UNIT 2 SUPERSTRUCTURE

Structure

2.1 INTRODUCTION

Superstructure of a building consists of the walls and framing above the foundations. The structural elements which transmit the loads of the building to the foundation can consist of load bearing walls or framed construction with infill (non-load bearing) walls. Structural framework can be either of steel or reinforced cement concrete (RCC) construction.

In this unit, we shall deal with walls, materials used for their construction and other relevant details.

Objectives

After studying this unit, you should be able to

- differentiate between various types of walls,
- familiarize yourself with the materials used in such a superstructure,
- explain various classifications and constructional details of brick, stone and block masonry,
- describe various types and constructional features of partitions walls, retaining walls, cavity wall and piers, and
- explain the importance of workmanship and quality assurance in masonry construction.

2.2 WALLS

Let us first try to analyse the various functions served by walls in a building.

(a) Walls support loads of upper floors and roof (in case of load bearing walls).

(b) Exterior wall of a building has to give protection against natural elements like sun, wind, rain, snow etc.

(c) Ground floor wall has to resist dampness also.

(d) They provide enclosure for ensuring security and privacy.

(e) Walls provide support for doors and windows.

(f) Walls provide thermal insulation.

(g) Walls provide sound insulation.

(h) Walls offer adequate resistance to fire.

(i) Walls serve as a base for suitable aesthetic treatment.

Walls can be constructed in various ways using a variety of building materials. The common materials used for construction of walls are as follows :

(a) bricks,

(b) stones, and

(c) various type of blocks.

The details of materials and construction practices of walls built from these materials are described in subsequent sections.

2.2.1 Partition Wall

The space inside a building has to be subdivided into rooms to serve different functions. This is carried out by partition walls. It ensures privacy, and may also provide insulation against heat and sound. Openings with door leaves are provided in these partitions for giving access. The partitions can be permanent or sometimes, as in offices, it may be desirable to have a system of internal divisions, which can be shifted to suit the possible changes in the use pattern of the spaces. They could be folding or sliding type also. They normally extend from the floor to the ceiling, but in some offices low partitions are used to afford a limited degree of privacy. They could be solid, hollow or louvered. Partitions can be opaque, transparent or translucent. Internal load bearing walls also serve the purpose of partitions. Non-load bearing partitions can be constructed from a wide variety of materials. The choice would depend on a number of factors such as thickness, weight, sound insulation, cost, ease of construction, necessity to shift, decorative treatment and fire resistance. For support of non-load bearing partitions, like for half brick masonry, there should be adequate structural arrangement.

Types of Non-load Bearing Partitions

Partitions can be divided broadly into two categories :

(a) Made from blocks and slabs laid in suitable mortar.

(b) Made of boards, sheets etc.

Under the first category fall partitions made from bricks, cement concrete blocks, burnt clay blocks, gypsum blocks etc. These are normally self-supporting if confined within permissible spans and heights. The latter category consists of several types of construction made of wooden panels, plywood, gypsum board, lath and plaster, hard and soft fibre boards, metal sheets etc. These partitions are framed with timber, metal or concrete frames, the sheets being fixed to one or both sides by means of screws, nails, clamps or other means. Alternatively, these partitions can be of build-up construction type fabricated in factories.

Brick Partition

These are constructed to half brick thickness by laying the bricks as stretcher. The mortar can be of lime or cement. Generally, the mortar used is sand cement mortar of 1 : 3 or 1 : 4 mix. The walls are plastered on both sides. For added strength, reinforcement can be provided as indicated in the section on reinforced brickwork. This type of partition is extensively used in buildings and is easy to construct along with the brickwork in the rest of the building. It has a good sound insulation and fire resistance properties. The earlier practice of providing timber frames called nogging and constructing the brickwork within is now not popular.

Block Partitions

This can be built from the various types of blocks, described later in this unit, in suitable mortar and is generally 10 cm wide. The distance between supports for these partitions in the vertical or horizontal direction whichever is smaller should not be more than 48 times the thickness of the blocks. If required, reinforcement, as in reinforced brickwork, can be provided and both sides plastered. Hollow burnt clay blocks can also be used for partitions. They are comparatively lighter being only about 40 to 50% the weight of a solid brick wall of same thickness and provide good sound insulation. Other materials like gypsum block, wood wool slabs etc. are also used. Glass blocks can be used where light is required to come in. Glass blocks of various sizes and shapes are available. Generally, they are hollow. It has to be ensured that no other load than self-weight comes on these partitions. The blocks can be laid in cement lime mortar (1 : 1 : 4). If blocks are larger than 30 cm, the joints are reinforced with hoop iron or expanded metal strips. It has an attractive appearance, can be easily cleaned and has good sound insulation properties.

Partitions of Sheeted Materials

The conventional timber partitions known as *stud partitions* are constructed of 100 × 75 mm heads and sills with vertical members or studs of 75 × 38 mm or 100 × 50 mm framed at about 400 mm centres (Figure 2.1). Horizontal timber members known as noggings of size 100 × 38 mm. Timber boards are nailed on both sides of the frame and painted or polished stiffen the studs.

Other sheets like gypsum plasterboard, fibre building board, plywood, particle board, blocks board, AC sheet, GI sheet etc., can also be used with a timber frame. The details of spacing of supports and the spacing of nails for some of the commonly used sheets are given in Table 2.1.

Table 2.1 : Spacing for Support and Fixing of Rigid Wall Board

Sl. No.	Type of Board	Thickness (mm)	Spacing of Supports (mm)	Nail Spacing c/c (mm)		Min. Edge Clearance of Nails (mm)
				At Edges	At Supports	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Gypsum Board	9.5 12.5 15	400 500 600	100 to 150	100 to 150	10
2.	Fire Building Board, Particle Board etc.	10 12 20	400 500 600	75	150 to 200	10
3.	Plywood, Block Board etc.	6.9 12 16	400 500 600	150	300	10
4.	Asbestos Board	6	400	150 to 200	150 to 200	

Note :

(a) Nails with shank diameter 2, 2.34 or 2.50 mm are commonly used.

(b) Joint thickness shall be of 6 mm. All vertical joints shall be staggered, particularly when both sides of the wall are covered.

All portions of timber built into or against masonry or concrete shall be given two coats of boiling coal tar. All wood work shall be painted with approved wood primer.

The framework for fixing the sheets can also be of light steel sections.

Partitions with sheets are light in weight and hence, can be put up directly over slabs. They are easy to install and can be dismantled without any difficulty.

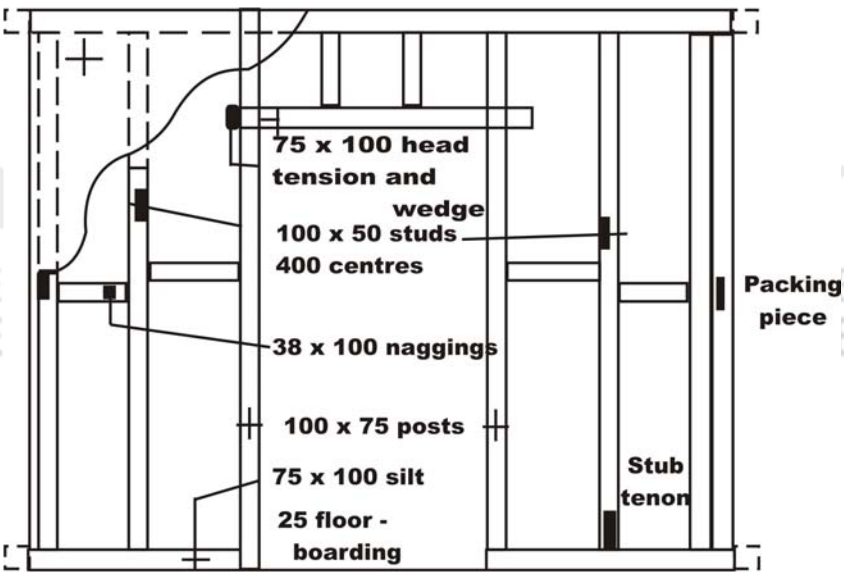

Figure 2.1: Timber Partitions (All Dimensions are in mm)

SAQ 1

Explain in detail how you would proceed with the construction of plywood partitions in an office building?

2.2.2 Retaining Wall

Retaining walls are structures which helps in maintaining the surface of the ground at different elevations on either side of the structure. If the retaining wall was not there, the soil at higher elevation would tend to move down till it acquires its natural, stable configuration.

Consequently the soil that is now retained at a steeper slope than it can sustain by virtue of its shear strength exerts a force on the retaining wall. The different types of retaining walls are as follow :

(a) Gravity walls

(b) Cantilever walls

(c) Counterfort walls

(d) Buttress walls

(e) Crib walls

(f) Gabion wall

(g) Sheet pile walls

(h) Anchored earth walls

(i) Diaphragm walls

(j) Reinforced earth walls

A brief description of each wall is given in below.

Gravity Walls

This wall depends on its self-weight for its stability. It is designed so that the overturning effect of the lateral earth pressure does not induce tensile stresses within the section. This is used for walls of low height and is not economical for large heights. Gravity walls have been built of stone, bricks, mass concrete and precast concrete blocks.

The cross section of the wall is trapezoidal with a base width between 0.3 and 0.5 H, where H is the height of the wall. The top width varies from 0.2 to 0.3 m. For concrete, a top width of 0.3 m is recommended for proper placement of concrete.

Cantilever Walls

Reinforced concrete cantilever retaining walls are suitable for heights up to 7 m. It has a vertical stem monolithic with the base. The slender sections are possible as the tensile stresses within the stem and the base are resisted by steel reinforcement. If the face of the wall is to be exposed a small backward batter of about 1 in 50 is provided in order to compensate for any forward tilting of the wall as shown in Figure 2.2.

Figure 2.2 : Cantilever Wall

Counterfort Wall

These walls are used for heights greater than about 6.0 m. Its wall stem acts as a slab spanning between the counterfort supports. The spacing between supports is about 2/3 H but should not be less than 2.5 m. Details of the walls are given in Figure 2.3.

Figure 2.3 : Counterfort Wall

Buttress Walls

A form of counterfort wall is the buttressed wall where the counterforts are built on the face of the wall and not within the backfill. These walls are not very popular because of the exposed buttressed which consume space and spoil the appearance.

Crib Wall

The crib wall is shown in Figure 2.4. It consists of a series of boxes made from timber, precast concrete or steel members, which are filled with granular soils. It acts as a gravity wall with the advantage of quick erection.

Figure 2.4 : Crib Wall

It can also withstand relatively large displacements due to its flexible nature. It is usually fitted so that its face has a batter of 1 in 6. The width of the wall varies from 0.5 to 1.0 H and is suitable for walls up to a height of

about
7.0 m. Note that the crib wall should not be subjected to surcharge loadings.

Gabion Wall

A gabion wall is built of rectangular metal cages or baskets. They are made from a square grid of steel fabric, generally 5 mm in diameter and spaced 75 mm apart. These baskets are usually 2 m long and 1 m in cross section. A central diaphragm fitted in each metal basket divides it into two equal 1 m × 1 m sections and adds stability. During construction the stone filled baskets are secured together with steel wire of 2.5 mm diameter. The base of the gabion wall is about 0.5 H. A typical wall is illustrated in Figure 2.5. A front face batter can be provided by slightly stepping back each succeeding layer.

Figure 2.5 : Gabion Wall

Sheet Pile Walls

These walls are made up from a series of interlocking piles individually driven into the foundation soil. Most modern sheet pile walls are made of steel. Sometimes timber or precast concrete sections are also used.

Cantilever sheet pile walls are held in the ground by the active and passive pressures that act on its lower part (Figure 2.6).

Figure 2.6 : Sheet Pile Wall

Anchored Earth Walls

Anchored sheet piles walls are fixed at the base and are supported by a row or two rows of ties or struts placed near its top.

Diaphragm Walls

A diaphragm wall can be classified either as a reinforced concrete wall or sheet pile wall. It consists of a vertical concrete reinforced concrete slab fixed in position. It is held in position by the passive and active pressures acting on its lower portion.

A diaphragm wall is constructed by a machine digging a trench in panels of limited length filled with the bentonite slurry as the digging proceeds to the required depth. In clays there is no penetration of bentonite slurry into the soil. But in sands and silts, bentonite slurry initially penetrates into the soil and creates a virtually impervious skin of bentonite particles, only a few mm thick, on the sides of the trench. The lateral pressure created by slurry acts on the sides of the short trench panel and prevents its collapse. The required steel reinforcement is lowered into position when excavation is complete. The trench is then filled with concrete by means of a tremie pipe, the displaced slurry being collected for cleaning and further use.

A wall is constructed in alternating short panel lengths. When the concrete has developed sufficient strength, the remaining intermediate panels are excavated and constructed to complete the walls. The various construction stages are shown in Figure 2.7.

(a) **(b)** **(c)** **(d)**

Figure 2.7 : Diaphragm Wall; (a) Trench Dug, (b) Reinforcement Insert, (c) Concrete Displaces Bentonite and (d) Soil Excavated in Front of Wall

Reinforced Earth Walls

The use of reinforcement to strengthen the soil has been known for centuries. Straw has been used to strengthen unburnt bricks and fascine mattresses have been used to strengthen soft soil deposits prior to road construction. The principle of reinforced earth is that a mass of soil can be given tensile strength in a specific direction if lengths of a material capable of carrying tension are embedded within it in the required direction. A rational approach to the design of reinforced earth was presented by Vidal in 1966. Reinforced earth has been used in many geotechnical applications. Here, we are only concerned with retaining structures.

A reinforced earth wall is a gravity structure. A simple form of such a wall is illustrated in Figure 2.8. The components listed are described below :

Figure 2.8 : Reinforced Earth Walls

The soil fill should be granular and free draining. The reinforcing elements can be either metal strips or geosynthetics. This metallic strips, 50-100 mm wide and 3 to 5 mm thick, are generally used. Metal grids have also been employed in some cases. Galvanised steel strips are the most common reinforcement. Aluminium alloy, copper and stainless steel are the other metals used. All these materials have a high modulus of elasticity and negligible strains are created within the soil mass.

There have been increasing use of geosynthetics as reinforcement in reinforced earth from 1975. Woven geotextiles and geogrids have the advantage of greater durability than metals in corrosive soil. Their tensile strength can approach that of steel. Geogrids can achieve high frictional properties between itself and the surrounding soil. However, all the geosynthetics undergo creep deformation under sustained loading which can lead to large strains within the soil mass.

At the boundary of reinforced earth structure it is necessary to provide a facing so that fill is contained. The facing does not contribute to the structural strength of the wall. The facing is usually built up from prefabricated units small and light enough to be handled by manual labour. The most common facing material is precast concrete though steel, aluminium and plastic units have been used. A concrete foundation is required to form a platform from which facing units can be built up.

Reinforced earth can provide a satisfactory method for retaining soil when existing conditions do not allow construction by conventional methods. A compressible soil may be capable of supporting a reinforced earth structure while pile foundation may be required in the case of gravity or cantilever walls. The technique can also be used when there is insufficient land space to construct the sloping side of an earthen embankment.

Please note that in developed countries reinforced earth is often the first choice for design engineers when considering an earth retaining structure.

2.2.3 Cavity Wall

A cavity wall consists of two walls with a cavity of 5 to 8 cm between them. The outer wall consists of a 100 mm thick wall and the inner wall is sufficiently thick and strong to carry the imposed loads safely. The minimum thickness of the inner wall is restricted to 100 mm.

A cavity wall have the following advantages :

(a) The provision of a continuous cavity in the wall efficiently prevents the transmission of dampness to the inner wall.

(b) Cavity walls have good sound insulation property.

(c) Construction of cavity walls are economical.

(d) There is no possibility of the moisture travelling from the outer leaf to the inner leaf because there is no intimate contact between the two leaves except at the wall ties.

(e) Cavity walls have 25% greater insulating value than solid walls.

(f) Cavity walls are best suitable for a tropical country like India.

The following points should be kept in mind during construction of a cavity wall :

(a) The contact between the inner and outer wall should be avoided.

(b) During construction, necessary precautions are required to be taken so that no mortar or any other thing should get accumulated in the cavity.

(c) The horizontal damp proof course should be built in two separate widths under each leaf of the wall and divided by cavity.

(d) The cavity should be free from any projections.

(e) The heads of openings should be carefully attended for damp prevention whenever doors and windows are provided in the wall.

(f) Ties should be able to prevent transmission of water from inner face to the outer face and it must be of rust proof material.

2.2.4 Piers

It is a vertical member generally constructed of stone or brick masonry to support an arch, beam or lintel etc., the width of which exceeds four times its thickness. The piers are made monolithic with the wall for the purpose of increasing the stability and stiffness of the wall to carry more concentrated loads.

Brick piers are generally built in either English Bond or Double Flemish Bond. The main function of brick piers attached to main walls is to provide a large bearing area for giving support to the roof. It also helps in increasing the stability of the wall by stiffening it at intermediate points along the length of the wall.

2.3 DEFINITION OF THE TERMS

Header

It is a full brick or stone, which is laid with its length perpendicular to the face of the wall. This denotes the end of a brick as seen in the wall face measuring 9 cm.

Stretcher

It is a full brick or stone, which is laid with its length parallel to the face of the wall. The side of a brick have seen in elevation in a wall, where the brick is laid flat measuring 19 cm × 9 cm.

Bed

It is the lower surface of the brick on which it rests.

Courses

A complete layer of bricks laid on the same bed is termed as course.

Header Course

It consists of only headers as seen in elevation.

Stretcher Course

It consists of only stretchers as seen in elevation.

Face

The surface of a wall exposed to weather is termed as face.

Joint

The junction of two or more bricks or stones is known as joint.

Bed Joints

Horizontal mortar joints between the two courses of bricks or stones are termed as bed joints.

Cross Joints

The joints which are perpendicular to the face of wall are termed as cross joints.

Closer

It is a portion of a brick cut longitudinally in such a way that its one long face remains uncut.

Frog

It is a depression on the top face of a brick provided to form a key for holding the mortar.

Quoin

The brick or wedge shaped stone used for the corner of walls is known as quoin.

Cornice

It is a projecting ornamental course near the top of a building or at junction of a wall and ceiling.

Throating

These are grooves cut on the under surfaces of a projecting course of masonry to prevent the water from trickling down the walls.

Templates

These are blocks of stone or concrete placed under the end of a beam or girder to distribute the load over a greater area.

2.4 BRICK MASONRY

Bricks are still one of the most popular materials for construction of walls on account of its ready availability, ease of handling and construction, and economy.

2.4.1 Bricks

Bricks are made from ordinary clay, moulded and burnt in kilns. They can be hand moulded or machine pressed or extruded and wire cut. They should be well burnt, of uniform colour, free from cracks and nodules of free lime. They have, generally, a depression on one flat face, known as a *frog*, which enables better keying of the mortar joint. Bricks are available in the traditional nominal dimensions of 22.9 × 11.4 × 7.5 cm (actual 22.5 cm × 11.1 cm × 7 cm) or modular nominal sizes of 20 cm × 10 cm × 10 cm (actual 19 cm × 9 cm × 9 cm).

The traditional brick sizes vary in different parts of the country with length from 21 to 25 cm, width 10 to 13 cm and height 7 to 7.5 cm. With a view to achieve uniformity of size throughout the country, the Bureau of Indian Standards standardized the modular size of bricks.

BIS Classification of Bricks

The BIS has classified the bricks into HI, HII, FI, FII, I, II, LI and LII categories, primarily according to the compressive strength. Table 2.2 gives the BIS classification of bricks.

Table 2.2 : BIS Classification of Bricks

Class of Bricks	Minimum Compressive Strength (kg/cm^2)	Minimum Absorption in 24 Hours in Percent of Dry Weight	Efflorescence	Tolerance in Dimension in Percent	Shape and Other Properties
HI	440	5	No	± 3	Metallic sound, smooth, rectangular
HII	440	5	No	± 8	Slight deformation in shape permitted.
FI	175	12	Very little	± 3	Smooth, rectangular, metallic sound when two bricks strike.
FII	175	12	Very little	± 8	Slight deformation in shape permitted
I	70	20	Very little	± 3	Smooth, rectangular, metallic sound when two bricks strike.
II	70	20	Very little	± 8	Slight deformation in shape permitted
LI	35	25	Very little	± 3	Rectangular, sharp edge, metallic sound on striking need not be present
LII	35	25	Little	± 8	Slight deformation in shape allowed.

In general bricks may be classified into five categories

(a) First class bricks

(b) Second Class bricks

(c) Third Class bricks

(d) Over burnt or Jhama bricks

(e) Under burnt or killa bricks

[**Note :** You may go through study material of Engineering Materials BET-015 for detailed information of above classification.]

Certain tests are necessary to be conducted for judging the quality of a brick lot. These tests are :

(a) Water absorption test

(b) Test for presence of soluble salts

(c) Crushing strength test

(d) Hardness test

(e) Shape and size test

(f) Soundness test

Water Absorption Test

There are two tests to determine the water absorption. These are

(a) 24-hour immersion cold water test, and

(b) 5-hour boiling water test.

24-Hour Immersion Cold Water Test

Dry specimen is put in an oven maintained at a temperature of 105 to 115°C, till it attains substantially constant mass. Weight of specimen (W_1) is recorded after cooling it to room temperature. The dry specimen is then immersed completely in water at a temperature of 27 ± 2°C for 24 hours. Take the specimen out of water and wipe out all traces of water with damp cloth. Complete weighing of the specimen 3 minutes after the specimen has been removed from water. Let this weight be (W_2).

Water absorption percent by mass, after 24 hours immersion in cold water is given by

$$\frac{W_2 - W_1}{W_1} \times 100$$

5-Hour Boiling Water Test

The specimen is dried in an oven at 105 to 115°C till it attains constant mass. Cool the specimen at room temperature and record its weight (W_1). The brick is immersed in boiling water for 5 hours. The water is allowed to cool at 27 ± 2°C with brick immersed. The brick is taken out and wiped with damp cloth. Complete the weighing of the specimen in three minutes. Let it be W_3.

Water absorption, percent by mass, is given by

$$\frac{W_3 - W_1}{W_1} \times 100$$

Test for Presence of Soluble Salts

Soluble salts if present in the brick cause efflorescence. Presence of such salts can be determined as follows :

Place on the ends the bricks in 25 mm depth of water in a dish of minimum diameter 150 mm and depth 30 mm. The dish is made of glass, porcelain or of glazed stone work. The experiment is performed in a well-ventilated room between "20 to 30°C" till all the water in the dish is either absorbed by the specimen or is evaporated. After the specimens have dried add similar quantity of water to the dish and let it too be absorbed by the specimen for efflorescence after the second evaporation. Presence of efflorescence shall be classified as nil, slight, moderate, heavy or serious as defined below :

Nil

When the deposit of efflorescence is imperceptible.

Slight

When the deposit of efflorescence does not cover more than 10% of the exposed area of the brick.

Moderate

When the deposit of efflorescence is heavier than slight and does not cover more than 50 percent of the exposed area of the brick surface. The deposit should not, however, powder or flake of the surface.

Heavy

When the deposit of efflorescence salts is heavy and covers 50 percent or more of the exposed area of brick surface. The deposit, however, does not powder or flake of the surface.

Serious

When the deposit of efflorescence salts is heavy and is accompanied by powdering and/or flaking of the exposed surfaces.

Crushing Strength Test

In this test well-burnt bricks areas elected. Grind the two bed faces to provide smooth, even and parallel faces. Immerse the specimen in water at room temperature. Fill up flush the frog and all voids with cement mortar (1 part cement and 1 part clean coarse sand of grade 3 mm and down), store under damp jute bags for 24 hours and then immerse in clean water for 3 days. Remove and wipe out any traces of moisture.

Place the specimen between two plywood sheets; each 3 mm thick, with flat faces horizontal and mortar filled face facing upwards. The specimen sand wiched between the ply sheets are carefully centred between plates of compression testing machine. Apply axial load at a uniform rate of 140 kg/cm^2 per minute till failure. The maximum load at failure divided by the average area of the bed faces gives the compressive strength.

Hardness Test

Hardness of the bricks can be estimated with the help of the scratch of the fingernail. If no nail scratch is left on the brick, it is considered to be having sufficient hardness.

Shape and Size Test

All the faces of the brick should be truly rectangular and size truly standard as specified by Indian Standards. All the edges should be sharp and right-angled.

Soundness Test

Soundness of the bricks is estimated by striking two bricks against each other. They should emit ringing sound. Soundness of the brick is also tested by the fall of the brick. A good sound brick should not break, when made to fall flat on hard ground from a height of about 1 m.

2.4.2 Mortars

There are many types of mortars used in brickwork. The type and mix of mortar has to be decided taking into account the strength required, and, the availability of materials and skilled labour etc. In general, the strength of the mortar shall not be greater than that of the masonry unit.

2.4.3 Materials

Water

Water used shall be clean and reasonably free from deleterious materials like oils, acids, alkalies, salts etc. Potable water is generally considered satisfactory. Water should be tested for the following characteristics :

Limits of Acidity

To neutralise 200 ml sample of water, it should not require more than 2 ml of 0.1 normal caustic soda solutions.

Limits of Alkalinity

To neutralise 200 ml sample of water, it should not require more than 10 ml of 0.1 normal hydrochloric acid.

Percentage of Solids

It shall not exceed the following limits for various solids :

Organic	200 mg/l
Inorganic	3000 mg/l
Sulphates	500 mg/l
Chlorides	2000 mg/l
Suspended matter	2000 mg/l

The pH Value

The pH value of water shall generally be not less than 6.

Cement

Cement shall conform to any one of the following specifications :

33 grade ordinary portland cement, IS : 269 – 1989

43 grade ordinary portland cement, IS : 8112 – 1989

53 grade ordinary portland cement, IS : 1269 – 1987

Rapid hardening portland cement, IS : 8041 – 1990

Low heat portland cement, IS : 12600 – 1989

Portland Pozzolana cement, IS : 1489 – 1991

Portland slag cement, IS : 455 – 1989

Lime

Lime shall conform to standards given in IS: 712 – 1984.

Building lime shall be classified as follows :

Class A – Eminently hydraulic lime used for structural purposes.

Class B – Semi-hydraulic lime for masonry.

Class C – Fat lime used for finishing purposes; it can be used for masonry mortar with addition of pozzolanic material.

Class D – Magnesium lime used for finishing coat.

Class E – Kankar lime used for mortar.

Carbide lime obtained as a byproduct in the manufacture of acetyline meets the requirement of class C lime and can be used for mortar.

Fine Aggregate

This consists of natural pit or river sand, or crushed stone, most of which passes through IS Sieve 4.75 mm. It shall not contain harmful organic impurities in such form or quantities (5%) to affect the strength of the mortar. Sand is generally classified as fine or coarse.

Fine Sand

This shall be river sand and the grading shall be within the limits of grading Zone IV of Table 2.3.

Table 2.3 : Grading of Fine Aggregate

IS Sieve Designation	Percentage Passing Grading				
	Zone I	Zone II	Zone III	Zone IV	Zone V
10 mm	100	100	100	100	-
4.75 mm	90-100	90-100	90-100	95-100	-
2.36 mm	60-95	75-100	85-100	95-100	100
1.18 mm	30-70	55-90	75-100	90-100	100
600 μ	15-34	35-59	35-60	80-100	85-100
300 μ	5-20	8-30	8-30	20-65	65-95
150 μ	0-10	0-10	0-10	0-15	0-60

Stone Dust

This shall be obtained by crushing hard stones and the grading shall be within the limit for Zone III of Table 2.3.

Coarse Sand

This shall be either river sand or pit sand and shall conform to the grading of Zone III of Table 2.3.

The silt or organic content in fine aggregate should not in any case exceed 8%. Placing a sample of sand in a 200 ml measuring cylinder tests the silt content. The volume of sample will be such that it fills up to the 100 ml mark. Clean water shall be added up to the 150 ml mark. Before adding water, dissolve a little salt (one teaspoon per half liter) in the water. Shake the mixture vigorously. Allow the contents to settle down for three hours. The height of the silt visible as a layer above the sand shall be expressed as a percentage of the height of sand below.

Sand having more than the allowable percentage of silt shall be washed to bring down the silt content within the specified limits.

Cement Mortar

This shall be prepared by mixing cement and sand in the specified proportion for the given work. For load bearing construction coarse sand is used in the mix of the mortar. The proportion of cement and sand in cement mortars varies generally from 1 cement to 3 to 8 of sand, the strength and workability improving with increase in the proportion of cement. Mortars richer than 1 : 3 are not used in masonry because of high shrinkage with no appreciable gain in the strength of the masonry. Mortars leaner than 1 : 6 proportion tend to become harsh and, hence, unworkable.

Lime Mortar

This consists of lime as a binder and sand, surkhi, cinder as fine aggregates, generally in the proportion 1 : 2 or 1 : 3. Lime is slaked and used as lime putty. Hydrated lime available in powder form can also be used. Lime mortar gains strength slowly. The main advantages of lime mortar are its good workability, high water retentivity and low shrinkage.

Cement Lime Mortar

This type of mortar has some of the advantages of both the types of mortars. It has medium strength along with good workability and water retentivity. Commonly adopted proportions are Cement : Lime : Sand of 1 : 1 : 6, 1 : 2 : 9 and 1 : 3 : 12. The mix proportion of binder (cement plus lime) to sand is kept as 1 : 3.

The mix proportion and compressive strength of some of the commonly used mortars are given in Table 2.4.

Table 2.4 : Mix Proportion and Strength of Commonly Used Mortars

Sl. No.	Mix			Min. Compressive Strength (N/mm^2)
	Cement	Lime	Sand	
(1)	(2)	(3)	(4)	(5)
1	1	0-1/4C	3	10
2(a)	1	0	4	7.5
2(b)	1	1/2C	4 .5	6
3(a)	1	0	5	5
3(b)	1	1C	6	3
4(a)	1	0	6	3
4(b)	1	2C	9	2
4(c)	0	1A	2-3	2
5(a)	1	0	8	0.7
5(b)	1	3C	12	0.7
6	0	1B or C	2-3	0.5

Note 1 : A, B, C, denote eminently hydraulic lime, semi-hydraulic lime, and fat lime respectively, as stipulated in IS 712 : 1984.

Note 2 : When using plain cement sand mortars (Sl. No. 2(a), 3(a), 4(a) and 5(a), it is desirable to include a plasticizer in the mix to improve its workability.

Note 3 : For Mortar at Sl. No. 6, if lime C is used, part of sand should be replaced by some pozzolanic material, for example, burnt clay or fly ash, in order to obtain the requisite strength.

Note 4 : Strength of a mortar may vary appreciably, depending on angularity, grading and fineness of sand. Quantity of sand in the mix may, therefore, be varied where found necessary to attain the desired strength.

Preparation of Mortar

For proportioning with cement mortar, the unit of measurement is a cement bag of 50 kg whose volume is taken as 0.35 cu m. While measuring sand, allowance shall be given for bulking (which is the phenomenon of increase in the volume of sand in the presence of moisture). The amount of bulking can be determined by making use of the fact that the volume of inundated sand is the same as that of the dry sand. To find bulking, pour the sand up to the 200 ml mark of a 250 ml measuring cylinder. Then fill the cylinder with water and stir well. It will be seen that the sand surface is now below its original level. Suppose the surface is at the mark – Y ml, the percentage of bulking is $\left[\frac{200-Y}{Y}\right]\times 100$.

Table 2.5 : Relationship Between Moisture Content and Percentage of Bulking for Practical Guidance

Sl. No.	Moisture (%)	Bulking (% by Volume)
1.	2	15
2.	3	20
3.	4	25
4.	5	30

Mixing of mortar shall be preferably done in a mechanical mixer. Cement mortar shall be used within 30 minutes of mixing. Mixing lime putty, sand and surkhi and grinding it either manually or in a mechanical mortar mill generally make lime mortar. As a rule lime mortar shall be used on the same day it is made. For lime cement mortar, lime putty and sand shall be ground in a mill and the required quantity taken out and mixed thoroughly with the specified quantity of cement in a mechanical mixer.

In view of easy availability of cement, convenience in use, uniformity of quality and the difficulty in obtaining lime of good and consistent quality, as well as the cumbersome process of preparation of lime putty etc., the general practice in the country is to use cement mortar in masonry.

2.4.4 Brick Masonry

Construction Practices

Bricks are bedded in and jointed with mortar. The bricks are laid to any specific pattern known as bonds. The primary object of bond is to give maximum strength to the masonry and ensure equitable distribution of load. In bonded walls, the vertical joints of successive layers of brickwork are staggered and the pattern gives an attractive appearance to the wall face.

The various types of bonds used in brick masonry are as shown below.

Table 2.6 : Bonds in Brick Masonry

1.	English Bond	6.	Facing Bond
2.	Flemish Bond	7.	Raking Bond
3.	Stretching Bond	8.	Dutch Bond
4.	Heading Bond	9.	English Across Bond
5.	Garden Wall Bond	10.	Zig-zag Bond

The commonly used bonds are the English bond and the Flemish bond which are described below.

English Bond

The bricks in the facing are laid in alternate courses of headers and stretchers. The header course is commenced with a quoin header followed by a queen closer (which is a half brick cut longitudinally) and continued with successive headers. Stretchers having a minimum lap of one quarter their length over the header form the stretcher courses. Figure 2.9 shows details of the corner of a one brick wall and a one-and-a half brick wall and also a stopped end.

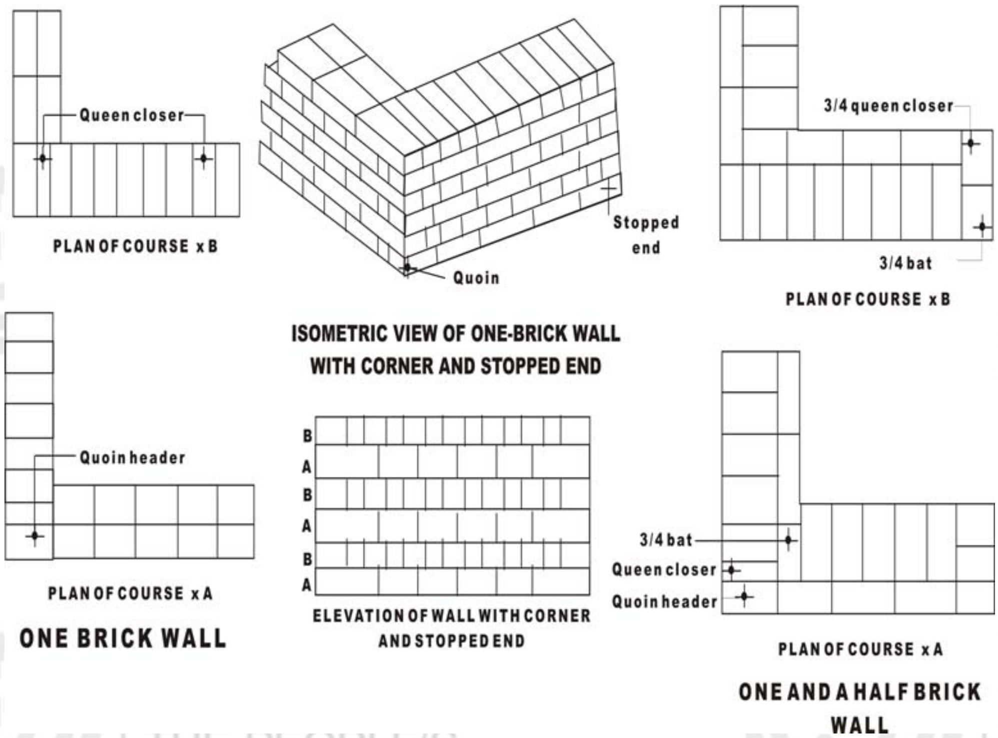

Figure 2.9 : English Bond

Flemish Bond

Bricks are laid as alternate header, and stretchers in the same course, the header in one course being in the center of the stretcher in the course above and below. In this bond, in addition to queen closer, a three-fourth brick bat has to be used. Figure 2.10 gives the details with a stopped end.

The choice of the bond depends on the situation, function, load and thickness of the wall. A Flemish bond gives an attractive appearance while an English bond is stronger. In our country, English bond is used widely for constructing brick masonry.

Construction

Bricks shall be adequately soaked in water before use. Wetting helps in removing dirt, dust and ash from the face of the bricks and in spreading of the mortar more evenly under the brick and also ensures better adhesion. It prevents absorption of water by the bricks from the mortar, which may cause decrease in its strength. The bricks shall be laid in courses according to the specific bond.

Bricks shall be laid on a full bed of mortar. Each brick shall be properly bedded by slightly pressing so that the brick surface is fully in contact with the mortar. All joints shall be properly flushed and packed with mortar so that no hollow spaces are left. Properly filled joints ensure strength of the masonry and resistance to penetration of moisture.

The thickness of joints shall not exceed 1 cm. All the face joints shall be raked to a depth of 15 mm during the progress of work when the mortar is still green to ensure proper keying of plaster or pointing. Where plastering or pointing is not to be done, the joints shall be finished flush at the time of laying.

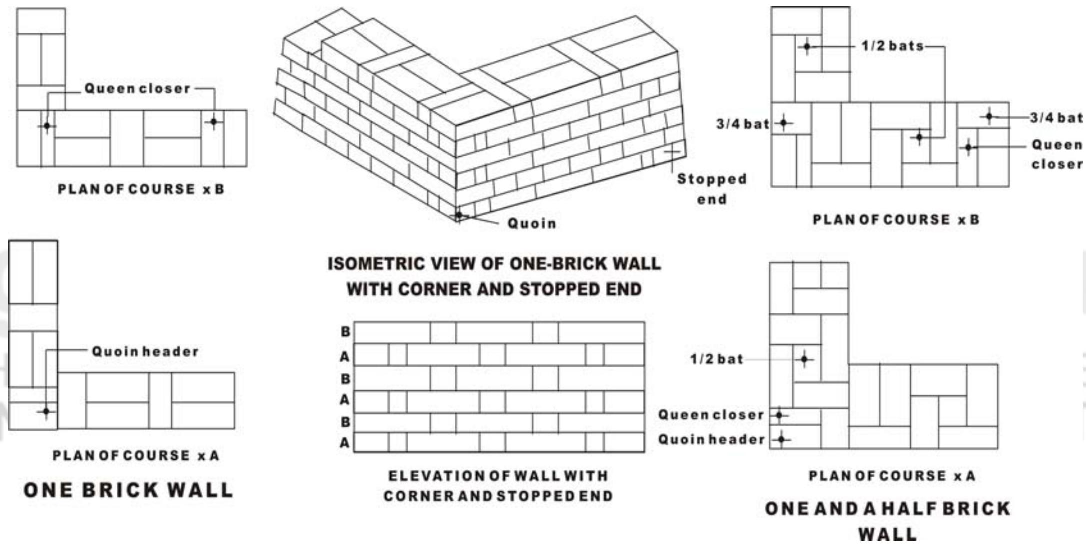

Figure 2.10 : Flemish Bond

Scaffolding

In order to construct masonry, scaffolding is used to facilitate the necessary movements of workers. Double scaffolding having two sets of vertical supports shall be used for all important works and also where exposed brick work is to be done. In single scaffolding, there is only one set of vertical supports and the wall under construction provides the other support. In such scaffolding, the placing of the poles on the brick work shall be so adjusted that they are on the header course, so that only one header is left out for each pole, which can subsequently be filled up with a full brick. Such holes shall not be allowed in pillars and columns less than one meter wide.

Curing

The brickwork shall be cured by constantly keeping it wet on all exposed faces for a minimum period of seven days.

All connected brickwork shall be taken up together and no portion of the work is left more than one meter below the rest of the work. Where this is not possible, the work shall be raked back, according to the type of bond being followed, in a series of steps at an angle not steeper than 45^o. Leaving such joints vertical with recesses or toothing in alternate layers should not be allowed as this will form a plane of weakness.

Cutting and Chasing

As far as possible services such as concealed pipes, conduits etc. should be planned with the help of vertical chases, while horizontal chases should be avoided. For load bearing walls, the depths of vertical and horizontal chases shall not exceed one-third and one-sixth the thickness of the masonry, respectively.

Verticality and Alignment

All masonry shall be built true and plumb within the tolerance limits specified below :

(a) Deviation in verticality in the total height of any wall of a building, more than one storey high, shall not exceed ± 12.5 mm.

(b) Deviation from the vertical within a storey shall not exceed ± 6 mm per 3 m height.

(c) Deviation from the position shown on the plan of any brickwork, more than one storey high, shall not exceed 12.5 mm.

(d) Relative displacement in load bearing walls in adjacent storeys intended to be in vertical alignment shall not exceed 6 mm.

(e) Deviation of horizontal mortar joints from the level shall not exceed
6 mm up to 12 m length, and for longer length shall not exceed 12.5 mm in total.

(f) Deviation from the specified thickness of horizontal and vertical joints shall not exceed ± 3 mm.

These tolerances are particularly relevant for load bearing walls.

2.4.5 Reinforced Brickwork

Plain brickwork is not capable of taking any tensile stress. By providing reinforcement of steel bars or flats or wire mesh the brickwork would be able to withstand some amount of tensile force. Such brickwork is known as reinforced brickwork. Good quality bricks having average compressive strength of 7.5 N/mm^2 and above and cement mortar not leaner than 1 : 4 is used in such a construction. Reinforced brickwork can be used in the construction of retaining walls. In half brick masonry, it is the general practice to provide at every third or fourth course, reinforcement consisting of two 6 or 8 mm dia bars or hoop iron of dimension 25 mm × 3 mm. Half the mortar for the joint is first laid, the reinforcement placed and the remaining mortar laid so that the steel is fully embedded in the mortar. Reinforced brickwork has the following advantages :

(a) Simplicity of construction.

(b) Good sound and permanent work involving very low repairing charges.

(c) Reinforced brick construction is fire proof.

(d) Neat and better appearance of the finished work.

(e) Cool rooms.

(f) It is cheaper than any other forms of pucca roofing.

SAQ 2

(a) What are the different functions served by walls in buildings?

(b) Describe the various tests to be carried out to ascertain the quality of bricks.

(c) Explain the purpose of providing a bond in the construction of a brickwork?

(d) When do you use reinforced brickwork? Explain the details of its construction.

(e) Discuss the class designation of bricks and cement : sand ratio of cement mortar suitable for reinforced brickwork.

2.5 STONE MASONRY

Stone masonry is a traditional form of construction in this country. However, in view of the ready availability of bricks and ease of constructing brickwork, the use of stone masonry is not very common.

Construction of stone masonry requires skilled masons, trained in dressing stones. Large irregular shaped stones have to be handled as compared to conveniently sized bricks or blocks. In hilly areas where stones are easily available and for prestigious buildings where the architects desire an elevation with stones, this type of masonry is still popular.

The common types of stone available in the country are granite, sandstone, limestone, basalt, marble etc. The strength of the building stone to be used shall be adequate to carry the imposed load. The crushing strengths of some of the types of stones are given below :

Type of Stone	Crushing Strength (N/mm^2)
Granite	100
Sandstone	30
Limestone	20
Basalt	40
Marble	50

The stones used in masonry shall be hard, sound, free from cavities, cracks, flaws, sandholes, veins, patches of soft or loose materials etc. The stone should not contain deleterious material like iron oxide and organic impurities. All stones should be wetted before use.

In selecting stones, the situation where this material is to be used has to be considered. Table 2.6 gives the recommended use of common types of stones :

Table 2.6 : Use of Common Types of Stones

Sl. No.	Situation	Types of Stone
1.	For carved ornamental work, arches, veneers etc.	Soft stones like marble, sandstone.
2.	For face work of building.	Granite, marble and close grained sandstone.
3.	Masonry work below plinth level and in subsoil water.	Dense stones like granite.
4.	Masonry work exposed to smoke or chemical fumes.	Granite, quartize.
5.	Fire resistant masonry.	Compact sandstone.

2.5.1 Types of Stone Masonry

The common types of stone masonry are listed and described below :

(a) Random rubble,

(b) Squared rubble,

(c) Coursed rubble, and

(d) Ashlar

Random Rubble

Uncoursed

Stones as obtained directly from the quarry are used, and are only hammer dressed on the face and sides so that they can be bedded properly with the adjacent stones (Figure 2.11).

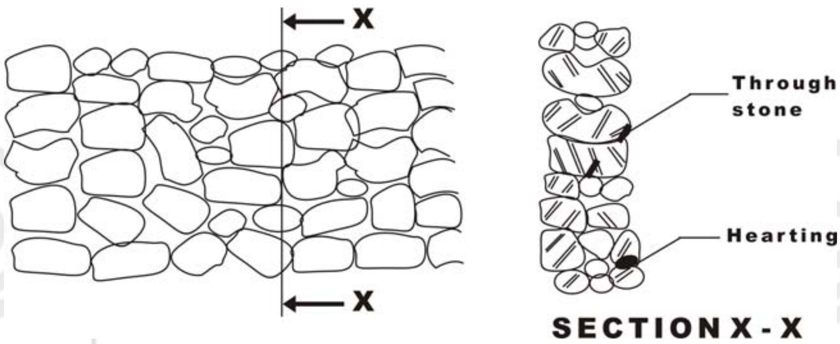

Figure 2.11 : Random Rubble Uncoursed Masonry

Normally, the size of a stone used is such that it can be lifted and placed manually. The length of the stone shall not exceed three times the height and the breadth on the base shall not be greater than three-fourth the thickness of the wall and not less than 15 cm.

The wall shall be taken up truly plumb. The stone work may be brought to course at the plinth, window sill and roof levels. The face stones shall extend and bond well into the backing. Work should be carried out in such a manner that the joints are staggered. The face joints shall not be more than 20 mm thick. Bond or through stones running right through the thickness of the wall shall be provided at the rate of one for every 0.5 m^2 of the wall area in order to tie the faces and strengthen the work. If the walls are thicker than 60 cms, instead of providing a single through stone, two stones one from each face – overlapping by at least 15 cm could be provided. The quoins or corner stones shall be selected stones, hammer dressed or chisel dressed and laid as headers and stretchers alternately.

Brought to Course

This is an improved version of random rubble masonry, except that the work is roughly levelled up to courses at intervals varying from 300 mm to 900 mm, according to the locality and the type of stone used (Figure 2.12).

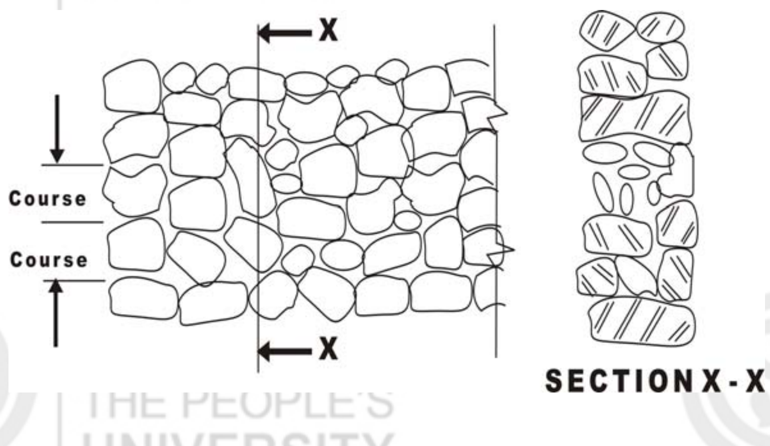

Figure 2.12 : Random Rubble Masonry Brought to Course

Squared Rubble

Uncoursed

In this type, the stones are roughly squared by hammer, and are laid as risers or jumpers and stretchers of varying height without bringing to course (Figure 2.13).

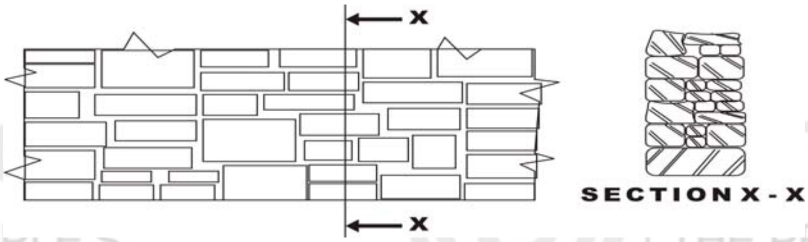

Figure 2.13 : Squared Rubble Uncoursed Masonry

Brought to Course

In this type, the work is levelled up to courses of varying depth from 300 to 900 mm (Figure 2.14).

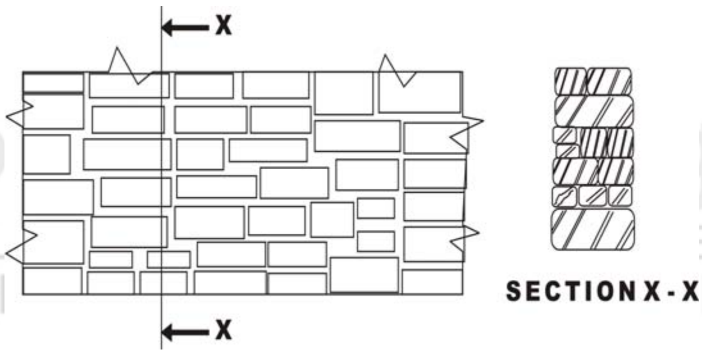

Figure 2.14 : Squared Rubble Masonry Brought to Course

Coursed Rubble Masonry

Ist Sort

The face stones shall be hammer dressed on all sides to give them approximately rectangular shape. These shall be squared on all joints and beds (Figure 2.15).

The bed joints are rough chisel dressed to a depth of at least 8 cms from the face and the side joints for at least 4 cms such that no portion of the dressed surface is more than 6 mm from a straight edge placed on it. The projections (or bushings) on the face stone shall not be more than 4 cms beyond the side or bed joint. The courses shall be laid as alternate headers and stretchers in horizontal layers and the side joints shall be vertical. The height of each course is normally between 15 cm to 30 cm. No face stone shall be less in breadth than its height and at least one third of them shall tail into the hearting to a length equal to twice their height. The hearting or the interior shall also consist of stones carefully laid on their beds. Chips can be used to fill the interstices but the quantity used should not exceed 10% of the stone masonry. Bond stones shall be provided in every course, the spacing being 1.5 to 1.8 m. The quoins shall be of the same height as the course and at least 45 cm long, laid as headers and stretchers. The beds of these stones shall be chisel dressed to a depth of 10 cm. Generally, quoins have a chisel draft 2.5 cm wide along the edges of the face. The face joints in the masonry shall not be more than 1 cm thick.

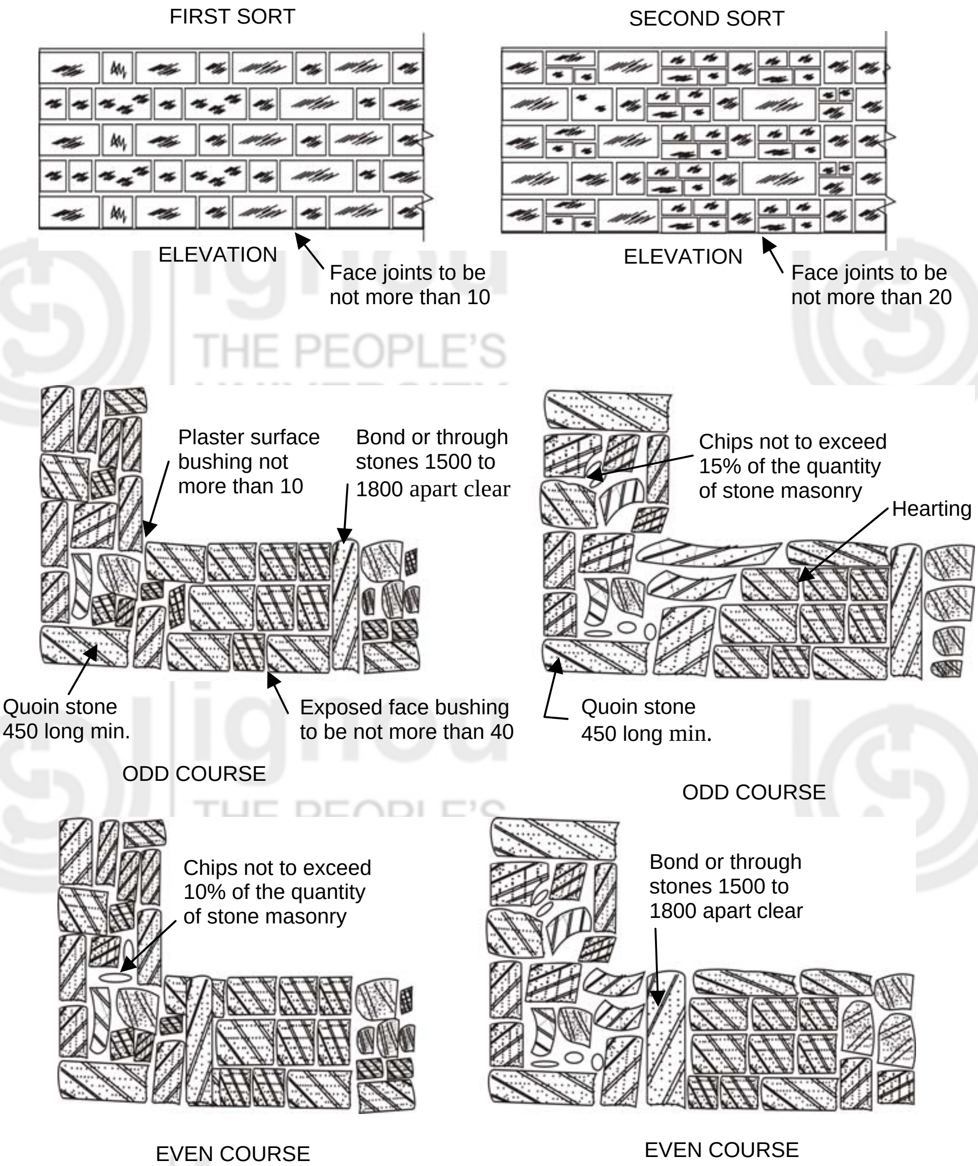

Figure 2.15 : Coursed Rubble Masonry (All Dimensions are in mm)

2nd Sort

This is similar to the work discussed earlier, except that the dressing of the joints could be rougher, with the deviation being 10 mm from a straight edge and the use of chips in the hearting could be 15%. Some of the stones in each course could be of half height so that two stones are used to make up the course. The face joints could be 2 cm thick.

Ashlar

Plain Ashlar

Each stone shall be cut to the required size and shape so as to be free from any distortion and to give truly vertical and horizontal joints (Figure 2.16). Stones are laid in regular courses, not less than 15 cm in height, and up to a maximum of 30 cm. All the courses shall be of

ignou THE PEOPLE'S UNIVERSITY

the same height unless otherwise specified. The length of the stone shall not be less than twice the height and the breadth at base shall not be greater than three fourth the thickness of the wall nor less than 15 cm. The faces that are to remain exposed in the final construction and the adjoining faces shall be fine chisel dressed to a depth of 6 mm so that when checked with a straight edge the variation shall not be more than 1 mm. The courses shall be laid headers and stretchers alternately unless otherwise specified, and the headers shall be arranged to come as nearly as possible in the middle of stretcher above and below. Bond stones shall be provided in every course, 1.5 to 1.8 m apart. The face joints in the work shall not be more than 5 mm thick.

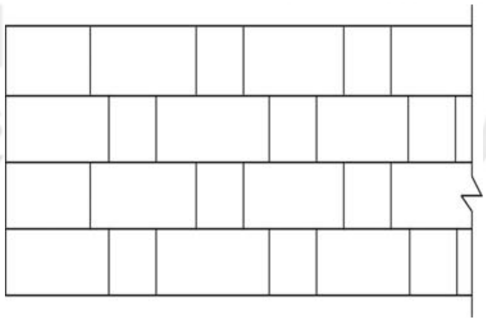

Figure 2.16 : Plain Ashlar Masonry

Punched Ashlar

This is similar to plain ashlar except that all exposed faces shall have a fine chisel draft 2.5 cm wide all round the edges, and shall be rough tooled between the drafts, such that the dressed surface does not show a variation of more than 3 mm when checked with a straight edge. This is also known as rough tooled ashlar shown in Figure 2.17.

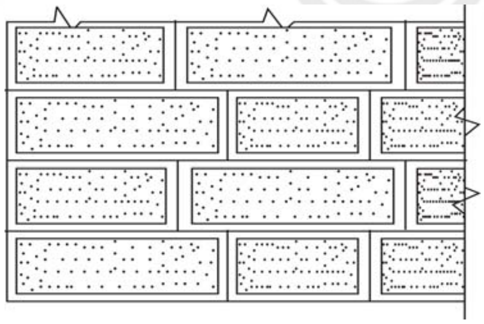

Figure 2.17 : Punched Ashlar Masonry

Ashalr Rockfaced

This type is like punched ashlar with chisel drafting all round the edges of the exposed face, but the portion within the draft is left rough as it comes from the quarry except for light hammer dressing to restrict the bushing (projection from the plane of drafts) to 75 mm (Figure 2.18).

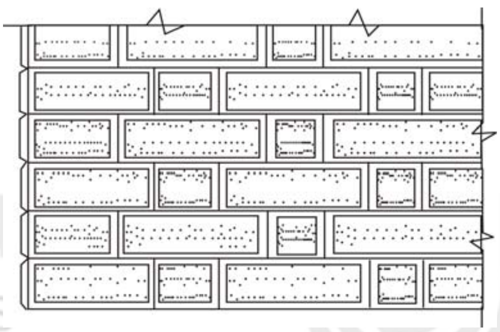

Figure 2.18 : Ashlar Rockfaced Masonry

Ashlar Chamfered

This is similar to plain ashlar except that the edges of the exposed faces are chamfered to an angle of 45^o to a depth of 25 mm as shown in Figure 2.19.

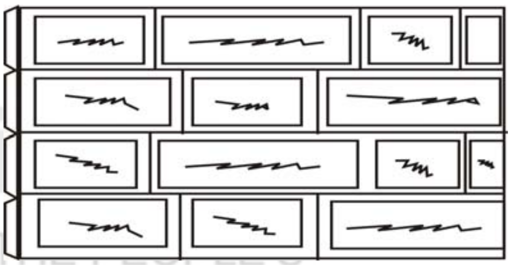

Figure 2.19 : Ashlar Chamfered Masonry

Ashlar Facing

Here the main wall may be of rubble masonry, brickwork or concrete onto which a facing of ashlar is provided. In this construction, the appearance is improved by ashlar face but all the same cost is reduced. The back face of the stone may be left rough for better adhesion. Bond stones should be provided over the full thickness, including the backing.

2.5.2 Stone Masonry

Construction Practices

Bureau of Indian Standards has laid detailed rules regarding construction practices. However, in general, following principles in this regard are in order :

Mortar for Joints

Same types of mortars are used in stone masonry as in the case of brickwork. Generally, good quality stonework is built in cement mortar 1 : 3.

Curing

All faces of the masonry work shall be kept moist for a minimum period of seven days.

Scaffolding

While single scaffolding can be allowed for rubble masonry, it would be preferable to have double scaffolding for coursed rubble masonry of first sort.

In the case of ashlar work, only double scaffolding should be permitted.

SAQ 3

(a) What are the common types of building stone and in what situations are they used?

(b) What is a bond stone and what is its purpose? At what intervals would you provide bond stones in random rubble, coursed rubble and plain ahslar masonry?

2.6 BLOCK MASONRY

Various types of blocks can also be used to construct masonry. As these blocks can be made under controlled conditions it is possible to achieve the desired quality. As they can be made to sizes larger than bricks and at the same time true to size and shape, the construction is faster and the quantity of mortar required for the masonry work is less. The faces of blocks being fairly smooth, the walls can be left unplastered, and even if they are plastered the quantity of mortar required would be less than in brick masonry and very much less than in stone work.

A variety of blocks are available for use, such as concrete blocks, lime based blocks, soil based blocks etc.

Concrete Blocks

Blocks can be solid or hollow. They can be hand made or machine made. The materials required for their manufacture are cement, aggregate and water. Fly ash or other admixtures are also sometimes used. The concrete mix used for the manufacture of blocks is normally (1 cement to 5 or 6 of combined aggregates) by volume. The fineness modulus of the combined aggregate shall be between 3.6 and 4. The blocks can be compacted in the moulds manually or preferably manufactured in block making machines. The blocks shall be cured for 14 days. Steam curing can be adopted to save time.

The nominal dimensions of concrete blocks are as given below :

Length : 400, 500 or 600 mm

Width : 50, 75, 100, 150, 200, 250 or 300 mm

Height : 100 or 200 mm

Hollow concrete blocks are manufactured in three grades, as described below :

Grade A

Load bearing units with a minimum density of 15 kN/m^3. The average compressive strength shall be 3.5, 4.5, 5.5 or 7 N/mm^2. The thickness of the face shell and web shall not be less than 25 mm.

Grade B

Load bearing unit with a block density between 10 to 15 kN/m^3. The average compressive strength shall be 2, 3 or 5 N/mm^2.

Grade C

Non-load bearing units with block density between 10 to 15 kN/m^3. The average compressive strength shall not be less than 1.5 N/mm^2.

Solid concrete blocks are made for load bearing units with a block density of not less than 18 kN/m^3. The average compressive strength shall be between 4.0 to 5.0 N/mm^2.

The water absorption of the concrete blocks shall not exceed 10% by weight.

Precast Concrete Masonry Blocks

These are precast solid concrete blocks embedded with stone spalls, i.e. broken stone pieces (20 to 30% by volume). The concrete is usually made of 1 part of cement and 9 parts of combined fine and coarse aggregate. The mix is placed in the mould in layers along with stone spalls and compacted.

The blocks are cured for 14 days. The density and strength characteristics are similar to that of solid concrete blocks.

Lime Based Blocks

These are made from a combination of materials consisting of lime, cement, fly ash, burnt clay pozzolana etc.

The normal nominal sizes of blocks are :

Length : 400 mm

Width : 100, 200 or 300 mm

Height : 100 or 200 mm

The density is of the order of 10 kN/m^3 and compressive strength 3.5 N/mm^2.

Lime Flyash Bricks

They are made from fly ash (80-90%), sand (2-12%) and lime (1-10%) with small quantity of chemical accelerator. They have a density of 15 kN/m^3 and a compressive strength of 7.5 to 10 N/mm^2.

Sand Lime Bricks

It is composed of sand (91-93%) and lime (7-9%). The components are mixed with water and compressed in moulds under pressure and then autoclaved. The density is 8 kN/m^3 and compressive strength 10 N/mm^2.

Flyash Lime Gypsum Bricks

This is made from a mixture of flyash, lime, gypsum and sand. After mixing with water, the mixture is compacted in moulds and cured. The density is 14 kN/m^3 and compressive strength 8 to 10 N/mm^2.

Autoclaved Aerated Concrete Blocks

These are made from the sand or selected quality of flyash or mixtures of both and a binder of lime and cement. The cellular character of the blocks, which gives good thermal properties and a high strength to density ratio, is formed as a result of aeration caused by adding traces of aluminium powder. These blocks have a density of 6.5 kN/m^3 and compressive strength of 3.5 to 4.0 N/mm^2. They have high thermal and sound insulation properties and are fire resistant also.

Soil Based Blocks

Most of the soils can be satisfactorily stabilised by the addition of lime or cement. It is however necessary to analyse the properties of the soil through a laboratory testing to determine the optimum quantity of stabilisers to be added to impart the desired properties to the block. Soil containing 0-10% gravel, 40-75% sand, 15-25% silt, and 8-25% clay is suitable for making blocks. It should not contain more than 0.5% of organic matter and the pH value should be less than 7. Soil based blocks are cheap and can be used with advantage in the construction of low cost houses.

These blocks are manufactured from the mixture of suitable soil and a stabilizer (cement, lime or gypsum or a combination) thoroughly mixed, preferably in a mechanical mixer at suitable moisture content and then pressed into moulds. The blocks are cured for 14 days by gently sprinkling water. Cement (5% by weight) is generally recommended for non-cohesive soils with low clay content while a combination of cement and lime (2.5% by weight of each) can be used if the clay content is higher. The nominal sizes of the blocks are 20 × 10 × 10 cm, 20 × 10 × 5 cm and 30 × 20 × 10 cm. The density of the block is about 20 kN/m^3 and the compressive strength of the order of 2 to 3 N/mm^2. Water absorption of the block should be less than 20%.

2.6.1 Blocks Masonry

Construction Practices

The mortar can be cement-sand, lime-sand or combination mortars. The strength of the mortar should be weaker than the strength of the blocks to avoid formation of cracks. Cement sand mortars of 1 : 4 : to 1 : 6 and corresponding lime or combination mortars could be used.

The blocks may be slightly wetted/moistened before construction to prevent absorption of water from the mortar and also to ensure proper adhesion with the mortar. The masonry should be constructed to a suitable bond so that the vertical joints in successive layers are staggered. The work shall be cured appropriately for due period of time. Scaffolding shall be single or double depending on the importance of the work.

2.7 WORKMANSHIP AND QUALITY ASSURANCE IN MASONRY CONSTRUCTION

Brick masonry is usually classified as first, second and third class depending on the strength, characteristic and uniformity of shape of bricks and also the workmanship as well as the mortar used.

Stone masonry is classified into various types depending on the preparation of stone pieces and labour involved. Random rubble masonry requires least amount of preparation of stone. Ashlar masonry involves maximum preparation of stone. Stones shall be laid on their planes and dressed properly.

In stone masonry, bond stones or through stones which run through thickness of the wall are very important. The stones should be laid breaking joints and should overlap each other making it a homogeneous mass.

Corner in a stone masonry like window door joints walls etc. are very important. Special type of stones called quions should be used.

In case of veneer work, clamps and cramps should be used at proper intervals and shall be of the size and material specified.

The following points shall be checked while supervising masonry construction :

(a) Brick shall be checked for strength, efflorescence, dimensional accuracy, water absorption and proper burning. Stones should be checked for uniformity of colour, strength, texture, compressive strength and water absorption.

(b) Grading and silt content of sand for mortar.

(c) In brick masonry, thickness of joint shall not exceed 1 cm.

(d) The joints shall be filled up with mortar.

(e) Joints shall be staggered.

(f) In brick masonry, face joints shall be raked to a depth of 15mm when the mortar is still green.

(g) Masonry should be plumb or in specified batter.

(h) Bricks and stones should be fully soaked in water and laid skin dry.

(i) Brick courses and ashlar masonry should be laid level.

(j) Mortar should be properly mixed on a hard platform.

(k) Strength of mortar can be checked by scratching with any sharp instrument.

(l) Joints between main and cross walls should be properly bonded.

(m) Curing should be proper and at least for seven days.

(n) General quality of works with respect to lines, levels, thickness and trueness of the joints.

(o) In brick masonry, top courses in plinth, in window sill, below RCC slab and parapet shall be provided in brick on edge.

(p) Holes of scaffolding should be properly filled up.

(q) Specified reinforcement in half brick masonry and in corners etc. shall be provided.

(r) Required number of bond stones to be provided.

(s) Quality of dressing.

(t) In stone masonry, thickness of joints should not be excessive.

(u) Cramps and dowels to be checked for materials size and number.

(v) All pipe fittings and specials, spouts, hold fasts and other fixtures which are required to be built into the walls shall be embedded, as specified, in their correct positions as the masonry work proceeds.

(w) To facilitate taking service lines later without excessive cutting of completed work sleeves shall be provided where specified, while raising the masonry work.

(x) Outlets shall be provided wherever water is likely to accumulate.

2.8 SYSTEM OF BUILDING STRUCTURES

There are primarily the following three systems of a building structure :

Load Bearing Structure

In this system, the load bearing walls are constructed on a continuous foundation and they are designed to support the entire load including their own load. Hence in this type of structure, the beams, trusses, or other heavy parts and fittings are always made to rest on load-bearing walls.

Framed Structure

In this system, a number of piers or columns are erected on their own independent foundations and are braced together by beams and floors. In this way, the whole structure is erected including the roof, and the gaps between the piers or columns are filled with walls, which are called ‘panel’, ‘curtain’, and ‘screen or filler walls’. The function of walls is simply to support their own weight and to serve as a screen for privacy and afford protection against weather effects. The frame carries the entire load on the structure both live and dead.

Composite Structure

In this system, which is combination of a load bearing structure and framed structure, the outer side walls consist of bearing walls whereas the frame of columns and beams rests with one end on bearing walls and the other end on inner columns with thin partitions between bearing walls.

SAQ 4

What are the relative advantages and disadvantages of brick, stone and block masonry constructions?

2.9 SUMMARY

In this unit, we have studied the functions served by various types of wall. The characteristics of bricks, tests to be carried out on them to assess their suitability, different types of mortar used in masonry, importance of bonds and constructional details of brick masonry have been explained. Similarly, various aspects of stone masonry have also been given. We have also seen that masonry can be constructed with blocks, manufactured from a variety of materials. Lastly the workmanship and quality assurance in masonry construction have been discussed.

In the next unit, you will be introduced to the different treatments normally employed in the building for curbing termites and dampness.

2.10 ANSWERS TO SAQs

Refer the relevant preceding text in the unit or other useful books on the topic listed in the section ‘Further Reading’ given at the end to get the answers of the SAQs.