BUILDING CONSTRUCTION (TH-III)
Lectures Notes & Question Bank

Government Polytechnic, Bhubaneswar

Diploma in Architecture Assistantship | III Semester

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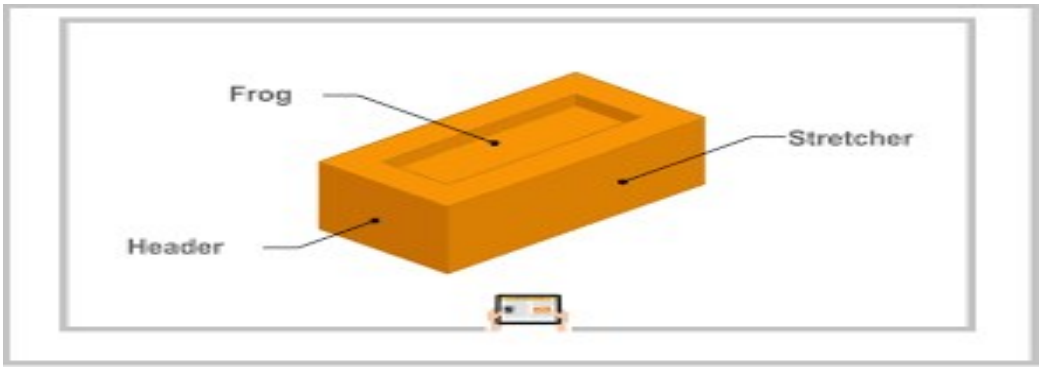
MASONRY

- Masonry may define as the construction of building units bonded together with mortar.
- The building units known as masonry units may be made of stones, bricks and mud.

TERMS USED IN MASONRY:

1. **STRETCHER:**
   A Brick, laid with its length horizontal and parallel with the face of the wall or other masonry member is called "**stretcher**" and a course, in which, all the bricks are laid as Stretchers is called a "**Stretching Course**" or "**Stretcher course**"
2. **HEADER:**
   A Brick laid, so that only its end shows on the face of a wall is called a "**Heading Course** "or "**Header course** "
3. **ARISE:**
   The edges formed by the interaction of the plane surface of brick are called the arise and they should be sharp, square and free from damage
4. **FROG:**
   Forged bricks shall have depression in one or more bed faces but their total volume shall not exceed 20% of gross volume of a brick.



5. **BED :**
   It is the surface of stone perpendicular to the line of pressure . It indicates the lower surface of bricks or stones in each course.

6. **BED JOINTS :**
   If the joints is parallal to the bed of bricks or stones in a course then it is termed as Bed Joints .
7. **PERPENDS :**
   The vertical joints separating the bricks in either length or cross direction are known as the Perpends .
8. **BOND :**
   Bond is the arrangements 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 couses , , both on the face and in the body of a wall .
9. **COURSE :**
   Each horizontal layer of bricks laid in mortar in a brick work is called a Course .
10. **BRICK BATS :**
    The pieces of Bricks ,cut long their length and having width equivalent to that of a full or half brick are called Brick Bats .
11. **QUEEN CLOSER :**
    Queen closer is a brick , which is half as wode as full brick and is made by cutting a whole brick lengthwise into two portion . These are generally used next to the Quoin Header for creating bonds in Brickwork.
12. **BEVELLED CLOSER :** A Brick cut longitudinally along a vertical plane , starting at the middle of end to the far corner . One quarter of the brick is cut off in this way .

01 . STONE MASONRY

Rock, that is removed from its natural site and generally, cut or dressed and then finished for building purposes, is called “Stone” and the art of building the structure with stones as constructional units is called “Stone masonry “.

MAJOR TYPES OF STONE MASONARY:

- RUBBLE MASSONRY
- ASHLAR MASONRY

RUBBLE MASONRY –

The stone masonry in which either understand or roughly dressed stones are laid is called “Rubble Masonry”. In this masonry, the joints of mortar are not of uniform thickness.

The strength of rubble masonry dependson:

- The quality mortar.
- The use of long through stones.
- The proper filing of mortar between the spaces of stones.

TYPES OF RUBBLE MASONRY:

- Coursed Rubble Masonry
- Un – Coursed rubble Masonry
- Random Rubble Masonry
- Polygonal Rubble Masonry
- Flint Rubble Masonry Dry Rubble Masonry

1. **Coursed Rubble Masonry –**
    - 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 work is carried out in courses such that the stones in a particular such that the stones in a particular course are of equal height.
    - Used in residential construction, commercial construction.
2. **UNCOURSED RUBBLE MASORY:**
    - In these types of masonry, the stones used are of widely different sizes. This is the roughest and cheapest form of stone masonry.
    - In un – coursed random rubble masonry, the course is not maintained regularly. The larger stones are laid first and the spaces between them are then filled up by means of spalls or sneaks.
    - Used in compound walls, godown, garages, labor quarters.
3. **RANDOM RUBBLE MASONRY:**

- 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 works is carried out in coursed of varying depth.

4. **POLYGONAL RUBBLE MASONRY:**

   In these types of rubble masonry stone used are flint or cobbles. These are irregularly shaped nodules of silica. The stones are extremely hard. But they are brittle and therefore they break easily.

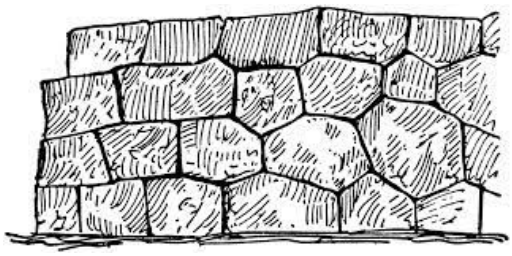
5. **FLINT RUBBLE MASONRY:**

   In this type of masonry stone used are flint or cobbles. These are irregularly shaped nodules of silica. The stones are extremely hard. But they are brittle and therefore they break easily.

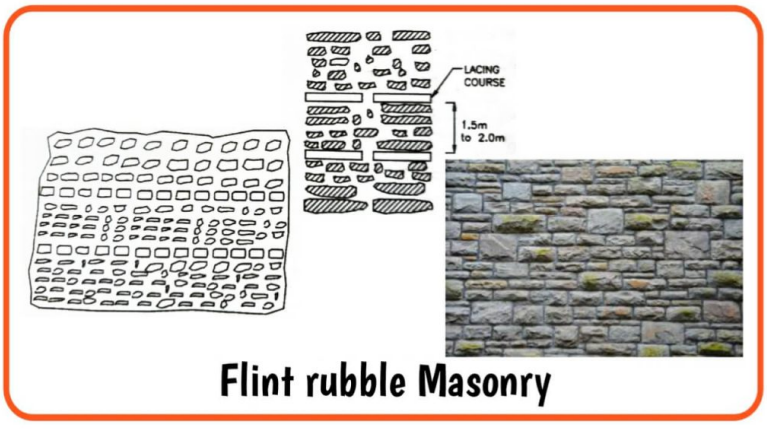
6. **DRY RUBBLE MASONRY:**

   In these types of masonry, mortar is not used in the joint. This type of construction is the cheapest and requires more skill in construction. This may be used for non – load bearing wall such as compound wall.

RANDOM RUBBLE MASONRY



POLYGONAL RUBBLE MASONRY



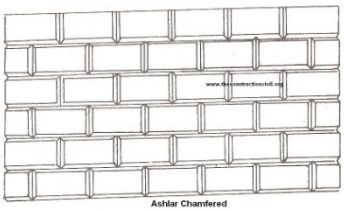
<u>ASHLAR MASONRY</u> –

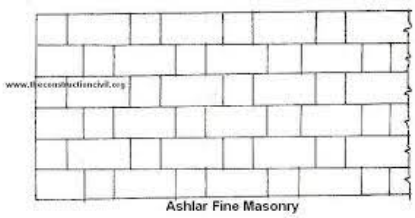
- The stones masonry in which finely dressed stones are laid in cement or lime mortar is known as “Ashlar Masonry”.
- In this masonry all the joints are regular , thin and of uniform thickness.
- This type of masonry is costly in construction as involves heavy cost of dressing of stones.

- This masonry is used for heavy structure, arches, architectural building , high pier , abutments of bridges etc.

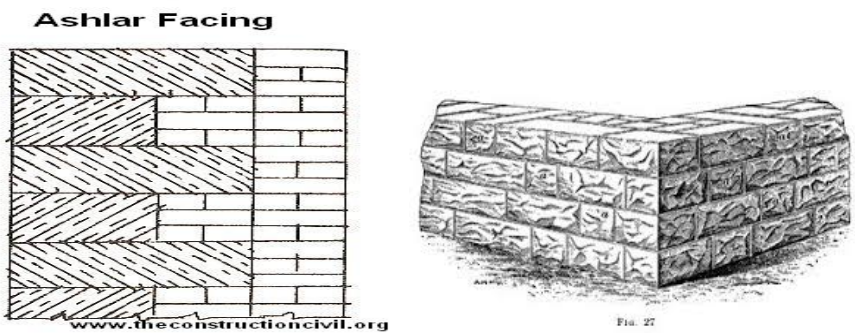
TYPES OF ASHLAR MASONRY -

1. **ASHLAR FINE MASONRY :**
   In this type ashlar masonry each stone is cut to uniform size and shape with all sides rectangular so that the stones gives perfectly horizontal and vertical joints with adjoining stones . This type of ashlar masonry is very costly .
2. **ASHLAR ROUGH MASONRY :**
   In this type of ashlar masonry, the beds and sides are finely chisel dressed . But the side are finely chisel dressed. But the face is made rough by means of tools. A strip about 25mm wide and made by means of chisel is provided around the perimeter of the rough dressed face of each stone.
3. **ASHLAR ROCK AND QUARRY FACED :**
   In this type of shlar masonry , a strip about 25mm wide are made by means of chsel is provided around the perimete of every stone as in case of rough tooled ashlar masonry.
4. **ASHLAR CHAMFERED MASONRY :**
   In this type of ashlar masonry , the srip is provide as below .But it is chamfered or beveled at an angle of 45degree by mean of chisel for a depth of about 25 mm
5. **ASHLAR BLOCK IN COURSE MASONRY:**
   This is combination of rubble masonry and ashlar masonry. In this type of masonry , the face work is provided with rough to led on hammer dress at ones backing of the wall may be made in rubble masonry .
6. **ASHLAR FACING NASONRY :**
   Ashlar facing masonry is provided along with brick or concrete block masonry, to give better appearance. The sides and beds of each block are properly dressed so as to make them true to shape.





ASHLAR CHAMFERED MASONRYASHLAR FINE MASONRY



ASHLAR BLOCK IN COURSE MASONRY

ASHLAR ROUGH MASONRY

ASHLAR ROUGH MASONRY

TOOLS AND IMPLEMENTS FOR STONE DRESSING –

1. **Spall Hammer :** Used for rough dressing of stones.
2. **Screbbling Hammer** : Used for removing irregular bushing.
3. **Mash Hammer :** Used for rough dressing.
4. **Wallers Hammer:** Used for removing spalls.
5. **Club Hammer :** Used to strike narrow – headed chisel.
6. **Mallet :** Used to strike mallet headed chisels.
7. **Dummy :** Used for striking chisel for carving work.
8. **Gad :** Used to split stones
9. **Drag :** Used to give drag finish.
10. **Hand Saw :** Used to cut soft stones
11. **Cross – cut Saw** : Used to cut hard stone.
12. **Frame Saw :** Used to cut large blocks of stones.
13. **Pitching Tool:**used to make stones of required size.
14. **Square :** Used to set edges at right angles.
15. **Boaster :** Used to cut soft stones.
16. **Punch :** Used for rough dressing.
17. **Point :** Used for rough dressing of hard stones.
18. **Gouge :** Used to dress stone for cornices, string courses.
19. **Broad Tool :**Used to form chisel lines on stone surface.

20. **Wood Handled Chisel :**Used to dress soft stones,
21. **Claw Chisel :** Used to dress hard stones.
22. **Tooth Chisel :**Used to dress hard stones.
23. **Drafting Chisel :**Used for fine dressing.

TOOLS FOR STONE DRESSING

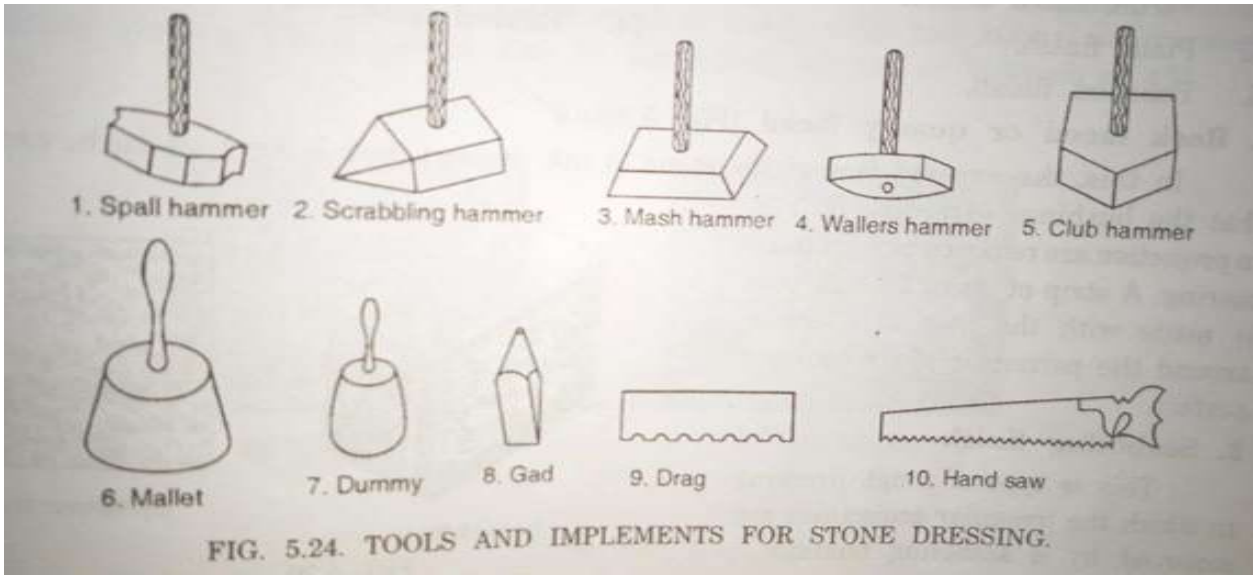


FIG. 5.24. TOOLS AND IMPLEMENTS FOR STONE DRESSING.

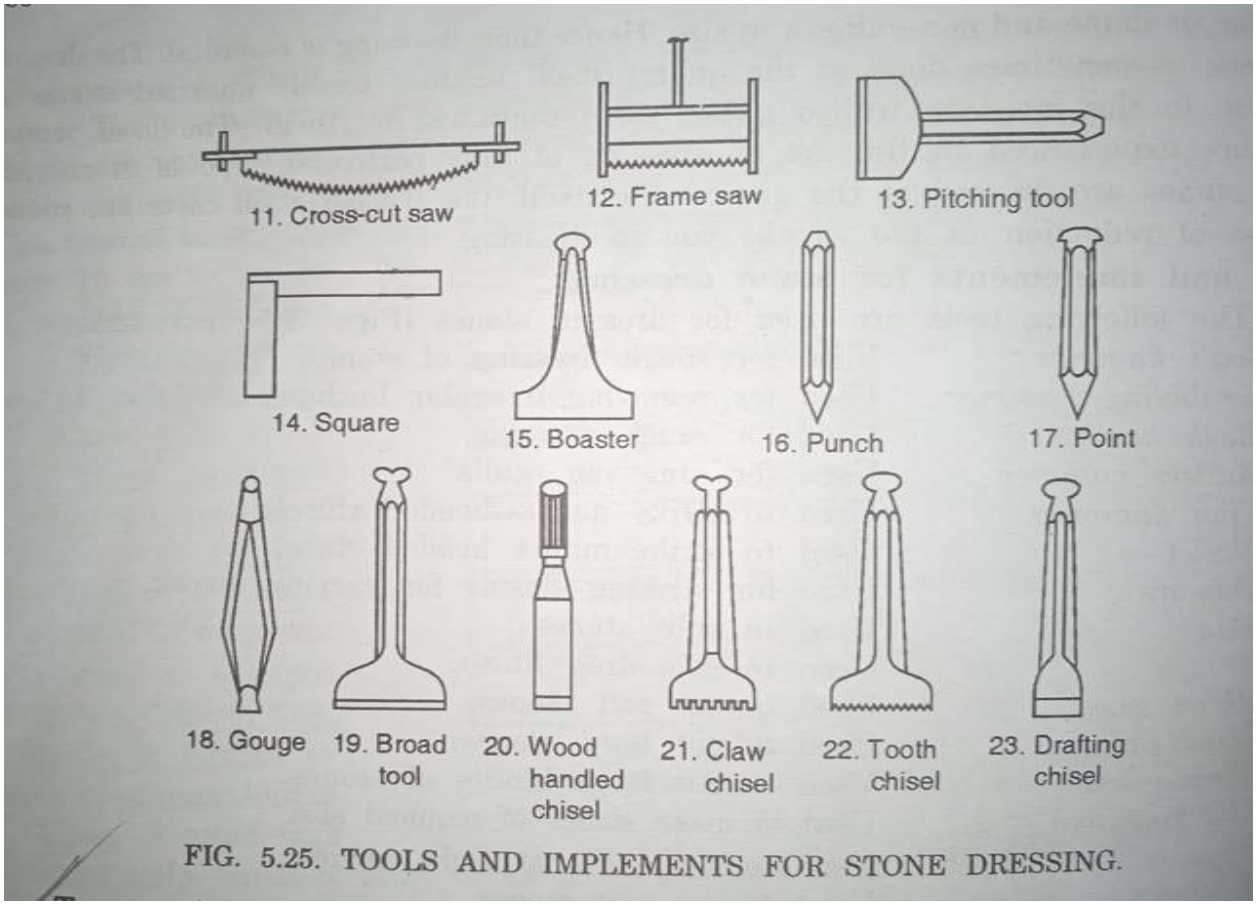


FIG. 5.25. TOOLS AND IMPLEMENTS FOR STONE DRESSING.

TYPES OF STONE DRESSING –

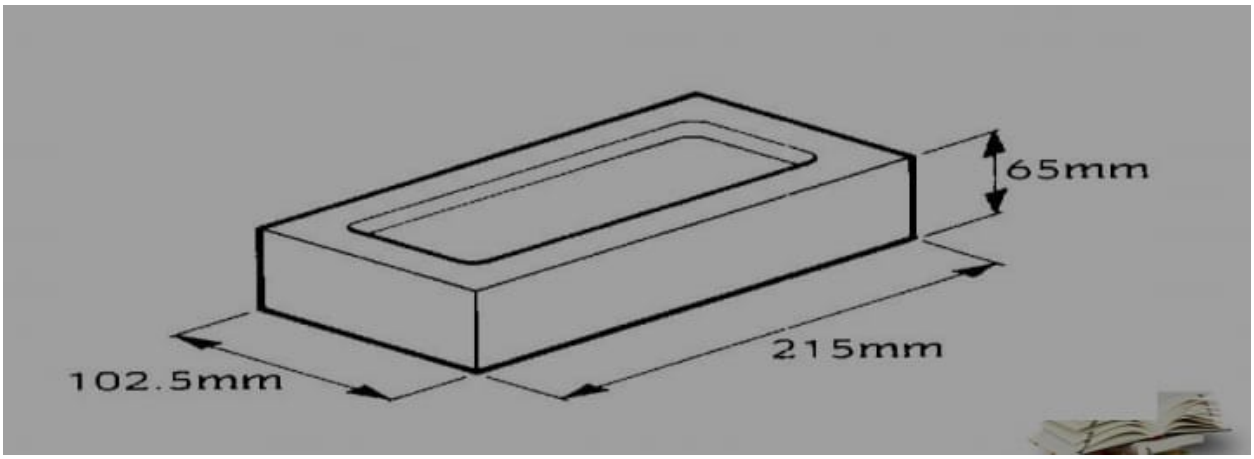
1. **Rock faced or Quarry faced :**
   In this the exposed face of the stone is not dressed, but is kept as such, except that the bushing exceeding 80mm in projection are removed by light hammering. A strip of about 25mm wide is made with the help of a chisel, around the perimeter of the exposed.
2. **Scabbing finish :**
   This is type of rough dressing in which the irregular projections are removed by scabbling hammer.
3. **Hammer dressed finish :**
   The stone blocks are made roughly square or rectangular by means of Waller's Hammer. The exposed face is roughly shaped by means of mash hammer. The beds and joints are dressed back some 75 to 100mm from the face. This is done by using the square to mark the boundaries and using pitching tools along the boundaries.
4. **Axed finish :**
   This type of finishing is used in hard stones like granite, where the dressing is done with the help of an axe.
5. **Punched , Broaded or Strugged finish :**

This is another form of rough dressing, usally used for lower portions of the buildings. The exposed face of the stone is dressed with the help of a punch, thus making depression or punch holes on a sone regular distance (25mm) apart. A 25mm wide stripe is made aroung the perimeter of the stones with the help of chisel.

6. **Picked finish:**
   This is similsr to above except thet a point is used in the place of punch , thus forming small pits on the exposed face.
7. **Boasted or Droved finish:**
   The dresssing is done with help of a boaster and hammer, forming a series of 38 to 50mm wide bands of more or less parrallel tools marks , which cover the whole surface . These marks may be horizontal, vertical or inclined at 45degree.
8. **Tooled or batted finish :**
   This type of dressing is done as a further step to boasting. After having boasted thesurface, a sreies of countinous and parrallel fine chisel lines are formed with the hep of batting or broad tool. This is common dressing for aslar work.
9. **Furrowed finish :**
   This type of finish is applied to the fillets or flat bands of cornices, string courses, doors and windows, architraves etc. After boasting the surface and then rubbing it.
10. **Dragged or combed finish :** In, this type of finish , a drag or a comb, which it's a piece of steelwith a number of teeth, is rubbed on the surface in all direction. The finish is suitable for soft stones only.
11. **Reticulated finish :** This type of finish, presents a net like appearance. A margin, about 20mm wide, is marked on the edges of the stone and irregular sinkings are made on the enclosed space.
12. **Vermiculated finish :** This finish is just similar to the reticulated type except that the sibking are more curved. The finish presents a worm eaten appearance.
13. **Boasted or drooved finish :** In this type of finish, the boaster is used to make non – countinousparrallel marks on the stone surface.
14. **Plain finish:** In this type of finish, the surface of the stone is made approximately smooth with a saw or with a chisel.
15. **Chisel – draughted margins:** In order to obtain uniform joints, the margins are placed which may be either squared or pitched or chamfered.
16. **Sunk finish:** This finish is obtained by sinking the surface below the original level in the form of wide grooves, chamfers, inclined surfaces, etc.
17. **Rubbed finish:** this type of finish is obtaind by rubbing a piece of stone with the surface or by rubbing the surface with the halp of a suitable machine.
18. **Moulded finish:** The surface of stones can br moulded in any desired shape so as to improved the appearance of the work.

02. BRICK MASONRY

Bond is the arrangement of bricks 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.

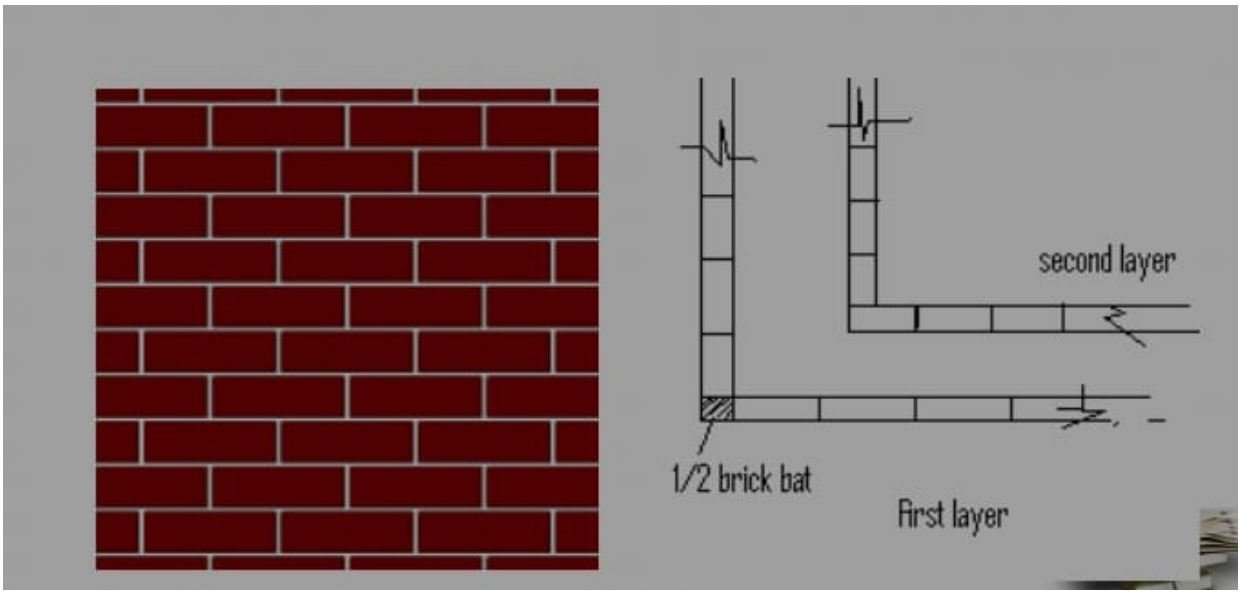


TYPE OF BONDS:

- **STRECHING BOND**
- **HEADING BOND**
- **ENGLISH BOND**
- **FLEMISH BOND**
    1. **DOUBLE FLEMISH BOND**
    2. **SINGLE FLEMISH BOND**
- **GARDEN WALL BOND**
    1. **ENGLISH GARDEN WALL**
    2. **FLEMISH GARDEN BOND**
- **RANKING BOND**
    1. **HERRING BONE BOND**
    2. **DIAGONAL BOND**
- **DUTCH BOND**

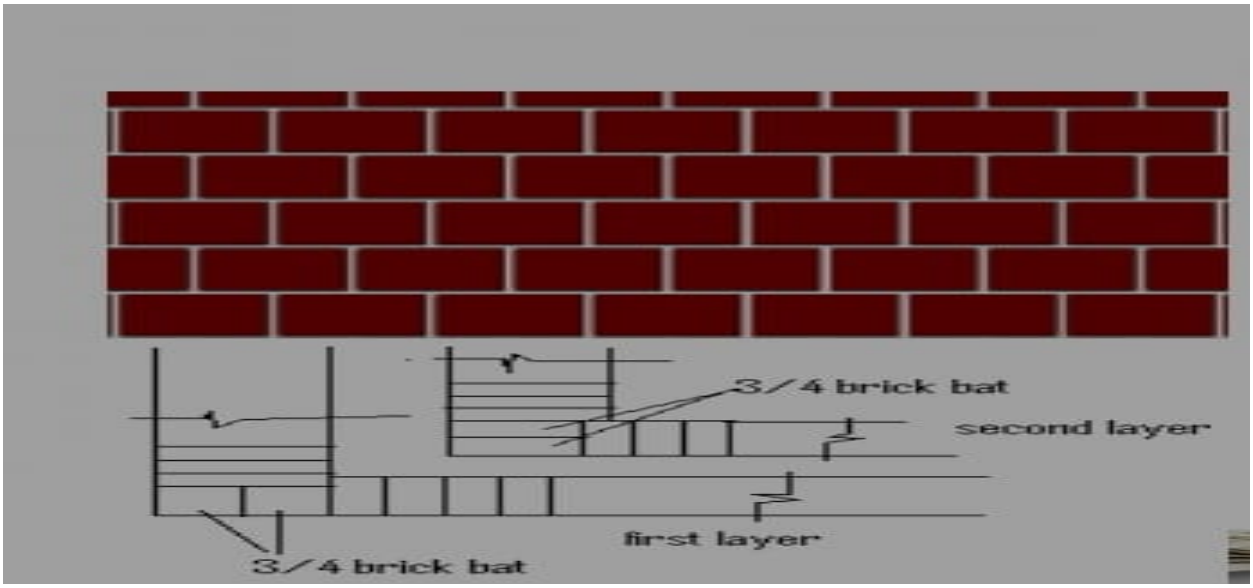
STRECHING BOND –

The bond in which all the bricks are laid as stretchers in every course is called "**Stretcher bond**". Used in not more than one brick partition wall.



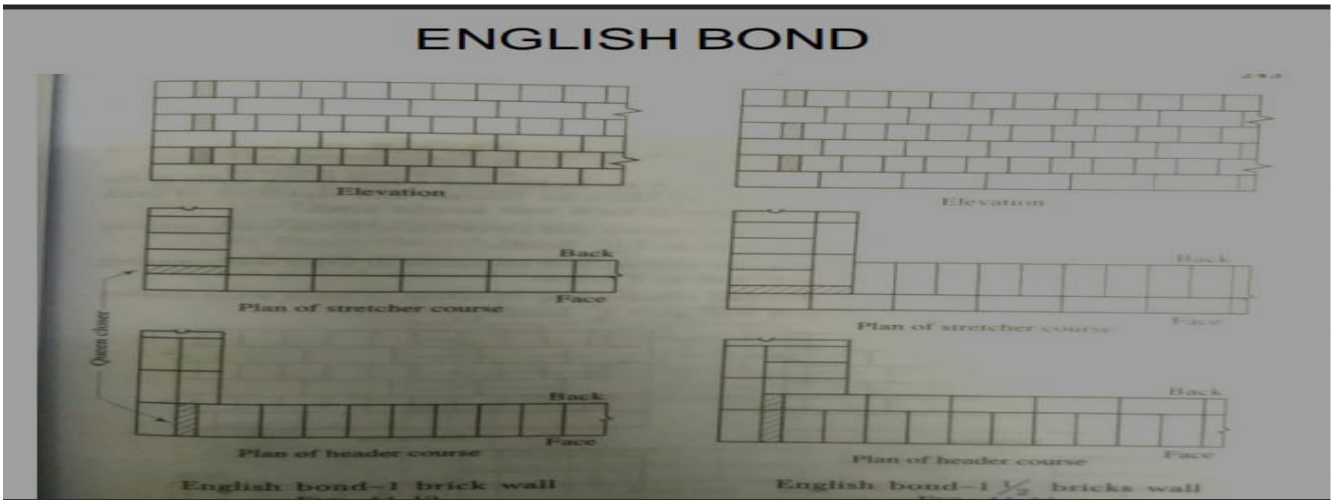
HEADER BOND-

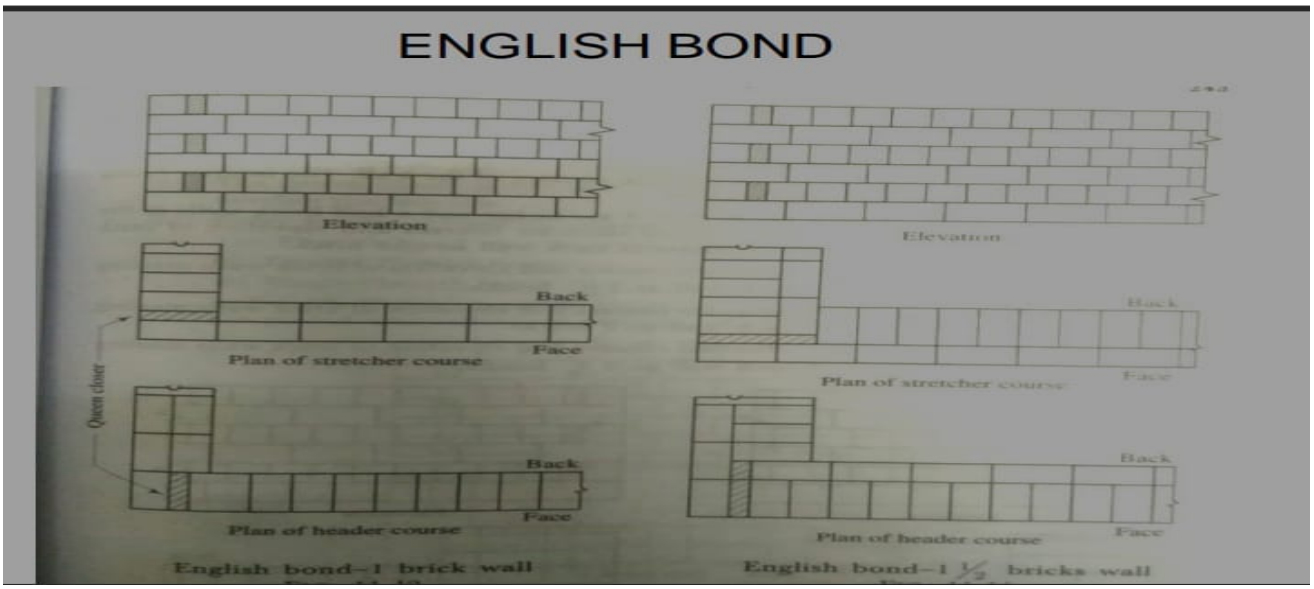
- The bond in which all the bricks are laid as headers in every course of a wall is called "**Header bond**".
- This bond is commonly used for constructing staining of wells, footing of walls and columns, or bels cornice, etc.



ENGLISH BOND –

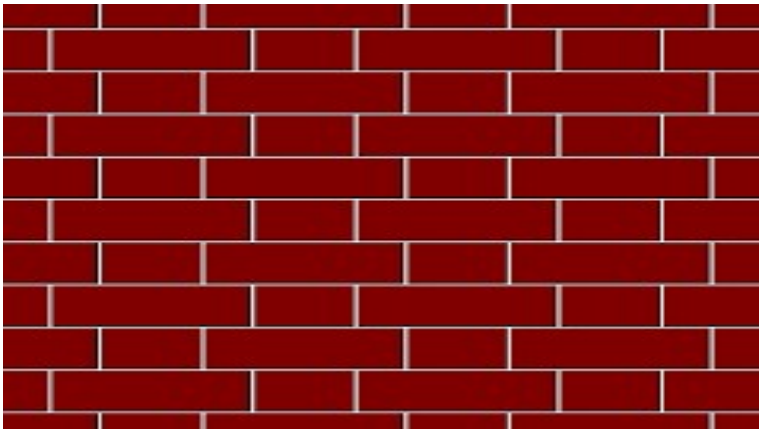
- This bond consists of headers and stretchers laid in alternative courses.
- It is the strongest of all bonds.
- It provided rough appearance especially for one brick thick walls.
- There are no noticeable continues vertical join in the structure built in this bond.
- Much attention is not required in providing this bond.
- Progress of work is more.
- It is costly because the use of brick bats is not allowed.
- In stretcher course, the stretcher have a minimum lap one fourth of their lemgth.





FLEMISH BOND –

- In this type of bond , each course is comprised of alternate headers and strechers. Every alternate course starts with a header at the corner i.e queen header. Queen closure are placed next to the queen header in alternate courses to develop the face lap. Every header is centrally supported over the stretcher below it.



The Flemish bond is of two type –

- **Double Flemish bond**
- **Single Flemish bond**

DOUBLE FLEMISH BOND – The bond in which headers and stretcher are laid alternately in each course, both in the face and back of the wall, is called Double Flemish Bond.

In the double Flemish bond, each course presents the same appearance both in the front face as well as in the back face. Flemish bond presents better appearences than English bond.

FEATURES OF DOUBLE FLEMISH BOND –

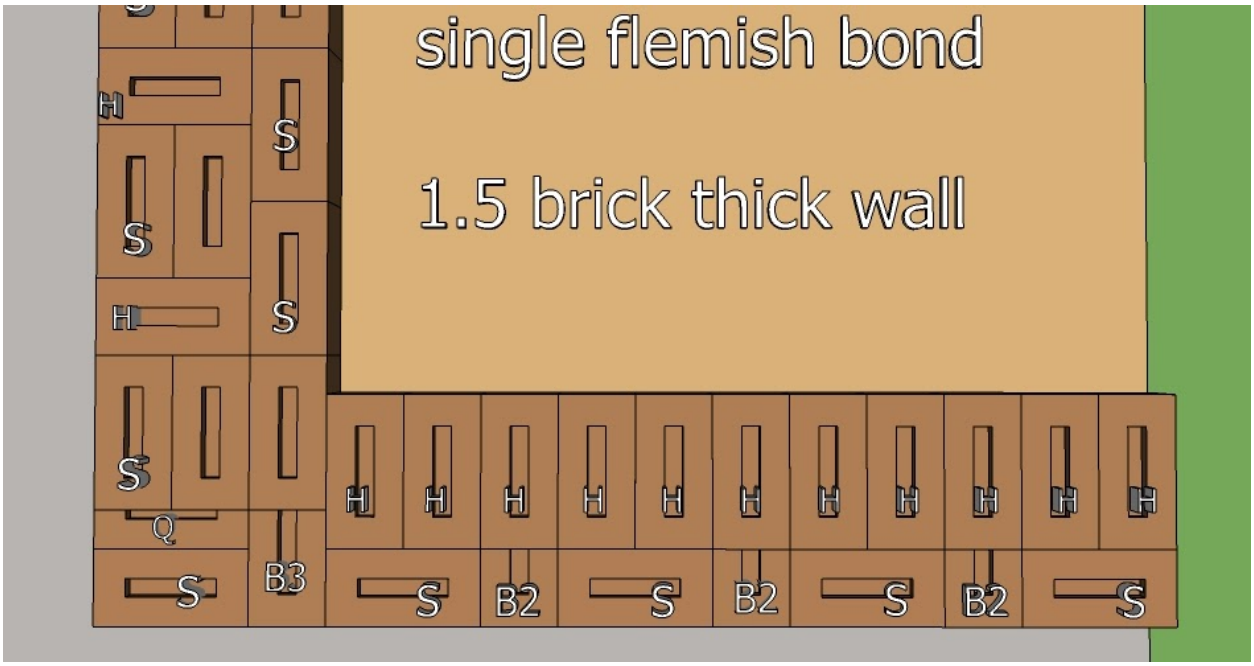
1. Every course consists of header and stretchers placed alternately.
2. The facing and backing of the wall, in each course, have the same appearance.
3. Queen closers are used next to queen headers in every alternate course.
4. In walls having thickness equal to odd multiple of half bricks, half bats and three – quarters bats are amply used.
5. For walls having thickness equal to even multiple of half bricks, no bats are required.
6. A header or stretcher will come out as header or stretcher on the same course in front as well as back faces

SINGLE FLEMISH BOND –

The bond is provided in a wall with Flemish bond in facing and English bond in backing is called **Single Flemish bond** or **Cross Bond.** this bond combines the advantages of both English and Flemish bonds and simuntanously eliminates their disadvantges.

FEATURES OF SIBGLE FLEMISH BOND –

- The front and back elevations of each course in Double Flemish bond have the exact identical appearance.
- Headers and stretchers are arranged alternately along each course. From the standpoints of economics and appearance, this kind of bond is ideal.
- It permits a single brick wall to have flat, even faces on both sides.
- Compared to an English bond, this kind of bonding is weaker.



DIFFERENCE BETWEEN FLEMISH BOND AND ENGLISH BOND –

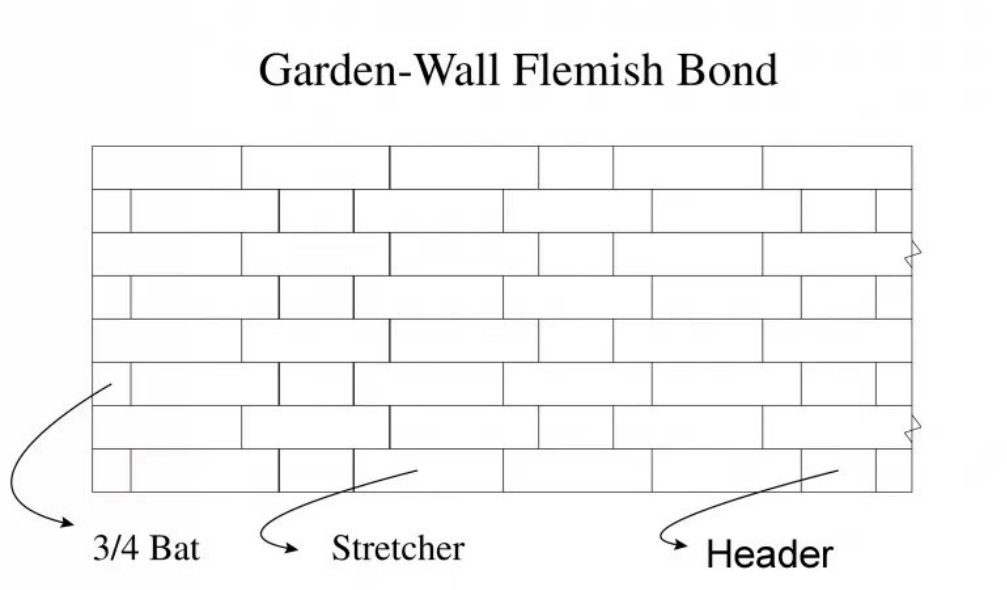
	ENGLISH BOND	FLEMISH BOND
1	This bond consist of headers and stretchers laid in alternative courses	This bond consists of headers and stretchers laid alternatively in each course.
2	It is strongest of all bonds.	It is less strong for walls having thickness more than 13 ½ inches.
3	It is provides rough appearance especially for one brick thick walls.	It is good appearances 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 bricks bats is not allowed.	It is economical because brick bats are allowed for forming this bond.

GARDEN WALL BOND –

This bond is used for constructing one brick thick garden walls, boundary walls, and other walls such as outer leaves of cavity walls to provide good appearance. The height does not exceed 2m.

There is two types of Garden walls:

1. **English Garden Wall.**
2. **Flemish Garden Wall**



ENGLISH GARDERN WALL BOND- The garden wall bond in which a heading course is provided after 3 or 5 courses is "**English Garden Wall Bond".**

FLEMISH GARDEN WALL BOND – In this bond a header is provided after 3 or 5 stretches in each course. This bond is also known as "**Sussex or Scotch Bond".**

RANKING BOND: In this bond alteranate course are placed in different direction to get maximum strength in the wall.

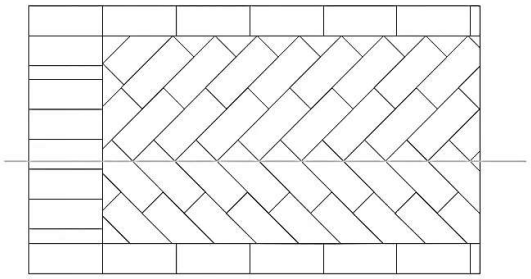
Two types of Ranking Bond –

1. **Herring wall bond**
2. **Diagonal wall bond**

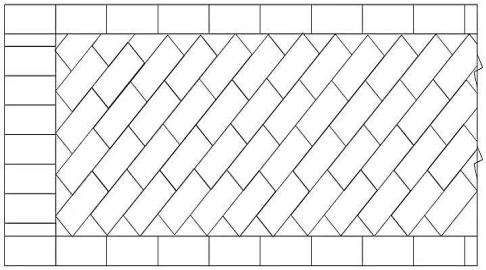
HERRING WALL BOND – The Ranking bond in which bricks are laid at an angle of 45^{o}, starting at the central line and proceeding towards the facing and backing of the wall, is called ' **Herring wall bond**'.

DIAGONAL BOND – The ranking 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**"

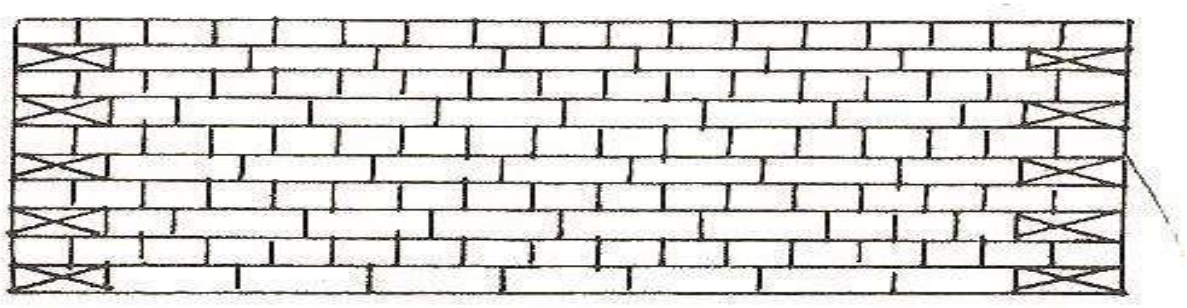
Herring-Bone Bond



Diagonal Bond In Brick Masonry



DUTCH BOND – This bond in which two stretcher and one header are laid alternately in each course is called "**Dutch Bond**". This bond is used in the construction of boundary walls.



Elevation of a wall in Dutch bond

03. FOUNDATION

A structure essentially consists of two parts, namely the super structure which is above the plinth level and the substructure which is above the plinth level and the substructure which is below the plinth level.

Substructure is otherwise known as the foundation and this forms the base for any structure. Generally about 30% of the total construction cost is spent on foundation. The soil on which the foundation rests is called the foundation soil.

OBJECTIVE OF A FOUNDATION:

The foundation are provided for provided for following purposes :

1. To distribute the total load coming on the structure on a larger area bring down the intensity of load at its base below the safe bearing capacity of sub – soil
2. To support the structure.
3. To give enough lateral stability to the structures against various disturbing horizontal forces such as wind, rain, earthquake, etc.
4. To prepare a level and hard surface for concrete and masonry work
5. To transmit the super imposed loads through side friction and end bearing in case of deep foundation.
6. To distribute the non – uniform load of the superstructure evenly in the sub – soil
7. To provide the structural safety against undermining or scouring due to animal
8. To prevent or minimize cracks due to movement of moisture in case of weak or poor soils.

ESSENTIAL REQUIREMENT OF A GOOD REQUIREMENT –

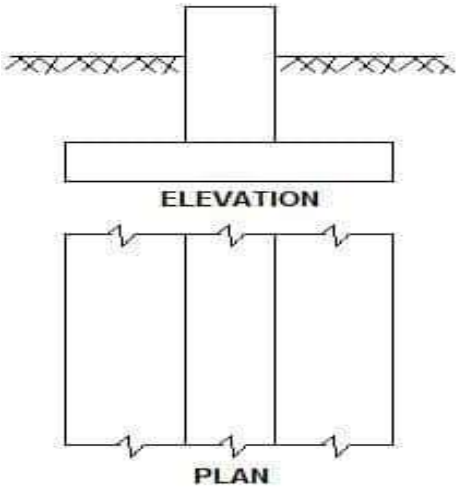
- **Location –**The foundation structure should be so located that it is able to resist any unexpected future influence which may adversely affect its performance. This aspect requires careful engineering judgement.
- **Stability –** The foundation structure should be stable or safe against any possible failure. The foundation structure should base should be rigid enough to bring down the difference settlements to a minimum extent so as to impair its usefulness or the stability to define the objectionable amount of settlement or deflecion.

SHALLOW FOUNDATION –

A shallow foundation is a type of building foundation that transfers structural load to the earth very near to the surface, rather than to a subsurface layer or a range of depths, as does a deep foundation.

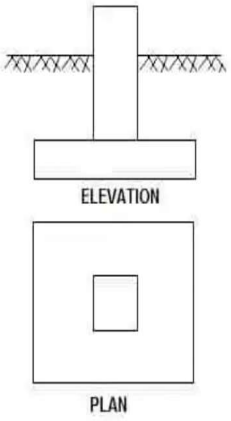
The shallow foundation is divides into –

- **Strip footing**
- **Spread footing**
- **Combined footing**
- **Strap footing**
- **Raft foundation**



STRIP FOOTING – A strip footing is provided for a load bearing wall. A strip footing is also provided for a row of columns which are so closely spaced that their spread footing overlap or nearly touch each. In such case it is mote economical to provide a strip footing than to provide a number of spread footing in one line. A strip footing is also known as continuous footing.

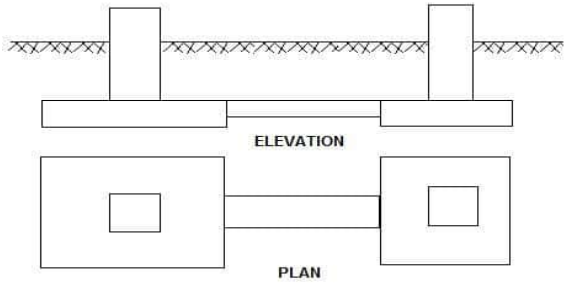
SPREAD OR ISOLATED OR INDIVIDUAL FOOTING – A spread footing also called as isolated footing, pad footing and individual footing is provided to support an individual column. A spread footing is circular, square or rectangular slab of uniform thickness. Sometimes, it is stepped or haunched to spread the load over a large areas.

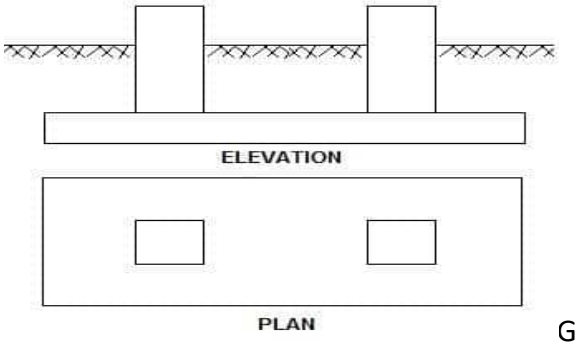


COMBINED FOOTING – A combined footing supports two columns. It is used when the two columns are so close to each other that their individual footing would overlap. A combined footing is also provided when the property line is so close to one column that a spread footing would be eccentrically loaded when kept entirely within the property line. By combining it with of an interior column, the load is evenly distributed. A combined footing may be rectangular or trapezoidal.

STRAP FOOTING – A strap footing consist of two isolated footing connected with a structural strap or a lever. The strap connects the two footings such that they behave as one unit. The strap is designed as a rigid beam. The individual footings are so designed that their combined line of action passes through the resultant of the total load. A strap footing is more economical than a combined footing when the allowable soil pressure is relatively high and the distances between the column is large.

RAFT OR MAT FOOTING – A mat or raft foundation is a large slab supporting a number of columns and walls under the entire structure. A mat is required when the allowable soil pressure is low or where the columns and walls are so close that individual footings would overlap or nearly touch each other. Mat foundation are useful in reducing the differential settlement on nom – homogenous soils or where there is a large variation in the load on individual columns.





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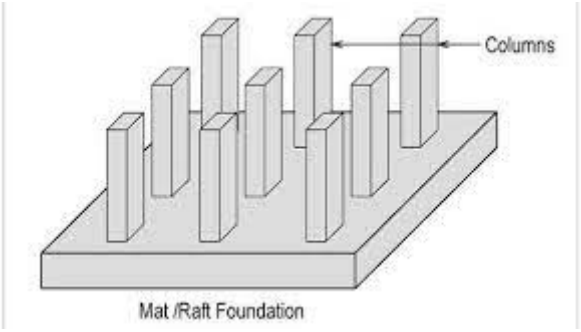
STRAP FOOTING **COMBINED FOOTING**



MAT / RAFT FOUNDATIN

DEEP FOUNDATION - A deep foundation is a type of foundation which is placed at a greater depth below the ground surface and transfers structure loads to the earth at depth. The depth to width ratio of such a foundation is usually greater than 4 to 5.

There are three types of deep foundation –

- **Pile foundation**
- **Well foundation**
- **Pier foundation**

PILE FOUNDATION – The most common type of deep foundation widely used for large structures. The pile foundation method is suitable for clayey soil or where the soil contains low bearing capacity.

The loa will transfer from the superstructure to type deep ground soil through a vertical pile. Different types of pile foundation are used depending on soil condition.

- The pile foundation is used in high rise buildings. The methodlogy of pile foundation of pile foundation is simple.
- It sustains greater load; however, sometimes it may fail. So the number of piles and its depth should be designed accurately.
- It reduces the construction time compared to the other types of foundation.

CAISSONS OR WELL FOUNDATION – The well foundation areas such as river, lakes, and the coastal zone. The well foundation is likely to seem either in a circular or rectangular shape, and the inner portion of the foundation will be hollow.

Types of caisson or well foundation –

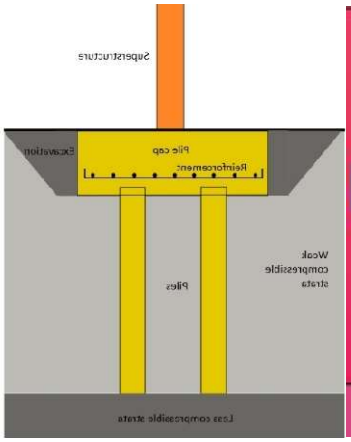
- **Open caisson**
- **Closed caisson**
- **Pneumatic caisson**

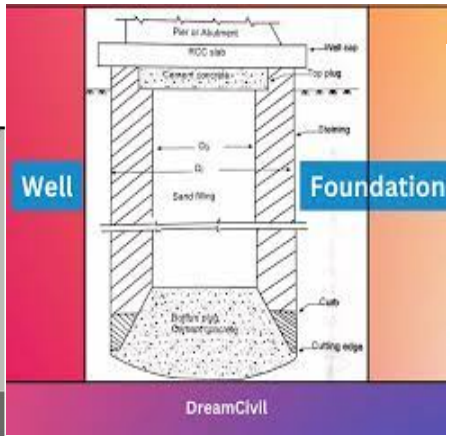
The caisson foundation is used in the construction of bridge where it is located in a river or lake area. The construction method of the well. Foundation is a little tricky thus highly skilled manpower is required.

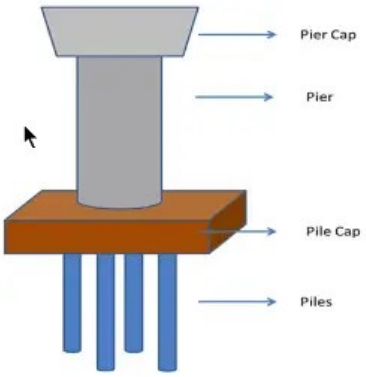
PIRE FOUNDATION – The pier foundation method is mostly used in bridge construction.The pier foundation consists of a large cylindrical column that rests on the hard rock below the structure will be transferred through the column to the ground soil.

Suitable condition to use Pier Foundation –

- Presence of decomposed rocks on the top soil surface.
- Inadequate bearing capacity of the soil.
- Slope soil surface.
- Moisturised soil layer .







PILE FOUNDATION **WELL FOUNDATION** **PIER FOUNDATION**

ADVANTAGES OF SHALLOW FOUNDATION –

- Shallow foundation is convenient for foundation having depth is equal or less than the foundation width.
- It is used if bearing capacity of soil is high at shallow depth.
- For compressive soils, it helps to reduce settlements.
- No piling is required. so it reduces a great cost.

DISADVANTAGES OF SHALLOW FOUNDATION –

- If weight of structure is high and load of the structure is distributed unequally.
- The bearing capacity of top surface soil is less.
- If sub soil water level is high and it is uneconomical to pump out the water from the hole or canal.
- If there is a chance of scouring as the structure is near sea or river shallow foundation can not be used.

ADVANTAGES OF DEEP FOUNDATION –

- It can sustain the heavy load
- We can construct high rise structures in low bearing capacity of the soil.
- Used to build large scale structures.
- It can resist the seismic load impact

DISADVANTAGES DEEP FOUNDTION –

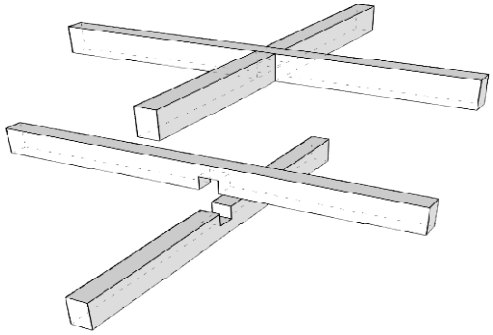
- The cost of deep foundation construction is high.
- Highly skilled manpower is required.
- Much more safety precaution required while execution.

04. CARPENTRY AND JOINRY

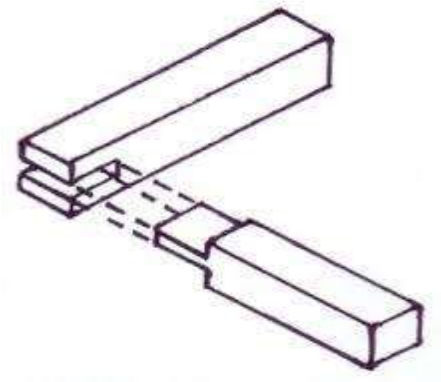
JOINERY – It is a part of wood working that involves joining together pieces of wood, to produce more complex items. The place or part where two things or parts are joined or united. The union of two or more smooth or even surface admitting of close fitting or junction.

TYPES OF JOINT –

HALVED JOINTS – A halved joints is a wood working joint in which the two members are joined by removing material from each at the point of intersection so that they overlap. In this type of joint, one place crosses over the other.



BBRIDLED JOINTS –These two bridle joints are used when a light frame is needed. For example, a picture frame. One part of the joint fits into the other part and is glued permanently in position.



MORTICE AND TENON JOINTS – The basic mortise and tenon comprise two component: the mortise hole and the tenon. The tenon, formed on the end of the member generally refered to the rail, is inserted into a square or rectangular hole cut into the corresponding member.

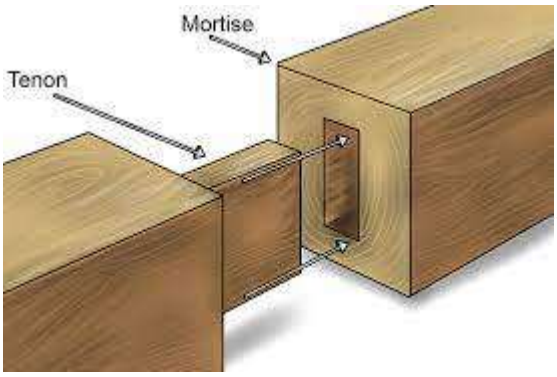
The tenon is cut to fit the mortise hole exactly and usually has shoulder that seat when the joint fully enters the mortise hole. The joint may be glued, pinned or wedged to lock it in place. These are used when making tables cabinets and they are very strong when glued together.

DOWELLED MORTICE AND TENON JOINTS – This is another type of tenon joint. However, in this example a piece of dowel rod is drilled through the mortice and the tenon. This helps keep the joint together even when it is under great pressure. This is used as a joint on chairs and other pieces of furniture so that the joints do not break apart when extra weight is applied.

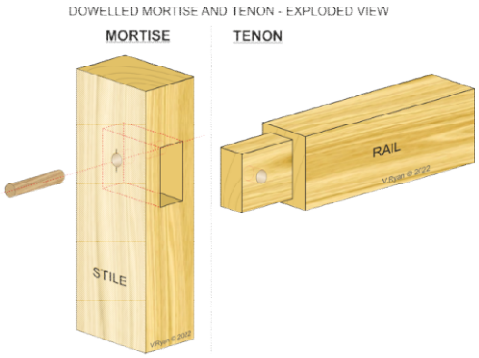
This is another way in which dowels can be used to form a joint. Morden pieces of furniture are often jointed in this way. It is a permanent method but it is not the strongest joint as the parts can eventually pill apart, especially as the joint becomes old. Modern glues that are very strong have meant that this joints is often used to quickly fix parts together.

SECRET HAUNCH MORTICE AND TENON – If the mortice and tenon joint is used as part of a frame, a secret or sloping haunch is used. The tenon does not show on the joint and it gives greater gluing area , adding to the overall strength of the joint.

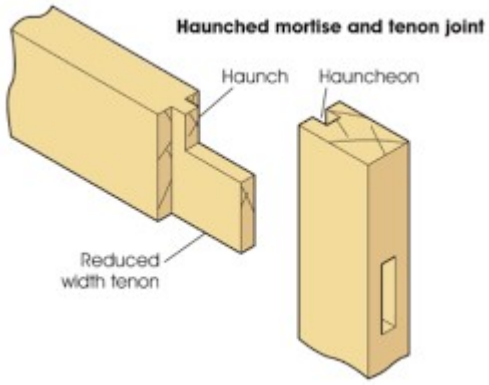
WEDGED MORTICE AND TENON – This is a very strong and attractive joint. The tenon has two slots and when it is pushed into the mortice, wedges, are trapped into position. The wedges hold the joint together firmly and they also give the joint an interesting look.



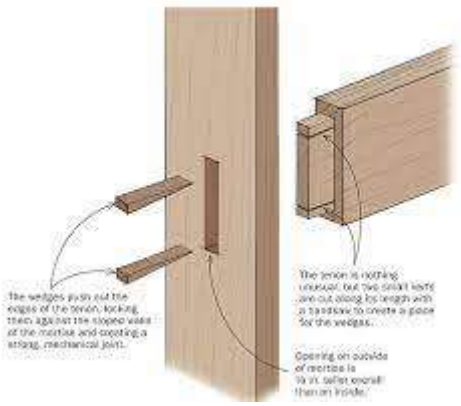
MORTICE AND TENON JOINTS



DOWELLED MORTICE AND TENON JOINTS



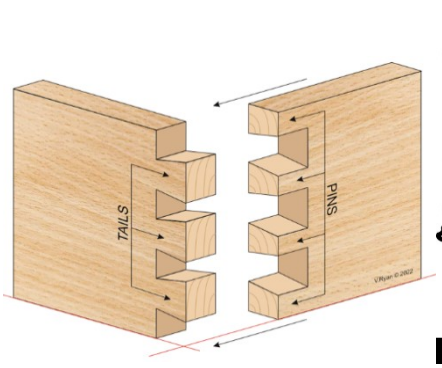
SECRET HAUNCHED MORTISE AND TENON JOINTS

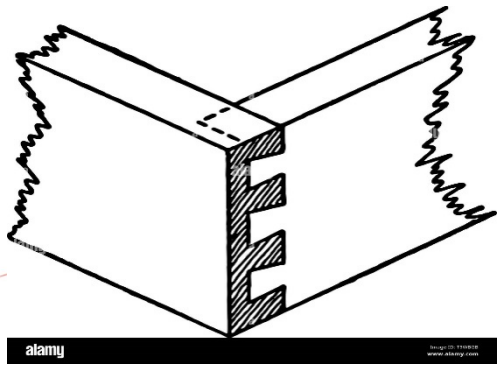


WEDGED MORTICE AND TENON

DOVE TAIL JOINT – the dove tail joint is very strong because of the way the tails and pins are shaped. This make it difficult to pull the joint apart and virtually imposible when glue is added. This make it difficult to pull the joint apart and virtually impossible when glue is added. This type of joint is used in box constructions such as drawers, jewelry boxes, cabinet and other pieces of furniture where the strength is required. it is difficult joint which requires practice. There are different types of dovetail joint and when cut accurately they are very imperessive and attractive.

LAPPED DOVETAIL JOINT – This type of dovetail joint is often used for drawers where the joint can only be seen from one side. The joint is very strong as are all dovetail joints. This type of joints is sometimes used as the joints for book cases and cabinets.

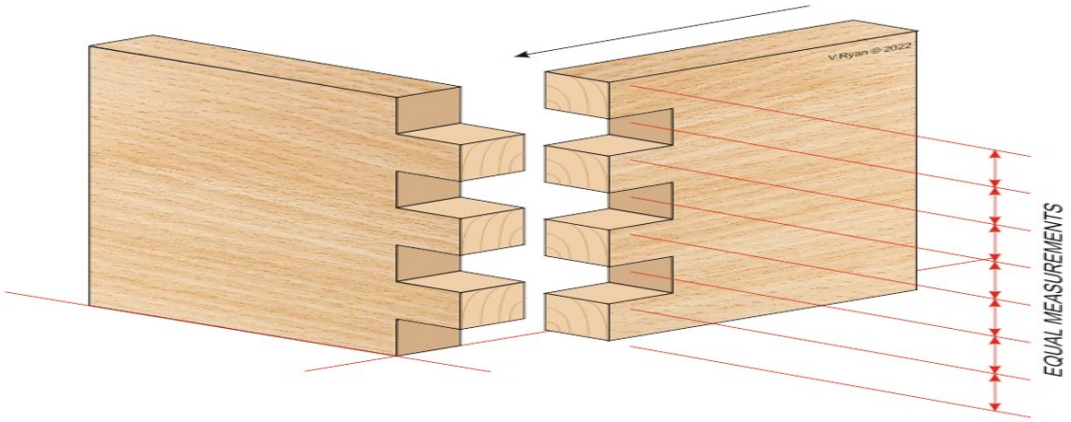




DOVE TAIL JOINTS **LAPPED DOVETAIL JOINTS**

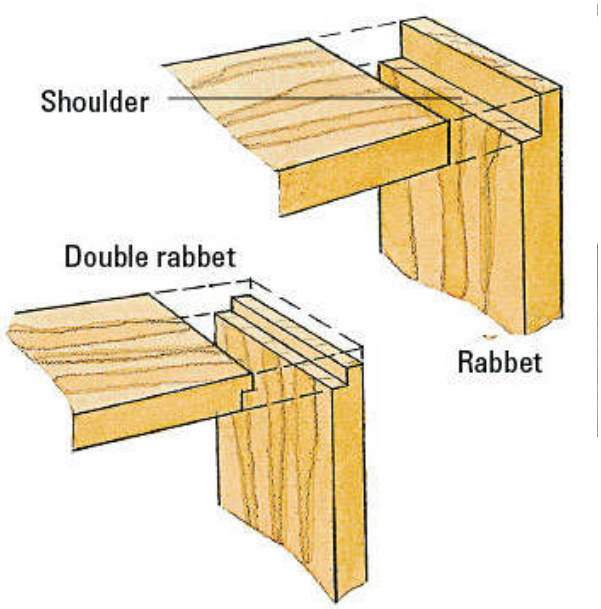
FINGER JOINT – Ideal for box constructions and is suitable for use with natural woods such as pine and mehgony or even manmade boards such as plywood. The joints is strong especially when used with a good quality glue such as PVA (woodworks adhesive) or cascamite.

If the joint is cut accurately, the fingers should fit together without any gaps and the glue ensures that they are virtually indestructible. They are used for a wide range of products including jwellery boxes, cabinet construction, kitchen cupboards and many others.



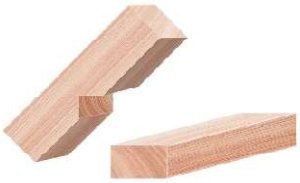
LAPPED/ REBATE/ SHOULDER JOINTS – The joints to the left is a simple lapped joint. The shoulder can be seen clearly, this is usually planned using rebate/shoulder plane or combination plane. This type of joint is often seen as a corner joint.

The jwellery box seen to the right has a base which sits inside a rebate or shoulder which has been planned/cut into each of the sides. The base has been pushed into the shoulder and this means it is level with the sides.



TOUNGUE AND GROOVE JOINT – It is a method of fitting similar objects together, edge to edge, used mainly with wood: flooring, parquetry, paneling and similar construction.

BIRDS MOUTH JOINTS –An angular notch is made in the inclined members. This notch is called a birds mouth. The other member fit into the birdsmouth.



MITRE JOINT - The two members meeting at an angle can be joined by a mitre joint. The mitre joints for the members meeting at a right angle. For inclined members, the mitre joints may be formed on the same line.

OBLIQUE TENON JOINTS – This joint is used to connect members of bigger size, the tenon of the inclined member is oblique and it fits into the corresponding mortise of the horizontal member. This joint is frequently used in the construction of timber roofs and it is sometimes strengthened by means of bolts, strap.

CHASE MORTISE JOINT – This joint is used when a timber piece is to be placed between two member which are previously fixed. A chase or recess of wedge – shape is formed. The cross piece is provided with tenon of corresponding shape.

COGGED JOINT – This joint is used when it is desired to maintain the full depth of beam for strength. The lower piece is provided with a projection at the center. This uncut portion is called a cog and the upper piece contains a small notch to accommodate this cog.

DOUBLE TENON JOINT – This joint consists of double tenons and is used for large sized timber pieces.

HOUSED JOINT – In this type of joint, the whole end of one piece of timber is accommodated or housed for a short distance into other piece.

JOGGLE TENON JOINT – In this type of joints, the tenon is short and it does not extend to tha full depth of mortise.

NOTCHED JOINT –This joint consists of forming a notch in one or both the pieces of timber. The former is known as a single notched joint and the latter is called double notched joint.

TOOLS FOR CARPENTRY :

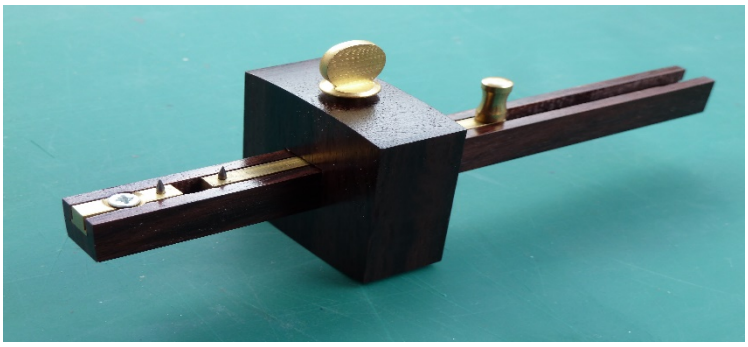
GENERAL CHISELS – There are many different types of chisels and each has a particular use. The handles of most chisels are made from ash, beech, box wood or plastic and a mallet (not a hammer) is normally used to apply force.

- **Bevel** edged chisels are slightly undercut making them easy to push into corners. They are normally used for finishing dovetail joints.
- **Firmer** chisels have a blade with a rectangular cross – section. This means that they are stronger and can be used for tougher/heavier work.
- **Pairing** chisel is a longer, thinner chisel which can be pushed into long jointssuch as housing joints. It is used for cleaning up the joint and to make it an accurate fit.
- **Mortise** chisels are used for chopping out joints chiselling away the waste wood. They are particularly useful for cutting mortise joints as they are strong enough to withstand heavy blows with a mallet.

TRY SQUARE – The wood worker try square is composed of two main parts – the stock and the blade. The blade is made from hardened and tempered steel which makes is resistant to damage. The stock is usually made from

rosewood although cheeper version can be made from plastic or cheap woods.

MORTISE GAUGE – The mortise gauge is a special type of marking gauge and it is used to mark wood so that a mortise can be cut into it. The mortise is marked out using the mortise gauge although it must be set to the correct size of mortise chisel is then used to remove the waste wood.



TENON SAW – Back saw / tenon saws get their name from steel or brass back. The heavy back gives the saw its weight which is useful when sawing wood.

COPING SAW – Coping saws are used for cutting a range of woods are very useful for cutting unusal shapes or curves. Using a coping saw is a test of skill as it can be difficult to control and requires practice.

COPPING SAW

BACK SAW

05. FLOORING

A floor is the bottom surface of a room or vehicle. Flooring is the general term for a permanent covering of a floor, or for the work of installing such a floor covering. A lot of varieties exists in flooring due to the fact that it is the first thing that catches your eye when you walk into a house, as it spans across the length and breadth of the house. It is also the surface that goes through the most wear and tear and that's why choosing the right material is of utmost importance.

TYPES OF FLOORING –

- **MUD FLOOR –** mud flooring is commonly constructed in village where by using stabilizers the properties of the soil are enchanced by manipulating its composition by adding suitable stabilizers. The tensile and shear strength of the soil is increased and shrinkage is reduced.
- **BRICK FLOORING –** Brick flooring is one of the types of floors whose topping is of brick. There are easy to construct and repair but the surface resulting from these is not smooth and is rough, hence easily absorbs and retains moisture which may cause dampness in the building.

- **METHOD OF CONSTRUCTION –**
  For constructing a brick floor, the top surface of earth or murram filling is properly consolidated. Over this compacted earth, a layer of clean sand about 10 cm thick is evenly spread. Then layer a lime concrete (1:4:8) or lean cement concrete (1:4:16) is laid, compacted and cured. Over this base concrete well soaked bricks are laid in cement mortar (1:4) in any suitable bond. in case pointing is to be done, the minimum thickness of joints should not exceed 2mm and the mortar in joints is struck off with a trowel. When the pointing is to be done, the minimum thickness of joints is kept 6 mm and the pointing may be done.
- **TILE FLOOR –** The floor whose toping is of tiles is called tile floor. The tiles used may be of any desired quality, color, shape or thickness.

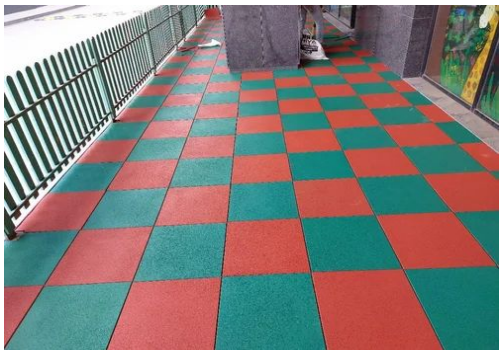
  METHOD OF CONSTRUCTION –
  For constructing a tile floor, the base course is prepared in the same manner as in case of brick flooring. Over the base course thus prepared, a thin layer of lime or cement mortar is spread with the help of screed battens. Then the screeds are properly leveled and fixed at the correct height. When the surface mortar has hardened sufficiently, the specified tiles are laid on a 6 mm thick bed of wet cement mortar.(1:5). The surplus mortar which comes out of the joints is cleaned off.

- **CEMENT AND CONCRETE FLOORING -** Concrete is the most common type of flooring because it can be used in any type of building and is cheaper and more durable than other options. As a base course, you can use a concrete mix of 1:3:6 to 1:5:10 or lime concrete with 40% of 1:2 lime sand mortar and 60% of coarse aggregate. As a topping**,** a layer of 1:2:4 cement concrete mix 40 mm thick is placed on top. The Granolithic finish is used in industrial buildings to make a surface that can withstand wear and tear. It is made from thick concrete and has a tough mix of coarse aggregates.

- **MARBLE FLOOR** -Marble is a type of metamorphic rock that is often used for flooring in businesses, bathrooms, kitchens, and other places. Marble flooring doesn't stain and is easy to clean. So, they are extensively used in bathrooms and other places where extra cleanliness is needed. If the marble is finished the right way, it can be used as a beautiful floor. These are the most advanced floors one can put in their home.

- **CORK FLOORING** -One of the most common floorings in residential houses is flooring made with wood or timber. It is preferred in cold climates and at places where wood is cheap. Apart from residential houses, other places with suitable wooden floors include dance floors, auditoriums, etc. While placing these floors, a damp-proof course is necessitated under the floor.

- **RUBBER FLOORING** -Rubber tiles can also be employed as flooring. Pure rubber is mixed with cotton fibre and asbestos fibre to make Rubber flooring. These rubber tiles are stuck to the concrete or wooden base with glue. Rubber flooring is used in libraries, offices, and other places where noise control is mandated.



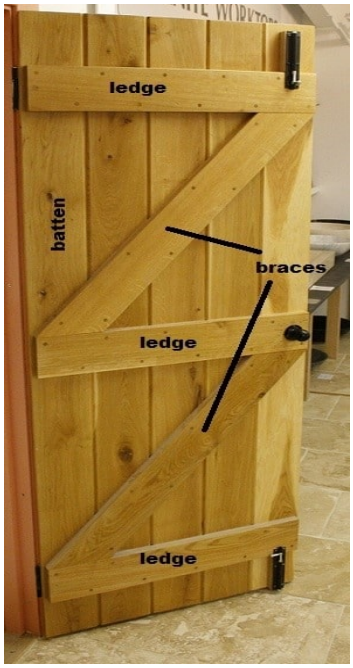
- **LINOLEUM FLOORING** - Linoleum flooring is made by putting linseed oil in gum, resins, pigments, cork dust, etc., and letting it oxidize. This flooring comes in sheets that are usually used to cover floors made of concrete or wood. The sheets could be plain or may have designs for embellishing them.

06. DOOR AND WINDOWS

DOORS - A door is a movable barrier secured in an opening, known as the doorway, through a building wall or partition for the purpose of providing access to the inside of a building or rooms of a building. A door is held in position by doorframes, the members of which are located at the sides and top of the opening or doorway.

Functions of Doors:

- The structure includes doorways that provide entry within the building's rooms.
- The doors in the buildings act as a link between the various parts of the building's interior.
- It will also provide the chamber with ventilation and lighting.
- It will aid in maintaining the rooms' modesty.

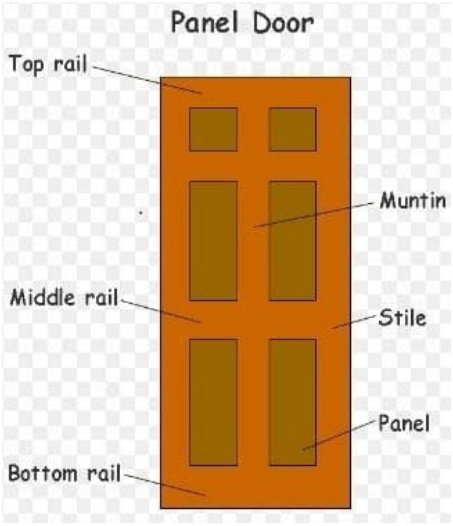


TYPES OF DOOR –

LEGDED AND BATTENED DOOR - Battens are vertical bonds which are having grooves are attached together by horizontal supports called ledges. General Dimensions of batten are 100-150mm width and 20-30mm thick.General, dimension of ledges are 100-200mm width and 25-30mm thick.This type of battened and ledged doors suitable for narrow openings.

BATTENED, LEDGED AND BRACED DOOR – The framework consists of vertical styles, three ledges and two inclined braces. The braces are normally housed into rails at about 40 mm from the styles. The thickness of the styles and top rail is same which is equal to the thickness of braces and battens. This types is suitable for external door and door subjected to rough handling.

FRAMED AND PANELED DOOR – These types of doors are widely used in all types of buildings since they are strong and give better appearences than battened doors. Panel doors consist of vertical members called stiles and horizontal members called rails. Stiles and rails form the framework into which panels are inserted. Panels may be solid wood, plywood or louvered or have glass inserts. Additionals verticals members called mullions are used to divide the door into any number of panels.



FLUSH DOOR - In flush doors, a solid or semi-solid or core portion is covered on both sides with plywood or face veneer. Now a days these type of doors are widely used because of good appearance, economic, ease of construction and greater durability.

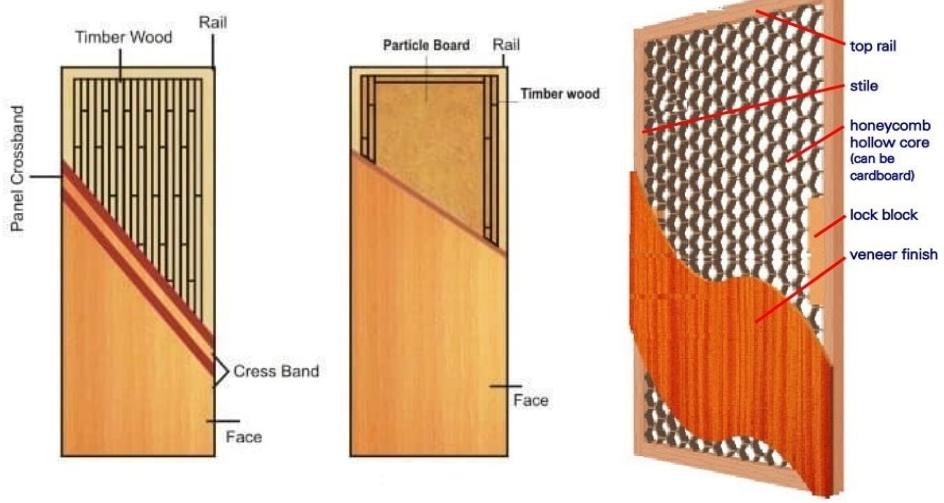
There are two types of Flushed doors:

Solid Core or Laminated Core Flush Door

- The core part in solid core flush door consists of core strips of timber which are glued under high pressure condition. Similarly in the laminated core, battens of 25mm width are glued under high pressure.
- These doors consists of wooden frame with stiles and rails for holding the core.
- Finally plywood sheets or face veneer and cross-bands are glued under pressure on both side of doors.

Hollow core and cellular core flush door

- In this case also stiles and rails are provided for frame. But, a minimum of two intermediate rails should be provided.
- The inner space of door consists of equally space battens of width 25mm each. Other space is called void space which does not exceed 40% of the area of door.
- Here also face veneer and cross-bands are glued under high pressure.



SOLID CORE FLUSH DOOR **HOLLOW CORE FLUSH DOOR**

REVOLVING DOORS -Revolving doors are only provided in public buildings like museums, banks, libraries etc., because of constant visitors. It consists mullion at its centre to which four radiating shutters are attached.

SLIDING DOORS – In these doors, the shutter slide horizontally along tracks with help of runners and rails, often for space. Sliding doors consists of either one, two or three doors that slide by each other on a track depending upon the size of opening and space available for sliding

COLLAPSIBLE DOOR – Such doors are used in garages, workshops, public building, etc. to provide increased safety and protection to property. The doors do not requirehinges to close or open the shutter nor the frame to hang them. The door is made up from vertical double channels (20 x 10 x 2 mm), jointed together with the hollows on the inside to create a vertical gap. These diagonals allows the shutter to open or closed.

ROLLING SHUTTER - Rolling steel shutter doors are commonly used for warehouses, garages, shops etc.. These are very strong and offer proper safety to the property. The door consists frame, drum and a shutter of thin steel plate inter locked together. A horizontal shaft is provided in the drum which helps to open or close the shutter.

TYPES OF WINDOWS –

FIXED WINDOW – Fixed windows are fixed to the wall without any closing or opening operation. In general, they are provided to transmit the light into the room. Fully glazed shutters are fixed to the window frame. The shutters provided are generally weatherproof.

SLIDING WINDOW – In this case, window shutters are movable in the frame. The movement may be horizontal or vertical based on our requirements. The movement of shutters is done by the provision of roller bearings. Generally, this type of window is provided in buses, bank counters, shops, etc..

PIVOTED WINDOW – In this type of windows, pivots are provided to window frames. Pivot is a shaft which helps to oscillate the shutter. No rebates are required for the frame. The swinging may either horizontal or vertical based on the position of pivots.

LOUVERED WINDOW – Louvered windows are similar to louvered doors which are provided for the ventilation without any outside vision. The louvers may be made of wood, glass or metal. Louvers can also be folded by provision of cord over pulleys. We can maintain the slope of louvers by tilting cord and lifting cord. Recommended angle of inclination of louvers is about 45^{o}. The sloping of louvers is downward to the outside to run-off the rain water. Generally, they are provided for bathrooms, toilets and privacy places etc.

CASEMENT WINDOW – Casement windows are the widely used and common windows nowadays. The shutters are attached to frame and these can be opened and closed like door shutters. Rebates are provided to the frame to receive the shutters. The panels of shutters may be single or multiple. Sometimes wired mesh is provided to stop entering of fly's.

SASH WINDOW – Sash window is type of casement window, but in this case panels are fully glazed. It consists top, bottom and intermediate rails. The space between the rails is divided into small panels by mean of small timber members called sash bars or glazing bars.

BAY WINDOW – Bay windows are projected windows form wall which are provided to increase the area of opening, which enables more ventilation and light form outside. The projection of bay windows are of different shapes. It may be triangular or rectangular or polygonal etc. They give beautiful appearance to the structure.

GABLE WINDOW – Gable windows are provided for sloped roof buildings. These windows are provided at the gable end of sloped roof so; they are called as gable windows. They also improve the appearance of building.

LANTERN WINDOW – Lantern windows are provided for over the flat roofs. The main purpose of this window is to provide the more light and air circulation to the interior rooms. Generally, they are projected from the roof surface so, we can close the roof surface when we required.

CLESTROY WINDOW – If the rooms in a building are of different ceiling heights, clerestory windows are provided for the room which has greater ceiling height than the other rooms. The shutters able to swing with the help of cord over pulleys. These also enhances the beauty of building.

DORMER WINDOW – Dormer windows are provided for sloped roofs. These are projected from the sloping surface as shown in below image. They provide ventilation as well as lighting to the room. They also enhance aesthetic sense of room.

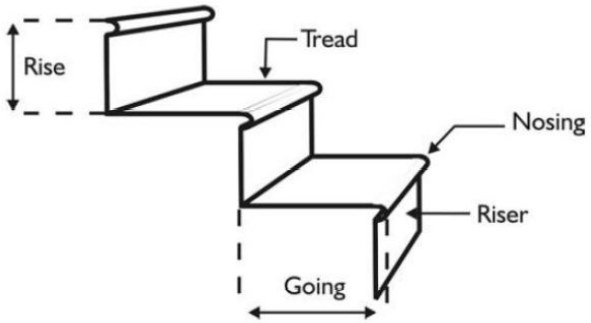
07. STAIRS

Stairs are a structure designed to bridge a large vertical distance between lower and higher levels by dividing it into smaller vertical distances. This is achieved as a diagonal series of horizontal platforms called steps which enable passage to the other level by stepping from one to another step in turn.

TERMS USED IN STAIRS –

- **STEP -** This is a portion of stair which permits ascending or descending from one floor to another. It is composed of a tread and a riser. A stair is composed of a set of steps.
- **TRED -** It is the upper horizontal portion of a step upon which the foot is placed while ascending or descending a stairway.
- **RISER -** It is the vertical portion of a step providing a support to the tread.
- **RISE –** It is the vertical distance between two successive tred face.

- **FLIGHT -**It is a series of steps without any platform or landing or break in their direction.
- **LANDING -** This is a platform provided between two flights. A landing extending to full width of staircase is known as half spaced landing and the space extending only half across a staircase is called a quarter space landing. A landing facilitates change of direction and provides an opportunity for taking rest during the use of the stair.



- **GOING -** It is the horizontal distance between two successive riser faces.
- **NOSING -** This is the outer projecting edge of a tread. This is generally made rounded to give more pleasing appearance and makes the staircase easy to navigate.
- **SCOTIA -** It is a moulding provided under the nosing to improve the elevation of the step, and to provide strength to nosing.
- **LINE OF NOSING -** It is an imaginary line parallel to the strings and tangential to the nosings. It is useful in the construction of hand rails, giving the line with which the under surface of the hand rail should coincide.
- **STRING -** These are the sloping members which support the steps in a stair. They run along the slope of the stair.
- **NEWEL POST -** Newel post is a vertical member which is placed at the ends of flights to connect the ends of strings and hand rail.
- **BALUSTER -** It is a vertical member of wood or metal, supporting the hand rails.
- **BALUSTRADE -** The combined framework of handrail and baluster is known as balustrade. This provides protection for the user of the stair.
- **HAND RAIL -** It is a rounded or moulded member of wood or metal following generally the contour of the nosing line, and fixed on the top of balusters.

- **HEAD ROOM -** It is the minimum clear vertical distance between the tread and overhead structure.

TYPES OF STAIRCASE –

STRAIGHT STAIRS - Generally for small houses, available width is very retractable. So, this type of straight stairs are used in such conditions which runs straight between two floors. This stair may consists of either one single flight or more than one flight with a landing.

TURNING STAIRS - In case of turning stair, the flight take turn. The usual types of turning stairs are

- **QUARTER TURB STAIR –**A quarter turn stair is the one which changes its direction either to the right or to the left but where the turn being affected either by introducing a quarter space landing or by providing winders. In these type of stairs the flight of stair turns 90 degrees art landing as it rises to connect two different levels. So it is also called as L-stair.
- **HALF TURN STAIR –** A stair turning through two right angles is known as a half turn stair. A half turn stair may be of dog legged stair or open newel stair –
  DOG LEGGED STAIR - Because of its appearance in sectional elevation this name is given. It comes under the category of newel stairs in which newel posts are provided at the beginning and end of each flight.
  OPEN NEWEL STAIR - These type of stairs have clearly visible newel posts at the beginning of flight as well as at the end. At the quarter turn, there may either be quarter space landing or there may be winders.
- **THREE QUARTER TURN STAIR –** The direction of stairs changed three times with its upper flight crossing the bottom one in the case of three quarter turn stairs. These stairs are may either be newel or open newel type. This type stairs are generally used when the vertical distance between two floors is more and as well as length of the stair room is limited.
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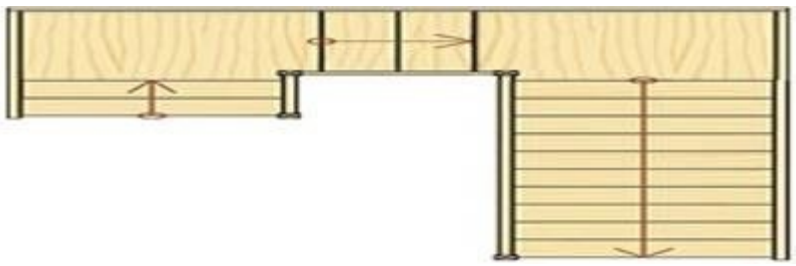
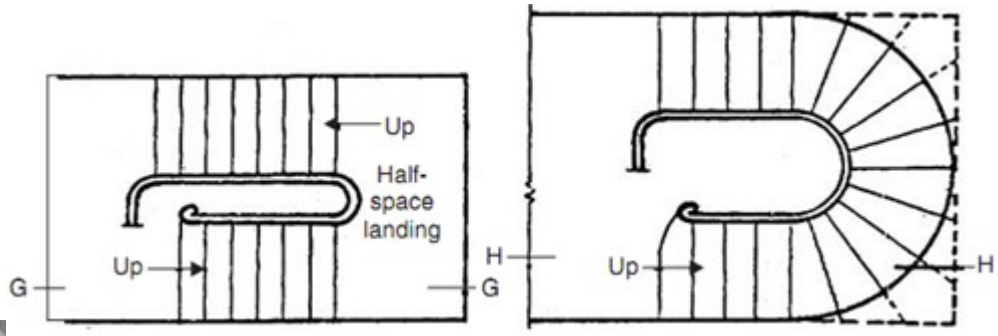
GEOMETRICAL STAIR – These stairs have any geometrical shape and they require no newel posts. The handrails of a geometrical stairs continues without interruption and without any angular turns.



HALF TURN GEOMETRICAL STAIRS - In case of geometrical half turn stairs the stringers and the hand rails are continuous, without any intervening newel post. These stairs may contains either with half space landing or without landing.

SPIRAL STAIRS - In this type of stair, the step radiate from the centre and they do not have either any landing or any intermediate newel post.



WOODEN STAIRS – As wooden stairs are light in weight, they are mostly used for residential buildings. The main objection to the provision to a woodenstairs is that it is easily attacked by fire and thus in case of a fire the occupant of upper floors cannot escape. But if a wooden stair is constructed from good quality timber such as teak and it its thickness is about 45mm, it becomes sufficiently fire – proof and it allows enough time for the occupants of upper floor to escape.

R.C.C STAIRS - RCC STRUCTURES are nothing but reinforced concrete structures. RCC structure is composed of building components such as Footings, Columns, Beams, Slabs, Staircase etc.These components are reinforced with steel that give stability to the structure.STAIRCASE is one such important component in a RCC structure.Standard mix used for stairs are 3 parts cement, 2 parts sand, 4 parts gravel and water. It is recommended to use a concrete vibrator while pouring the concrete to completely fill the gaps of the stairs and to avoid the honeycomb formation.

08. ROOF

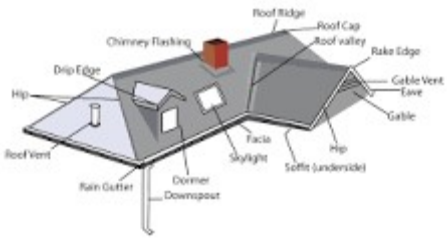
A roof is the uppermost part of a building whose main function is to enclose the space and to protect the same from the effects of weather elements such as rain, wind, sun, heat and snow. A good roof is just as essential as a safe foundation.

REQUIREMENT OF A GOOD ROOF:

1. It should be durable against the adverse effect of various agencies such as wind, rain, sun, etc.
2. It should grant the desirable insulation against sound and heat.
3. It should be structurally stable and sound and it should be capable of taking the loads likely to come over it.
4. It should be well – drained.
5. It should have efficient water – proofing arrangement.
6. It should be fire resistant.

PITCHED OR SLOPING ROOFS –

1) **Barge boards:** These are the wooden planks or boards which are fixed on the gable end of a roof. they connect the ends of ridges, purlins and wall plates.
2) **Battens:** These are the thin strips of woods which are fixed on the rafters or ceiling.They support the roof ceiling.
3) **Cleats:** These are small blocks of wood which are fixed on the trusses to prevent the sliding of purlins.
4) **Dragon Beam:** The lower end of a hip rafter is generally supported on a diagonal piece of woods which is laid across the corner of the wall.
5) **Eaves:** The lower edges of a roof which are resting upon or projecting beyond the supporting walls are known as the eave.



6) **Gable:** The triangular upper part of a wall formed at the end of pitched roof is known as a gable **.**
7) **Hip:** The angle formed at interaction of two roof slopes is known as the hip .
8) **Pitch:** The inclination of slides of a roof to the horizontal places is knowas the pitch and it can be expressed eith in terms of degrees or as a ratio of rise to span.
9) **Purlins:**The wooden pieces which are pced horizontally on principal rafters to carry the common rafters are known as the purlins.
10) **Rafters:** These are the pieces of timber which extend from the eaves to the ridge.
    - **Common Rafter –** These are the intermediate rafters which give support to the roof covering.
    - **Hip rafters –** These are the rafters which are provided at the junction of two roof slopes.

- **Jack rafters –** Any rafter which is shorter than a common rafter is known as a jack rafter.
- **Principal rafter –** These are the inclined members of a truss.

11) **Ridge:** A wooden piece provided at the ridge line of a sloping roof is known as the ridge or ridge board or ridge piece.
12) **Span:** The horizontal distance between the internal faces of walls or supports is known as a span. The effective span indicates the horizontal distance between the center of wall or supports.
13) **Truss:**The framework usually of triangles and designed to support the roof covering or ceiling over rooms is known as truss.
14) **Verge:** The edges of a gable, running between the eaves and ridge, is known as a verge.
15) **Valley:** When two roof surface meet together and form an internal angle, a valley is formed.
16) **Wall plates:** These are the long wooden members which are embedded on top of walls to receive the common rafters. They actually connect the walls to the roof.

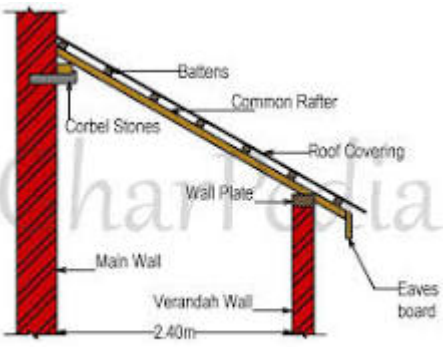
TYPES OF ROOF:

The pitched roof is classified into:

1) Single pitched roof
    - Lean to roof
    - Couple roof
    - Couple close roof
    - Collar beam
    - Collar and scissor roof.
2) Double or purlin roof
3) Trussed roof
    - King post truss
    - Queen post truss
    - Mansard truss
    - Truncated truss
    - Bel – fast truss
    - Steel trusses
    - Composite

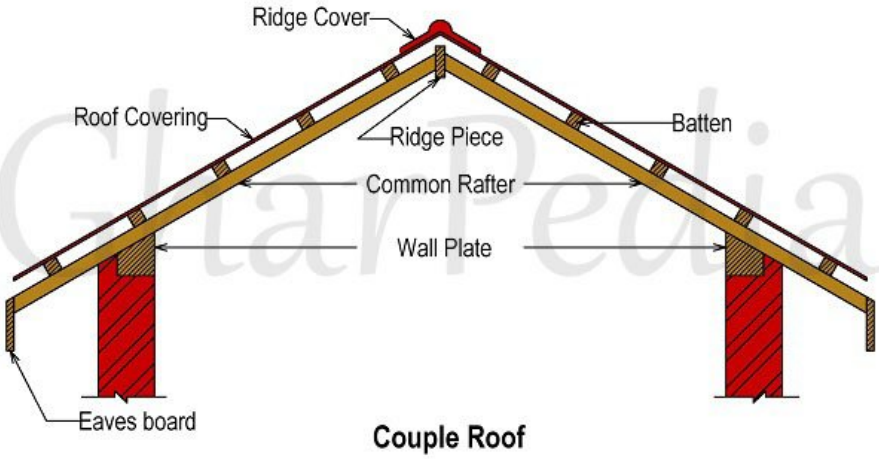
SINGLE ROOF –

LEAN – TO – ROOF: A lean-to roof is a single sloped roof that attaches to an existing building. Homeowners most often use lean-to roofs for home and outbuilding additions. The most significant advantage of a lean-to roof is the easy construction. Since these roofs only have one slope, they don't require a lot of material or labor costs.



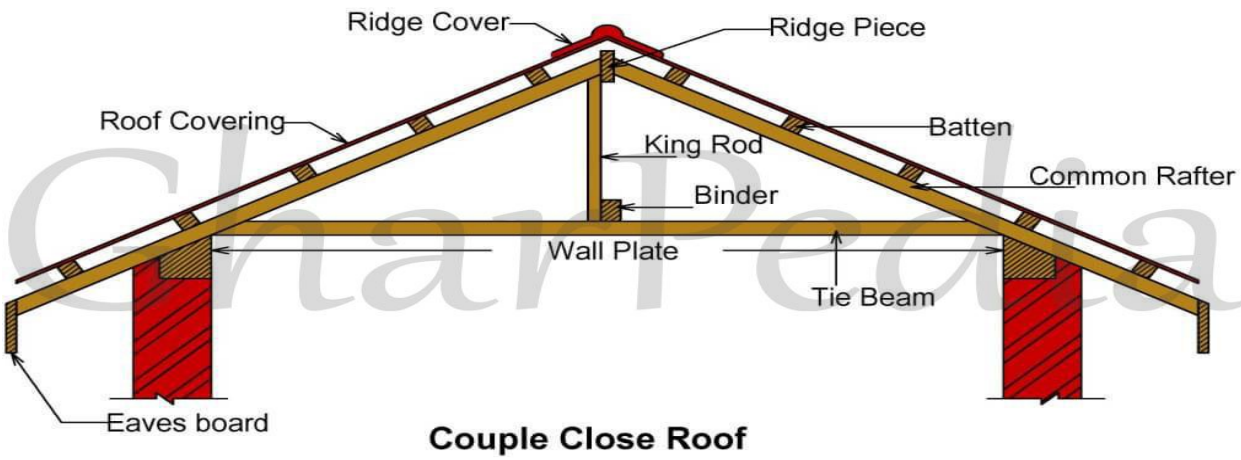
Lean to Roof

COUPLE ROOF: Couple Roof is the simplest form of the pitched roof. In this roof construction, the common rafters slope upwards from the opposite walls and they meet on a ridge piece in the middle. This form of pitched roof is a pair of rafters acting like two arms pinned at the top and hence it is called couple roof.



Couple Roof

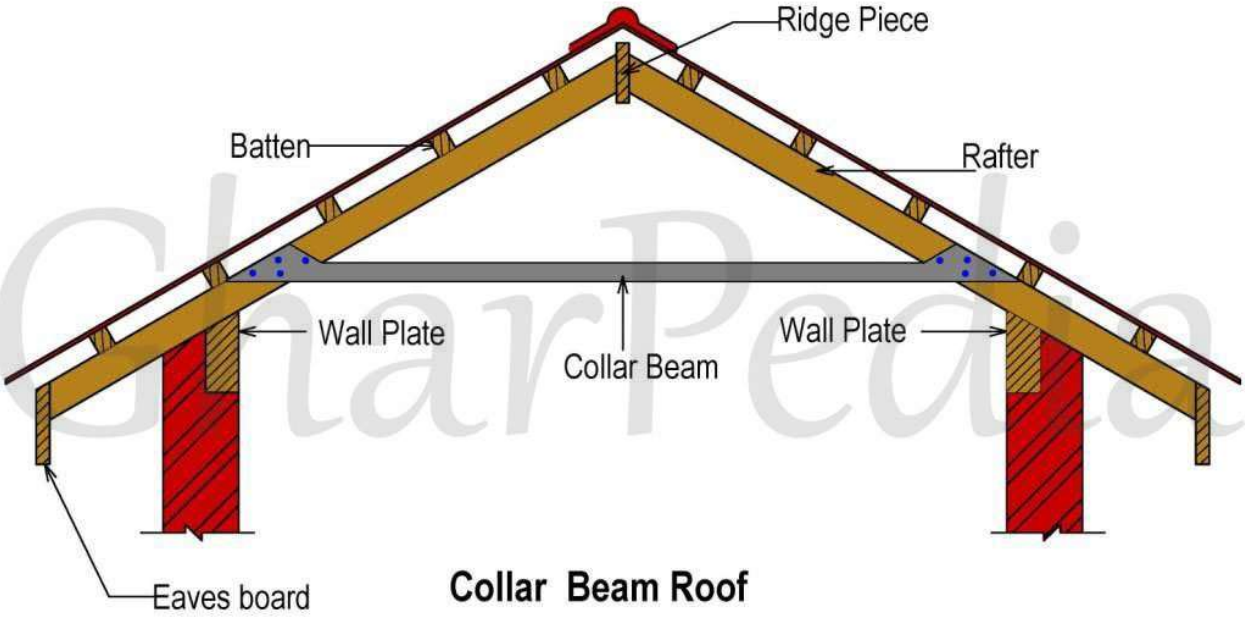
COUPLE CLOSE ROOF: Couple close roof is similar to a couple roof but the legs of the common rafters are closed by a horizontal tie known as tie beam. This tie beam prevents the rafter from the spreading and thrusting out of the wall because it is connected to the feet of the common rafter. These ties are nailed to the rafters and also nailed to the wall plate. This tie beam is made from the wood and steel rod.



Couple Close Roof

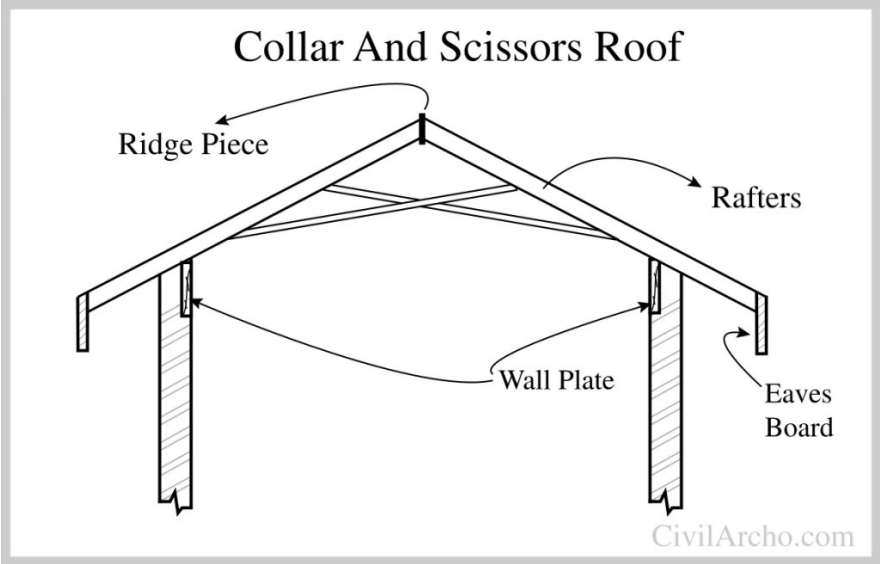
COLLAR ROOF: A collar beam or collar is a horizontal member between two rafters and is very common in domestic roof construction. Often a collar is structural but they may be used simply to frame a ceiling. A collar beam is often called a collar tie but this is rarely correct.The collar

beam is usually fixed at one – third to one – half the vertical height from the wall to the ridge. The lower is the collar, the strongest is the roof. This roof can be adopted up to a maximum span of 4.80.

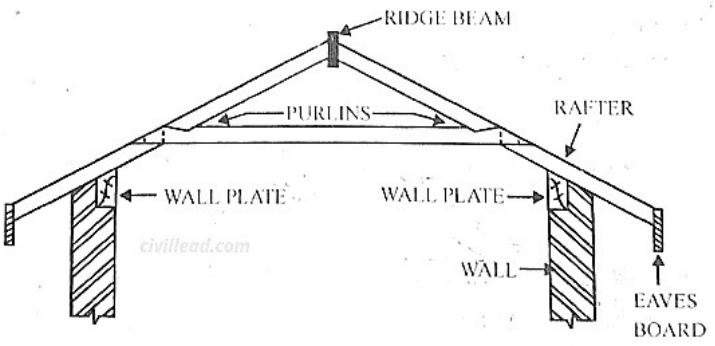


Collar Beam Roof

COLLAR AND SCISSOR ROOF – This roof is similar to the collar beam roof except that two collar beams which are crossing each other to present an appearance of scissors are provided. Such a roof.



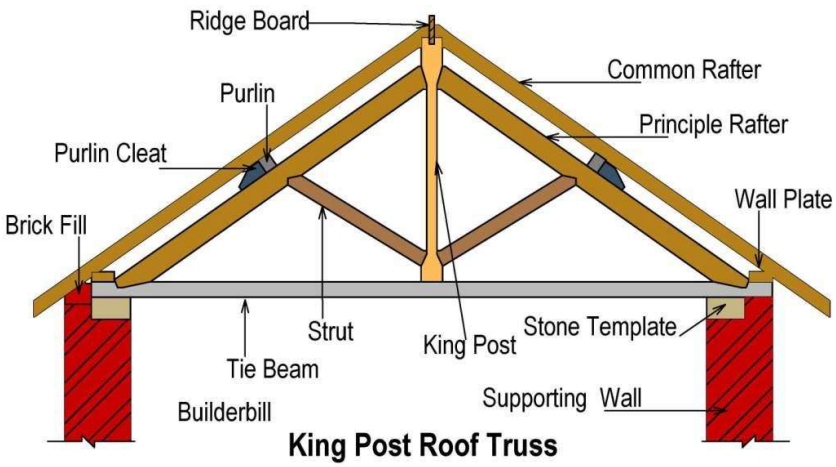
DOUBLE PURLIN ROOF - These roofs have two basic elements: i) rafters and ii) purlins The purlins give intermediate support to the rafters, and are supported on end walls. The intermediate supports so provided in the form of purlins, reduce the size of the rafters to the economical range. Such a roof is also known as rafter and purlin roof. The rafters are provided fairly close (40 to 60 cm c/c). Each rafter is thus supported at three points i) at the bottom, on the wall through wall plate ii) at the top, by the ridge beam, and iii) at the centre by a purlin. By supporting the rafter at its mid-point with a purlin, the span is halved, thus enabling the rafter to be made considerably lighter than it would need to be if it spanned the whole distance from eaves to the ridge. For larger roofs, two or more purlins may be provided to support each rafter.



Double or Purlin Roofs

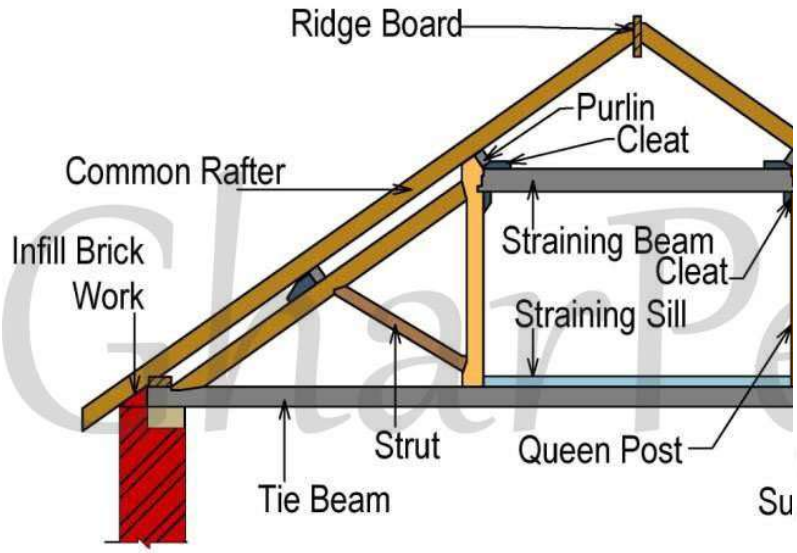
TRUSS ROOF – When the span exceeds 4.80m and there are no inside supporting walls or partition for the purlins, the framed structure is known a s truss.

- **KING POST TRUSS -** In king post truss, purlins are supported by the principal rafter. The purlins support the closely spaced common rafters. The slope of common rafters is same as that of the principal rafter. The common rafters support the roof covering.In king Post truss, The Bottom chord of the truss acts as tie beam and this tie beam receives the ends of the principal rafters and prevents the wall from spreading out due to thrust. The vertical king post is used to prevent the sagging of tie beam at the centre of a span. The Struts are connected to the tie beams and the principal rafters in the inclined direction.The Spacing of King Post truss is limited to 3 m centre to centre. The truss is suitable for spans varying from 5 to 8 metre. It is not suitable for the long span. The king post truss does not provide storage space because the frames are usually exposed and do allow extra room.

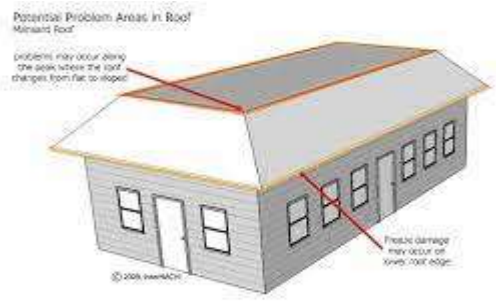


King Post Roof Truss

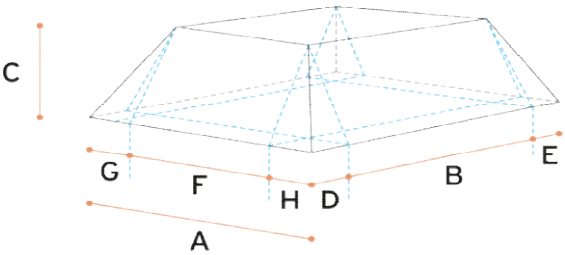
- **QUEEN POST TRUSS -** In this roof, The Queen posts are the tension members which are used to prevent the sagging of tie beam. The upper ends of the queen-posts are kept in position by straining beam. The straining beam receives the thrust from the principle rafters and also keeps the junction in a stable position.A straining sill is fixed on the tie beam and also fixed between the feet of Queen post. This straining sill is used for reducing the thrusts from struts. The principal rafters, Straining beams, struts and straining sill are in compression whereas the queen posts and tie beam are in tension. Purlins are horizontal wooden members laid on principal rafters on wall-to-wall to support common rafter of a roof which is fixed with cleat. Queen post truss is suitable for 8 to 12 meters. This truss is made from a variety of materials such as timber or steel. The Queen post truss is simpler and lighter in weight. It does not put weight on the centre of the main tie beam, as the king post truss.Queen post truss is used when there is a need to cover large areas. It is relatively low-cost and can be made to fit almost any size or slope of the roof.



Queen Post Truss



MANSARD ROOF - The mansard truss consists of the king-post and queen-post trusses and it has two pitches, the upper pitch, and the lower pitch.Mansard truss is a two-storey truss, the upper portion consisting of king post truss and the lower one consisting queen post truss.The disadvantage of the mansard truss is, it is old and ugly in appearance.



TRUNCATED ROOF - The truncated truss is similar to the mansard truss. The only difference is the truncated truss top is finished flat with a slope to one side.The truncated truss is used when a room is needed in the roof.

BELL – FAST TRUSS - Bel-Fast truss is suitable for a span length up to 30 meters. And it is also known as latticed roof truss or low string truss.The bel-fast truss is in the form of a bow and it consists of a thin section of timber.

STEEL TRUSSES - The steel trusses are used for spans greater than 12 meters.In India, steel trusses are selected over timber trusses due to the big differences in the costs.

COMPOSITE TRUSS - The composite trusses consist of steel members and wooden members. The advantage of composite trusses is, they are economical and light in weight.

09. FORM WORK

Formwork is the structure, usually temporary, used to contain poured concrete and to mould it to the required dimensions and support until it is able to support itself. It consists primarily of the face contact material and the bearers that directly support the face contact material.

FUNCTION OF FORMWORK –

Formwork molds the concrete to the desired size and shape, and controls its position and alignment. It is a temporary structure that supports its own weight and the freshly placed concrete, as well as construction live loads including materials, equipment, and workers.

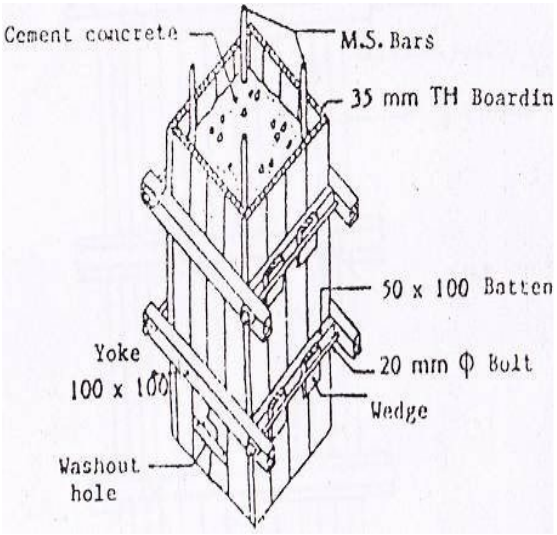
MATERIAL USED AS FORM WORK –

- **STEEL FORMWORK –** The steel is used for formwork when it is desired to reuse the formwork several times. The initial cost of steel formwork is very high. But it proves to be economical for large works requiring many repetitions of the formwork. The erection and removal of steel formwork are simple and it presents a smooth surface on removal.
- **TIMBER FORMWORK –**when formwork is required for small works requiring less repetitions, the timber is preferred to steel. The timber formwork is cheap in initial cost and it can be easily adopted or altered for a new use. The timber to be used as formwork should be well seasoned, free from loose knots, light in weight and easily workable with nails without splitting.

FORMWORK FOR COLUMNS –

The column formwork consist of box prepared from four separate sides. The four sides of the box are held in position by wooden blocks, bolts and yokes. The details of formwork for an R.C.C column of section 300mm X 300mm. The important features of the formwork for R.C.C column are –

1. The formwork should be designed to resist the high pressure esulting from the quick filling of the concrete.
2. The spacing of yokes is about one metre. But it should be carefully determined by working out greatest length of the formwork which can safely resist the load coming on the formwork.
3. Depending upon the shape of the column, the box can be suitably prepared.



4. A hole is generally provided at the bottom of the formwork of column to remove the debris which might fallen before concrete placed.

5. A wash of water is given to the inside of formwork just before starting the laying of concrete.
6. The boxes should be designed in such a way that with little alteration, they can be re – used for columns with smaller cross section on upper floors.
7. In order to make the dislocation, the nails are kept projecting instead of being firmly driven.
8. The wood yokes being efficient and cheap are widely used. But they can be replaced by the metal clamps of suitable design.
9. The formwork for circular columns is made of narrow vertical boards. These are known as the staves and they are correctly shaped to the required curvature.

FORMWORK FOR FLOORS –

The formwork for an R.C.C floor consist of a skeleton to receive the concrete. It consists of rows of vertical posts which carry small wooden beams at their tops.

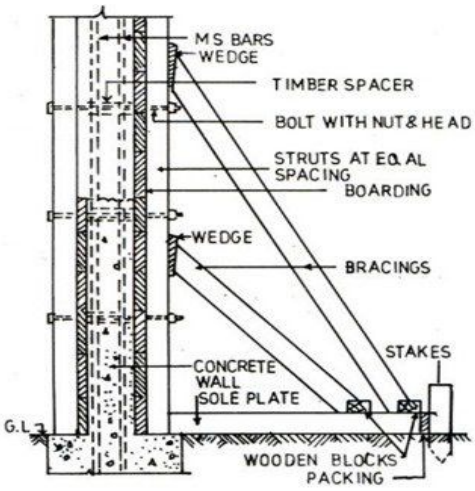
Following important facts of formwork for the floors should be remembered.

1. The formwork for floor should be designated for the weight of concrete plus some additional load to the extent of about 30 percent to provide for labour strorage of material, equipment.
2. If required, the posts should be provided with the diagonal braces.
3. It is possible to use steel forms for slab, the other components being of wood.
4. The vertical supports should be firmly supported at the bottom. For this purpose, the base – plates of steel may be used. The wooden wedges are provided at the bottom so as to facillate tighting or loosening of the post.
5. The formwork for floor should be given necessary slope as required and the whole surface should be thoroughly cleaned with water before starting the laying of concrete on the formwork.
6. The box for beam formwork is generally prepared at ground level and hoisted and placed in position. This arrangement will avoid the construction of formation on the scaffolding.
7. When secondary beams are to rest on the main beams, suitable opening the correct positions are provided in main beams to receive the formwork of secondary beam.

FORMWORK FOR WALLS –

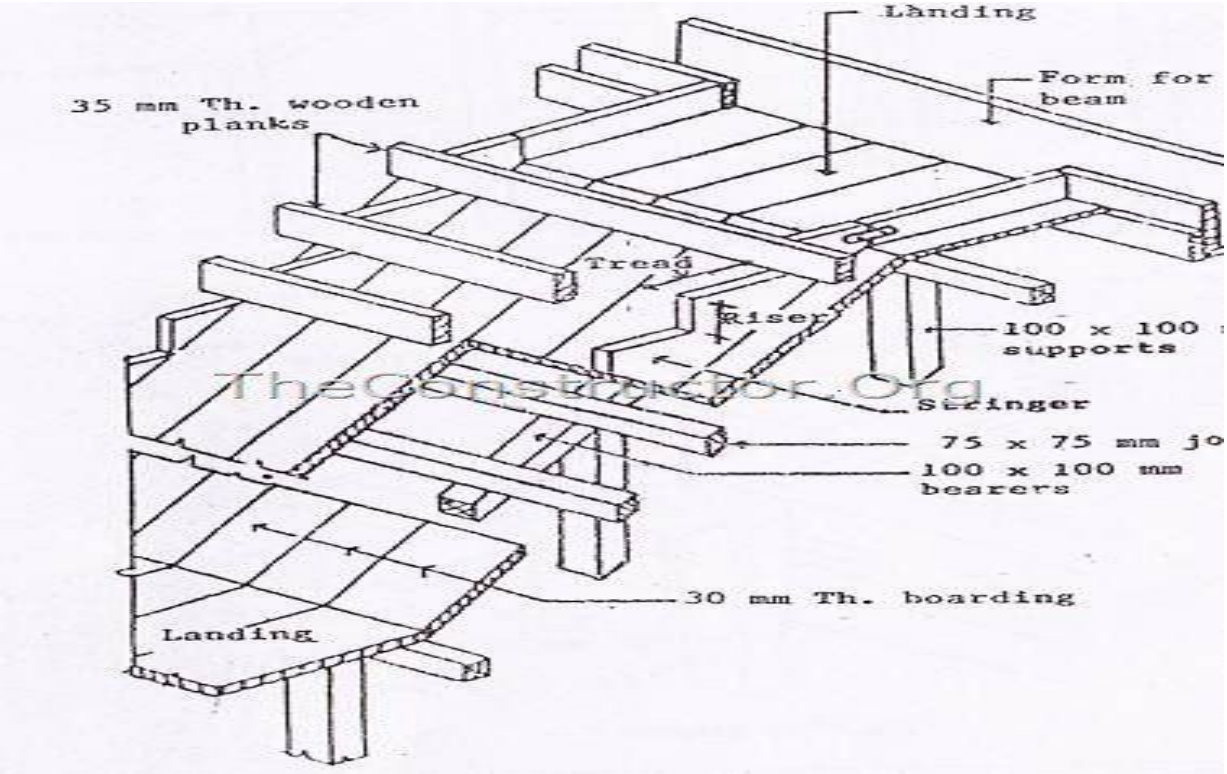
The formwork for wall consists of sheets, studs, wales, ties and braces. The sheets are supported by vertical studs and horizontal wales. The tiles are provided to maintain the distance between the sheets and to resist the bursting action of concrete. The small pieces of timber known as the spacers may be used and they are to be removed as the concrete reaches that levels. In addition, the wires ties and bolts may be also provided.

The wires are placed at the horizontal distance of about 600 mm and they are taken round the wales. When formwork is struck off, the ends of wire ties are cut off and provided with rich quality of cement mortar to avoid rusting. If bolts are used, they are to be provided with rich quality of cement mortar to avoid rusting. If bolts are used, they are to be provided with grease or to be embodied in cardboard tubes so as to make their removal easy after 2 days or 3 days of pouring concrete.



FORMWORK FOR STAIRS –

The formwork for stairs consists of stringers, sheet, joists, bearers and vertical posts. The riser forms are supported on cleats which are fixed on stringers or wall as the case may be. The bottom edges of the riser forms is chamfered so that concrete can on the bearers. The vertical posts support the bearers. Suitable alternation in the formwork is made at the floor level and landing level. The treads are kept open so as to permit the filing of concrete.



10. POINTING AND PLASTERING

OBJECTIVES OF POINTING AND PLASTERING –

The following are the main objects for objects for providing pointing and plastering to the exposed surfaces –

1. To improve the appearance of the structure as a whole and to give smooth surface.
2. To protect the exposed surfaces from the effects of atmospheric actions.
3. To rectify the defective workmanship or to conceal inferior material.

POINTING –

The term pointing is used to denote the finishing of mortar joints of either stone masonry or brick masonry. The joints are raked out to a depth of about 20mm and then, these spaces are filled up by suitable mortar in the desired shape.

METHODS OF POINTING –

1. The mortar of the masonry joints to be covered by pointing is raked out at least to a depth of 20mm.
2. The dust from the masonry joints is removed by the brushes.
3. The surfaces is then washed with clear water and it is kept wet for a few hours.
4. The mortar is then carefully placed in desired shape in these prepared joints. The mortar is placed by a small trowel and it is slightly pressed to bring it into close contact with the old interior , mortar of the joint.
5. The finished surface is well weathered for a period of a least 3 days, if lime mortar is used and 10 days, if cement mortar is used.

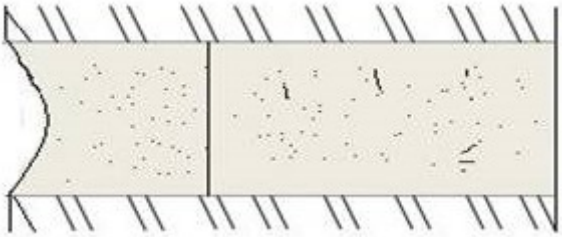
TYPES OF POINTING –

- **BEADED POINTING:** It is formed by a steel or iron rod with a concave edge. The beaded pointing is good in appearance. But it is difficult to maintain as it can be easily damaged.

- **FLUSH POINTING:**it is forming by removing the excess mortar from the joint. The joint is made flush with the face. This type of joint does not give good appearance. But it is durable as it does not provide any space for accumulation of dust, water, etc. and hence it is extensively used.

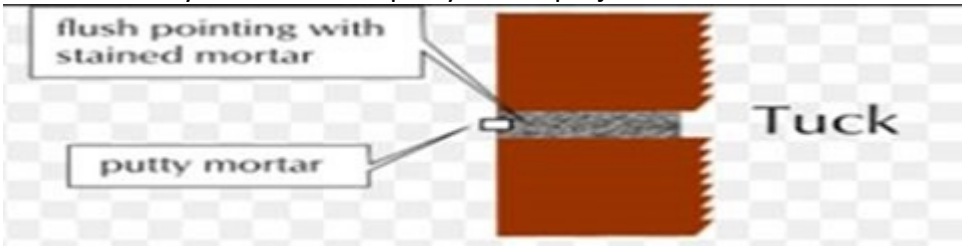
- **RECESSED POINTING:**The face of the pointing is kept vertical and it is pressed inside the wall surface by a suitable tool to a depth of about 5mm or more. The pointing gives very good appearance.

- **RUBBED OR KEYED OR GROOVED POINTING:**In this type of pointing a groove is formed at the center of height by a pointer. This type of pointing gives better appearance and is generally adopted.

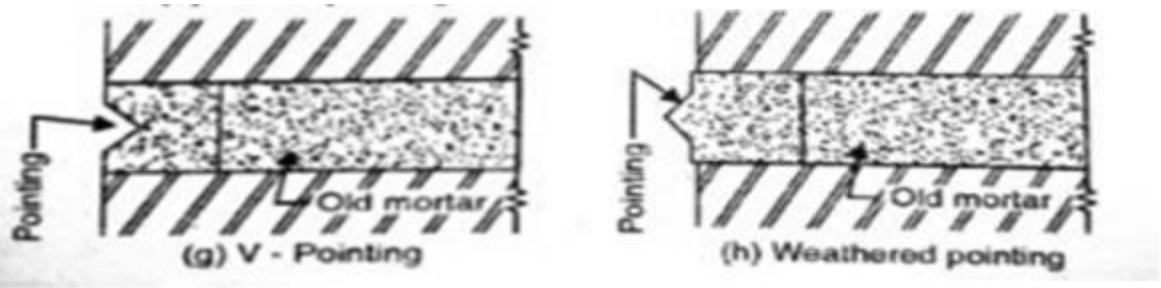


- **STRUCK POINTING:**This is a modification of flush pointing in which the face the pointing is kept inclined, with its upper edge pressed inside the face by 10mm which drains water easily.

- **TUCK POINTING:**In this type of pointing a grooved is formed at the center of joint. The width and depth of groove are respectively 5 mm and 3 mm. the groove is then filled in or tucked in by white cement putty with a projection of 3 mm.



- **VEE POINTING:**In this type of pointing, a Vee – shaped groove is formed in the mortar joint.
- **WEATHERED POINTING:**In this type of pointing, a projection in the form of a Vee – shape is formed.



PLASTERING – The term plastering is used to describe the thin plastic covering that is applied on the surface of walls and ceiling. The plastering removes the uneveness of the surfaces and sometimes the plastering is used to develop decorative effects.

REQUIREMENT OF GOOD PLASTERING –

1. It should adhere to the background and should remain adhered during all climatic changes.
2. It should be cheap and economical.
3. It should be hard and durable.
4. It should be possible to apply it during all weather conditions.
5. It should effectively check the entry or penetration of moisture from the surfaces.
6. It should possess good workability.

METHOD OF PLASTERING –

1. The plaster may be applied in one or more coats, but the thickness of a single coat should not exceed 12 mm.
2. In the case of the inferior or cheaper type of construction, the plaster may usually be one coat. For the ordinary type of construction, the plaster is usually applied in two coats, whereas for a superior type of works it is applied in three coats.
3. The final setting coat should not be applied until the previous undercoat is almost dry.
4. Before applying the next coat of plaster the previous plastered surface should be scratched or roughened to form a key with an overcoming layer.
5. In plastering plaster mix is either applied by throwing it with great force against the wall or by pressing it on the surface.

STEPS OF TWO COATS PLATERING –

STEP 1. PREPARATION OF WALL SURFACE –

- Keep all the mortar joints of wall rough, so as to give a good bonding to hold plaster.

- Clean all the joints and surfaces of the wall with a wire brush, there should be no oil or grease, etc. left on the wall surface.
- If the surface is smooth or the wall to be plastered is old, then rake out the mortar joint to a depth of at least 12 mm to give a better bonding to the plaster.
- If the projection on the wall surface is more than 12 mm, then knock it off, so as to obtain a uniform surface of the wall. This will reduce the consumption of plaster
- If there exist any cavities or holes on the surface, then fill it in advance with appropriate material.
- Roughen the entire wall to be plastered.
- Wash the mortar joints and entire wall to be plastered, and keep it wet for at least 6 hours before applying cement plaster.

STEP – 2 . GROUND WORK FOR PLASTERING –

- In order to get the uniform thickness of plastering throughout the wall surface, first, fix dots on the wall.
- A dot means a patch of plaster of size 150 mm * 150 mm and having a thickness of about 10 mm.
- Dots are fixed on the wall first horizontally and then vertically at a distance of about 2 meters covering the entire wall surface.
- Check the verticality of dots, one over the other, by means of plumb-bob.
- After fixing dots, the vertical strips of plaster, known as screeds, are formed in between the dots. These screeds serve as the gauges for maintaining even. the thickness of plastering being applied.

STEP – 3. APPLYING FIRST COAT –

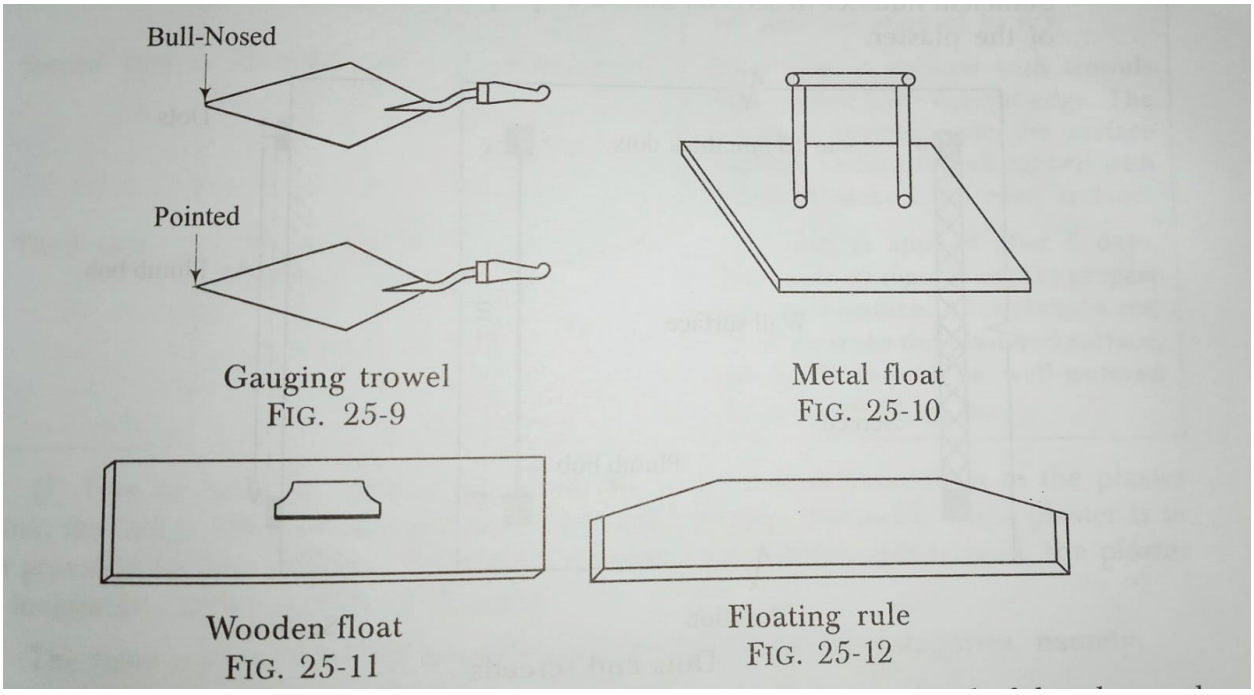
- In the case of brick masonry, the thickness of first coat plaster is in general 12 mm and in the case of concrete masonry, this thickness varies from 9 to 15 mm.
- The ratio of cement and sand for first coat plaster varies from 1:3 to 1:4.
- Apply the first coat of plaster between the spaces formed by the screeds on the wall surface. This is done by means of the trowel.
- Level the surface by means of flat wooden floats and wooden straight edges.
- After leveling, left the first coat to set but not to dry and then roughen it with a scratching tool to form a key to the second coat of plaster.

STEP – 4 . APPLYING SECOND COAT OR FINISHING COAT –

- The thickness of the second coat or finishing coat may vary between 2 to 3 mm.
- The ratio of cement and sand for second coat plaster varies from 1:4 to 1:6.
- Before applying the second coat, damp the first coat evenly.
- Apply the finishing coat with wooden floats to a true even surface and using a steel trowel, give it a finishing touch.
- As far as possible, the finishing coat should be applied to start from the top towards the bottom and completed in one operation to eliminate joining marks.
- After completion of the plastering work, it is kept wet by sprinkling water for at least 7 days in order to develop strength and hardness.

<u>TOOLS FOR PLASTERING –</u>

1. **Gauging trowel:** This is the ordinary trowel and is useful for applying mortar to moulding, corners, etc. it has a pointed or bull – nose end.
2. **Float:** This tool is used for applying and spreading the cement mortar on the surface. It is a flat wooden or metal board with a handle on a flat surface. There are two types of floats based on the type of material used to make it.
3. **Floating rule:** This tool is used to check the level of the plastered surface between the successive screeds.
4. **Plumb bob:**This tool is very much useful in forming screeds in the same vertical plane.
5. **Miscellaneous tools:** In addition to the above tools, other tools such as brushes, sprit level set square, straight edges**.**



Gauging trowel
FIG. 25-9

Metal float
FIG. 25-10

Wooden float
FIG. 25-11

Floating rule
FIG. 25-12

EXERTNAL FINISHES –

1. **Smooth cast finish -** In smooth cast finish, a completely smooth and levelled surface is acquired. The mortar prepared for the smooth cast finish is made of cement and fine sand, which are mixed in the ratio of 1 part cement and 3 parts of fine sand. Water is added according to the required quantity. The prepared mortar is applied using the wooden float. Steel floats are generally avoided for applying the plaster on external surfaces because the steel float gives a super smooth surface, which may develop cracks under exposure to atmospheric conditions.

2. **Sand faced finish -** Sand faced finish is obtained when the plastering is done in two coats. The ingredients are the same as the mortar prepared for smooth cast finish. The ratio of cement and sand for the first coat 1:4. The thickness of the first coat is 12mm.The first coat is provided with zigzag lines. It is because a smooth surface won't hold a freshly applied coat of mortar. The first coat is cured for 7 days with water.Then after the second coat of 8mm thickness is applied. The ratio of cement sand mix mortar for the second coat is taken as 1:1 respectively.Then after the second coat of 8mm thickness is applied. The ratio of cement sand mix mortar for the second coat is taken as 1:1 respectively.

3. **Rough cast finish or Spatter dash finish -** It is a type of plaster finish in which the mortar consists of coarse aggregates too with the regular plaster mortar ingredients. The mortar, here, consists of cement, sand, and coarse aggregates in the ratio of 1:1.5:3, respectively. The mortar is dashed against the plastered surface using is a large trowel. Then the surface is roughly finished by the means of a wooden float. This type of finish is commonly used for external renderings. Rough cast finish is waterproof, durable and a crack-resistant type of finish.

4. **Pebble dash finish -** The final coat of pebble dash finish or dry dash finishes a thickness of 12mm. The mortar is same as the mortar used for smooth cast finish, in the ratio 1:3.Pebbles of size 10mm to 20mm are dashed against the surface of fresh plaster. The pebbles are lightly pressed into the mortar using a wooden float. This type of Plaster finish normally used for decorative purposes.

5. **Depeter finish -** Depeter finish is similar to the pebble dash finish. A 12mm coat is applied & while the plaster is still wet, small pieces of gravel or flint are pressed with a hand on the surface of the plaster. To obtained different and beautiful patterns, flints of various colours are used like the pebble dash finish, depeter finish is also a decorative type of plaster finish.

6. **Scrapped finish -** The thickness coat of scrapped finish varies from 6mm to 12mm. After the coat is stiffened, the surface is scrapped in different patterns, which are 3mm deep.Different tools such as steel straight edges or old saw blades are used for scrapping the plastered surface. Scrapped surfaces are usually less liable to cracks.

7. **Textured finish -** Textured finishes are generally used with stucco plastering. Different textures, as well as various ornamental patterns, are created on the surface of plaster. The textures and patterns are created using some special tools and also skilled workers are required for that.

11.CEMENT CONCRETE CONSTRUCTION

Concrete is a vital element and a vitally important thing that is used in several individual and commercial buildings. It solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. It binds other building materials together. It is a material extensively used in the construction process and is made by mixing aggregate, cement, small stones, sand, gravel, and water. All the components bond together to create a stone-like material.

MATERIAL USED IN CONCRETE –

1. **Cement:** Most of the cement concrete work in building construction is done with ordinary Portland cement at present. But other special varieties of cement such as rapid hardening cement and high alumina cement are used under certain circumstances.
2. **Aggregates**: These aggregates are the inert or chemically inactive material which forms the bulk of cement concrete. These aggregates are bound together by means of cements

   The aggregates are of two types –
   - **Natural aggregates**
   - **Artificial aggregates**

1. **Natural aggregates** – The term natural aggregates is loosely to designate aggregates which need only be removed from their natural deposits . the natural aggregates can be divided into following :
   - Crushed – rock aggregate: the crush rock aggregate is obtained crushing rock pieces into suitable sizes.
   - Gravel: the term gravel is used to mean the coarse material resulting from the disintegration of natural rock due to weathering and carried away by water and subsequently deposited on the river banks.
   - Sand: The final residue of the resistant mineral grains resulting from the weathering action upon the rocks is known as Sand.
2. **Artificial aggregates** – The blast furnace slag is perhaps the only artificially prepared aggregates which are used in construction.
3. **Steel:** The steel reinforcement is generally in the form of round bars of mild steels. The diameter of bars varies from 5mm to 40mm.
4. **Water:** This is the least expensive but most important ingredient of concrete. The water, which is used for making concrete, should be clean and free from harmful impurities such as oil, alkali, acid, etc.

MIXING OF CEMENT CONCRETE – The mixing operation consists of rotation or stirring, the objective being to coat the surface the allaggregate particles with cement paste, and to blind

all the ingredients of the concrete into a uniform mass; this uniformity must not be disturbed by the process of discharging from the mixer.

It is important to know the minimum mixing time necessary to produce a concrete of uniform composition, and of reliable strength. The mixing time or period should be measured from time all the cementing materials and aggregates are in mixer drum till taking out the concrete.

Mixing time depends on the type and size of mixer, on the speed of rotation, and on the quality of blending of ingredients during charging of the mixer. Generally, a mixing time of less than 1 to 1.25 minutes produces appreciable non-uniformity in composition and a significant lower strength; mixing beyond 2 minutes causes no significant improvement in these properties.

PLACING AND TRANSPORTING OF CEMENT CONCRETE –

The operation of placing and compaction are interdependent and are carried out simultaneously. They are most important for the purpose of ensuring the requirements of strength, impermeability and durability of hardened concrete in the actual structure. As for as placing is concerned, the main objective is to deposit the concrete as close as possible to its final position so that segregation is avoided and the concrete can be fully compacted. The aim of good concrete placing can be stated quite simply.It is to get the concrete into position at a speed, and in a condition, that allow it to be compacted properly.

To achieve proper placing following rules should be kept in mind:

1. The concrete should be placed in uniform layers, not in large heaps or sloping layers.
2. The thickness of the layer should be compatible with the method of vibration so that entrapped air can be removed from the bottom of each layer.
3. The rate of placing and of compaction should be equal. If you proceed too slowly, the mix could stiffen so that it is no longer sufficiently workable. On no account should water ever be added to concrete that is setting. On the other hand, if you go too quickly, you might race ahead of the compacting gang, making it impossible for them to do their job properly.
4. Each layer should be fully compacted before placing the next one, and each subsequent layer should be placed whilst the underlying layer is still plastic so that monolithic construction is achieved
5. Collision between concrete and formwork or reinforcement should be avoided.
6. For deep sections, a long down pipe ensures accuracy of location of concrete and minimum segregation.
7. You must be able to see that the placing is proceeding correctly, so lighting should be available for large, deep sections, and thin walls and columns.

COMPACTING OF CEMENT CONCRETE –

Once the concrete has been placed, it is ready to be compacted. The purpose of compaction is to get rid of the air voids that are trapped in loose concrete.Fully compacted concrete is dense, strong and durable; badly compacted concrete will be porous, weak and prone to rapid

deterioration. Sooner or later it will have to be repaired or replaced. It pays, therefore, to do the job properly in the first place.

CURING OF CONCRETE - Concrete curing is the process of maintaining adequate moisture in concrete within a proper temperature range in order to aid cement hydration at early ages. Hydration is the chemical reaction between cement and water that results in the formation of various chemicals contributing to setting and hardening.

The American Concrete Institute (ACI) recommends a minimum curing period corresponding to attaining 70% of the compressive strength of concrete. The specifications say that this can happen after seven days of curing. However, 70% strength can be reached quickly when concrete cures at higher temperatures, or when certain admixtures are used in the concrete mix. Similarly, more time may be needed for curing when concrete or ambient temperatures are lower. Typically, the ideal curing temperature would be 20°F or 68°F.

TYPES OF CEMENT CONCRETE

IN SITU - cast-in-situ concrete is cast into forms on the building site. It offers unlimited possibilities to the designer for any shape formation with a limitless selection of surface textures.In the cast-in-situ concrete, column, slab etc. elements are casted on site in the open environment and hence it is difficult to control mix, placement and curing.

PRE – CAST CEMENT CONCRETE - Concrete cast into structural members under factory conditions and then brought to the building site. A 20th-century development, precasting increases the strength and finish durability of the member and decreases time and construction costs. Concrete cures slowly; the design strength is usually reached 28 days after initial setting. Using precast concrete eliminates the lag between the time on-site concrete is placed and the time it can carry loads. Precast concrete components include slabs, beams, columns, walls, stairways, modular boxes, and even kitchens and bathrooms with precast fixtures.

ADVANTAGES OF CEMENT CONCRETE IN CONSTRUCTION –

- Ingredient of concrete are readily available in most places
- Unlike natural stones, concrete is free from defects and flaws.
- Concrete can be manufactured to the desired strength with an economy.
- The durability of concrete is very high.
- It can be cast to any desired shape.
- The casting of concrete can be done on the working site which makes it economical.
- The maintainance cost is negligible.
- The deterioration of concrete is not appreciable with age.
- Concrete makes a building fire – safe due ti its non – combustible nature.
- Concrete can withstand high temperatures**.**

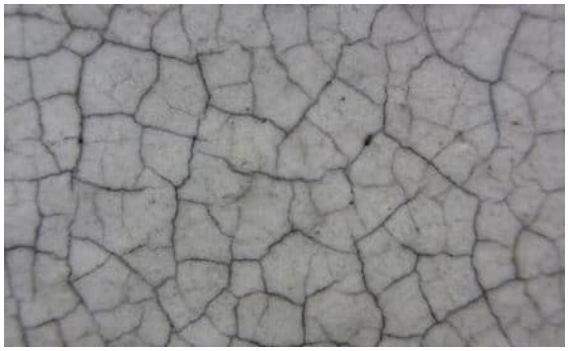
DEFECTS IN CONCRETE –

1. Cracking –

Cracks are formed in concrete due to many reasons but when these cracks are very deep, it is unsafe to use that concrete structure. Various reasons for cracking are improper mix design, insufficient curing, omission of expansion and contraction joints, use of high slump concrete mix, unsuitable sub-grade etc. To prevent cracking, use low water – cement ratio and maximize the coarse aggregate in concrete mix, admixtures containing calcium chloride must be avoided. Surface should be prevented against rapid evaporation of moisture content. Loads must be applied on the concrete surface only after gaining its maximum strength.

2. Crazing –

Crazing also called as pattern cracking or map cracking, is the formation of closely spaced shallow cracks in an uneven manner. Crazing occurs due to rapid hardening of top surface of concrete due to high temperatures or if the mix contains excess water content or due to insufficient curing. Pattern cracking can be avoided by proper curing, by dampening the sub-grade to resist absorption of water from concrete, by providing protection to the surface from rapid temperature changes.



3. Blistering –

Blistering is the formation of hollow bumps of different sizes on concrete surface due to entrapped air under the finished concrete surface. It may cause due to excessive vibration of concrete mix or presence of excess entrapped air in mix or due to improper finishing. Excessive evaporation of water on the top surface of concrete will also cause blistering. It can be prevented by using good proportion of ingredients in concrete mix, by

covering the top surface which reduces evaporation and using appropriate techniques for placing and finishing.

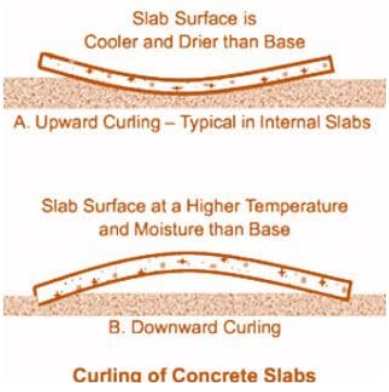
4. Delamination –

Delamination is also similar to blistering. In this case also, top surface of concrete gets separated from underlying concrete. Hardening of top layer of concrete before the hardening of underlying concrete will lead to delamination. It is because the water and air bleeding from underlying concrete are struck between these two surfaces, hence space will be formed. Like blistering, delimitation can also be prevented by using proper finishing techniques. It is better to start the finishing after bleeding process has run its course.

5. Dusting –

Dusting, also called as chalking is the formation of fine and loose powdered concrete on the hardened concrete by disintegration. This happens due to the presence of excess amount of water in concrete. It causes bleeding of water from concrete, with this fine particle like cement or sand will rise to the top and consequent wear causes dust at the top surface. To avoid dusting, use low slump concrete mix to obtain hard concrete surface with good wear resistance. Use water reducing admixtures to obtain adequate slump. It is also recommended to use better finishing techniques and finishing should be started after removing the bleed water from concrete surface.

6. Curling –



Curling of Concrete Slabs

When a concrete slab is distorted into curved shape by upward or downward movement of edges or corners, it is called curling. It occurs mainly due to the differences in moisture content or temperature between slab surface (top) and slab base (bottom). Curling of concrete slab may be upward curling or downward curling. When the top

surface is dried and cooled before bottom surface, it begins to shrink and upward curling takes place. When bottom surface is dried and cooled due to high temperature and high moisture content, it will shrink before top surface and downward curling occurs. To prevent curling, use low shrink concrete mix, provide control joints, provide heavy reinforcement at edges or provide edges with great thickness.

7. Efflorescence –

Efflorescence is the formation of deposits of salts on the concrete surface. Formed salts generally white in color. It is due to the presence of soluble salts in the water which is used in making concrete mix. When concrete is hardening, these soluble salts gets lifted to the top surface by hydro static pressure and after complete drying salt deposits are formed on the surface. It can be prevented by using clean and pure water for mixing, using chemically ineffective aggregates etc. And make sure that cement should not contain alkalis more than 1% of its weight.

8. Scaling and Spalling –

Scaling and spalling, in both the cases concrete surface gets deteriorated and flaking of concrete occurs. The main cause for this type of cases is penetration of water through concrete surface. This makes steel get corroded and spalling or scaling may occurs.