and prevent any leakage of mortar grout. Any mortar contaminating the bearings during concreting shall be completely removed before setting.

**III. POT – CUM PTFE BEARINGS**

**A. General**

Pot type bearings shall consist of a metal piston supported by a disc or unreinforced elastomer confined within a metal cylinder to take care of rotation. Horizontal movement, if required, shall be provided with a system of sealing rings be provided by sliding surfaces of PTEE pads sliding against stainless steel mating surfaces. The pot bearings shall consist of cast steel assemblies or fabricated structural steel assemblies.

Provisions of IRC-83 (Part I) shall be applicable for all metallic elements. Provisions of IRC: 83 (Part II) shall be applicable for all elastomer elements. When any items are not covered by IRC: 83 and BS: 5400 (Sections 9.1 and 9.2), except that no natural rubber shall be permitted. If there is any conflict between BS on the one hand and IRC on the other, the provisions of IRC will be guiding.

Combination bearing using a judicious combination and sliding element shall be permitted. As for example:

**Table 5.21.29** EXAMPLE FOR THE COMBINATION BEARING

| Name | Rotation Element | Sliding Element | Generally for |
|---|---|---|---|
| Pot | Pot | None | Vertical Load |
| Elastomer | Elastomer | None * | Horizontal Buffer |
| Spherical Knuckle PTFE | Spherical Knuckle | PTFES-SS ** | Vertical Load and Horizontal Load |
| Elastomer PTFE | Elastomer | PTFE-SS** | Transverse Guide |
| Elastomer SS ** | Elastomer | SS-SS** | Transverse Guide |

- Elastomer shall permit movement by shear
- Stainless Steel

For special and innovative bridges, new combinations beyond what is shown may be required. The same may be used after approval by the Engineer.

**B. Fabrication**

The surface mating with the PTFE in the sliding pair shall be corrosion resistant stainless steel. Normally, the stainless steel shall form the upper component. The stainless steel shall overlap the PTFE after full movement on all sides. If a stainless steel sheet is used, it should be bonded by continuous welding along the ends. Adhesive or any other bonding can be approved by the Engineer. The surface shall be prepared by thorough cleaning to remove grease, dust or any other substance.

PTFE modular sheets of the slicing pair shall be located by confinement assisted by bonding. Confined PTFE shall be recessed into the metal backing plate. The shoulders of the recess shall be sharp and square to restrict the flow of PTFE.

The thickness of the PTFE shall not be less than 4.5 mm with projection above the recess not exceeding 2.0 mm. when the piston is subjected to titling, the seal must slide.

**C. Materials**

(a) Steel

i) Structural steel shall conform to IS: 226 and IS: 2062, as applicable.

ii) Cast steel shall conform to Gr 280-520W of IS: 1030. 0.3 to 0.5 per cent copper may be added to increase the corrosion resistance properties.

iii) Stainless steel shall conform to AISI: 304 or X04 Cr 17 Nil 12 Mo2 of IS: 6911.

(b) PTFE

PTFE (poly tetra fluoro ethylene) shall be of unfilled pure virgin quality. It shall be free sintered. The mechanical properties of unfilled PTFE shall comply with Grade A of BS: 3784.

**D. Tolerances**

**Table 5.21.30** TOLERANCE FOR POT – CUM PTFE BEARINGS

| Sl. No | Item | Tolerance |
|---|---|---|
| **I.** | Plan dimensions | - 0 to + 5 mm |
| II. | Overall height | - 0 to + 3 mm |
| III. | Height of elastomer | ± 5 per cent |
| **IV.** | Height of any steel component | |
| a. | Machined | -0 to + 1 mm |
| b. | Unmachined | Class 2 of IS: 4897 |
| V. | Stainless steel sliding surface | |
| a. | Flatness | 0.0004L, where L= length in direction of measurement |
| b. | Surface Finish | Ra ≤ 0.25 pm as per IS: 3073 |

**E. Acceptance test on bearing**

i) All bearings shall be checked for overall dimensions.

ii) All bearings shall be load tested to 1.1 times maximum design capacity.

iii) A pair of Barings selected at random will undergo testing in order to determine the coefficient of friction's" The coefficient of friction shall be ≤ 0.05 at the design load.

iv) Two bearings selected at random shall be tested for permissible rotation.

**F. Installation of POT-cum-PTFE Bearings**

**(a) General**

i) Care shall be taken during installation of the bearings to permit their correct functioning in accordance with the design scheme.

ii) To prevent contamination, dismantling of the bearings at site shall not be done.

iii) The load shall be transferred onto the bearings only when the bedding material has developed sufficient strength. The props for the formwork shall be removed after the lapse of appropriate time. In special cases, this can be ensured by suitable devices like jacks, etc.

iv) Temporary clamps and shims (introduced to maintain working clearance) shall be removed at an appropriate time, before the bearing is required to permit movement.

v) Permitted installation tolerance of the bearing from the plane of sliding shall be maintained.

vi) Cement based non-shrink grout with air releasing additive and epoxy based grout, whichever is specified shall be first tried at the site. For the proprietary grout mixes, appropriate instructions from the manufacturer shall be followed especially with regard to the following

(a) Preparation > concrete cleaning, roughening, pre-soaking, etc

(b) Forms>sturdiness, leak proofing, shape, header funnel vents, etc

(c) Bearing Base> cleaning, etc

(d) Placement>mixing, consistency, time period, finishing, etc

(e) Protection>curing, ambient temperature, etc.

**(b) In-situ casting of superstructure**

i) Formwork around the bearing shall be carefully sealed to prevent leakage.

ii) Sliding plates shall be fully supported and care taken to prevent tilting, displacement or distortion of the bearings under the weight of wet concrete.

iii) Bearings shall be protected during concreting operation. Any mortar contaminating the bearing shall be completely removed before it sets.

**(c) Seating of bearing**

**Using Templates**

i) Templates with required rigidity and matching holes corresponding to the base of the bearing shall be used.

ii) All the anchors shall be fitted to the lower face of the template using the anchor screws but with steel washer replacing the elastomer washers. Separate screws may be used in case of inconvenience in the length of the original anchor screws.

iii) The template assembly shall be located with regard to level and alignment. It shall be ensured that the top of the anchors lie in a horizontal plane at the required elevation. The anchors shall be tied/welded to reinforcement to avoid displacement during concreting.

iv) Concreting of the pedestal/pier cap shall be done to a level leaving a gap of 25.50 mm below the template.

v) The template and steel washers shall be removed prior to placement of the bearing assembly with temporary clamps. The bearing assembly shall be fitted to the anchors with the help of anchor screws and elastomer washers. Level at the bearing shall be checked.

vi) The gap below the bearing assembly shall be grouted with cement-based grout. Reference may be made to Clause 2006.6.1(vi)

**Without Template with Gap**

i) Pockets commensurate with the sizes of the anchors shall be kept in pedestals during concreting of the same. The pedestal shall be cast approximately 25 mm short of the required finished level.

ii) Anchors shall be fitted to the bearing bottom with elastomer washers and anchor screws. The bearing assembly shall be seated in the location of steel chairs/packs.

The anchors fitted below the bearing shall go into pockets in the bed block. Level and alignment of the bearing shall be checked. It shall be ensured that the bearing sits in a horizontal plane.

iii) The gap below the bearing assembly including anchor pockets shall be grouted with cement based grout. Reference may be made to Clause 2006.6.1

**Without Template without Gap**

Elongated pockets commensurate with the sizes of the anchors shall be kept in pedestals during concreting of the same. The geometry and location of the anchor pockets (with tapered funnel extension, if required) shall be such that after placement of the bearing the pockets can be successfully grouted. The pedestal shall be cast 5 mm – 15 mm short of the required finished level. The required level shall be achieved by chipping before placement of the bearing. Careful control shall be exercised to cast at the exact finished level or 1 mm – 3 mm down from the required finished level.

**Seating of bearings shall be as per manufacturer's instructions.**

**(d) Inspection and testing**

Where any patents are used, the manufacturer's certificate with test proofs shall be submitted along with the design and got approved by the Engineer before their use in work

**(e) Tests and standards of acceptance**

The materials shall be tested in accordance with these specifications and shall meet the prescribed criteria.

The work shall conform to these specifications and shall meet the prescribed standards of acceptance.

**(f) Measurements for payment**

Bearing shall be measured in numbers, according to their capacities and particular specifications given on the drawings.

**(g) Rate**

The contract unit rate of each type of bearings shall include the cost of supplying and fixing the bearings in position complete as specified on the drawings or as decided by the Engineer.

The rate shall also include the cost of samples and their testing when desired by the Engineer.

In case of steel bearings the rate shall include the cost of all nuts, bolts, and the cost of all tests prescribed in the specifications and shown on the drawings.

### 5.21.11.2 STRIP SEAL EXPANSION JOINT

**I. Components**

Strip seal expansion joint shall comprise the following items:

(a) Edge beams- The special claw leg profiled member shall be of extruded rolled steel section combining good weld ability with notch toughness.

(b) Strip seal- This shall be of chloroprene with high tear strength, insensitive to oil, gasoline, and ozone. It shall have high resistance to aging. This component, provided

to ensure water tightness, shall have a bulbous shape of the part of the seal which is inserted into the groove, provided in the edge beam. The seal should be vulcanized in a single operation for minimum full length of joint.

(c) Rigid anchorage – This shall be welded to the edge beam at staggered distance.

(d) Anchor loops – This shall be made of weld able steel connecting the rigid anchorage with deck reinforcement.

**II. Material**

(a) Edge beams of this special section are at present being directly imported in India. The steel shall confirm to steel grade Rest 37-2 of German Standard or equivalent.

(b) Chloroprene of strip seal shall confirm to clause 915.1 of IRC: 83 (Part II). The properties of chloroprene shall confirm to Table 5.21.24

(c) Anchorage steel shall confirm to IS: 2062.

(d) Anchor loop shall confirm to IS: 2062.

**III. Strip seal element specifications**

The sealing element is made of chloroprene and must be an extruded section. The working movement range of the sealing element shall be at least 80 mm with a maximum of 100 mm at right angles to the joint and ±40mm parallel to the joint.

**Table 5.21.31** STRIP SEAL ELEMENT SPECIFICATIONS

| Sl. No | Property | Specified value |
|---|---|---|
| **1.** | Hardness | 63+ 5 shore A |
| 2. | Tensile Strength | Min 11 MPa |
| 3. | Elongation at fracture | Min 350 per cent |
| **4.** | Tear Propagation Strength | |
| | Longitudinal | Min 10 N/mm |
| | Transverse | Min 10N/mm |
| 5. | Shock Elasticity | Min 25 percent |
| 6. | Abrasion | Min 220 mm |
| 7. | Residual Compressive Strain (22 h/70 deg C/30 per cent strain) | Max 28 percent |
| 8. | Ageing in hot air (14 days/70 deg C) | |

| | | |
|---|---|---|
| | Change in Hardness | Max +5 shore A |
| | Change in tensile strength | Max -20 per cent |
| | Change in elongation at fracture | Max -20 per cent |
| 9. | Ageing in ozone (24 h/50pphms/25 deg C/20 per cent strain) | No cracks |
| 10. | Swelling behavior in Oil (116 h/25 per cent C) ASTM Oil no. | |
| | Volume Change | Max 5 per cent |
| | Change in hardness | Max 10 shore A |
| 11. | ASTM Oil no.3 | |
| | Volume change | Max 25 per cent |
| | Change in hardness | Max 20 shore A |
| | Cold Hardening Point | Min -35 deg C |

**IV. Fabrication (Pre-installation)**

(a) Rolled steel profiles are edge beams that are long enough to cater for a 2-lane carriageway. These shall be cut to size of actual requirements by means of a mitre box saw. Alignment of the cut-to –size steel profiles shall then be made in accordance with the actual bridge cross-section on work tables. For this purpose, the contour of bridge cross-section shall be sketched onto these tables. After the steel profiles are aligned, they will be chucked to the tables by means of screw clamps and tacked by welding.

(b) Anchor plates shall be cut to the required size by gas cutting. These shall be welded to the edge beams.

(c) Anchor loops shall be bent to the required shape and welded to anchor plates.

(d) The finally assembled joints shall then be clamped and transported to the work site.

**V. Handling and Storage**

(a) For transportation and storage, auxiliary brackets shall be provided to hold the joint assembly together.

(b) The manufacturer shall supply either directly to the Engineer or to the Bridge Contractor all the materials of strip seal joints including sealants and all other accessories for the effective installation of the jointing.

(c) Expansion joint material shall be handled with care. It shall be stored under cover on suitable lumber padding by the Contractor to prevent damage. Any damage

occurring after delivery shall be made good at the Bridge Contractor's expense to the satisfaction of the Engineer.

**VI. Installation**

The width of the gap to cater for movement due to thermal effect, prestress, shrinkage and creep, superstructure deformations (if any) and sub-structure deformations (if any) shall be determined and intimated to the manufacturer. Depending upon the temperature at which the joint is likely to be installed, the gap dimension shall be preset

Taking the width of the gap for movement of the joint into account, the dimensions of the recess in the decking shall be established in accordance with the drawings or design data of the manufacturer. The surfaces of the recess shall be thoroughly cleaned and all dirt and debris removed. The exposed reinforcement shall be suitably adjusted to permit unobstructed lowering of the joint into the recess.

The recess shall be shuttered in such a way that dimensions in the joint drawing are maintained. The formwork shall be tight.

Immediately prior to placing the joint, the presetting shall be inspected. Should the actual temperature of the structure be different from the temperature provided for presetting, correction of the presetting shall be done. After adjustment, the brackets shall be tightened again.

The joint shall be lowered in a predetermined position. Following placement of the joint in the prepared recess, the joint shall be leveled and finally aligned and the anchor loops on one side of the joint welded to the exposed reinforcement bars of the structure. Upon completion, the same procedure shall be followed for the other side of the joint. With the expansion joint finally held at both sides, the auxiliary brackets shall be released, allowing the joint to take up the movement of the structure.

High quality concrete shall then be filled into the recess. The packing concrete must feature low shrinkage and have the same strength as that of the superstructure, but in any case not less than M 35 grade. Good compaction and careful curing of concrete is particularly important. After the concrete has cured, the movable installation brackets still in place shall be removed.

Rolled up neoprene strip seals shall be cut into the required length and inserted between the edge beams by using a crow bar pushing the bulb of the seal into the steel grooves of the edge beams. A landing to a bead shall be formed in the thickened end of the edges of the seal which would force the thickened end against the steel beam due to wedge effect when the strip seal is buttoned in place.

As soon as the concrete in the recess has become initially set, a sturdy ramp shall be placed over the joint to protect the exposed steel beams and neoprene seals from site traffic. Expansion joints shall not be exposed to traffic loading before the carriageway surfacing is placed.

The carriageway surfacing shall be finished flush with the top of the steel sections. The actual junction of the surfacing/wearing coat with the steel edge section shall be formed by a wedge shaped joint with a sealing compound. The horizontal leg of the edge beam shall be cleaned beforehand. It is particularly important to ensure through and careful compaction of the surfacing in order to prevent any premature depression forming in it.

**VII. Acceptance Test**

i) All steel elements shall be finished with corrosion protection system

ii) It shall also be stretch tested. If a manufacturer is to supply this type of joint, they will have to produce a test certificate accordingly conducted in a recognized laboratory, in India or abroad.

iii) In view of the importance of the built up edge beams, special investigation of fatigue strength of this section with anchorages to withstand 2 x 10 load change cycles without showing signs of damage, will be required. The supplier shall have to produce a test certificate in this regard, conducted in a recognized laboratory, in India or abroad.

iv) The manufacturer shall produce test certificates indicating that the anchorage system had been tested in a recognized laboratory to determine optimum configuration of anchorage assembly under dynamic loading.

v) The manufacturer shall satisfy the Engineer that a water tightness test for the type of joint had been carried out in a recognized laboratory to check the water tightness under a water pressure of 4 bars.

vi) As strip seal type of joint is specialized in nature, generally of the proprietary

**VIII. Measurements for payments**

The expansion joint shall be measured in running meters. For filled joints, the rate per running meter shall include the cost of sealant for the depth provided in this drawing.

**IX. Rate**

The contract unit rate shall include the cost of all material, labour, equipment and other incidental charges for fixing the joints complete in all respects as per these specifications in the case of Bridge Contractor supplying the expansion joint. If the manufacturer supplies the expansion joint directly to the Engineer, the cost of installation, handling and fixing shall be borne by the Bridge Contractor.

### 5.21.11.3 DRAINAGE SPOUTS

**I. Scope**

This work shall consist of furnishing and fixing in position of drainage spouts and drainage pipes for bridge decks as per drawing and specification.

**II. Fabrication**

The drainage assembly shall be fabricated to the dimensions shown on the drawings; all materials shall be corrosion resistant; steel components shall be of mild steel conforming to IS: 226. The drainage assembly shall be seam welded for water tightness and then hot-dip galvanized.

**III. Placement**

The galvanized assembly shall be given two coats of bituminous painting before placement. The whole assembly shall be placed in true position, lines and levels as shown in the drawing with necessary cut-out in the shuttering for deck slab and held in place firmly. Where the reinforcements of the deck are required to be cut, equivalent reinforcements shall be placed at the corners of the assembly.

**IV. Finishing**

After setting of the deck slab concrete, the shrinkage cracks around the assembly shall be totally sealed with bituminous sealant as per IS:1834 and the excess sealant trimmed to receive the wearing coat. After the wearing coat is completed, similar sealant shall be finished to cover at least 50 mm on the wearing coat surface all round the drainage assembly.

**V. Measurements for payment**

The measurement for payment for Drainage spouts shall be number.

**VI. Rates**

The contract unit rate for each drainage spout shall include the cost of all labour, materials tools and plant required for completing the work as per these Specifications. It shall also include the cost of providing flow drain pipes with all fixtures up to the point of ground drains wherever shown on the drawings.

### V.21.12.1 FACTORY MADE CEMENT CONCRETE INTERLOCKING PAVER BLOCK

Interlocking paver block to be fixed on the bed 50 mm or specified otherwise thick of coarse sand of approved specification and filling the joints with the sand of approved type and quality or as specified and as directed by Engineer-in-charge.

Factory made precast paver block should conform to IS 15658: 2006

- *Providing and laying factory made Cement Concrete paver blocks in footpath, parks, lawns, drive ways or light traffic parking etc, of required strength, thickness & size/ shape, laid in required colour & pattern over 50mm thick compacted bed of sand, compacting and proper embedding/laying of inter locking paver blocks into the sand bedding, filling the joints with sand and cutting of paver blocks as per required size and pattern, finishing and sweeping extra sand, complete all as per direction of Engineer-in-Charge*

*RW0300 Interlocking Paver Block (Zig Zag) 80mm Thk. Colour*
*RW0301 Interlocking Paver Block (Zig Zag) 80mm Thk. Ash Grey*
*RW0302 Interlocking Paver Block (Zig Zag, Tri-Hex, Brook, Cosmic) 60mmThk. Colour*
*RW0303 Interlocking Paver Block (Zig Zag, Tri-Hex, Brook, Cosmic) 60mm Thk. Ash Grey*
*RW0304 Interlocking Paver Block (Tri-Hex, Brook, Cosmic) 40mm Thk. Colour*
*RW0305 Interlocking Paver Block (Tri-Hex, Brook, Cosmic) 40mm Thk. Ash Grey*
*RW0306 Rectangular Paver Block 60mm Thk. Colour*
*RW0307 Rectangular Paver Block 60mm Thk. Ash Grey*
*RW0308 Rectangular Paver Block 40mm Thk. Colour*
*RW0309 Rectangular Paver Block 40mm Thk. Ash Grey*
*RW0310 Coral Stone Finished 60mm Thk. Colour*
*RW0311 Coral Stone Finished 60mm Thk. Ash Grey*
*RW0312 Coral Stone Finished 40mm Thk. Colour*
*RW0313 Coral Stone Finished 40mm Thk. Ash Grey*

*- Chequerred precast cement concrete tiles 22 mm thick in footpath & courtyard, jointed with neat cement slurry mixed with pigment to match the shade of tiles, including rubbing and cleaning etc. complete, on 20 mm thick bed of cement mortar 1:4 (1 cement: 4 coarse sand).*

*RW0320 Chequered tiles, Paver tiles 25mm Thk. Colour*

*RW0321 Chequered tiles, Paver tiles 25mm Thk. Ash Grey*

*RW0335 Providing and laying Tactile Floor Tiles - Concrete in different sizes (Sizes and thickness to be specified by the engineer/as per design) in all colours and shade, laid on 20 mm thick cement mortar 1:4 (1 cement: 4 coarse sand) finished with flush pointing in white cement*

**Measurement**

Area provided with paver block to be measured in sq.m, correct up to two places of decimal.

**Rates**

The rate includes the cost of the material, labour, tools etc. required in all the operations described above.

### V.21.12.2 KERB STONE (PRECAST)

Trenches shall first be made along the edge of the wearing course of the road to receive the kerb stones of cement concrete of specified grade. The bed of the trenches shall be compacted manually with steel rammers to a firm and even surface and then the stones shall be set in cement mortar of specified proportion.

The kerb stones with top 20 cm. wide shall be laid with their length running parallel to the road edge, true in line and gradient at a distance of 30 cm. from the road edge to allow for the channel and shall project about 12.5 cm. above the latter. The channel stones top 30 cm. wide shall be laid in position in a chamber with finished road surface and with sufficient slope towards the road gully chamber. The joints of kerb and channel stones shall be staggered and shall be not more than 10 mm. Wherever specified all joints shall be filled with mortar 1:3 (1 cement : 3 coarse sand) and pointed with mortar 1:2 (1 cement: 2 fine sand) which shall be cured for 7 days.

The necessary drainage openings of specified sizes shall be made through the kerb as per drawings or as directed by the Engineer-in-Charge for connecting to storm water drains. Berms and road edges shall be restored and all surplus earth including rubbish etc. disposed of as directed by the Engineer-in-charge. Nothing extra shall be paid for this.

| | |
|---|---|
| *RW0322* | *Providing and laying at or near ground level factory made kerb stone (Edging) 100mm thick, in position to the required line, level and curvature, jointed with cement mortar 1:3 (1 cement: 3 coarse sand), including making joints with or without grooves (thickness of joints except at sharp curve shall not to more than 5mm), including making drainage opening wherever required complete etc. as per direction of Engineer-in-charge (length of finished kerb edging shall be measured for payment)* |

**Measurements**

It shall be measured in sq. meters with Length of the finished work.

**Rate**

The rate shall include the cost of all the materials and labour involved in all the operations described above.

# 5.22 Chapter 22: Occupational Health and Safety (OHS)

## 5.22.1 General OHS Requirement

*OHS001 Incorporation of Occupational Health and Safety measures at construction sites, including Insurance, Personal Protective Equipment (PPE), First Aid kits, Boundary Fencing, Scaffolding, Safety nets, Traffic management, signage, etc, as listed in the specifications. The standards and specifications for the Insurance, OHS materials and (or) equipment shall comply with the Labour and Employment Act - 2007, Regulation on Occupational Health, Safety and Welfare - 2012, and other relevant national documents. All OHS items will remain the property of the bidder upon completion of the project.*

The following list of OHS inputs are the minimal mandatory requirements at a construction site. These requirements had been derived in consensus with the Department of Labour (DoL), Ministry of Labour and Human Resources (MoLHR).

### 5.22.1.1 Insurance

Every worker shall be insured for the entire period of construction. The capital sum to be insured shall be as per the requirements of Labour and Employment Act of Bhutan - 2007 and its regulations.

### 5.22.1.2 Personal Protective Equipment (PPE)

Every worker shall be provided with minimal PPE to minimize exposure to hazard and to ensure safety at the construction sites "at all times". The PPE could be grouped and provided as below:

- ❏ To be provided to all:
  - Safety helmet
  - Safety shoes
  - Protective gloves
  - High visibility Vest
  - Dust mask
- ❏ To be provided to specific workers: [1]
  - Safety belt
  - Safety harness
  - Safety goggle and spectacle
  - Ear muffs
  - Ear plugs
  - Welding shield/glass

### 5.22.1.3 Common Protection Measures (CPMs)

- First Aid tool box with aid kits
- Medical examination and records
- Adequate safety signs and signboards
- Boundary fence/barricade

[1] *Specific workers include (but not limited to) those workers working at height, welders, workers engaged in works with high noise level, etc.*

- Fire and electrical safety
- Fall protection (scaffolding and safety net)
- Trained OHS Officer/ Safety Supervisor/Safety Representative [2]
- Trained first aider [3]
- Safety and health orientation to new workers and safety training
- Housekeeping
- Traffic management at construction site
- Trenching and excavation safety

The standards and specifications for the OHS materials and (or) equipment shall be in compliance with the Labour and Employment Act - 2007, Regulation on Occupational Health, Safety and Welfare - 2012, and other relevant national documents.

The list of the OHS requirements as per the above list with additional list (if any) shall be attached along the Bill of Quantities (BoQ) along with an appropriate item description to allow the bidder to quote reasonably against the item, and to enable strict compliance and ease the monitoring during the project implementation time.

The procuring agency may allow the reuse of OHS items so long as these reused items serve the intended purpose. Furthermore, all OHS items will remain as the property of the bidder upon completion of the project. This is to encourage the bidders to conscientiously assess the OHS cost and quote reasonably keeping in view the reusability of such items in later projects.

Procuring agencies may also include the OHS officer and the first aider as 'key personnel' required by Labour and Employment Act – 2007 and its regulations depending on the complexity of the project.

Monitoring: Once OHS is integrated into the project cost and the work awarded, the contractor will have to mandatorily mobilize the resources. The site engineers and the respective Procuring Agencies will have to monitor and ensure that the OHS requirements are provided by the contractor at site and used appropriately "at all times". Besides this regular monitoring, a Third-Party monitoring of OHS will also be carried out by the Construction Development Board and the Ministry of Labour from time to time.

Mode of Payment: It is recommended that the payment mode be designed to suit the procuring agency. Before making the payment, the project engineer/site engineer and the project manager should verify and confirm that the OHS input requirements have been mobilized and implemented at site. It is also recommended that the payment be made in phases depending on the nature and duration of the project.

No additional payment for OHS shall be made for Variations (Change of rate, time extension, deviation, price adjustment, additional works, etc.)

General Note: The guideline is prepared fundamentally for the purpose of estimation of the cost of OHS in the project. For the purpose of the payment, it shall be based on the contractor's quoted amount/contract agreement.

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[2] *This requirement will only come into effect after the DoL and CDB starts the required training. The site engineer/project manager of the contractor can be an OHS officer after getting trained.*

[3] *The site supervisor or one of the workers can be the first aider after getting trained.*

In case of works executed departmentally, the agencies have to insure the workers and procure the PPE/CPM following proper procuring procedures. The items must be properly stored for future use and inventory of the same must be maintained.

## 5.22.2 Accommodation Standard

*OHS002* *Providing temporary living accommodation which includes bed room, kitchen, and toilet cum bathroom including proper water supply and electricity as per the drawing and temporary living accommodation standards. The accommodation facilities must be dismantled and cleaned upon the completion of the project. All reusable materials of the accommodation facilities will remain as the property of the bidder upon completion of the project.*

When providing living accommodation to workers at construction sites, the objective should be to ensure adequate and decent accommodation and a suitable living environment for workers. The provision of accommodation to workers shall align with the objectives of Occupational Health and Safety. Therefore, it shall meet certain minimum specifications in respect of the nature and standard of the accommodation, and facilities to be made available.

The following specifications are drawn for the provision of accommodation to workers in Bhutanese construction industry based on international labour standards.

### 5.22.2.1 Location

The temporary living accommodation for employees should be constructed at the safest place where there is no risk of flooding, landslide, collapse hazards, falling boulders and other elements.

### 5.22.2.2 Accommodation

a) Gender friendly living accommodation should be provided.

b) Accommodation should be constructed where workers are protected against the elements (such as wind, cold, rain, heat, etc.)

c) There should be one room for every 4 employees. Adequate headroom and movement space shall be provided. The size of the room shall be at least 3.5 square meters per person (refer drawing).

d) A separate kitchen shall be provided if employees cook by themselves. However, if the meals are provided by the employer, a common dining room, canteen or mess room, located away from the sleeping areas should be provided.

e) A separate pour-flush toilet cum bathroom, washing facilities for male and female shall be provided. There shall be one toilet cum bathroom for every six users. The size of the toilet shall comply with the Building Code of Bhutan/ the attached drawing.

f) The floors of each room shall be constructed of wood or concrete. Floor shall be provided with good finishes. All wooden floors shall be elevated not less than 1 foot above the ground level at all points to prevent dampness and to permit free circulation of air beneath.

g) The walls of the bed room and the kitchen must be constructed preferably with ply boards of at least 10 mm thickness (or equivalent) and CGI/ PPI Sheet for roofing. For toilets, both walls and roof shall be constructed with CGI/ PPI sheets (or equivalent).

h) There should be adequate natural light during the daytime and adequate artificial light (refer drawing).

i) Adequate ventilation to ensure sufficient movement of air in all conditions of weather and climate.

#### 5.22.2.3 Health and Hygiene

a) An adequate and convenient water supply shall be provided for drinking, cooking, bathing, and laundry purposes.

b) The accommodation should maintain good sanitation and hygiene (proper drainage system, proper waste management, good housekeeping, etc.).

c) Measures should be taken to prevent the spread of diseases, especially communicable diseases.

#### 5.22.2.4 Safety at temporary accommodation site

a) Any electricity supplied for the accommodation should abide by the Electricity Act of Bhutan, 2001.

b) There should not be any exposed live wire or unattended electrical switches & sockets in the living accommodation.

c) Every cable used for any purpose should have a plug at one end.

d) Combustible, explosive, and highly flammable materials should not be stored in the living accommodation.

e) Fire safety measures should be taken, including installing and maintaining fire equipment.

f) As far as possible, floors, walls, ceilings and equipment should be constructed to minimize health risks.

The accommodation shall be provided and maintained for the entire contract period including the time extension if any or the delays. The complete work of providing temporary living accommodation to workers at construction sites shall be treated as an item of work under Occupational Health and Safety.

The construction shall be durable taking into account local conditions, such as liability to earthquakes, flood and landslide. The materials used for accommodation will remain as the property of the bidder upon completion of the project. The reuse of the materials may be permitted as long as these reused items serve the intended purpose or as approved by the procuring agency.

***Notes:***

*1. In case the contractor fails to provide specified temporary living accommodation, then the procuring agencies will construct accommodation facilities as specified above. The actual cost of construction will be recovered from the first running bill with the condition that the useful materials of the accommodation facilities can be taken ownership by the contractor.*

*2. No additional payment for accommodation shall be made for variations (Change of rate, time extension, deviation, price adjustment, additional works, etc.).*

*3. The quoted rate shall be inclusive of shifting and rebuilding cost of the accommodation facilities if required.*

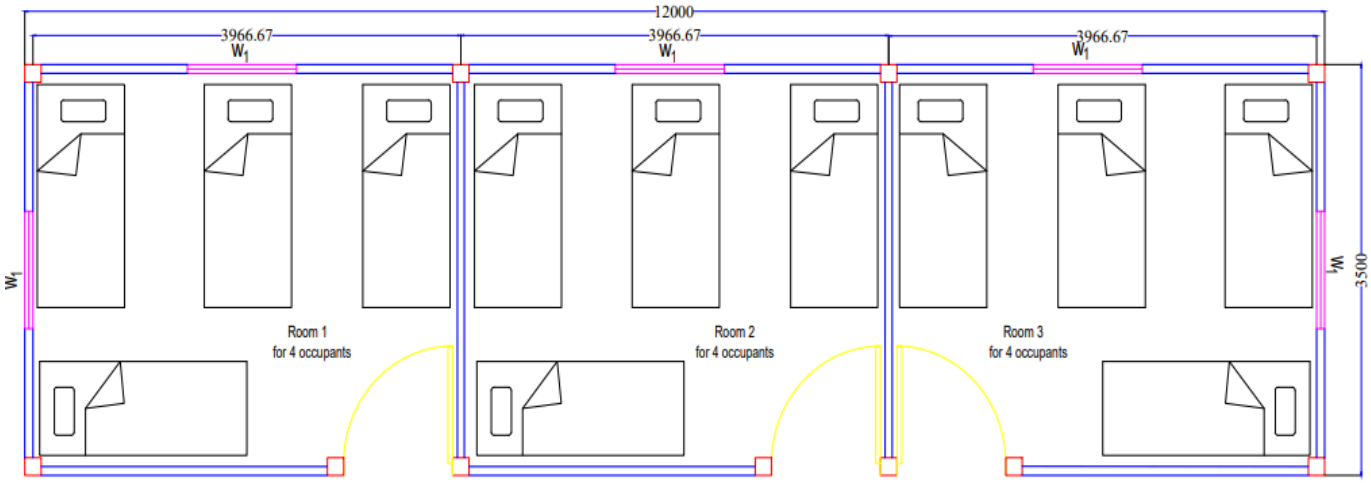



**Figure 5.22.1** Bed Room Plan for 12 Occupants

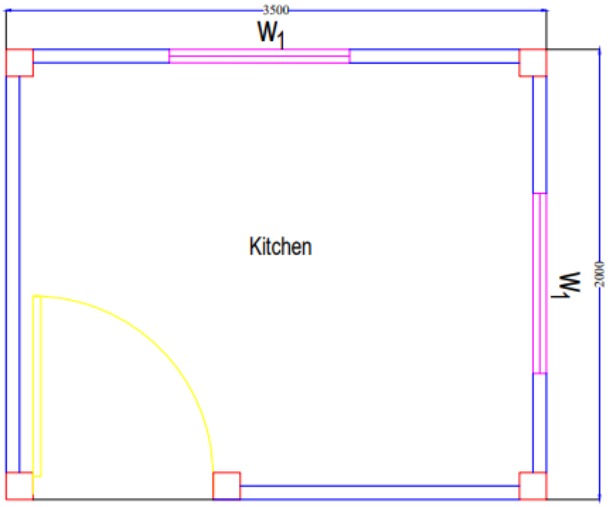



**Figure 5.22.2** Kitchen Plan for 12 Occupants

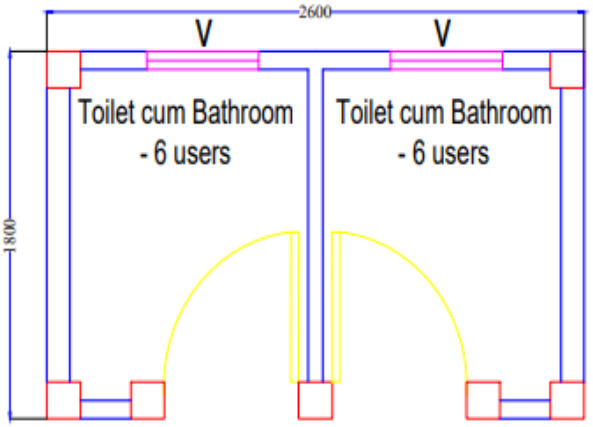



**Figure 5.22.3** Toilet Plan for 12 Occupants

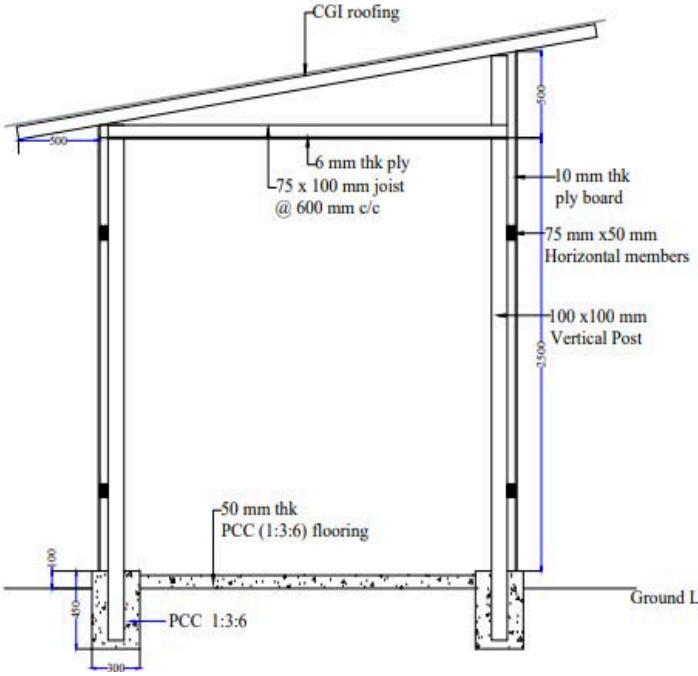



Figure 5.22.4 Section for Bed Room and Kitchen

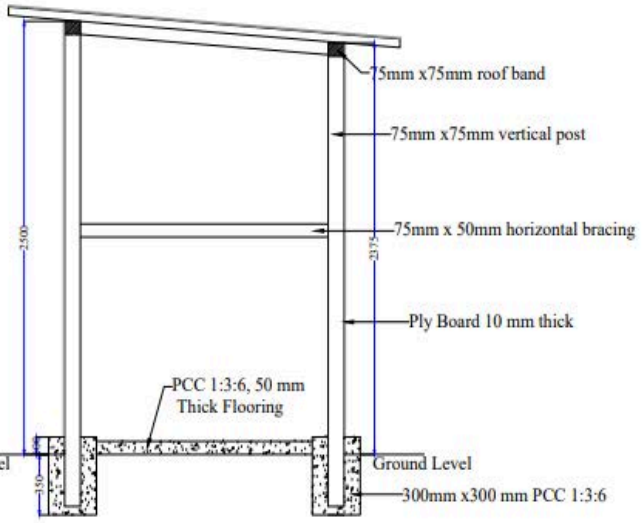
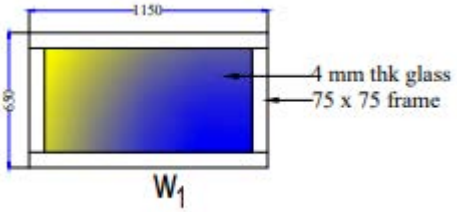
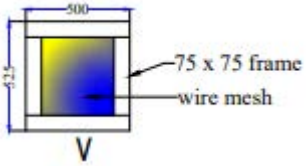



Figure 5.22.5 Section for Toilet




| SL.NO. | LEGENDS<br>DESCRIPTION | SYMBOL |
|---|---|---|
| 1 | INDOOR SURFACE/RECESS IN NORMAL TUBE FRAME WITH LED LAMP OF 1X15W | |
| 2 | SURFACE/RECESSED CEILING FOR OUTDOOR WITH LED LAMP OF - 1X12 W | |
| 3 | MODULAR POWER SOCKET OUTLET WITH 16A SWITCH FOR 2000W | |
| 4 | 6A 1-WAY & 2-WAY SWITCH AT 1.5M HEIGHT | |
| 5 | WALL MOUNTED MAIN DISTRIBUTION BOARD AT 1.8 M HEIGHT IN GROUND FLOOR | MDB |
| 6 | SUB DISTRIBUTION BOARD AT 1.8M HEIGHT FROM FINISHED FLOOR LEVEL | SDB |
| 7 | SWITCH BOARD INDICATION IN CONDUIT LAYOUT | |

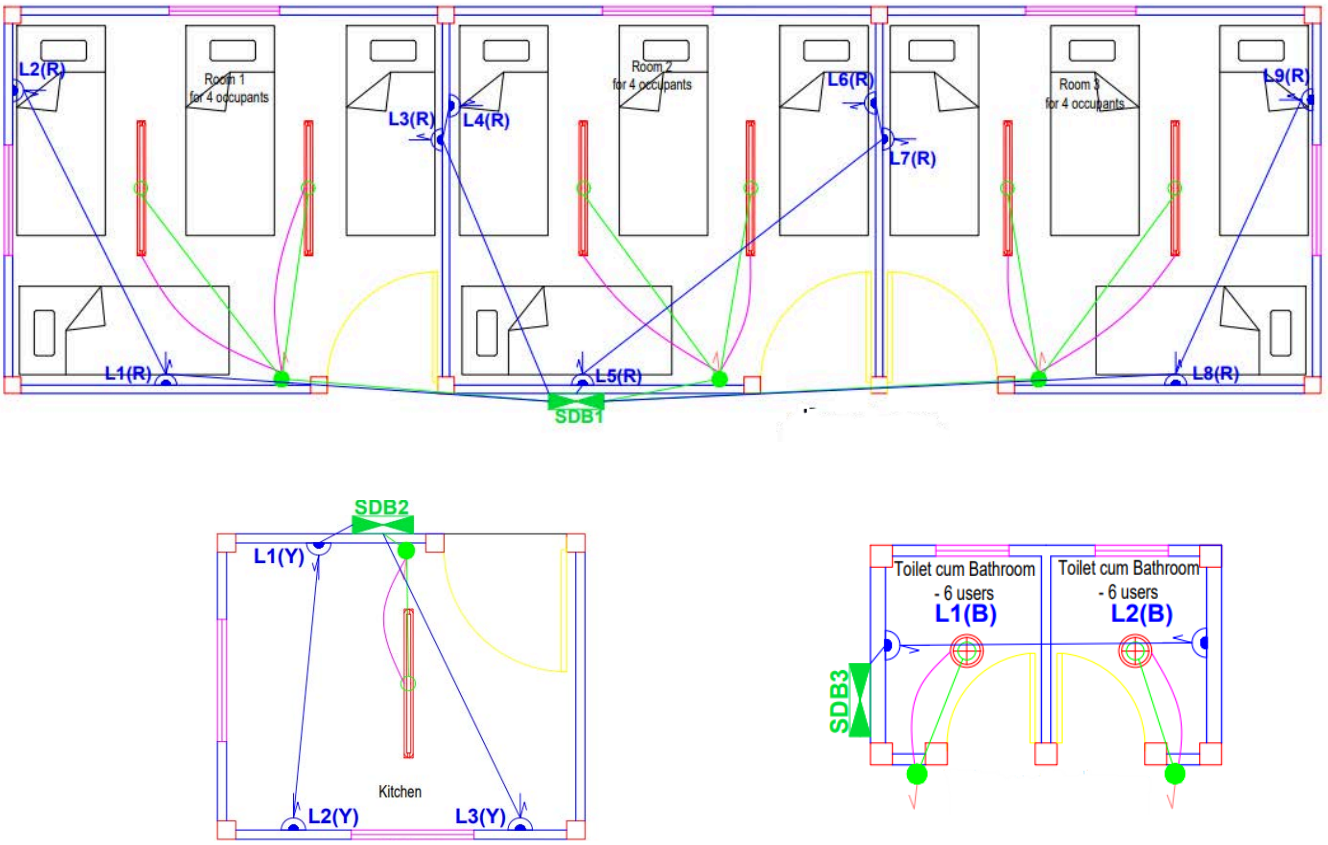



**Figure 5.22.6** Light and Power Point Layout

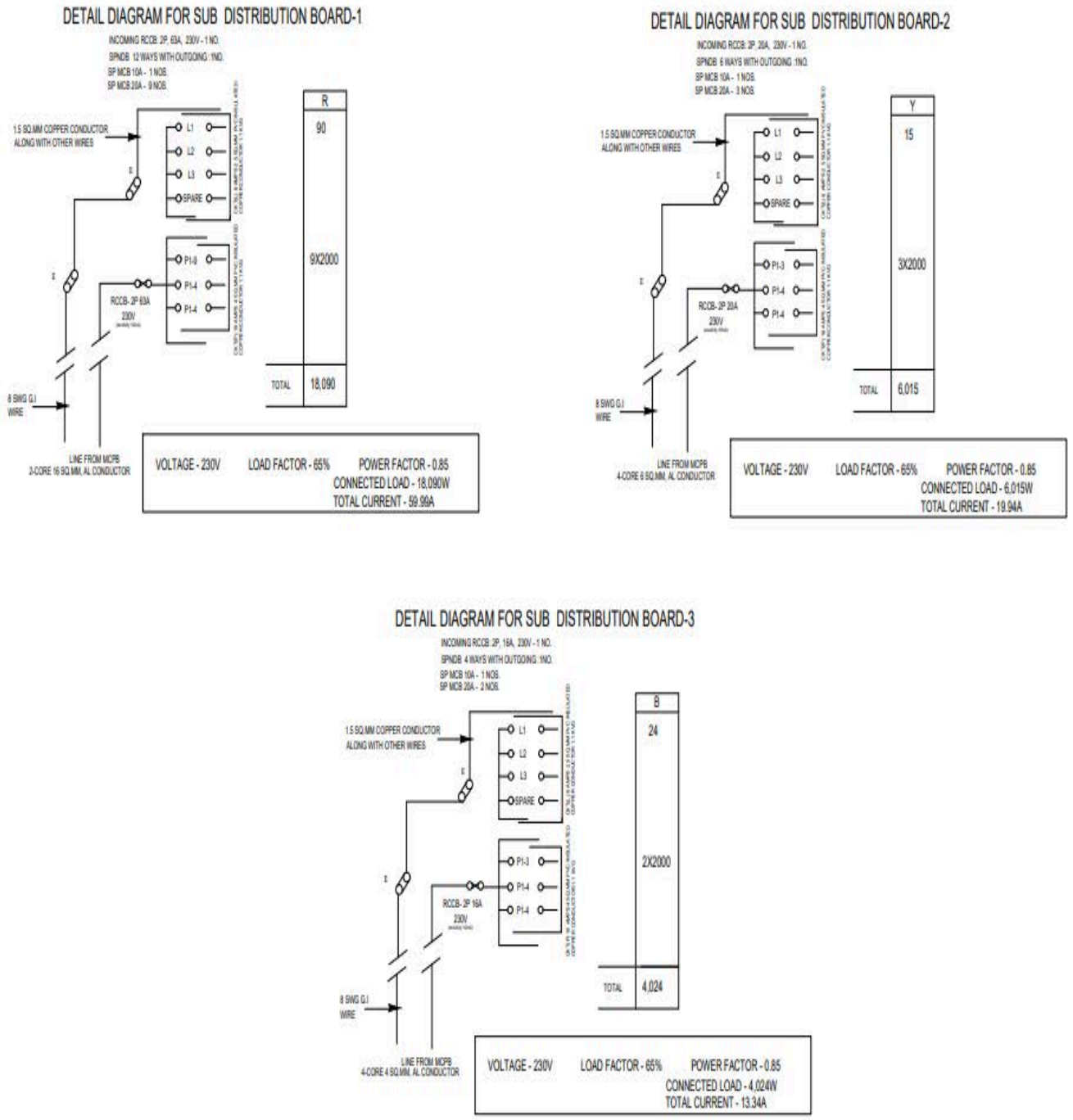



**Figure 5.22.7** SDB Detail

### 5.22.3 Standard For Prefabricated Site Office

*OHS003 Providing temporary site office with Puff-sheet roof & walls | PCC flooring | Aluminium door & windows | necessary electrical and plumbing | furniture. The accommodation facilities must be dismantled and cleaned upon the completion of the project. All reusable materials of the accommodation facilities will remain as the property of the bidder upon completion of the project.*

#### 5.22.3.1 Purpose

This Standard establishes the minimum design, construction, fit-out, and maintenance requirements for prefabricated (prefab) site offices used on construction projects and temporary work sites. It ensures that all site offices provide a safe, functional, and comfortable working environment while maintaining cost-effectiveness and speed of deployment.

#### 5.22.3.2 Scope

This document applies to all prefab site offices procured, erected, or operated under this organisation, including:

- New construction of prefab site office units
- Relocation and re-erection of existing prefab units
- Fit-out and furnishing of site office spaces
- Maintenance and upkeep during the operational period

This Standard covers three standard configurations:

**Table 5.22.1** Three standard configurations

| | **Units Included** | **Approx. Floor Area** |
|---|---|---|
| Type A | Hall + Toilet + Pantry | ~23 m² |
| Type B | 1 Room + Hall + Toilet + Pantry | ~30.5 m² |
| Type C | 2 Rooms + Hall + Toilet + Pantry | ~38 m² |

#### 5.22.3.3 Reference Document & Standard

The following codes and standards shall be referred to alongside this document:

- Bhutan Building Code
- Bhutan Schedule of Rate
- Specification for Building & Road Works
- IS 875 (Part 1–5) — Code of Practice for Design Loads
- Bhutan Environmental & Labour regulations

### 5.22.3.4 Definitions

**Table 5.22.2** Terms and Definitions

| Term | Definition |
|---|---|
| Prefab / Prefabricated | Structure manufactured off-site in standardised components and assembled on-site. |
| Puff-sheet / PIR Panel | Prefabricated sandwich panel comprising two colour-coated GI metal skins bonded to a rigid Polyisocyanurate (PIR) foam core. |
| PCC Flooring | Plain Cement Concrete floor slab, M15 grade, minimum 75 mm thick, laid over a compacted sub-base. |
| Hall | Multi-purpose meeting and work area, minimum 4 m × 3 m internal clear dimension. |
| Office Room | Private office space, minimum 3 m × 2.5 m internal clear dimension. |
| Pantry | Utility space for food preparation and serving, minimum ~3 m². |
| Toilet | Sanitary facility, minimum ~2.5 m², comprising one WC, one WHB, and one shower provision. |
| MDB | Main Distribution Board — electrical panel supplying power to the entire site office. |
| CPVC | Chlorinated Polyvinyl Chloride — material used for hot and cold-water supply piping. |

### 5.22.3.5 Site Selection Criteria

- Locate the site office on firm, level, well-drained ground within the project boundary.
- Maintain a minimum 6 m clearance from the nearest active construction activity or heavy equipment path.
- Ensure unobstructed vehicle access (minimum 3 m wide access road) for delivery of prefab components.
- Position with the primary entrance facing away from the prevailing wind direction to reduce dust ingress.
- The site office shall not be placed in a flood-prone or low-lying area; the finished floor level shall be minimum 300 mm above the highest recorded ground water / flood level.

### 5.22.3.6 Steel Structural Frame

- Primary frame: MS Hollow Section (SHS/RHS), Grade Fe 410 to IS 2062, hot-rolled.
- Secondary members (purlins, girts): MS C-section or angle iron.
- All welding to IS 9595; welds to be visually inspected and any defects repaired before painting.
- Base connections: anchor bolts (M16 minimum) set in PCC slab with 200×200×10 mm MS base plates.

- Frame design to withstand wind speed as per IS 875 Part 3 for the site location; minimum design wind speed 39 m/s.
- Seismic design as per IS 1893 for the applicable zone.

#### 5.22.3.7 Puff-Sheet / PIR Sandwich Panel Walls

**Table 5.22.3** Comparison of PUF Sheet and PIR Sandwich Wall Panels

| Parameter | Wall Panels | Roof Panels |
|---|---|---|
| Core material | PIR (Polyisocyanurate) | PIR (Polyisocyanurate) |
| Core thickness | 50 mm minimum | 75 mm minimum |
| Skin material | Colour-coated GI (G-350) | Colour-coated GI (G-350) |
| Skin thickness | 0.50 mm (both sides) | 0.50 mm (both sides) |
| U-value (max.) | 0.50 W/m²K | 0.40 W/m²K |
| Fire rating | Class 1 surface spread of flame | Class 1 surface spread of flame |
| Joint type | Male-female interlocking | Male-female interlocking |

- All panel joints to be sealed with a continuous bead of neutral-cure silicone sealant on both faces.
- Colour: exterior — standard light grey or off-white; interior — white or cream.
- Panels shall be free of dents, scratches, or delamination on delivery.

**Table 5.22.4** Office Room Furniture

| Item | Qty per Room | Minimum Specification |
|---|---|---|
| Executive desk | 1 | 1500×750 mm, engineered wood / pre-lam board, PVC edge band |
| Executive chair | 1 | Medium-back, gas lift, 5-star castor base, adjustable armrests |

**Table 5.22.5** Hall Furniture

| Item | Qty | Minimum Specification |
|---|---|---|
| Conference table | 1 | 1800×900 mm, 8-seater, engineered wood top on MS frame |
| Conference chairs | 8 | Cushioned seat/back, stackable, powder-coated frame |

The Site office shall be provided and maintained for the entire contract period including the time extension if any or the delays. The complete work of providing Site Office at construction sites shall be treated as an item of work under Occupational Health and Safety.

The construction shall be durable taking into account local conditions, such as liability to earthquakes, flood and landslide. The materials used for accommodation will remain as the property of the bidder upon completion of the project. The reuse of the materials may be permitted as long as these reused items serve the intended purpose or as approved by the procuring agency.

***Notes:***

*j) Although a proper site office for Medium & Large work is encouraged to be provided, its need for a particular project shall be decided by the procuring agency. Some works such as minor maintenance, community contracting, projects with very short project duration, etc., may not require. Therefore, the decision on this shall be taken by the procuring agencies diligently.*

*k) For the estimation purpose, the project estimator can use table – 8.1.2. However, the payment for the same shall be made based on the contractor's bid*

*l) In case the contractor fails to provide specified Site Office, (as per Contract Agreement) then the procuring agencies will construct accommodation facilities as specified above. The actual cost of construction will be recovered from the first running bill with the condition that the useful materials of the accommodation facilities can be taken ownership by the contractor.*

*m) No additional payment for Site Office shall be made for variations (Change of rate, time extension, deviation, price adjustment, additional works, etc.).*

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