Guidelines for Construction of Reinforced Cement Concrete Buildings

Engineering Service Division
Department of Engineering Services
Ministry of Works and Human Settlement

Guideline for Construction of Reinforced Cement Concrete Buildings

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Ministry of Works and Human Settlement

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Forward

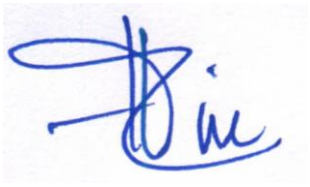
The Department of Engineering Services, Ministry of Works and Human Settlement is pleased to bring out "Guideline for Construction of RCC Building" for the benefit of all architects, engineers and builders.

With the advancement of construction technology and rapid infrastructure development taking place in the country, the professionals in the construction sector today are faced with increased challenges in construction of buildings in terms of maintaining quality and preservation of traditional architecture. In addition, Reinforced Cement Concrete (RCC) buildings provide new challenges due to multi-storied floors and adoption of unique and creative designs by designers obliging to the wishes of modern clients.

This document, is a first of its kind in Bhutan. It primarily focuses on the construction of a RCC building. It clearly outlines the different stages of a RCC building construction process starting from site layout and foundation to building finishes. It tries to comprehensively cover different aspects of a building construction viz. architecture, civil, electrical, plumbing and sewer components. It is also intended to guide the professionals to control the material quality and workmanship by specifying various tests to be carried out and measures to be taken at site. References are also made to relevant codes and standards for further information. It is the objective of this document to provide a clear guidance for supervising and monitoring professionals. The check list provided in this book shall benefit the professionals in quality assurance and proper management.

I am optimistic that this document prepared in-house by our own experienced professionals will have positive impact in our building construction sector for all times to come. I sincerely hope our architects, engineers and builders will read and refer to this document in their day to day work.

Tashi Delek!



Tenzin

Director

Department of Engineering Services

Preface

With rapid urbanization and infrastructure development, there have been drastic change in the construction technology and building design in Bhutan. Therefore, it is important to streamline and establish proper building construction procedures and practices.

This document seeks to provide clear and concise construction procedures and methods that can help Architects, Engineers and Builders to build infrastructure of highest quality. Therefore, Engineering Services Division, Department of Engineering Services, Ministry of Works and Human Settlement has developed this document in its first attempt to compile the whole range of best practices and standards for easy reference and implementation. However, this document attempts to focus only on the RCC structures and may not be applicable to other construction typologies.

We are sure that with the extensive use of this document and feedback from the users, further revisions and improvement will follow. This document is initiated and developed by the department in the hope that it will reach maximum user and benefit them while taking up construction projects.

Phub Rinzin

Chief Engineer

Engineering Service Division

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Acronyms and Abbreviations

BoQ	Bill of Quantities
BSB	Bhutan Standard Bureau
BSR	Bhutan Schedule of rates
DB	Distribution Board
DPC	Damp Proof Course
FIFO	First In First Out
HDPE	High Density Polyethylene
IS	Indian Standard
LAN	Local Area Network
MCPB	Main Control Panel Board
PCC	Plain Cement Concrete
PVC	Polyvinyl Chloride
RCC	Reinforced Cement Concrete
RRM	Random Rubble Masonry
SDB	Sub Distribution Board
SBRW	Specifications for Building and Road Works
SP	Special Publication

Background

Ministry of Works and Human settlement as a parent agency for Architects and Engineers play vital role in the management and capacity development of professionals. One critical strategy to enhance the capacity of the professionals is to set working standards through publications of guidelines, manuals, and standards.

There have been several attempts to publish manuals and guideline for construction of the building, however, emphasis have not been paid to construction procedures and practicality; limiting the whole content to citation of Codes and Standards. Professionals like Engineers and Architects play vital role in the development of the country and constructing infrastructure of highest quality and standards.

In this document, the construction procedures are stated in context of Bhutan and also keeping true to standards and codes. Step by step construction procedures are spelled out clearly highlighting important methods and practices while interlinking this process to checklist and tests to ensure that construction practices are as per accepted standards and finish product of highest quality. It is important to compile all components of building like civil, architectural and electrical and sanitation works under one envelop to have better understanding of building construction; this document attempts to cover topics from earthwork excavation to truss, from reinforcement to sanitary fittings thus making it a comprehensive reference document for professionals while taking up construction of buildings.

One important aspect of this document is the detailed and exclusive checklists drawn from the construction processes which will be important tool in quality assurance. Checklist can be used either during construction or post construction and can also be used as a check and balance tool. Further, Engineers and Architects in the Dzongkhags and Thromdes mandated to implement Five Year Plan developmental programs related to infrastructure construction are expected to make use of this document as a tool and guide the professionals in achieving their targets.

Finally, this document is prepared with the hope that it will play a vital role in standardization of processes in building construction and steer the professionals to achieve quality construction.

Objective

This document is an attempt to compile the building construction procedures in one book; presently, many codes and standards are used for specific construction procedures making the whole process tedious and time consuming.

In this document, step by step procedures are spelled out for Architects and Engineers for the building construction. It is developed with the view that compilation of codes, standards, and guidelines in construction process is required under one document. This document also serves as checklist to furnish complete set of detailed drawings.

The main objectives of this document are:

- to guide architects and engineers in building construction
- to ensure proper building construction procedures are followed
- to assure quality construction of building and
- to serve as a checklist for monitoring and supervising professionals

Scope and Limitation

This document is intended to assist architects and engineers for supervision and monitoring of building construction.

This document is primarily for RCC frame structures. It spells out clear construction procedures, methodology, tests and checklist. However, it is important to use the manual in conjunction with relevant codes and standards. Design and approval processes, and project management aspects are beyond the scope of this manual.

Since this document covers only RCC construction methods, it will not be applicable to other construction methods like Load Bearing (Stone Masonry/Adobe) and Rammed Earth. Therefore, relevant codes, standards, and guidelines should be used for other construction methods. It should be noted that this document do not cover aspects of the construction like site development, interior finishing and sewerage works. However, certain provisions like service ducts and some general provisions have been covered for sewerage and plumbing works. Different units of measurement are being followed in this document for practical reasons.

As this is the first attempt to develop such document, there might be shortcomings and deficiencies. With the advancement of construction technology in the country, this document shall be continuously improved and updated to include latest technology and information. Any feedback from the users shall also be incorporated in next edition of this document.

Chapter 1 : Architectural and Civil works

- The construction site shall be supervised by competent Site Engineers (Civil & Electrical Engineers).
- Construction works shall be monitored periodically by a competent Architect, Structural and Electrical Engineers.

1.1. Basic Construction Material

1.1.1. The choice of material should be done according to the drawings and BOQ.

1.1.2. Cement:

1.1.2.1. The type of cement to be used for construction will be clearly mentioned in the general notes of the structural drawing.

1.1.2.2. The quality of cement is determined on the basis of its conformity to the performance characteristic given in their respective Indian standards. [1]

1.1.2.3. Cement shall be stored at the work site in a building or shed which is dry, leak proof and moisture proof as possible.

1.1.2.4. The height of the cement stack shall be not more than 15 bags to prevent the possibility of lumping up under pressure. [2]

1.1.2.5. Use 'first in, first out (FIFO)' method

1.1.3. Coarse aggregate:

1.1.3.1. As far as possible preference should be given to natural aggregates. [3]

1.1.3.2. The aggregates should be stored on flat surfaces. Always store fine and coarse aggregates separately. Try to store the fine aggregates in such a way that there is minimum loss due to wind and low possibility of contamination by foreign substances. [4]

1.1.3.3. Wash the coarse aggregates prior to use. Use only graded aggregates for RCC works.
Test recommended: Sieve Analysis

1.1.4. Fine aggregate:

1.1.4.1. The sand should be free of silt content and other foreign substances.

1.1.4.2. Check bulking of fine aggregate and make necessary adjustments.[5]

1.1.4.3. Sieve the sand before use.

1.1.5. Reinforcement:

1.1.5.1. Reinforcements should be free of any materials that may destroy or reduce the bond.

1.1.5.2. Steel reinforcement should be stored according to length, size and shape. There should be enough space between piles so that it can be accessed easily and safely.[6]

1.1.5.3. A basic test for steel would be specific gravity or density test.
Other test recommended: Tensile test (IS 1608:2005)
Bend test (IS 1599:1974)

1.1.6. Water:

1.1.6.1. Water should be free from any deleterious materials.

1.1.6.2. The pH value of water should not be below 6.

1.1.6.3. Generally potable water is considered satisfactory for mixing concrete.[7]

1.1.7. Brick:

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[1] Refer clause 5.1 of IS 456:2000 for more details
[2] For more details refer SP62(S &T):1997 and IS 7969:1975
[3] Refer *Clause 5.3*, IS 456:2000 for more details
[4] For more details refer SP62(S&T):1997, IS 1769:1975 and IS 4082:1996
[5] Refer clause 4 of IS 2386 (Part 3):1963 if bulking of aggregate is noticed
[6] For more details refer IS 7969:1975 and IS 4082:1996 for more detail
[7] Refer clause 5.4 of IS 456:2000 for more details

1.1.7.1. The type and size would be mentioned in the drawings or Bill of Quantities.[8] [9]
Recommended field test: Drop test

1.1.8. Wood/Timber:

1.1.8.1. Timber shall be stacked on unyielding and level dunnage so as to be above the ground level by at least 150mm. Cross strips or cross piling shall be used where the pile is more than 1 m high.

1.1.8.2. The timber shall preferably be stored separately in different lengths and sizes. Material of equal lengths shall be piled together in layers with wooden battens, called crossers, separating one layer from another.

1.1.8.3. Only permissible water content as specified in the technical specification should be used to avoid later damages such as warping, splitting, etc.
Test Recommended: Moisture content test (IS 11215:1991 & IS 287:1893)

1.1.9. Admixture:

1.1.9.1. In case if any admixtures are used for special concreting, note down the type and purpose of the admixture.[10]

1.2. Site layout and preparation

1.2.1. Locate the boundary pegs at site; verify if the boundary pegs are in accordance with the coordinates given in the official site plan.

1.2.2. Clear the construction site of any bushes, trees and obstruction if any.

1.2.3. Establish bench marks and datum level at site.

1.2.4. Any deviations at site should be referred back to approving authority.

1.3. Setting out

1.3.1. Study the Architectural and Structural drawings to ensure that gridlines and spacing dimensions are consistent.

1.3.2. Identify the starter column and clearly mark it on the ground. After marking all the position of the columns as per the construction drawings, cross check the diagonal distance between individual columns.

1.3.3. Methods of setting out :

i. Using surveying instruments like Total Station, Theodolite etc.
ii. Triangulation, builders' square
iii. Line intersection method
iv. Pythagoras theorem (3, 4 and 5) can be adopted to cross check the triangulation of a regular building.

1.3.4. Provide and fix adequate recovery pegs in suitable locations away from the excavation area.

1.3.5. Cross check the final set out by Pythagoras theorem or Intersection Method.

[8] Refer IS 1077:1992 for Common burnt clay building bricks specification
[9] To determine the compressive strength, water absorption, efflorescence and warpage of burnt clay bricks, refer IS 3495(1-4):1992
[10] For more details about admixture, refer IS 9103:1999 Concrete admixture specification

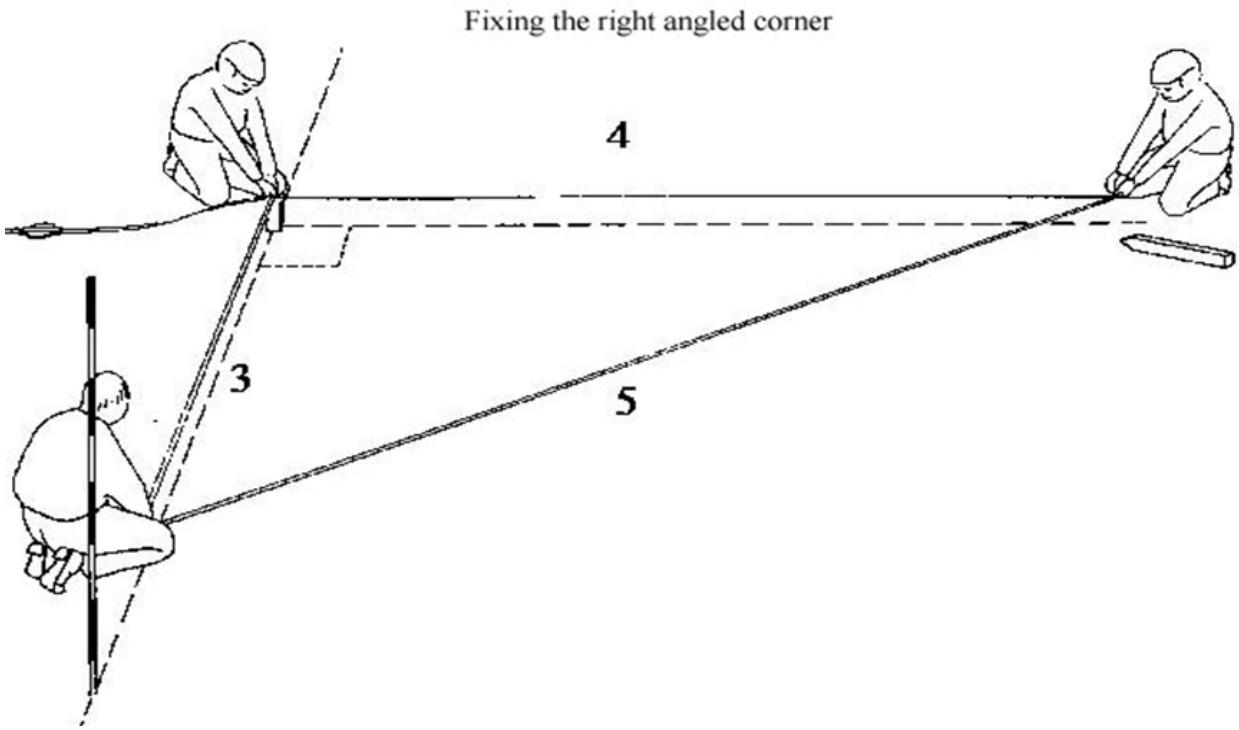


Figure 1.1: Use of Pythagoras theorem for triangulation

1.4. Excavation and Earthwork

1.4.1. In the structural drawing, refer the foundation layout plan for the dimensions of foundation and the section details and foundation schedule for the depth of the foundation.

1.4.2. Check for existing service lines like electrical connection, water supply and drainage connection telephone line etc. below the ground level.

1.4.3. Mark the size of the footing on the ground with the help of plumb bob, the grids of string and lime powder.

1.4.4. Excavate the soil till the depth of the foundation given in the drawing.

1.4.5. Provide temporary supports for the sides of excavation.

1.4.6. Level and prepare the bottoms of excavations.

1.4.7. At the given depth, if the engineer encounters poor soil condition, then report to the designer concerned before proceeding further. [11]

1.4.8. Maintain the natural drainage to avoid water logging.

1.4.9. Dispose the excess excavated earth at the dumping site identified by the authority concerned.

1.4.10. If encountered, remove rocks till the formation level.[12]

1.4.11. If any water is encountered, follow proper dewatering procedure.[13]

1.5. Foundation

1.5.1. Centre the position of the footing and column as per the drawings.

[11] For more details on excavation, refer clause 3 under section 5 of Bhutan Schedule of Rates (Specifications for building and road works) and IS 3764:1992 the requirements for carrying out the excavation work safely.
[12] More details in chapter 2 of SP 62 and clause 3.4 under section 5 of SBRW
[13] Refer clause 1.2 under chapter 3 of SP62 and clause 3.9 under section 5 of SBRW

1.5.2. Check and note if any expansion joints are present in the drawing. The construction of joints should be according to their respective code:

- *IS 3414: 1968, Code of practice for design and installation of joints in buildings*
- *IS 5256: 1992, sealing expansion joints in concrete linings of canal- Code of practice*
- *IS 1838:2011(Part 3) Preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type) — specification*
- *Refer section 5 clauses 8.2 of SBRW for more details on construction joint and expansion joint.*

1.5.3. Stone soling:

1.5.3.1. Lay stone soling as per drawings and specification.

1.5.3.2. Do not use flaky or round stones.

1.5.4. Plain Cement Concrete(PCC):

1.5.4.1. Place plain cement concrete with grade, thickness and dimension as specified in the drawing.

1.5.4.2. Mark the center of the columns and footings on the PCC layer.

1.5.5. Footing Reinforcement:

1.5.5.1. For the footing sizes, sections and details refer the footing details in the structural drawings. Development lengths, anchorage lengths, concrete cover and reinforcement spacing may also be referred from the structural drawings.

1.5.5.2. Prepare bar bending schedule from the approved structural drawing. The reinforcement detailing should conform to *IS 13920:1993*

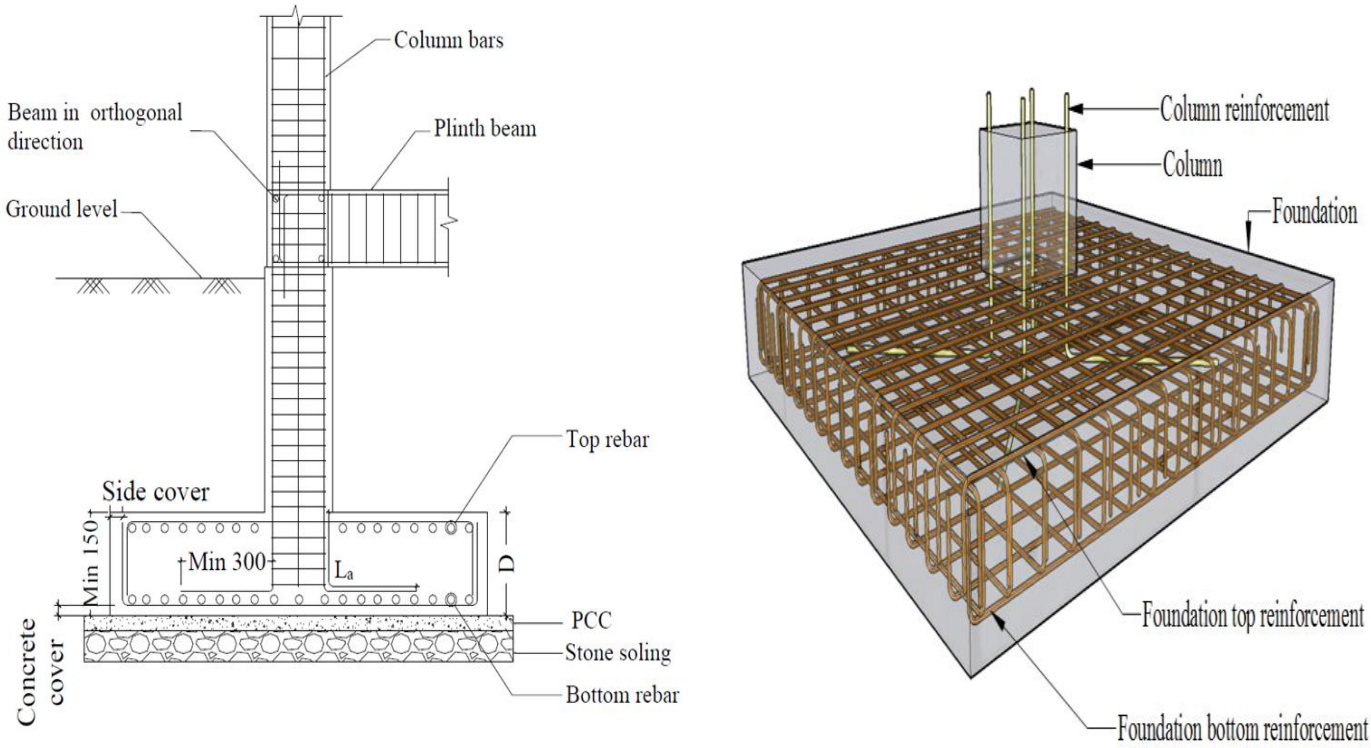


Figure 1.2: Typical details of isolated footing

1.5.5.3. Provide sufficient chairs/spacer to keep the footing reinforcement bar in place.

1.5.5.4. Provide clear cover as per specification. If concrete cover blocks are used, tie it with the reinforcement at the time of placement. [14]

[14] Refer section 7.3 of IS 2502-1963 for more details

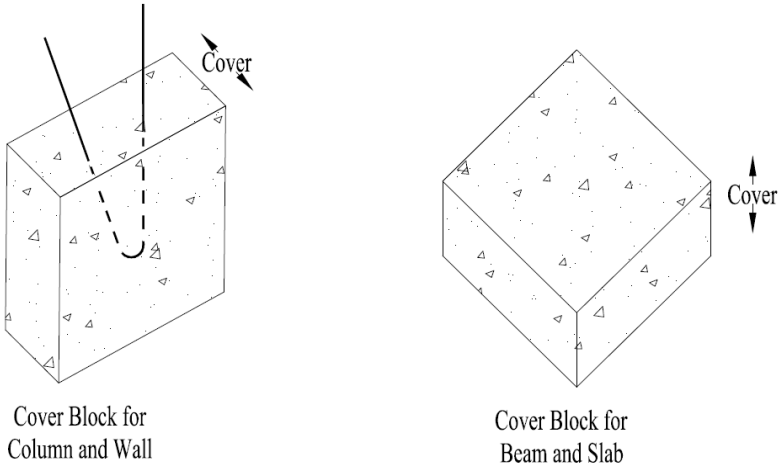


Figure 1.3: Concrete cover block for reinforcements

1.5.5.5. Bend, place and bind the reinforcement bars in accordance with procedure given in *IS 2502:1963*.

1.5.6. Column Reinforcement:

1.5.6.1. For column sizes and reinforcement, refer the structural drawings.

1.5.6.2. Splicing zones, development lengths, anchorage lengths and ties provision should be kept in bar bending schedule.

1.5.6.3. Erect the column reinforcement manually or mechanically, keeping center of the columns as marked on the PCC layer.

1.5.6.4. While tying and placing the reinforcement bars, the following things should be kept in mind:

i. Avoid rough handling, shock loading (before embedment) and dropping of reinforcement from height.

ii. Avoid contact between different metal types to prevent bimetal corrosion.

iii. Ensure that concrete can be placed between the reinforcements without much segregation.

iv. The tolerance for placement is as given :

For effective depth of 200mm or less	±10mm
For effective depth more than 200mm	±15mm

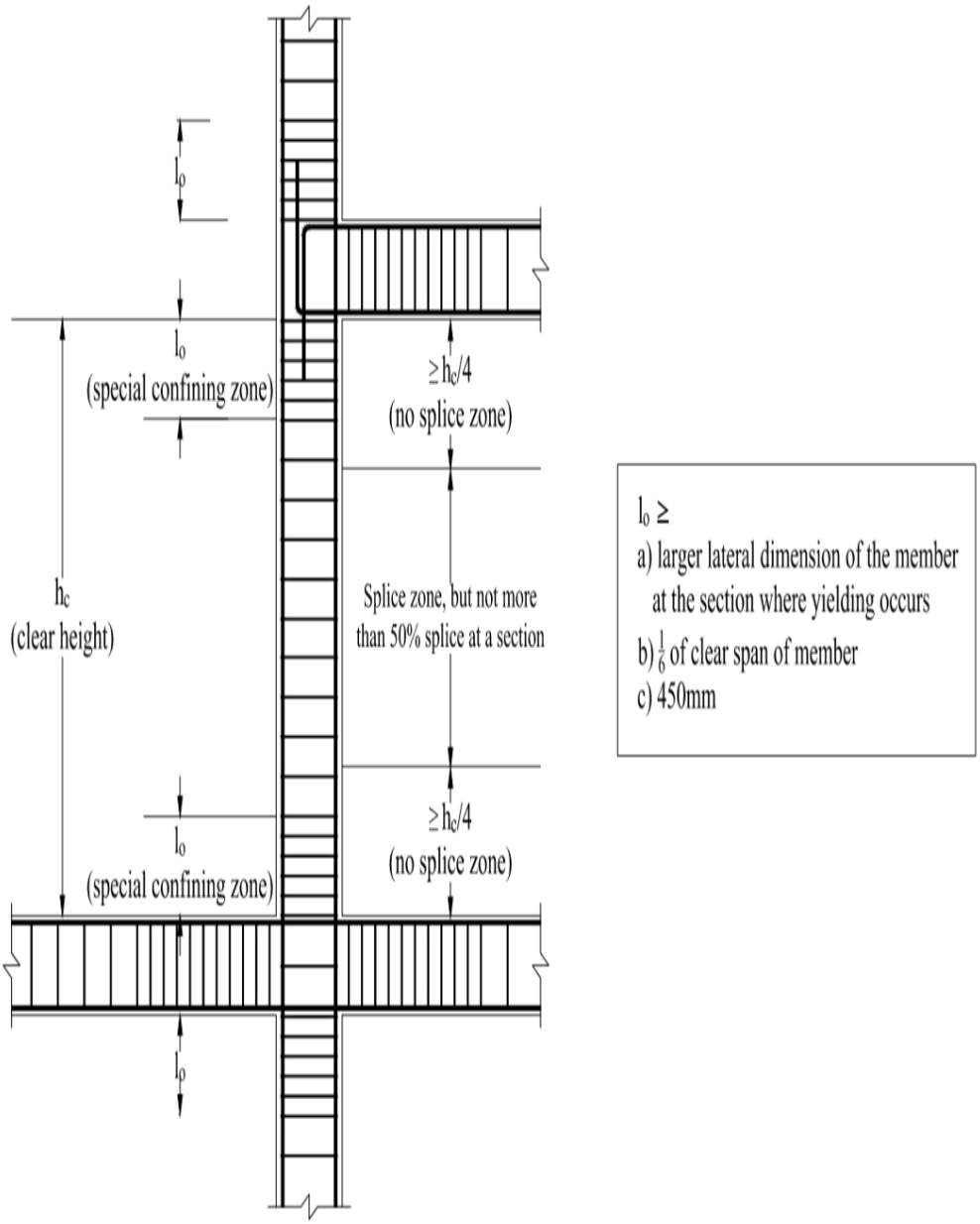


Figure 1.4: Typical column detail

1.5.7. Formwork:

1.5.7.1. The formwork of foundation will vary depending on the type of foundation. Formwork can be made from steel, plywood[15], wooden planks, etc.

1.5.7.2. Refer footings sizes and depth in the drawings to make formwork inclusive of clear cover to the reinforcement bars. Provide adequate support and braces for the footing formwork.

1.5.7.3. Generally in footings a minimum cover of 50 mm for sides exposed to soil and 40mm for external exposed sides is given however, the minimum cover differs depending upon the exposure condition. Refer the foundation details for the cover and other details.

[15] For more specifications on plywood for shuttering work, refer IS 4990:2011

Table 1.1: Nominal cover to meet Durability requirement

Exposure	Nominal Concrete Cover in mm not Less than
Mild	20
Moderate	30
Severe	45
Very Severe	50
Extreme	75

1.5.8. Concreting:

1.5.8.1. Refer technical notes and specification in the structural drawings for the grade of concrete.

1.5.8.2. Carry out mix design for concrete with compressive strengths of M25 and above at site to achieve the specified grade of concrete.

For handling of special concrete refer the respective codes:

i. *IS 4926:2003 Ready-mixed concrete - Code of Practice*
ii. *IS: 7861 (Part 1) – 1975 Code of practice for Extreme Weather Concreting Part 1; Recommended Practice for Hot weather concreting*
iii. *IS: 7861 (Part 2) – 1981 Code of practice for Extreme Weather Concreting Part 2; Recommended Practice for Cold weather concreting*
iv. *Specifications for building and road works*

1.5.8.3. **Proportioning**

- ❖ The proportioning of material is usually done by volume. Generally boxes of 35 x 25 x 40 cm (equivalent to volume of 1 bag of cement) internal dimensions are used.
- ❖ For mix design of concrete, follow procedure given in *IS 10262:1982 and SP 23(S&T):1982*

Table 1.2: Nominal mix proportion for concrete

Mix	Ratio	Approximate quantity of water(liters) per 1 bag(50kgs) of cement
M7	1:5:10	60
M10	1:4:8	45
M12	1:3:6	40
M15	1:2:4	36
M20	1:1.5:3	30
M25	1:1:2	27

Note: The ratio is to be read as Cement: Sand: Aggregates. One bag of cement=50kg and 0.035m^3

1.5.8.4. **Mixing**

- ❖ Mixing should be done by a mechanical mixer. Add the measured dry materials i.e. coarse aggregate, fine aggregate and cement and mix for at least four turns of the drum. Then gradually add the correct quantity of water (Water: Cement ratio).
- ❖ Mix the material for a period of not less than 2 minutes until a uniform colour is obtained.
- ❖ Flush the drum clean when the mixer is closed down for any time exceeding 20minutes.
- ❖ Hand mixing is employed only in special cases and it should be done on a smooth, clean and water tight platform.
- ❖ Test the concrete mix before concreting.

Test recommended: Slump test (Refer IS: 7320 -1974 for more details.

Cube Test (Refer IS 516-1959 for more details)

Table 1.3: Allowable slump for concrete work

	Slump in mm	
	Vibrator used	Vibrator not used
Mass concreting in foundation footings, retaining walls and pavement.	10-25	50-75
Thin section of flooring less than 75mm thickness	25-40	75-100

1.5.8.5. **Placing**

- ❖ Clean the formwork off debris, saw-dust, etc. before any concreting is done. Special attention should be given for the cleaning of formworks at the beam-column junction.
- ❖ Deposit the concrete as nearly as practicable in its final position to avoid re-handling.
- ❖ Place and compact the concrete before the initial setting.
- ❖ Try to prevent segregation and also avoid movement of formwork and reinforcement.
- ❖ Maximum permissible height of 1.5m is taken for free fall of concrete.

1.5.8.6. **Compaction**

- ❖ The concrete should be thoroughly compacted using mechanical vibrators complying to *IS 2505:1992, IS 2506:1985, IS 2514:1963* and *IS 18652:2005.*
- ❖ Skilled labor shall operate the vibrators. Inadequate vibration will result in voids while excessive vibration will result in segregation thereby affecting the strength of the concrete.

1.5.9. Curing and formwork stripping:

1.5.9.1. The curing shall be started once the concrete hardens. Normally curing of concrete commences after 8 to 10 hours of pouring (final setting time)

1.5.9.2. The curing should continue along with the masonry work to a minimum of 14 days.

**Refer Table 1.4 for the minimum period of formwork striping.*

Table 1.4: Minimum period for striping of formwork

Type of formwork	Minimum period before striping formwork
Vertical formworks 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 up to 4.5m	7 days
Props to slabs spanning over 4.5m	14 days
Props to beams and arches spanning up to 6m	14 days
Props to beams and arches spanning over 6m	21 days

Refer clause 6 of section 5 of SBRW, clause 4 under chapter 5 of SP 62 and clause 9 of IS 456:2000 for more details on concreting.

1.5.10. Backfilling:

1.5.10.1. Enough time should be given for the concrete to gain strength before any backfilling is done.

1.5.10.2. The earth from cutting shall be directly used for filling. Filling of earth shall be done in regular horizontal layers, each not exceeding 20 cm. Each layer should be compacted by ramming it.

1.5.10.3. Avoid using huge stones/rocks for backfilling.

1.6. Basement (If applicable)

1.6.1. Refer elevations in architectural drawing for all room floor levels.

1.6.2. Collaborate with the supervisors for Electrical and Plumbing (including sewer) work to check if any of their work has to be done before or during the construction of basement.

** Refer section 2.1 for any electrical work in the basement.*

1.6.3. RRM wall below beam(If applicable):

1.6.3.1. Check the foundation layout plan and other elevation drawings under structural drawing for details of RRM wall.

1.6.3.2. Mark the centerlines and angles of the RRM wall with the help of measuring tape and theodolite.

1.6.3.3. The dressing of stone shall be as specified for individual types of masonry work and it shall also conform to the general requirements for dressing of stone covered in *IS1129:1972.*

1.6.3.4. Stones shall be sufficiently wetted before laying it down to prevent absorption of water from mortar.

1.6.3.5. Prepare the required grade of mortar mix.

1.6.3.6. Lay the stone in such a way that the pressure is always perpendicular to the natural bed.[16]

1.6.4. Beam:

1.6.4.1. Refer the basement beam layout plan and section details in the structural drawing for the dimensions of the beam, cover and other details.

1.6.4.2. **Formwork**

- ❖ Do the shuttering to hold the concrete in place without seepage.
- ❖ Place the beam bottom on the column/wall. The form for the sides should be made as well.
- ❖ The cover to reinforcement will be given in the structural drawing. A minimum cover of 20mm is generally given for beams but it also depends on the exposure condition.

  **Refer Table 1.1 for more details.*
- ❖ Provide props and braces for stabilizing the forms.

1.6.4.3. **Reinforcement**

- ❖ The reinforcement should be given as mentioned in the reinforcement schedule and detail drawing under the structural drawing.
- ❖ Bind and place the reinforcement in the form once it is completed. The reinforcement should be fixed properly with the column reinforcement.

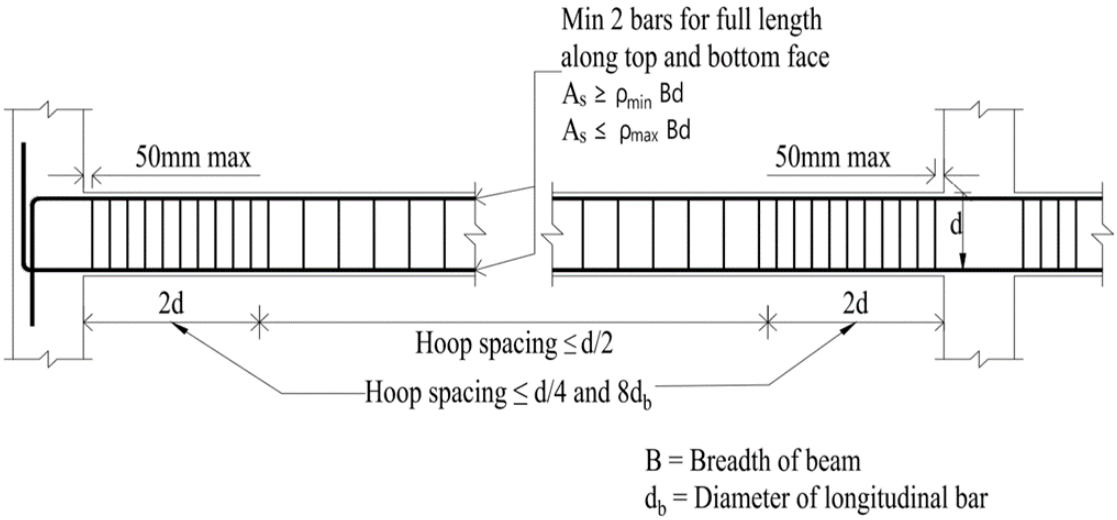


Figure 1.5: Typical Beam Reinforcement detail

[16] Refer IS 1597(Part 1)-1992: Construction of Stone Masonry- Code of Practice

❖ Ensure that the splicing and bending of reinforcement is of right length. Generally the development length and anchorage length are given in the drawing. In case if it is not given, then it can be calculated as follows:
From clause 26.2.1.1 of IS 456:2000:

$$Development\ length, L_d = \frac{0.87 f_y}{4\tau_{bd}} \emptyset$$

Table 1.5: Design bond stress in limit state method for plain bars in tension

Grade of steel	M20	M25	M30	M35	M40
Design bond stress, τ_{bd}, N/mm^2	1.2	1.4	1.5	1.7	1.9

From clause 26.2.1.1 of IS 456:2000:
Development length, L_d can be written as

$$L_d = k\emptyset$$

Where,
$\emptyset$ is the diameter of the bars and
k is a constant depending on grade of concrete and steel

Table 1.6: k value for different pair of grade of concrete and steel bars in tension

Grade of steel	k for different grade of concrete				
	M20	M25	M30	M35	M40
Fe 250	45	39	36	32	29
Fe 415	47	40	38	33	30
Fe 500	57	49	45	40	36
Fe 550	62	53	50	44	39

From clause 6.2.5 of IS 13920:1993 anchorage length would be as follows:

$$Anchorage\ length, L_a = L_d + 10\emptyset$$

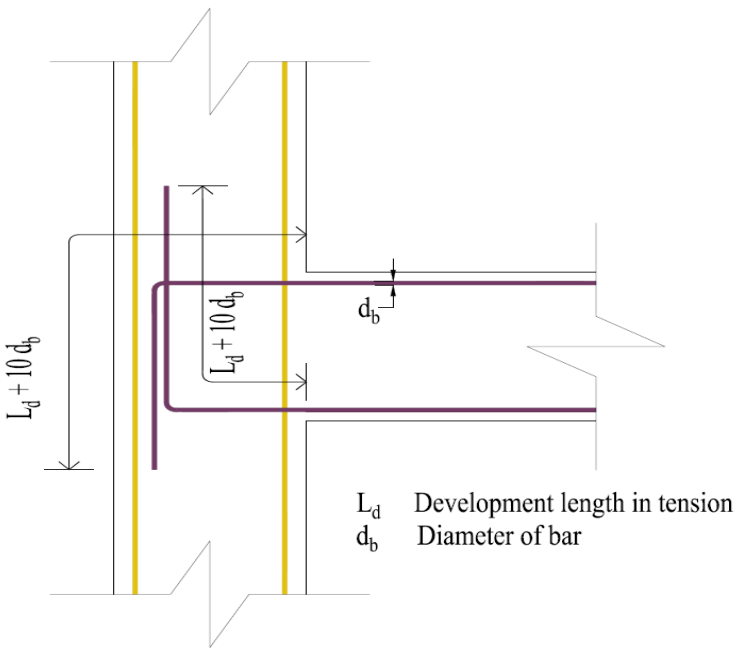


Figure 1.6: Anchorage of beam bars in an external joint

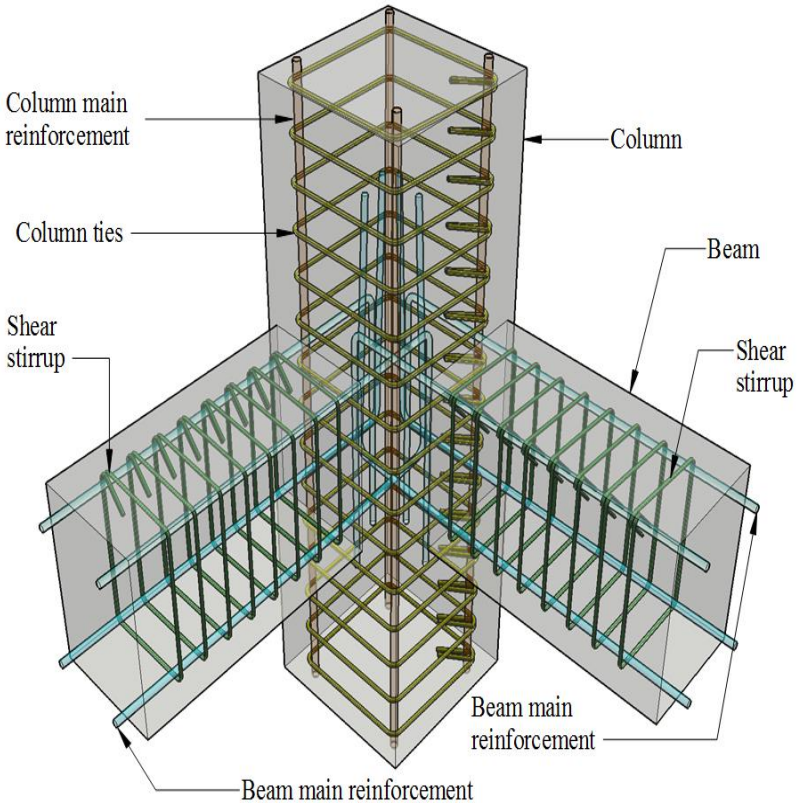


Figure 1.7: Corner beam-column junction

1.6.4.4. **Concreting**

- ❖ Check the grade of concrete from the beam details.

**Follow steps in section 1.5.8 for concreting*

1.6.4.5. **Curing and formwork stripping**

- ❖ The curing shall be started once the concrete hardens.
- ❖ The curing should continue to a minimum of 14 days.
- ❖ The soffit form work of beam can be removed after a minimum of 7 days from the day of casting.

**Refer Table 1.4 for minimum period for formwork stripping*

1.6.5. Column:

1.6.5.1. **Reinforcement**

- ❖ For the column sizes and reinforcement, refer the structural drawings

**Refer section 1.5.6 for details on column reinforcement*

1.6.5.2. **Form Work**

- ❖ Formwork should be smooth on the inner surface. It should be clean and secure.
- ❖ The cover to reinforcement will be given in the structural drawing. A minimum cover of 40mm is generally given for columns but it also depends on the exposure condition.
- ❖ Make forms for the vertical faces of the column. If the entire length of the column cannot be casted in one go, the height of the form would be determined by the height to which the casting is planned.
- ❖ Column forms should be capable of being stripped easily.
- ❖ In tall forms provide windows at appropriate levels on at least one face to facilitate inspection, concrete placement and vibration.

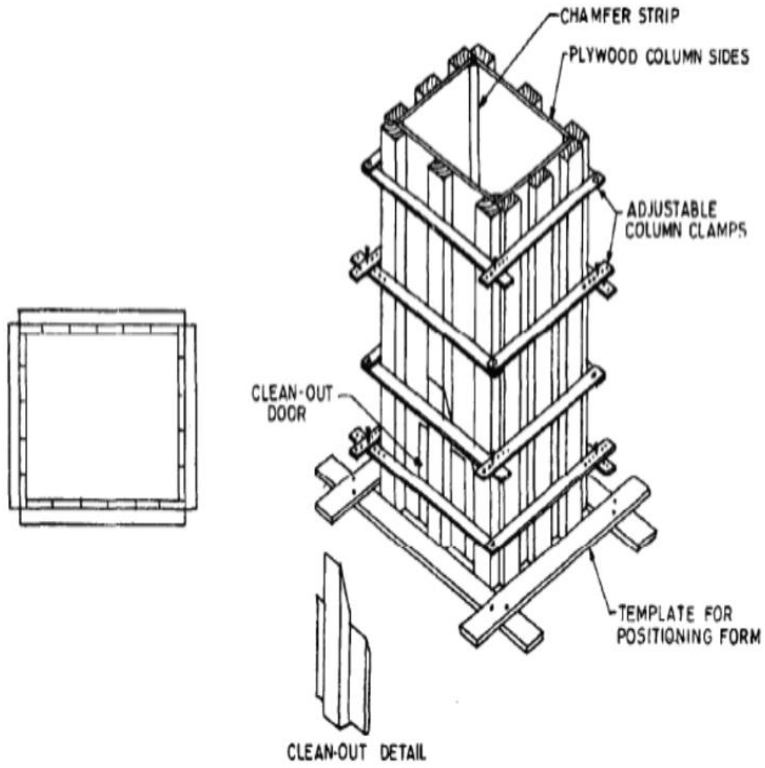


Figure 1.8: Formwork for column

- ❖ Use clamps, bolts, purpose made yokes, etc. to hold the panels in place. The spacing and size of these clamps shall depend upon the lateral pressure of fresh concrete.
  Refer IS 14687:1999 for more details on false work

1.6.5.3. **Concreting**

- ❖ Weigh, batch and mix the required grade of concrete.
  **Follow steps in section 1.5.8 for concreting*
- ❖ Pour the concrete in the center of the column in layers of about 7 or 8 cm and tamp it with a rod constantly.
- ❖ Pour the concrete in the form work by using chute and pump and as far as possible avoid throwing concrete from a height. According to clause 13.2 of IS 456:2000, the maximum permissible free fall height of concrete is 1.5m
- ❖ Check the anchorage length requirement from the drawings and stop the column concreting below the beam to fulfill the anchorage length requirement

1.6.5.4. **Curing and formwork stripping**

- ❖ The curing shall be started once the concrete hardens.
- ❖ The curing should continue along with the masonry work to a minimum of 14 days.
- ❖ The concrete shall be protected from quick drying with the help of moist gunny bag, mesh cloth, plastic, etc.
  **Refer Table 1.4 for minimum period for formwork stripping*

1.6.6. Shear Wall:

1.6.6.1. Refer all the details of the shear wall in the structural drawings.

1.6.6.2. **Reinforcement**

- ❖ For the size, spacing and other details of horizontal and vertical reinforcement, refer the structural drawings.

1.6.6.3. **Form work**

- ❖ For the design of formwork refer IS 14687: 1999.

- ❖ The shuttering shall be fixed at required distance equal to the required wall thickness. The two faces of shutters of the wall should be kept in place by appropriate ties with spacer tubes or bolts, braces and studs.

1.6.6.4. **Concreting**

- ❖ The type of cement, grade of concrete, etc. for shear wall may be different from other members. Check the details in the shear wall detail drawing.

**Follow steps in section 1.5.8 for concreting*

1.6.6.5. Curing and formwork stripping

- ❖ The curing shall be started once the concrete hardens i.e. 8-10 (final setting time) hours after the laying of concrete.
- ❖ The curing should continue to a minimum of 14 days.

**Refer Table 1.4 for minimum period for formwork stripping*

1.6.7. Slab:

1.6.7.1. Identify the type, thickness and other extra details of the basement slab from the structural drawing.

1.6.7.2. **Form work**

- ❖ Prepare the form work for the slab
- ❖ Place the formwork in place providing enough braces to support it.
- ❖ Ensure that the formwork is sealed. And do other details according to the drawing

1.6.7.3. **Reinforcement**

- ❖ In case of RCC slab, study the reinforcement details from the basement slab reinforcement layout drawing in structural drawing.
- ❖ Weave bottom reinforcements. Make cover blocks and place the bottom reinforcement on it.
- ❖ Weave the top reinforcement. Place the top reinforcement in place with the help of chairs.

1.6.7.4. **Concreting**

- ❖ Concreting should be done after all the formworks and reinforcement are in place.
- ❖ Identify the grade and type of concrete from the structural drawing.

**Follow steps in section 1.5.8 for concreting*

1.6.7.5. **Curing and formwork stripping**

- ❖ The curing shall be started once the concrete hardens.
- ❖ The curing should continue to a minimum of 14 days.

**Refer Table 1.4 for minimum period for formwork stripping*

1.6.8. Internal wall:

1.6.8.1. Study the architectural drawing and note the location, size and type of internal walls if present.

**Do the internal wall layout with any methods mentioned in section 1.3*

1.6.8.2. Ventilation for basements should be kept as mentioned in the drawing. In absence of ventilation provisions, report back to the designer.

**Construct the walls following procedures given in section 1.9*

1.6.8.3. As the wall construction proceeds check the vertical and horizontal alignment constantly with spirit level, laser, total station or other equipment.

1.6.9. Damp proofing:

1.6.9.1. Damp-proofing work shall be taken up only when the subsoil water level is at its lowest, that is, in dry season.[17]

[17] Refer section 6.1 of IS 3067:1988 for details on damp proofing of basement

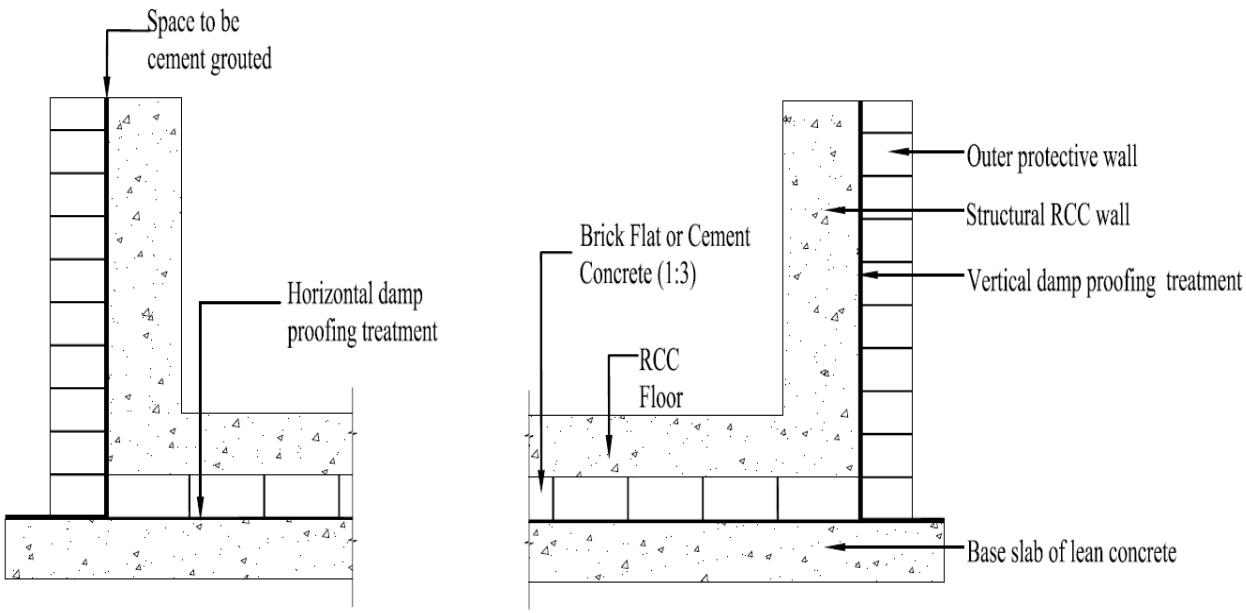


Figure 1.9: Typical damp-proof treatment for basement in new buildings under construction

1.6.10. Lift shaft provision and construction (If applicable):

1.6.10.1. In presence of a lift in the building, study the details from the drawing and also the instructions from the manufacturer.

1.6.10.2. The shaft for the lift should be kept at every floor.

1.6.10.3. The lift pit and machine room should be constructed as per drawing.

1.6.10.4. The installation of the lift should be done in consultation with the lift engineers and following instructions from the manufacturer and Indian codes.
IS 15259:2002 Installation and Maintenance of Home Lifts — Code of Practice
IS 15785:2007 Installation and Maintenance of Lift Without Conventional machine rooms — Code of Practice

1.7. Plinth level/Ground floor level

1.7.1. Collaborate with the supervisors for Electrical and Plumbing (including sewer) work to check if any of their work has to be done before or during the construction of plinth/ground floor.

1.7.2. RRM wall below beam (If applicable):

1.7.2.1. Check the foundation layout plan and other elevation drawings under structural drawing for details of RRM wall if any.
**Refer section 1.6.3 for procedure of RRM wall construction.*

1.7.3. Plinth/Ground floor Beam:

1.7.3.1. For the size, reinforcements and other details refer the plinth/ground floor beam layout plan and section drawings under structural drawing.
**Construction procedures are as mentioned in section 1.6.4*

1.7.4. Slab:

1.7.4.1. For the size, reinforcements and other details refer the plinth/ground floor slab layout plan and section drawings under structural drawing.
**Construction procedures are as mentioned in section 1.6.7*

1.7.5. Column:

1.7.5.1. For the size, reinforcements and other details refer the column layout plan and section drawings under structural drawing.
**Construction procedures are as mentioned in section 1.6.5*

1.7.6. DPC (if applicable):

1.7.6.1. Depending on the type of back filling used in the working area and type of tanking used, provide protective layers for the wall surfaces as specified in the construction drawings.

1.7.6.2. From the structural drawing, refer the thickness and location of the DPC if any.

1.7.6.3. Clean the surface on which asphalt/bitumen is to be laid.

1.7.6.4. Ensure uniformity in the membrane by avoiding undue ridges, indentations and irregularities.

1.7.6.5. The surface of the structure should permit the laying of bitumen mastic in complete continuity up to 150 mm above ground level.[18]

1.7.7. Infill wall/Internal wall:

1.7.7.1. Study the architectural drawing for location of internal walls.

1.7.7.2. Refer Electrical and plumbing/sewer drawings for any ducts, shaft and power cables and piping provisions to be kept along or inside the wall.

**Do the internal wall layout with any methods mentioned in section 1.3*

**Construct the walls following procedures given in section 1.9*

1.7.7.3. As the wall construction proceeds the vertical and horizontal alignment should be checked constantly with spirit level, laser, total station or any other equipment.

1.8. First floor and above

1.8.1. Collaborate with the supervisors for Electrical and Plumbing (including sewer) work to check if any of their work has to be done before or during the construction of each floor.

1.8.2. Column:

1.8.2.1. For the size, reinforcements and other details refer the column layout plan and section drawings under structural drawing.

**Construction procedures are as mentioned in section 1.6.5*

1.8.3. Staircase:

1.8.3.1. Refer architectural drawing for the location, layout and height of staircase landing. Refer structural drawing for foundation and reinforcement details.

1.8.3.2. Mark the location of the staircase clearly on the ground.

1.8.3.3. **Formwork**

- ❖ Refer staircase details and accordingly prepare the formwork as per the sizes and numbers of treads and risers.
- ❖ Ensure that the formwork is leakage proof and secure it properly

1.8.3.4. **Reinforcement**

- ❖ Provide and fix the reinforcement as per staircase reinforcement details.
- ❖ Place the distribution bars above the main bars. Provide adequate cover and chairs/spacers.

1.8.3.5. **Concreting**

- ❖ Keep provision for fixing of railing post and baluster while concreting.
- ❖ Weigh, batch and mix the required grade of concrete.

  **Follow steps in section 1.5.8 for concreting*
- ❖ Start the concreting from the bottom. Pour concrete in one step at a time and then proceed to next.

1.8.4. Beam and Slab:

1.8.4.1. For the size, reinforcements and other details refer the respective floor beam layout plan and section drawings under structural drawing.

**Construction procedures are as mentioned in section 1.6.4*

[18] For more details refer IS 7198:1974 Code of practice for Damp-proofing using bitumen mastic

1.8.4.2. For the size, reinforcements and other details refer the first floor slab layout plan and section drawings under structural drawing.

**Construction procedures are as mentioned in section 1.6.7*

1.8.5. Infill wall layout:

1.8.5.1. Study the architectural drawing for location of internal walls.

1.8.5.2. Refer Electrical and plumbing/sewer drawings for any ducts, shaft and power cables and piping provisions to be kept along or inside the wall.

**Do the internal wall layout with any methods mentioned in section 1.3*

**Construct the walls following procedures given in section 1.9*

1.8.5.3. As the wall construction proceeds the vertical and horizontal alignment should be checked constantly with spirit level, laser, total station or other equipment.

1.8.6. Cornices:

1.8.6.1. Study the architectural drawing to identify the location, size and type of cornice if any.

**Refer section 1.11 for the construction procedure.*

1.9. Infill wall

1.9.1. Collaborate with the supervisors for Electrical and Plumbing (including sewer) work to check if any of their work has to be done before or during the wall construction.

1.9.2. Material, type and layout of wall:

1.9.2.1. Refer the architectural drawing and identify type of infill wall. Mark the location of the walls on the floor as per the floor plans of the architectural drawing.

**For wall layout, use any methods mentioned in section 1.3*

1.9.2.2. Locate and mark openings for doors, windows, ventilators, etc. from the architectural drawing.

1.9.2.3. Provide RCC bands/lintels as per the structural drawing.

**Follow procedure mentioned in section 1.10 for band construction*

1.9.2.4. Do not use single scaffolding for important works.[19]

1.9.2.5. Refer structural drawing if strengthening of walls are indicated.

**For shear walls refer section 1.6.6 for construction procedure*

**For masonry walls, follow procedure in section 1.9.3*

[19] Scaffolding design should conform to IS 3692(part 1): 1997 or IS 4014(Part 2): 1967

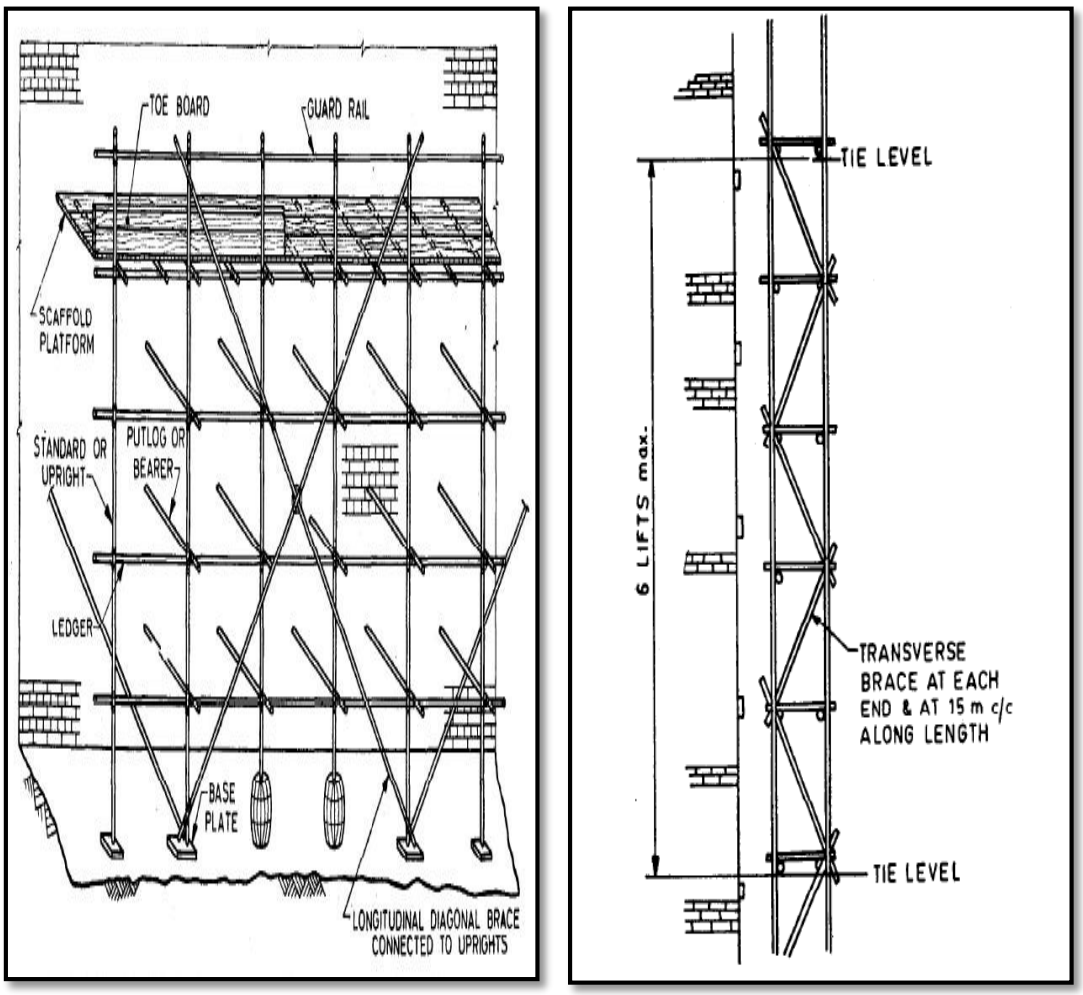


Figure 1.10: Left: Typical sketch illustrating components of a single scaffold. Right: Transverse bracing for double scaffold

1.9.3. Mortar and masonry work:

1.9.3.1. Note the type and grade of mortar from the drawing.

1.9.3.2. Provide bond of the bricks as stated in the drawing.[20]

1.9.3.3. Use plumb bob and level to ensure the perpendicularity of the wall.

1.9.3.4. Cement mortars should be used as soon as possible after mixing and in any case within 2 hours.[21]

1.9.3.5. Generally, only as much quantity of cement mortar as would be sufficient for 30 minutes work shall be mixed at a time. [22]

1.9.3.6. Lay the bricks on full bed of mortar. The cross joints and wall joints shall be flushed and packed with mortar so that no hollow spaces are left.

1.9.3.7. Avoid continuity of vertical joints in same line and lay the brickwork in uniform layers.

1.9.4. Curing:

1.9.4.1. The curing shall be started once the mortar hardens.

1.9.5. Finishing : Plastering and painting:

1.9.5.1. Refer the BOQ for type of paint, thickness of plaster, etc.

**Refer section 1.15.1 for details on plastering*

[20] For more details on brick work, refer clause 9 under section 5 of Bhutan Schedule of Rates (Specifications for building and road works). Refer chapter 4 of SP 62(S&T) for details on masonry work

[21] Refer chapter4(clause 3.3.1) of SP 62(S&T) for more details

[22] Refer clause 8.2.1 of IS 2250:1981(Code of practice for preparation and use of masonry mortars) for more details

**Refer section 1.15.2 for details on painting*

1.10. Bands

1.10.1. Identify the location of bands from the drawing be it lintel, sill, etc.

1.10.2. Schedule the band construction according to its location.

1.10.3. Formwork:

1.10.3.1. Make form for the sides and bottom face.

1.10.3.2. Connect the forms with help of braces to make the mold.

1.10.3.3. Place it into position with the help of props.

1.10.4. Reinforcement:

1.10.4.1. Weave the reinforcement and place it in the form ensuring adequate cover for reinforcement.

1.10.5. Concreting:

1.10.5.1. Weigh, batch and mix the required grade of concrete.

**Follow steps in section 1.5.8 for concreting*

1.10.5.2. Do not use single scaffolding for important works.[23]

1.10.5.3. Start the concreting removing the air bubbles in the process.

1.10.6. Curing and formwork stripping:

1.10.6.1. The curing shall be started once the concrete hardens.

1.10.6.2. The curing should continue to a minimum of 14 days

1.11. Cornices and other traditional element

1.11.1. Study the plans, elevations and sections in architectural drawing to identify the location, size and type of cornice.

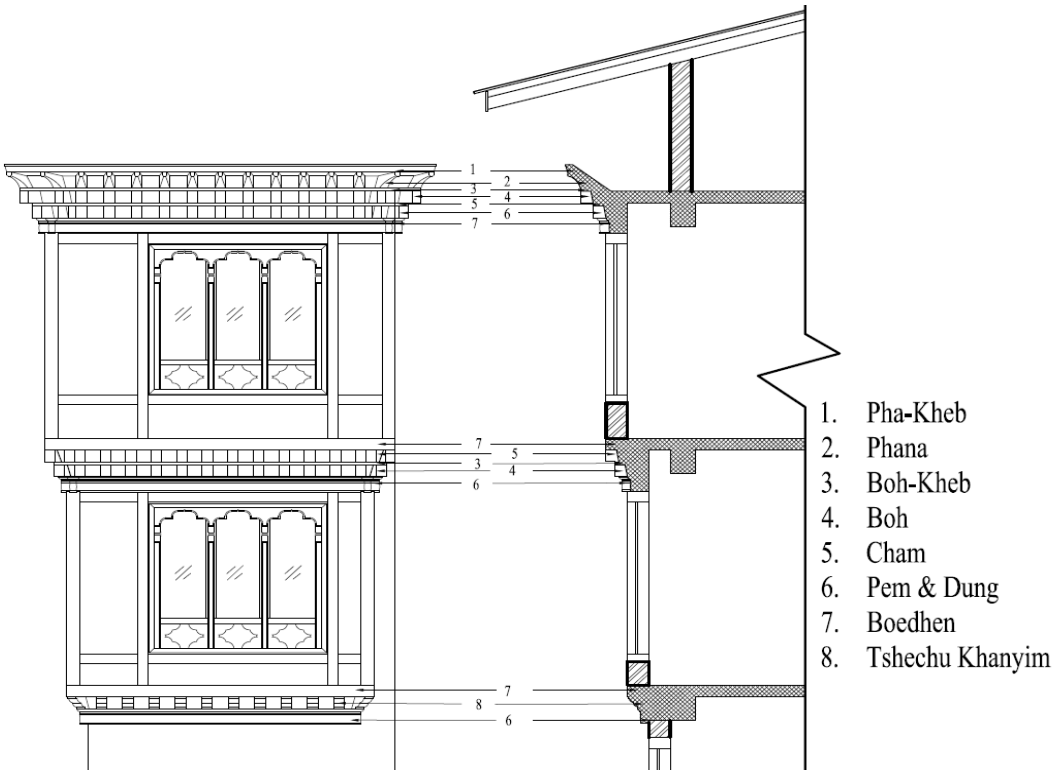


Figure 1.11: Typical section and detail of RCC cornice

1.11.2. For wooden cornices, note the size, shape and connection details from the structural drawing. Carve and fix the cornice pieces in place as per the connection details given in the drawing.

1.11.3. For RCC cornices, study the cornice detail from structural drawing.

1.11.3.1. **Formwork**

- ❖ Prepare the form work as per the design of the cornice. Some details of the cornice may be carved out with the help of plaster later.
- ❖ The formwork for cornice shall be placed along with the formwork for slab and beam.

1.11.3.2. **Reinforcement**

- ❖ Study the cornice reinforcement details from the structural drawing.
- ❖ Cut, bend and place the reinforcement with adequate cover.

1.11.3.3. **Concreting**

- ❖ Weigh, batch and mix the required grade of concrete. Usually cornices are concreted alongside the beam and slab

**Follow procedure mentioned in section 1.10 for band construction*

1.11.3.4. **Curing and formwork stripping**

- ❖ The curing shall be started once the concrete hardens i.e. 8-10 hours after the laying of concrete.
- ❖ The curing should continue to a minimum of 14 days

1.11.3.5. **Plastering**

- ❖ Plastering is very crucial, especially in carving out shapes and details of the traditional elements which are very small and which cannot be achieved by a formwork.

**Refer section 1.15.1 for details on plastering*

Note: Study and schedule the work for all other traditional architectural elements accordingly.[24]

1.12. Doors, Windows and Rabsay

1.12.1. Fix the frames, doors and windows to brickwork, block work and concrete (including ironmongery) according to the construction drawings.

1.12.2. Generally, the doors and windows are fixed to brick work by providing hold fast (Minimum 2 at the sides).

1.12.3. Study the door and window schedule provided in the drawings for the sizes of the individual members.

1.12.4. Refer the architectural drawing plan to identify the location of doors and windows.

1.12.5. Mark the layout of the door and windows before laying the brick wall and maintain the sill and lintel height as provided in the architectural drawing.

1.12.6. General precaution: while installing doors and windows:

i. All materials used shall be installed in strict accordance with the standards under which the materials are accepted and approved by the Bhutan Standard of bureau (BSB). Any door and window design must satisfy the technical requirements of the relevant parts of the building. The main considerations are the size, format, divisions, and way of opening, frame material and surface treatment.

ii. Avoid Cutting of RCC beams, columns while fixing the door and windows.

iii. Ventilation, thermal and sound insulation, fire resistance and general safety issues, including the use of the security glazing, must also be taken into account to ensure long lasting water and draught-proof seal.

iv. There must be weather protection to front doors (a porch). This may require canopy and walls to protect from the prevailing wind, or a canopy alone may be sufficient

v. When providing canopy cover, it is important to retain good light to the entry.

vi. Main access doors should be hinged and not sliding type.

[24] Refer Bhutanese Architectural guideline for more details on the traditional architectural elements

vii. The minimum recommended width for a front door is 910mm.

1.13. Roof

1.13.1. Roof truss:

1.13.1.1. Study the type of material and details of roof truss from the drawings. [25]

1.13.1.2. Set out and mark the areas on the roof floor where the props are going to rest. The marking has to be done using threads on all the corner of the building to maintain equal spacing of the roof overhang.

1.13.1.3. Install the props in its place. Ensure that the props are stable and its top surface leveled.

1.13.1.4. Study the connection detail of the roof from the architectural and structural drawing.

1.13.1.5. Mark the location of each individual truss and later fixed to the building as per the connection detail provided in the construction drawings.

1.13.1.6. Align the pitch of the roof as per the construction drawings.

Table 1.7: Differences in procedure based on material of truss

Steel	Wooden
• Check the roof plan and roof connection details in the structural drawing. • Steel truss can be made by connecting the pieces of steel tubes or angles by welding or bolting as mentioned in the drawing. • The truss is then fixed to the props with connection details as per the drawing.	• Check the roof plan and roof connection details in the structural drawing. • The pitch of the roof shall be preferably not more than 18 degrees. If steeper pitch is used, increase the end lap length between adjacent sheets. • Bolt and nail each truss and connections in place. • Lay the purlins at intervals mentioned in the drawing.

1.13.2. Roofing sheet:

1.13.2.1. Identify the material for roofing sheet from the drawing.[26]

1.13.2.2. Check the following things if corrugated galvanized steel sheets are used

a) Spacing between purlins

Table 1.8: Maximum spacing of purlin for corrugated galvanized steel sheet

Thickness of steel sheet, mm	Maximum spacing of purlins, c/c, m
1	2
0.8	1.8
0.63	1.6

b) Minimum end lap between sheets of 150mm

c) Minimum side lap of two corrugations which may be increased to avoid cutting

[25] Refer Bhutanese Architectural Guideline for clarity of components of traditional roofing system

[26] Refer SBRW for more details on roofing

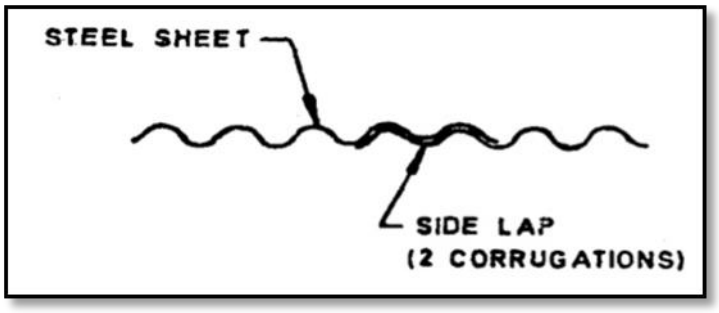


Figure 1.12: Overlapping of corrugated galvanized steel sheet

d) The sheet shall be laid on the purlin or other structural member as indicated in the structural drawing. The laying of sheet should start from the outer periphery of the roof.[27]

1.13.3. Gutter (If applicable):

1.13.3.1. Find the material and size of gutter and its bracket from the drawing and Bill of Quantities.

1.13.3.2. The brackets to hold the gutters shall be laid at maximum spacing of 1.2m.

1.13.3.3. Lay the gutters with a minimum slope of 1 in 120.

1.13.4. General precaution for roofing:

- ❖ Maximum purlin spacing : 1.6 m
- ❖ The roof should not be pitched at a flatter slope than 1 vertical to 5 horizontal
- ❖ Minimum lap between sheets 20 cm(1:3 or flatter)
- ❖ Minimum lap between sheets 15 cm(steeper)

**Refer section 2.5 for any electrical work on the roof like lightening arrester*

1.14. Ceiling and flooring

1.14.1. Collaborate with the supervisors for Electrical and Plumbing (including sewer) work to check if any of their work has to be done before or during the construction of ceiling and flooring.

1.14.2. Ceiling:

1.14.2.1. Refer the architectural drawing for the room ceiling height.

1.14.2.2. Refer architectural drawing and structural drawings if any false ceilings are to be provided.[28]

1.14.3. Flooring:

1.14.3.1. Refer architectural drawing for the type, material and level of floors.

1.14.3.2. The alignment of floor should be maintained according to the drawing with spirit level and other leveling equipment.

1.14.3.3. The grade, type, etc. of subgrade/under layer would be specified in the drawing and shall be done accordingly.

1.14.3.4. The joints in the floors shall be given depending on the type of material.

1.14.3.5. Slope/gradient of the floor shall be maintained as per the drawing.

1.15. Finishing

1.15.1. Plastering: [29]

1.15.1.1. Identify the surfaces to be plastered and note the grade of mortar to be used.

1.15.1.2. **Preparation of surface**

- ❖ Brush off and scrap the dust ,loose mortars and efflorescence

1.15.1.3. **Scaffolding**

[27] For more details on galvanized steel sheets refer IS 277 and for more details on roofing refer chapter 11 of SP62(S&T):1977

[28] Refer IS 2441:1984:Code of practice for fixing ceiling coverings for more details

[29] Refer IS 1661:1972, Code of practice for application of cement and cement-lime plaster finish and Section 18(Page 338) of SBRW for more details

- ❖ Provide double scaffolding for all exposed brickwork and tile work.
- ❖ Provide strong and sound vertical supports. Tie the horizontal pieces well on the support and lay the scaffolding plank on it. Provide additional bracing members if required.

1.15.1.4. **Mortar**

- ❖ Prepare the mortar mix specified in the drawing.
- ❖ Cover the surface of any area where you don't want the plaster.
- ❖ Plaster the ceiling first and then the walls.
- ❖ Plaster about 15X15 cm, horizontally and vertically, at not more than 2m intervals to achieve uniform thickness.
- ❖ Bring the plaster to its true thickness with the help of wooden straight edge.

1.15.1.5. **Finish**

- ❖ Test all horizontal lines and surfaces with the help of level and all cornices and jambs with the help of plumb bob as and when the work proceeds to finish with the proper degree of smoothness as required.
- ❖ Measure the thickness of the plaster. The average thickness of the plaster shall not be more than the specified thickness

1.15.1.6. **Curing**

- ❖ As soon as the mortar hardens, start the curing work. The plaster should be kept wet for at least 7 days.

1.15.2. Painting:

1.15.2.1. Before any painting work, the surface should be inspected by the engineer for approval.

1.15.2.2. Identify the type of surface to be painted and type of paint to be used.

1.15.2.3. **Scaffolding**

- ❖ Scaffolding if necessary shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks are to be fixed.

**Refer Figure 1.10 and section 1.15.1.3 for typical scaffolding detail.*

1.15.2.1. **Preparation of surface**[30]

- ❖ The surface preparation will wary depending on the type of surface but in any case the surface should be dry and free from any dust and foreign substances.

1.15.2.2. **Application of paint**

- ❖ The painting works shall be carried out as per the specification of the material.

1.16. Drainage

1.16.1. Study the sewer network system from the drawings and identify the location and number of inspection chambers.

1.16.2. Refer inspection chamber detail drawing.

1.16.3. Prepare the ground where the plinth protection is to be laid to achieve the required slope.

1.16.4. Make trenches of required depth and width along the edge of the plinth protection. Compact the trenches to a firm and even surface. Prepare the subgrade with the specified material and consolidate it. Check for any depressions with a straight edge. If present, the depressions shall be filled up and consolidated. Grout the subgrade with fine sand and ram it.

1.16.5. Lay the cement concrete and finish it off with a wooden float,

1.16.6. Cure the concrete after its initial setting.

[30] Refer section 19 of SBRW for details on painting and IS 2395(Part1): 1994, Painting of concrete, masonry and plaster surfaces-Code of practice

Chapter 2 : Electrical work

- The Electrical installation works shall be carried out by certified electrician.
- The electrical engineer and the electrician should go through the electrical drawings and prepare for installation.
- Visit the site and identify the source of electrical source of supply.

2.1. Basement/Plinth level

2.1.1. Refer the electrical layout plan to identify the location of distribution box (DB) and main control panel board (MCPB)

2.1.2. Lay conduit for compound lightings (if applicable) as per compound lighting layout plan.

2.1.3. Lay separate conduits for incoming power cable and utility services like Telecommunication, Television, internet etc. as specified in the electric conduit layout and TV & Telephone layout. Select the appropriate size of the conduit in such a way that 40% of the space is free.

2.1.4. Lay the conduit for earth leads as per the electrical drawing (Earthing detail layout).

2.1.5. Shear wall (If applicable):

2.1.5.1. For concealed wiring, lay conduits in shear wall for switches, sockets and fixtures as per the electrical drawing before concreting

2.1.5.2. Refer the layout from the electrical drawing for the location of the switch boards

*Refer2.4.3 for surface wiring

2.2. Ground floor and above

2.2.1. Before concreting at every floor level, lay the conduits of appropriate sizes as per conduit layout plan for lighting, power and utilities.

Table 2.1: Maximum number of PVC insulated 650/110 V Grade aluminum/copper conductor cable that can be drawn in one conduit

Nominal cross sectional area of conductor in sq.mm	30 mm		25 mm		32 mm		38 mm		51 mm		64 mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1	2	3	4	5	6	7	8	9	10	11	12	13
1.5	5	4	10	8	18	12	-	-	-	-	-	-
2.5	5	3	8	6	12	10	-	-	-	-	-	-
4	3	2	6	5	10	8	-	-	-	-	-	-
6	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	6	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

2.2.2. Note and record the number of light, power, switches and utility points, on each floor.

2.2.3. In case of the conduits laid in RCC works, tie it securely with binding wire to the external reinforcement.

2.2.4. Laying of conduits diagonally can be permitted in the bricks/stone masonry wall provided there is no crossing with the other pipes or change in direction.

2.2.5. Refer specification for standard position of fittings (ceiling rose)

2.2.6. Lay circular boxes of appropriate sizes and ways in the appropriated location as per the drawing

2.2.7. Mark the position of the fitting on the slabs as per the dimension given in the drawing.

2.2.8. Provide fan hooks (if required) as illustrated below. [31]

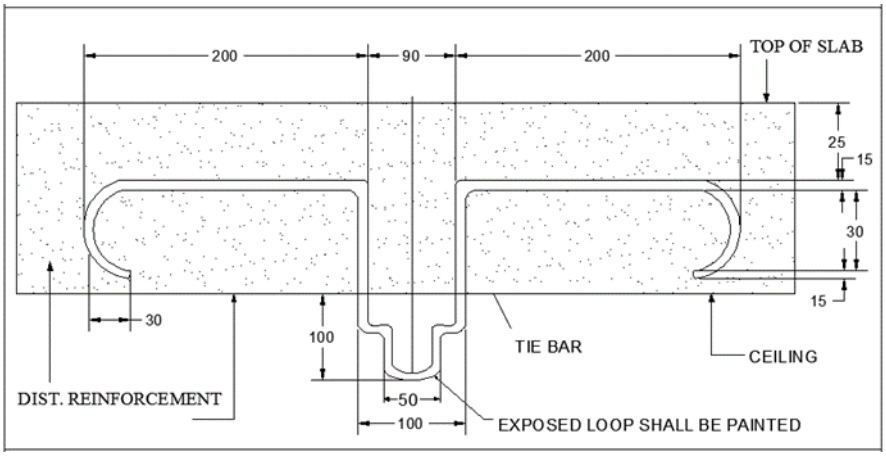


Figure 2.1: Typical design of M.S fan clamp fixed during laying of R.C.C slab

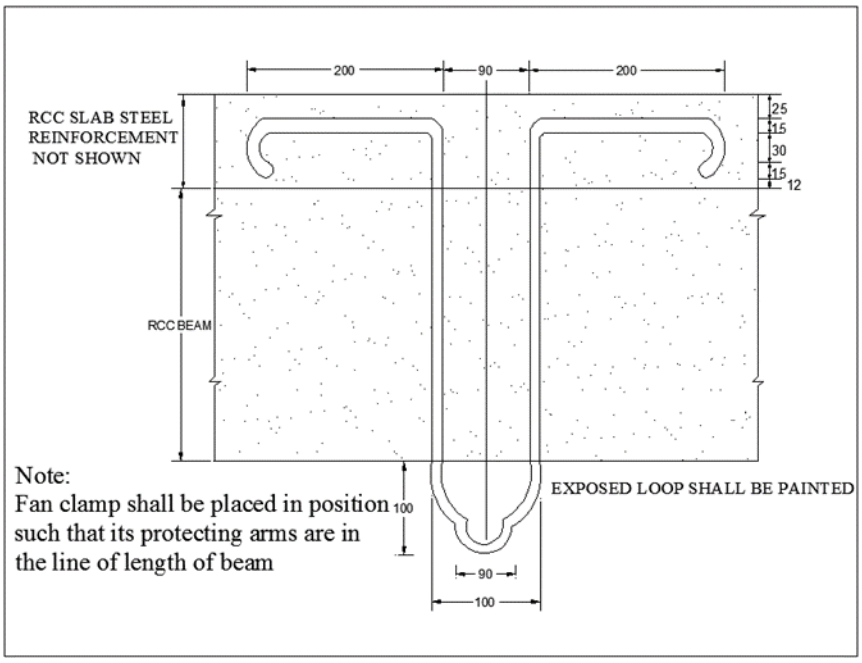


Figure 2.2: Typical design of M.S fan clamp fixed during laying of R.C.C beam

2.2.9. Lay conduits for sub main cable for distribution boxes as per the electrical drawing.

2.2.10. False ceiling:

2.2.10.1. For surface wiring, fix the conduit on the ceiling with conduit saddles at spacing of not more than 50 cm.

2.2.10.2. Provide saddles at the ends of the pipes if bend and circular boxes are used.

2.2.10.3. In case of wooden surface, directly screw on the screws without sleeve.

2.2.11. Trunking and cable trays:

[31] Refer section 8.5.1"BSR-specifications for electrical materials & works" for details

2.2.11.1. Trunking is generally installed to provide ease of access to cable circuits throughout the route.
2.2.11.2. Refer the electrical design drawing to cross check the route of trunking.
2.2.11.3. Provide suitable inspection plates and pulling out points to enable inspection, repair and drawing out of cables.

2.3. Staircase

2.3.1. Lay the conduits for stair case lighting and power points (if any) as per the conduit layout plan
2.3.2. Refer the design drawing for specification of switch used in stair case lighting

2.4. Walls

2.4.1. Study and mark the position of the wall fittings, switches and sockets as per the electrical layout drawing.

2.4.2. Concealed wiring:
2.4.2.1. Accordingly mark and cut the route of the conduits, on the walls.
2.4.2.2. Note and record the number of wall fittings, switches and sockets
2.4.2.3. Fix metallic boxes for switches and sockets and circular boxes for the light points.
2.4.2.4. Lay and place the conduit firmly in the walls. The HDPE pipes can be run whether in horizontal or vertical position as required. It should be embedded in the wall up to depth from 16 mm to 25 mm from the finished plaster level.
2.4.2.5. Where applicable, secure the pipe by binding wires tied on nail to hold it till the plastering sets to its strength.
2.4.2.6. Do not bent conduits which passes through the wall.

2.4.3. Surface wiring:
2.4.3.1. Fix PVC casing and capping properly to hold wires laid in it
2.4.3.2. Screw the casing rigidly at 150 mm interval crosswise with suitable wooden screws.
2.4.3.3. Do not put the capping until the work has been inspected and approved by the engineer-in-charge.
2.4.3.4. In case of wooden surface, directly screw the screws without sleeve.

2.4.4. Sub Distribution Box (SDB):
2.4.4.1. Refer the SDB detail layout plan for the type and the location of the DB
2.4.4.2. For concealed DB, cut the walls as per the size of the DB.

2.5. Roofing

2.5.1. Lay the conduits for aesthetic lighting under the roof as per the lighting conduit layout plan.
2.5.2. Provide lightening arrester after the completion of roofing and all other structures,
2.5.2.1. Place all the air terminals (with vertical or horizontal conductors) on the upper most part of the buildings. The lightening conductors should be connected to the air terminals and to the earth as illustrated below

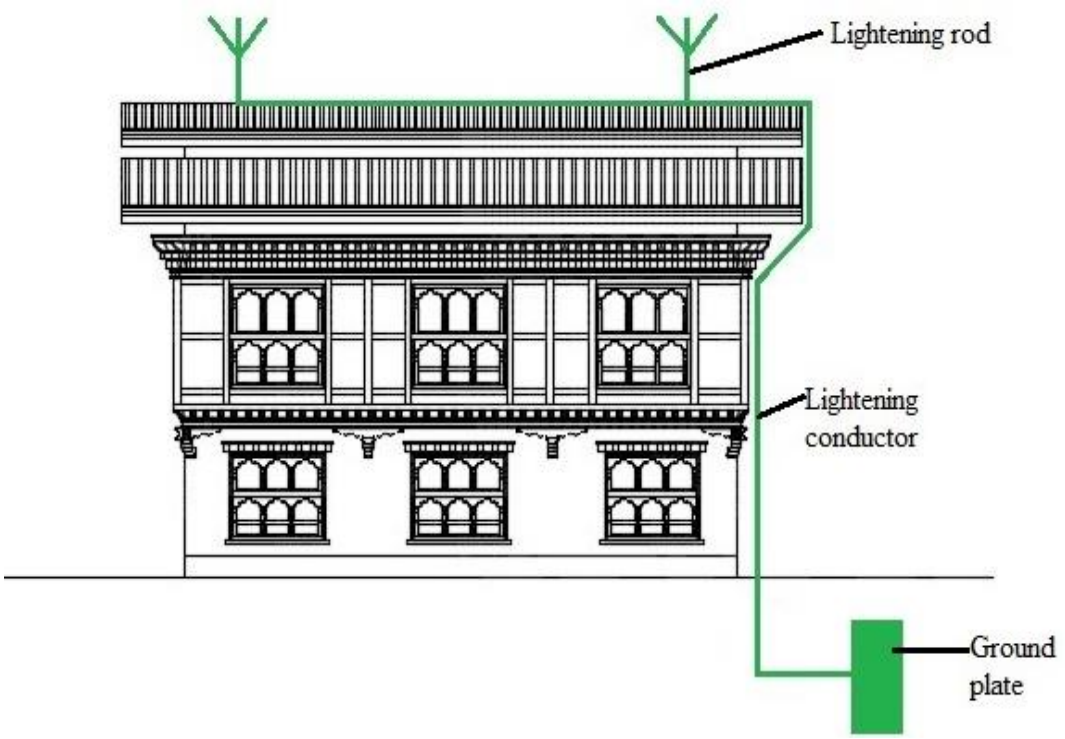


Figure 2.3: Typical diagram for connection of lightening arrester

2.5.2.2. In general, for the purpose of providing an acceptable degree of protection, the protective angle of any single component part of an air terminal (vertical or horizontal conductor) is considered to be 45˚.

2.5.2.3. Between two or more vertical conductors of equal heights spaced at a distance not exceeding twice their height, the equivalent protective angle within the space bounded by the air terminal may be taken as 60˚to the vertical and while the protective angle away from conductors as 45˚to the vertical.

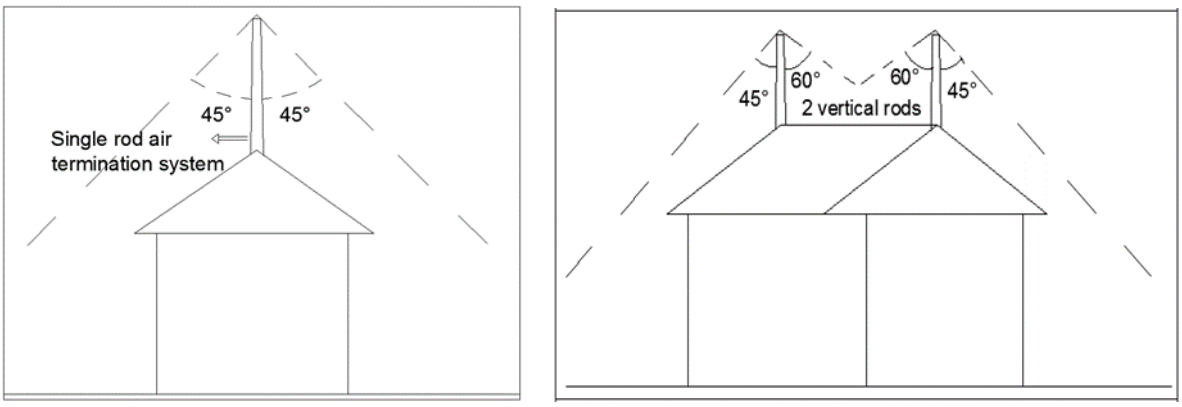


Figure 2.4: Protective angle of vertical conductors

2.5.2.4. Provide Separate earth electrode for the lightning arresters with resistance to earth not exceeding 10 ohms

2.6. Wiring

2.6.1. Draw the required number of wires of specified sizes for lighting points and power points in the conduits provided on every floor plan
2.6.2. Draw the required number of wires of specified sizes for utilities like TV and Telephone and LAN in the conduits provided on every floor plan
2.6.3. Do the connections as per the detailed drawings
2.6.4. The wiring throughout the installation shall be such that there is no break in the neutral wire except in the form of linked switchgear/looping in the switchboard.
2.6.5. The size of earth continuity wire should not be less than 1.5 sq.mm and 2.5 sq.mm bare copper wire for light and power circuit respectively
2.6.6. Connect all metallic parts, switchboards, light fittings and power sockets to the earth wires and make sure that the connections are electrically and mechanically sound.
2.6.7. Mark the neutral shall also be distinctly.

2.7. Fittings

2.7.1. Fix electrical switches, sockets and fixtures as per the drawing
2.7.2. Install the switches, receptacles, phone, coax TV jacks and plates and connect the wires after the completion of civil works.
2.7.3. Install Water Heater, Air Conditioner and Furnace if applicable.

2.8. Control gears

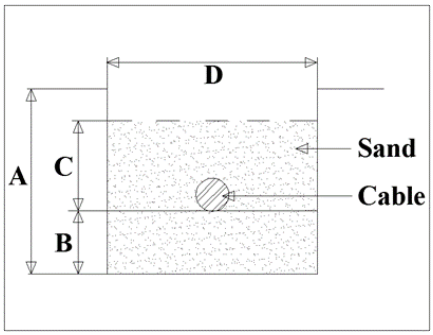
2.8.1. Install the switchboard within 1.25 m above the floor unless the front of the switchboard is completely enclosed by a door, or the switchboard is located in a position to which only authorized person(s) have access
2.8.2. Paint all the metal switchgears and switchboards with coat of antirust primer prior to erection.
2.8.3. Main bus bar connection and auxiliary wiring etc. shall conform to the table below:

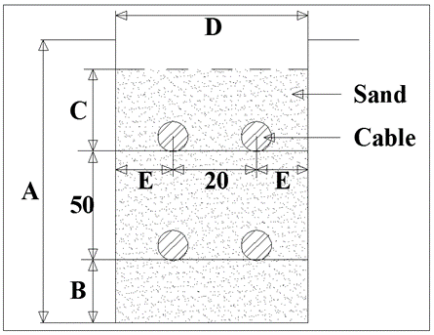
Table 2.2: Bus bar marking

Bus bar and main connection	Color	Letter/Symbol
Three phase	Red, Yellow, Blue	R,Y,B
Two phase	Red, Blue	R,B
Single phase	Red	R
Neutral connection	Black	B
Connection to Earth	Green	G
Phase variable (such as connection to motors)	Grey	Gy

2.9. Incoming cable

2.9.1. Lay the incoming cables as recommended by the service provider
2.9.2. Confirm proper right off route Prior to laying the cables, as specified in section 9.4 “BSR-specifications for electrical materials & works”
2.9.3. Lay the cables in the trenches as illustrated below





For Cable of Rating		
REF	UPTO 1.1 Kv	Exceeding 1.1 Kv
A	75	120
B	8	8
C	17	17
D	35	35

For Cable of Rating		
REF	UPTO 1.1 Kv	Exceeding 1.1 Kv
A	(75+M1x30)	(120+M1x30)
B	8	8
C	17	17
D	(30+M2x20)	(30+M2x20)
E	15	15

M1; Number of RDDL cables on Vertical formation
M2; Number of RDDL cables on Horizontal formation
Note: Values indicated are minimum values
All the dimensions in cm

2.9.4. Carry out Cable termination by using proper type and size of cable gland and termination box.

2.9.5. Keep approximately 0.5 m of excess cable for maintenance purpose at both the incoming and terminating ends.

2.9.6. After laying the power cable Mark the trench route as illustrated below:

2.10. Earthing

2.10.1. Carry out the earthing as per the detailed earthing drawing

2.10.2. Draw earth wire from the earthing plate till the MCPB in HDEP conduit

2.10.3. Location of earth electrode should not be less than 1.8m from the building footing.

2.10.4. Test the earthing as per "BSR-specifications for electrical materials & works"

2.10.5. Generally Earth resistance should be 5 ohms and in case of rocky soil/area the resistance should be 8 ohms.

2.11. Testing and commissioning

2.11.1. After the completion of electrical installations following test should be conducted as specified in section 14 "BSR-specifications for electrical materials & works:

i. Insulation resistance test between earth and conductor
ii. Insulation resistance test between conductors
iii. Polarity test of switch
iv. Continuity test
v. Earth path continuity test
vi. Earth electrode resistance test

2.12. Safety Procedure

2.12.1. The control switches and distribution boards duly marked, the distribution diagrams of sub-stations prominently displayed, sub-station premises, main switch rooms and distribution board enclosure

are kept clean. Particular care should be taken to prevent the sub-station to be used as store for inflammable materials, broken furniture, wastage materials

2.12.2. Rubber or insulation mats should be provided in front of main switchboards or any control equipment of medium voltage and above

2.12.3. No work shall be undertaken on LIVE installations or on installations which could be energized unless one another person is present to immediately isolate the electric supply in case of any accident and to render FIRST AID if necessary

2.12.4. The electrical switchgears and distribution boards should be clearly marked to indicate the areas being controlled

2.12.5. Before starting any work on the existing installation, it shall be ensured that all electric supply to that portion in which work is undertaken is cut off

2.12.6. Before energizing on an installation after the work is complete, it should be ensured that the tolls have been removed and accounted, no person is present inside any enclosure of the switchboard etc. any earthing connection made for doing the work has been removed[32]

2.13. Provision for generators (If applicable)

2.13.1. Generator should not be housed above first floor level

2.13.2. The generating set should preferably be housed in the substation (if any) to enable transfer of electrical load with negligible voltage drop as well as to avoid transfer of vibration and noise to the main building

2.13.3. The generator room should have significant amount of ventilation and fitted with a number of ceiling fans and firefighting equipment.

2.13.4. The generator engine exhaust should be properly taken out of the building and the generator oil tank should be place away from the control panel side.

2.13.5. The generator is connected at the supply input point after the energy meter and after the main incoming switch or the main incoming circuit breaker, but through a changeover switch of appropriate rating. The changeover switch should ensure that when moved to the mains position, there is no chance that the generator will be connected and vice versa.

2.13.6. The generator frame and body should be earthed by two separate and distinct connections to earth.

2.14. Provision for elevators (If applicable)

2.14.1. Installation of elevators and any other electrical work related to elevators should be carried out by trained professional and should follow the proper installation manual.

2.15. Energy efficiency

2.15.1. Use of LED lightings is highly recommended for following reasons:

i. It uses less power (watts) per unit of light generated (lumens) therefore resulting in lower electric bills.
ii. It reduces greenhouse gas emissions
iii. LED lights uses lesser amount of energy to attain the same level of illuminations as traditional lights
iv. LEDs do not contain the toxic mercury which is harmful for our health and environment as well. It also emits less heat since there is no filament.
v. The lifespan/watt hour is much more than the traditional lights

[32] Refer Section 16 “BSR-specifications for electrical materials & works”

2.16. General standards/Practices

i. Fix the Main control panel board: 0.5m above finished floor level
ii. Fix the Sub distribution box:2.1m from the finished floor level
iii. Socket Outlets:
   a) Fix the 16 amperes socket outlet: 0.25m above floor level
   b) Fix the 6A socket outlet: 1.2m from the finished floor level.
iv. Socket outlets in toilet & kitchen:1.2m from the finished floor level
v. Telephone and Television terminal cabinet: 2.1m from the finished floor level.
vi. Telephone and television socket outlet: 0.25m above floor level.
vii. Fix the Ceiling fan: 2.75 m above finished floor level.
viii. Fan shall not be provided for ceiling height less than 2.5m
ix. The connections between the switchgear mounting and the outgoing cable up to the wall shall be enclosed in a protection pipe.
x. All main switchgears shall be of metal clad and shall be fixed at close proximity to the point of entry of supply as given in the electrical drawing
xi. Main switchboards shall be placed installed in rooms or cupboards having provision for locking arrangement so as to safeguard against operation by unauthorized personnel.
xii. In damped situation or where inflammable or explosive dust, vapor or gas is likely to be present, the switchboards shall be totally enclosed or made flame proof as may be necessitated by the particular circumstance.
xiii. Plumbing and electric conduit should not have any interferences[33]

[33] For further reference refer BSR-specifications for electrical materials & works

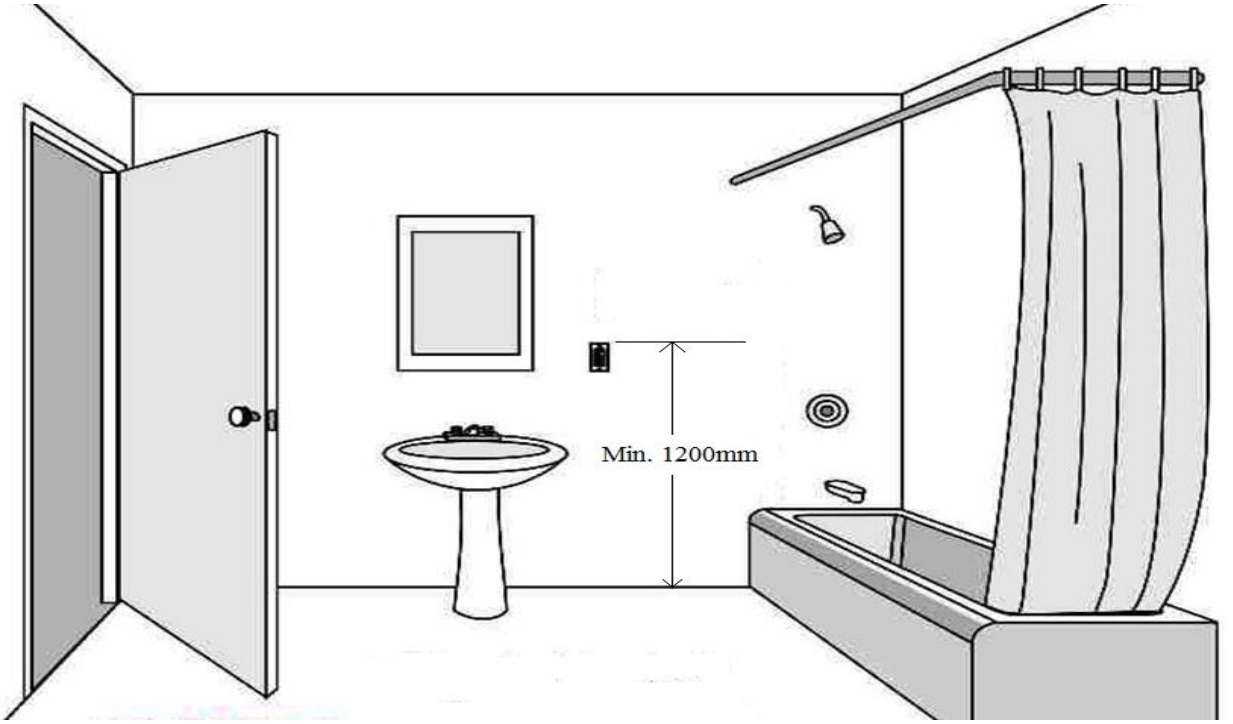


Figure 2.5: Standard height of electrical fittings in bathroom

Figure 2.6: Standard height of electrical fittings in kitchen

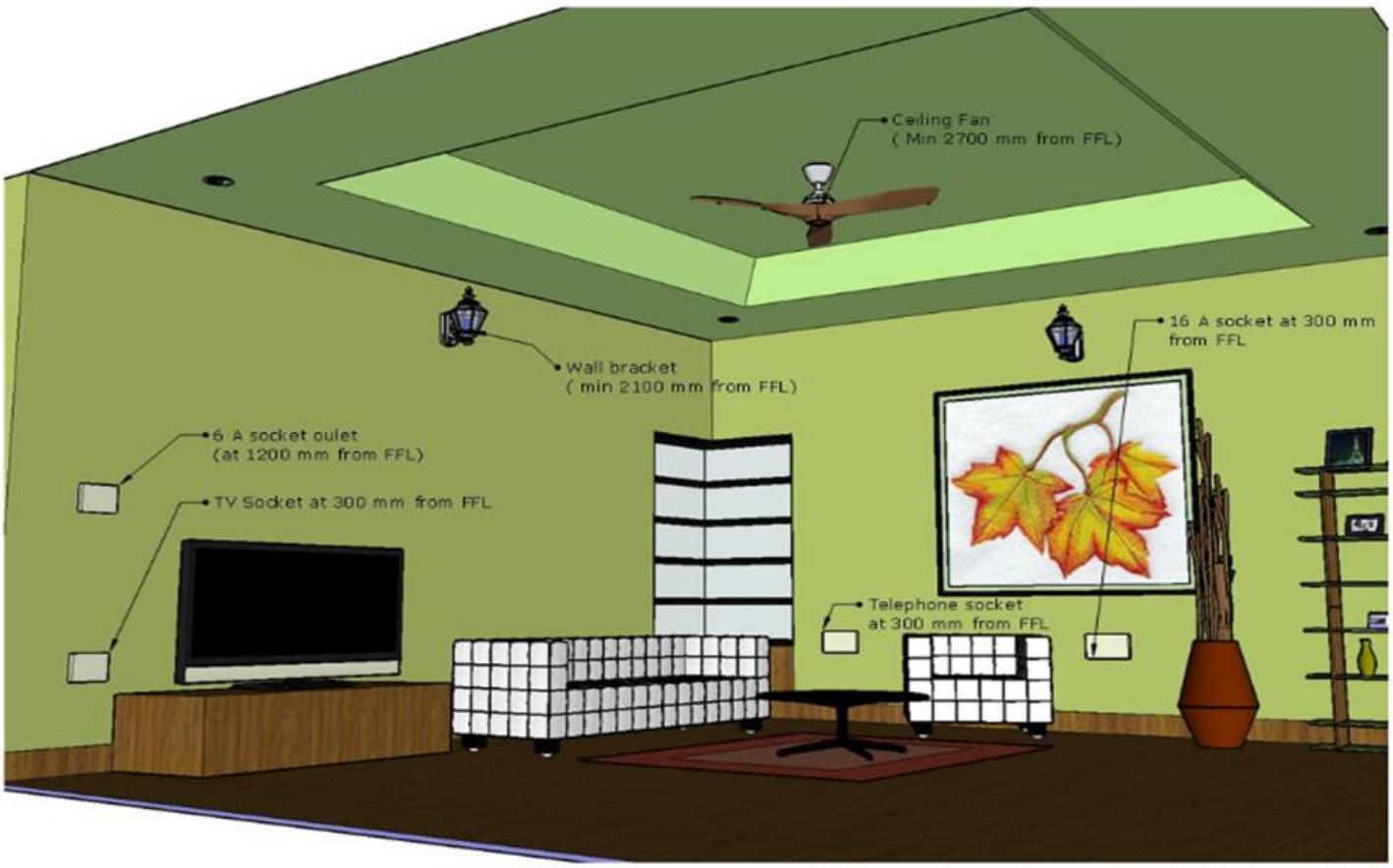


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Figure 2.7: Standard heights of electrical fittings in living room

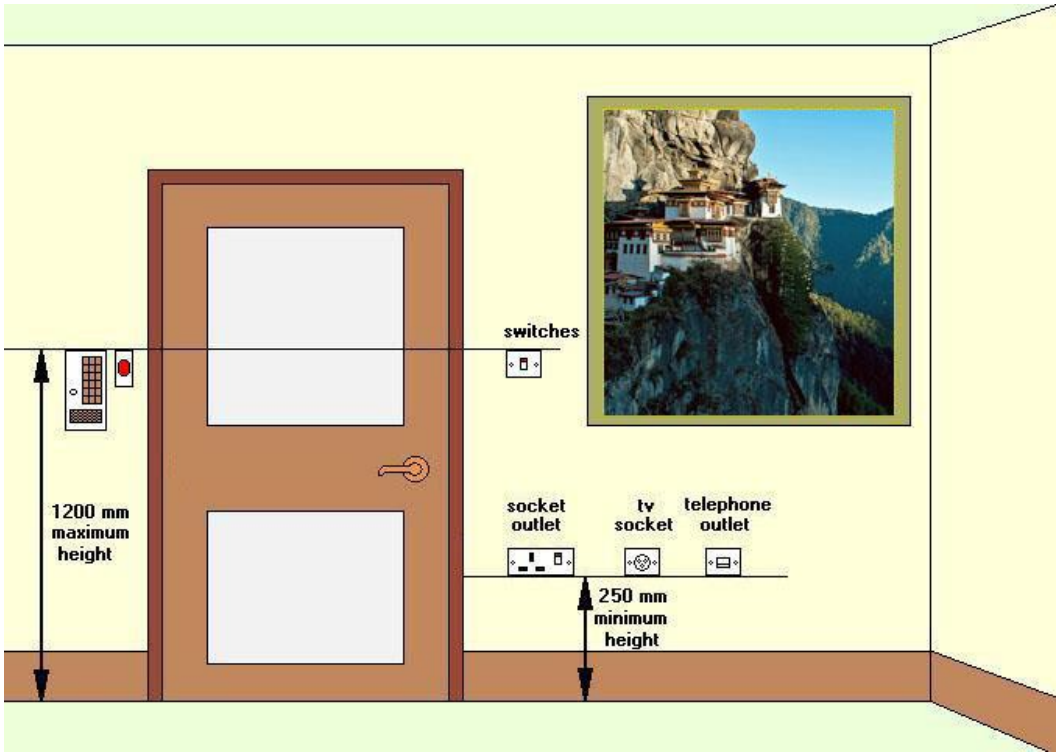


Figure 2.8: Standard height of electrical fittings

Chapter 3 : Plumbing and Sewer Works

- The plumbing installation works shall be carried out by certified plumber.
- The plumber shall refer the approved drawings and prepare for installation.
- Visit the site and identify the source of water, locate the water tank and position of water meter for urban water supply.
- Study the plumbing and sewer system in detail and locate the municipal sewer lines.
- Carry out the plumbing layout as per the plumbing drawing. Where appropriate, the construction documents shall indicate the direction of flow, all pipe sizes, grade of horizontal piping, loading, and location of fixtures and appliances.

3.1. Material selection and Storage

3.1.1. Refer the approved drawing and BoQ for the number and material of all plumbing and sanitary appliances and fixtures. All appliances should be made of BSB approved material. Sanitary appliances and their components shall be durable, impervious, and corrosion resistant and have smooth surface which may be easily cleaned.[34]

3.1.2. Fixing positions of appliances shall be established prior to the commencement of building construction. Collaborate with the supervisors for Electrical and Civil work and schedule the works accordingly.

3.1.3. As much work as possible can be done for the assembly of appliances shall be done during the progress of the erection of the building before surface finishes are carried out.

3.1.4. Identify a suitable space for storage of appliances until their assembly.

3.1.5. Check all appliances to ensure that they are in accordance with the requirement and free from defects and damage.

3.2. General plumbing and sewer work

3.2.1. Study the plumbing layout drawing to identify the location of storage tanks and plumbing pipes for bathrooms, toilets and kitchens.

3.2.2. Identify various appliances such as sink, water closet, bath tub etc. to be provided in a particular room.

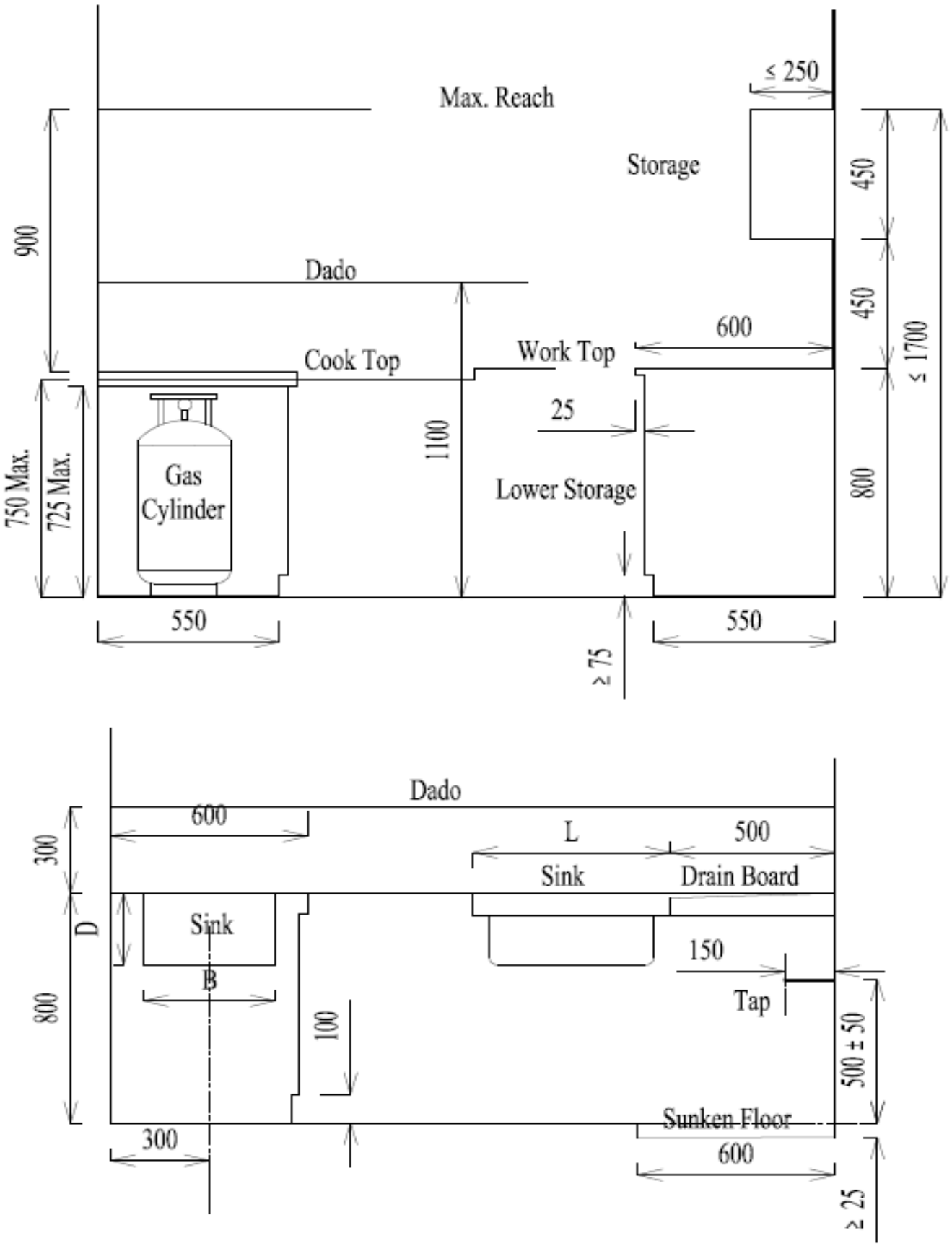
3.2.3. Determine the placement of each of those appliances in the room. From there determine the location from where the pipelines are to be run. Mark the layout of the pipelines on the wall and floors. Crosscheck the mark before any permanent works are done.

3.2.4. Install all waterlines for each fixture, for example two waterlines (hot and cold) each for bathtub and sink and a cold waterline for toilet. Attach flexible lines from the hot and cold water lines to the sink and bathtub faucets.

3.2.5. Use the appliances as a guide to determine the drain line on the floor or wall. Mark the drain lines. Place the drain lines including traps for each fixture and connect it sloping downward to the main/outlet drain line. Note that the outlet drains for sullage water and soil would be different and so will be the drain lines connecting to it.

3.2.6. Install all the appliances and other fixtures related to it following the manufacturer's instruction. Make sure the appliances are leveled.

[34] IS 2064:1993 Selection, installation and maintenance of sanitary appliances-Code of practice



(All dimension in mm)

Figure 3.1: Typical Arrangement of Kitchen

3.3. General precaution while carrying out plumbing works

3.3.1. Install the plumbing system so as to prevent any damages to the pipes. Where necessary, provision shall be made to protect piping from damage resulting from expansion, contraction and structural settlement.

3.3.2. Avoid cutting of RCC beams, columns while concealing the pipe layout.

3.3.3. Plumbing systems shall not be located in an elevator shaft or in an elevator equipment room. Ensure that plumbing lines are located away from the electrical lines.

3.4. General precaution while carrying out sewer works

3.4.1. Study the lowest depth of the house sewer and main sewer line to determine the pitch. Ensure that the house sewer outlet is higher than the main sewer line.

3.4.2. Manholes should be provided at every bend or turn and at an interval of 20 meters.

3.5. Water supply pipes

3.5.1. Ensure that there is no cross connection between pipes/fittings for conveying wholesome water and pipes/fittings for conveying impure/used water or sullage. Avoid laying pipes through or any sewer, scour outlet or drain.

3.5.2. For pipes and fittings running on the surface of the walls or ceiling, fix it by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm clear of the wall.

Table 3.1: Spacing of Fixing for Internal Piping

Kind of Piping	Size of Pipe (mm)	Interval for Horizontal Runs (m)	Interval for Vertical Runs (m)
Lead	All sizes	2	3
Copper, light guage	15	1	2
	20	2	2.5
	25	2	2.5
	32	2.5	3
	40	2.5	3
	50	2.5	3
	65	3	3.5
	80	3	3.5
	100	3	3.5
Copper, heavy guage, wrought iron and mild steel	15	2	2.5
	20	2.5	3
	25	2.5	3
	32	2.5	3
	40	3	3.5
	50	3	3.5
	65	3.5	5
	80	3.5	5
	100	4	5
Cast iron	50	2	2
	80	2.5	2.5
	100	2.5	2.5

Plastics	20	0.7	1.5 times horizontal spacing
	25	0.75	
	32	0.825	
	40	0.975	
	50	0.975	

3.5.3. Do not bury pipes 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. Avoid contact between pipe and lime mortar or lime concrete to prevent the pipe bring affected by lime. Under the floors, the pipes shall be laid in layer of sand filling as done under concrete floor

3.5.4. Wrap any pipe or fittings which is proposed to be concealed either in the wall or below the flooring with hessian cloth dipped in bitumen. Before the actual concealment work is done, test the fittings for adequate water tightness.

3.5.5. Cutting and threading

3.5.5.1. File out the ends to be cut or rethreaded to remove obstruction to bore.

3.5.5.2. Thread the end of the pipes carefully with pipe dies and taps in in such a manner as not to result in slackness of joints when the two pieces are screwed together.

3.5.5.3. Use the taps and dies to straighten screw threads which have become bent or damaged. Do not use the taps and dies for turning the threads as it may not result in water right joints.

3.5.5.4. Protect the screw threads of pipes and fittings from damage until they are fitted.

3.5.6. Jointing

3.5.6.1. Clean the pipes and clear of all foreign matter being laid.

3.5.6.2. Oil the inside of the socket and the screwed end of the pipe and rub them with a white lead. Wrap few turns of spun yarn around the screwed end of pipes.

3.5.6.3. Screw the end in the socket, tee etc. with a pipe wrench.

3.5.6.4. Keep the pipes and fittings free from dust and dirt during fixing.

3.5.6.5. Remove any burns from joint after screwing.

3.5.6.6. Temporarily plug the open ends of the pipes to prevent access of water, soil or any other foreign matter.

3.5.7. Testing

3.5.7.1. Test the pipes and fittings to a hydraulic pressure of 6kg/cm^2 (60 meters of head of water)

3.6. Accessories plumbing fittings

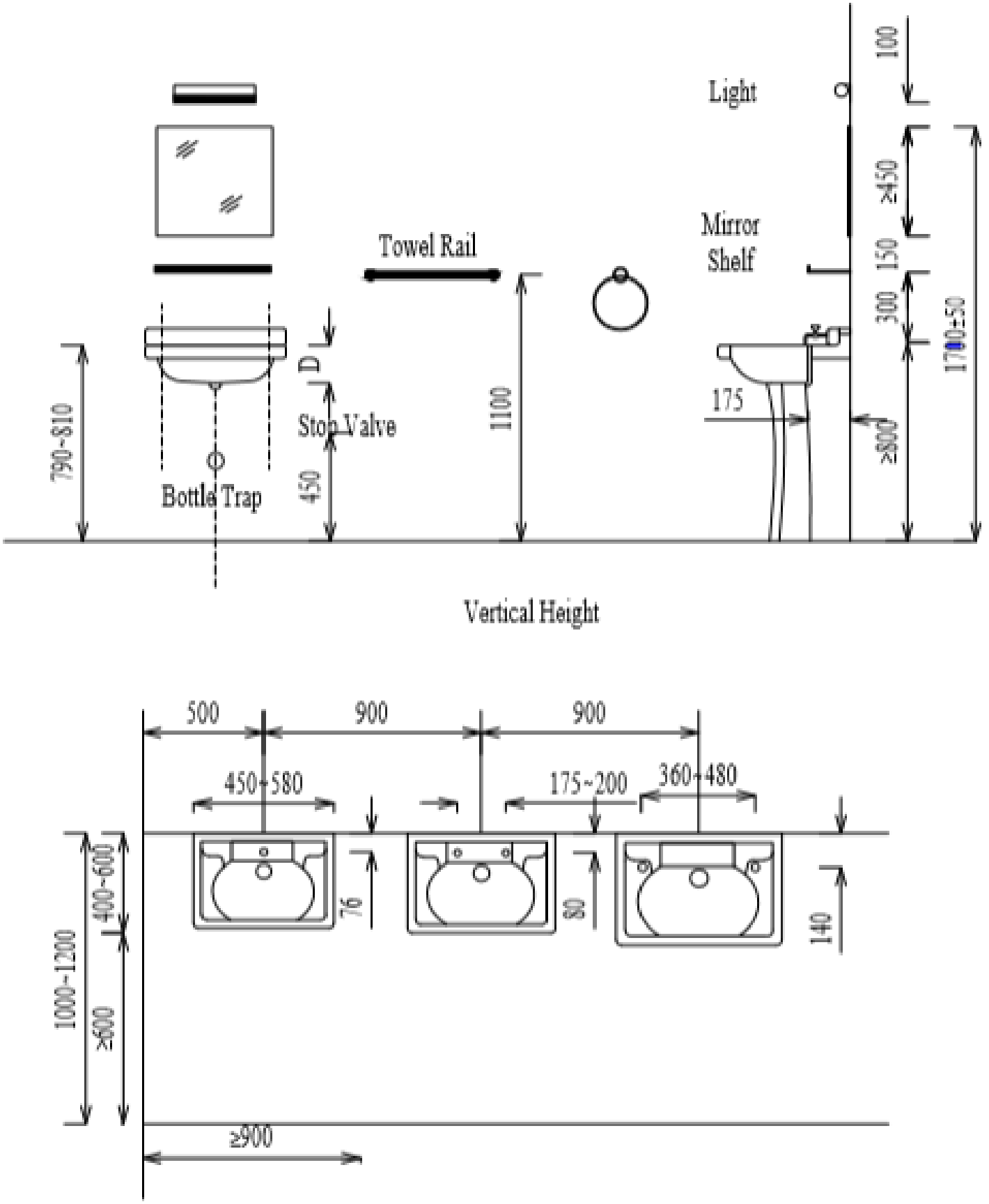
3.6.1. Bathtub

Assemble the bath-tub, pillar taps, chain with stay plug and waste arrangements.
Connect the tub shall to a waste pipe and anti-siphon stack unless it discharges into a floor trap or in a channel.

3.6.2. Wash basin

The design, shape, size and colour of wash basins are available in varying degrees. The wash basin may be mounted on pedestal or fixed on wall with/without bracket. In case of corner location special type shall be used. Since the wash basin forms part of wet area proper planning for the arrangement of wash basin is required.[35]

[35] Refer IS 771 (Part 1 to 3) and IS 2556 (Part 1 to 5) for general planning guidelines



Vertical Height

(All dimension in mm)

Figure 3.2: Typical Arrangement of Hand Wash Basins

Table 3.2: Space clearance required for Wash Basins, Water closet and Bath tub

	Wash Basin	**Minimum (mm)**	**Adequate (mm)**
Width	Centre axis to adjacent wall	510	560
	Side edge to side of adjacent tub	50	50
Depth	Front edge to opposite wall	760	900
	Front edge to opposite tub	530	760
	Water Closet	**Minimum (mm)**	**Adequate (mm)**
Width	Centre axis to adjacent wash basin	350	360
	Centre axis to adjacent tub	410	460
	Centre axis to adjacent wall	410	460
Depth	Front edge to opposite wall	410	600
	Front edge to opposite tub	530	600
	Front edge to opposite wash basin	600	760

3.6.3. Water closet

3.6.3.1. The water closet should be placed so that the large soil pipe runs between and parallel to existing floor joists. The water closet may be squatting type (Indian type) or Western type.

3.6.3.2. Squatting pan:

- ❖ Sink the pan shall into the floor and embed it in a cushion of average15 cm thick cement concrete 1:5:10 (1 cement: 5 fine sand: 10 graded brick ballast 40 mm nominal size).
- ❖ Leave the concrete 115 mm below the top level of the pan so to allow flooring and its bed concrete.
- ❖ Provide the pan with a 100 mm S.C.I.(H.C.I.),'P' or 'S' type trap with an approximately 50mm seal and 50 mm dia. vent horn, where required by the Engineer.
- ❖ Make the joint between the pan and the trap leak proof with cement mortar 1:1 (1 cement: 1 sand).

3.6.3.3. Western type water closet:

- ❖ Fix the seat to pan by means of two 8mm diameter corrosion resistant hinge bolts with a minimum length of shank of 65 mm and threaded to within 15 mm of the head.
- ❖ Provide each bolt 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, provide one non-ferrous or stainless steel 8mm washer with each bolt. The maximum external diameter of the washer fixed on the underside of the pan shall not be greater than 25mm.
- ❖ Fix one arm of the hinge in each bolt to the underside of the seat by three Nos. 20mm long, 6-gauge wood screws.
- ❖ Fix the other arm of the hinge to the underside of the cover, flush with the surface by means of three 10mm long 6-gauge wood screws.
- ❖ Fix the closet to the floor by means of 75mmlong 6.5mm diameter counter sunk bolts and nuts embedded in floor concrete.

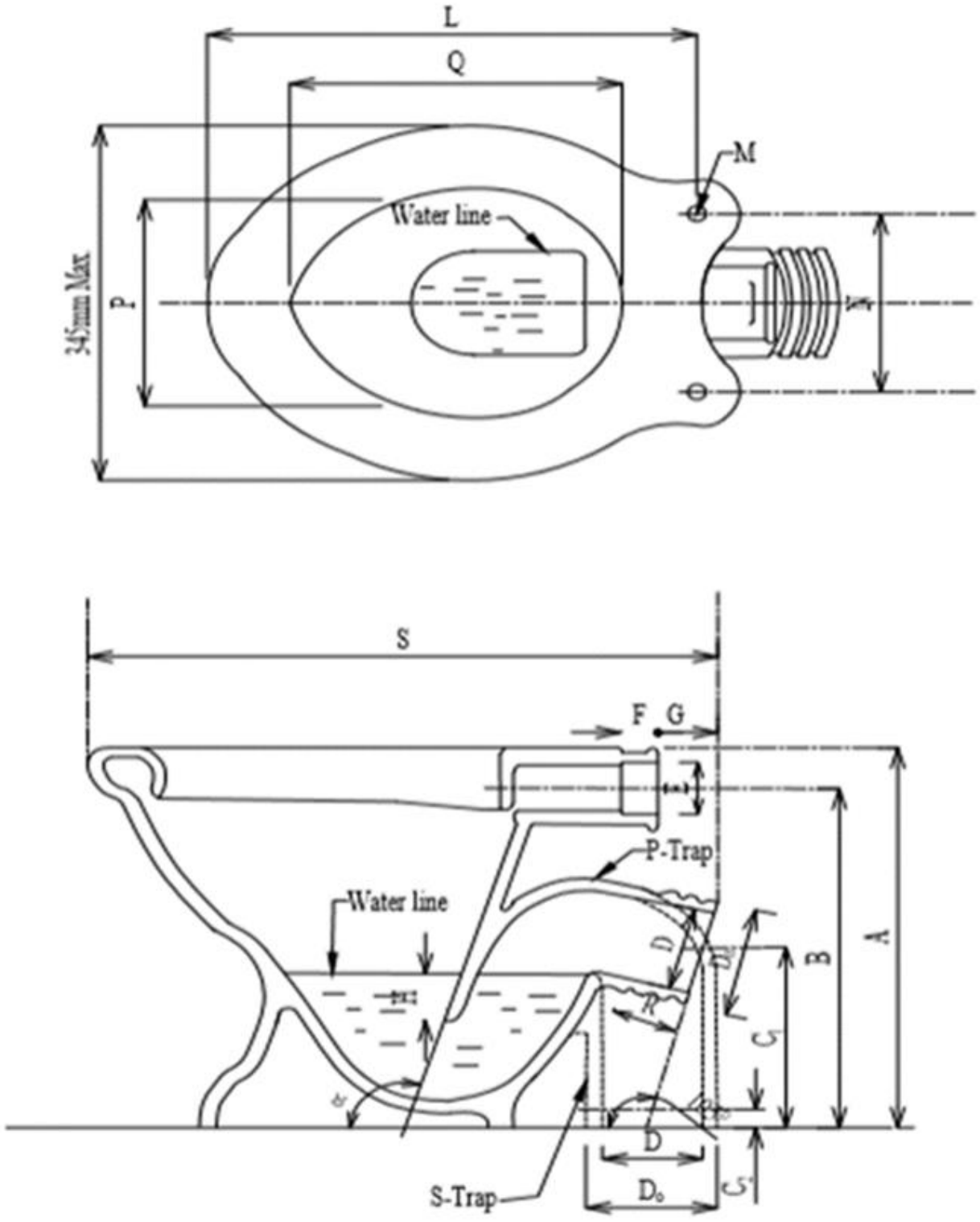


Figure 3.3: Western Type Pattern 1 Water Closet

Table 3.3: Dimensions and Permissible tolerances of Pattern 1 Water Closets

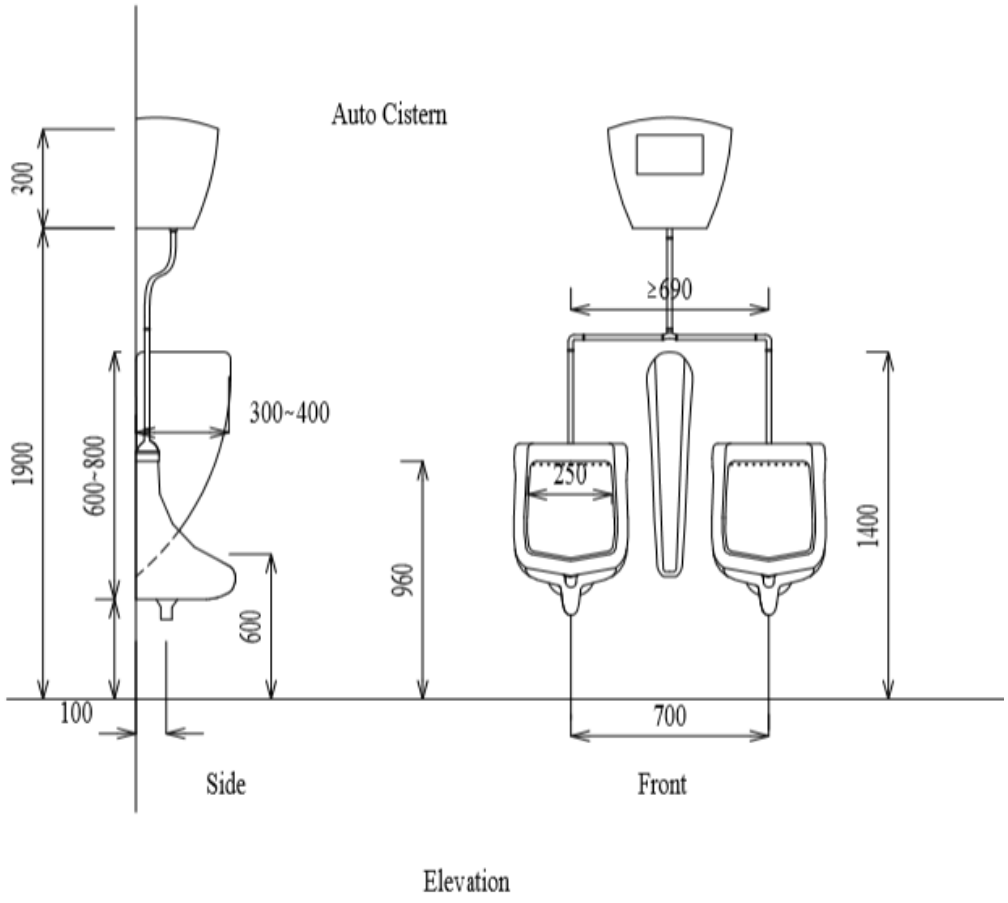
Description	Reference in figure	S-Trap	P-Trap	Tolerance
Height	A	390	390	±20
Height of centerline of flush inlet	B	350	350	±20
Height of centerline of flush outlet for P-Trap only	C_1	-	180	±10
Distance from end of trap to floor for S-Trap only	C_2	20	-	±5
Internal diameter of outlet, Minimum *	D	80	80	-
External diameter of outlet, Maximum *	D_o	110	110	-
Internal diameter of flush inlet socket	E	50	50	±3
Depth of flush inlet socket	F	30	30	±5
Distance of flush inlet socket to outside of outlet, minimum	G	45	45	-
Depth of water seal	H	Not less than 50mm. Water surface not less than 15000mm^2		
Length from seat bolt holes to front rim	L	430	430	-
Diameter of seat bolt holes	M	13	13	-
Distance between centers of seat bolt holes	N	Min 160	160	-
		Max 175	175	-
Width of opening, Minimum	P	240	240	-
Length of opening, Minimum	Q	290	290	-
Length of serrated part of outlet, Minimum	R	40	40	-
Overall length	S	500 to 575	500 to 575	-
Angle of back plate	α	90° to 135°	90° to 135°	-
Angle of outlet	$\ominus$	-	104°	-
Trap inlet depth, Minimum	T	75	75	-

3.6.4. Urinal

- ❖ Fix the urinals in position by using wooden plugs and screws.
- ❖ Fix the plugs in cement mortar 1:3. Cure the mortar until it is set.
- ❖ Connect each urinal to 32mm diameter waste pipe, which shall discharge into the channel or a floor trap.
- ❖ Make the connection between the urinal and the flush or waste pipe by means of putty or white lead mixed with chopped hemp.

Table 3.4: Size of GI flushing pipe for urinal

No. of urinals in range	**Size**	
	Main	**Distribution**
One	-	15mm
Two	20mm	15mm
Three	25mm	15mm



Elevation

(All dimension in mm)

Figure 3.4: Urinals

3.7. Testing and commissioning

3.7.1. After the completion of plumbing and sewer installations conduct the tests as specified in section 14 *"BSR-specifications for roads and building materials & works"*

3.7.2. All plumbing system piping shall be tested with either water or, for piping systems other than plastic, by air. After the plumbing fixtures have been set and their traps filled with water, the entire drainage system shall be submitted to final tests.

3.7.3. Test all plumbing system with water or air depending on the material of the plumbing pipes.

3.7.4. Gravity sewer tests shall consist of plugging the end of the building sewer at the point of connection with the public sewer, filling the building sewer with water, testing with not less than a 10-foot (3048 mm) head of water and maintaining such pressure for 15 minutes.

3.7.5. Smoke test can be utilized by filling all traps with water and then introducing into the entire system a pungent , thick smoke produced by one or more smoke machines. When the smoke appears at stack openings of the roof, the stack openings shall be closed and a pressure equivalent to a 1-inch water column shall be held for a test period of not less than 15 minutes.

3.7.6. The final test of the completed drainage and vent systems shall be visual and in sufficient detail to determine compliance with provisions of this document.

Chapter 4 : Annexure (Checklist)

Note:

The checklist can be customized according to the type of work or project. It can be used for works other than building construction such as bridge, water tanks, road etc.

The checklist has been made in a way such that it can be used on the go like a to-do list; the supervisor can check against the work as and when it is completed.

4.1. Annexure 1: Checklist for drawings and documents required at site

4.1.1. Contract documents:

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Bill of quantities						
2.	Technical specifications						
3.	Standard bidding documents and approved drawings						

4.1.2. Architectural drawing:

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Site plan/Master plan						
2.	Building floor plans						
3.	Building elevations						
4.	Building sections						
5.	Basement water proofing details(if applicable)						
6.	Staircase details						
7.	Door details						
8.	Window details						
9.	False ceiling details(if applicable)						
10.	Glazing details(if applicable)						
11.	Roof details						

4.1.3. Plumbing and sewerage drawing:

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
Plumbing Drawing							
1.	Water supply distribution layout plan						
2.	Section						
Sewerage Drawing							
1.	Sanitary line connection layout plan						
2.	Septic tank plan(if applicable)						
3.	Septic tank section(if applicable)						
4.	Inspection Chamber plan						
5.	Inspection Chamber section						
6.	Soak Pit plan						
7.	Soak pit section						

4.1.4. Structural drawing:

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	General structural notes						
2.	Footing layout plan						
3.	Footing details						
4.	Column layout plan						
5.	Column details						
6.	Lift layout plan (if applicable)						
7.	Lift details (if applicable)						
8.	Basement beam layout plan(if any)						
9.	Basement beam details(if applicable)						
10.	Plinth/Ground floor beam layout plan						

11.	Plinth/Ground floor beam details						
12.	Beam layout plan for all other successive floors						
13.	Beam details for each floor/grid						
14.	Beam column splicing and connection details						
15.	RC Wall connection details.						
16.	RC Band/lintel details						
17.	Splicing and connection details for cornices for every floor level(if applicable)						
18.	Slab layout plan for every floor						
19.	Bottom reinforcement layout plan for every floor						
20.	Top reinforcement layout plan for every floor						
21.	slab sectional details for every floor (if applicable)						
22.	Staircase layout plan and its sectional details						
23.	Truss layout plan						
24.	Truss sectional elevations.						
25.	Truss sectional properties						
26.	Truss connection details.						

4.1.5. Electrical drawing:

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Legends						
2.	Specifications						
3.	Electric Wiring layout						
4.	Lighting conduit layout						
5.	Power conduit layout						
6.	Television and Telephone conduit layout						
7.	Sub Distribution Board detail layout						

8.	Main Control Panel Board detail layout						
9.	Earthing detail layout						

4.2. Annexure 2: Checklist for Architectural and Civil Works

4.2.1. Site layout preparation:

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Contour/survey plan as per approved drawing						
2.	Coordinates of control points for the plot/boundary, main grid lines, center lines in both directions, block levels, spot levels etc. established						
3.	Set back as per the norms of local authority & approved drawings						If **NO**, report back to the competent authority or approving authority
4.	Clearing and grubbing work done						
5.	Bench mark and Datum line established						
6.	Presence of deviation noted						If **YES,** report back to approving authority

4.2.2. Setting out:

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Gridlines for column consistent with Architectural and Structural drawings						
2.	Starter column identified and marked on the ground as per drawing						
3.	Other columns located and marked						
4.	Diagonals crosschecked						

5.	Adequate number of recovery pegs fixed at suitable locations						
6.	Final set out crosschecked						

4.2.3. Excavation and Earthwork:

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Checked for existing service lines like electrical connection, water supply and drainage connection, telephone line etc. below ground level						
2.	Marked excavation area as per footings size given in drawing						Applicable for all footings
3.	Footing depth achieved as per the approved drawing						Report to designer/approving authority if poor soil condition is met at designed depth. Applicable for all footings
4.	Temporary supports like shoring provided where necessary						
5.	Footing base levelled and prepared						
6.	Excess excavated earth disposed						
7.	Dewatering carried out using appropriate method before starting foundation works						

4.2.4. Foundation:

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Column and footing located and laid out as per drawing						
2.	Stone soling laid as per drawings and BoQ						
3.	PCC laid as specified in drawings and BoQ						

4.	Expansion joints set out as per the approved drawing							
5.	Column and footing position re-centered and marked on the PCC layer							
6.	i. Footing Reinforcement							
	Bottom Reinforcement as per approved drawing	Size						
		Grade						
		Spacing/Numbers						
	Provided chairs ensuring the proper height for resting top reinforcement							
	Top Reinforcement as per approved drawing	Size						
		Grade						
		Spacing/Numbers						
7.	ii. Column Reinforcement							
	Calculated the height till which the column reinforcement is to be erected							
	Main reinforcement given as per drawing	Size						
		Grade						
		Spacing/Numbers						
	Ties and stirrup given as per drawing	Size						
		Grade						
		Spacing/Numbers						
	Achieved the anchorage length required							
8.	iii. Formwork							
	Provided the cover of size specified in drawing							
	Form work with internal size equal to size of footing and cover block together made and put in place							
	Provided enough shoring and battens to support the formwork							
	Checked formwork to ensure it is leakage proof							
9.	iv. Concreting							
	Prepared concrete with grade as specified							
	Carried out slump test to check workability of concrete							

	Poured concrete and enough vibration provided for even spreading of concrete						
	Concrete cured properly till its requirement						
	Formworks removed after the concrete gained strength						
10.	Backfilled the soil around the footing						

4.2.5. Basement(if applicable):

4.2.5.1. General

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Collaborated with the supervisors for Electrical and Plumbing (including sewer) work to check if any of their work has to be done before or during the construction of basement						If any work has to be done, refer their respective checklist and schedule the work accordingly
2.	Floor levels consistent with architectural drawing						
3.	**RRM wall below beam(if applicable):**						
	Centre lines and angles as per drawing						
	Prepared stone and mortar as specified in drawings and BoQ						
	Wall laid and constructed as per drawing						

4.2.5.2. Beam

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	**Formwork:**						
	Formwork made as per design and positioned in place with supports						
	Form work checked to ensure it is leak-proof						
	Prepared cover for beam						

2.	**Reinforcement:**							
	Main reinforcement provided as per approved drawing	Size						
		Grade						
		Spacing/Numbers						
	Main reinforcement spliced and bent as required							
	Anchorage and development length achieved							
	Stirrups provided as per approved drawing	Size						
		Grade						
		Spacing/Numbers						
	Reinforcements positioned in place with help of the covers prepared before							
3.	**Concreting:**							
	Prepared concrete with grade as specified							
	Carried out slump test to check workability of concrete							
	Poured concrete and enough vibration provided for even spreading of concrete							
	Concrete cured properly till its requirement							
	Formworks removed after the concrete gained strength							

4.2.5.3. Column

Sl. No	Details		Check		Name and signature of Engineer	Verified by	Date	Remarks
			Yes	No				
1.	**Reinforcement:**							
	Main reinforcement provided as per approved drawing	Size						
		Grade						
		Spacing/Numbers						
	Stirrups/Ties provided as per approved drawing	Size						
		Grade						
		Spacing/Numbers						
	Main reinforcement spliced/lapped and bent as required							

	Anchorage and development length achieved						
	Prepared cover for column						
	Reinforcements positioned in place with the help of supports						
	Tie up/Put the covers prepared before in place with the reinforcement						
2.	**Formwork:**						
	Formwork made as per design and positioned in place with supports						
	Form work checked to ensure it is leak-proof						
3.	**Concreting**						
	Prepared concrete with grade as specified						
	Carried out slump test to check workability of concrete						
	Poured concrete and enough vibration provided for even spreading of concrete						
	Concrete cured properly till its requirement						
	Formworks removed after the concrete gained strength						

4.2.5.4. Shear Wall (If applicable)

Sl. No	Details		Check		Name and signature of Engineer	Verified by	Date	Remarks
			Yes	No				
1.	Collaborated with the supervisors for Electrical and Plumbing (including sewer) work to check if any of their work has to be done before or during the construction of shear wall							If any work has to be done, refer their respective checklist and schedule the work accordingly
2.	**Reinforcement**							
	Vertical reinforcement	Size						
		Grade						
		Spacing/Numbers						

	Horizontal reinforcement	Size						
		Grade						
		Spacing/Numbers						
	Prepared cover for shear wall							
	Reinforcements positioned in place with the help of supports							
	Tied or Put the covers prepared in place with the reinforcement							
3.	**Formwork**							
	Formwork made as per design and positioned in place with supports							
	Form work checked to ensure it is leak-proof							
4.	**Concreting**							
	Prepared concrete with grade as specified							
	Carried out slump test to check workability of concrete							
	Poured concrete and enough vibration provided for even spreading of concrete							
	Concrete cured properly till its requirement							
	Formworks removed after the concrete gained strength							

4.2.5.5. Slab

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Collaborated with the supervisors for Electrical and Plumbing (including sewer) work to check if any of their work has to be done before or during the construction of slab						If any work has to be done, refer their respective checklist and schedule the work accordingly
2.	Type of slab identified						If PCC, skip the reinforcement parts.
3.	**Reinforcement:**						

	Cover block prepared and positioned in place							
	Bottom reinforcement provided as per approved drawing	Grade						
		Size						
		Numbers/Spacing						
	Reinforcements bent and curtailed as specified							
	Chairs prepared and positioned in place							
	Top reinforcement provided as per drawing	Grade						
		Size						
		Numbers/Spacing						
	Reinforcements bent and curtailed as specified							
4.	**Formwork:**							
	Formwork made as per design and positioned in place with supports							
	Form work checked to ensure it is leak-proof							
5.	**Concreting:**							
	Prepared concrete with grade as specified							
	Carried out slump test to check workability of concrete							
	Poured concrete and enough vibration provided for even spreading of concrete							
	Concrete cured properly till its requirement							
	Formworks removed after the concrete gained strength							

4.2.5.6. Internal Wall / Infill Wall

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Collaborated with the supervisors for Electrical and Plumbing (including sewer) work to check if any of their work has to be done before or during the construction of walls						If any work has to be done, refer their respective checklist and schedule the

							work accordingly
2.	Type of wall identified						If it's shear wall, follow procedures given for shear wall.
3.	Materials identified and procured as required						
4.	**Wall layout**						
	Wall layout done and marked as per drawing						
	Decided on the bond of brick						
5.	**Mortar and Masonry work**						
	Mortar of required grade prepared						
	Bricks laid in uniform layers and glued together by mortars						
	Strengthening of wall done as specified						Skip to next step if not applicable
	Constantly levelled it vertically and horizontally						
	Provided scaffolding as the wall height increased						
6.	**Curing and removal of scaffolding**						
	Properly cured and scaffoldings removed						
	Plastering and other finishing work done as specified						
	Plasters properly cured						

4.2.5.7. Damp proofing (If applicable)

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
	Provided damp proofing of type and variety specified						

4.2.5.8. Lift shaft provision and construction(if applicable)

	Details	Check			Date	Remarks

Sl. No		Yes	No	Name and signature of Engineer	Verified by		
	Constructed lift shaft with details as specified						

4.2.6. Plinth/Ground floor level:

4.2.6.1. General

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Floor levels consistent with architectural drawing						
2.	**RRM wall below beam(if applicable):**						
	Centre lines and angles as per drawing						
	Stone and mortar as specified in drawings and BoQ						
	Wall laid and constructed as per drawing						

4.2.6.2. Beam

Sl. No	Details		Check		Name and signature of Engineer	Verified by	Date	Remarks
			Yes	No				
1.	**Formwork:**							
	Formwork made as per design and positioned in place with supports							
	Form work checked to ensure it is leak-proof							
	Prepared cover for beam							
2.	**Reinforcement:**							
	Main reinforcement provided as per approved drawing	Size						
		Grade						
		Spacing/Numbers						

	Main reinforcement spliced and bent as required							
	Anchorage and development length achieved							
	Stirrups provided as per approved drawing	Size						
		Grade						
		Spacing/Numbers						
	Reinforcements positioned in place with help of the covers prepared before							
3.	**Concreting**							
	Prepared concrete with grade as specified							
	Carried out slump test to check workability of concrete							
	Poured concrete and enough vibration provided for even spreading of concrete							
	Concrete cured properly till its requirement							
	Formworks removed after the concrete gained strength							

4.2.6.3. Column

Sl. No	Details		Check		Name and signature of Engineer	Verified by	Date	Remarks
			Yes	No				
1.	**Column Reinforcement**							
	Calculated the height till which the column reinforcement is to be erected							
	Main reinforcement given as per drawing	Size						
		Grade						
		Spacing/Numbers						
	Ties and stirrup given as per drawing	Size						
		Grade						
		Spacing/Numbers						
	Main reinforcement spliced/lapped and bent as required							
	Anchorage and development length achieved							
	Prepared cover for column							
	Reinforcements positioned in place with the help of supports							

	Tie or Put the covers prepared, in place with the reinforcement						
2.	**Formwork**						
	Formwork made as per design and positioned in place with supports						
	Form work checked to ensure it is leak-proof						
	Provided enough shoring and battens to support the formwork						
	Checked formwork to ensure it is leakage proof						
3.	**Concreting**						
	Prepared concrete with grade as specified						
	Carried out slump test to check workability of concrete						
	Poured concrete and enough vibration provided for even spreading of concrete						
	Concrete cured properly till its requirement						
	Formworks removed after the concrete gained strength						

4.2.6.4. Slab

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Collaborated with the supervisors for Electrical and Plumbing (including sewer) work to check if any of their work has to be done before or during the construction of slab						If any work has to be done, refer their respective checklist and schedule the work accordingly
2.	RCC slab identified						If PCC, skip the reinforcement parts.
3.	**Reinforcement:**						
	Cover block prepared and positioned in place						
	Grade						

	Bottom reinforcement provided as per approved drawing	Size						
		Numbers/Spacing						
	Reinforcements bent and curtailed as specified							
	Chairs prepared and positioned in place							
	Top reinforcement provided as per drawing	Grade						
		Size						
		Numbers/Spacing						
	Reinforcements bent and curtailed as specified							
4.	**Formwork**							
	Formwork made as per design and positioned in place with supports							
	Form work checked to ensure it is leak-proof							
5.	**Concreting**							
	Prepared concrete with grade as specified							
	Carried out slump test to check workability of concrete							
	Poured concrete and enough vibration provided for even spreading of concrete							
	Concrete cured properly till its requirement							
	Formworks removed after the concrete gained strength							

4.2.6.5. Internal Wall/Infill wall

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Collaborated with the supervisors for Electrical and Plumbing (including sewer) work to check if any of their work has to be done before or during the construction of walls						If any work has to be done, refer their respective checklist and schedule the work accordingly
2.	Type of wall identified						If it's shear wall, follow

							procedures given for shear wall.
3.	Materials identified and acquired as required						
4.	**Wall layout**						
	Wall layout done and marked as per drawing						
	Decided on the bond of brick						
5.	**Mortar and Masonry work**						
	Mortar of required grade prepared						
	Bricks laid in uniform layers and glued together by mortars						
	Strengthening of wall done as specified						Skip to next step if not applicable
	Constantly levelled it vertically and horizontally						
	Provided scaffolding as the wall height increased						
6.	**Curing and removal of scaffolding**						
	Properly cured and scaffoldings removed						
	Plastering and other finishing work done as specified						
	Plasters properly cured						

4.2.6.6. Damp proofing (if applicable)

Sl. No	**Details**	**Check**		**Name and signature of Engineer**	**Verified by**	**Date**	**Remarks**
		Yes	**No**				
1.	Provided damp proofing of type and variety specified						

4.2.6.7. Lift shaft provision and Construction (if applicable)

Sl. No	**Details**	**Check**		**Name and signature of Engineer**	**Verified by**	**Date**	**Remarks**
		Yes	**No**				

1.	Constructed lift shaft with details as specified						

4.2.7. First floor and above:

4.2.7.1. General

Sl. No	Details		Check		Name and signature of Engineer	Verified by	Date	Remarks
			Yes	No				
1.	Floor levels consistent with architectural drawing							
2.	**Beam:**							
	i. Formwork:							
	Formwork made as per design and positioned in place with supports							
	Form work checked to ensure it is leak-proof							
	Prepared cover for beam							
	ii. Reinforcement:							
	Main reinforcement provided as per approved drawing	Size						
		Grade						
		Spacing/Numbers						
	Main reinforcement spliced and bent as required							
	Anchorage and development length achieved							
	Stirrups provided as per approved drawing	Size						
		Grade						
		Spacing/Numbers						
	Reinforcements positioned in place with help of the covers prepared before							
	iii. Concreting							
	Prepared concrete with grade as specified							
	Carried out slump test to check workability of concrete							
	Poured concrete and enough vibration provided for even spreading of concrete							
	Concrete cured properly till its requirement							

	Formworks removed after the concrete gained strength						

4.2.7.2. Beam

Sl. No	Details		Check		Name and signature of Engineer	Verified by	Date	Remarks
			Yes	No				
1.	**Formwork:**							
	Formwork made as per design and positioned in place with supports							
	Form work checked to ensure it is leak-proof							
	Prepared cover for beam							
2.	**Reinforcement:**							
	Main reinforcement provided as per approved drawing	Size						
		Grade						
		Spacing/Numbers						
	Main reinforcement spliced and bent as required							
	Anchorage and development length achieved							
	Stirrups provided as per approved drawing	Size						
		Grade						
		Spacing/Numbers						
	Reinforcements positioned in place with help of the covers prepared before							
3.	**Concreting**							
	Prepared concrete with grade as specified							
	Carried out slump test to check workability of concrete							
	Poured concrete and enough vibration provided for even spreading of concrete							
	Concrete cured properly till its requirement							
	Formworks removed after the concrete gained strength							

4.2.7.3. Column

Sl. No	Details		Check		Name and signature of Engineer	Verified by	Date	Remarks
			Yes	No				
1.	**Column Reinforcement**							
	Calculated the height till which the column reinforcement is to be erected							
	Main reinforcement given as per drawing	Size						
		Grade						
		Spacing/Numbers						
	Ties and stirrup given as per drawing	Size						
		Grade						
		Spacing/Numbers						
	Main reinforcement spliced/lapped and bent as required							
	Anchorage and development length achieved							
	Prepared cover for column							
	Reinforcements positioned in place with the help of supports							
	Tie or Put the covers prepared, in place with the reinforcement							
2.	**Formwork**							
	Formwork made as per design and positioned in place with supports							
	Form work checked to ensure it is leak-proof							
	Provided enough shoring and battens to support the formwork							
	Checked formwork to ensure it is leakage proof							
3.	**Concreting**							
	Prepared concrete with grade as specified							
	Carried out slump test to check workability of concrete							
	Poured concrete and enough vibration provided for even spreading of concrete							
	Concrete cured properly till its requirement							
	Formworks removed after the concrete gained strength							

	Formworks removed after the concrete gained strength						

4.2.7.4. Slab

Sl. No	Details		Check		Name and signature of Engineer	Verified by	Date	Remarks
			Yes	No				
1.	Collaborated with the supervisors for Electrical and Plumbing (including sewer) work to check if any of their work has to be done before or during the construction of slab							If any work has to be done, refer their respective checklist and schedule the work accordingly
2.	**Reinforcement:**							
	Cover block prepared and positioned in place							
	Bottom reinforcement provided as per approved drawing	Grade						
		Size						
		Numbers/Spacing						
	Reinforcements bent and curtailed as specified							
	Chairs prepared and positioned in place							
	Top reinforcement provided as per drawing	Grade						
		Size						
		Numbers/Spacing						
	Reinforcements bent and curtailed as specified							
3.	**Formwork**							
	Formwork made as per design and positioned in place with supports							
	Form work checked to ensure it is leak-proof							
4.	**Concreting**							
	Prepared concrete with grade as specified							
	Carried out slump test to check workability of concrete							

	Poured concrete and enough vibration provided for even spreading of concrete						
	Concrete cured properly till its requirement						
	Formworks removed after the concrete gained strength						

4.2.7.5. Internal Wall/ Infill wall

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Collaborated with the supervisors for Electrical and Plumbing (including sewer) work to check if any of their work has to be done before or during the construction of walls						If any work has to be done, refer their respective checklist and schedule the work accordingly
2.	Type of wall identified						If it's shear wall, follow procedures given for shear wall.
3.	Materials identified and acquired as required						
4.	**Wall layout**						
	Wall layout done and marked as per drawing						
	Decided on the bond of brick						
5.	**Mortar and Masonry work**						
	Mortar of required grade prepared						
	Bricks laid in uniform layers and glued together by mortars						
	Strengthening of wall done as specified						Skip to next step if not applicable
	Constantly levelled it vertically and horizontally						
	Provided scaffolding as the wall height increased						
6.	**Curing and removal of scaffolding**						

	Properly cured and scaffoldings removed						
	Plastering and other finishing work done as specified						
	Plasters properly cured						

4.2.7.6. Cornices (if applicable)

Sl. No	Details		Check		Name and signature of Engineer	Verified by	Date	Remarks
			Yes	No				
1.	Identified the type, material, sizes and location of cornices							If the cornices are wooden, skip the following step
2.	**Formwork**							
	Prepared the form work as per design of cornices							
	Form work checked to ensure it is leak-proof							
3.	**Reinforcement**							
	Reinforcement laid as per the drawing	Grade						
		Size						
		Numbers/Spacing						
4.	**Concreting**							
	Concrete prepared and poured as per the grade in the drawing							
	Concrete curing done							
	Removed formwork after the concrete gained strength							
	Finishing of cornices done							

4.2.7.7. Lift shaft provision and Construction (if applicable)

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
2.	Constructed lift shaft with details as specified						

4.2.8. Doors and windows:

4.2.8.1. General

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	The location of doors and windows identified from the architectural drawing						
2.	Marked the location of door and windows before starting wall construction						
3.	Sill height maintained as per architectural drawing						
4.	Windows and doors installed as per the drawing						

4.2.8.2. Lintels/Bands

Sl. No	Details		Check		Name and signature of Engineer	Verified by	Date	Remarks
			Yes	No				
1.	Identified the type, material, sizes and location of band							If the bands are wooden, skip the following step
2.	**Formwork**							
	Shuttering provided as required.							
	Form work checked to ensure it is leak-proof							
3.	**Reinforcement**							
	Reinforcement laid as per the drawing	Grade						
		Size						
		Numbers/Spacing						
4.	**Concreting**							
	Prepared concrete with grade as specified							
	Carried out slump test to check workability of concrete							
	Poured concrete and enough vibration provided for even spreading of concrete							

	Concrete cured properly till its requirement						
	Formworks removed after the concrete gained strength						

4.2.8.3. Cornices

Sl. No	Details		Check		Name and signature of Engineer	Verified by	Date	Remarks
			Yes	No				
1.	Identified the type, material, sizes and location of cornices							If the elements are wooden, skip the following step
2.	**Formwork**							
	Shuttering provided as required.							
	Form work checked to ensure it is leak-proof.							
3.	**Reinforcement**							
	Reinforcement cut, bent and laid as per the drawing	Grade						
		Size						
		Numbers/Spacing						
4.	**Concreting**							
	Prepared concrete with grade as specified							
	Carried out slump test to check workability of concrete							
	Poured concrete and enough vibration provided for even spreading of concrete							
	Concrete cured properly till its requirement							
	Formworks removed after the concrete gained strength							

4.2.8.1. Other traditional elements such as Pem, Dung, etc.

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				

1.	Identified other small traditional elements which cannot be achieved with the help of formwork.						
2.	Made the small elements with the help of plaster.						

4.2.9. Roof :

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Identified the type of roof and material for it.						
2.	Marked the layout of the roof on the floor						
3.	Provided prop in their position						
4.	Provided the horizontal member (Dhingri) on the props						In case of trusses which are pre-made and directly connected to the position, skip to step 7
5.	Provided vertical post and connected them properly to the Dhingri as well as the other members						
6.	Inclined members connected to the vertical post						
7.	Rafter provided over the truss formed.						
8.	Purlin laid perpendicular to the rafter.						
9.	Sheeting of given material laid over the purlin and connected with it.						

4.3. Annexure 3: Checklist for Electrical Works

4.3.1. Basement/Plinth level:

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Location of DB and MCPB identified.						
2.	Separate conduits for incoming cables and utility services laid						

3.	Conduit for earthing laid.						
4.	Conduit for compound lighting laid (if applicable)						
5.	Provided for surface conduiting						
6.	Conduits for lighting, power and utilities laid as per the drawing						
7.	Conduit pipes firmly placed in RCC works						
8.	Positions of the lighting, power, switches and utility points are marked and placed as per the drawing						
9.	Number of lighting, power, switches and utility points are noted						
10.	Provide surface conduit for false ceiling						
11.	Trunking and cable trays are laid as per the electrical drawing						

4.3.2. Ground floor and above:

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Location for the distribution board marked						
2.	Conduits for lighting, power and utilities laid as per the drawing						
3.	Firmly placed conduit pipes laid in RCC works						
4.	Positions of the lighting, power, switches and utility points are marked and placed as per the drawing						
5.	Number of lighting, power, switches and utility points are noted						
6.	Surface conduit for false ceiling provided						
7.	Trunking and cable trays are laid as per the electrical drawing						

4.3.3. Staircase:

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Laid conduit for stair case lightings						
2.	Positions of the lighting, power, switches and utility points marked and placed as per the drawing						

4.3.4. Walls:

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Located the DB positions and for concealed DB from the SDB detail layout plan and cut the walls as per the size of the DB						
2.	Positions of wall fittings, switches and sockets are marked						
3.	Conduit routes marked and cut according to the drawing						
4.	Number of wall fittings, switches and sockets noted and recorded.						
5.	Metallic boxes for the switches and sockets and circular boxes for the light points fixed as per the drawing						
6.	Embedded HDPE pipes in the wall and secured it by binding wire tied on the nail to hold it till the plaster sets to its strength						
7.	For surface type, HDPE pipe/PVC casing and capping fixed on the wall using proper saddles						

4.3.5. Roof:

Sl. No	Details	Check		Name and signature	Verified by	Date	Remarks
		Yes	No				

				of Engineer			
1.	Conduits for aesthetic lightings are laid as per the lighting conduit layout plan						
2.	Lighting arresters are provided						

4.3.6. Wiring:

Sl. No	**Details**	**Check**		**Name and signature of Engineer**	**Verified by**	**Date**	**Remarks**
		Yes	**No**				
1.	Wires of specified sizes for lighting points and power points drawn						
2.	Laid wires of specified sizes for utilities like TV, Telephone and LAN with sufficient gap between the conduits						

4.3.7. Earthing wire:

Sl. No	**Details**	**Check**		**Name and signature of Engineer**	**Verified by**	**Date**	**Remarks**
		Yes	**No**				
1.	The earth continuity wire of required sizes drawn						
2.	All metallic parts, switchboards, light fittings and third pin of power sockets connected to earth wires						
3.	Checked the connection to make sure that they are electrically and mechanically sound						
4.	Distinctly marked the neutral						

4.3.8. Fittings:

Sl. No	**Details**	**Check**		**Name and signature of Engineer**	**Verified by**	**Date**	**Remarks**
		Yes	**No**				

1.	The electrical fixtures, sockets and switches fixed as per the electrical conduit layout plan						
2.	Telephone, TV sockets and plates fixed as per the drawing.						

4.3.9. Control gears:

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	All the metal switchgears and switchboards painted with coat of antirust primer						
2.	Fixed all metal switchgears and switchboards						
3.	Installed busbar as per the specification provided						
4.	Installed MCB, RCCB, MCCB and DB of proper ratings as per the details provided.						

4.3.10. Incoming cable:

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Electrical trench route marked and dug for power cable laying from BPC Distribution Box to MCPB						
2.	The incoming cables laid as recommended by BPC and by directly burying in the trench						
3.	Kept approximately 0.5 m of excess cable for maintenance purpose at both the incoming and terminating ends						

4.3.11. Earthing:

Sl. No	Details	Check		Name and signature	Verified by	Date	Remarks
		Yes	No				

				of Engineer			
1.	Location for Earthing pit marked						
2.	Earth wire from the Earthing plate till MCPB laid in PVC conduit as per the approved drawing						
3.	Earthing tested and required resistance achieved						

4.3.12. Lightening Arrester:

Sl. No	**Details**	**Check**		**Name and signature of Engineer**	**Verified by**	**Date**	**Remarks**
		Yes	**No**				
1.	Location of Earthing pit for Ligtening Arrester marked.						
2.	Installed lightening spikes at roof top of the building						
3.	Drew strip type copper conductor from Lightening Arrester to the Earthing pit.						

4.3.13. Finishing:

Sl. No	**Details**	**Check**		**Name and signature of Engineer**	**Verified by**	**Date**	**Remarks**
		Yes	**No**				
1.	Plastered and painted the finished wall						
2.	Alignment of switches and sockets plates done						
3.	Buried all electrical conduit from the DB to the area where the meter will be installed (MCPB).						

4.3.14. Testing and commissioning:

Sl. No	**Details**	**Check**		**Name and signature of Engineer**	**Verified by**	**Date**	**Remarks**
		Yes	**No**				

1.	Conducted insulation resistance test between earth and conductor						
2.	Conducted insulation resistance test between conductors						
3.	Conducted polarity test of switch						
4.	Conducted continuity test						
5.	Conducted Earth path continuity test						

4.3.15. Safety Procedure

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Location of distribution board and main control panel cleaned and kept away from inflammable materials						
2.	Insulation provided in front of main switchboard						
3.	Danger plate has placed on the MCPB						

4.3.16. Compound lighting

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Feeder pillar position marked and installed as per the specification provided						
2.	Trenches for compound lighting marked and dug for conduit layout						
3.	Conduit for compound lighting laid as per the drawing						
4.	Compound lighting poles fixed as per the drawing						
5.	Wiring for compound lighting done as per the drawing.						
6.	Individual poles earthed						

4.4. Annexure 4: Checklist for Plumbing and Sewer Works

4.4.1. General Plumbing and sewer

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Location of the water tank and position of water meter identified at the site						
2.	Plumbing layout carried out as per the approved plumbing drawing						
3.	Identified various appliances to be in a particular room provided and determined their placement						
4.	Marked the layout of pipelines on the wall and floors						
5.	Cross checked the layout of pipelines						
6.	Installed all waterlines						
7.	Determined the drain lines and marked it on the floors and walls						
8.	Placed the drain lines and traps for each fixture and connected it with the main drain						
9.	Installed all appliances and leveled it						
10.	Carried out other finishing work						

4.4.2. Testing and commissioning

Sl. No	Details	Check		Name and signature of Engineer	Verified by	Date	Remarks
		Yes	No				
1.	Carried out air test for pipe system other than plastic						
2.	Carried out gravity sewer tests for sewer system						
3.	Carried out smoke test for traps						

Appendix A- References

1. Building code of Bhutan 2003
2. Bhutan building rules 2002
3. Construction quality series (Manual No. 2- Guidelines for site supervisor)
4. Bhutanese Architectural Guideline
5. IS 456:2000 Plain and Reinforced Concrete
6. SP 62(S&T):1997 Hand book on Building Construction Practices
7. IS 7969:1975 Safety Code for Handling and Storage of material
8. IS 4082:1996 Stacking and Storage of Construction Materials and Components at site-Recommendations
9. IS 1608:2005 Metallic Materials - Tensile testing at ambient temperature
10. IS 1599:1974 Method for Bend test
11. IS 1077:1992 Common burnt clay building bricks - Specification
12. IS 3495(1-4):1992 Methods of tests of burnt clay building bricks
13. IS 11215:1991 Moisture content of timber and timber products - Methods for determination
14. IS 287:1893 Permissible moisture content for timber used for different purposes Recommendations
15. IS 2386:1963 Method of test for Aggregates for Concrete
16. IS 9103:1999 Concrete Admixtures - Specification
17. Bhutan Schedule of Rates (Specifications for building and road works)
18. IS 3764:1992 Excavation Work - Code of Safety
19. IS 3414:1968 Code of practice for design and installation of joints in buildings
20. IS 5256: 1992 Sealing expansion joints in concrete linings of canal- Code of practice
21. IS 1838:2011(Part 3) Preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type) — specification
22. IS 13920:1993 Ductile Detailing of Reinforced Concrete Structure subjected to Seismic forces
23. IS 2502:1963 Code of practice for bending and fixing of bars for concrete reinforcement
24. IS 4990:2011 Plywood for concrete shuttering works — Specification
25. IS 4923:2003
26. IS 7861(Part1):1975 Code of practice for extreme weather concreting Part I Recommended practice for hot weather concreting
27. IS 7861(Part2):1975 Code of practice for extreme weather concreting Part II Recommended practice for cold weather concreting
28. IS 10262:2009 Concrete Mix Proportioning - Guidelines
29. SP 23(S&T):1982
30. IS 2505:1992 Concrete vibrators-Immersion type- General requirements
31. IS 2506:1985 General requirements for concrete vibrators, screed board type
32. IS 2514:1963 Specification for concrete vibrating tables
33. IS 18652:2005 building construction machinery and equipment - external vibrators for concrete
34. IS 1129:1972 Recommendation of dressing of natural building stones
35. IS 1597(Part1):1992 Construction of stonemasonry -Code of practice Part 1- Rubble stone masonry
36. IS 14687:1992 False work for concrete structures - Guidelines
37. IS 3067:1988 Code of practice for general design / details and preparatory work for damp-proofing and water-proofing of buildings
38. IS 15259:2002 Installation and Maintenance of home lifts — Code of practice
39. IS 15785:2007 Installation and Maintenance of lift without conventional machine rooms - Code of practice
40. IS 7198:1974 Code of practice for damp-proofing using bitumen mastic

41. IS 3962(Part 1):1987
42. IS 4014(Part 1:1967) Code of Practice for steel tubular scaffolding Part I Definitions and materials
43. IS 4014(Part 2: 1967) Code of Practice for steel tubular scaffolding Part II Safety regulations for scaffolding
44. IS 277: 2003 Galvanized steel sheets (plain and corrugated)-Specification
45. IS 2441:1984 Code of practice for fixing ceiling coverings
46. IS 1661:1972 Code of practice for application of cement and cement-lime plaster finishes
47. IS 2395(Part 1):1994 Painting of concrete, masonry and plaster surfaces-Code of practice Part 1 Operations and Workmanship
48. IS 2395(Part 2):1994 Painting of concrete, masonry and plaster surfaces- Code of practice Part 2 Schedules
49. IS 875:1987 Code of Practice for Design Loads for Buildings and structures
50. IS 1893:1984 Criteria for Earthquake Resistant Design of Structures
51. IS 2250-1981 Code of practice for preparation of Masonry mortar
52. IS 14667:1999 False work for concrete structures-Guidelines
53. IS: 7320 -1974 Specification for concrete slump test apparatus
54. Bhutan Schedule of Rates- Specification for Electrification work
55. IS 2064:1993 Selection, installation and maintenance of sanitary appliances-Code of practice

Appendix B

Technical team composition:

Technical core group for Architectural and Civil Work

1. Mr. Phub Rinzin, Chief Engineer
2. Mr. Dechen Norbu, Executive Engineer
3. Mr. Tshering Wangchuk, Executive Engineer
4. Mr. Choki Tashi, Executive Engineer
5. Mr. Tandin Dorji, Senior Architect
6. Mr. Tshering Norbu, Senior Architect
7. Mr. Tempa Gyeltshen, Senior Architect
8. Ms. Tshering Pelden, Engineer

Technical core group for Electrical Work

1. Mr. Namgyel Wangchuk, Dy. Executive Engineer
2. Mrs. Dechen Dema, Engineer

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