UNIT 2

MASONRY- ROOF - FLOOR CONSTRUCTION

Masonry construction - Stone masonry: types - Brick masonry: types of bonds - Hollow block masonry reinforced - masonry - composite masonry - Walls: types and their uses - Floors and Roofs: different types of floors and their suitability - floor finishes - Roofs: different types of flat, pitched and curved roofs - Roof coverings

INTRODUCTION

Masonry construction has progressed through several stages of development. Fired clay brick became the principal building material. Masonry consists of a variety of materials. Raw materials are made into masonry units of different sizes and shapes, each having specific physical and mechanical properties. Both the raw materials and the method of manufacture affect masonry unit properties.

The word “masonry” is a general term that applies to construction using hand-placed units of clay, concrete, structural clay tile, glass block, natural stones and the like. One or more types of masonry units are bonded together with mortar, metal ties, reinforcement and accessories to form walls and other structural elements.

Definition of Masonry

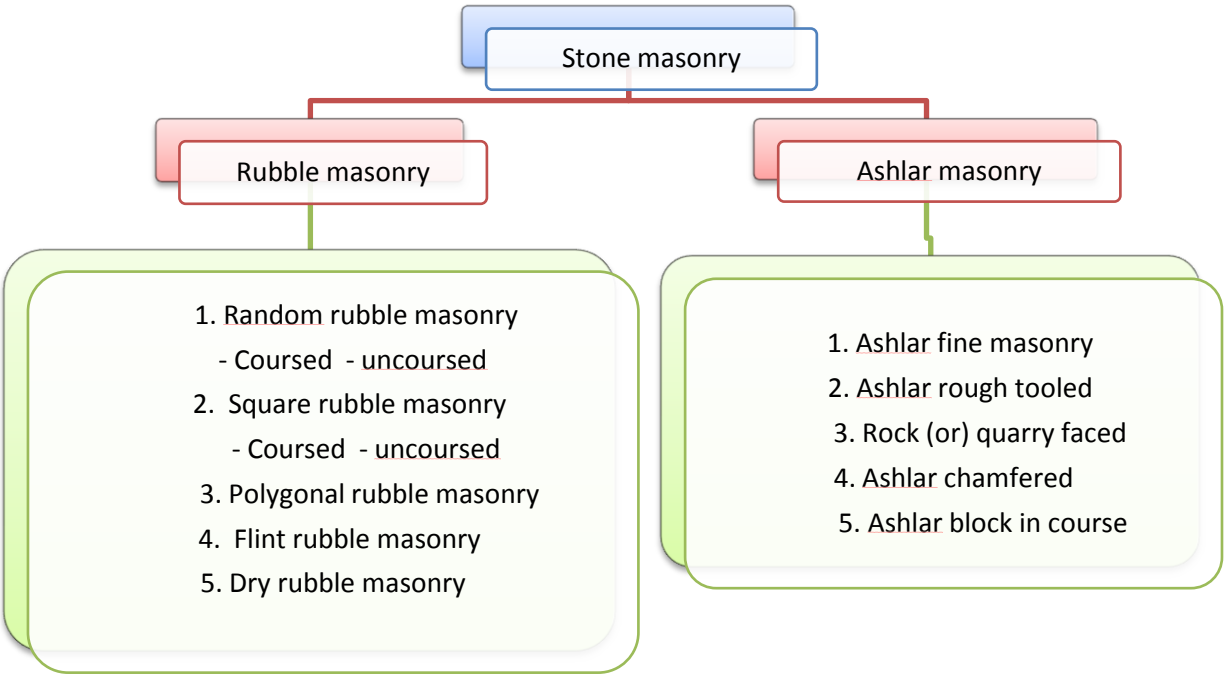
It is an assembly or combination of small building units made of bricks or stones or concrete. Normally the masonry units are laid with cement mortar, which binds them together to create a structure. Masonry construction can provide beautiful walls and floors at economical prices Masonry consists entirely or partially of hollow or solid units which is laid closely in mortar.

Laying of Bricks - Masonry

STONE MASONRY

Stone masonry is made of stone units bonded together with mortar. Stone masonry is used for the construction of walls, columns, lintels, arches, beams, etc., of a building. Stones are abundantly available in nature and when cut and dressed to proper shapes, they provide an economical material for the construction of various parts of building. The materials used for stone masonry are stone and mortar.

Types of stone masonry

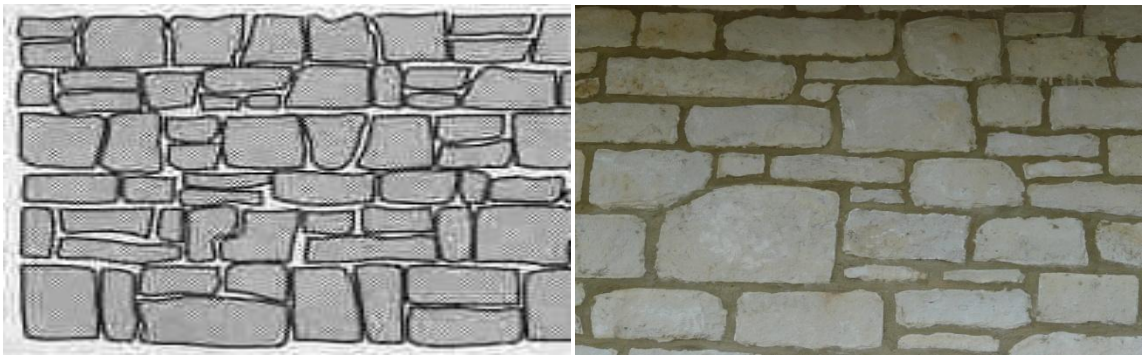


1. **Rubble masonry** - It is rough, uneven building stone set in mortar, but not laid in regular courses. It may appear as the outer surface of a wall or may fill the core of a wall which is faced with unit masonry such as brick or cut stone. This consists of blocks of stones either undressed or roughly dressed and having wider joints.

   i. Random rubble masonry – The rubble masonry in which either undressed or hammer dressed stones are used is called random rubble masonry. Further random rubble masonry is also divided into the following three types:

   a. Coursed - In this type of masonry, the stones used are of widely different sizes. This is the roughest and cheapest form of stone masonry. In coursed random

rubble masonry, the masonry work is carried out in courses such that the stones in a particular course are of equal height.



Coursed Random Rubble Masonry

b. **Uncoursed -** In this type of masonry, the stones used are of widely different sizes. This is the roughest and cheapest form of stone masonry. In uncoursed random rubble masonry, the coarses are not maintained regularly. The larger stones are laid first and the spaces between them are then filled up by means of spalls or sneeks.

Uncoursed Random Rubble Masonry

ii. ***Square rubble masonry –*** In this rubble masonry, in which the face stones are squared on all joints and beds by hammer dressing or chisel dressing before their actual laying, is called squared rubble masonry. There are two types of squared rubble masonry.

a. **Coursed** - In this type of masonry stones having straight bed and sides are used. The stones are usually squared and brought to hammer dressed or

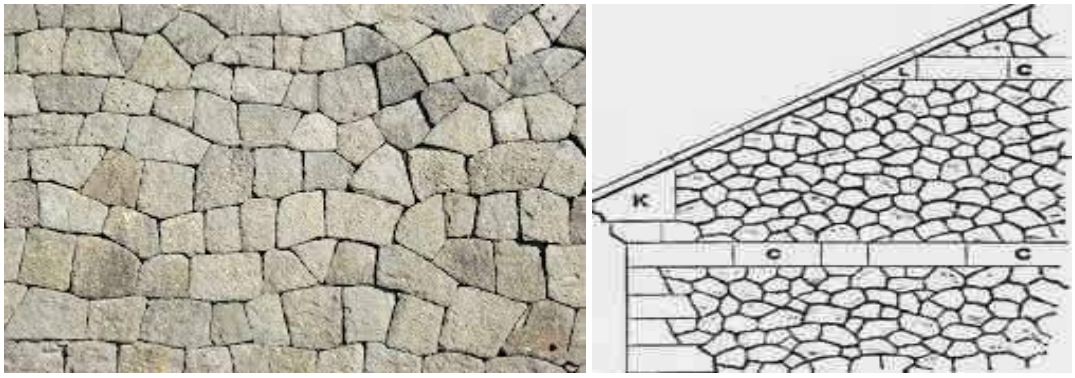
straight cut finish. In the coursed square rubble masonry, the work is carried out in courses of varying depth.

Coursed Square Rubble Masonry

b. Uncoursed - In this type of masonry stones having straight bed and sides are used. The stones are usually squared and brought to hammer dressed or straight cut finish. In the uncoursed square rubble masonry, the different sizes of stones having straight edges and sides are arranged on face in several irregular patterns.

Uncoursed Square Rubble Masonry

iii. Polygonal rubble masonry - In this type of rubble masonry, the stones are hammer dressed. The stones used for face work are dressed in an irregular polygonal shape. Thus the face joints are seen running in an irregular fashion in all directions.



Polygonal rubble masonry

iv. ***Flint rubble masonry -*** In this type of masonry, stone used are flints or cobbles. These are irregularly shaped nodules of silica. The stones are extremely hard. But they are brittle and therefore they break easily.

Flint rubble masonry

v. ***Dry rubble masonry -*** In this type of masonry, mortar is not used in the joints. This type of construction is the cheapest and requires more skill in construction. This may be used for non-load bearing walls such as compound walls.

Dry rubble masonry

2. **Ashlar Masonry –**It is finely dressed (cut, worked) masonry, either an individual stone that has been worked until squared or the masonry built of such stone. It is the finest stone masonry unit, generally cuboids or less frequently trapezoidal.

i. ***Ashlar fine masonry -*** In this type, each stone is cut to uniform size and shape with all sides rectangular, so that the stone gives perfectly horizontal and vertical joints with adjoining stone. This type is very costly.

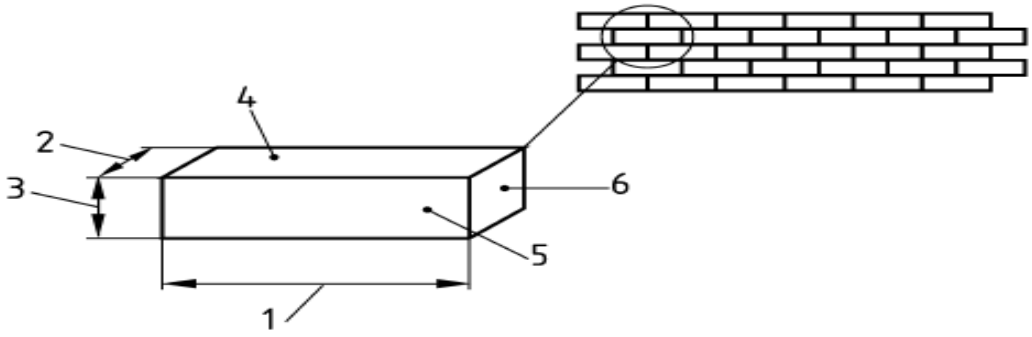
General principles to be followed in the construction of stone masonry:

1. The stone used shall be hard, durable and tough. All stones should be laid on its natural bed.
2. The pressure acting on the stones should not act parallel to the bedding planes. This will try to split the stones. Sometimes stones used in corbels are laid with pressure acting parallel to bedding planes.
3. The bond stones and headers should not be of dumb-bell shape.
4. Large flat stones should be laid under the ends of girders, roof trusses, etc.
5. In all slopping retaining walls, the beds of the stones and the plan of the courses should be at right angles to the slope.
6. All laid fine dressed stone work should be protected against damage during further construction by means of wooden boxes.
7. Jambs for door and window openings should be made of quoins which are equal in height to the course. They should be in breadth equal to at least 1½ times the height of the course and their length should be at least twice the height.
8. All the surfaces should be kept wet while the work is in progress and also till the mortar has set.
9. Double scaffolding will be used wherever it is difficult to fit in the stones later on.
10. All the portions of the masonry should be raised uniformly. Wherever this is not possible, the stone work built earlier should be raked (stepped) so that the new work can be bonded well with the old.
11. Sufficient through stones should be used and they should form ¼th of the area in elevation.
12. The hearting of the masonry should be properly packed with mortar and chips, if necessary, to avoid any hollows or very thick mortar joints.
13. Vertical faces of the masonry walls should be checked with a plumb rule and the battered faces should be tested with wooden template corresponding to the batter and a plumb rule to ensure a constant batter.
14. The stones used in the masonry should be wetted before use to avoid moisture being sucked from the mortar.
15. Masonry should not be allowed to take tension.

BRICK MASONRY

The art of laying bricks in mortar in a proper systematic manner gives homogeneous mass which can withstand forces without disintegration, called brick masonry. Bricks are of uniform size and shape, light in weight, durable, fire resistant, have high resale value, low maintenance cost and are easily available in plain areas. Brick Masonry is commonly used for construction of ordinary as well as important buildings in plain areas.

The surfaces of a brick have names 1) Top and bottom surfaces are beds 2) Ends are headers and header faces and 3) Sides are stretchers or stretcher faces.



Key

1 Length	2 Width	3 Height
4 Bed	5 Face	6 Header

Some important terms used in brick masonry

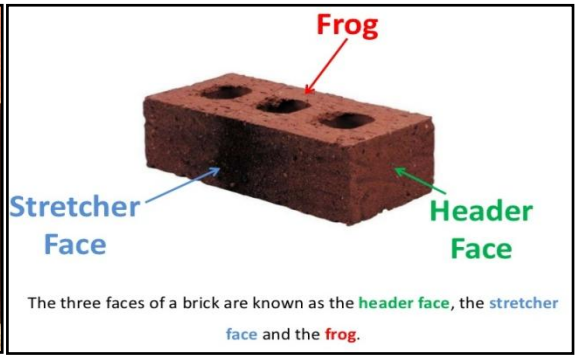
1. ***Brick*** **-** An artificial structural element in the form of a rectangular block of clay is called a "Brick ". Bricks can be manufactured of any required shape and size.

2. ***Frog*** **-** The depression provided in the face of a brick is called a "Frog". It is provided in the brick to achieve the following purposes:

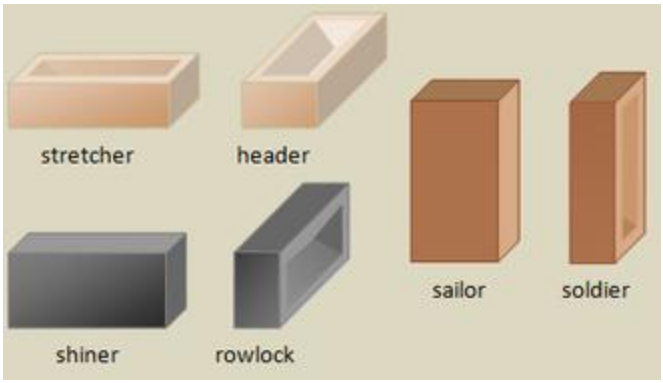
(a) To form a key of mortar in between any two adjacent courses of brick work, so as to increase the lateral strength of the structure.

(b) To reduce the weight of the bricks, so that the bricks can be laid with convenience.

(c) To provide a place for putting the impression of trade-mark or the year of manufacturing of the bricks.



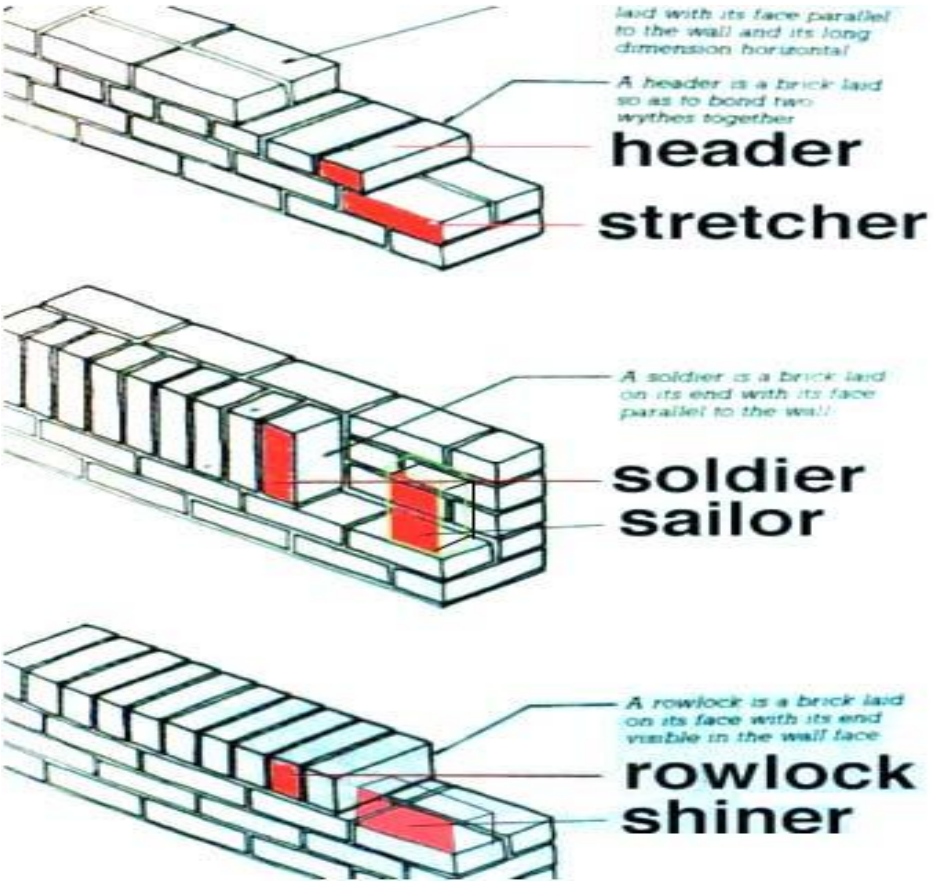
3. ***Position of bricks*** **–** Stretcher, Header, Sailor, Soldier, Shiner, Rowlock.



(a) The position of brick, when laid with its Frog upward in the horizontal plane, is termed as "*Brick on bed*".

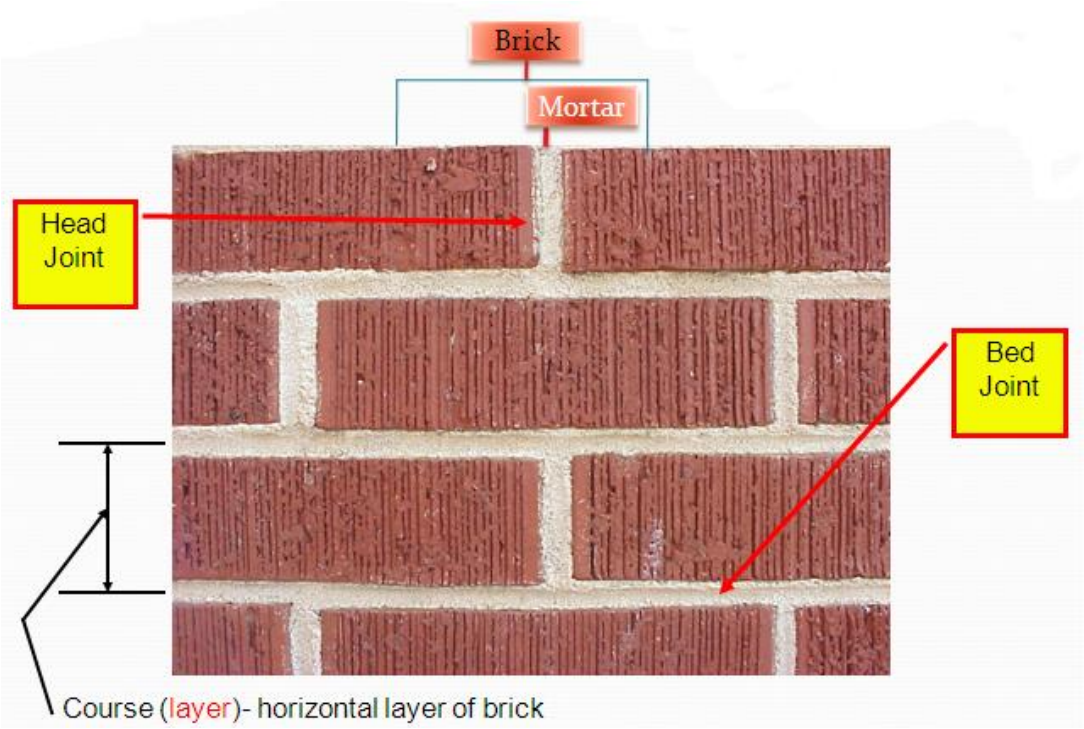
(b) The position of the brick when laid on its side with frog in the vertical plane is called "*Brick on edge*".

(c) The position of brick when laid on its side with frog in the vertical plane is called "*Brick on end*".

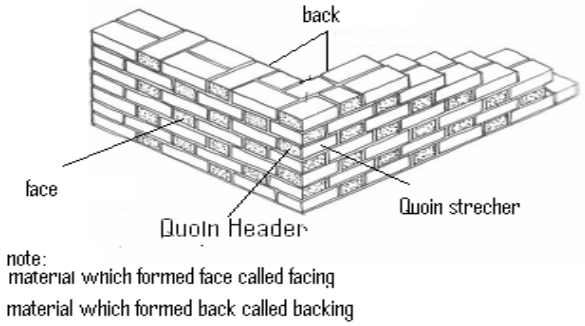


4. Course - Each horizontal layer of bricks laid in mortar in a brick work

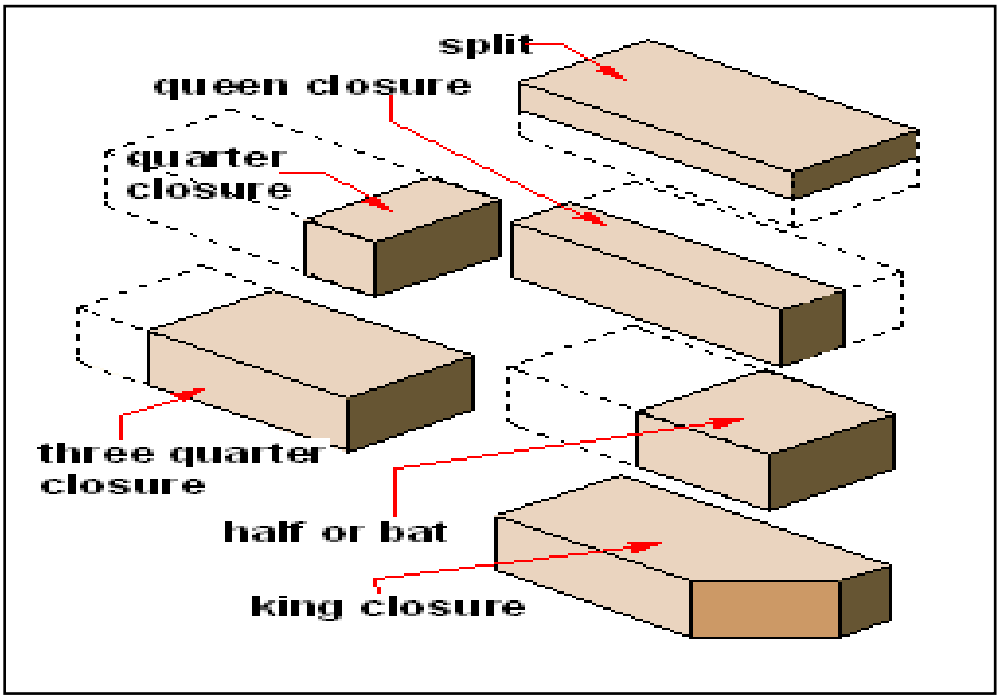
5. ***Joints*** – The two types of joints are head joints and bed joints.



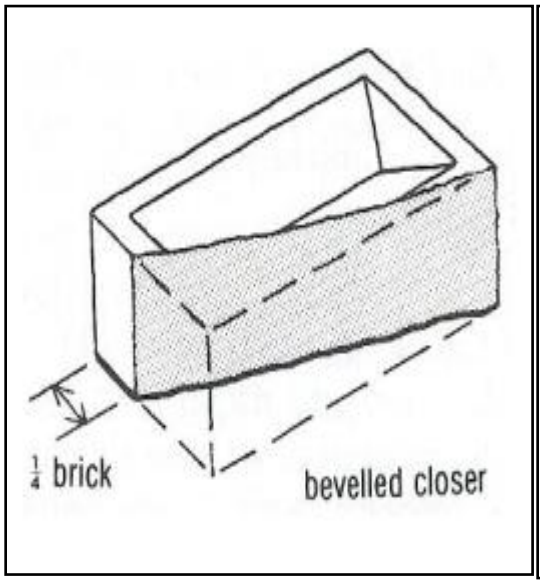
6. ***Stretcher*** - Brick, laid with its length horizontal and parallel with the face of the wall or other masonry member is called a Stretcher and a course, in which, all the bricks are laid as Stretchers is called a "Stretching course" or Stretcher course.
7. ***Header*** - A brick lay, so that only its end shows on the face of a wall is called a Header and a course, in which all the bricks are laid as headers, is known as Heading Course or Header course.
8. ***Quoin*** - The external corner of the wall
9. ***Quoin brick*** - The brick, which forms the external corner of a wall
10. ***Quoin header*** - A corner header, in the face of wall, which is a stretcher in the side wall
11. ***Quoin stretcher*** - A corner stretcher in the face of a wall, which is header in the side wall.

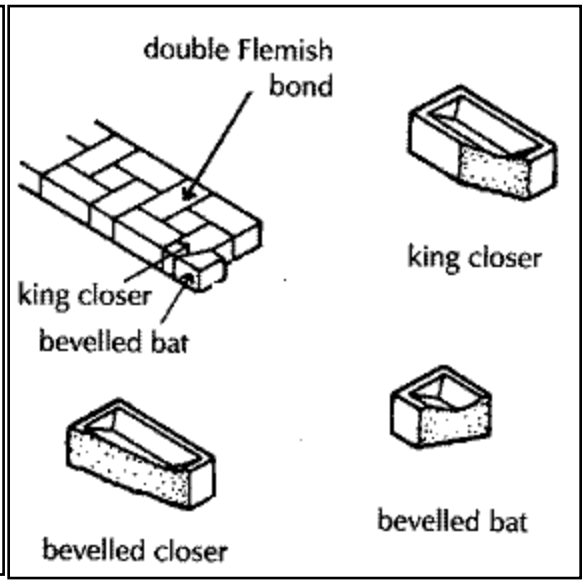


12. ***Brick bats*** - The pieces of bricks, cut long their length and having width equivalent to that of a full or half brick
13. ***Queen closer*** - A brick, which is half as wide as full brick and is made by cutting a whole brick lengthwise into two portions. These are generally used next to the Quoin header for creating bonds in brickwork.
14. ***King closer*** - A brick whose one diagonal piece is cut off one corner by a vertical plane passing through the center of one end to the center of one side. It is actually 7/8 of a full brick but is usually called a 3/4 brick



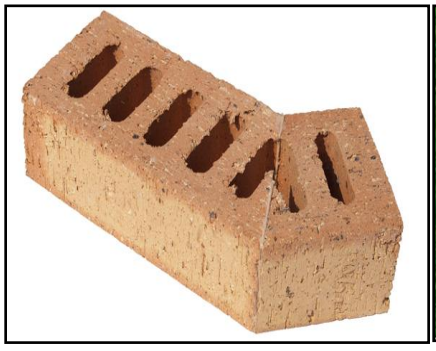
15. Beveled closer **-** A brick cut longitudinally along a vertical plane, starting at the middle of one end to the far corner. One quarter of the brick is cut off in this way.



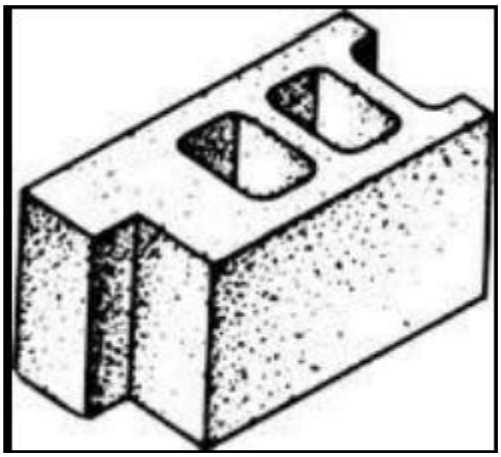


16. Bull nose brick - A brick with rounded corners

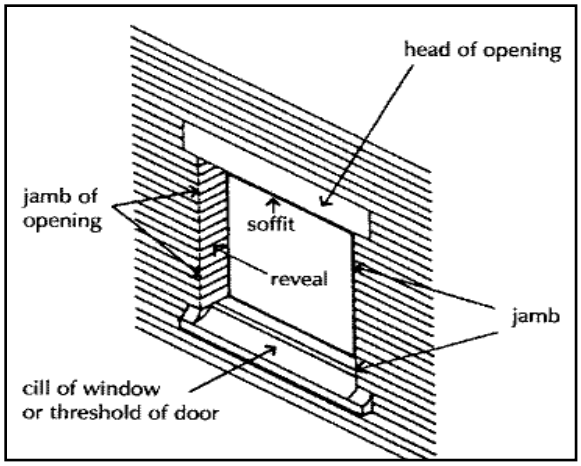
17. Squint bricks - These bricks are used to construct acute (>90 degree) or obtuse (< 90 degree) corners in brick masonry. These are special forms of bricks.



18. Jamb - The vertical sides of door or window openings provided in a wall



19. Reveals - The part of the Jamb opening , which is exposed between a door or window frame and the face or back of a wall



20. Sill - The horizontal part (either of timber, concrete, stone, metal, etc) at the bottom of a door or window, supporting the vertical members of the frame is known as Sill and its height window base from the floor level is known as Sill level.

21. Mortar **-** The paste obtained by mixing a binding material and a fine aggregate in suitable proportions in addition to water is known as Mortar. Cement and Lime are used as binding materials and Sand, Surkhi, Cinder, etc. are used as fine aggregates. The mortars are named according to the type of binding material used in their preparation such as, cement mortar, lime mortar, etc. The mortar prepared from simple earth is known as "Mud Mortar". The mortar not only acts as a cementing bed between any two courses of bricks but also, gives strength to the structure by holding the individual bricks together to act as a homogenous mass.



BONDS

Bond is the arrangement of bricks or stones in each course, so as to ensure the greatest possible interlocking and to avoid the continuity of vertical joints in two successive courses, both on the face and in the body of a wall.

Objectives of bonds

(a) The primary objective of providing a bond is to break the continuity of the vertical joints in the successive courses both in the length and thickness of masonry structure. As a result, the structure will act as a bounded mass and its load will be transmitted uniformly to the foundations.

(b) To ensure longitudinal and lateral strength of the structure.

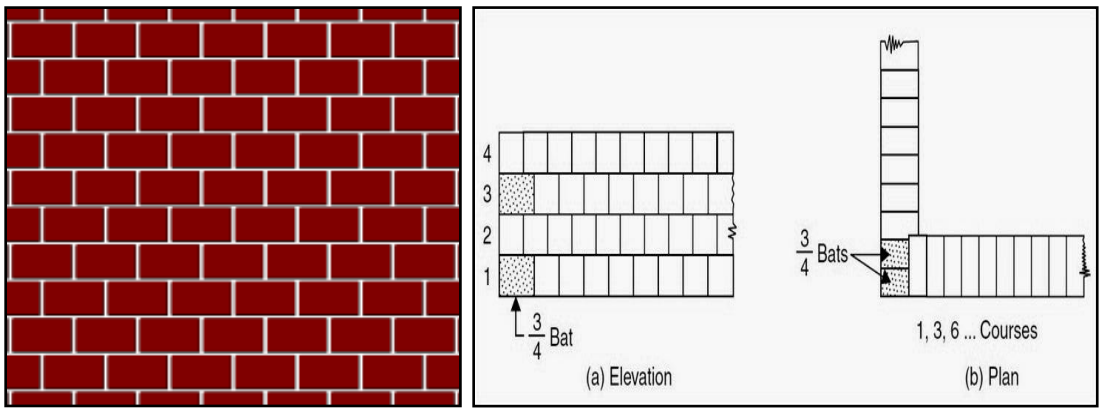
(c) To provide pleasing appearance by laying bricks symmetrically.

(d) To do masonry work quickly by engaging more masons on a job at a time.

Types of bonds

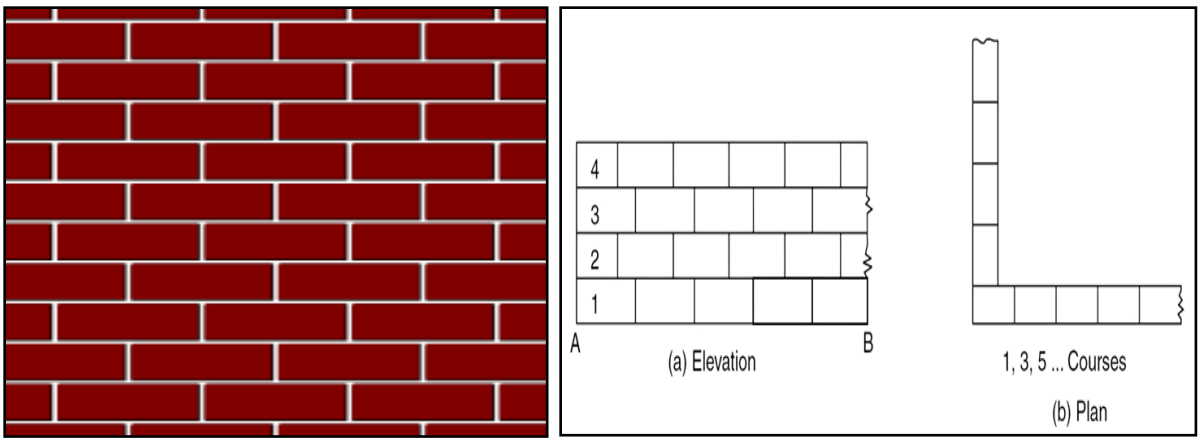
1. Header Bond
2. Stretcher Bond
3. English Bond
4. Flemish Bond
    a. Double Flemish Bond
    b. Single Flemish Bond
5. Raking Bond
    a. Herring bone bond
    b. Diagonal bond
6. Zig-Zag bond

1. Header Bond - A header is the shorter face of the brick as seen in the elevation. In header bond brick masonry all the bricks are arranged in the header courses. This type of bond is useful for the construction of one brick thick walls.



Header Bond

2. ***Stretcher Bond*** - A stretcher is the longer face of the brick as seen in the elevation. In stretcher bond masonry all the bricks are arranged in stretcher courses. However care should be taken to break vertical joints. This type of construction is useful for the construction half brick thick partition wall

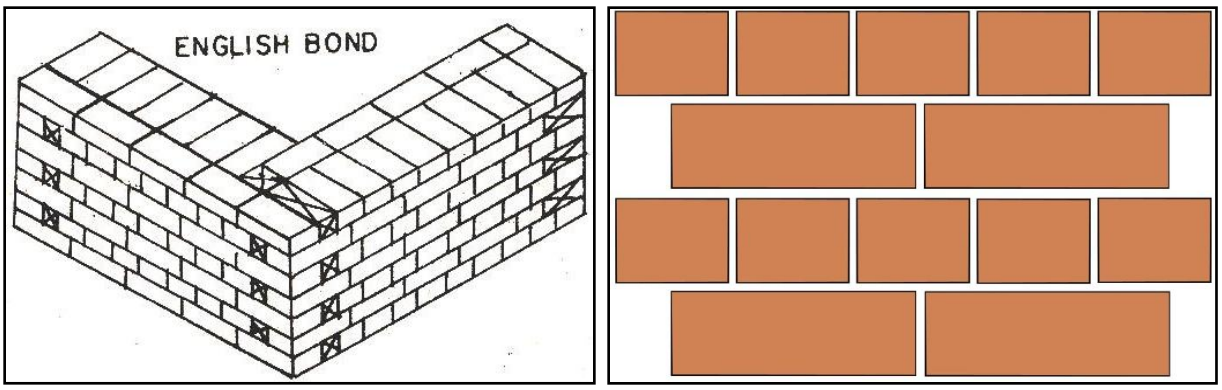


Stretcher Bond

3. ***<u>English Bond</u>*** - The bond, in which headers and stretchers are laid in alternate courses.

The following are the salient features of English bond:

- Headers and stretchers are laid in alternate courses.
- In each heading course, a queen closer is placed next to quoin header and the remaining bricks are laid as headers.
- Every alternate header in a course comes centrally over the joint between two stretchers in the course below.
- The same course will show headers or stretchers on face and back, if the thickness of the wall is an even multiple of half bricks
- The same course will show headers on the face and stretchers on the back and vice versa, if the thickness of the wall is an odd multiple of half brick.
- The middle portion of the thicker walls consists entirely of headers.
- Every transverse joint is continuous from face to face.



English Bond

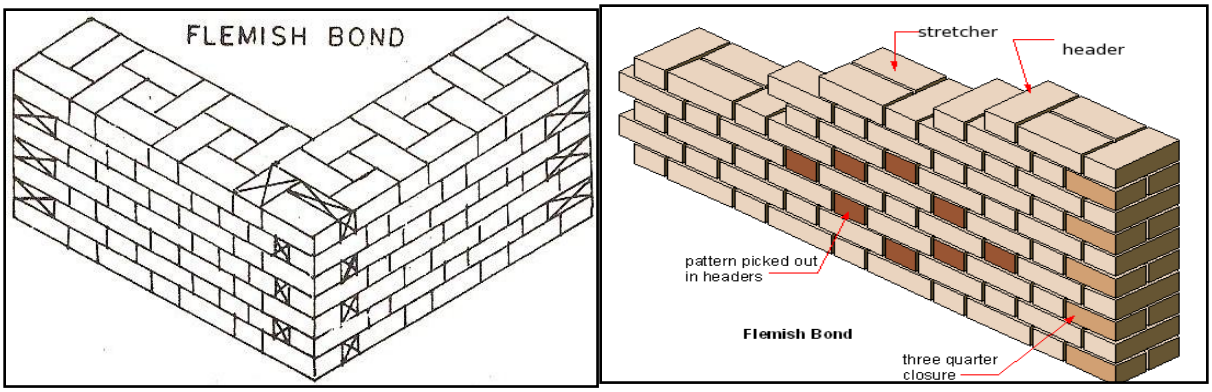
4. ***Flemish Bond*** - In this type of bond each course comprises of alternate header and stretcher. The alternate courses start with stretcher and header. To break the vertical joints queen closers are required, if a course starts with header. Every header is centrally supported on the stretcher below it.

Flemish bonds may be further classified as

- Double Flemish Bond
- Single Flemish Bond

In case of ***Double Flemish bond***, both faces of the wall have Flemish look, *i.e.* each course consist of alternate header and stretcher, whereas ***Single Flemish bond*** outer faces of walls have Flemish look whereas inner faces have look of English bond.

Construction of Flemish bond needs greater skill. It gives more pleasing appearance. But it is not as strong as English bond. If only pointing is to be used for finished wall, Flemish bond may be used to get good aesthetic view. If plastering is going to be used, it is better to use English bond.



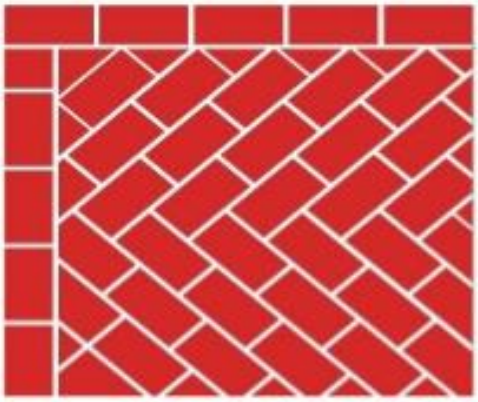
Flemish bond

Comparison of English Bond and Flemish bond

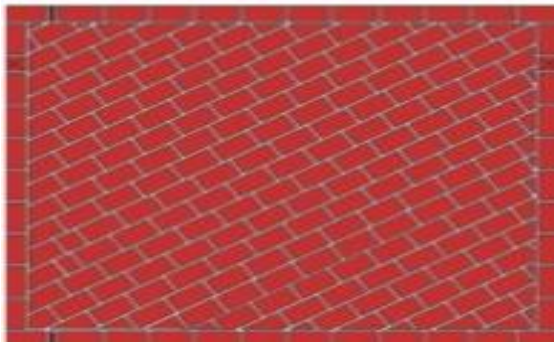
Sl. No.	***English Bonds***	***Flemish bond***
1	This bond consists of headers and stretchers laid in alternative courses.	This bond consists of headers and stretchers laid alternatively in each course.
2	It is strongest of all the bonds.	It is less strong for walls having thickness more than 13 ½ inches.
3	It provides rough appearance especially for one brick thick walls.	It provides good appearance for all thickness of walls.
4	There are no noticeable continuous vertical joints in the structure built in this bond.	There are partly continuous vertical joints in the structure built in this bond.
5	Much attention is not required in providing this bond.	Special attention is required in providing this bond.
6	Progress of work is more.	Progress of work is less.
7	It is costly because the use of brick bats is not allowed.	It is economical because brick bats are allowed for forming this bind.

5. ***Raking Bond*** - The bond in which all the bricks are laid at an angle other than 90° to the facing and backing of the wall is known as Raking bond. This bond is used for doing inner filling of walls at suitable intervals to improve their longitudinal strength. The angle of rake between any two adjacent courses should be 90 º to attain maximum transverse strength of the wall. This bond can also be used as paving in case of brick floors.

a. *<u>Herring bone bond</u>* - The raking bond in which bricks are laid at an angle of 45º, starting at the central line and proceeding towards the facing and backing of the wall, is called Herring Bone Bond.



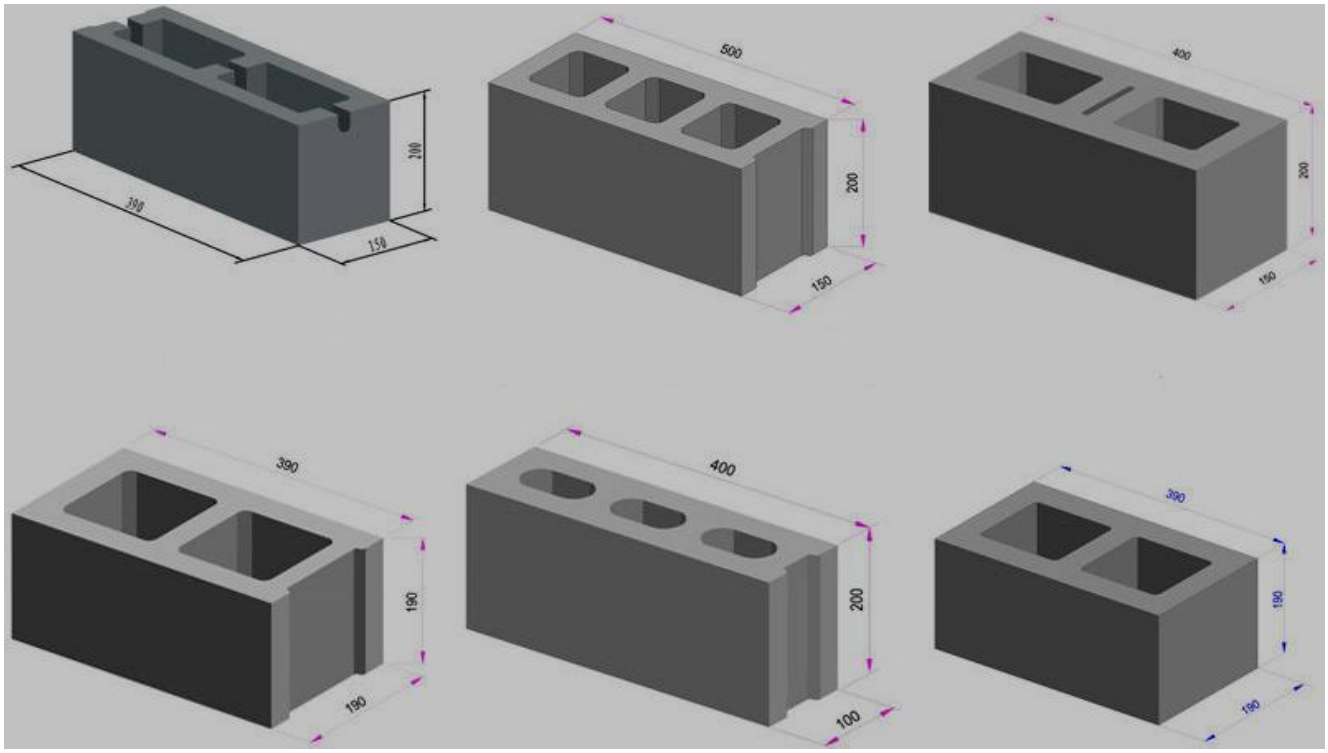

b. *<u>Diagonal bond</u>* - The raking bond in which bricks are laid starting from the corner in parallel rows inclined to the facing and backing of the wall is known as Diagonal bond.




6. ***Zig-Zag bond*** - This is similar to herring-bone bond with the only difference that in this case the bricks are laid in a zig-zag fashion. This is commonly adopted in brick paved flooring.


HOLLOW BLOCK MASONRY REINFORCED

Solid and hollow concrete blocks are manufactured to meet the growing requirement of building blocks in towns and cities. They are manufactured with lean mixes of cement, sand and aggregate of size less than 12mm. The size of solid concrete block is 400x200x150 mm (normal size). The minimum strength prescribed is 4 N/mm^2. The block should have sharp edges and right angled corners. Hollow block of normal sizes 400x200x190mm and 400x300x190mm are manufactured. The net area of hollow block is 55-60% of the gross area. They should have sharp edges and right-angled corners.



Requirement of good Hollow blocks

- Blocks should be dry before use.
- Vertical joints should be broken.
- Mortar used should not be stronger than the block itself. The preferable mortar is 1:1:10 cement-lime-sand mix.
- The joints should be 5-10mm thick.
- The blocks used for external walls should have absorption less than 10%. For internal walls, adsorption up to 15% may be permitted.
- Solid concrete blocks or hollow blocks filled with site concrete should because in the junction of walls and also in the middle of long walls to avoid cracking due to expansion

Advantages of using concrete block

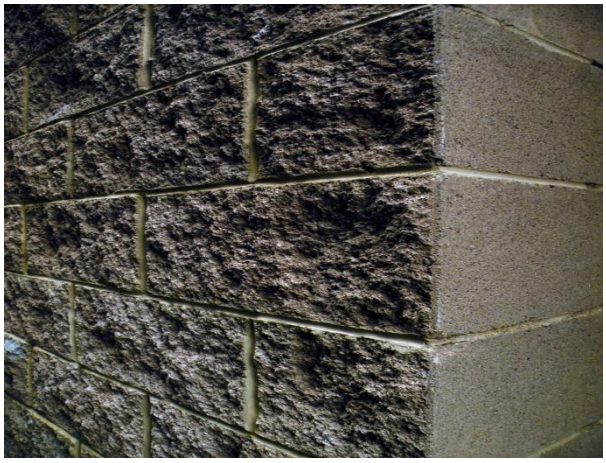
1. Construction is fast, as the size of the block is large and the mortar required is less.
2. To build a 1 m^2 and thickness 200mm, only 10 blocks are required as against 115clay bricks. It needs only 13 liters of cement mortar as against 45 liters required in brick masonry.
3. Highly Durable - The good concrete compacted by high pressure and vibration gives substantial strength to the block. Proper curing increase compressive strength of the blocks.
4. Low Maintenance, Color and brilliance of masonry withstands outdoor elements.
5. Load Bearing, strength can be specified as per the requirement.
6. Fire Resistant
7. Provide thermal and sound insulation: The air in hollow of the block, does not allow outside heat or cold in the house. So it keeps house cool in summer and warm in winter.
8. Economical
9. Environment Friendly, fly ash used as one of the raw materials.

Use of Hollow blocks in surface finishes as:

a) Coarse textured
b) Glazed finish
c) Slumped finish
d) Specially faced finish
e) Colored finish

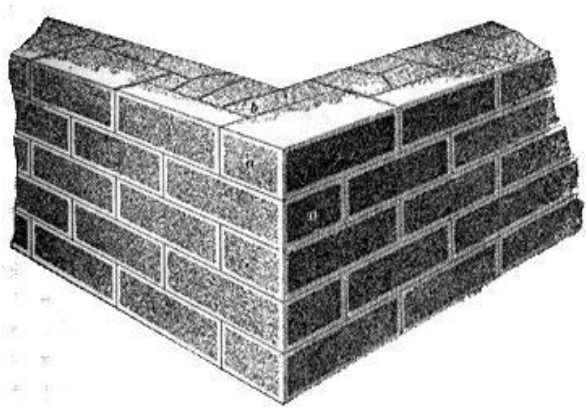
COMPOSITE MASONRY

1. ***Stone Composite Masonry*** - Stone composite masonry is constructed with stone and one or more combinations of materials, like stone facing and brick backing or stone facing and concrete backing. Stone composite masonry is of different types, each having its own properties. To make use of both ashlar and rubble, composite masonry may be used. In such masonry, the facing is with ashlar masonry, while the backing is with rubble masonry.

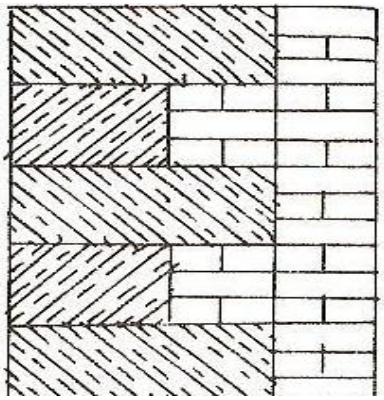
2. ***Brick-Stone Composite Masonry***

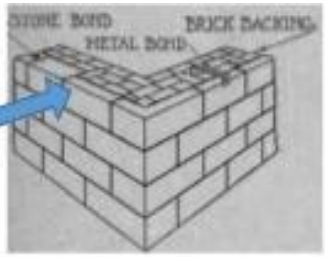
   i. *Rubble-Backed Brick Masonry* - The facing is of brick masonry, while the backing is of rubble stone masonry. This type of composite masonry is commonly adopted in locations where stone is available locally in large quantities.

   ii. *Brick-Backed Ashlar Masonry* - In this type the facing is of ashlar stone masonry, while the backing is of brick masonry. It is used where skilled labor and beautiful stones are

available. The stones thickness should be such that multiple layers of bricks match it. Care should be taken to break vertical joints. Cement mortar is preferred for such masonry.





Ashlar facing masonry.

iii. *Brick-Backed Stone Slab Masonry* - The facing is granite or marble and the backing is of bricks. It is preferable to use metal cramps to connect the facing and backing.

3. ***Reinforced Brick Masonry*** - Ordinary brick masonry cannot take tensile stresses because bricks get pulled apart at the mortar joints. In such situations brick masonry is reinforced by steel bars or expanded bars. Reinforced brick works are commonly used in lintels, retaining walls, walls built on soil that is susceptible to large settlement and in seismic zones. Sometimes, brick columns are strengthened with bars to increase their compressive load-carrying capacity.


WALLS

Function of Walls

- To provide protection from weather, animal
- To divide the areas
- Act as sound barriers
- As fire walls to attenuate the spread of fire from one building unit to another
- Separate the interior spaces
- To improve the building appearance
- To provide privacy

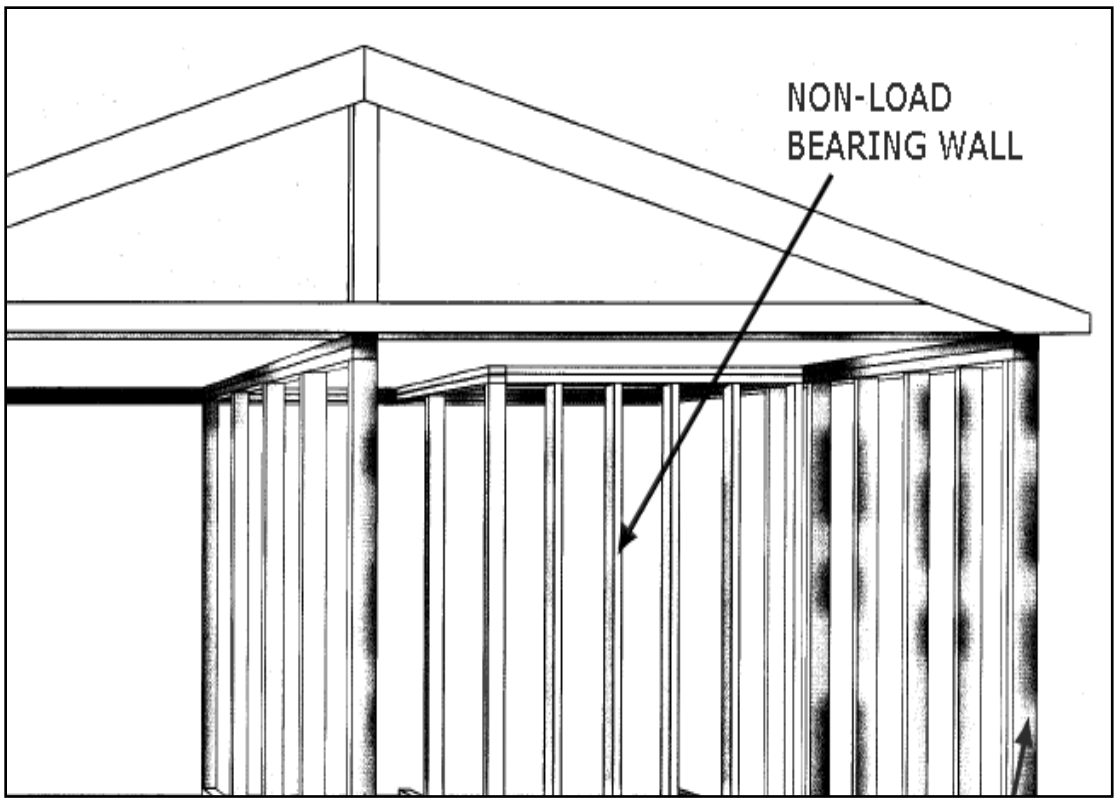
Material for Wall Construction

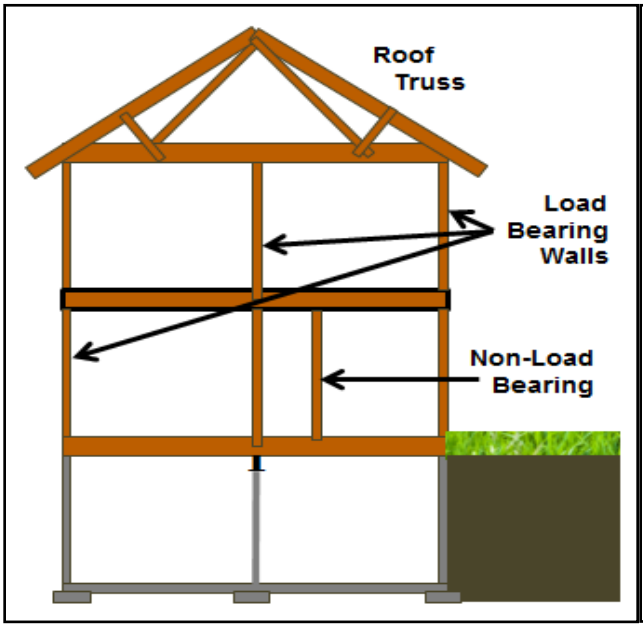
Timber, brick, concrete block, reinforced concrete can be used for wall construction. They are good for wall construction due its durability, beauty and able to provide comfortable area. The Reinforced concrete is also used for precast concrete panel on walls.

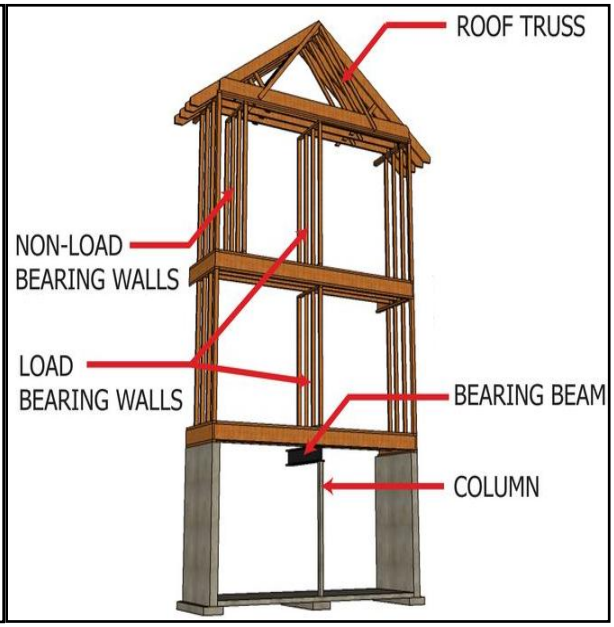
Wall Classification

There are 2 types of wall that is:

1. **Load Bearing Wall** - Able to carry the load from above (own weight & load from roof) and transfer it to the foundation. It can be exterior wall or interior wall. It brace from the roof to the floor.


NON-LOAD
BEARING WALL


Roof
Truss
Load
Bearing
Walls
Non-Load
Bearing


ROOF TRUSS
NON-LOAD
BEARING WALLS
LOAD
BEARING WALLS
BEARING BEAM
COLUMN

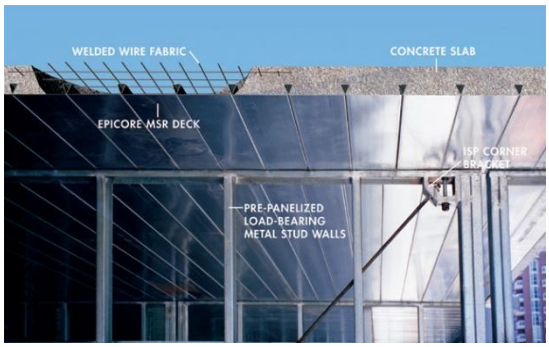
Types of LBW:

- Pre Cast Concrete Wall


- Retaining Wall


- Masonry Wall


- Pre Panelized Load Bearing Metal Stud Walls

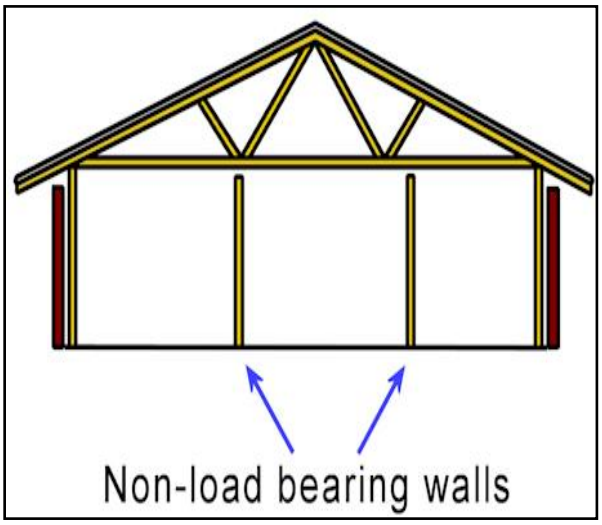


- Engineering Brick Wall


- Stone Wall


As the height of the building increased, required thickness of wall and resulting stress on foundation will also increase and cause it to be uneconomical.

2. **NON-LOAD BEARING WALL** - known as interior wall (doesn't carry other load than its own load)



Types of NLBW:

- Hollow Concrete Block

- Façade Bricks

- Hollow Bricks

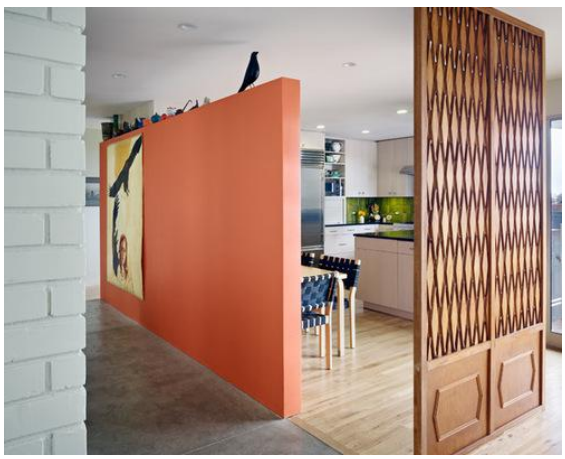
- Brick Wall

3. **Moveable walls -** accordion walls and modular panels. If space needs change often, you should consider using moveable walls. Conference centers, office spaces, etc.


Accordion Walls


Modular Panels

4. **Partial Walls -** Walls that are less than ceiling height, offer visual privacy but not acoustical privacy. It provides ventilation.

5. **Spur or Freestanding -** Walls that do not join adjacent wall at both ends. Example: fireplaces in the center of rooms, walls behind reception desks.


<u>Types of Masonry walls</u>

1. Load Bearing Masonry Walls

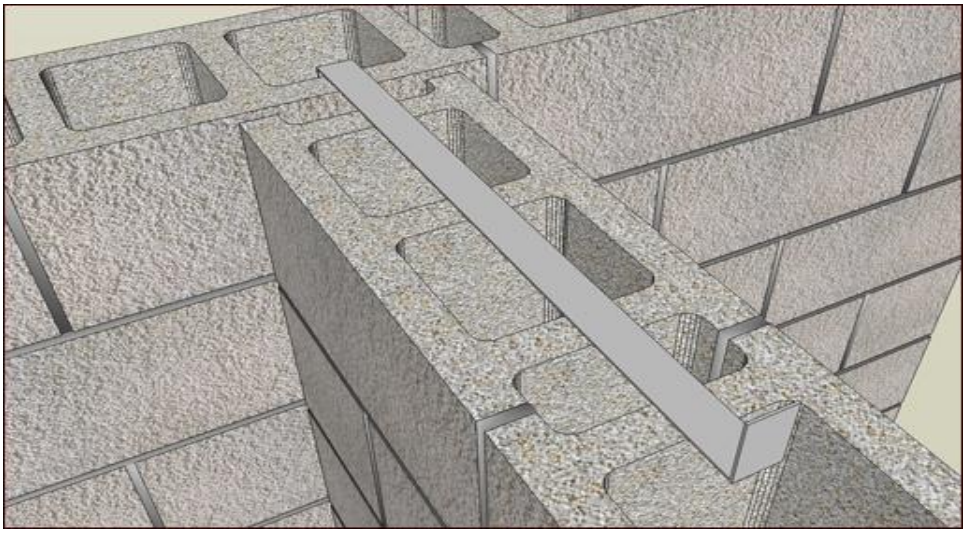
Load bearing masonry walls are constructed with bricks, stones or concrete blocks. These walls directly transfer loads from the roof to the foundation. These walls can be exterior as well as interior walls. The construction system with load bearing walls are economical than the system with framed structures. The thickness of load bearing walls is based on the quantity of load from roof it has to bear. For example a load bearing wall with just a ground floor can have its outer walls of 230mm, while with one or more floors above it, based on occupancy type, its thickness may be increased. The load bearing walls can be reinforced or unreinforced masonry walls.

2. **Reinforced Masonry Walls:**

Reinforced masonry walls can be load bearing walls or non-load bearing walls. The use of reinforcement in walls helps it to withstand tension forces and heavy compressive loads. The un-reinforced masonry walls are prone to cracks and failure under heavy compressive loads and during earthquakes. They have little ability to withstand lateral forces during heavy rain and wind. Cracks also develop in un-reinforced masonry walls due to earth pressure or differential settlement of foundations. To overcome such problems, reinforced masonry walls are used. Reinforcement in walls are at required intervals both horizontally and vertically is used. The size of reinforcement, their quantity and spacing are determined based on the loads on the walls and structural conditions.

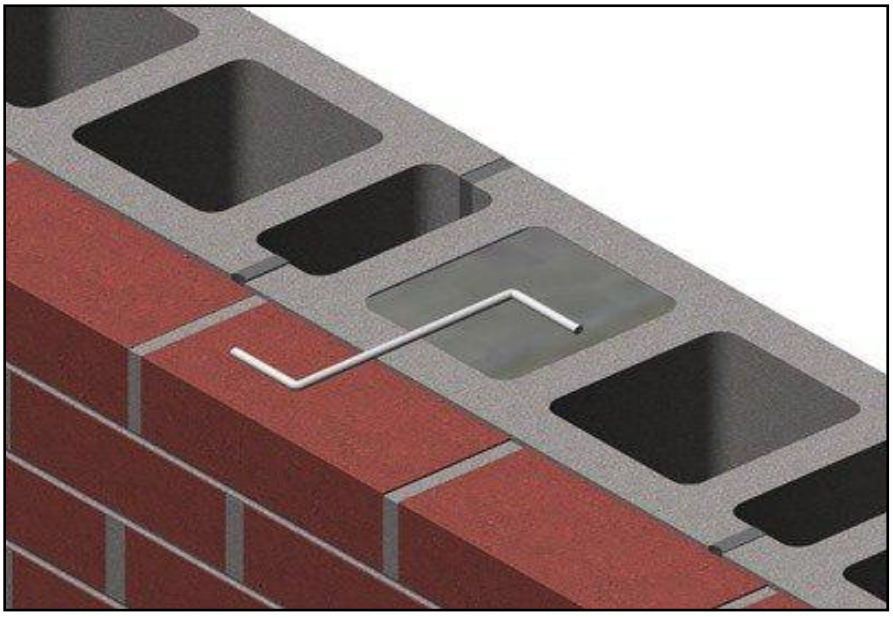
3. **Hollow Masonry Walls:**

Hollow or Cavity masonry walls are used to prevent moisture reaching the interior of the building by providing hollow space between outside and inside face of the wall. This wall also helps in temperature control inside the building from outside wall as the hollow space restricts heat to pass through the wall. When the wall is exposed to moisture for a sustained period and penetrates through the outer face, the water reaches the cavity or the hollow space and flows down. Then they are drained through the weep holes to the exterior of the building. These hollow spaces may be coated with water repellent coating or damp-proofing to further reduce the ingress of moisture



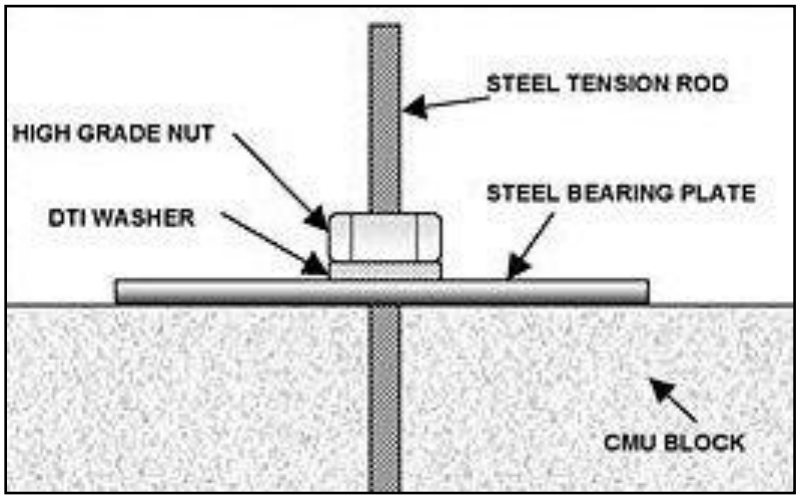
4. Composite Masonry Walls:

These walls are constructed with two or more units such as stones or bricks and hollow bricks. This type of masonry wall construction is done for better appearance with economy. In composite masonry walls, two Wythes of masonry units are constructed bonding with each other. While one Wythe can be brick or stone masonry while the others can be hollow bricks. A Wythe is a continuous vertical section of masonry one unit in thickness. These Wythe are interconnected either by horizontal joint reinforcement or by using steel ties.



5. Post-tensioned Masonry Walls

Post-tensioned masonry walls are constructed to strengthen the masonry walls against the forces that may induce tension in the wall such as earthquake forces or wind forces. These walls are constructed from the foundation level and post-tensioning rods are anchored into the foundation. These rods are run vertically between the wythes or in the core of concrete masonry units. After the masonry wall construction is completed and cured, these rods are tensioned and anchored on the steel place at the top of the wall.



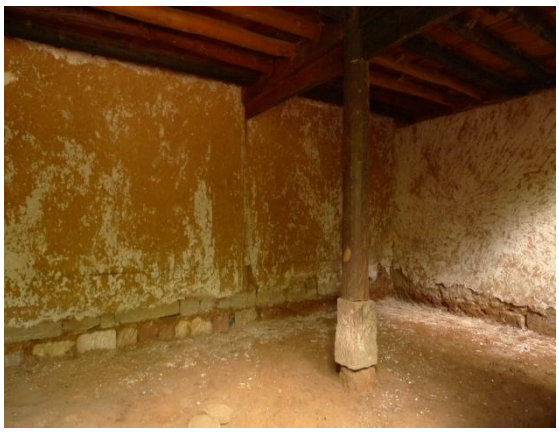
FLOORS

A part of a room, hallway, or the like, that forms its lower enclosing surface and upon which one walks or a continuous, supporting surface extending horizontally throughout a building, having a number of rooms, apartments, or the like, and constituting one level or stage in the structure.

Types of floor

- Muram or Mud floor
- Cement concrete floor
- Brick floor
- Tile floor
- Mosaic floor

1. Muram or Mud Floors - The ground floor having its topping consisting of Muram or mud is called Muram or Mud Floors. These floors are easily and cheaply repairable.



Method of Construction

- The surface of earth filling is properly consolidated
- 20cm thick layer of rubble or broken bats is laid, hand packed, wet and rammed
- 15cm thick layer of Muram or good earth is laid
- 2.5cm thick layer of powdery variety of Muram earth is uniformly spread
- The whole surface is well watered and rammed until the cream of Muram earth rises to the earth surface
- After 12 hours the surface is again rammed for three days.

- The surface is smeared with a thick paste of cow-dung and rammed for two days
- Thin coat of mixture of 4 parts of cow-dung and 1 part of Portland cement is evenly applied
- The surface is wiped clean by hand.
- For maintaining this type of floor properly, *gobri leaping** is done once a week

Suitability - These floors are generally used for unimportant building in rural areas

[**gobri leaping* - *After the mud plaster has dried, the surface should be given a coat of gobri leaping so as to completely fill any cracks that may have formed in the mud plaster. Mortar for gobri leaping shall be prepared by mixing equal quantities of fresh gobar and finely sieved clay and adding sufficient water to form a thin paste*]

Gobar

2. Cement Concrete Floor - The floor having its topping consisting of cement concrete is called Cement Concrete Floor or Conglomerate Floor.

Types of Cement Concrete Floor

According to the method of finishing the topping, Cement Concrete Floor can be classified into the following two types

i. Non-monolithic or bonded floor finish concrete floor
ii. Monolithic floor finish concrete floor

Non-monolithic or bonded floor finish concrete floor - The type of Cement Concrete Floor in which the topping is not laid monolithically with the base concrete is known as Non-monolithic or bonded floor finish concrete floor.

Method of Construction

- The earth is consolidated.
- 10cm thick layer of clean sand is spread.
- 10cm thick Lime Concrete (1:4:8) or Lean Cement Concrete (1:8:16) is laid thus forming base concrete
- The topping {4cm thick Cement Concrete (1:2:4)} is laid on the third day of laying base cement concrete, thus forming Non-monolithic construction.

This type of construction is mostly adopted in the field

The topping is laid by two methods

a) Topping laid in single layer - The topping consists of single layer of Cement Concrete (1:2:4), having its thickness 4cm
b) Topping laid two layers - The topping consists of 1.5cm thick Cement Concrete (1:2:3), which is laid monolithically over 2.5cm thick Cement Concrete (1:3:6)

Monolithic Floor Finish Concrete Floor - The Cement Concrete Floor in which the topping consisting of 2cm thick Cement Concrete (1:2:4) is laid monolithically with the Base Concrete is known as Monolithic Floor Finish Concrete Floor

Method of Construction

- The surface of Muram or earth filling is leveled, well watered and rammed
- 10cm layer of clean and dry sand is spread over
- When the sub soil conditions are not favorable and monolithic construction is desired, then, 5cm to 10cm thick hard core of dry brick or rubble filling is laid.
- 10cm thick layer of Base Concrete consisting of Cement Concrete (1:4:8) or Lean Cement Concrete (1:8:16) is laid.
- The topping {2cm thick layer of Cement Concrete(1:2:4)} is laid after 45 minutes to 4 hours of laying base Concrete

3. Brick Floors - The floors having its topping consisting of bricks are known as brick floor. These floors can easily be constructed and repaired. But this type of floor provides a rough surface. These can easily absorb moisture from the surrounding areas and may cause dampness in the building.


Method of Construction

- The Muram or earth filling is properly consolidated.
- 10cm thick layer of dry clean sand is evenly laid
- 10cm thick layer of Lime Concrete (1:4:8) or Lean Cement Concrete (1:8:16) is laid, compacted and cured to form a base concrete.
- Well soaked bricks are laid in Cement Mortar (1:4) in any desired bond pattern e.g. Herring Bond, Diagonal Bond or any other suitable bond
- In case the pointing is not to be done, the thickness of joints should not exceed 2mm and the mortar in joints is struck off flush with a trowel
- In case the pointing is to be done, the minimum thickness of joints is kept 6mm and the pointing may be done as specified.

Suitability - This type of floor is suitable for stores, god owns etc.

4. Tile Floor - The floor having its topping consisting of tiles is called tile floor.


Method of Construction

- The Muram or earth filling is properly consolidated.
- 10cm thick layer of dry clean sand is evenly laid
- 10cm thick layer of Lime Concrete (1:4:8) or Lean Cement Concrete (1:8:16) is laid, compacted and cured to form a base concrete.
- A thin layer of lime or cement mortar is spread with the help of screed battens.
- Then the screed battens are properly leveled and fixed at the correct height.
- When the surface mortar is harden sufficiently, 6mm thick bed of wet cement (1:5) is laid and then over this the specified tiles are laid.
- The surplus mortar which comes out of the joints is cleaned off.
- After 3 days, the joints are well rubbed with a carborundum stone to chip off all the projecting edges.
- Rubbing should not be done in case of glazed tiles
- The surface is polished by rubbing with a softer variety of carborundum or a pumice stone.
- The surface is finally washed with soap.

Suitability - This type of floor is suitable for courtyard of buildings. Glazed tiles are used in modern buildings where a high class finish is desired.

5. Mosaic Floors - The floors having its topping consisting of mosaic tiles or small regular cubes, square or hexagons which are embedded into a cementing mixture are known as Mosaic Floors.


Method of Construction

- The earth is consolidated.
- 10cm thick layer of clean sand is spread.
- 10cm thick Lime Concrete (1:4:8) or Lean Cement Concrete (1:8:16) is laid thus forming base concrete
- Over this base course 5cm thick Lime Mortar or Cement Mortar or Lime and Surkhi mortar (1:2) is laid.
- The mortar is laid in small area so that the mortar may not get dried before finishing the wearing course.
- 3mm thick cementing mixture is spread.
- The cementing mixture consists of one part of pozzolana, one part of marble chips and two parts of slacked lime.
- After nearing 4 hours, patterns are formed on the top of the cementing material.
- Now the tiles of regular shaped marble cubes are hammered in the mortar along the outline of the pattern.
- The inner spaces are then filled with colored pieces of marble.
- A roller 30cm in diameter and 50cm in length is passed gently over the surface.
- Water is sprinkled to work up the mortar between the marble pieces.
- The surface is then rubbed with pumice stone fixed to a wooden handle about 1.5m long.
- The surface is then allowed to dry up for 2 weeks

Selection of flooring material

It depends upon below factors:

- Initial Cost
- Appearance
- Cleanliness
- Durability
- Damp Resistance
- Sound Insulation
- Thermal Insulation
- Fire Resistance

- Smoothness
- Hardness
- Maintenance

Characteristics of a good floor finish

- It should be durable
- It should be easy to clean
- Noiseless
- Have Good Appearance
- Free from dampness
- Fire Resistant
- Low Maintenance cost

FLOOR FINISHES

A floor finish is a general term for a permanent covering of a floor. It is expected to protect and extend the life of the floor while providing an attractive appearance and slip resistant surface. The ingredients used are to enhance floor finish characteristics like **hardness, surface shine, clarity, scratch resistance, slip resistance, water and detergent resistance, rub ability, removability, recoat ability, and toughness.**

There are five basic categories of floor finish ingredients,

1) Polymer emulsions
2) Film formers,
3) Modifiers
4) Preservatives
5) Water

Types of floor finish

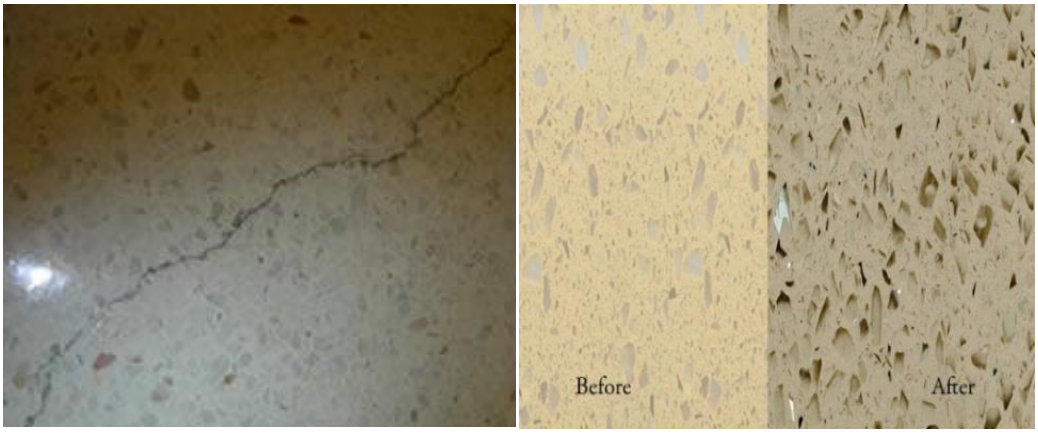
1) Terrazzo Flooring
2) Stone Flooring
3) Timber Flooring

1. ***Terrazzo Flooring*** - Terrazzo is a flooring material traditionally made by exposing marble chips on the surface of concrete and then polishing until smooth. However terrazzo is now available in tile form. It's often used in public buildings because it's long-lasting and can be refinished repeatedly. The typical thickness for terrazzo is between 2 1/2" and 3". It is best used for Flooring, walls and so on.

CONCRETE + STONE, GLASS, PLASTIC AGGREGATES = TERRAZO

Advantages and Disadvantages

Sl No.	***ADVANTAGES***	***DISADVANTAGES***
1	Unique beauty	Terrazzo is quite slippery.
2	Elegance	Expensive
3	Longevity	Need skills for installation
4	Comfortable under feet	Polishing needed for maintaining the look.
5	Controls noise	Cracks, Discoloration, Scratches



Cracks Discoloration

2. ***Stone Flooring -*** It is a type of flooring in which the floor is covered with stone slabs or stone tiles .Used in public buildings because of it durability and hardness. There are three basic types of rock from which we carve out stone floors i) Sedimentary rock ii) Igneous rock iii) Metamorphic

Types of stone flooring

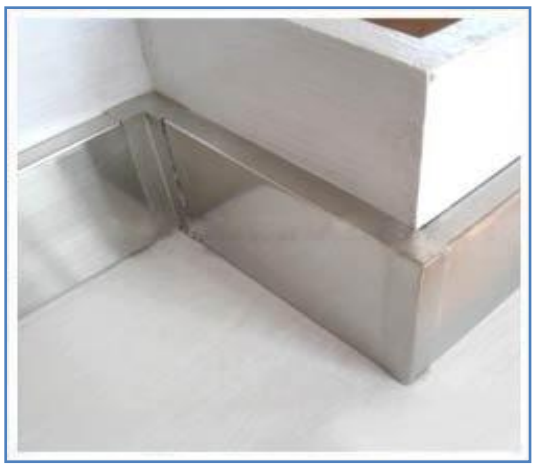
Marble Flooring – It is available in various colors depending on origin. It is fine and prosperous looking floors. It is mainly used in homes for interior flooring reason. It is an expensive flooring type which is available in different sizes.

➢ *Slate Flooring* – It can be used in homes for outdoor flooring reasons. It is very hard in nature. It has variety of colors. It is extremely durable and slip-resistant. This is also available in different sizes and shapes.

➢ *Granite Flooring* - It is composed of quartz and feldspar mixed with particles of mica. It is of coarse-grained, light-colored. It has long life and easy to install. The granite floors are being used in areas which are used every day.


Sl No.	***ADVANTAGES***	***DISADVANTAGES***
1	Very hard in nature	Formation of cracks
2	Extremely durable	Regular washing and cleaning
3	Variety of colors	Weight of material

3. ***Timber Flooring*** - It is any product manufactured from timber that is designed for use as flooring, either structural or aesthetic. It is a common choice as a flooring material due to its environmental profile, durability, and restorability. It is mainly used in interiors as well as exteriors. It is usually laid in interiors including bedroom, living area, dining area, kitchen but excluding the wet areas like bathroom. It used in skirting also. Nowadays, Timber planks are widely used in exteriors too.



Skirting

Timber floor construction

ROOFS - The structure forming the upper covering of a building is called as roofs.

Qualities of good roofs

- A roof must be weather resistant to rain, snow, wind and sun.
- The durability of a roof should be equal to or in excess of those materials used in the remainder of the building.
- A roof should have good thermal insulation properties.
- A roof should require a minimum of maintenance.
- A roof should be constructed in such a way as to retain structural stability when dead and imposed loads are applied to it: Dead loads are the weight of materials used to make the roof and Imposed loads are loads created by wind, snow, etc.

Types of roofs

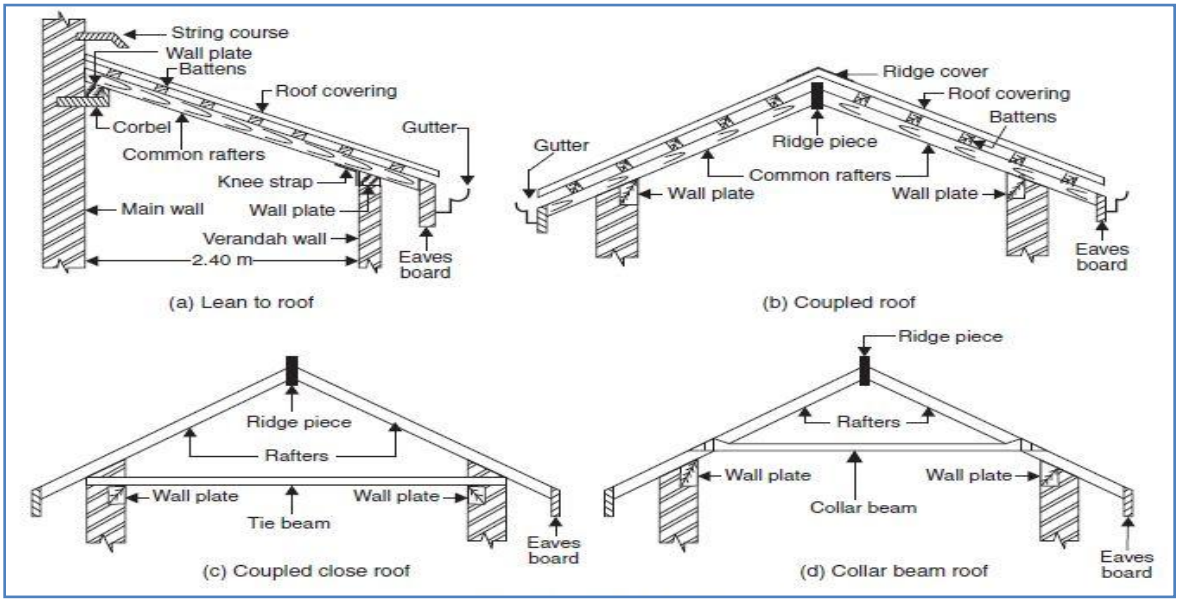
1. Pitch roof
2. Flat roof
3. Shells and folded plates.

Flat roofs are used in plains where rainfall is less and climate is moderate. Pitched roofs are preferred wherever rainfall is more. Shells and folded plate roofs are used to cover large column free areas required for auditoriums, factories etc.

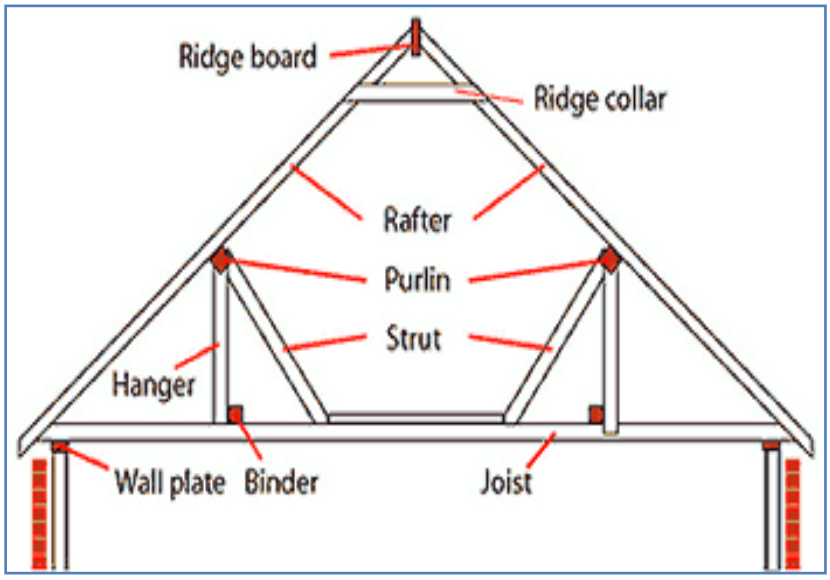
1. ***Pitch roof*** - In the areas of heavy rain falls and snow fall sloping roof are used. The slope of roof shall be more than 10°. They may have slopes as much as 45° to 60° also. The sloped roofs are known as pitched roofs. The sloping roofs are preferred in large spanned structures like workshops, factory buildings and ware houses. In all these roofs covering sheets like A.C. sheet, G.I. sheets, tiles, slates etc. are supported on suitable structures.

The pitched roofs are classified into (a) Single roofs (b) Double or purlin roofs (c) Trussed roofs.

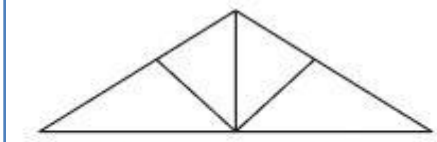
(a) Single Roof - If the span of roof is less than 5 m the following types of single roofs are used. (i) Lean to roofs (ii) Coupled roofs (iii) Coupled-close roof (iv) Collar beam roof. In all these roofs rafters placed at 600 mm to 800 mm spacing are main members taking load of the roof. Battens run over the rafters to support tiles.



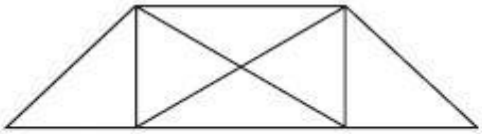
(b) Double or Purlin Roofs - If span exceeds the cost of rafters increase and single roof becomes uneconomical. For spans more than 5 m double purlin roofs are preferred. The intermediate support is given to rafters by purlins supported over collar beams.



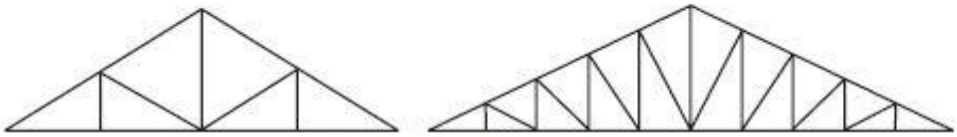
(c) Trussed roofs - If span is more, a frame work of slender members are used to support sloping roofs. These frames are known as trusses. A number of trusses may be placed lengthwise to get wall free longer halls. Purlins are provided over the trusses which in turn support roof sheets. For spans up to 9 m wooden trusses may be used but for larger spans steel trusses are a must. In case of wooden trusses suitable carpentry joints are made to connect various members at a joint. Bolts and straps are also used. In case of steel trusses joints are made using gusset plates and by providing bolts or rivets or welding. Depending upon the span, trusses of different shapes are used. End of trusses are supported on walls or on column.



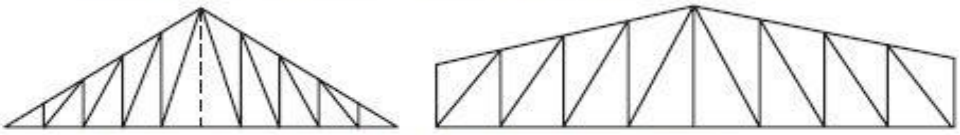
(a) King post spans up to 8 m



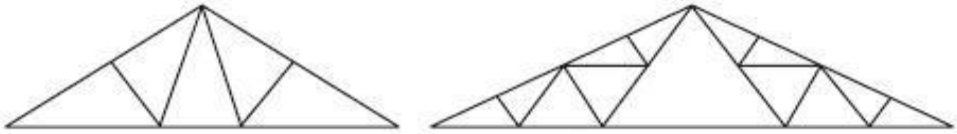
(b) Queen post spans up to 10 m



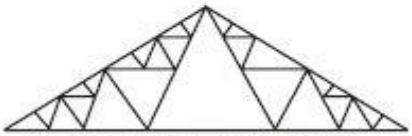
(c) Howe truss with 4 and 8 panels spans 6 m to 30 m



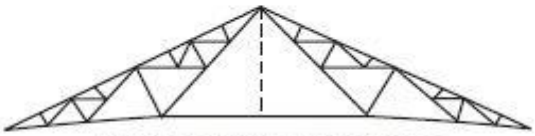
(d) Pratt truss spans 6 m to 100 m Modified pratt truss



(e) Fink or french roof trusses spans up to 10 m

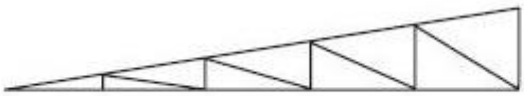


(f) Compound french truss
span 20 m to 30 m



Cambered french roof truss
span 20 m to 30 m

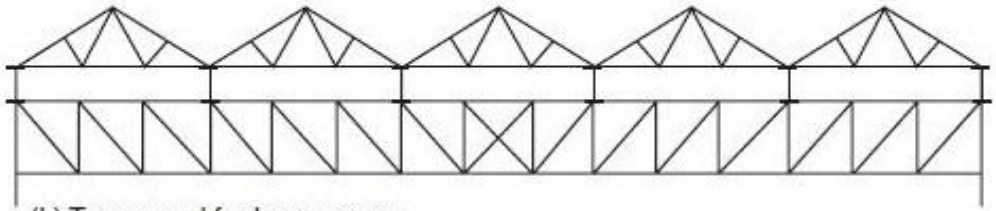
(g) Fan truss spans 10 m to 15 m



(h) North light roof truss span 8 m to 10 m

(i) Quadrangular truss

(j) Truss used for large span



(k) Truss used for large spans

2. ***Flat Roofs*** **-** These roofs are nearly flat. However slight slope (not more than 10°) is given to drain out the rain water. All types of upper storey floors can serve as flat roofs. Many times top of these roofs are treated with water proofing materials-like mixing water proofing chemicals in concrete, providing coba concrete. With advent of reliable water proofing techniques such roofs are constructed even in areas with heavy rain fall.

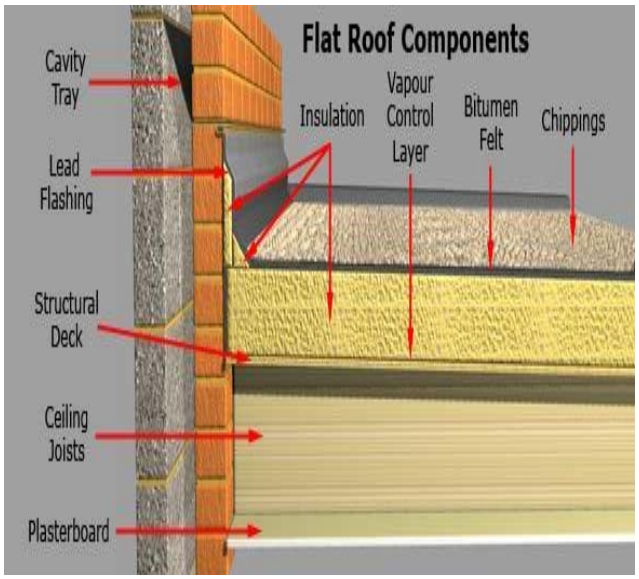
The advantages of flat roofs are

- The roof can be used as a terrace for playing and celebrating functions.
- At any latter stage the roof can be converted as a floor by adding another storey.
- They can suit to any shape of the building.
- Over-head water tanks and other services can be located easily.
- They can be made fire proof easily compared to pitched roof.

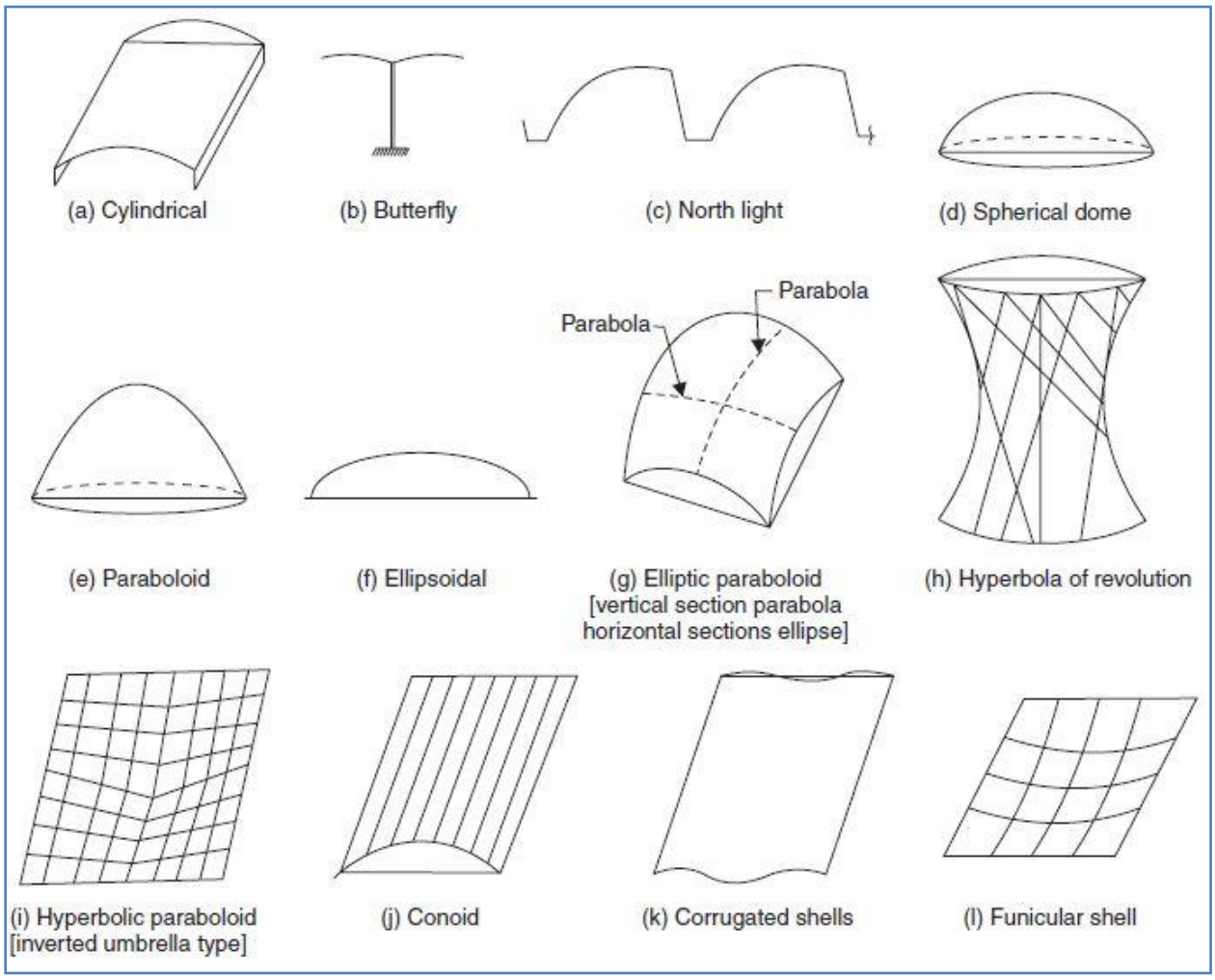
The disadvantages of flat roofs are

- They cannot cover large column free areas.
- Leakage problem may occur at latter date also due to development of cracks. Once leakage problem starts, it needs costly treatments.
- The dead weight of flat roofs is more
- In places of snow fall flat roofs are to be avoided to reduce snow load.
- The initial cost of construction is more.
- Speed of construction of flat roofs is less.

Types of Flat Roofs: All the types listed for upper floors can be used as flat roofs.



3. Shells and Folded Plate Roofs **-** Shell roof may be defined as a curved surface, the thickness of which is small compared to the other dimensions. In these roofs lot of load is transferred by membrane compression instead of by bending as in the case of conventional slab and beam constructions. Caves are having natural shell roofs. An examination of places of worships built in India, Europe and Islamic nations show that shell structures were in usage for the last 800 to 1000 years. However the shells of middle ages were massive masonry structures but nowadays thin R.C.C. shell roofs are built to cover large column free areas.



Advantages of shell roofs

(a) Good from aesthetic point of view

(b) Material consumption is quite less

(c) Form work can be removed early

(d) Large column free areas can be covered.

Disadvantages of shell roofs

(a) Top surface is curved and hence advantage of terrace is lost.

(b) Form work is costly.

Folded plate roofs may be looked as slab with a number of folds. These roofs are also known as hipped plates, prismatic shells and faltwerk. In these structures also bending is reduced and lot of load gets transferred as membrane compression. However folded plates are not as efficient as shells.

Advantages of folded plate roofs

- Form work required is relatively simpler.
- Movable form work can be employed.
- Design involves simpler calculations.

Disadvantages of folded plate roofs

- Folded plate consumes more material than shells.
- Form work can be removed after 7 days while in case of shells it can be little earlier.

Shell Roof

Flat folded Roof

ROOF COVERINGS

For Pitched Roof

Various types of covering materials are available for pitched roofs and their selection depends upon the climatic conditions, fabrication facility, availability of materials and affordability of the owner. Commonly used pitched roof covering materials are:

(a) Thatch
(b) Shingle
(c) Tiles
(d) Slates
(e) Asbestos cement (A.C.) sheets
(f) Galvanized iron (G.I.) sheets

(a) Thatch Covering - These coverings are provided for small spans, mainly for residential buildings in villages. Thatch is a roof covering of straw, reeds or similar materials. The thatch is well-soaked in water or fire resisting solution and packed bundles are laid with their butt ends pointing towards eves. Thickness varies from 150 mm to 300 mm. They are tied with ropes or twines to supporting structures. The supporting structure consists of round bamboo rafters spaced at 200 mm to 300 mm over which split bamboos laid at right angles at close spacing. It is claimed that reed thatch can last 50 to 60 years while straw thatch may last for 20–25 years.

The advantage of thatch roof is they are cheap and do not need skilled workers to build them. The disadvantages are they are very poor fire resistant and harbor rats and other insects.

(b) Shingles - Wood shingles are nothing but the split or sawn thin pieces of wood. Their size varies from 300 mm to 400 mm and length from 60 mm to 250 mm. Their thickness varies from 10 mm at one end to 3 mm at the other end. They are nailed to supporting structures. They are commonly used in hilly areas for low cost housing. They have very poor fire and termite resistance.

(c) Tiles - Various clay tiles are manufactured in different localities. They serve as good covering materials. Tiles are supported over battens which are in turn supported by rafters/trusses etc. Allahabad tiles, Mangalore tiles are excellent inter-locking tiles. They give good appearance also.

(d) Slates - A slate is a sedimentary rock. Its color is gray. It can be easily split into thin sheets. Slates of size 450 mm to 600 mm wide, 300 mm long and 4 to 8 mm thick are used as covering materials of pitched roofs in the areas where slate quarries are nearby. A good slate is hard,

tough, and durable. They are having rough texture and they give ringing bell like sound when struck. They do not absorb water.

(e) A.C. Sheets - Asbestos cement is a material which consists of 15 per cent of asbestos fibers evenly distributed and pressed with cement. They are manufactured in sufficiently large size. The width of A.C. sheet varies from 1.0 to 1.2 m and length from 1.75 to 3.0 m. To get sufficient strength with thin sections they are manufactured with corrugation. They are fixed to the steel purlins using J-bolts. The roofing is quite economical, waterproof. However it does not very good thermal resistant. They are commonly used as covering materials in ware houses, godowns or for larger halls. In auditorium etc., if these sheets are used, false ceilings are provided to get good thermal resistance.

(f) G.I. Sheets - Galvanized iron corrugated sheets are manufactured in the sizes 1.0 to 1.2 m wide and 1.65 m length. Galvanization of iron makes them rust proof. They are fixed to steel purlins using J-bolts and washers. They are durable, fire proof, light in weight and need no maintenance. They are commonly used as covering materials for ware houses, warehouse, sheds etc.

Comparison between GI and AC sheets for roof covering

S. No.	GI Sheets	A.C. Sheets
1.	Sheets are thin.	Not as thin as GI sheets.
2.	Light in weight.	Slightly heavier.
3.	Do not break while handling.	Chances of breaking are there during handling.
4.	Chances of corrosion can not be ruled out	No problem of corrosion.
5.	More noisy, if something falls over them.	Less noisy, if something falls over them.
6.	Less fire resistant.	More fire resistant.
7.	Less resistance to acids and fumes.	More resistant to acids and fumes.
8.	Cost is more.	Less costly.

For flat Roof

Various types of covering materials are available for flat roofs are

(a) Single-ply membrane: TPO (Thermoplastic Polyolefin)

Closely-associated with other thermoplastic elastomers, thermoplastic polyolefin elastomers (TPOs) are two-component elastomer systems consisting of an elastomer (such as ethylene-propylene-diene monomer or EPDM) finely dispersed in a thermoplastic polyolefin (such as polypropylene) where thermoplastic polyolefin is usually the major component.

TPO's usage has spread from the car industry and since around 1990 had been making steady inroads in construction until the last few years when its expansion accelerated when its superior environmental credentials became more recognized. TPO roofing membranes differ from EPDM membranes in that they are easily heat-weld able and, allegedly provide greater resistance to chemical and biological attack.

Advantages

- Reusable, particularly if mechanically fixed or better still ballasted with water or pebbles
- Some products include recycled content
- Durable - high resistance to UV, ozone and chemical exposure
- Does not pollute rainwater run-off

Disadvantages

- Comparatively new product, relatively untested over long periods
- Not as flexible as PVC
- Not easily recyclable
- Derived from oil, a non-renewable resource
- Pollution associated with the extraction and refining of oil
- Like all single-ply membranes - prone to punctures

(b) Single-ply membrane: EPDM (Elastomeric membranes)

Elastomeric systems are dominated by EPDM. Ethylene propylene diene monomer is a type of synthetic rubber made through the polymerization of ethylene and propylene in combination with ethylidene norbornene.

Advantages

- Reusable if it has been laid loose or mechanically fixed
- Highly durable - particularly resistance to UV light and ozone
- Does not pollute rainwater run-off

Disadvantages

- Not easily recyclable
- Derived from oil, a non-renewable resource
- Pollution associated with the extraction and refining of oil
- Like all single-ply membranes - prone to punctures

(c) Single-ply membrane: PVC

PVC is made by combining ethylene and chlorine to produce ethylene dichloride (EDC) which is then processed to produce vinyl chloride monomer (VCM). The VCM gas is polymerized into vinyl resin. Finally the resin is 'compounded' through the adding of plasticizers for flexibility, stabilizers for durability and pigments for color. PVC continues to have a dominant role in the single ply market. Conventionally, PVC has offered a tried-and-tested and durable roofing solution, but in recent years, concerns about the role of PVC in the environment have witnessed moves away from the material to alternative membranes that are felt to present a lesser risk.

Advantages

- Durable
- Some manufacturers provide recycling schemes
- Good resistance to pollutants

Disadvantages

- For many designers, the threat to the environment posed by the manufacture, use and disposal of PVC, render it unacceptable.

(d) Mastic Asphalt

Mastic asphalt is a blend of asphalt, limestone powder and limestone aggregate. The bitumen is derived from the distillation of crude oil or from natural deposits. Polymer-modified mastic asphalts, usually containing styrene butadiene styrene block copolymers, provide enhanced flexibility and a reduced susceptibility to the effects of temperature.


Advantages

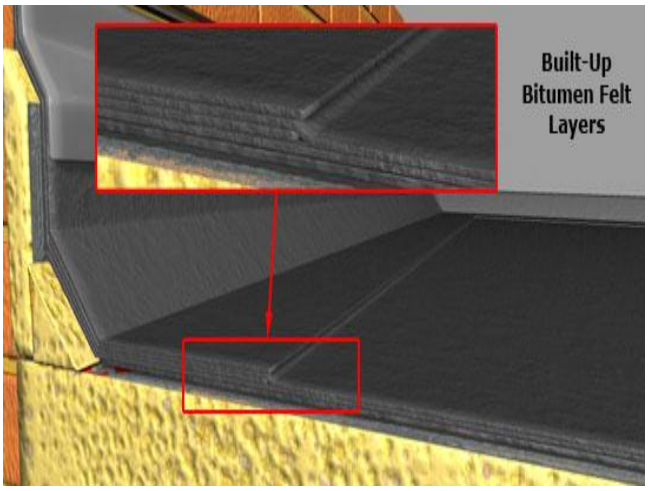
- Long track record, it is a well-understood roofing system
- Durable where provided with firm continuous support

Disadvantages

- Where derived from oil, pollution associated with extraction and distillation
- Where derived from natural deposits, degradation of the landscape
- Brittle when set
- Needs thermal protection

(e) Built-up felt

Built-up roofing consists of two or three layers of bitumen sheet bonded together through adhesive or hot bitumen. The bitumen is produced through the distillation of crude oil. Reinforced bitumen sheets are manufactured using a base layer consisting of one of a number of materials including organic fibers, glass fiber or bitumen-saturated polyester, though in practice, organic felts rarely meet performance criteria. The material is passed through a bath of molten bitumen and then coated with sand to prevent adhesion.



Advantages

- High material efficiency
- Tried and tested waterproofing ability

Disadvantages

- Un-recyclable and un-reusable
- Ultimate performance depends to a high degree on the quality of installation
- Bitumen is refined from a non-renewable resource
- Pollution associated with extraction and refining of oil
- A by-product of polyester fiber production is the toxic Methyl Bromide