UNIT 11
SUPERSTRUCTURE

Structure

11.0 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 (R.C.C.) construction.

11.1 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, and
- describe various types and constructional features of partitions.

11.2 WALLS

Let us first try to analyze he various functions served by walls in a building such as:

(a) support loads of upper floors and roof (in case of load beating 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) provides enclosure for ensuring security -and privacy,
(e) provide support for doors and windows,
(f) provide thermal insulation,
(g) provide sound insulation,

(h) offer adequate resistance to fire, and
(i) 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 types of blocks.

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

11.3 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.

11.3.1 Bricks

Bricks are made from ordinary clay, molded and burnt in kilns. They can be hand molded or machine pressed or extruded and wire cut. They should be well burnt, of uniform color, 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 x 11.4 x 7.5 cm (actual 22.5 cm x 11.1cmx7 cm) or modular nominal sizes of 20 cm x 10 cm x 10 cm (actual 19 cm x 9 cm x 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 modular size of bricks was standardized by Indian Standards Institution (now the Bureau of Indian Standards).

Classification of Bricks: Common burnt clay bricks are classified on the basis of compressive strength as given in Table11.1.

Table 11.1: Classification of Bricks

Class Designation	**35**	**30**	**25**	**20**	**17.5**	**12.5**	**10**	**7.5**	**5**	**3.5**
Ave. Compressive Strength										
N/mm^2	35	30	25	20	10.5	12.5	10	7.5	5	3.5
Kg/cm^2	350	300	250	200	175	125	100	75	50	35

Tolerance on bricks dimension shall be ± 3% for designation 10 and above and ± 8% for lower designations. Dimensional accuracy of bricks is necessary for ensuring proper bond. This is tested by selecting 20 bricks at random and laying them on a level surface in touch with each other in a straight line and measuring the total length and calculating the variation with respect to the standard dimension.

Other important tests to be conducted on bricks are for compressive strength, water absorption and efflorescence. For bricks of designation 10 and above one test each shall be done for every 50,000 bricks, while for lower designations the tests can be carried out for every 1 lakh bricks.

Compressive strength shall be taken as the average strength of five specimens. However, no value shall be less than 20% of the specified value. The bricks shall be immersed in water for 24 hrs. at 27ºC ± 2ºC. The surplus water is allowed to drain off. The frog of the bricks should be filled with 1 : 3 cement mortar flush to the surface and shall be cured under jute bags for 24 hr. The bricks shall then be immersed in water for 72 hr. The bricks after removal shall be wiped clean. Then the brick shall be placed in the compression testing machine with the flat face horizontal and mortar filled frog upward. Load shall be applied at a uniform rate of 140 kg/cm^2 after placing a plywood sheet on its top. The compressive strength is the load at failure of the brick, divided by surface area of the brick and is expressed as kg/cm2. Average of five results shall be taken as the relevant value. Water absorption shall not exceed 20% by weight up to class 12.5 and 15% by weight for upper classes. Five bricks shall be tested for water absorption. The bricks shall be dried in an oven at 110' to 115'C till they attain a constant weight. They shall be allowed to cool at room temperature. The cooled bricks shall be weighed. Then they shall be immersed in water at 27ºC ± 2'C for 24 hrs. After removal they shall be wiped clean and weighed again. The difference between the two weights as a percentage of the dry weight shall be calculated and the average of the results for five bricks shall be reported as the value of water absorption.

Efflorescence is the crystallization of water soluble salts in the bricks and results in white powder on the surface of the bricks, which may result in surface disintegration of the brick work. It is therefore necessary to test the bricks for efflorescence. Distilled water is partially filled in a shallow pan and five bricks are placed on their end so that they are immersed in the water to a depth of 2.5 cm. The bricks are allowed to absorb the whole water. Distilled water is again poured into the dish to a depth of 2.5 cm and the water allowed to get absorbed and evaporate as before. Bricks shall be examined after the second evaporation for efflorescence. Efflorescence shall be classified as 'nil' if there is no perceptible deposit of salts, 'slight' when not more than 10% of the area is covered with a thin deposit of salt, 'moderate' when there is heavier deposit covering up to 50% of the area, but unaccompanied by powdering or flaking of the surface, 'heavy' when heavy deposit covers 50% or more of the surface but unaccompanied by powdering or flaking, and 'serious' when there is heavy deposit of salts accompanied by powdering and/or flaking of the surface. Bricks having efflorescence beyond 'moderate' shall not be used.

11.3.2 Mortars

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

Materials

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

a. **Limits of Acidity:** To neutralize 200 ml sample of water, it should not require more than 2ml of 0.1 normal caustic soda solution.

b. **Limits of alkalinity:** To neutralize 200 ml sample of water, it should not require more than 10 ml of 0.1 normal hydrochloric acid.

c. **Percentage of solids:** It shall not exceed the following limits for various solids:

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

d. 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:

a. 33 grade ordinary Portland cement, IS: 269 - 1989
b. 43 grade ordinary Portland cement, IS: 8112 - 1989
c. 53 grade ordinary Portland cement, IS: 1269 - 1987
d. Rapid hardening Portland cement, IS: 8041 - 1990
e. Low heat Portland cement, IS: 12600 - 1989
f. Portland Pozzolana cement, IS: 1489 - 1991
g. 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 acetylene 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 11.2.

Table 11.2: 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 11.2.

Coarse Sand: This shall be either river sand or pit sand and shall conform to the grading of Zone III of Table 11.2

The silt or organic content in fine aggregate should not in any case exceed 8%. The silt content is tested by placing a sample of sand in a 200 ml measuring cylinder. 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 gms strength slowly. The main advantages of lime mortar are its good workability, high water retentively 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 retentively. Commonly adopted proportions are cement : Lime : Sand of 1 : 1 : 6,l : 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 below:

Table 11.3 : Mix Proportion and Strength of Commonly Used Mortars				
Sl. No (1)	**Mix**			**Min. Comp. Strength (N/mm^2)** (5)
	Cement (2)	**Lime** (3)	**Sand** (4)	
1	1	0-1/4 C	3	10
2 (a)	1	0	4	7.5
2 (b)	1	½ C	4½	6
3 (a)	1	0	5	5
3 (b)	1	I C	6	3
4 (a)	1	0	6	3
4 (b)	1	2 C	9	2
4 (c)	0	1 A	2-3	2
5 (a)	1	0	8	0.7
5 (b)	1	3 C	12	0.7
6	0	1 B 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 IS712:1984.
Note 2: When using plain cement sand mortars (S1. 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 *S1.* 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 *r* 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 bulk age (which is the phenomenon of Increase in the v (3lume of sand with presence of moisture). The amount of bulk age 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 bulk age, pour the sand up to the 200 ml mark of a 250ml 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 $\left[\frac{200-Y}{Y}\right]\times 100$. The following table gives the relationship between moisture content /and percentage of bulking for practical guidance:

Moisture Percentage	Bulking Percentage (by Volume)
2	15
3	20
4	25
5	30

Mixing of mortar shall be preferably done in a mechanical mixer. Cement mortar shall be used within 30 minutes of mixing. Lime mortar is generally made by mixing lime putty sand and surkhi and grinding it either manually or in a mechanical mortar mill. 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.

11.3.3 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. There are many types of bonds but the commonly used ones are the English bond and the Flemish bond which are described here.

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. The stretcher courses are formed by stretchers having a minimum lap of one quarter their length over the header. The Figure 5.1 shows details of the comer of a one brick wall and a one-and-a half brick wall and also a stopped end.

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 a queen closer, a three-fourth brick bat has to be used. The Figure 11.2 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 he laid in courses according to the specified bond.

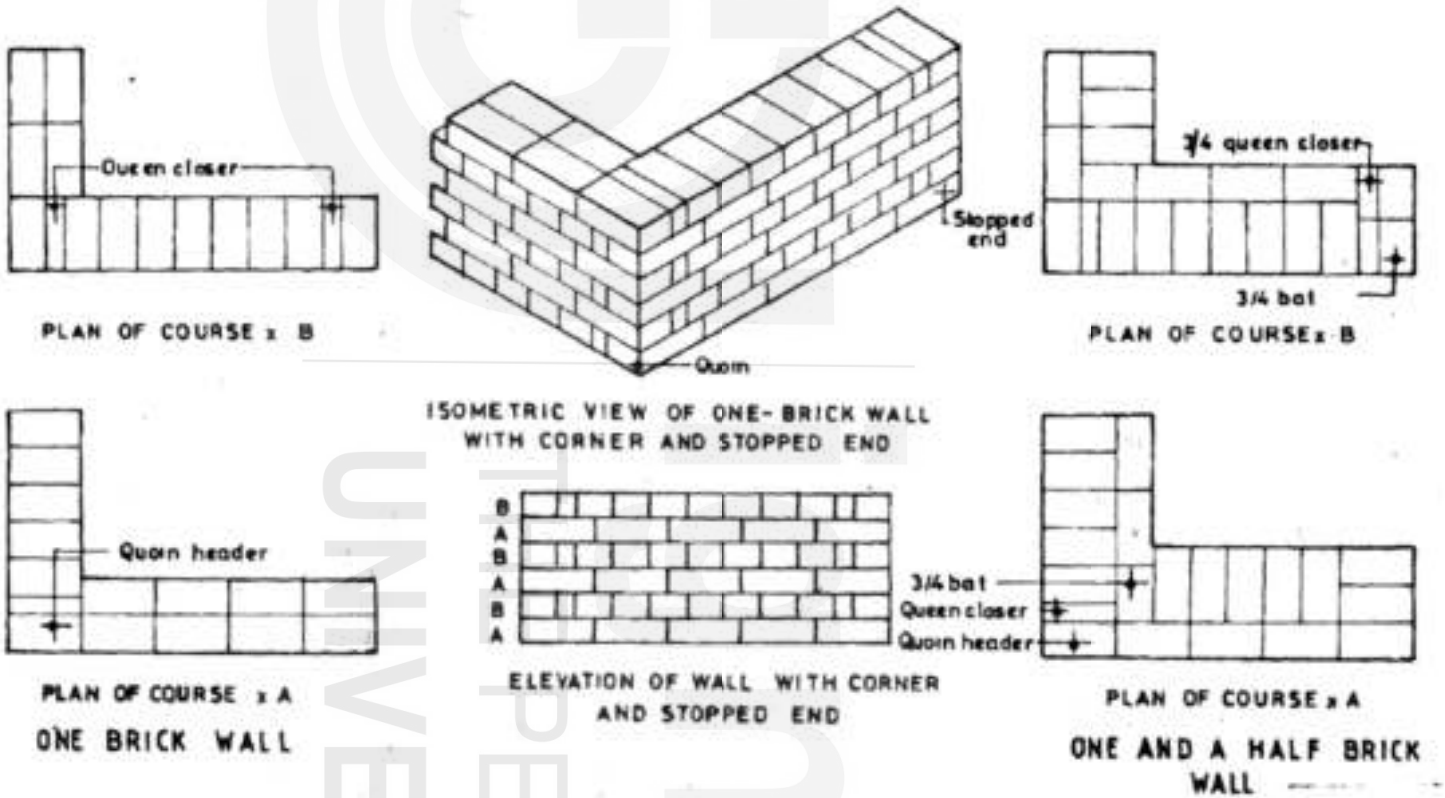
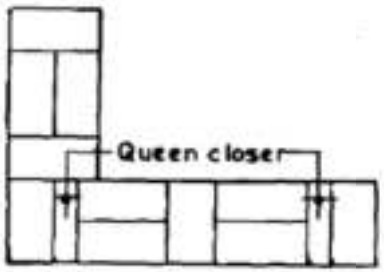
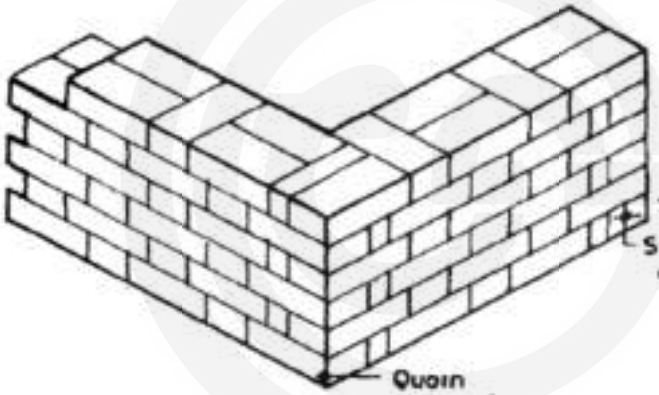


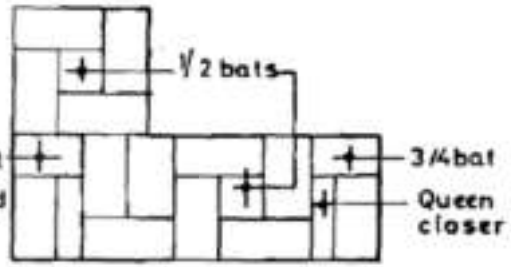
Figure 5.1 : English Bond



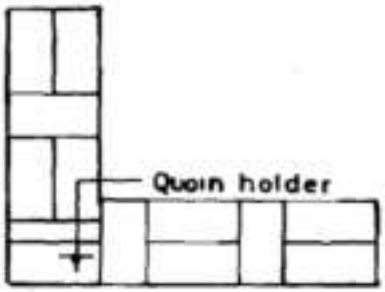
PLAN OF COURSE x B



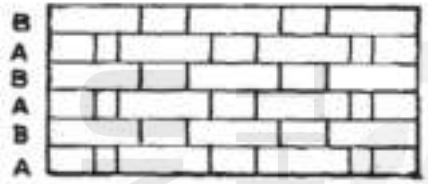
ISOMETRIC VIEW OF ONE - BRICK WALL
WITH CORNER AND STOPPED END



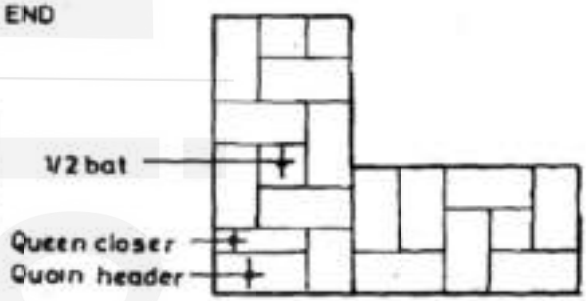
PLAN OF COURSE x B



PLAN OF COURSE x A
ONE BRICK WALL



ELEVATION OF WALL WITH
CORNER AND STOPPED END



PLAN OF COURSE x A
ONE AND A HALF BRICK
WALL

Figure 5.2 : Flemish 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 plaster or pointing is not to be done the joints shall be finished flush at the time of laying.

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 45º. 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, conducts 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 height, 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 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.

11.3.4 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 of class designation 7.5 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 x 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.

11.4 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 brick-work, 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 in N/mm2
Granite	100 (1000)
Sandstone	30(300)
Limestone	20 (200)
Basalt	40 (400)
Marble	50 (500)

The stones used in the 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. The table below gives the recommended use of common types of stones:

S. No.	Situation	Type 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, quartzite
5	Fire resistant Masonry	Compact sands tone

11.4.1 Types of Stone Masonry

The common types of stone masonry are listed below:

a. Random rubble,
b. Squared rubble.
c. Coursed rubble, and
d. Ashlar.

Random Rubble

Un-coursed: 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 11.3).

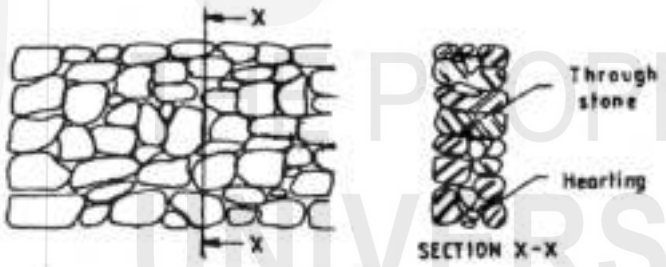


Figure 11.3: Random Rubble Uncaused Masonry

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 i& the backing. Work should be carried out in such a manner that the joints are shggered. 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 m2 of the wall area in order to tie the faces and strengthen the work. If the walls are thicker than 60 cm**,** 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 comer 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 11.4).

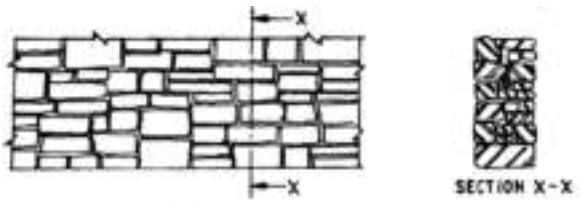


Figure 11.4: Random Rabble Masonry Brought to Course

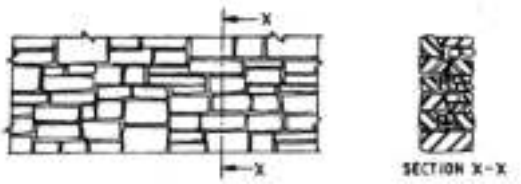


Figure 11.5: Squared Rubble Uncaused Masonry

Squared Rubble

Un-coursed: 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 11.5).

Brought to Course: In this type, the work is levelled up to courses of varying depth from300 to 900 mm (Figure 11.6).

Coursed Rubble Masonry

1st 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 11.7). The bed joints are rough chisel dressed to a depth of at least 8 cm 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 cm 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.

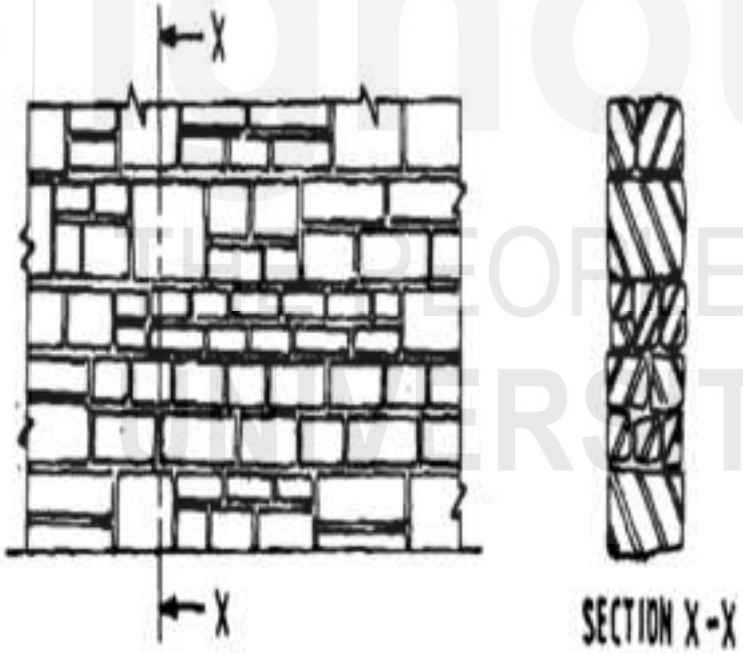


Figure 11.6: Squared Rubble Masonry Brought to Course

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.

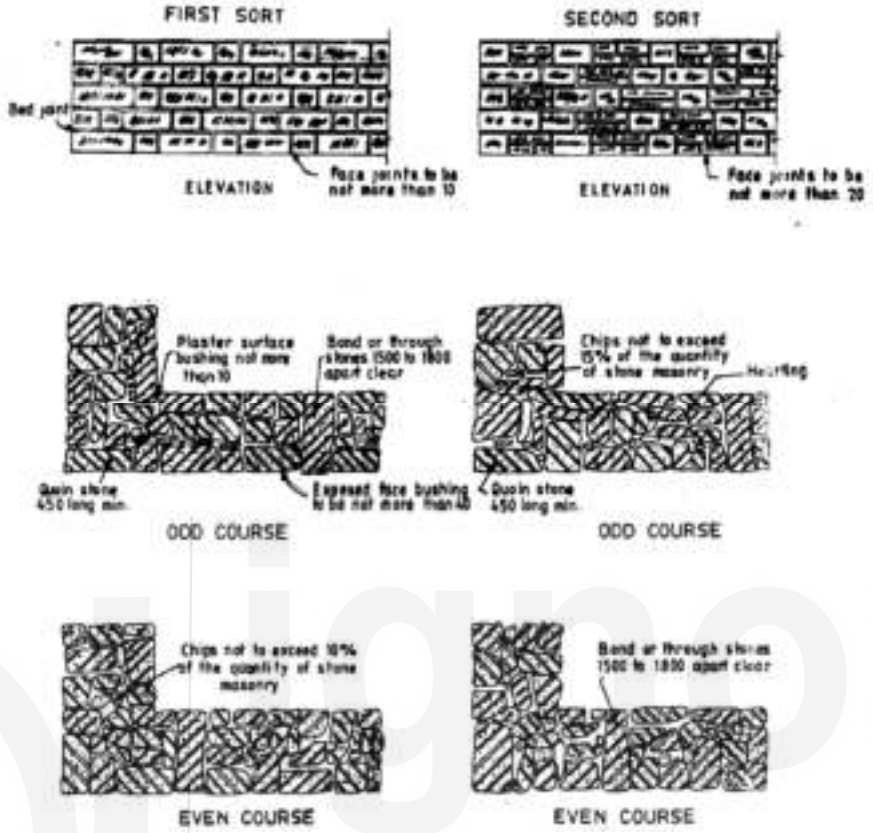


Figure 11.7 Coursed Rubble Masonry (All Diensions are in mm)

Ashlar

Plain Ashlar: Each stone shall be cut to the required size and shape so as to be free from my distortion and to give truly vertical and horizontal joints (Figure 5.8). 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 the same height unless otherwise specified. The length of the stone shall not be less than twice the height and the breadth : 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 adjusting faces shall be fine chisel dressed to a depth of 6 mm so that when check with a straight edge the variation shall not be more than 1 mm. The courses shell be laid headers and stretchers alternately unless otherwise specified, and the hears 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.

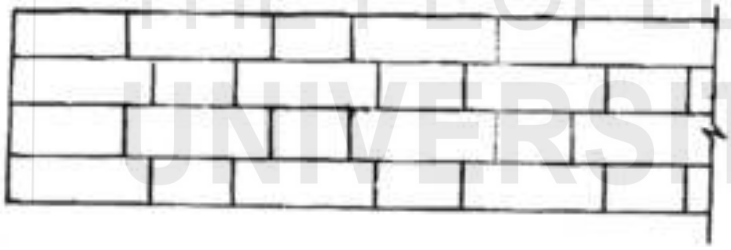


Figure 11.8 Plain Ashlar Monsonry

Punched Ashlar: This is similar to plan 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 (Figure 11.9).

Ashlar Rock faced: 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 11.10).

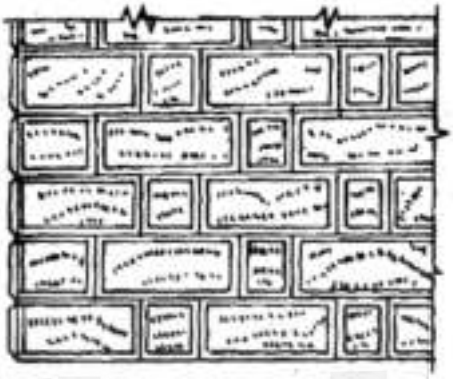


Figure 11.10 Ashlar Rockfaced Monsonry

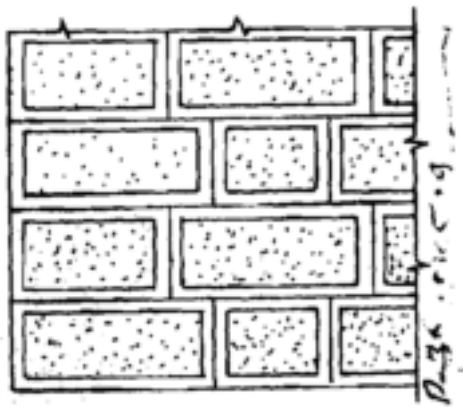


Figure 11.9 Punched Ashlar Monsonry

Ashlar Chamfered: This is similar to plain ashlar except that the edges of the exposed faces are chamfered to an angle of 45 degrees to a depth of 25 mm as shown in Figure 11.11.

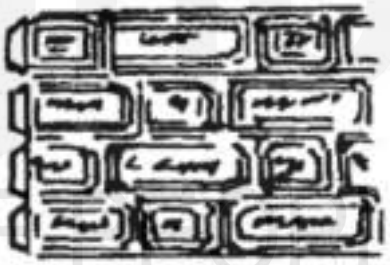


Figure 11.11 Ashlar Chamfered Monsonry

Ashlar Facing

Here the main wall may be of rubble masonry, brickwork or concrete onto which a facing of ashlar is revived. 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.

11.4.2 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 type of mortars are used in stone masonry as in the case of brickwork. Generally, good quality stone work is built in cement mortar 1 : 3.

Curing: All faces of the masonry work shall be kept moist fur 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.

11.5 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 un-plastered, 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 handmade 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 mounds 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 1500kg/m^3. The average compressive strength shall be 3.5,4.5,5.5 or 7 N/mm (35,45,55 or 70 kg/cm^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 1000 to 1500 kg/m^3). The average compressive strength shall be 2.3 or 5 N/mm^2 (20.30 or 50 kg/cm2).

Grade C: Non-load bearing units with block density between 1000 to 1500 kg/m^3. average compressive strength shall not be less than 1.5 N/mm^2 (15 kg/cm^2). Solid concrete blocks are made for load baring units with a block density of not less than 1800 kg/m3. The average compressive strength shall be between 4.0 to 5.0 N/mm^2 (4 0 to 50 kg/cm^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 mound in layers along with stone spalls 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 blocks are:

Length : 400 mm
Width : 100,200 or 300 m
Height : 100 or 200 mm

The density is of the order of 1000 kglm3 and compre8sive strength 3.5 N/mm^2 (35 kg/cm),

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 1500 kg/m^3 and a compressive strength of 7.5 to 10 N/mm^2 (75 to 100 kg/cm^2).

Sand Lime Bricks: It is composed of sand (91.93%) and lime (7- 9%). The components are mixed with water and compressed in mounds pressure and cured. The density is 800 kg/m^3 and compressive strength 10 N/mm^2 (100 kg/cm^2).

Fly Ash Lime Gypsum Bricks: This is made from a mixture of fly ash, lime, gypsum and sand. After mixing with water, the mixture is compacted in mounds and cure The density is 1400 kg/m^3 and compressive strength 8 to 10 N/mm (80 to 90 kg/cm^2).

Autoclaved Aerated Concrete Blocks: These are made from fine sand or selected quality of fly ash 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 aluminum powder. These blocks have a density of 650 kg/ m^3 and compressive strength of 3.5 to 4.0 N/mm^2 (3.5 to 4.0 kg/cm^2). They have high thermal and sound insulation properties and are fire resistant also.

Soil Based Blocks: Most of the soils can be satisfactorily stabilized by the addition of lime or cement. It is however necessary to analyze the properties of the soil through a laboratory testing to determine the optimum quantity of stabilizers 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 a suitable moisture content and then pressed into mounds. 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 x 10 x 10 cm 20 x 10 x 5 cm and

30 x 20 x 10 **cm** The density of the block is about 2000 kg/m^3 and the compressive strength of the order of 2 to 3 N/mm^2 (20 to 30 kg/cm^2). Water absorption of the block should be less than 20%.

11.5.1 Blocks Masonry: Construction Practice

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.

11.6 PARTITIONS

The space inside a building has to be subdivided into rooms to serve different functions. This is carried out by partitions which provide enclosures. 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. The details of such walls have already been dealt in the earlier parts of this unit. 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 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 fiber 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 built-up construction type fabricated in factories.

Brick Partitions: These are constructed to half brick thickness by laying the bricks as stretchers. The mortar can be of lime or cement. Generally, the mortar used is sand cement mortars 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 fie 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 earlier, 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 walls of same thickness and provide good sound insulation. Other materials like gypsum blocks, 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 Bound insulation properties.

Partitions of Sheeted Materials: The conventional timber partitions known as *stud partitions* are constructed of 100 x 75 mm heads and sills with vertical members or studs of 75 x 38 mm or 100 x 50 mm framed at about 400 mm centers (Figure 5.12). The studs are stiffened by horizontal timber members known as noggings of size 100 x 38 mm. Timber boards are nailed on both sides of the frame and painted or polished.

Other sheets like gypsum plaster board, fiber building board, plywood, particle board, block board, A.C. sheet, G.I. 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 11.4.

Table 11.4: **Spacing for Support and Fixing of Rigid Wall Board**

Sl.No	Type of Board	Thick-ness (mm)	Spacing of Supports(mm)	Nail Spacing C/c(mm)		Min. Edge Clearance of Nails (mm)
				At Edges	At Supports	
1.	Gypsum Board	9.5 12.5 15	400 500 600	100 to 150	100 to 150	10
2.	Fir Building Board,	10 12 20	400 500 600	75	150 to 200	10

	Particle Board etc.					
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
(1) Nails with shank diameter 2,2.34 or 2.50 mm are commonly used.
(2) 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.

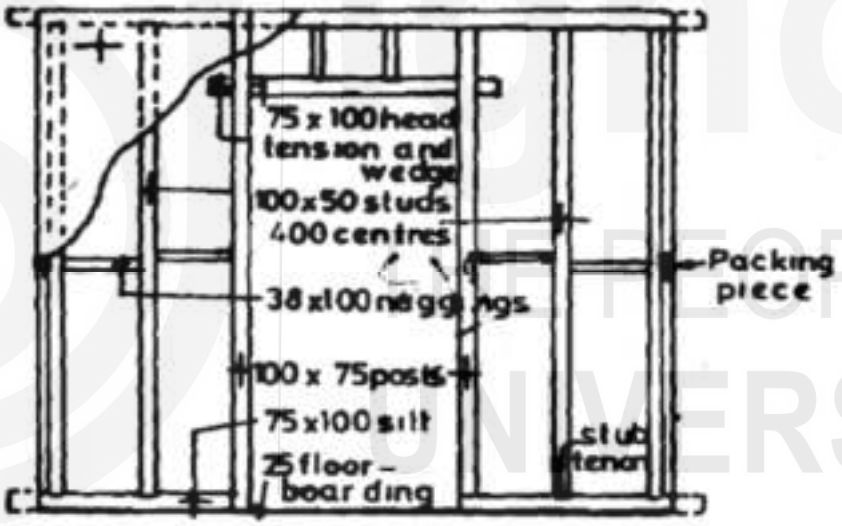


Figure 11.12 Ashlar Chamfered Monsonry

11.8 SUMMARY

In this Unit, we have studied the functions served by walls and partitions. The characteristics of bricks, tests to be carried out on them to assess their suitability, different types of mortars 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 a masonry can be constructed with blocks, manufactured from a variety of materials. Lastly, the types of partitions have been discussed.