

— ESENOTES.COM —

BUILDING CONSTRUCTION



BY JASPAL SIR

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Stone and Brick Masonry



Masonry : It is defined as construction of building units which are bounded together by the mortar.

— Depending upon the building units, masonry can be classified as follows:

- A. Stone masonry
- B. Brick masonry
- C. Hollow concrete block masonry
- D. Reinforced brick masonry
- E. Composite masonry

A. Stone Masonry

Materials required for construction of stone masonry are as follows:

1. Mortar
2. Stones



1. Mortar.

- It is a paste prepared by the addition of water in specified proportion in mixture of binding material & aggregate.

$$\text{BM} + \text{Aggregate} + \text{H}_2\text{O} = \text{Mortar.}$$

- Mortar used in stone masonry may be lime, cement, gauged mortar.
(Cement + Lime)

2. Stones

- It is obtained by quarrying of rocks.
- Stone used for stone masonry must be hard, durable and sound.

NOTE:

Rocks from which stones are obtained are classified into 3 :

A. Igneous rocks. Ex : Granite

B. Sedimentary rocks. Ex : Limestone and sandstone.

C. Metamorphic rocks. Ex : Slate, Marble.

Classification of stone masonry

Depending upon arrangement of the stones in construction degree of refine-

ment use in shaping and finishing adopted masonry is classified as follows:

1. Rubble Masonry .
2. Ashlar Masonry .



1. Rubble Masonry

In Rubble Masonry block of stones used are

- (i) undressed or roughly dressed. [size & shape prepared]
- (ii) irregular in size.
- (iii) wide or irregular joint.
- (iv) such they require more mortar.

— Rubble masonry is of following type:

A. Random Rubble masonry .

1. Uncoursed
2. Built to course.

B. Square rubble

1. Uncoursed
2. Built to course
3. Regular course.

C. Miscellaneous type

1. Polygon Walling
2. Flint Walling.



D. Dry Rubble Masonry .

A. Random Rubble

1. Uncoursed random rubble masonry

It is the most roughest and cheapest form of stone masonry .

- In this stones of different sizes are used and are not of uniform size.
- Width of the joint in this case is comparatively more.



2. Built to course random rubble masonry .

The method of construction in this case is same as that of above. Except that the courses varying from 30-45 cm thick are also provided.

NOTE: All the courses are not of same thickness.

B. Square Rubble

(undressed)



1. Uncoursed Square Rubble

It uses stones having straight bed and sides (square stone). The stones are dressed or straight cut finish.

* For proper arrangement depth of riser:
leveller: snack must be in ratio of 3:2
:1.

2. Built to course

This also uses same stones as use for uncoursed masonry.

Here work is carried out in courses of varying depth.

In each course the stones used are of different sizes.

3. Regular course

In this type of masonry the wall consists of various courses of the different heights, but the height of stones particular course is same.

C. Miscellaneous type



1. Polygon Rubble masonry

In this type the stones are hammered in the form of irregular polygon shape.

2. Flint Walling

The stones used in this masonry are flint or cobbles which vary in thickness from 7.5 - 15 cm and in length from 30 cm to 15 cm.

— The stones are brittle and hard.

(flint/cobbles)

↓
Particle Size > 300 mm

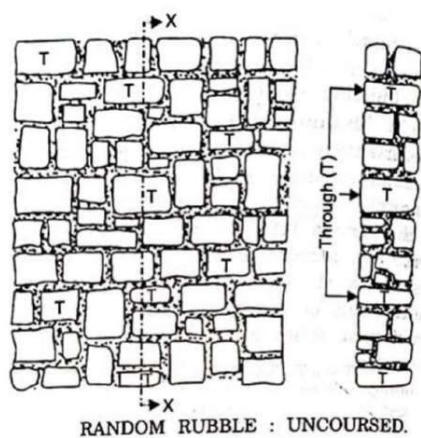
D. Dry Rubble masonry

In this type of masonry mortar is not used.

— This type of construction is cheapest

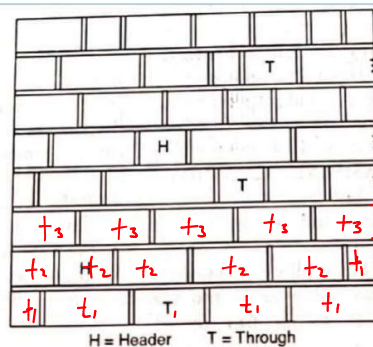
* Skilled workmanship is required for execution of dry rubble masonry.

— It is provided for non load bearing wall.



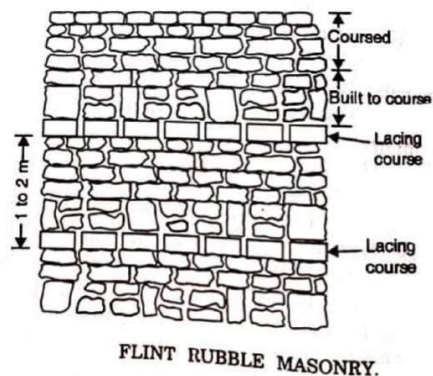
RANDOM RUBBLE : UNCOURSED.

(i)



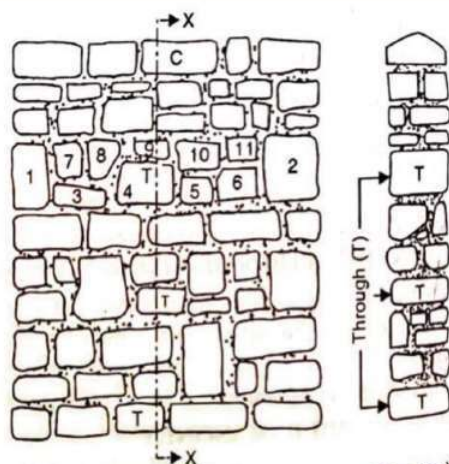
SQUARE RUBBLE : REGULAR COURSED.

(ii)



FLINT RUBBLE MASONRY.

(iii)

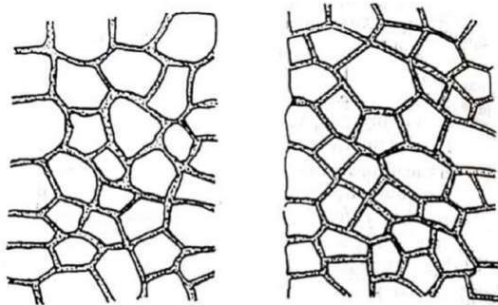


(a) Elevation

(b) Section X-X

RANDOM RUBBLE : BUILT TO COURSES.

(iv)

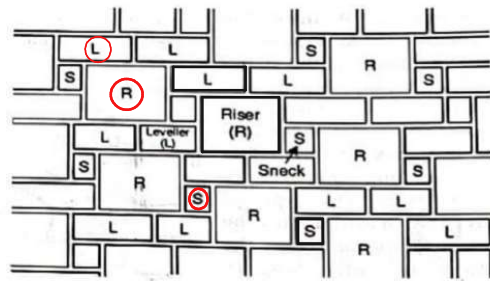


(a) Rough picked

(b) Close picked

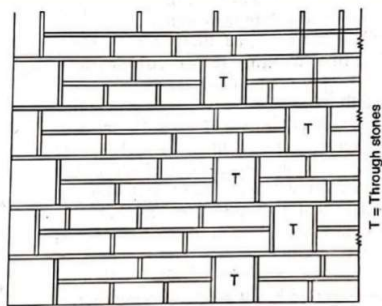
POLYGONAL RUBBLE MASONRY.

(v)



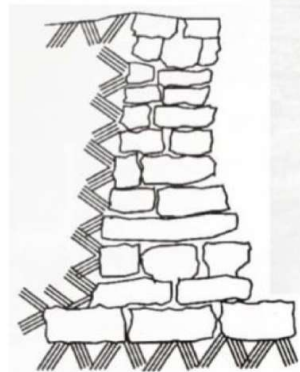
UNCOURSED SQUARE RUBBLE.

(vi)



SQUARE RUBBLE : BUILT TO COURSES.

(vii)



(viii) Dry Rubble
Masonry



2. Ashlar Masonry

Here stones are used comparatively dressed.

The size of joints is comparatively smaller



It is further classified into-

1. Fine tooled Ashlar masonry

This is finest type of stone masonry work. Each stone is cut to regular and perfectly equal shape and size as of rectangle and square.

2. Rough tooled

In this type of masonry, the beds and sides of each stone are finely chiseled as in previous case but exposed face is dressed roughly.

- Here the layers are also of different height.

3. Ashlar Rock rustic

It is the type of masonry in which exposed face of the stone is not dressed but a strip of about 25 mm wide is made along its perimeter.

4. Ashlar Chamfered

This is special format rock face ashlar masonry in which strip provided around the perimeter of stones is chamfered at an angle of 45° .



5. Ashlar block in course masonry

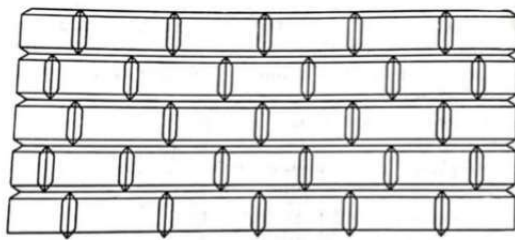
This type of masonry is intermediate betn rubble and ashlar masonry.

The faces of each stone are hammer dressed.
The vertical joints are not straight as in ashlar masonry.

- The layers provided are not of same thickness.

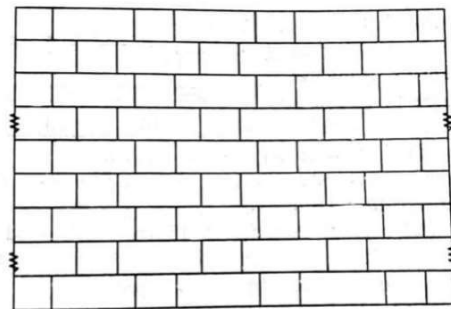
6. Ashlar facing masonry.

- It is provided along brick or concrete block.
- It gives comparatively better appearance.
- Stones are used in front and edges.
- Whereas brick work is used at back



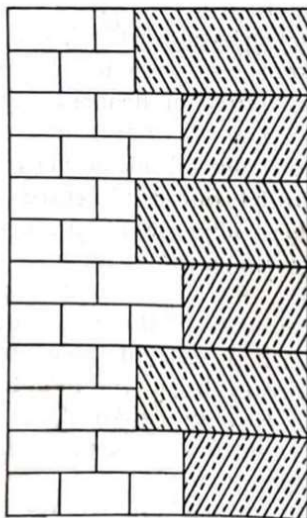
ASHLAR CHAMFERED

(i)



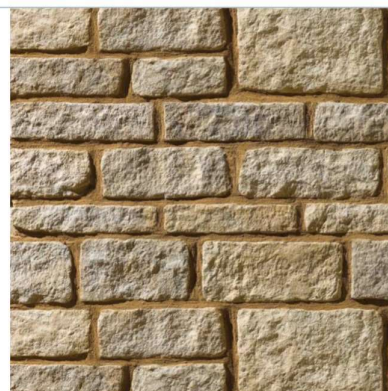
FINE TOOLED ASHLAR MASONRY

(ii)



ASHLAR FACING MASONRY.

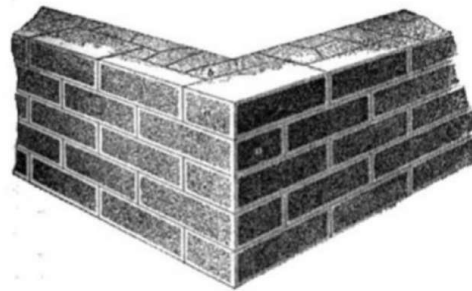
(iii)



(iv) Rough tooled Ashlar
Masonry



(v) Ashlar Rock
rustic



(vi) Ashlar Block in
course masonry

* Joints in Stone masonry

1. Butt joint

This is the most commonly used joint in stone masonry.

The dressed edges of stones are placed side by side in this case.



2. Rebated / Lapped joint

This type of joint is provided in arches, gables and coping.

- To prevent movement of stones.
- Lap provided between the stone in this case must be at least 70 mm.

3. Bed joint or tabled joint.

This joint is used to prevent lateral movement of stone.

- It is generally provided in masonry of water front structure.

4. Cramped joint

Cramp → Gun metal or copper.

This joint uses metal cramp instead of dowels.

- Holes are made in the adjacent stone and cramp is fitted in it.
- Cramp is made up of non-corrosive metal.

5. Plugged joint

This an alternative of cramped joint in this first plug holes are made which is filled with plug and is finally covered with molten lead or mortar from the top.



6. Dowelled joint

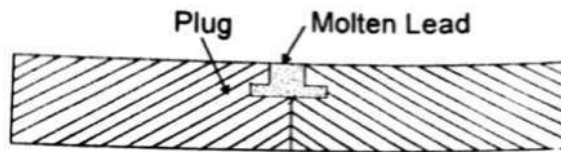
This is a simple type of joint used to increase stability against lateral displacement of the stones.

7. Rusticated joint

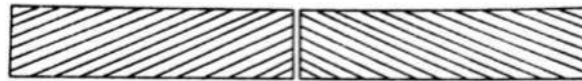
This joint is used in those stones whose edges are sink below the general level and in the arches to avoid the displacement between them.

8. Saddled joint / water joint

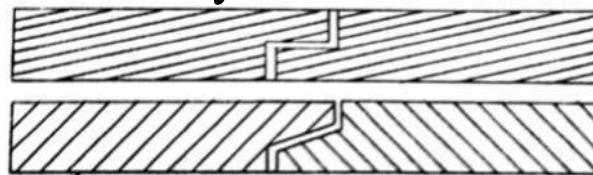
Such joint is used in cornices and such other weathered surfaces to divert the water from joints.



(i) Plugged joint



(ii) Butt joint

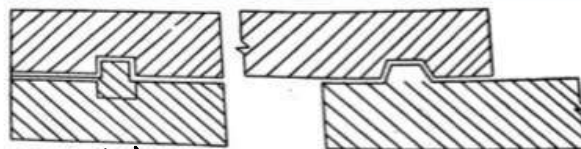
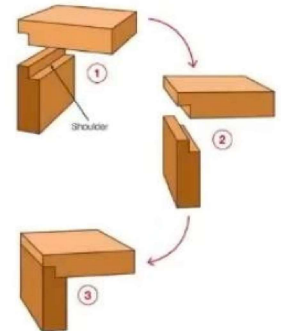


(iii) Rebated joints

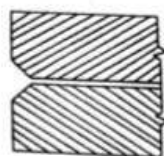
Butt Joint



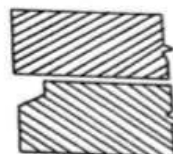
Rebated joint



(iv) Bed joint or Tablet joint

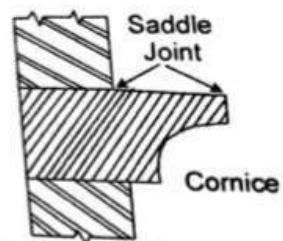


(a) Vee joint

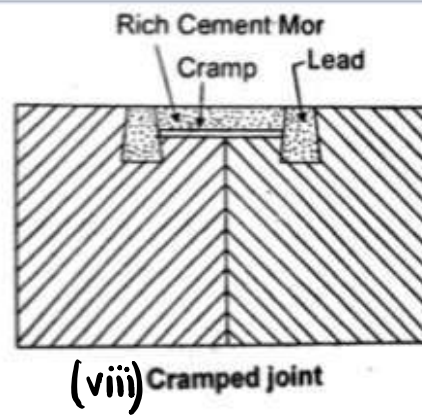
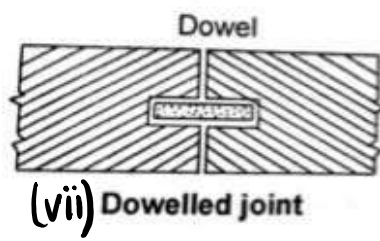


(b) Channelled joint

(v) Rusticated joint



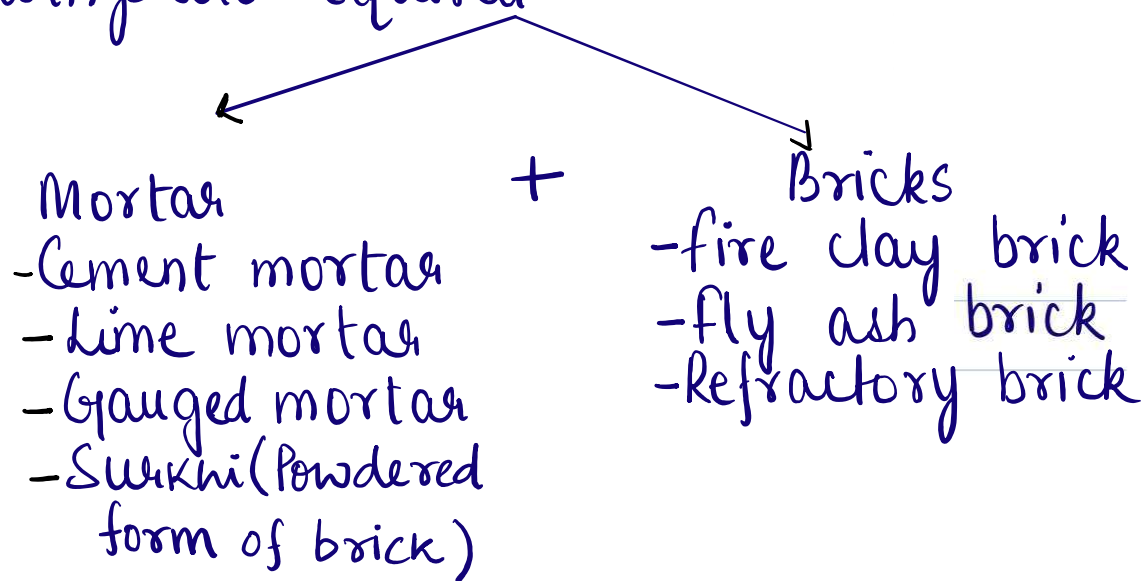
(vi) Saddle Joint

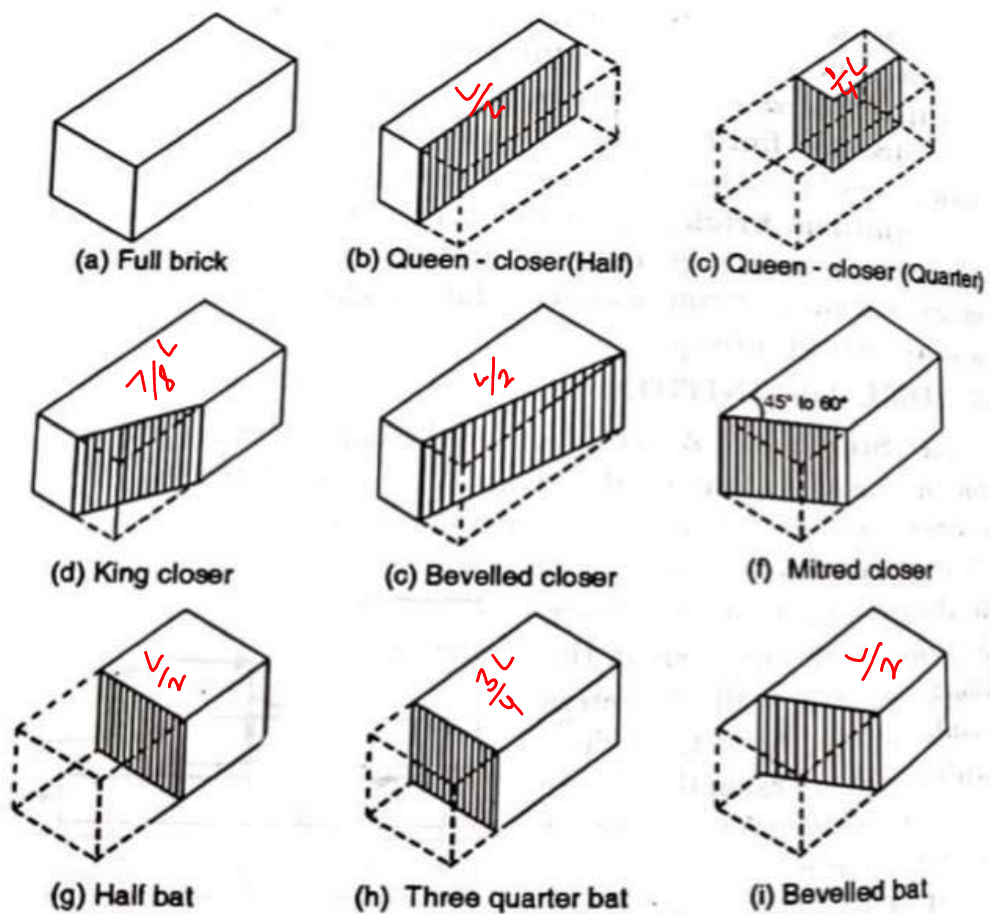


Brick masonry



for construction of brick masonry followings are required.





VARIOUS FORMS OF BRICK PORTIONS.

Bonding in bricks

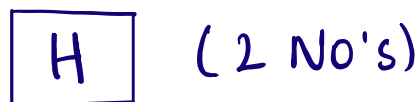


Terms used in bonding works.

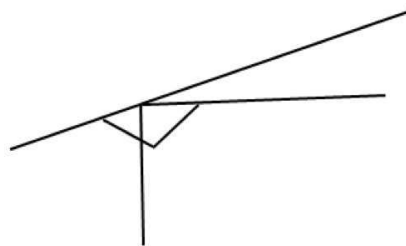
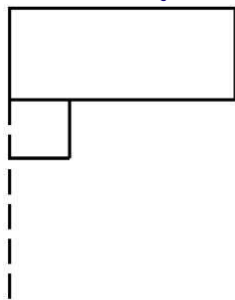
1. Stretcher : The longer face of brick is termed as stretcher (19 x 9 cm).



2. Header : The shorter face of brick is termed as header (9 x 9 cm)



3. Quoin : It is the outer of exterior angle on the face side of wall. It is generally kept 90°.





4. Closer : The portion of brick obtained by cutting along the length is termed as closer.
5. Bat : The portion of brick obtained by cutting along the width is termed as bat.

Bonds in bricks

It is a method of arranging a bricks in courses such that individual units are tied together and vertical joints of the successive course do not lie in same vertical line.

- Bonds of various types are distinguished by their elevation or face appearance.
- If the bonds are not arranged properly, continuous vertical joints will result in unbounded wall.
- Bonds help in distributing concentrated load over a large areas.

Rules of Bonding.

- Bricks should be uniform size.
- Amount of lap should be minimum $\frac{1}{4}$ brick along the length of the wall and $\frac{1}{2}$ brick across the thickness of wall.
- Use of brick bat should be avoided, except in some special location.
- Vertical joints in alternate courses should be along the same line.
- It is preferable to provide every sixth course as a header course on both sides wall.

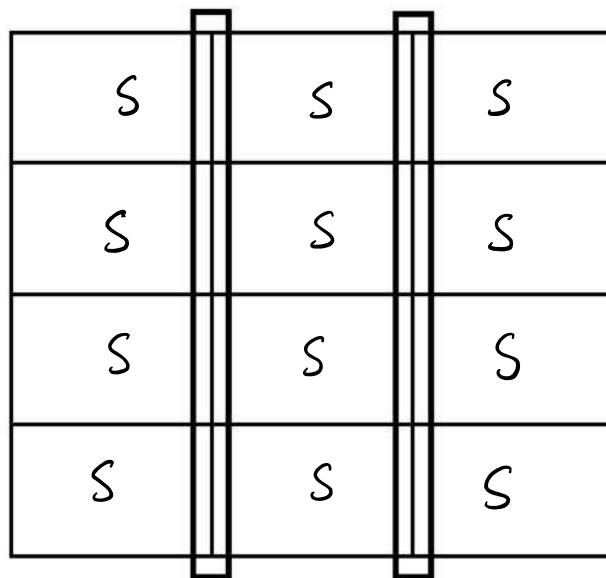
Types of bond.

1. Stretcher bond

It is the arrangement of bonding which consist of stretcher in all the courses.



- In order to break alignment of vertical joint to fall in same straight line, half bat is provided in every alternate course.
- An overlap of $\frac{1}{2}$ brick is available for all stretches.
- This pattern is used only for which having thickness of half brick i.e, portion walls, sleeper walls, division walls or chimney stack.

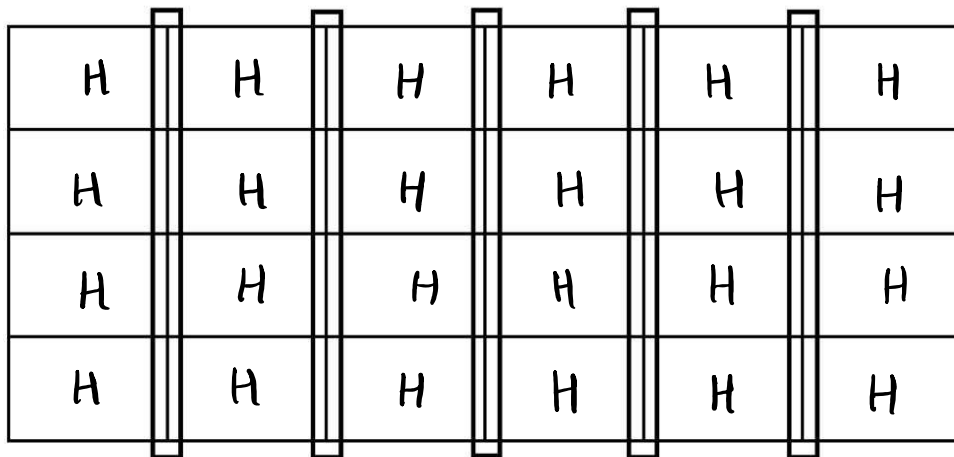




2. Header Bond.

It is the arrangement of bonding which consist of header in all the courses.

- In order to break the alignment of vertical joints to fall in same straight line, three quarter bat is provided in every alternate course.



- An overlap of $\frac{1}{4}$ th brick length is available for the headers.
- In this case width is thus along the

direction of wall.

- This is used when thickness of wall equal to one brick is required.

NOTE:

Minimum thickness of load bearing wall is one brick.

- It is useful for curved brick work where stretcher is used, would project beyond the face of the wall.
- It is also used in construction of footings due to its ability to distribute transverse loading.

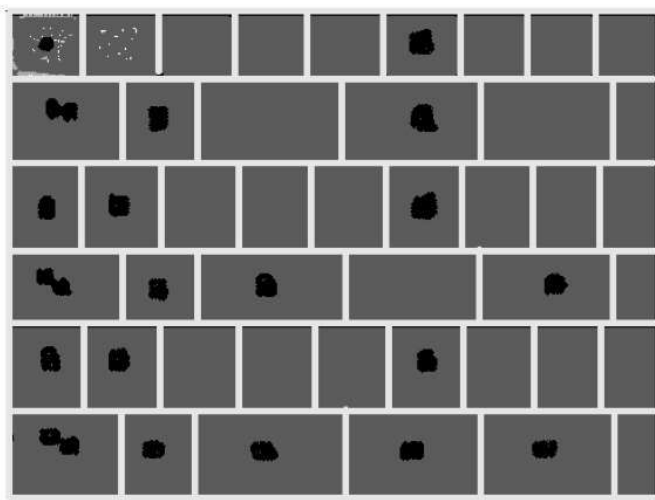
3. English bond (High Strengthy)

This is most commonly used wall is considered to be strongest.

- It consists of alternate of courses of stretchers and headers one over each other.



- In order to break the alignment of vertical joints to fall in same straight line, queen closer half is provided next to quoin header.
- An overlap of at least $\frac{1}{4}$ th brick is available for the stretcher over the header in every course.
- No header course, in this case must start from queen closer half, as it is liable to displace off.
- Queen closer are not required in stretcher course.

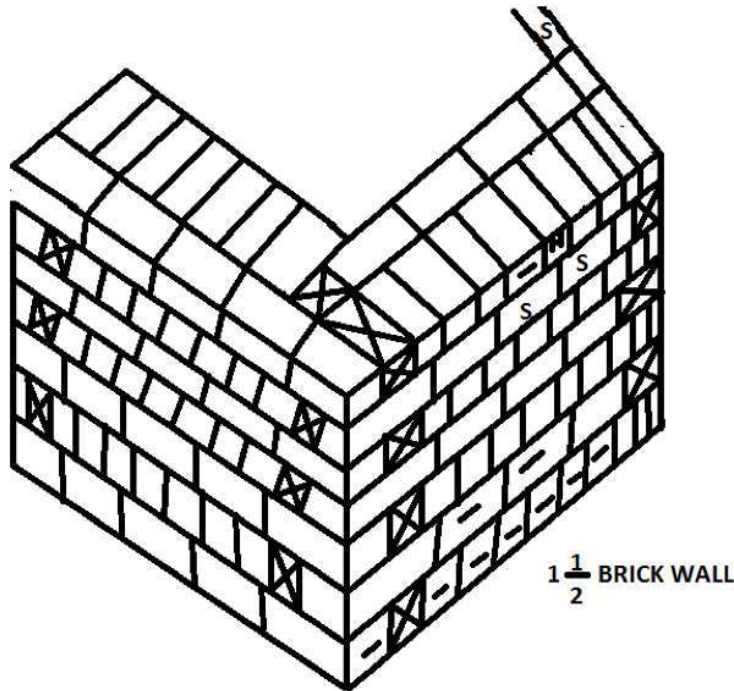


front elevation.

(Good Appearance)



4. flemish bond.



It is the arrangement of bonding which consists of alternate header and stretcher in every course.

- In order to break the alignment of vertical joints to fall in same straight line queen closer half is provided next quoion header.



- An overlap of at least $\frac{1}{4}$ brick length is available for stretchers in all courses.
- Every alternate course $\frac{1}{4}$ brick length is available for stretchers in all courses.
- Every alternate course in this case starts from header.
- Every header is centered over the stretcher below it.
- These bonds are further of two types
 - a) Double flemish bond
 - b) Single flemish bond.
- a) Double flemish bond

In this bond, back and front face are same in appearance.
- Each course has alternate header and stretcher.
- Wall having thickness equal to odd



multiple of half bricks, half bats and three quarter bats are usually used.

- for walls having thickness equal to even multiple of half bricks, no bats are required.

b) Single flemish bond

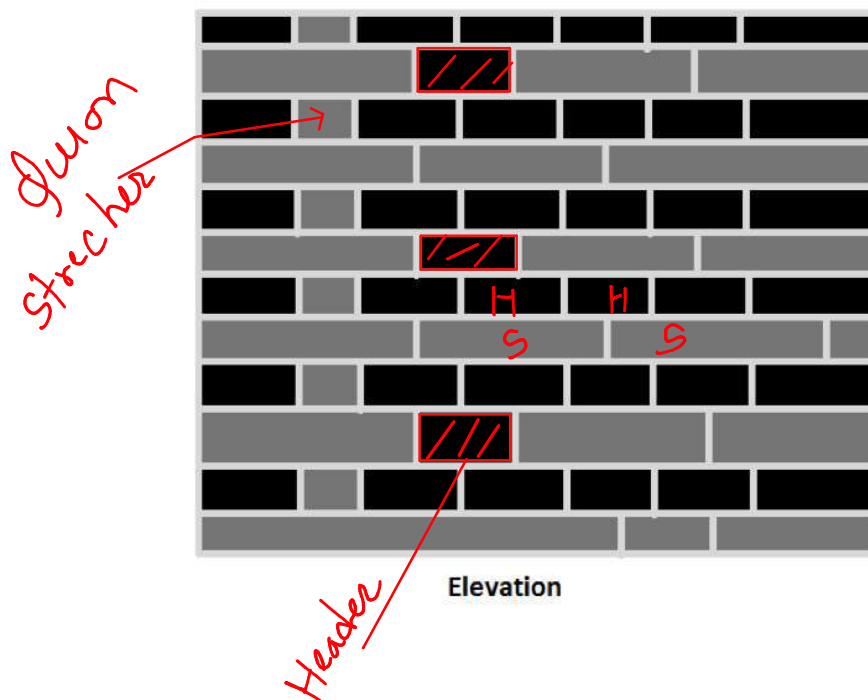
Stronger than DFB
In this bond facing has appearance of double flemish bond and backing of english bond.

- This bond can be used for those wall having thickness at least equal $1\frac{1}{2}$ brick.
- Double flemish bond facing is done with good quality bricks and cheaper brick can be used for brick and heating.



6. English cross bond

- This is a modification of english bond, used to improve the appearance of wall.
- In this bond, alternate course of headers and stretchers are provided as english bond.
- Queen closers are placed next to quoin header.
- A header is introduced next to the quoin stretcher in every alternate stretcher course.





Plan of 2, 4, 6 $\therefore$ Courses



Plan of 1, 5, 9 Courses



Plan of 3, 7, 11 Courses

7. Brick on edge bond (Silver lock's bond / Soldier's bond).

This bond is inspired by English bond but in this bond the stretcher course are replaced by laying the bricks on edges and header course are laid on the beds.

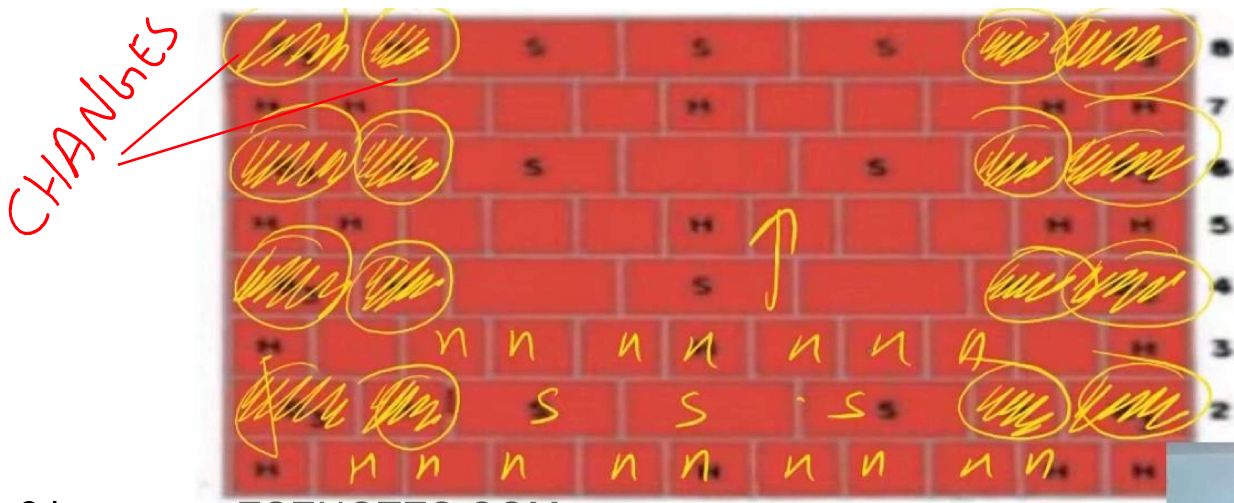


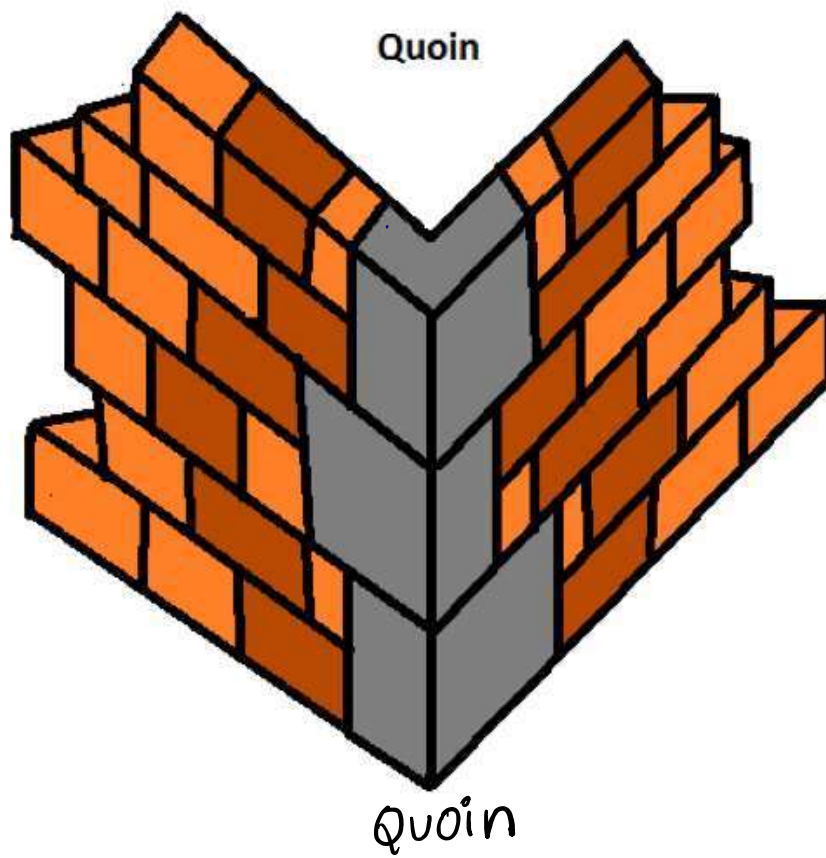
- Queen closer is provided after quoin header in the header course.
- This type of bond is weak in strength but economical, so usually used as garden walls or compound walls.

8. Dutch bond

This is another modified form of english bond. In this bond the corner of wall are strengthened by adding three quarter bat as quoin for every alternate course.

- Alternate courses are of header and stretchers are provided as in english bond.
- In every stretchers course, a header is placed next to three quarter brick quoin.







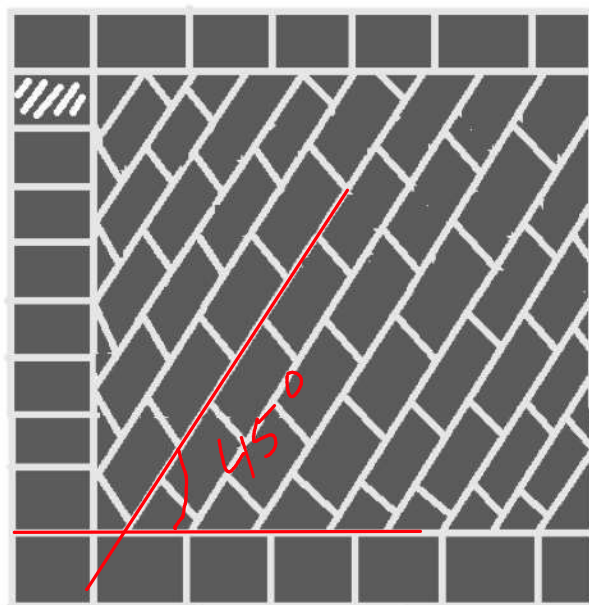
⑨ Raking bond

- This bond is used in thick walls. In this type of bond, the bonding bricks are kept at an inclination to the direction of the wall. at 45°
- Due to the longitudinal stability of thick wall built in english bond is increased.
- The bricks are arranged in inclined direction, in the space between the external stretchers of the wall.
- The raking or inclination should be in opposite direction in alternate course of raking.
- The raking bond is not provided in successive courses it is provided at a regular interval of four to eight courses in the height of the wall.
- The raking course is generally provided between two stretcher course of wall

having thickness equal to even multiple of half brick, to make the bond more effective.

— These are of two types

- a) Diagonal bond *Inclination In Single Side*
- b) Herring-bone bond *Inclination Opposite Sides (Double Side)*



Diagonal Bond

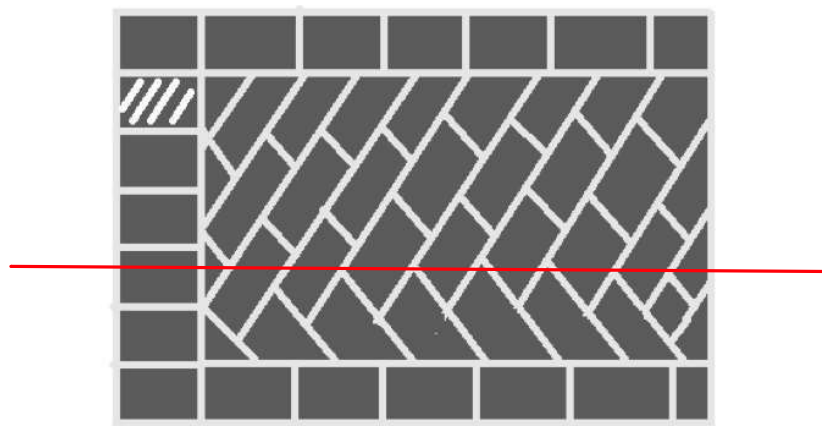
10. Zig Zag Bond

This bond is similar to herring-bone bond, except that the bricks are laid in



zig zag pattern.

- This bond is commonly used for making panels in the brick flooring or walls.



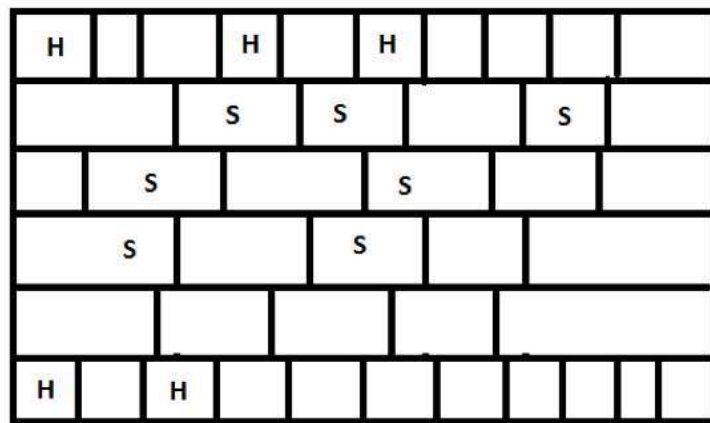
Herring bone Bond

11. Garden Wall English bond

- In this bond, the header course is provided only after three-five stretcher courses.
- In each header course, a quoin header is provided to provide necessary lap.



- In stretcher course, quoin headers are placed in alternate courses.



12. Garden wall flemish bond

In this bond each course contain one header after three to five stretchers continuously placed throughout the length of the course.

- Each alternate course contains a three quarter brick bat placed next to quoin header.
- This bond is also known as 'SCOTCH BOND'.



PREVIOUS YEAR QUESTIONS

IES

Question 1: When the deposit of efflorescence is more than 10% but less than 50% of the exposed area of the brick, the presence of efflorescence is

a) Moderate	c) Heavy
b) Slight	d) Serious

(2020)

Solution : (a)
10-50% of exposed area of the bricks. But not showing powdering and flaking of surface.

Question 2: Consider the following statements regarding refractory bricks in furnaces.

1. The furnace is fired at temperatures more than 1700°C .
2. Silica content in the soil should be less than 40%.

3. Water absorption of bricks should not exceed 10%.

4. Chrome bricks are known as basic bricks.

Which of the above statements are correct?

a) 1 and 2 only

c) 1 and 3 only.

b) 2 and 4 only

d) 3 and 4 only.

(2017)

Solution : (c)

Question 3 : Consider the following statement

1. IS 3583 refers to Burnt Clay Paving Bricks.

2. IS 5799 refers to Burnt Clay Soling Bricks.

3. IS 3952 refers to Burnt Clay Hollow Bricks

4. IS 2222 refers to Burnt Clay Lay Bricks.

Which of the above statements are correct?

a) 1, 2 and 3 only

c) 3 and 4 only

b) 1, 2 and 4 only

d) 1, 2, 3 and 4.

(2017)

Solution: (a)

SSC JE

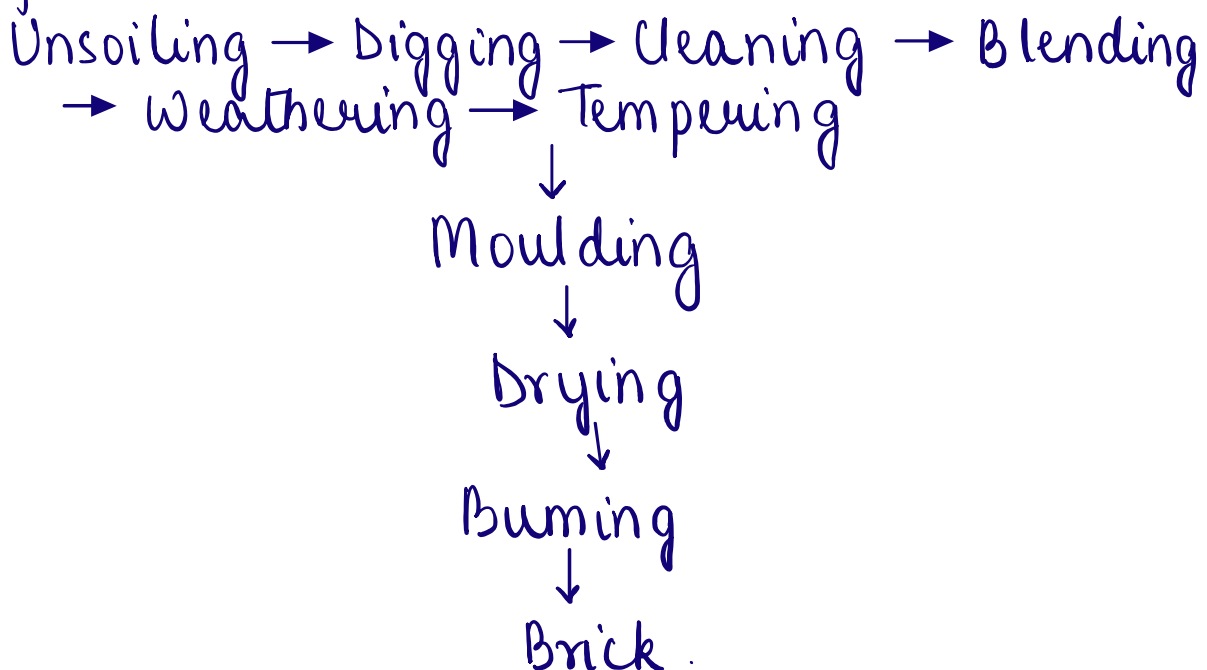
Question 1: Tempering is the process used in the manufacturing of

- | | |
|------------|-----------|
| a) Bricks | c) Cement |
| b) Bitumen | d) Paints |

(2017)

Solution: (a)

The manufacturing of brick is as follows :



Question 2: What is the nominal size (cm) of standard brick as per Indian standards?

- a) $19 \times 9 \times 9$
 - b) $20 \times 9 \times 9$
 - c) $20 \times 10 \times 10$
 - d) $22.9 \times 11.4 \times 7.6$
- (2017)

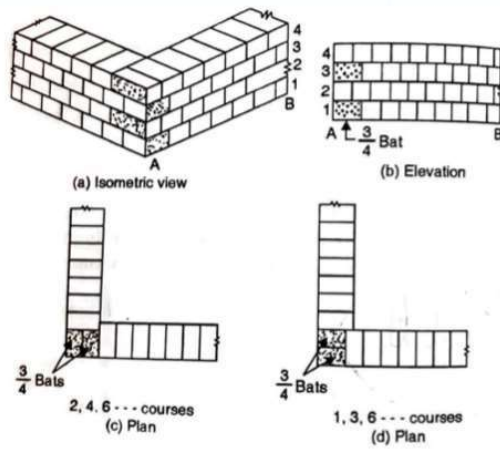
Solution: (c).

Question 3: Which of the following is burnt in the Hoffman's kiln during the process of manufacturing?

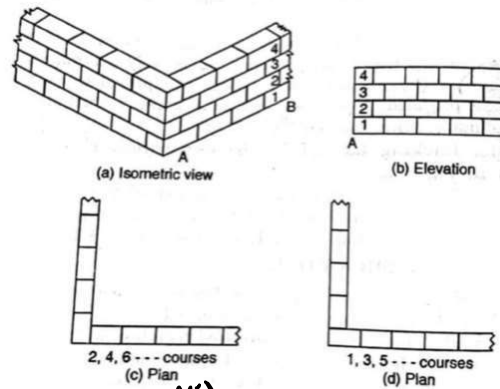
- a) Bitumen
 - b) Brick
 - c) Clinker
 - d) Varnishes
- (2017)

Solution: (b)

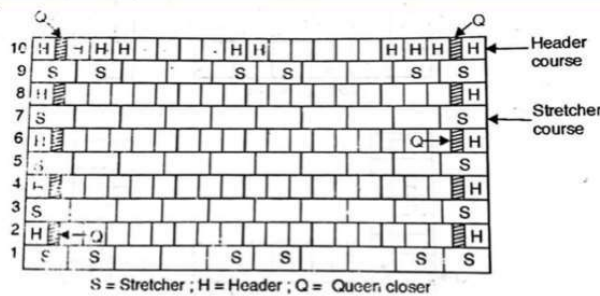
Burning is an important process in brick manufacturing as it provides hardness and strength to brick and makes them dense and durable.



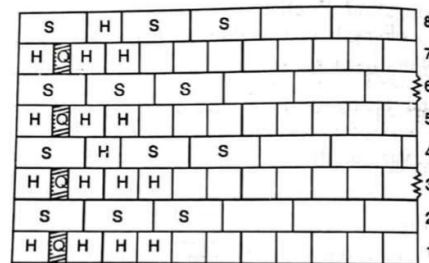
(i) HEADER BOND



(ii) STRETCHER BOND.



(iii) ENGLISH BOND.



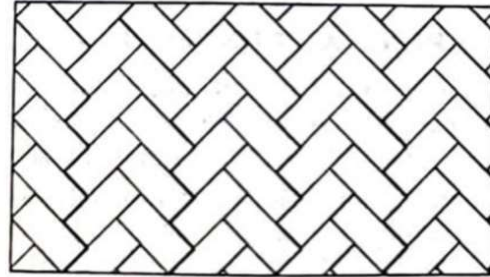
(iv) ENGLISH CROSS BOND



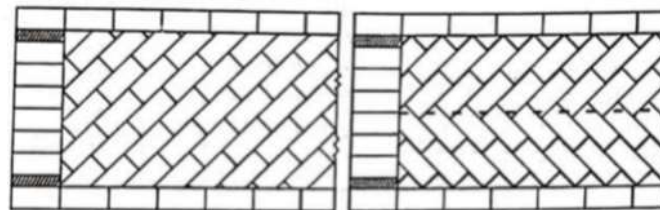
B ₃	H	S	S	S	H	B ₃	8
H	H			H		H	7
B ₃	H	S		S	H	B ₃	6
H	H			H		H	5
B ₃	H		S		H	B ₃	4
H				H		H	3
B ₃	H	S		S	H	B ₃	2
H				H		H	1

H = Header ; S = Stretcher ; B₃ = 3/4 brick bat

(v) DUTCH BOND.



(vi) ZIG-ZAG BOND.



(a) Diagonal bond

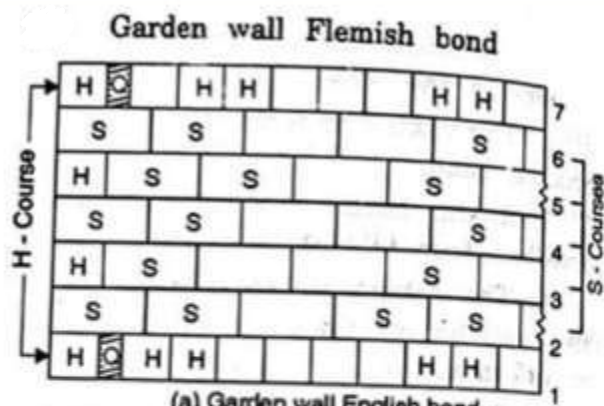
(b) Herring-bone bond

(vii) RAKING BONDS.

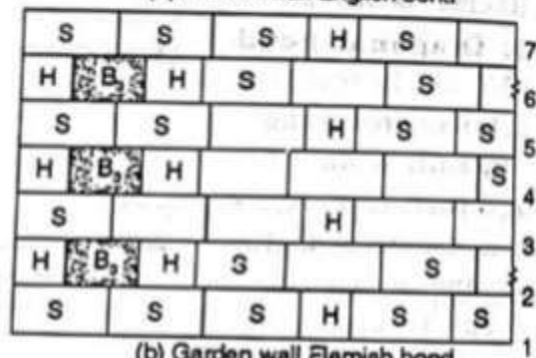
Facing Bond -

↳ Different types of Bricks are provided in front or back of the masonry work.

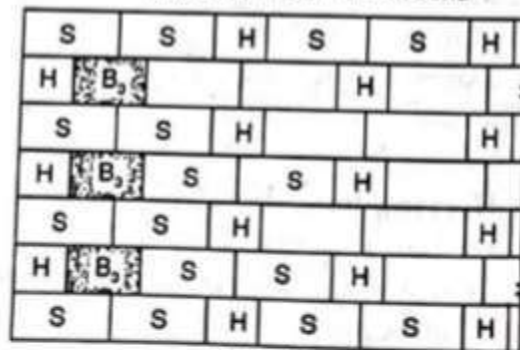
(Shape & Size)



(a) Garden wall English bond



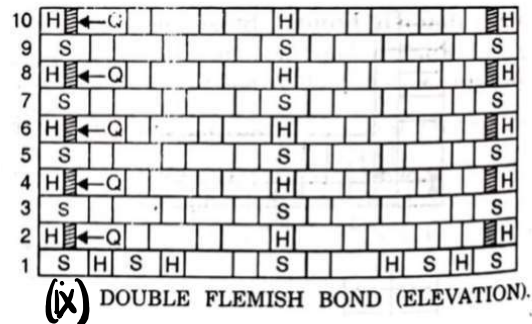
(b) Garden wall Flemish bond



(c) Monk bond

S = Stretcher ; H = Header ; B₃ = 3/4 Brick bats

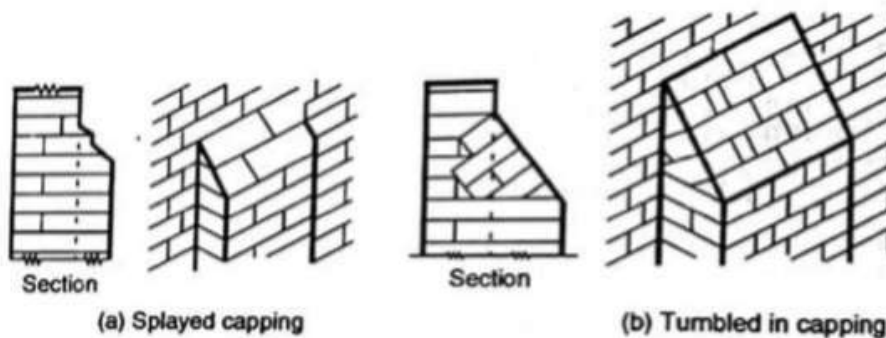
(viii) GARDEN WALL BONDS.



Typical Structures in brick work

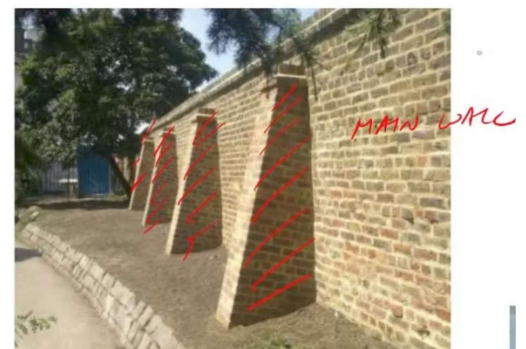
1. Buttresses

It is used to support main wall.



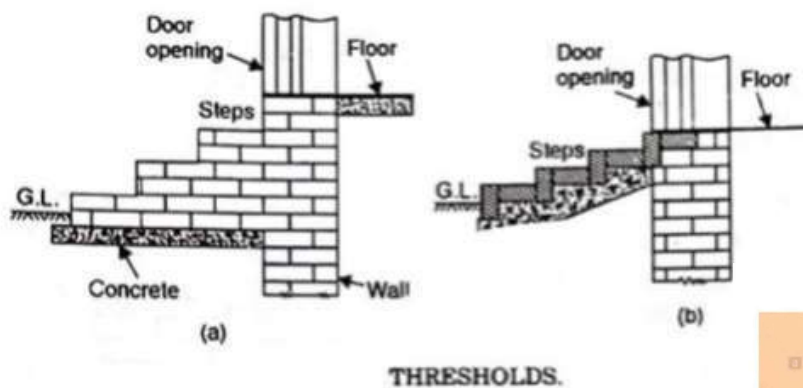
BUTTRESSES

(i) Buttresses



2. Threshold

It is arrangement of one or more than one steps at outside of door.
Above the threshold a hard bearing surface is provided.

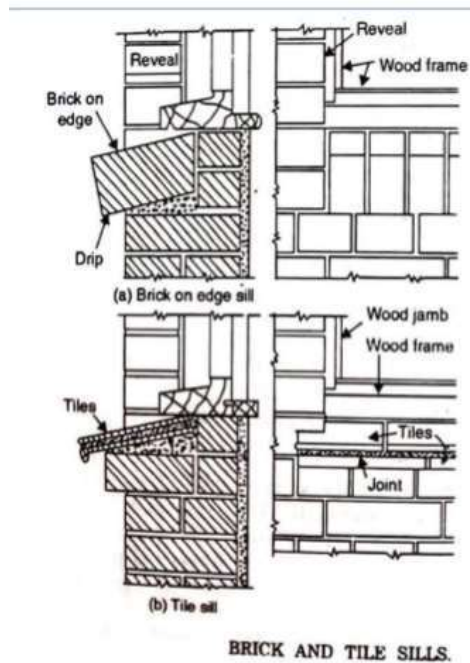


(ii) Thresholds



3. Window Sill

finishing at the window opening to protect the window.

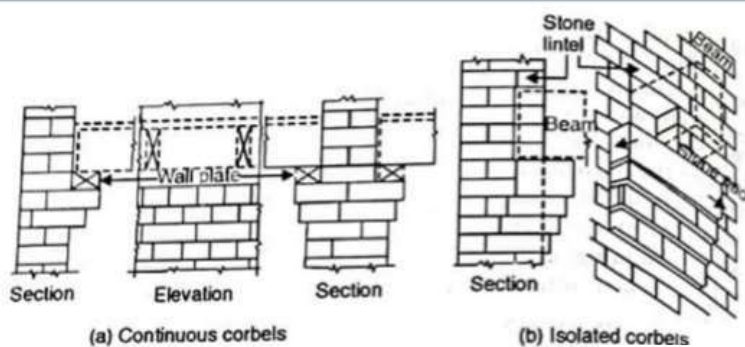


(iii) Window sill



4. Corbels

Projections of the bricks from the wall
Total projection $\nless 5$ cm.



(iv) Corbels

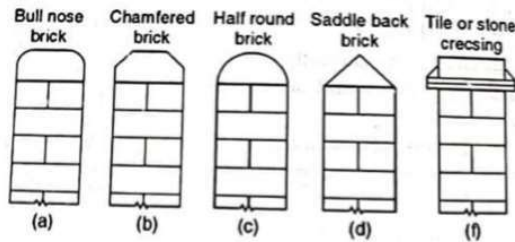


5. Copings

Protective covering at the wall top.



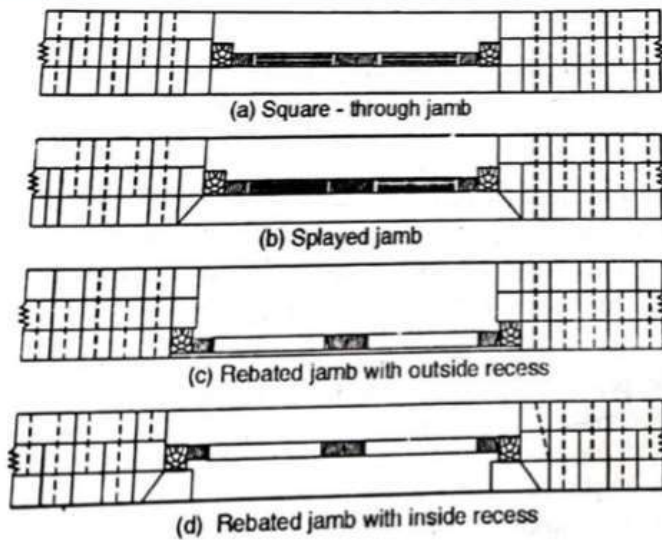
(V) Copings



COPINGS.

6. Jambs

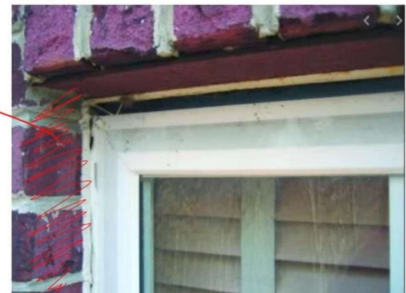
Vertical side of opening of door or window.



VARIOUS FORMS OF JAMBS.

(VI) Jambs

Vertical side



PERVIOUS YEAR QUESTION

ESE

Question 1: When provided with alternating courses of (a) all headers and (b) all stretchers, the front elevation of such brick masonry is designed by

- a) English bond
- b) Single flemish bond
- c) Double flemish bond
- d) Rat trap bond.

(2013)

Ans: (a)

Solution: English bond consists of alternate courses of headers and stretchers.

Question 2: The relation between the strength of brick masonry f_w , the strength of bricks f_b , and the strength of mortar f_m is given by (where k_w is a coefficient based on the layout of the bricks and the joints)

a)
$$f_w = \sqrt{k_w \frac{f_b}{f_m}}$$

b)
$$f_w = k_w \sqrt{\frac{f_b}{f_m}}$$

$$c) f_w = \sqrt{k_w f_b f_m}$$

$$d) f_w = k_w \sqrt{f_b f_m} \quad (2015)$$

Ans : (d)

Question 3: A masonry structure has a prism strength of 10 N/mm^2 with $\mu = 0.25$. The modulus of elasticity and the shear modulus of the masonry are respectively.

a) 5500 MPa and 2200 MPa.

b) 2000 MPa and 200 MPa

c) 5500 MPa and 1000 MPa

d) 2000 MPa and 1000 MPa (2018)

Ans: (a)

Solution : Given :

$$\mu = 0.25$$

Elastic modulus of brick

$$\text{modulus} = 550 \times \text{prism strength}$$

$$= 550 \times 10$$

$$E = 5500 \text{ N/mm}^2$$

$$\begin{aligned}\text{Shear modulus} &= \frac{E}{2(1+\mu)} \\ &= \frac{5500}{2(1+0.25)} \\ &= 2200 \text{ N/mm}^2.\end{aligned}$$

Brick Masonry :-

Brick

- Fire clay brick
- Fly ash brick
- Refractory brick

Mortar

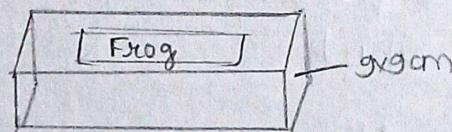
- Lime mortar
- Cement mortar
- Gauged mortar
-

Important Definition :-

- ① Face :- किसी भी wall की outer surface जो open to atmosphere है उसे face कहते हैं।
- ② Back :- किसी भी wall की internal surface जो directly atmosphere के contact में नहीं है।
- ③ ^{★★}Hearting :- When wall thickness is more, तो उस condition में face और back बना देने के बाद बीच का बचा हुआ portion Hearting कहलाता है।

Note :- Hearting में always Header course use में लेते हैं।

Header course :- Shorter face of the brick.

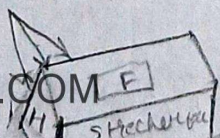


Stretcher course :- Longest face of the brick.
(19×9)cm.

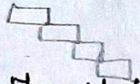
Arise :-  Arise

- Brick में कोई भी दो plan के intersection पर बनने

Arises



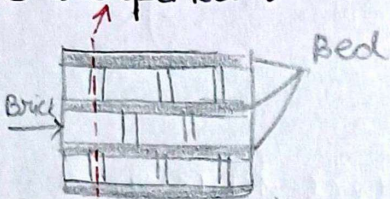
② Racking Back :- The termination of wall in stepped fashion is called Racking back.



③ Toothing :- The termination is such a fashion that each alternate course at end of wall project.



④ Perpend :- It is an imaginary line जो vertical joint को मिलाती है।



⑤ Lap :- Brick masonry में 2 vertical joint के मध्ये horizontal distance lap कहलाता है।

⑥ Coping :- किसी structure की ऐसी दिवार जो directly atmosphere में open होती है। तो top surface पर covered कर दिया जाता है। उसे coping कहते हैं।

⑦ Parapet :- Flat roof में सुरक्षा की दृष्टि से छत के चारों तरफ लगाई गई कम height (75cm-80cm) की wall parapet कहलाती है।

⑧ Cornice :- It is the projected ornamental brick और stone piece जो wall appearance बढ़ाने के लिए roof level के near लगाया जाता cornice कहलाता है।

* Frieze Course :- Masonry work में cornice के just नीचे लगाया गया course, frieze course कहलाता है।
use → cornice की appearance ↑

* Blocking course:-

Cornice के just upper लगाया गया course blocking course कहलाता है।

Reason:- cornice over turning को रोकने के लिए।

* String course :- किसी भी structure में इसकी पूरी लंबाई में बाह्य तरफ projected करते हुए लगाया गया course string course कहलाता है।

* Drip course :-

Spall :- ~~stone~~ small stone piece known as spall.

★ # Through stone :- Stone masonry करते समय इसकी complete width में लगाया गया stone through stone कहलाता है।

**** Stone masonry में through stone की max^m spacing 1.5m से अधिक नहीं होनी चाहिए।

** Stone masonry में किसी wall के $(\frac{1}{4}$ to $\frac{1}{8}$) of the vol^m, through stone का होना चाहिए।

Corbel :- जब किसी main structure के साथ कोई कम height का structure बनाया जा रहा हो तो इस structure के load को main structure पर transfer करने के लिए लगाया गया stone corbel कहलाता है।

★ Corbel का $\frac{2}{3}$ part wall के अंदर embedded होना चाहिए।

Types of bond	Minimum width of wall
- stretcher bond	$\frac{1}{2}$ brick or 90mm
- Header, English, Dutch, bond, garden wall bond, Double Flemish.	1 Brick (190mm)
- Single Flemish bond	$1\frac{1}{2}$ brick wall

Note: Dutch bond:

↳ modified version of English bond.

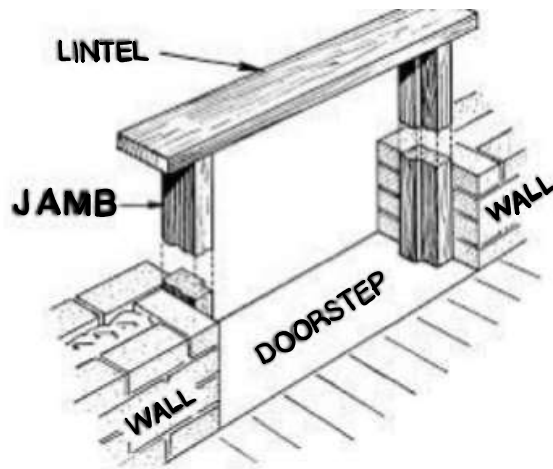
Difference between English & Flemish bond.

English bond	Flemish bond
- Good strength use in case of heavy load. - More compacted load - Brick bats are not use - Costly - Not in better appearance	- Not good strength so use in case of light load. - Not more compacted bond - Brick bats are used - PH costly ₹ - Better appearance.

LINTEL



- Opening are invariably left in wall for the provision of doors, windows, cupboard, wardrobe, almirahs.
- These opening are bridged by the provision of either lintel or arch.
- Thus both lintel and arch are structural member design to support the load of the portion of the wall situated above it and transfer it over the jambs.
- A lintel is a beam placed across the opening, width of which is equal to width of wall and the bearing of lintel into the wall is minimum of
 - (a) 10 cm
 - (b) height of lintel / thickness of lintel
 - (c) $\frac{1}{10}^{\text{th}}$ to $\frac{1}{12}^{\text{th}}$ span of lintel.



Classification of Lintels

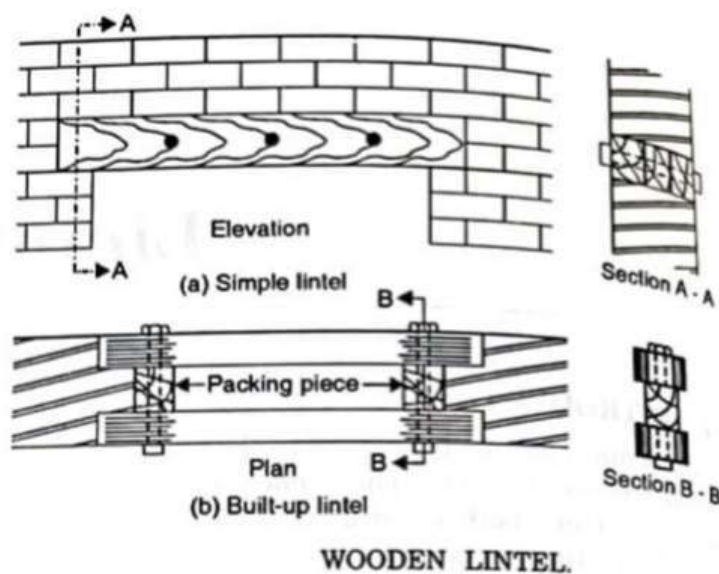
Lintels can be classified on the basis of material used as follows:

1. Timber lintels
2. Stone lintels
3. Brick lintels
4. Steel lintels
5. RCC Lintels.



1. Timber lintels

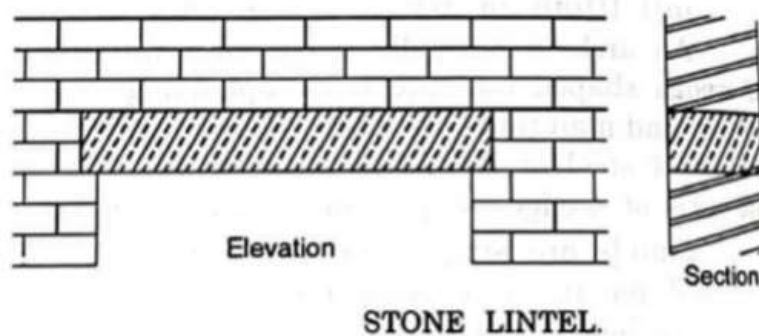
- Oldest type of lintels at present it is obsolete except in hilly areas
- Costlier, weak, sensitive to fire, reliable to undergo decay if not ventilated properly.



2. Stone lintel



- Most common type of lintel
- Span $\nless 2$ m , H $\nless 15$ cm , 10 cm /m of the span.
- Used where stone is in abundant.
- Gives architectural effect.
- width = width of wall.
- It is weak in tension avoided in earth quake prone area or where shock wave exist. Since stone will develop the crack due to the dynamic loading.



3. Brick lintel

- These are structurally not strong.
- Used for light load.

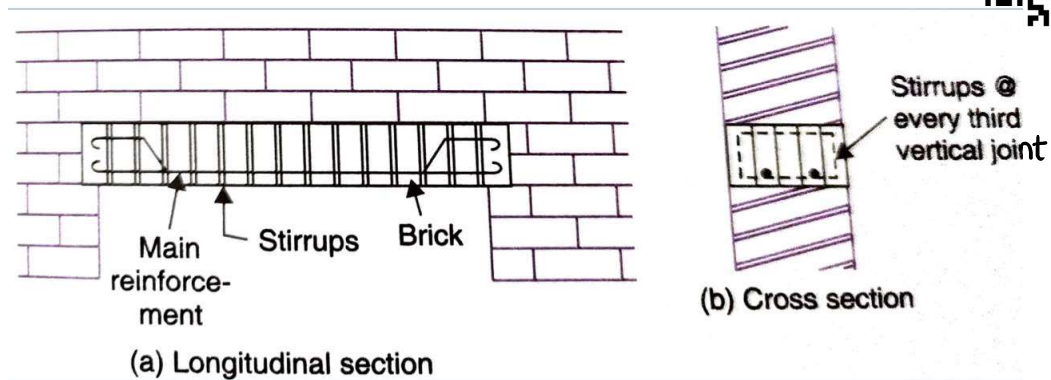
- Bricks with frogs are preferred.
- Depth of brick lintel is in range of 10-20 cm.



Brick Lintel

4. Reinforced Brick Lintel

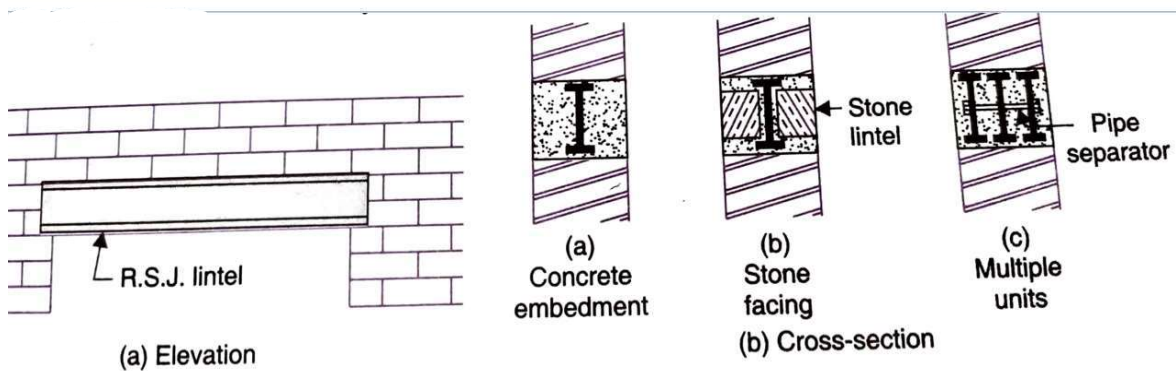
- Used when load is heavy and span is more
- Its depth is kept in multiple of 10 cm.
- After reinforcing the brick the gap between the bricks is filled with the mortar.



Reinforced Brick Lintel

5. Steel Lintel

It is used when span is larger and load is heavier.

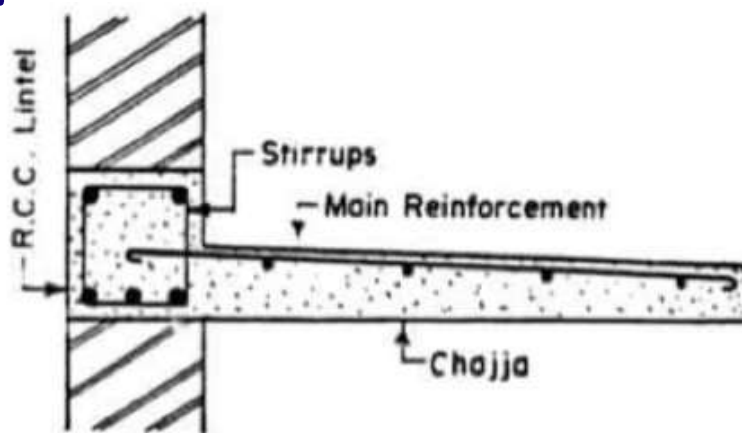


Steel Lintel



6. Reinforced concrete lintel

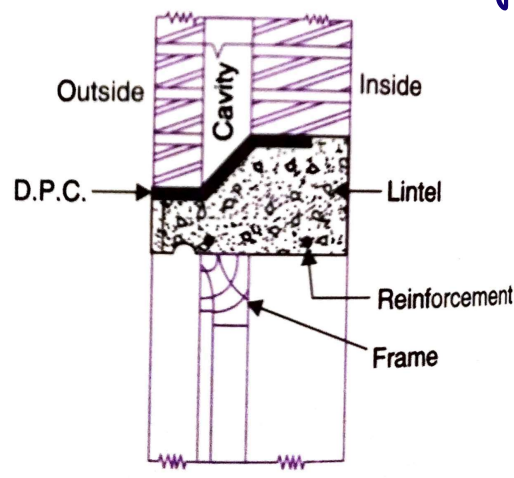
- It has replaced all type of lintel.
- It offers strength, rigidity, resistance against fire, cost, ease of construction



Reinforced concrete lintel

7. RCC boot lintel

It is provided below cavity walls.



Loading on lintel

Lintels are design to carry load of the wall above it and some time live load transferred by roof slab.

With view of distribution of load over the lintel following 5 cases may be observed. this is the most general case observed.

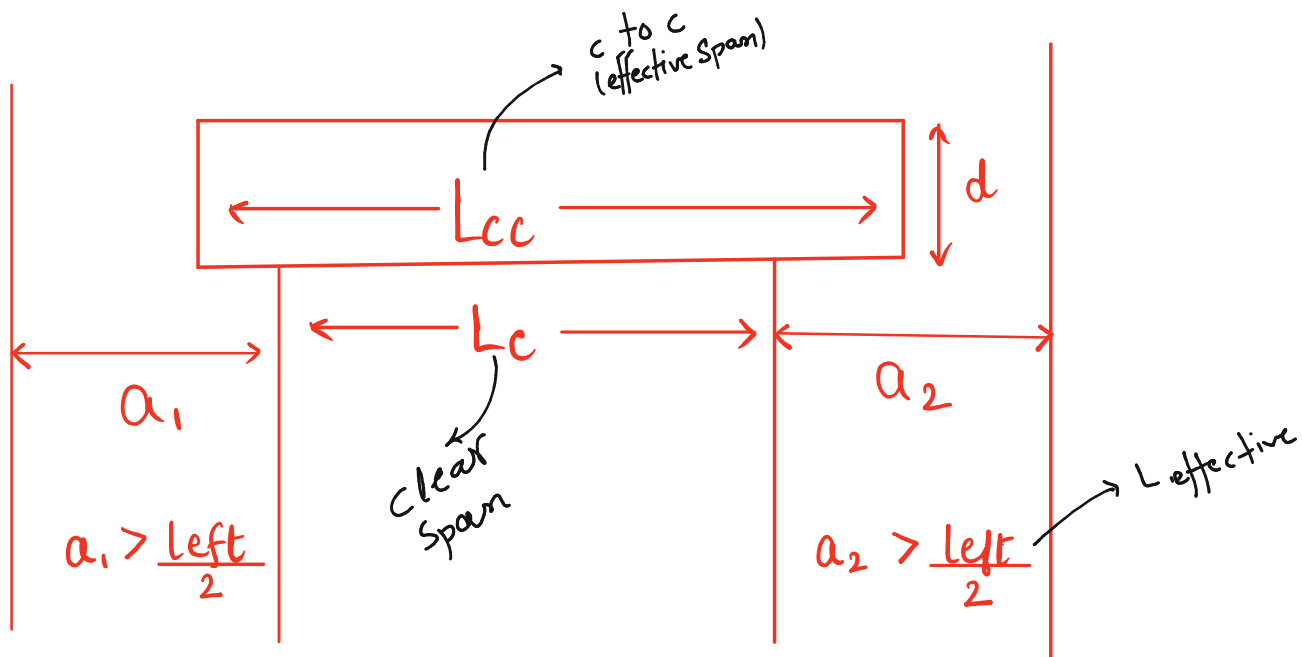
1. Length of wall on each side is more than half the effective span

— This is the most general case observe.

— Effective span of lintel is minimum of

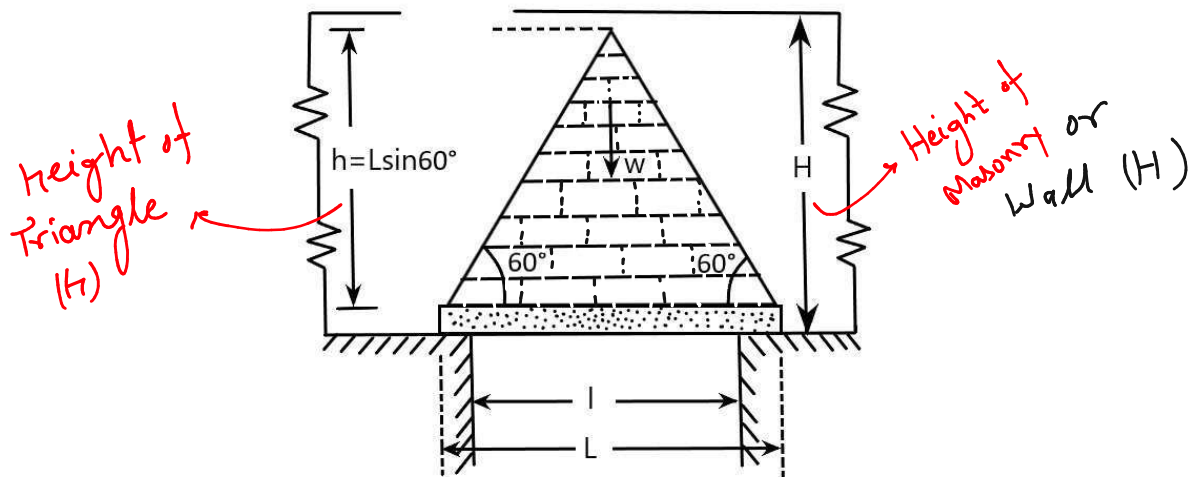
1. c to c distance between the bearing of lintel.

2. Clear span + Effective depth.



$$l_{eff} = \min \left\{ \begin{array}{l} l_{cc} \\ l_c + d \end{array} \right.$$

min will
be taken from
Both of these

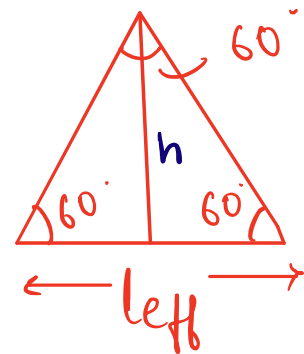


1. $h < H$, $H \rightarrow$ Height of masonry

$$h = \frac{\sqrt{3}}{2} l_{eff}$$

$$\tan 60^\circ = \frac{h}{\frac{l_{eff}}{2}}$$

$$h = \frac{l_{eff}}{2} \tan 60^\circ$$



$$W = V \times \gamma = A \times b \times \gamma$$

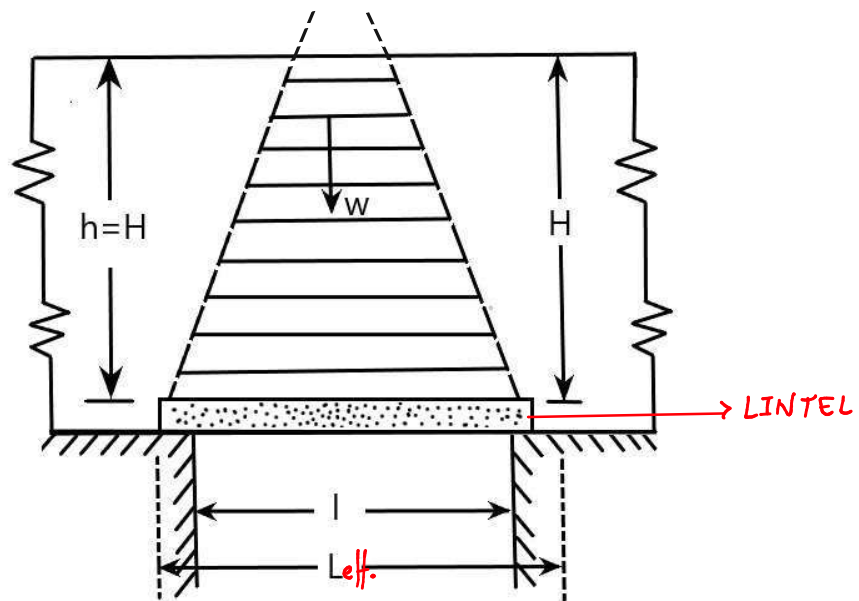
(Vol of Masonry) $\downarrow$ UNIT WT of Masonry

$$= \frac{1}{2} \times l_{eff} \times \frac{\sqrt{3}}{2} l_{eff} h \times \gamma$$



$$W = \frac{\sqrt{3}}{4} l_{eff}^2 b \times \gamma$$

b) $h > H$



$$\begin{aligned} W &= V \gamma \\ &= A b \times \gamma \\ &= H l_{eff} \times b \times \gamma \end{aligned}$$

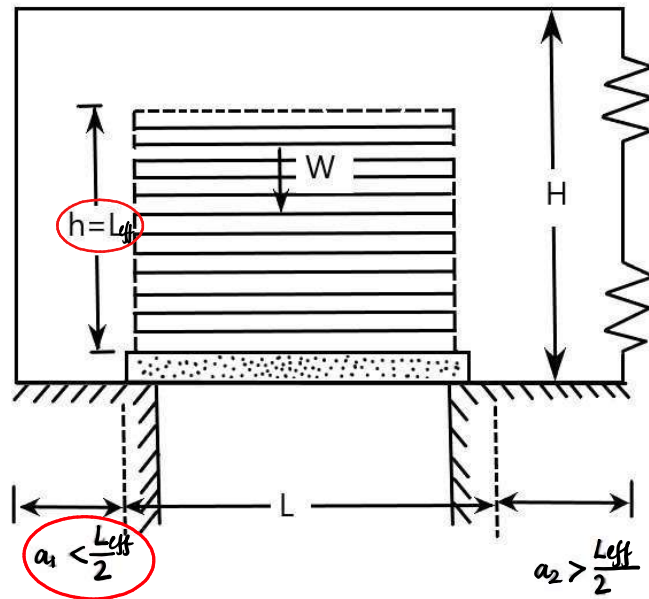
(γ = Gamma)

NOTE

Weight on LINTEL is calculated by which Area of Masonry work comes under an Equilateral Triangle.

$$\text{for } a_1/a_2 > \frac{l_{eff}}{2}$$

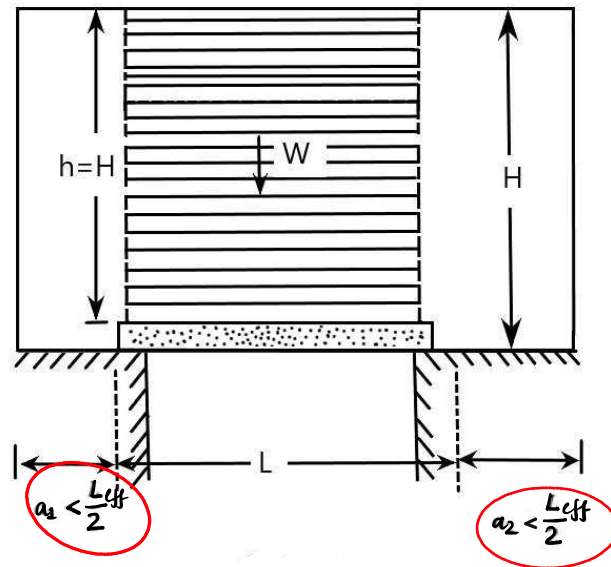
2. Length of wall on one side is less than half the effective span of lintel.



★ Weight of masonry work on Lintel is calculated under Rectangular Area for $a_1/a_2 < \frac{L_{eff}}{2}$

$$\begin{aligned} W &= V \times \gamma \\ &= A \times b \times \gamma \\ &= h \times L_{eff} \times \gamma \times b \\ &= L_{eff}^2 \times b \times \gamma \end{aligned}$$

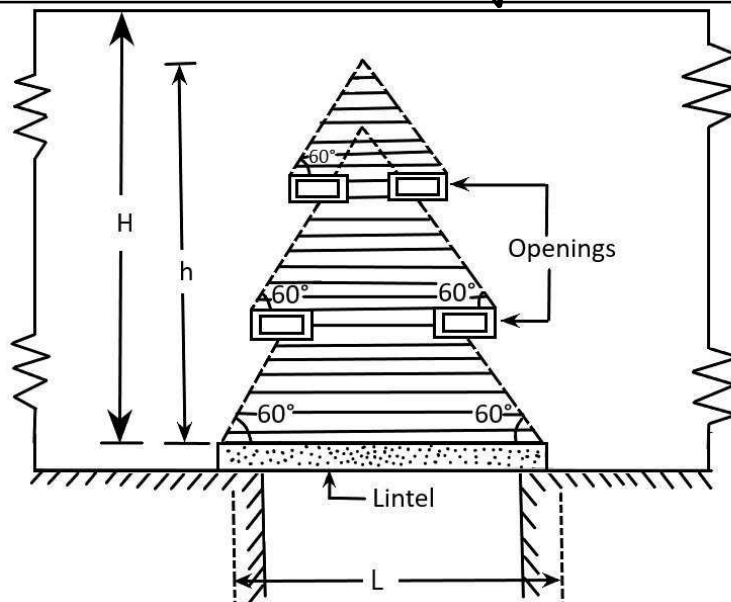
3. Length of wall on each side of lintel is less than half the effective span of lintel.



$$\begin{aligned}\omega &= \gamma \times V = A \times b \times \gamma \\ &= h \times l_{eff} \times b \times \gamma \\ \omega &= H \times l_{eff} \times b \times \gamma\end{aligned}$$

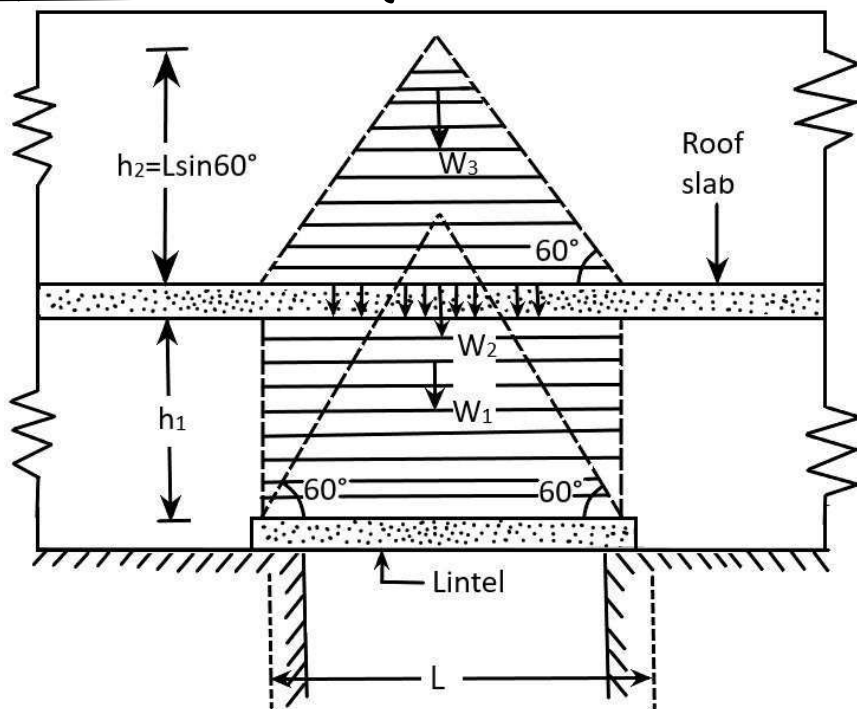


4. When there are openings on the lintel.



If there are opening due to provision of ventilation. Above the lintel and if these opening are intersected by the sides of loading equilateral triangle then this triangle is considered from the top edges of opening.

5. Load carrying slab falling within the dispersion triangle.



If the roof slab is provided at a level wall above the apex of loading triangle then the effect at slab is not considered.

— If the roof slab is provided at a level

below the apex of loading on triangle than following weight is consider to be transfer over the lintel.

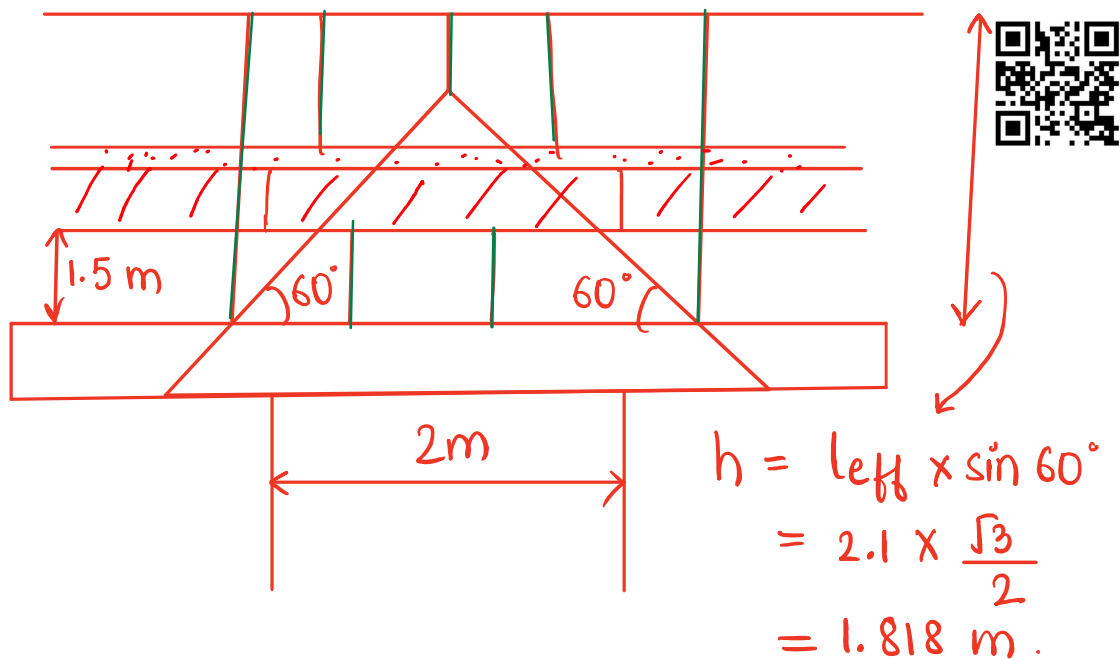


1. Load w_1 due to weight of masonry enclosed in rectangle upto the level of lintel.
2. Load w_2 carried by slab.
3. Load w_3 due to weight of masonry above the slab in equilateral loading triangle.

Question : Given is the cross section of wall for a roof 5m wide and 18m long from inside. Find the design load of the lintel for the window having a clear opening of 2m height of lintel is 30 cm. The reinforced concrete slab 16 cm thick may be assumed to transfer half the load to the wall.

Use the following data.

- | | |
|--------------------------------------|--------------------------|
| 1. Weight of lime concrete terracing | 19 kN/m ³ . |
| 2. Weight of masonry | 19.2 kN/m ³ . |
| 3. Weight of RCC | 24 kN/m ³ |
| 4. Superimposed load on slab | 1.6 kN /m ² . |



1. Weight of wall per meter of the span

$$= 0.3 \times 2.16 \times 1 \times 19.2$$

$$= 12.44 \text{ kN/m.}$$

2. Weight transfer by the slab $\Rightarrow$

Superimposed load $= 5 \times 1 \times 1.6 \times \frac{1}{2}$

$$= 4 \text{ kN/m.}$$

Half weight transferred by slab on wall

Weight of RCC slab $= \frac{5 \times 1 \times 16}{100} \times 24 \times \frac{1}{2}$

$$= 9.6 \text{ kN/m.}$$

Weight of lime ccf $= 5 \times 1 \times \frac{10}{100} \times 19 \times \frac{1}{2}$

$$= 4.75 \text{ kN/m.}$$

$$3. \text{ Self weight of lintel} = 0.3 \times 0.3 \times 1 \times 24$$

$$= 2.16 \text{ kN/m.}$$

$$\text{Design load} = (12.44 + 4 + 9.6 + 4.75$$

$$+ 2.16) \times \frac{2.1}{\text{effective span}}$$

$$= 69.199 \text{ kN.}$$





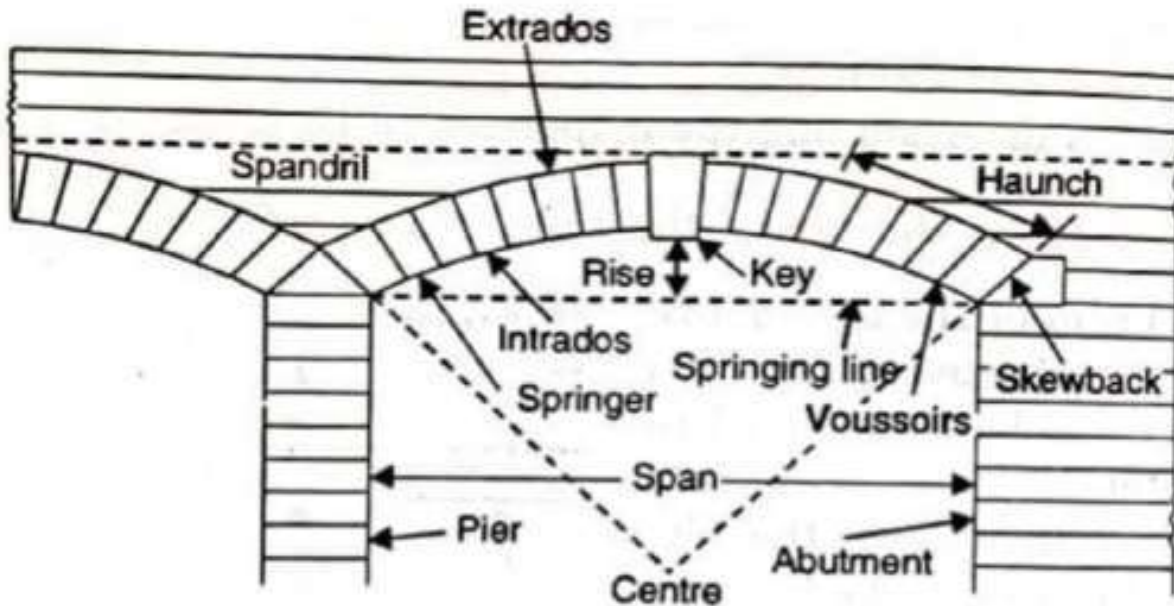
ARCHES

It is a structure constructed of wedge shaped units (bricks, stones) jointed together by mortar (lime/cement mortar).

- It spans over the opening and supports the weight of wall above it and any other superimposed load.
- Due to the application of pressure over the units of arch they compact and transfer this pressure over the adjoining supports.
- It is always in compression.

Elements of ARCH.

1. Intrados : This is the inner curve of the arch.
2. Soffit : The inner surface of the arch is Soffit.
3. Extrados : Outer curve of the arch.



ELEMENTS OF A SEGMENTAL ARCH

Fig.

4. Voussoirs : These are wedge shaped units of masonry forming an arch.
5. Crown : It is the highest part of the extrados .



6. Key : Wedge shaped unit fixed at the crown of arch.
7. Spandril : Curved triangle formed between the extrados and the horizontal line extending from the crown.
8. Springing Points : These are the points from which the curve of the arch start.
9. Springing line : It is an imaginary line joining the springing points.
10. Springer : It is the first voussoir at the springing level.
11. Skewback : It is the inclined surface of the abutment provided to receive the arch and from which the curve of the arch starts.
12. Abutment : End support of an arch.



13. Pier : The intermediate support of an arch.
14. Arcade : Row of The arches in continuation is termed as Arcade.
15. Haunch : Lower half of the arch is between crown and skewback.
16. Span : Clear horizontal distance between the supports.
17. Rise : It is the clear vertical distance between the highest point of the intrados and springing line.
18. Depth : Perpendicular distance between the intrados and extrados .
19. Thickness / Breadth : The horizontal distance between the inner and outer face of the arch.

The failure of the arch can takes place due to following reasons.



1. Crushing of masonry.
2. Sliding of voussoir.
3. Rotation of some joint about an edge.
4. Uneven settlement of abutment or pier.



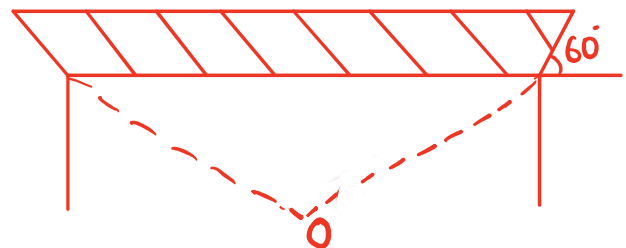
Classification of an arch:-

It can be classified on the basis of following:-

① On the basis of shape.

1. flat arch.

- It is the type of arch in which intrados and extrados are flat.
- It is used for light loads and for span upto 1.5 m, in this case skewback makes an angle of 60° with horizontal.



2. Segmental arch

- This is the most common type of arch. its



center lies below the springing line.

- The thrust transferred by this arch on the abutment is at an inclination.

3. Semi circular arch

- It is the modification of segmental arch in which centre lies over the springing line.
- The thrust transfer by this arch over abutment is in vertically downward direction.

4. Horse shoe arch

- The arch has a shape of horse shoe and incorporates more units than semicircle arch.
- It is mainly provided for architectural consideration.

5. Pointed Arch

- It is also termed as Gothic arch. It consists of two arc of circle meeting at the apex.
- The triangle formed in this case may be



equilateral and isosceles arch.

6. Venetian arch

- It is another form of pointed arch in which depth at crown is more than depth at springing.
- It has four centres, all of which are located on springing line.

7. Florentine arch

- It is the special type of Venetian arch in which intrados is semicircle.
- It has 3 centres located on the spring line.

8. Relieving arch

- This arch is constructed on flat arch on wooden lintel.
- This arch makes it possible to replace the lintel below it without disturbing the stability of the structure.

9. Stilted arch

- It consists of semicircular arch with two vertical portions at springing.



- The centre of this arch lies on horizontal line passing from top of the vertical portion.

⑧ On the basis of no. of center.

On the basis of no. of centers arches are classified as follows.

1. One centred arch

Segmental, semi-circular, flat, horseshoe, stilted, bull eye arch.

2. Two centred arch

Pointed arch, Florentine arch.

3. Three centred arch

Florentine arch.

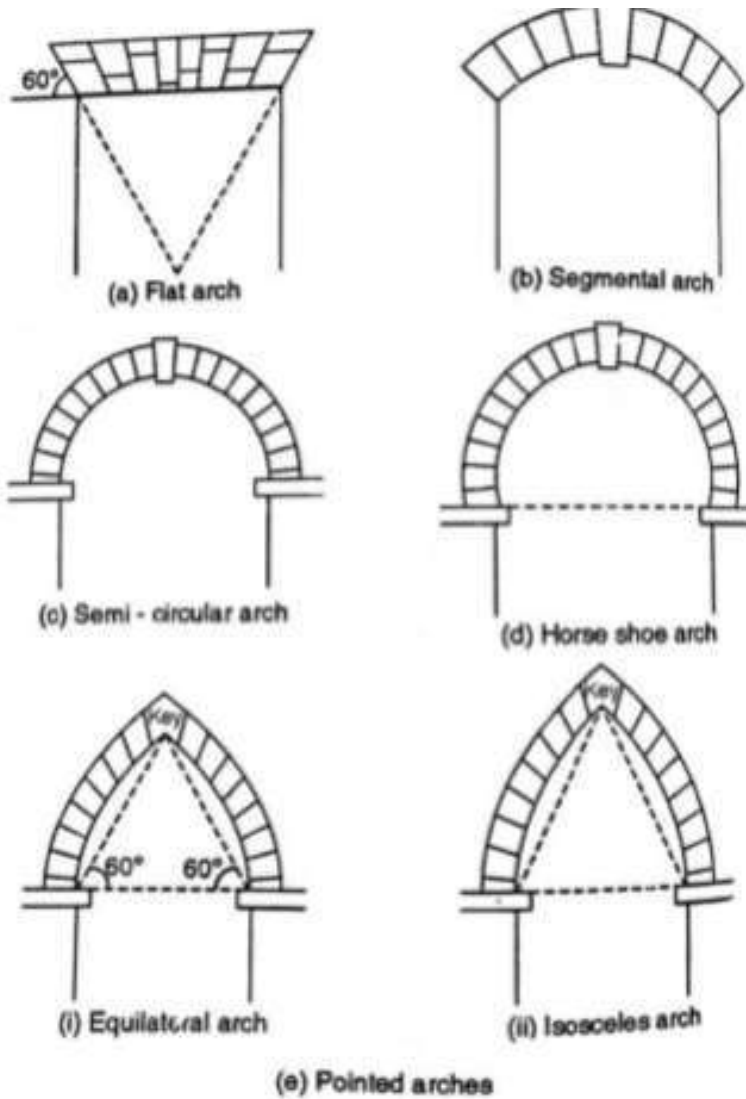
4. Four centred arch

Venetian Tudor arch.

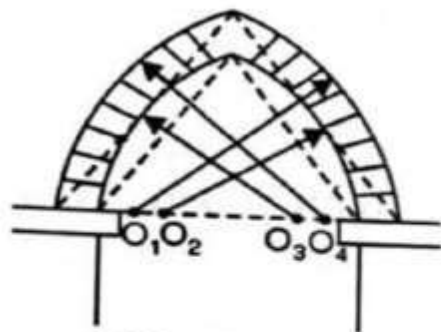
5. Five centred arch

Semi elliptical arch.

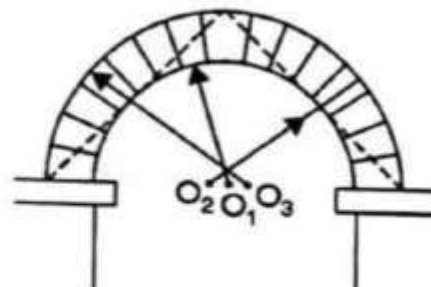
DIAGRAMS



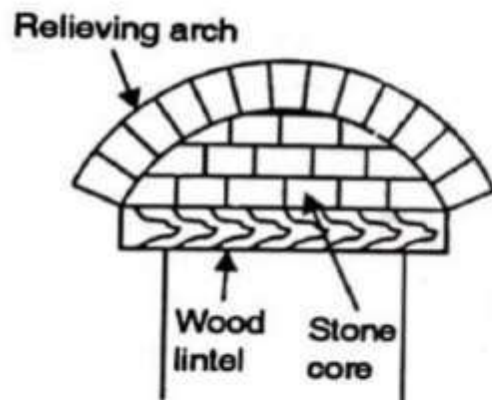
TYPES OF ARCHES.



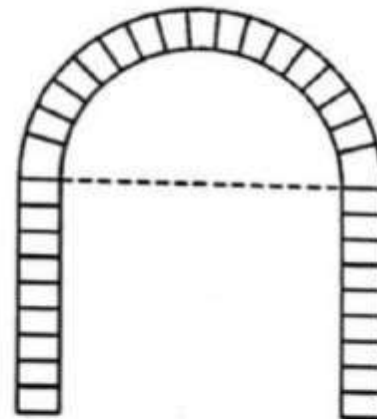
(a) Venetian arch



(b) Florentine arch

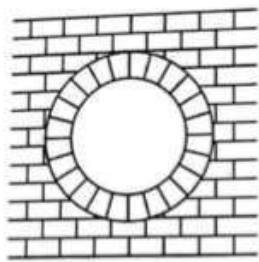


(c) Relieving arch

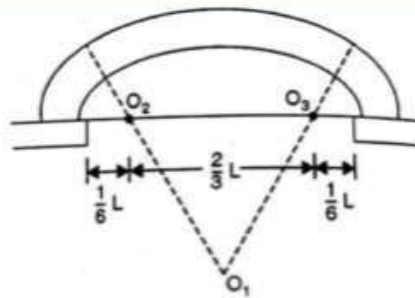


(d) Stilted arch

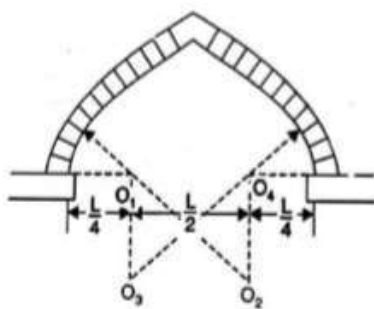
TYPES OF ARCHES.



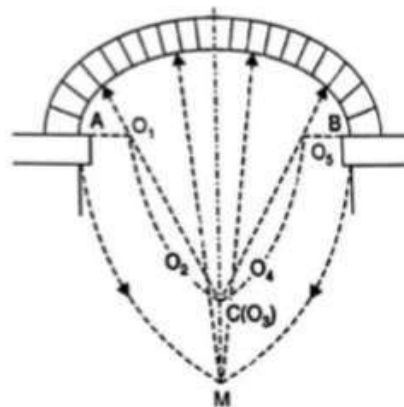
BULL'S EYE ARCH



THREE-CENTRED ARCH (ELLIPTICAL)



FOUR-CENTRED ARCH
(TUDOR ARCH)



FIVE-CENTRED ARCH
(SEMIL-ELLIPTICAL ARCH)



© On the basis of material use

1. Rubble
Ashlar
2. Brick arches
 - a) Rough brick
 - b) Axed brick
 - c) Gauged brick
3. Purpose made brick arch.
4. Concrete arch
 - a) Cast Insitu
 - b) Precast.



STAIRS

A stair is a set of step leading from one floor to another floor or it provides medium of ascent or decent between various floor.

- The roof or enclosure where stairs are constructed is termed as staircase.
- The space occupied by stairs in stair case is termed as stair way.

1. Step

- It is the portion of stair which permits ascending and descending.
- It consists of 2 components:-
 1. Tread
 2. Riser.
- A stair consists of set of step.

2. Tread

- It is upper horizontal portion of step over which foot is placed while ascending and descending.



3. Riser

- Vertical portion of stair providing support to the tread is termed as Riser.

4. Flight

- It is unbroken series of step between landing.

5. Landing

- It is the level platform at the top and bottom of flight.
- It facilitates change of direction.
- It provides the opportunity for rest during the use of stairs.

6. Rise

- It is the vertical distance between the tread faces.

7. Gang

- It is the horizontal distance between the two riser faces.

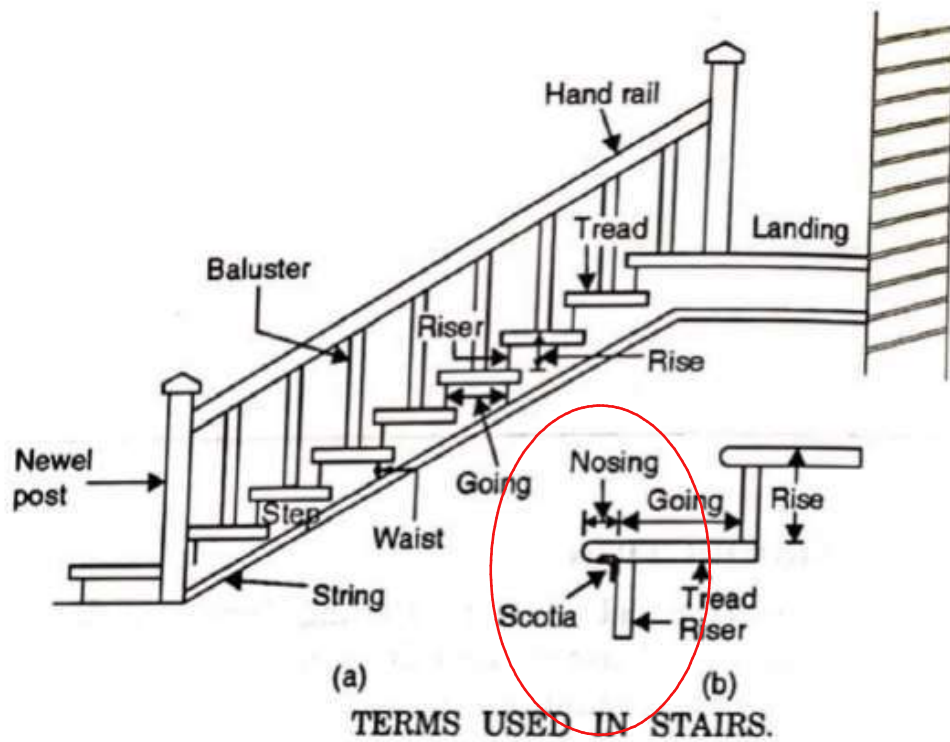
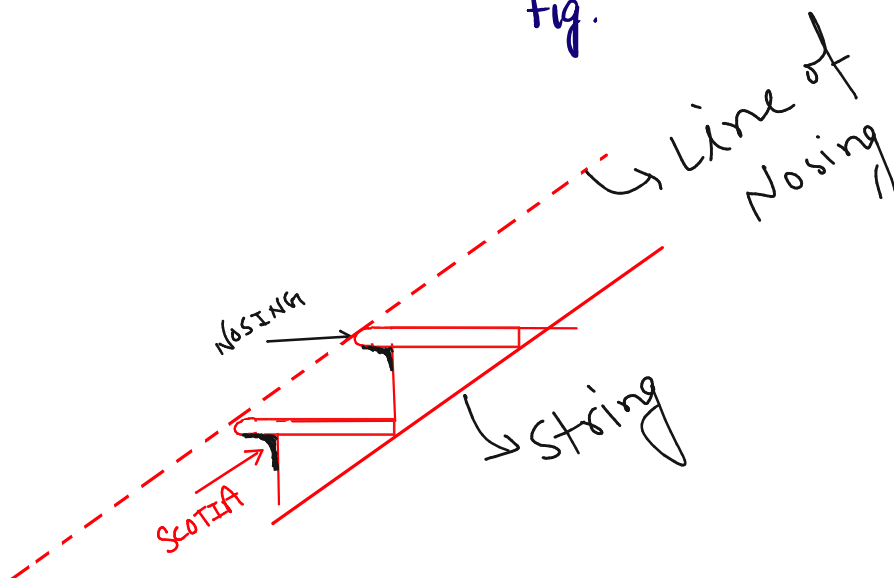


Fig.





8. Nosing

The projecting part of tread is termed beyond the face of riser is termed as Nosing.

- It is usually rounded off from architectural point of view.

9. Scotia

- A moulding provided below the nosing to improve its strength and elevation is termed as soffit.

10. Line of nosing

- Imaginary line parallel to string and tangential to string.

11. Slope / Pitch

- It is an angle made by line of nosing with horizontal.

12. String ^{stringer}

- The sloping member which supports the steps of stair is termed as string.



13. Newel post

- It is the vertical member provided at the start of flight to support the handrail.

14. Balusters

- Vertical member provided to support handrail after newel post.

15. Handrail

- It is moulded or rounded portion parallel to string used to provide support while using the stairs.

16. Run

- Total length of stairs in horizontal plane including landing.

17. Headroom

- Minimum clear vertical distance between tread and ceiling. (2.3 - 2.5 m)

18. Header

- It is the horizontal structural member provided to support the stair.



Requirement of good stairs

1. Location

It should be located such that it is easily accessible by all the occupants of the building.

- It should be well ventilated and well lighted from exterior.

- Width of the stair

- for domestic building it is 0.9 m and for public building 1.5 to 1.8 m.

- Length of the flight

from comfort point of view no. of step must not more than 12 and less than 3.

- Pitch or slope

It is kept in range of 30 to 45°.

- Headroom

It is kept in range of 2.1 to 2.3 m.



- Material used for construction
Material used for construction should be such that it has
 1. Sufficient strength
 2. Fire resistance.

- Step dimension

It should be such that it provides comfort to the user.

Going : 25 cm - 30 cm.

Rise : 10 - 15 cm

Condition -

$$1. 2 \times \text{Rise (cm)} + \text{going (cm)} = 60$$

$$2. \text{Rise (cm)} + \text{going (cm)} = 40 - 45$$

$$3. \text{Rise (cm)} \times \text{going (cm)} = 400 - 450.$$

Generally Rise 14 cm, and going 30 cm is adopted.

NOTE:

A thumb rule is followed for selecting other combination of rise and going.

- for every 2 cm subtracted from going and add 1 cm in rise.

- Rise : Going = 15 x 28, 16 x 26.



Types of steps

1. flier

It is ordinary step of uniform width and plan is rectangular.

2. Bull nose step

It is generally provided at the bottom of the flight and project in front of newel post.

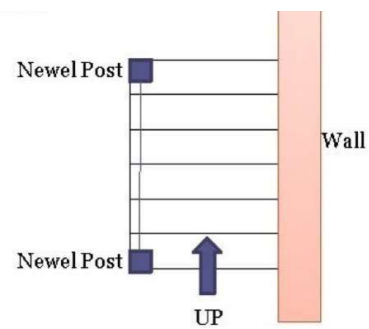
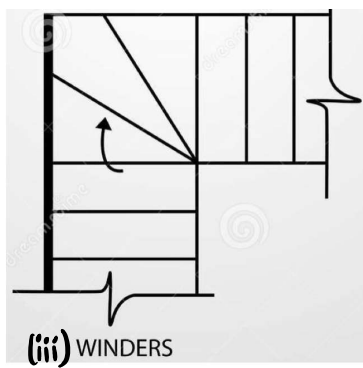
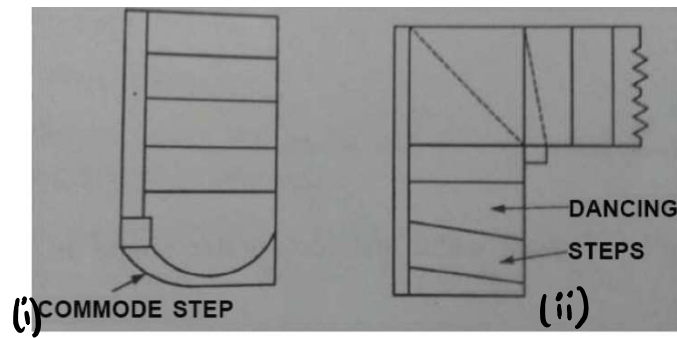
— Its end near the newel post forms quadrant of circle.

3. Round ended step.

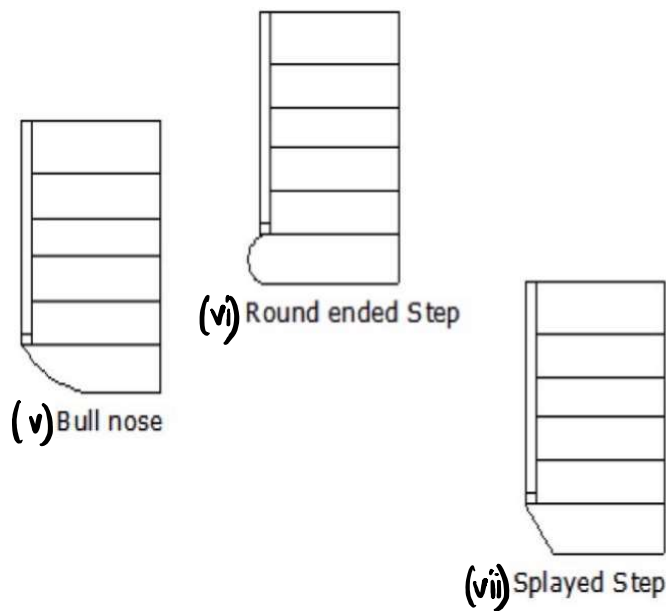
It is similar to bull nose step except it has semi-circular end which project out from the stringer.

4. Splayed step

It is provided at the beginning of flight. Its end near the newel post is splayed / curtailed.



(iv) Flier Step



Types of steps



5. Commode step.

It is provided at the beginning of flight.
It has curved tread and riser.

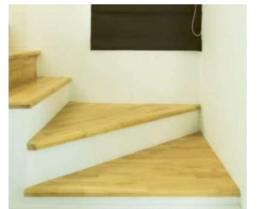
6. Dancing / Balancing step.

These are the step which do not have uniform going.

- Tapered steps are known as winders.
- Dancing steps are those winders of which do not radiate from common centre

7. Winders

Tapered step which radiate from the centre of newel are termed as winders.



Types of stairs.

1. Straight stairs

It has straight run between the two floor either in single flight or more than one flight. It is provided where there is restriction of width.



2. Turning stairs

These are the type of stairs in which there would be at least one change in direction.

These are of following types

1. Quarter turn stair.
2. Half turn stair / Dogg legged / open well stair.
3. 3 quarter turn stairs.
4. Bifurcated stairs.

1. Quarter turn stair

When the direction of flight is change at right angle either to be left or to be right quarter turn stairs are used.

Suitability → width → more but length limited.

2. Half turn stair

1. Dogg legged

It consists of two flight of stair which are opposite direction, no space is provided between the flight in plan.



2. Open well stair

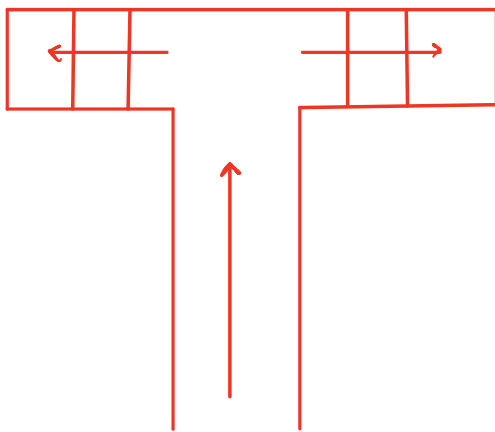
A half turn stair with a space between its flight is known as open well stair.
Suitability → multistorey building.

3. 3-quarter turn stair

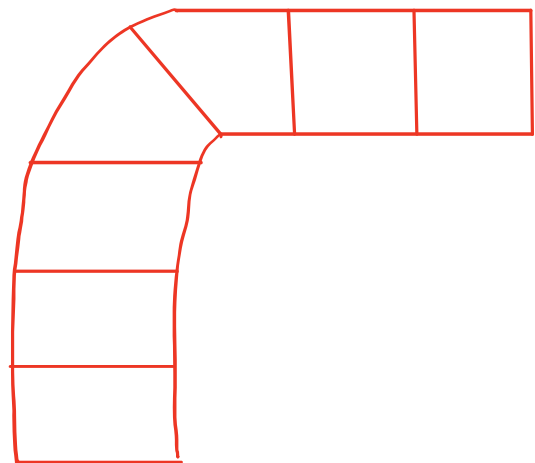
A stair turning through 3-right angle is known as 3-quarter turn stair.

4. Bifurcated stair

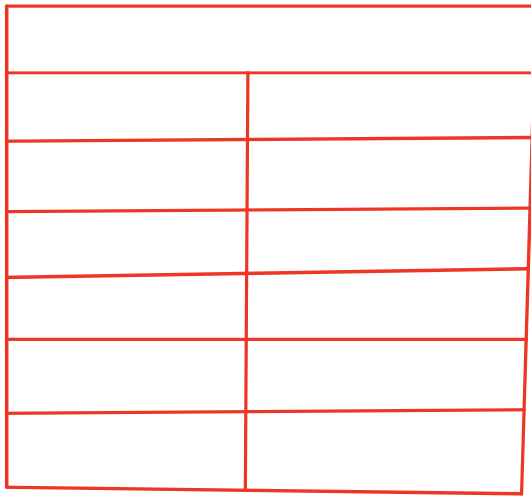
This type of stair has a wide flight of bottom which bifurcated in the narrow flight are turning in left side and other in right side at the landing.



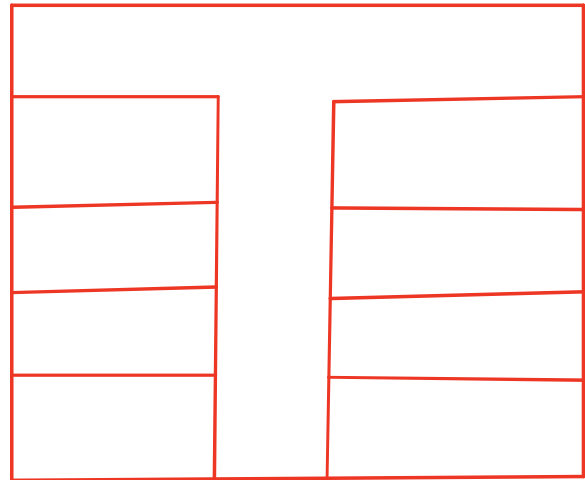
• Bifurcated stair



• Quarter turn.



- Dog legged



- Open space.

Continuous stairs.

The stairs which do not have any landing or intermediate newel post are termed as continuous stairs.

These are further classified as

1. Spiral
2. Circular
3. Helical.



Stairs of different material.

1. Timber stair

These stairs are light in weight. easy to



- construct. Very less fire resistant.
- Suitable for small residential building.
 - Unsuitable for public or large.
 - Timber used must be free from the effect of termites, insect and fungi.

2. Stone stairs.

It is widely used at places where ashlar stone is readily available.

It possesses strength, rigidity, resistance to wear and tear and fire will be more.

- These stairs are comparatively heavy.
- Stone stair may have following type of step - (a) Rectangular steps - No Stringer Provided
(b) Spandril steps

3. Brick stair

Uncommon stair.

- Used in villages. Its wear and tear is comparatively more. Hence, maintenance cost is also more.
- Generally used at the entrance or for the architectural purpose.



4. Metal stairs

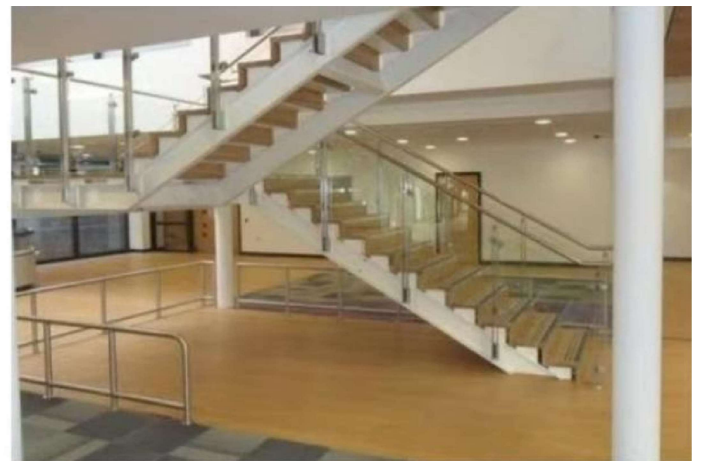
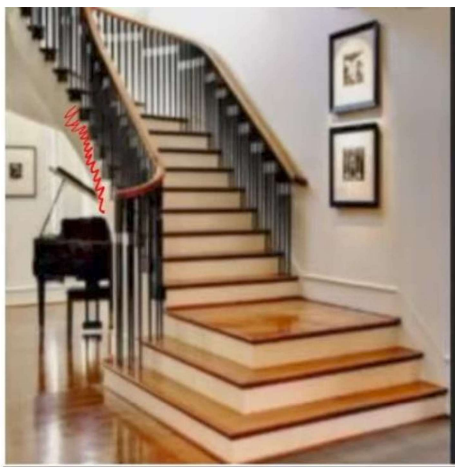
These are made up of mild steel or cast iron.

- These are use for emergency purpose.
- These are strong fire resistance but are not prefer in residential and public building as they are not good looking, and make noise.

5. RCC Stairs

These are most widely used stair both in residential and public building.

- These are strong, hard resistant against fire.
- Can be given any type of finish.
- It can be cast insitu or can be precast.



Spanning Horizontally
(Supported on Both Sides)

Spanning Longitudinally
(Supported by Landings)

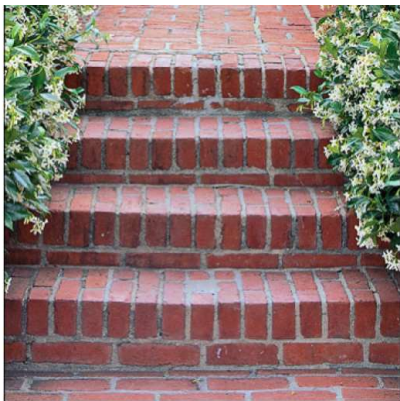
stairs of different material.



(i) Timber stair



(ii) Stone stair



(iii) Brick stair

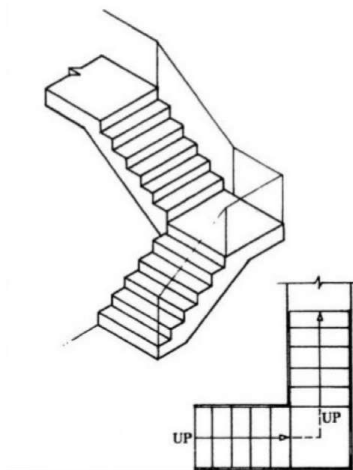
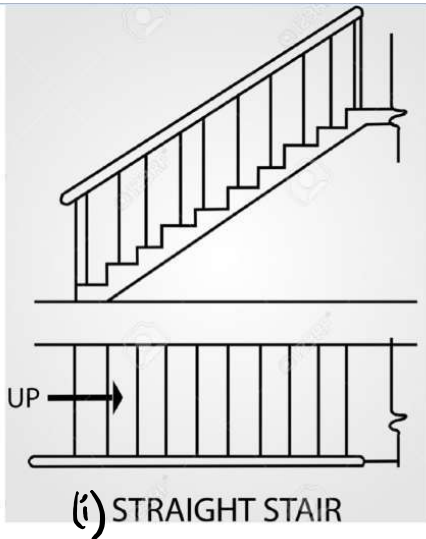


(iv) Metal stair

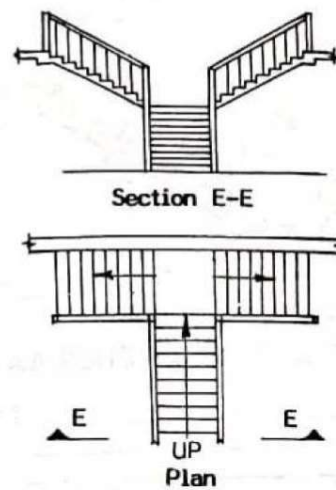
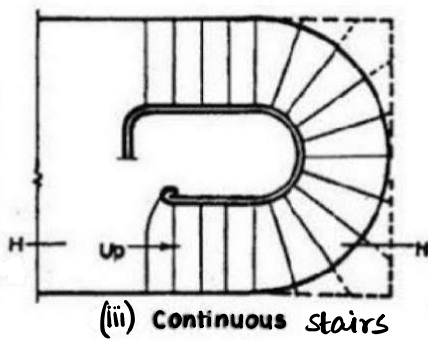


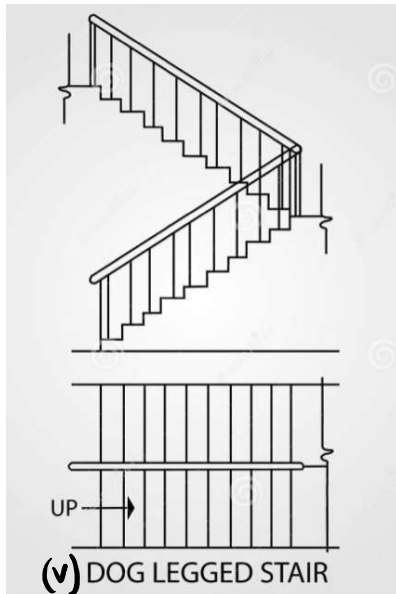
(v) RCC stair

Types of stairs

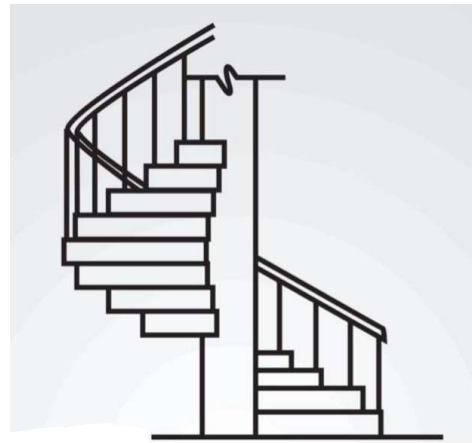
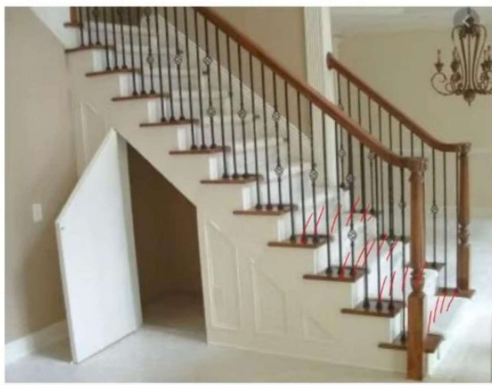


(ii) Quarter turn stairs





Spandrel steps



Rebated rectangular stone steps





DOORS AND WINDOWS

A door is defined as operable barrier secured in wall opening.

- It is provided to give access to the interior of the building and room.
- It act as mode of communication between different portions of building.

Window

Vented barrier secured in wall opening. It is provided to permit the entry of air and light inside the building and to provide view of outside of building.

- The following points must be considered while deciding the location of doors and window.
 1. The no. of doors in a room should be kept minimum as they cause obstruction and consume area in circulation.
 2. The location of the door should fulfill the functional requirement of room.



- It should not be located at the centre of the wall. It should be preferably be provided at corner nearly 20 cm away from the corner.
- 3. If two doors are provided preferably they should be opposite to each other to permit cross-ventilation.
- The no. and size of window is decided on the basis of function of room, distribution of light, ventilation and privacy of the occupants.
- If two windows are provided, they must be opposite to each to permit Cross ventilation.
- From point of view of fresh air, it must be provided as per direction of window.
- The sill of window must be 70-80 cm above the floor of the room.



Components of doors and windows.

1. Frame : It is an assembly of horizontal and vertical members forming an enclosure to which shutters are fixed.
2. Shutter : These are the openable parts of door and windows.
 - It consists of style, rail, panels.
3. Head : The top horizontal part of frame is termed as head.
4. Sill : The lowermost horizontal part of frame is termed as Sill.
 - It is not provided for doors.
5. Style : It is vertical outside member of the shutter at door or window.
6. Rail : It is the horizontal member of shutter.



7. Panel : Area enclosed between the adjacent rail is termed as panel.

~~248~~ 8. Mullion : It is vertical member provided to subdivide door or window vertically.

9. Transom : It is the horizontal member provided to subdivide the window horizontally.

10. Hold fast : These are mild steel flat used to fix the frame of doors and windows in the masonry.

~~11~~ Jamb : The vertical face of the opening which support the frame is termed as jamb.

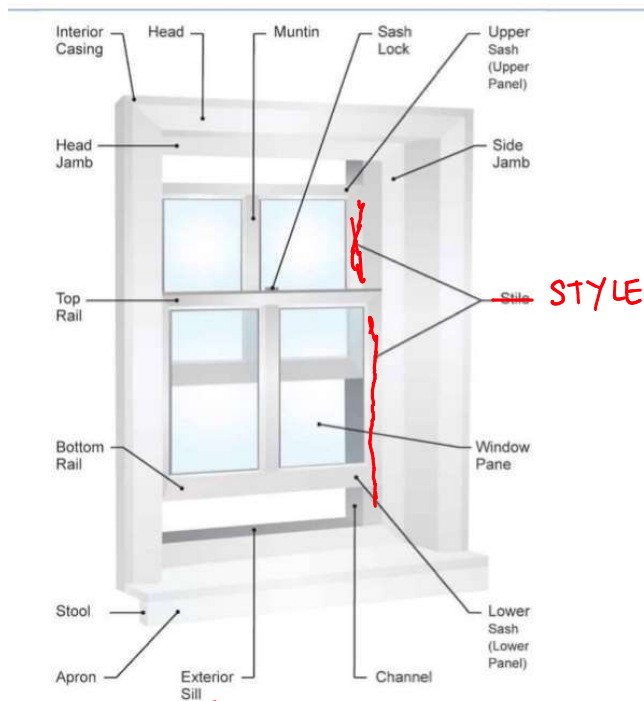
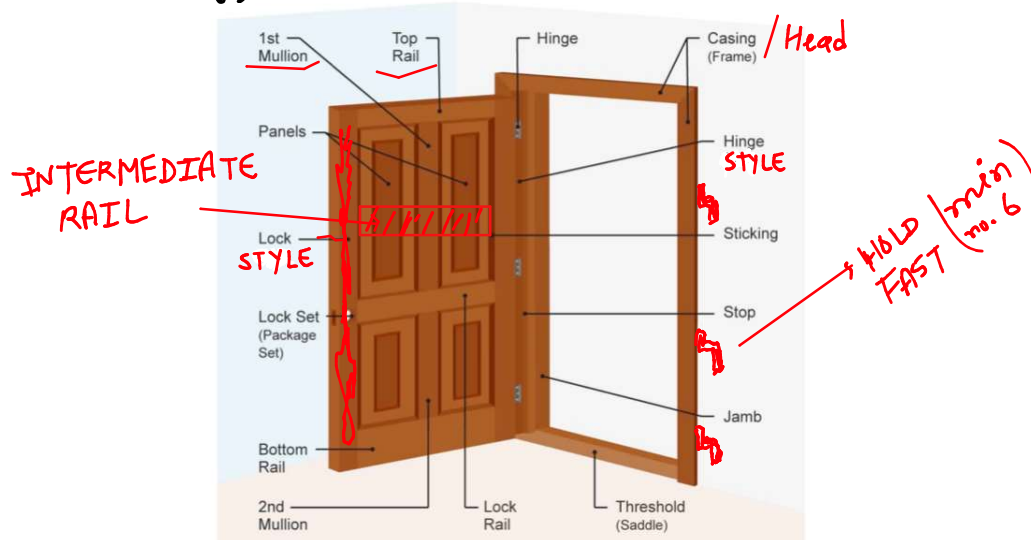
Width $\rightarrow$ 76 mm to 114 mm.

Depth $\rightarrow$ 57 mm to 76 mm.

12. Rebate : The depression made inside the door frame to receive the shutter.



(i) Door



(ii) Window





13. Transom: Horizontal member which sub divide window horizontally.

14. Reveal: The external jamb of door or window opening at right angle to the wall face.

★ # Size of door and window.

1. Door

The size of door should be such that, a tallest person or largest object can be able to pass through it.

- Hence it is kept in range of 1.8 - 2m.
- width is decided on the fact that two person can pass through it simultaneously, shoulder to shoulder.

- following conditions are to be fulfilled

1. width : Height = 0.4 - 0.6

2. Height = (width + 1.2) m

Ⓐ Doors of Residential building

1. External door : (1m x 2m) or



- 1.1 m x 2m.
2. Internal door : (0.9 m x 2m) or (1 m x 2m)
 3. Bathroom and Kitchen : (0.7 m x 2m) or (0.8 m x 2m)
 4. Garage for cars : 2.25 m x 2.25 m.

⑧ for public building : School,
Hospital and library

1. 1.2 m x 2 m
2. 1.2 m x 2.2 m
3. 1.2 m x 2.1 m.

// Indian standard recommends that the size of door frame should be considered allowing a margin of 5mm all around for ease of fixing.

— The width and height of door opening is indicated in terms of no. of module where each module is of 100 mm.



Designation	Size of opening (mm)	Size of frame (mm)
8 DS 20	800 X 2000	790 X 1990
9 DS 21	900 X 2100	890 X 2090
10 DT 20	1000 X 2000	990 X 1990
12 DT 21	1200 X 2100	1190 X 2090

D = Door

S = Single shutter.

T = Double shutter.

2. Window

following thumb rules are used to fix the size of window.

1. Breadth of window = $\frac{1}{8}$ th (width of room + Height of room).

2. The total area of window opening is 10-20% area of floor of that room.

↓
for public building.

3. In this case also size of window opening is expressed in terms of module



and size of each module is 100 mm.

Designation	Size of opening (mm)
6 W S 12	600 X 1200
10 W T 12	1000 X 1200
12 W T 12	1200 X 1200
6 W S 13	600 X 1300
10 W T 13	1000 X 1300

W = Window

S = Single shutter.

T = Double shutter.

Types of door and window.

Various types of windows are as follows.

1. Corner window

It is provided at the corner of room. It has two faces in two direction. Due to this, light and air enter from two direction, such a window improves the elevator of building also.

2. Gable window

It is a vertical window provided in the gable end of a roof.

3. Dormer window

It is a vertical window provided on a sloping roof with the object of providing an air to enclosed space below the roof.

4. Bay window

This window projected outward from the walls of room to provide an increased area of opening for admitting greater light and ventilation.

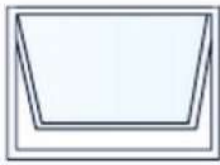
5. Clerestory window

Provided near the main roof of a room and opens above the adjoining verandah

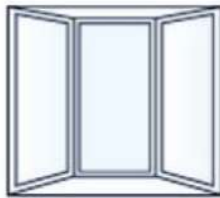
6. Casement window

Common type of window usually provided in a building. The shutters of this type of window are open like doors.

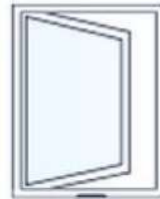
7. Sash or glazed window
Panels are fully glazed.



AWNING



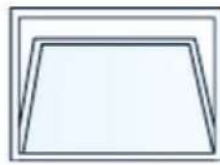
BAY & BOW



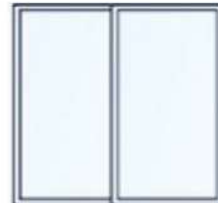
CASEMENT



DOUBLE HUNG

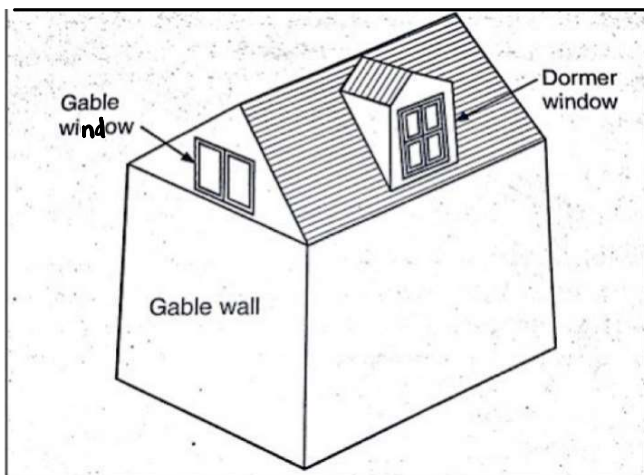


BASEMENT



SLIDING

(i)



(ii)



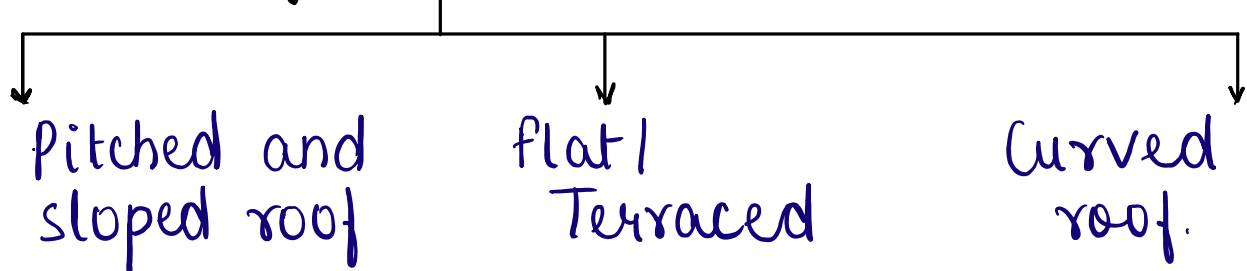
(iii) Glazed window



ROOFS AND ROOFS COVERING

- It is defined as the upper most part of the building which is being provided as structural covering to protect the building from weather (snow, humidity, rain, sun, wind).
- It consists of structural component to support the roof covering.
- The roof and roof covering must have following requirement.
 1. Strong to resist dead load, live load
 2. It should be durable to protect the building from weathering effect.
 3. It should provide thermal insulation, fire resistance, sound resistance.

Types of roofs





Selection of type of roof to be provided depends on

1. Shape and plan of building.
2. Climatic condition.
3. Construction material available.

Pitched roof.

The roof with sloping surface is termed as Pitched and sloping roof.

These are of following types:

1. Lean to roof / Pent roof / Aisle roof.

It has slope only one side.

Simplest sloping roof provided for short span.

Ex : Verandah on single room.

2. Gable roof.

Sloping in two direction.

These two slope meet at the ridge.

On this case at the end face a vertical triangle is also formed.

3. Hip roof

formed by four sloping surfaces.



At the end face sloped triangle is formed.

4. Gambrel Roof.

Same as gable roof having two sloping surface but there is the break in slope in this case.

In this case also at the end face vertical triangle is formed.

BOTH
Have
Breaking
in Slopes

5. Mansard or curb roof.

Equivalent to hip roof having 4 sloping surface but slope has break in between.

At the end faces sloped triangle are formed.

6. Deck roof

It is also same as hip roof having 4 sloping surface but it is provided with deck or plane surface at the top.

Elements of pitched roof.

LINES

1. Span : Clear distance between the support of arch.



2. Rise : Vertical distance between the top of the ridge and wall plates.
3. Pitch : It is the inclination of the sloping surface of roof with horizontal plane.
4. Ridge : It is defined as apex line of the sloping surface or roof. Topmost line
5. Eaves : Lower edge of the inclined roof surface from where the rain water falls off is termed as eaves.
6. Hip : Ridge formed by the intersection of the two sloping surface where the exterior angle $> 180^\circ$.
7. Valley : Ridge formed by the intersection of two sloping surface where the exterior angle $< 180^\circ$.
8. Verge : It is edge of gable roof between the ridge and eaves.



9. Ridge piece : It is the horizontal wooden member provided at the apex of roof.

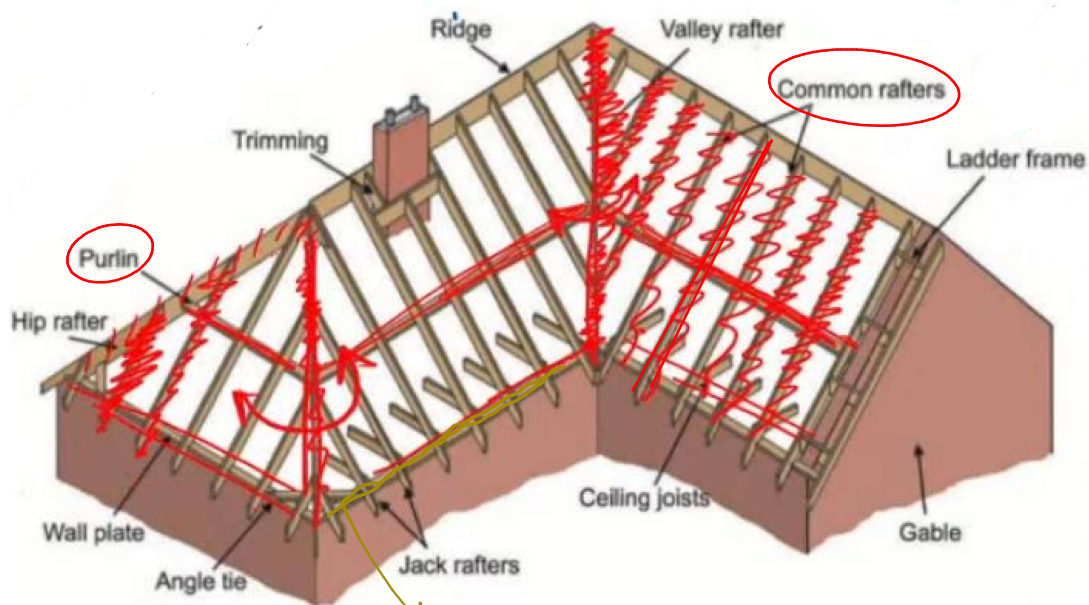
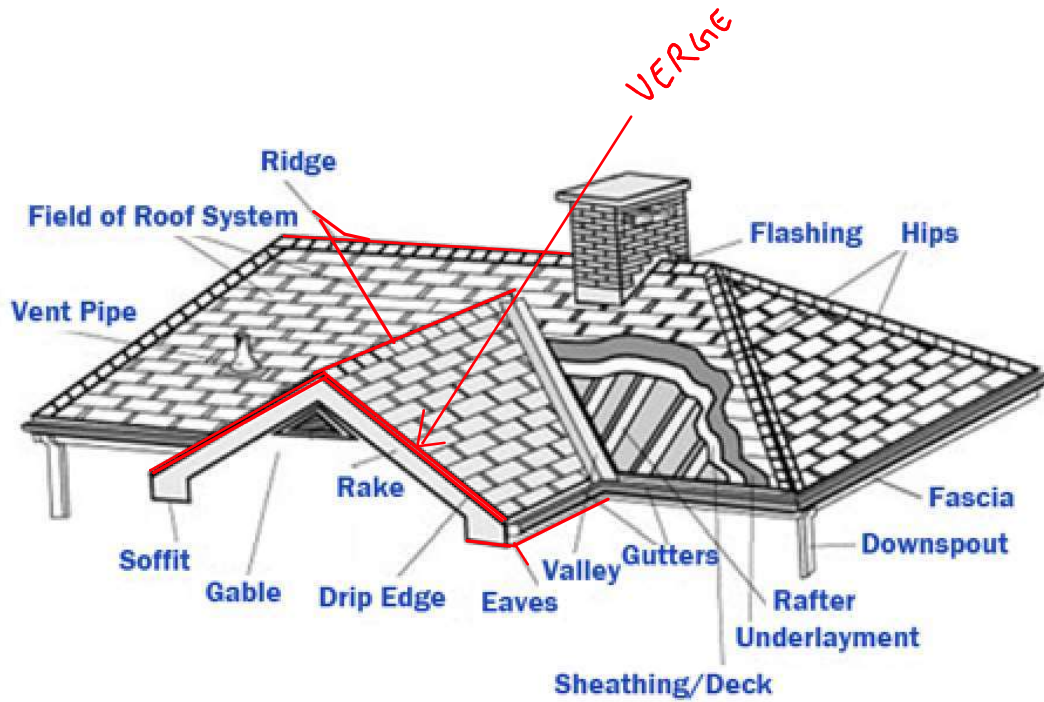
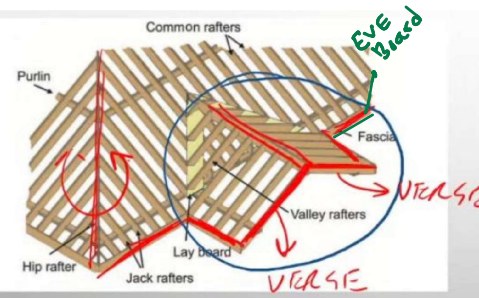
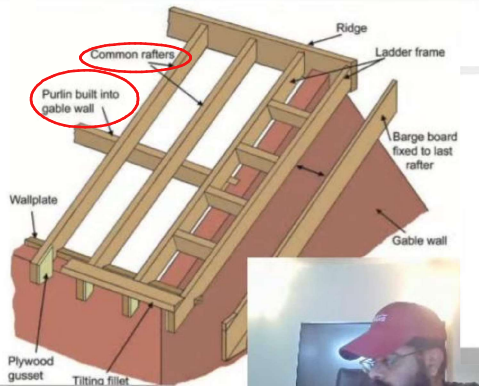
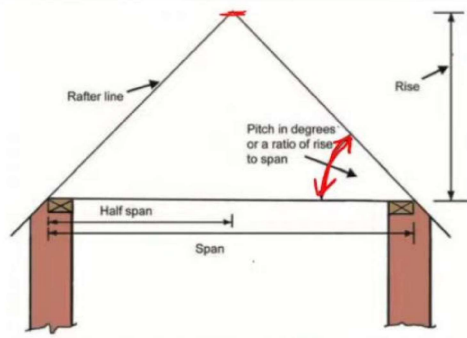
10. Common rafter : These are inclined wooden member which run from ridge to eaves.

Along with the Length
11. Purlins : These are horizontal wooden or steel member used to support the common rafter.

12. Hip rafter : It is inclined or sloping rafter which forms the hip of the sloping roof.

13. Valley rafter : It is inclined rafter which forms valley of sloping roof.

14. Jack rafter : These are the rafter shorter in length which run from hip or valley to the eaves or ridge.



Wall Plate



15. Eave board : Wooden plate or board fixed to the feet of common rafter at the eave.
16. Barge board : Timber board used to hold the common rafter forming verge.
17. Wall plates : These are long wooden members which are provided on the top of wall for the purpose of fixing the roof.
18. Template : A block of stone or concrete provided under the end of tie beam to spread the load from the roof over a large area of bearing.



Types of pitched roof.

- These are of following
1. Single roof.
 2. Double / Purlin



3. Triple - membered / framed / Truss roof.

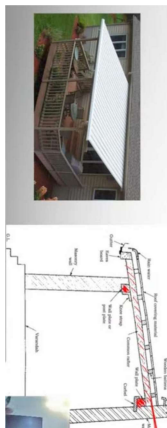
1. Single roof

It only consists of rafter supported at top and bottom i.e, at ridge and eaves.
It is provided for short span < 5 m.

a) Lean to roof (Verandah roof).

Span < 2.5 m.

This type of roof is formed by rafter which loops one side of ridge of the roof.
- Supported by wall plates which is embedded with the masonry.

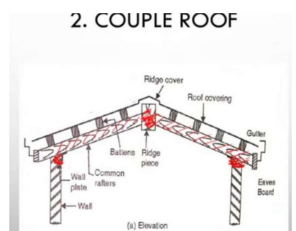


b) Couple roof

This type of roof formed by couple of rafter which loops on both sides of ridge of the roof.

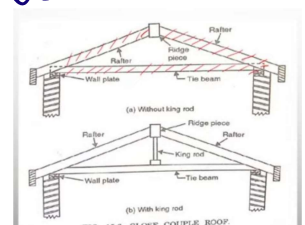
It is not proper generally.

- It is suitable for span upto 3.5 m.



c) Couple close roof.

This roof is similar to couple roof except that in the legs of common rafter are





connected by the tie beam. King rod to avoid sagging of rafter.
 $\text{Span} < 4.2 \text{ m.}$

4. COLLAR BEAM ROOF

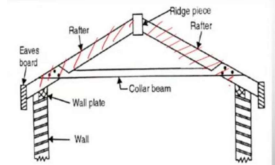


FIG. 15.7. COLLAR BEAM ROOF.

d) Collar beam roof.

This roof is similar to couple close roof except that in the latter case a tie beam is raised and placed at a higher level.

$\text{Span} \leq 5 \text{ m.}$

Collar and scissor roof

$\text{Span} \leq 5 \text{ m.}$

5. COLLAR AND SCISSORS ROOF (Span $\leq$)

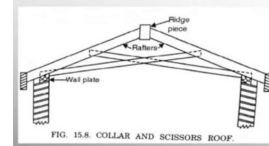
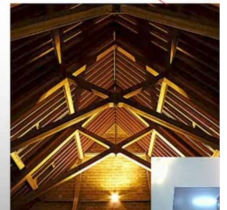


FIG. 15.8. COLLAR AND SCISSORS ROOF.

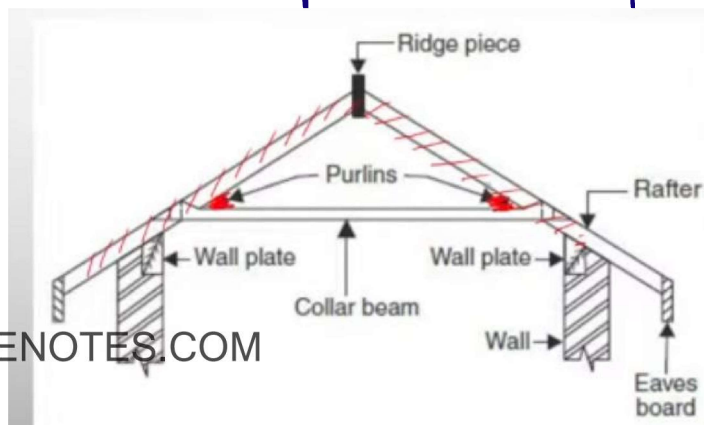


2. Double or Purlin roofs.

Consists of two basic elements.

Rafter, Purlin.

When span exceeds about 2.4m the necessary size for rafter becomes uneconomical. Hence, in order to reduce the size of rafter to be economical, the intermediate support called purlin are provided.





3. Triple-membered or framed or Trussed roofs.

a) King post Roof Truss

It consists of 3 types of elements
Rafter, Purlin, Truss.

Span: 5-8 m.

In this type of truss the central vertical post known as king post forms support to tie beam. The inclined member known as strut prevent the principle rafter from bending in middle.



b). Queen Post Roof Truss

Span: 8-12 m

This truss differs from king post truss roof in having two vertical posts known as queen post.

c) Combination of king post and queen post truss.

Span upto $\leq 18\text{m}$.

d) Mansard roof truss Odd Shape.

Inclination
Approx - 30°



It is the combination of king post and queen post trusses. In other word it work as two storey truss with upper portion consisting of king post truss and lower portion of queen post truss.

e) Truncated Truss

This truss is similar to masand truss except that the top is formed flat with gentle slope to one side.

This truss is used when it is required to provide a room in the roof.

f) Belfast roof truss

Also some time known as latticed roof truss or bow string truss.

Span < 30

Provided the light roof covering is used.

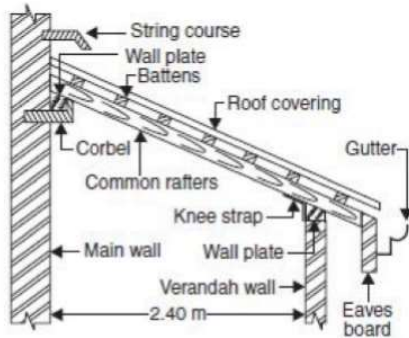
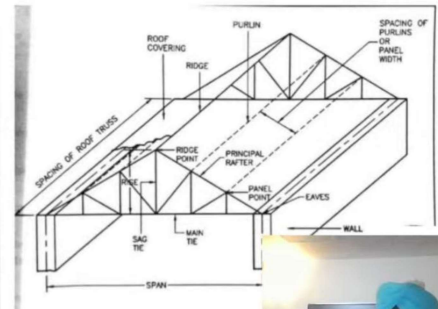
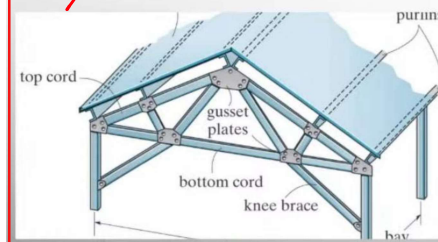
g) Steel truss

It is most common type of roof truss. Most economical, easy to construct, fire resistant, more rigid upto 30 m.

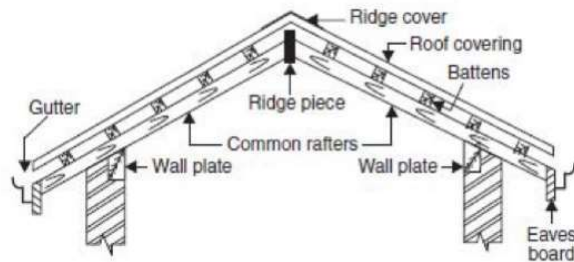
Factory
- storage
- parking

INDUSTRIAL BUILDING BENTS

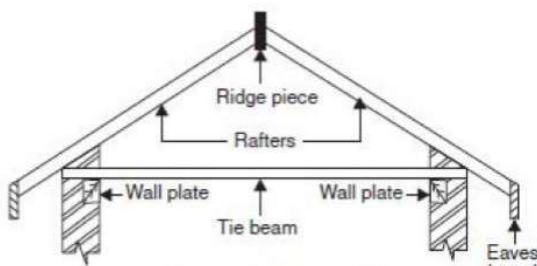
1. Single Roof



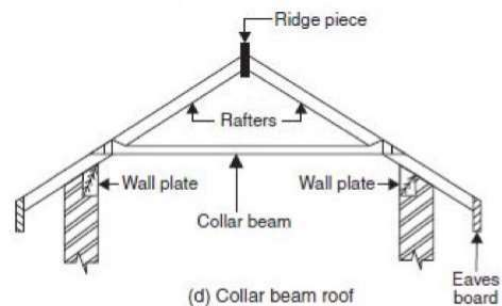
(a) Lean to roof



(b) Coupled roof

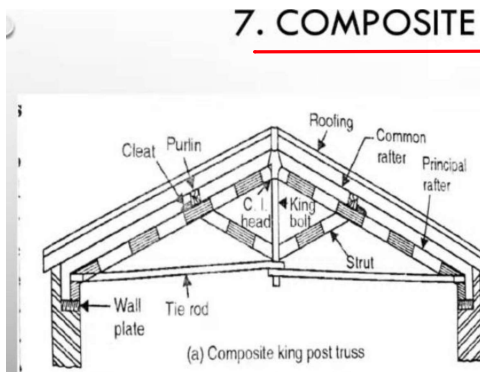


(c) Coupled close roof

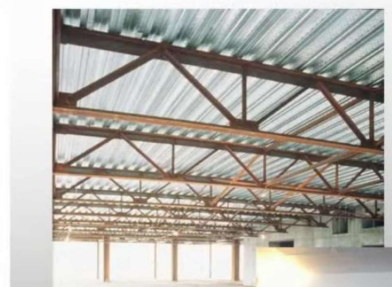


(d) Collar beam roof

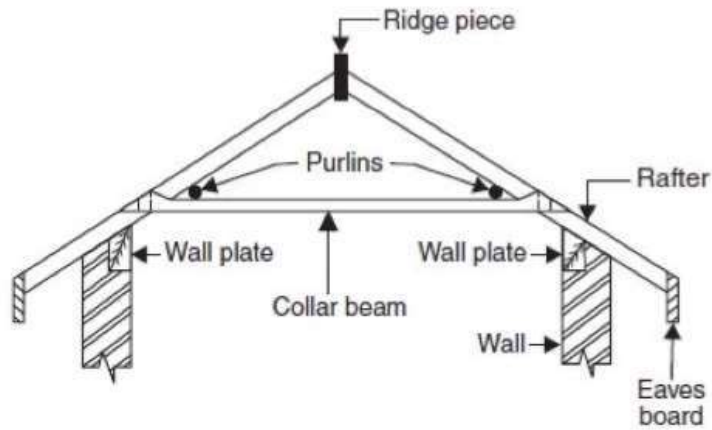
7. COMPOSITE ROOF TRUSSES



(a) Composite king post truss

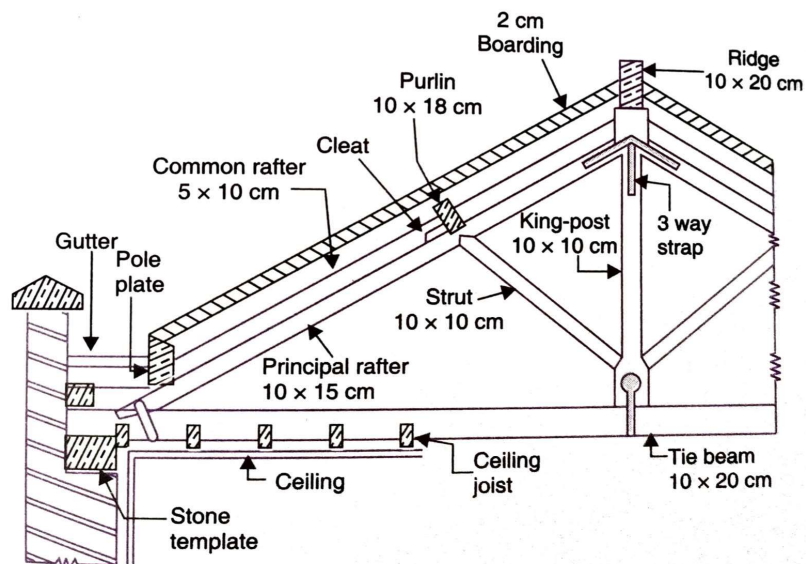


2. Double roof

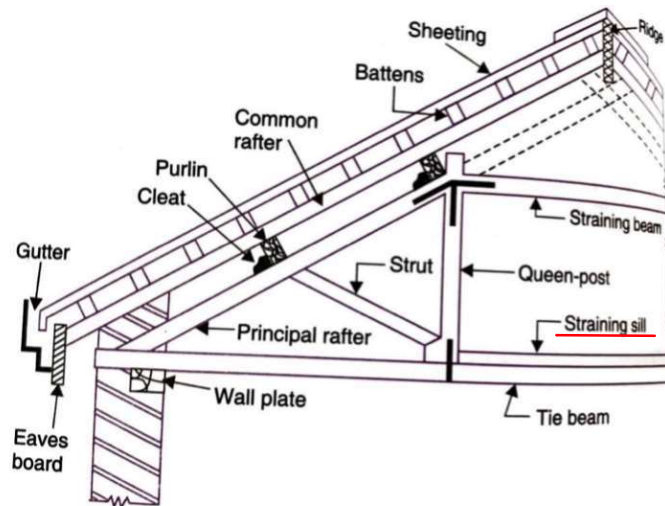


Double or purlins roofs

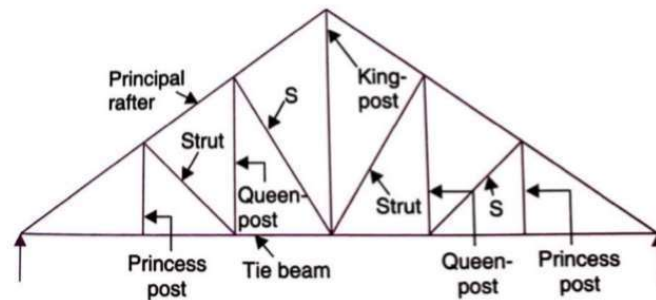
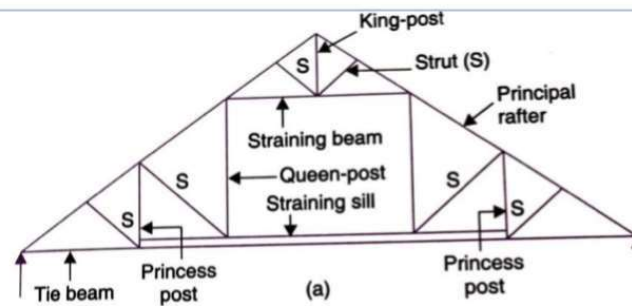
3. Truss roof



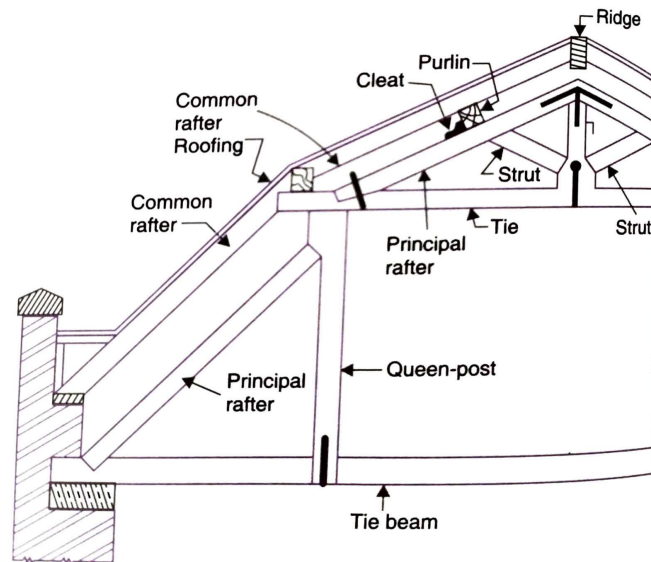
(i) King-Post truss (span 7m)



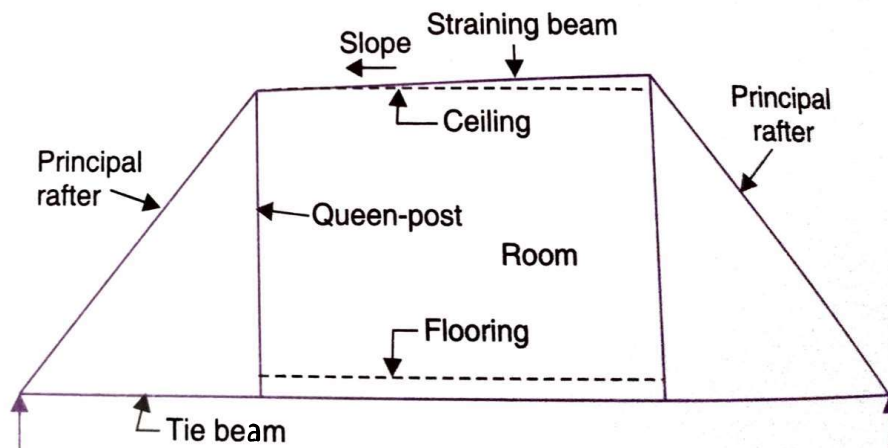
(ii) Queen-post truss



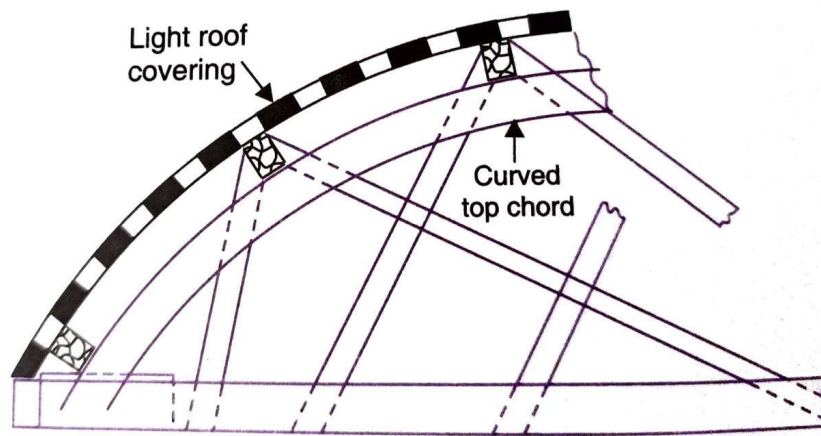
(iii) Combination of King-Post and Queen Post trusses.



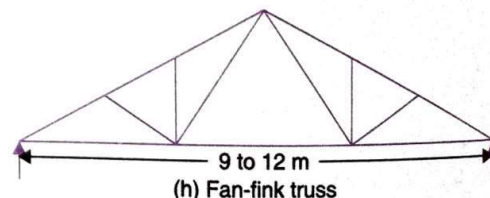
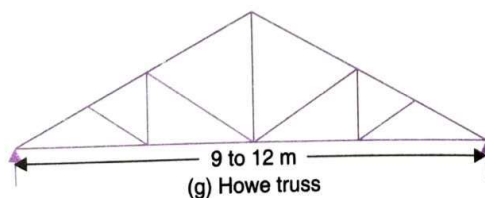
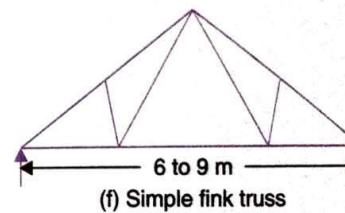
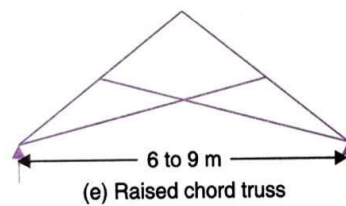
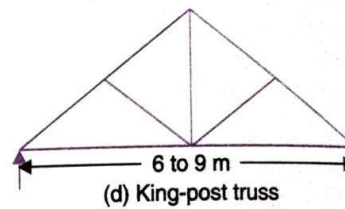
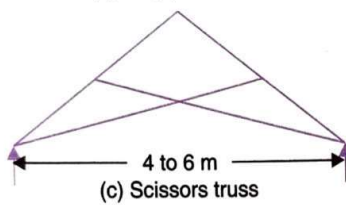
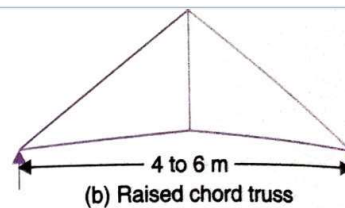
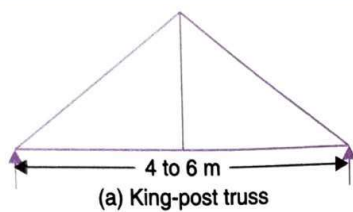
(iv) Mansard Truss



(v) Truncated Truss



(vi) Bel-Fast Truss



(vii) Steel Trusses



Roof covering materials for pitched roof

1. Thatch covering
made up of straw. (Dry grass)



2. Wood Shingle roofing
- Roofing with the help of wooden timber.
- Low fire resistance.

3. Tile roofing (made of clay) (curved/bending)
1. Plain or flat tiles. (camber of 5-10mm in between)



2. Curved or pan tiles.

flat longitudinal curve in transverse direction.

3. Half round country or pot tiles / spanish tiles are provided in pair have different radius at head and tail so the locking should be better.



4. Italian or Allahabad tiles

Bottom portion → flat, upper portion curved.

5. Interlocking tiles, Single Roman Interlocking

6. Double roman tile.

7. flat interlocking tile

8. Asbestos cement sheet.

9. Galvanised corrugated iron sheet
10. Slate Roofing
11. Light weight roofing metal roofing.
12. Pitch corrugated sheet.
13. Aluminium alloy and steel decking.



Flat roof :

It is horizontal roof only provided with a slope angle of $<10^\circ$ to drain out the water easily.

1. Mud Terrace Roofing

It is suitable where rainfall is less.

It can be provided over tiles or on wooden walls.

Punjab

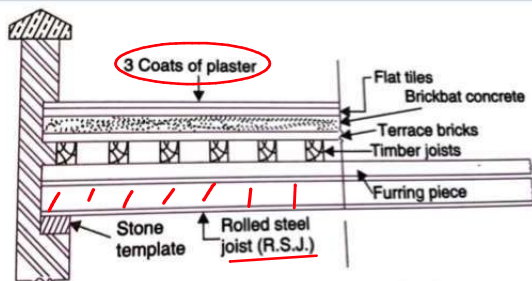
- It is popularly used in Maharashtra and MP.

2. Brick Jelly or Madras Terrace Roofing.

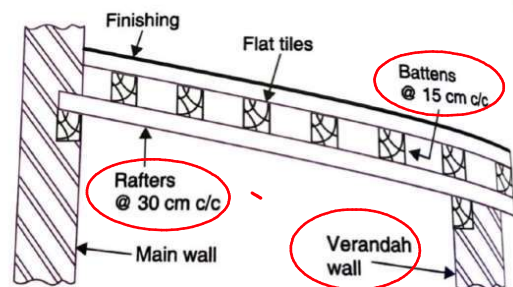
Wooden / RST $\rightarrow$ Wooden Rafters $\rightarrow$ Brick layer $\rightarrow$ Brick Jelly $\rightarrow$ 3 coat plaster.

3. Mud Phuska Terracing with tile Paving

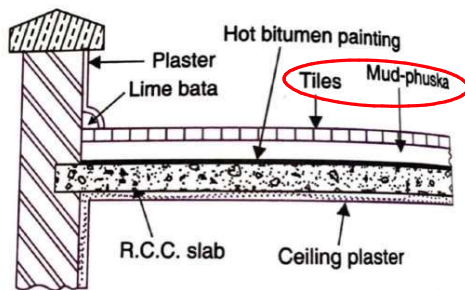
RCC Slab $\rightarrow$ Hot bitumen layer $\rightarrow$ Mud



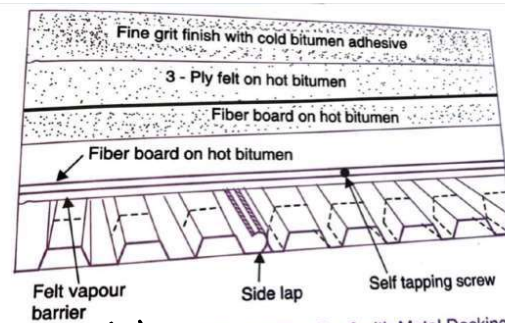
(i) Madras Terrace Roof



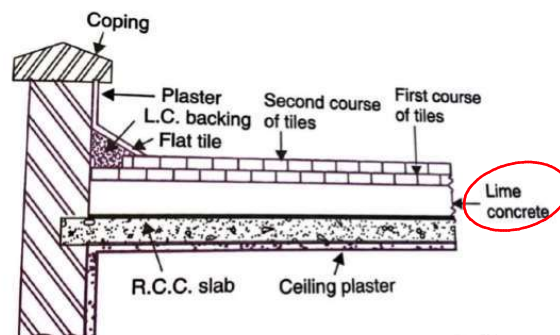
(ii) Bengal Terrace roofing



(iii) Mud-Phuska and Tile Terracing



(iv) Light Weight Flat Roof with Metal Decking



(v) Lime Concrete and Tiles Roofing



Phuska → A layer of suitable for hot and arid region and is provided over RCC slab.

4. Lime concrete Terracing.
Sulphur type

HOT Region

Jodhpur Type

5. Lime concrete Terracing with tiles.
RCC roof → concrete layer → tiles.

6. Bengal Terrace Roofing
Adopted for timber roof.

Wooden Rafter → Baffens in transverse direction → flat tile → finishing two lime plaster or cement plaster.

7. Light weight flat roof with metal decking.

Dead load decrease, supported over RCC or steel slab.



★ # Shoring

It is the construction of temporary structure to support the unsafe structure



temporary. It provide lateral support to the wall and is used in following condition.

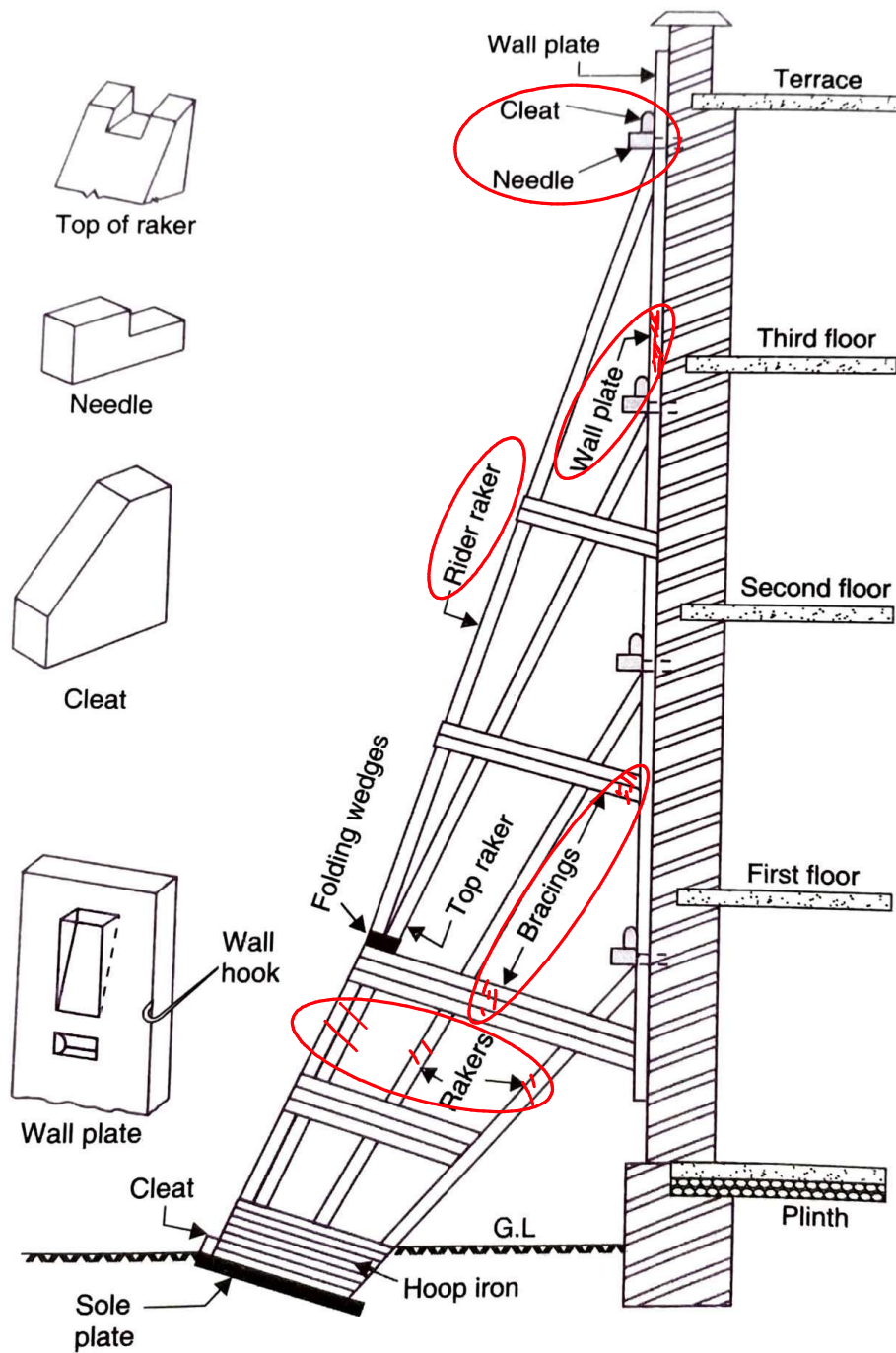
1. When wall shows sign of bulging due to poor workmanship.
2. When cracks develop due to unequal settlement of foundation.
3. When adjacent structure undergoes dismantling.
4. When opening are made or enlarge in the wall, shores may be of following types:

1. Raking Shoring

In this method consists of following member.

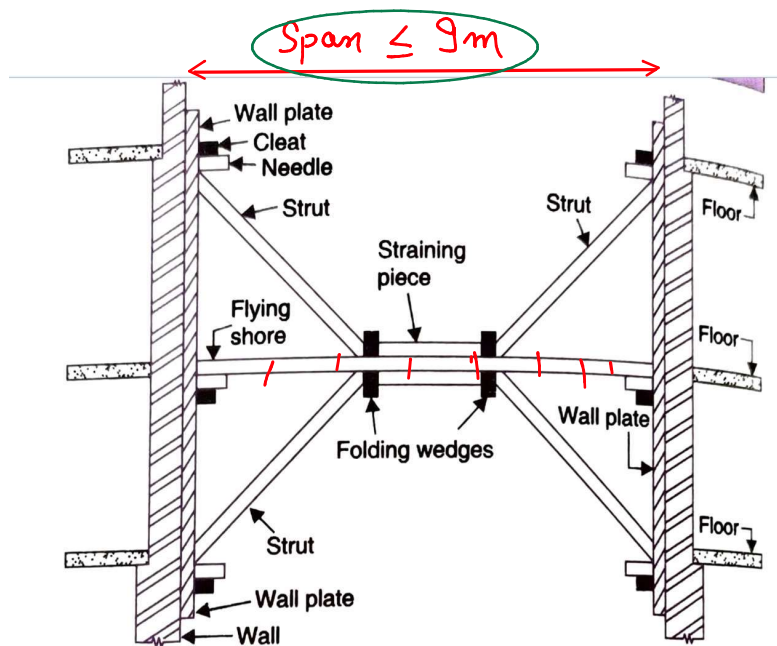
1. Raker $\rightarrow$ inclined member (to provide lateral support).
2. Wall plate
3. Needle.
4. Cleat
5. Bracing
6. Sole plate

Angle $45^\circ - 75^\circ$ between inclined member and ground surface.



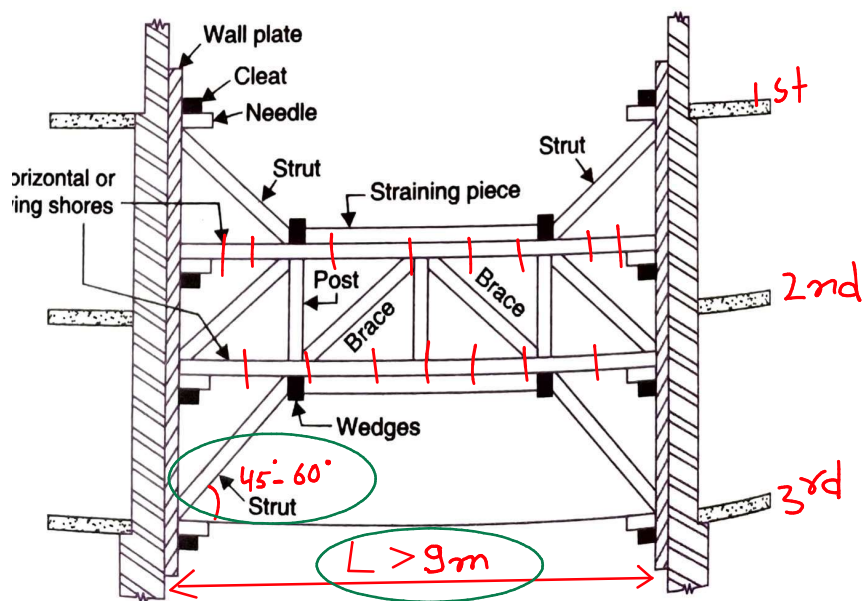
Raking Shore



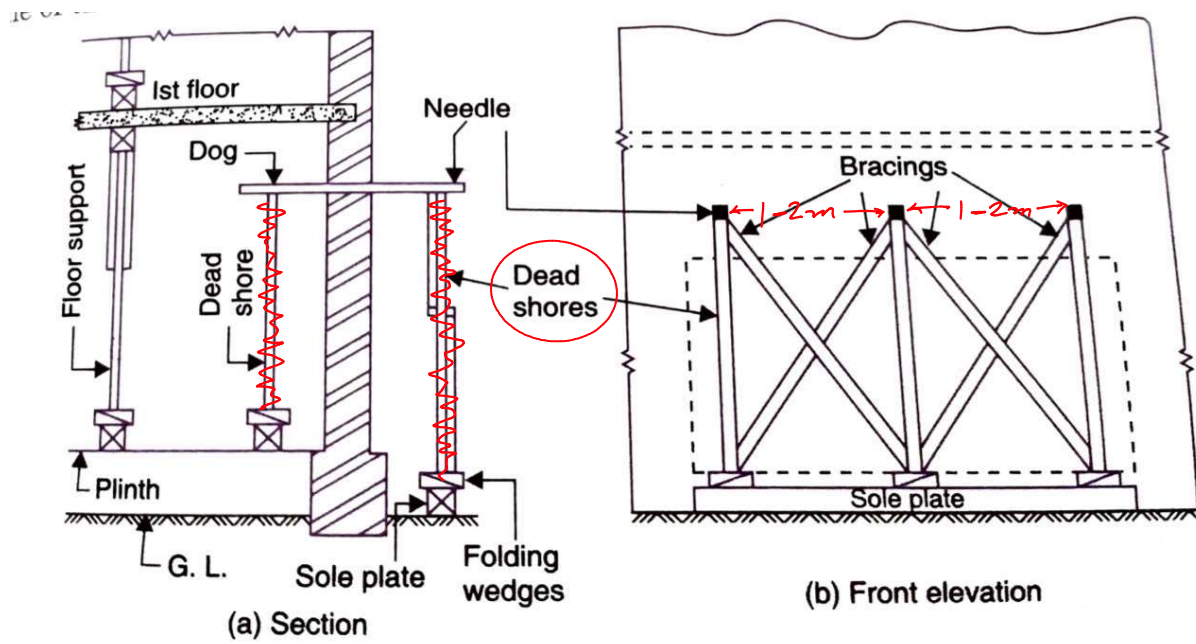


Single Flying Shore (Single member)

for,
Span $> 9m$



Double Flying Shore (Double members)



Dead shore (vertical shores)

Horizontal Members



2. Flying / Horizontal Shoring

In this method, horizontal temporary support is provided to two adjacent parallel party wall of the two building where the intermediate building is to be down and rebuilt.

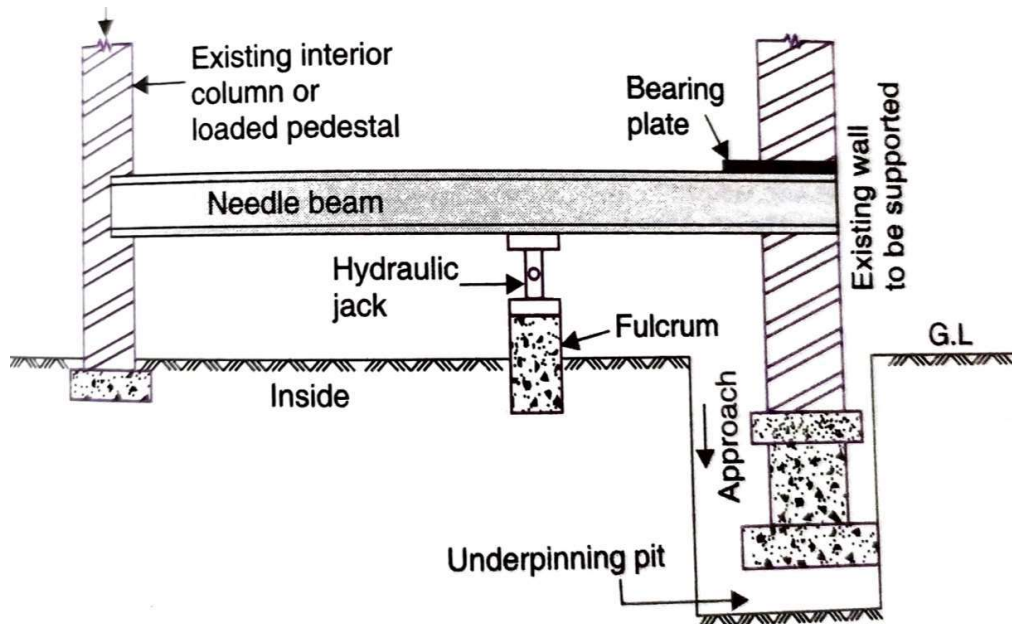
3. Dead or vertical shores

In this system, vertical support is provided to wall, roofs, floors etc when the lower part of a wall has to be removed for the purpose of providing an opening the wall.

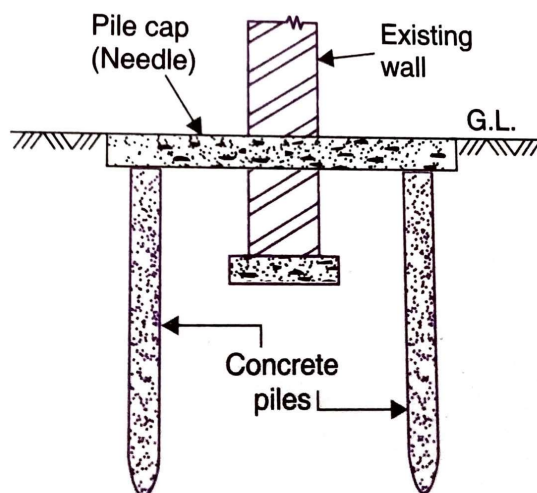


Underpinning

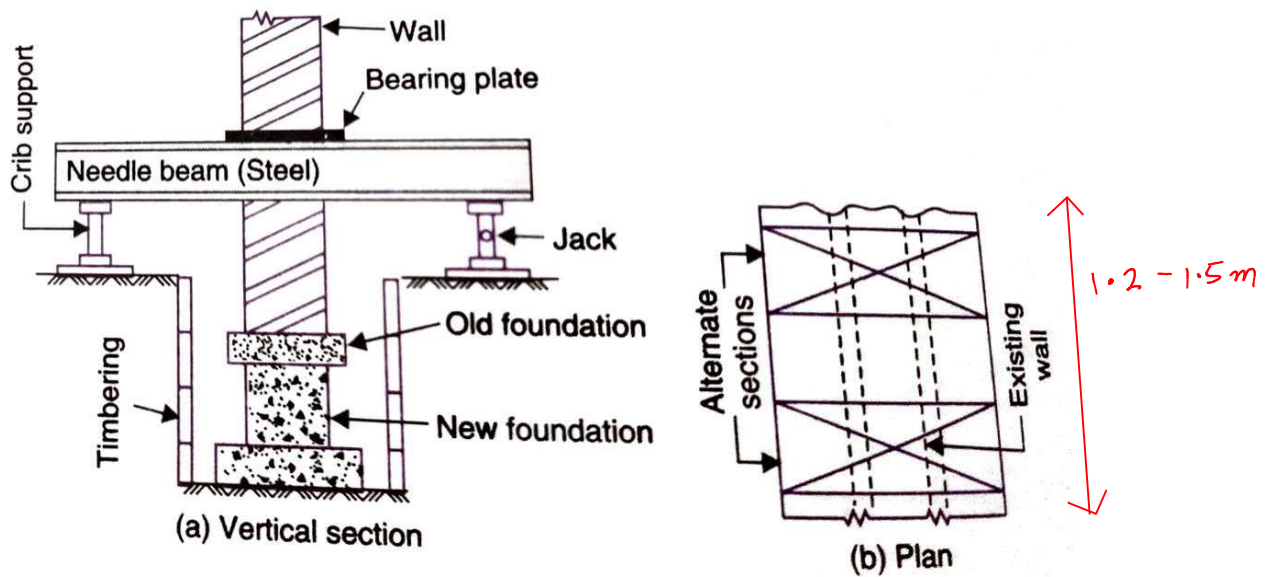
The process of constructing a new foundation below the existing foundation or strengthening the existing foundation is termed as underpinning.



(i) Pit Method with Cantilever Needle



(ii) Pile Method



(iii) Pit Method

The underpinning is required in following situation:

1. When a building with deep foundation

- i to be constructed to an existing building.
2. When the settlement of existing foundation has taken place, resulting in serious crack in the wall.
3. When a basement is to be provided to an existing building.
4. When the existing foundation are to be deepened so as to rest them on soil of higher bearing power.

— The underpinning may be carried out by the pit method or pile method or cantilever Needle method.

Scaffolding



Temporary structure to support the platform over which workman can sit and execute the construction work in case the height of wall or column is more than 1.5 m.

An ordinary scaffolding consists of standard, ledgers, putlogs, guardrail, toe board, braces.



Standard : These are vertical member which is supported on the ground, or embedded into the ground.

Ledgers : Horizontal member running parallel to the wall.

Braces : Diagonal component which support standards.

Putlog : Transverse member which are placed right angle to the wall to support ledgers.

One end is embedded into wall and other end is supported on the ledger.

To support Platform

Guard rail : Ledgers which is given for safety purpose to workmen.

Toe board : Parallel to the ledgers supported on putlog.
for protection of workman.



1. Single brick layer scaffolding
Widely used for brick work, some time also known as Putlog scaffolding.

2. Double or Manson scaffolding
Stronger than single scaffolding.
Used for stone masonry.
Some time known as independent scaffolding.

3. Cantilever or needle scaffolding
Used under following circumstances.

1. When the ground is weak to support the stand.
2. When the construction for the upper part of a multi-storeyed building is to be carried.
3. When the ordinary scaffolding will obstruct the traffic on road such as for a building the side of busy street.

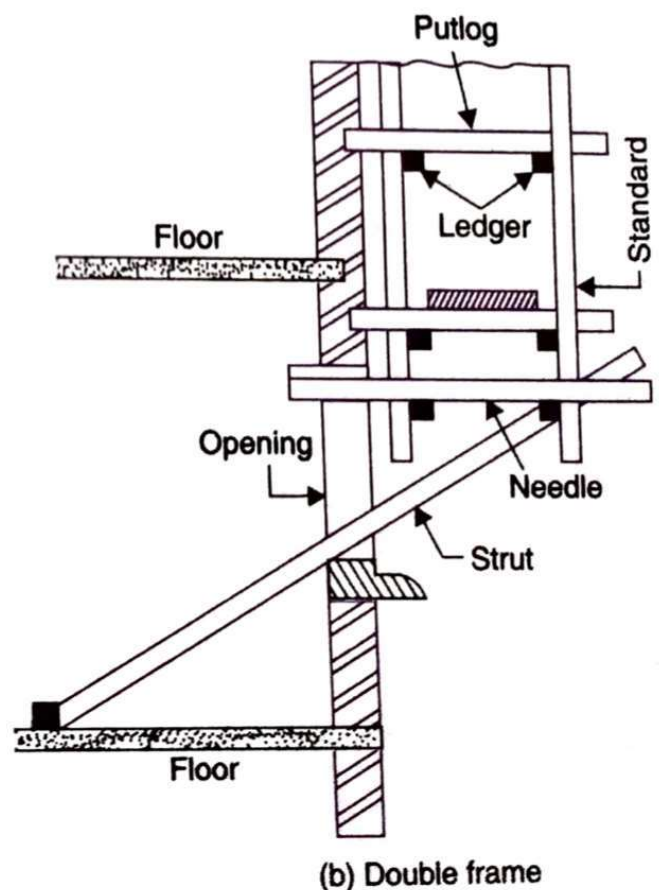
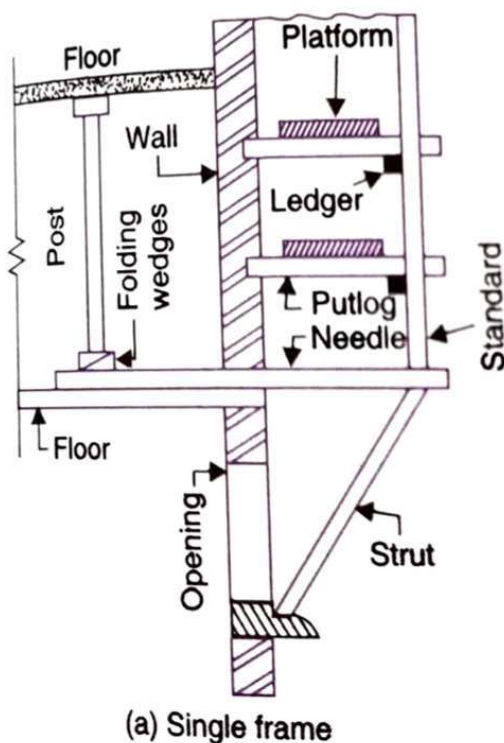
4. Suspended Scaffolding
This is a light weight scaffolding used for repair work such as painting, pointing, white washing distemping etc.



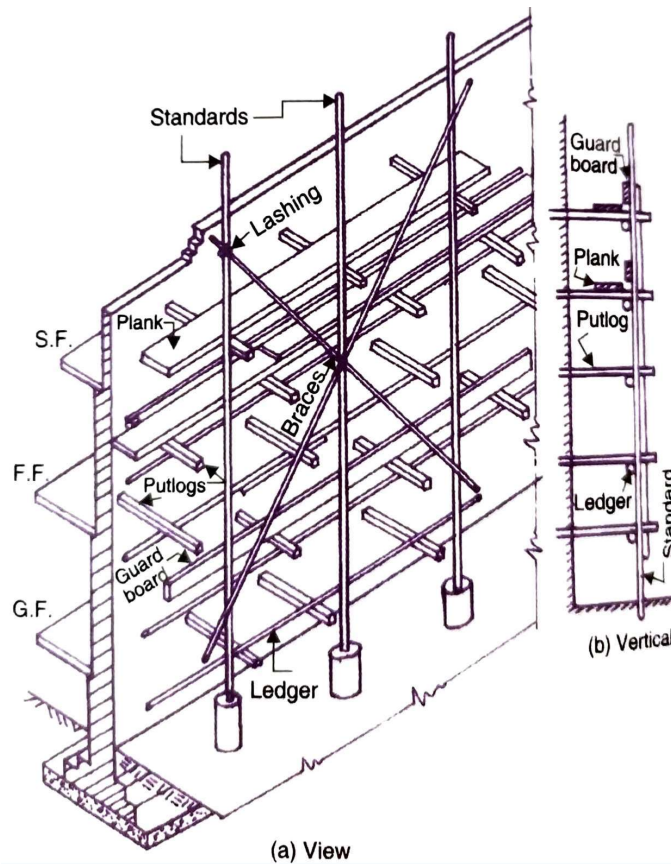
The working platform is suspended from the roof by means of wire ropes.

5. Trestle Scaffolding

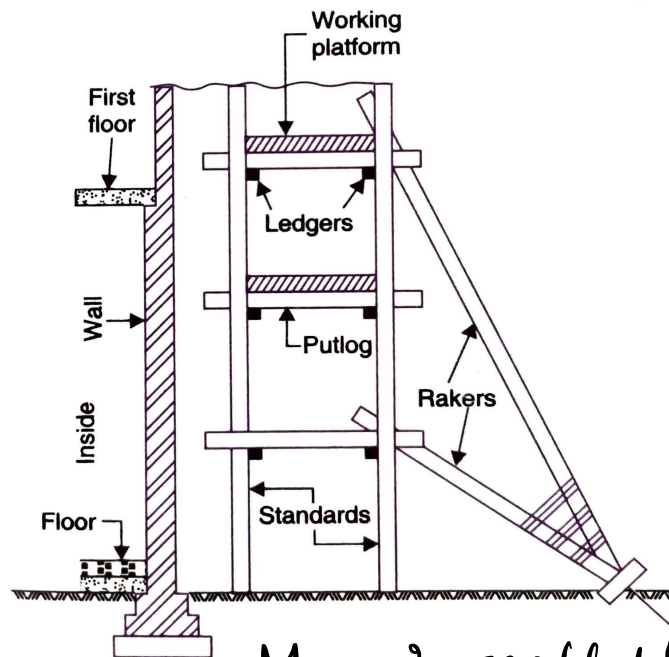
This type of scaffolding is used for painting and repair works inside the room upto a height of 5 m.



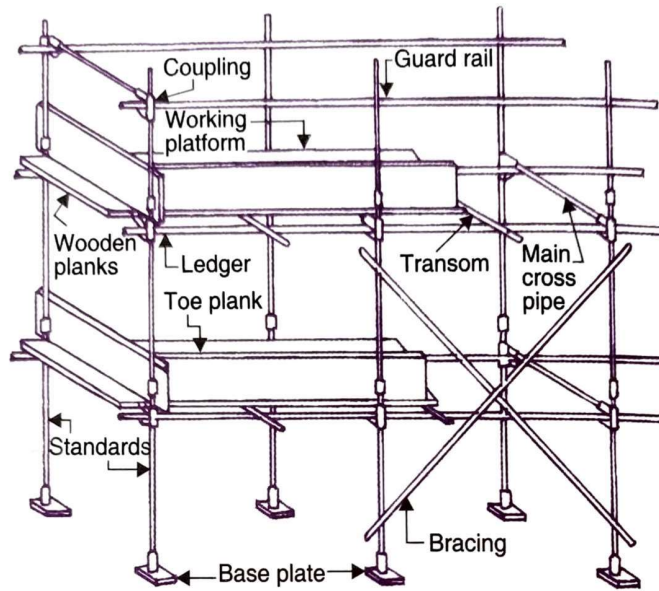
Needle Scaffolding



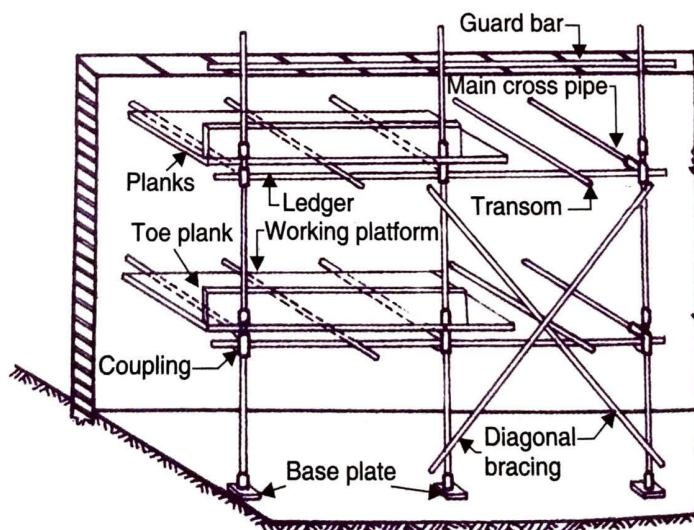
Brick layer Scaffolding



Mason's scaffolding



(a) For brick wall (Single frame type)



(b) For stone wall (Double frame type)

Steel Scaffolding



GROUND FLOORS

The purpose of floor is to provide level surface capable of supporting the occupants, furniture, equipment and partition walls.

- The floor must satisfy following property
 - a) Adequate strength and stability
 - b) fire resistance.
 - c) Damp resistance.
 - d) Thermal insulation.
 - e) Sound insulation.
- The floor resting on ground is termed as ground floor and rest all the floor for upper storey are termed as upper floor.

Components of floor .

1. Sub floor or base course (floor base)
2. Floor covering or flooring.

- The floors supported directly on the



ground are known as solid floor and the floors provided above the ground level are termed as suspended floors.

- Material use for floor base is cement cct, lime cct, stones, bricks, timber.

Solid ground floor.

Earth properly compacted → PPC → Lime concrete or cement concrete → floor finishing.

- The second layer provided above the base course is termed as flooring which may be of following type
 - a) Mud and Murram.
 - b) Brick
 - c) flag stones
 - d) Concrete
 - e) Terrazzo
 - f) Mosaic
 - g) Tile, marble
 - h) Glass flooring.
 - i) Rubber and Asphalt flooring.
 - j) Plastic



k) Wood.

Selection of flooring material

It is done on the basis of following.

- Initial cost, appearance, cleanliness, durability, damp resistance, sound insulation, thermal insulation, fire resistance, smoothness and hardness, maintenance.

Flag stone → any laminated sand stone.

Generally used in paving.

Terrazzo flooring :

very decorative, widely used in residential building.

Specially prepared cct surface with white cement (1:2).

Mosaic flooring

Made up of small pieces of broken tile which is made up of china clay.

It is also layed on cct surface (3 to 8 mm)



Asphalt flooring

1. Asphalt Mastic flooring.
Sand + Asphalt $\rightarrow$ 2:1.
2. Asphaltic Tiles flooring.
3. Asphaltic mosaic.
4. Acid proof mastic flooring.

Rubber flooring.

Linoleum flooring (Covering)

Available in rolls.

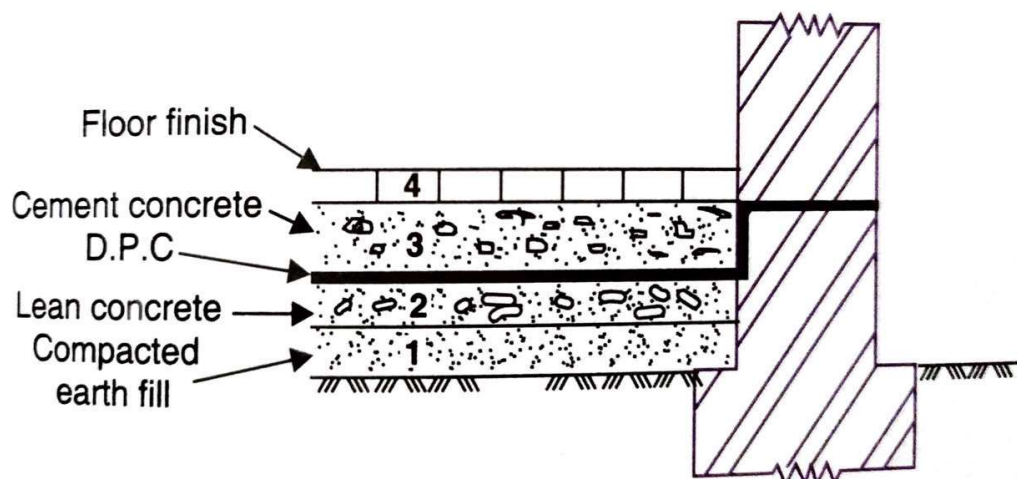
Linseed oil + Resin + Pigment + Wood floor
 $\rightarrow$ Linoleum.

Cork flooring

Perfectly noiseless.

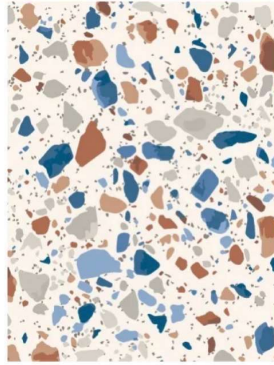
Used in lab, bread cutting department.

Granules of cork + linseed oil $\rightarrow$ Cork.





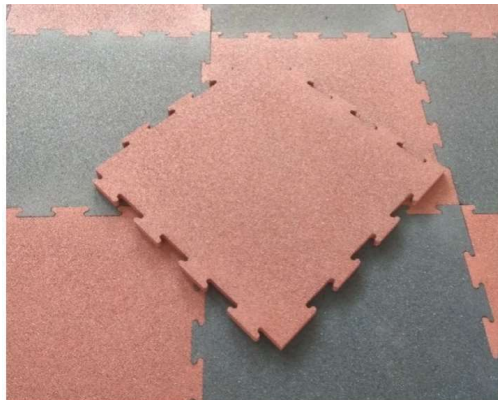
(i) Terrazzo Flooring



(ii) Mosaic
Flooring



(iii) Asphalt Flooring



(iv) Rubber Flooring



(v) Linoleum Flooring



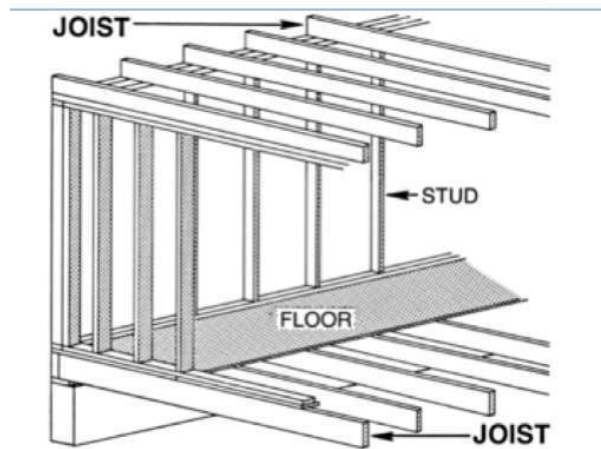
(vi) Cork Flooring



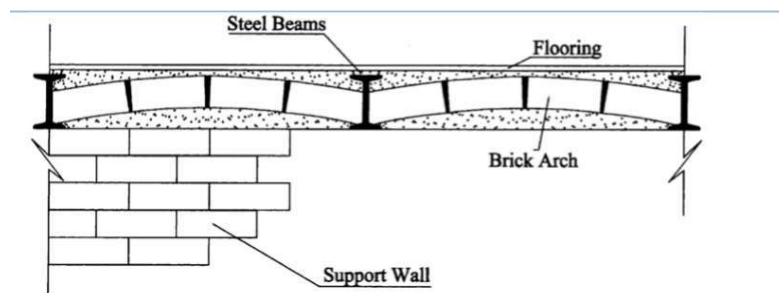
UPPER FLOORS

Introduction.

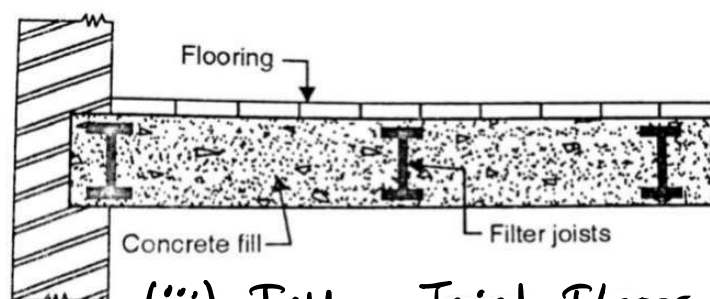
- An upper floor is basically a principal structural element, and the general structural design of a building will greatly influence the choice of the type of floor.
The structural design of upper floors has to be such as to support the loads set up by the use of the building.
- Depending upon the materials used for construction, and upon the arrangement of beams, girders etc, for supporting the flooring, upper floors may be classified into the following types:
 1. Steel joist and stone or precast concrete floors.
 2. Jack arch floors.
 3. Reinforced cement concrete floors.
 4. Ribbed or hollow tiled flooring.
 5. Filler joist floors.
 6. Precast concrete floors.



(i) Steel Joist Floor



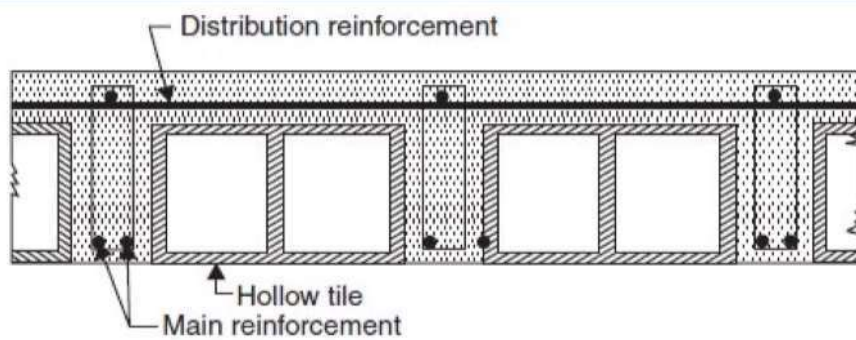
(ii) Jack Arch Floor



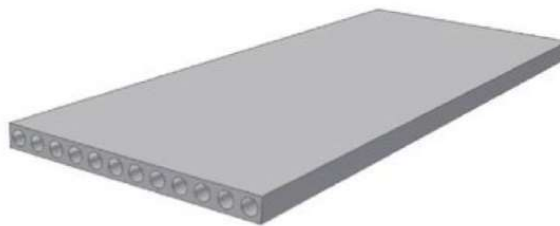
(iii) Filler Joist Floor



(iv) Timber Floor



(v) Ribbed or Hollow tile
Flooring



(vi) Hollow Core Precast
floor panels



7. Timber floors.

Steel joist and stone or precast concrete slab floors.

- This type of floor is quite common in locations where flag-stones or stone slabs are readily available in spans of 1 to 3 m and widths 30 to 60 cm. Where stone slabs are not available, precast concrete slabs can be used.
- The slabs are placed at the lower flange of rolled steel joists (R.S.J), specially where plain ceiling is required, though in case the bearing to the slabs is small. Otherwise, the slabs can be supported on the upper flange of R.S.J by inserting wide stone bedding plate, called suboti between the flange and the slab.
- When the slabs are placed on the lower flange of joists, the space between the top of the slab and top of R.S.J is filled with lime concrete or light weight cement concrete



after encasing the steel joists completely in cement concrete so that they do not get rusted.

Jack Arch floors

Jack arch is an arch of either brick or concrete, supported on lower flange of mild steel joists (R.S.J). The joists are spaced 1 to 1.5 m centre to centre, and are supported at their ends either on the walls or on longitudinal girders.

- The rise of the arch is kept equal to $\frac{1}{12}$ th of the span. The minimum depth of concrete at the crown is kept equal to 15 cm. Since the superimposed load is being borne by arch action, tension is developed on the supporting walls, specially at the end span.

Reinforced Cement Concrete floors

Floors of modern buildings are invariably made of reinforced cement concrete (R.C.C),



because of the inherent advantages of this type of construction. Concrete, though strong in compression is weak in tension. However, it is suitably reinforced with the help of steel bars which take the entire bending tension. Due to this, the overall thickness of R.C.C floors is comparatively small, thereby reducing the self weight of floor itself. R.C.C floors are also comparatively fire proof and damp proof.

- The method of construction is also easy except that centering is required. These floors can also be used on large spans, and therefore, more suitable for big size rooms, halls etc.
- R.C.C floors can be classified into the following types :
 1. Simple slab flooring
 2. Reinforced brick flooring
 3. Beam slab flooring.
 4. Flat slab flooring.
 5. Ribbed flooring or hollow tiled flooring.



Ribbed or Hollow tiled flooring.

Concrete is incapable of resisting tension which is caused in the lower part of the thickness of the slab. This lower part does not partake in load bearing, and hence part of it can be replaced by hollow tiles so that weight of the slab is reduced. Unlike T-beam construction, the ribs of hollow tile construction are closely spaced. The clear spacing of ribs depends upon the size of hollow blocks available, but it should normally not exceed 50 cm. The width of ribs may vary between 6 to 10 cm. The span of ribs may be as much as 7 m. However, when the span exceeds 3 m, lateral ribs of the same width as the main longitudinal ones are provided at intervals between 1 to 3 metres. In that case, longitudinal ribs are designed as continuous beams. Main reinforcement is provided at the bottom of the rib. To resist the support moment (negative) an additional bar is placed at the top of the rib section. A minimum cover of 2.5 cm is provided. The depth of rib is calculated on the basis of bending moment as well as the



cost ratio of steel and concrete. Depth of rib is usually kept as at least $L/20$ with free support and at least $\frac{L}{25}$ with fixed support, where L is the span of the ribs.

Filler Joists floors

This is a typical type of composite construction in which R.S.J of small sections are placed in concrete.

The spacing of the joists may vary between 40 to 90 cm. The filler joists may either rest on walls (if the span is less) or on longitudinal steel beams.

The joists act as reinforcement, and no separate reinforcement is provided in the concrete filled in between the joists. Concrete should completely surround the filler joists and steel beams, with a minimum cover of 2.5 cm over filler joists.



Precast Concrete floors

With the modern developments in construction technology, precast beam slab units are now available with the help of which the floors can be constructed easily and expeditiously, without the aid of any form work.

- These precast units are available in about 25 cm width, various depths, and various spans, and can be supported either on walls or on rolled steel joists. The sides of each unit are provided with grooves to form connecting joggles for adjacent units. The joints are grouted with cement mortar, using concrete guns.
- Such floors are economical, light weight, sound proof, fire proof, and economical.

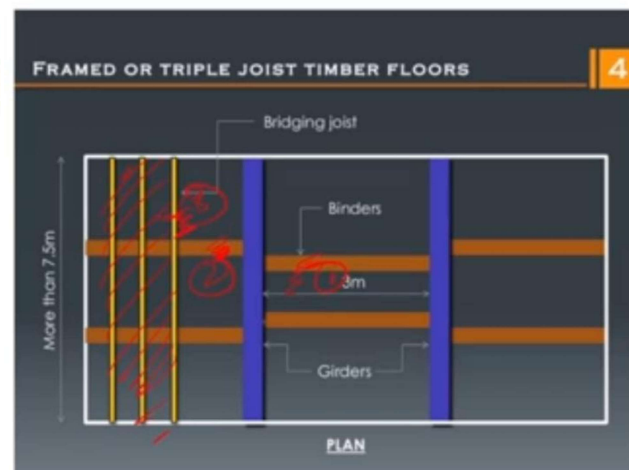
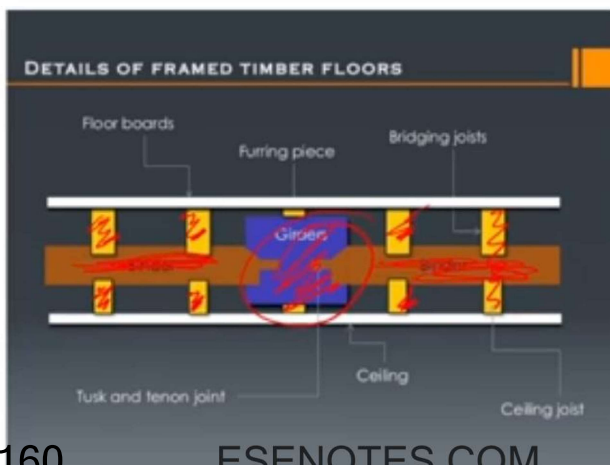
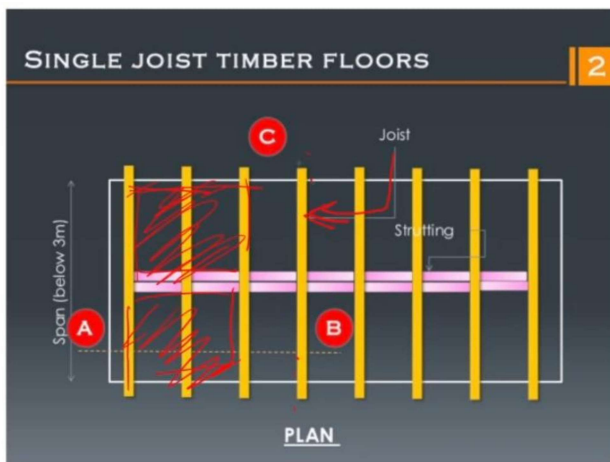
Timber floors.

- Timber floors, though quite light in weight,



have poor fire resistance and sound insulation properties.

- They are quite costly, except at those location where local timber is cheaply available.
- It is also highly vulnerable to termite attack.
- Timber floors are basically of three types:
 1. Single joist timber floors. (3-4m)
 2. Double joists timber floors. (3.5-7.5m)
 3. framed or triple joist timber floors.



Type of Building

* Buildings are classified in groups :-

- Group A = Residential Building
- Group B = Educational Building
- Group C = Institutional Building
- Group D = Assembly Building
- Group E = Business Building
- Group F = Mercantile Building
- Group G = Industrial Building
- Group H = Storage Building
- Group I = Hazardous Building

① Residential Building :-

↳ ऐसी Building जिसमें रहने के साथ-साथ खाने की व्यवस्था की गई हो।

Ex:- Hotel, Apartment, flats, Villas, hostel.

② Educational Building :-

Ex:- School, college, library, university.

③ Institutional Building :-

↳ ऐसी Building जिसका use medical, health, physical, Mental संरक्षक संस्थान, सजा देने वाली structure (Penal) etc

ex: Hospital, penal

④ Assembly Building :-

↳ ऐसी building जहाँ पर public किसी मनोरंजन के उद्देश्य से, धार्मिक आस्था के लिए एकत्रित होते हैं।

Ex:- मंदिर, मस्जिद, चर्च, गुरुद्वारे, cinema

⑤ Business Building :-

Ex:- Beauty parlour,

Bank,

Barbar shop

⑥ Mercantile Building

Ex:- Shop,

Showroom.

⑦ Industrial Building :-
↳ material production,
Ex :- Factory, gas plant, etc.

⑧ Storage Building :-
Ex :- cold storage, ware house

⑨ Hazardous Buildings :-
↳ जहाँ पर वास्नद, acid से सब रखे जाते है।

Q:10 — are provided as a protective coatings to wall at its top to prevent seepage of water.

→ Coping.

Q:11 For plastering the exposed brick walls, the cement sand mortar ratio should be

→ 1:4

Brick masonry = 1:6

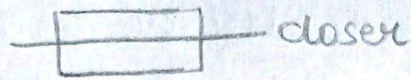
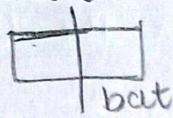
Plastering = 1:4

Grouting = 1:1.5

Gunting = 1:3

Q:1 The portion of a brick cut across the width of is called

→ Bat



Q:2 An external corner in brick masonry is called

→ Guein

Q:3 A bull Nose brick is not used for
→ Rounding off sharp corners, pillars, Decoration purpose.

✓ d) Arches

Q:4 Minimum thickness of wall where single flemish bond can be used is ?

→ One and half brick thick

Q:5 As per IS, for a load bearing brick masonry wall built in cement mortar, the maximum permissible slenderness ratio is :

→ 27 IS 1905; Table 7

Q:6 A queen closer is

→ Longitudinally $\frac{1}{2}$ brick

Q:7 King closers are related to
→ Brick masonry.

Q:8 Dutch bond is a modification of
→ English bond.

Q:9 The ornamental moulded course placed on the top of a wall is called

→ Cornice

- AC sheet बनाने के लिए cement के साथ 15% Asbestos mix करके बनायी जाती है।

Q:1 Queen post truss is suitable for span upto (span 8-12 m)
→ 12m

Q:2 The function of king post in a king post roof truss is.
→ To prevent the tie beam from sagging at its centre.



★★ Q:3 Name the short sections of wood or steel, which are fixed on principle rafter of trusses to support purlin.

→ Cleat Note: Cleat are small section of steel or timber fixed to the rafter of truss to support purlin from slip.

★★★ ग्रीपर Note:

- i) Principle rafter, purlin की support करती है।
- ii) Purlin, common rafter की support करती है।
- iii) Common rafter, wooden batten की support करती है।
- iv) Purlin की tilting की cleat angle होता है।

Q:4 The type of roof suitable in plains where rainfall is meagre and temperature is high.

→ Flat roof.

Q:5 The type of truss suitable for a span of about 3m.

→ King Post Truss

* Q:6 The function of cleats in a roof truss is
→ To prevent the purlins from tilting.

Q:7 The pitched roof which slopes in all the four directions is named as.

→ Hip roof

Q:8 Structural members ~~aka~~ of the truss which are supported on the principle rafter and which run transverse to the truss are called

→ Purlins ✓

Q:9 The pitched and sloping roofs are suitable for

→ Coastal regions

Q:10 The Queen post roof truss is suitable for

→ (a) 9 to 14 m (8-12 m) near to

(b) 5 to 9 m

(c) 14 to 18 m

(d) None of the above

Q:11 The moisture content of timber used in building frames can be.

→ 8% to 12%

Q:12 Slate and marble stone belongs to

→ Metamorphic rocks

Q:13 What is the equivalent strength of concrete for the mix ratio of 1:2:4?

→ M15

Q:14 To produce low heat cement, it is necessary to reduce the compound.

→ C₃S

(C₃A) Exam H₂
et tick ka

C_3A, C_3S $C_3A > C_3S$
(4-14%) (45-65)%
→ max^m heat amount
 $C_3A \downarrow$

Ex: Total heat of hydration
 $H = aA + bB + cC + dD$

$a, b, c, d \rightarrow$ proportion of bogue compound

$A, B, C, D \rightarrow$ heat of hydration of respective bogue compound

Ex: 100gm OPC

C_3A ↓ 10% 10gm	C_4AF ↓ 15% 15gm	C_3S ↓ 40% 40gm	C_2S ↓ 35% 35gm
----------------------------	-----------------------------	----------------------------	----------------------------

Total heat

$$H_{3\text{days}} = 10 \times 210 + 15 \times 70 + 40 \times 60 + 35 \times 10$$

$$= \textcircled{2100} + 1050 + \textcircled{2400} + 350$$

Q:15 The primary function of calcium sulphate (Gypsum $CaSO_4$) in the cement is to:

→ Increase the initial setting time of cement.

Q:16 An aggregate is said to be flaky if its least dimension is less than.

→ $3/5$ mean dimension.

Q:17 Temporary support provided to the structure which has become unsafe due to excessive differential settlement is called.

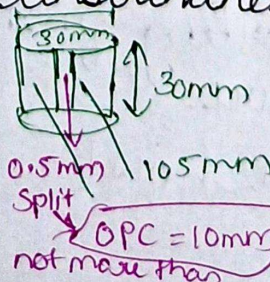
→ Shoring

Q:18 Identify the incorrect statement about soundness.

1) Autoclave test ^{increase pressure} is sensitive to unsoundness lime due to only magnesia - $25 \times 25 \times 282 \text{ mm}$ $P=21$

2) Le Chatelier tests unsoundness due to Only lime. ^{Pressure} 0.8%

→ Only 1 is incorrect



Q:19 A projecting stone which is usually provided to serve as support for roof truss, beam, weather shed etc is known as

→ Corbel

* String course :- It is a horizontal projecting course of masonry projecting out of the wall for shedding rainwater off the face.

* Coping :- It is a course placed upon the exposed top of an external wall to prevent the seepage of water.

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

* Corbel :- It is a projecting stone which is usually provided to serve as support for roof truss, beam, weather shed etc.

Q:20 The disease of dry rot in timber is caused by

→ Lack of ventilation.

Q:21 The commonly used lime in white washing is

→ Fat lime.

Q:22 Which of the following methods used in transporting fresh concrete in high rise structures?

→ Skip and hoist.

Q:22 Plasticizers and superplasticizers are used to.

- a) Reduce $\frac{w}{c}$ ratio
- b) Increase workability
- c) Increase strength
- d) All of the above

Q:23 CPM is the

→ activity oriented technique

Q:24 For proper workability of concrete, the water cement ratio varies from —

→ 0.4 to 0.6

Q:25 Which of the following aggregates gives max^m strength in concrete?

→ Cubical aggregate.

Q:26 The amount of water used in performing setting time test of cement is (assuming p - standard consistency of cement)

→ $0.85 P$

Q:27 As per Mohs scale of hardness, the hardness — moving from Quartz to gypsum.

→ decreases

#	Mineral	Scale number
	Talc	1
	Gypsum	(2)
	Calcite	3
	Fluorite	4
	Apatite	(5)
	Feldspar	6
	Quartz	(7)
	Topaz	8
	Corundum	9
	Diamond	(10)

Plastering and Pointing

- Plastering is the process of covering rough surface of walls, columns, ceiling and other structural components with thin coat of plastic mortar to form a smooth durable surface.
- Coating of this plastic mortar is called as plaster.

Objectives of Plaster:-

- i) To protect the external surface from weathering agencies.
- ii) To give smooth surface.
- iii) To give decorative effects.

Requirement of good Plaster:-

- i) It should be hard, durable,
- ii) It should possess good workability
- iii) It should be possible to apply it during all weather conditions.
- iv) It should be cheap.
- v) It should adhere to the background.

Types of Mortar used for plastering :-

① Lime Mortar :- lime used for plastering be either fat lime or hydraulic lime.

- However for lime preferred for plastering work.

- The mix proportion varies from $[1:3 - 1:4]$

↓
Fat lime.

$1:2 \rightarrow$ Hydraulic lime

② Cement Mortar :- Ratio varies from $1:4 - 1:6$

③ Lime Cement Mortar :- Ratio may be

$[1:1:8, 1:1:6, 1:2:8]$

Cement : Lime : Sand .

Note :- Cement lime mortar impart better plasticity resulting better smoothness of surface.

Terminology used in Plastering :-

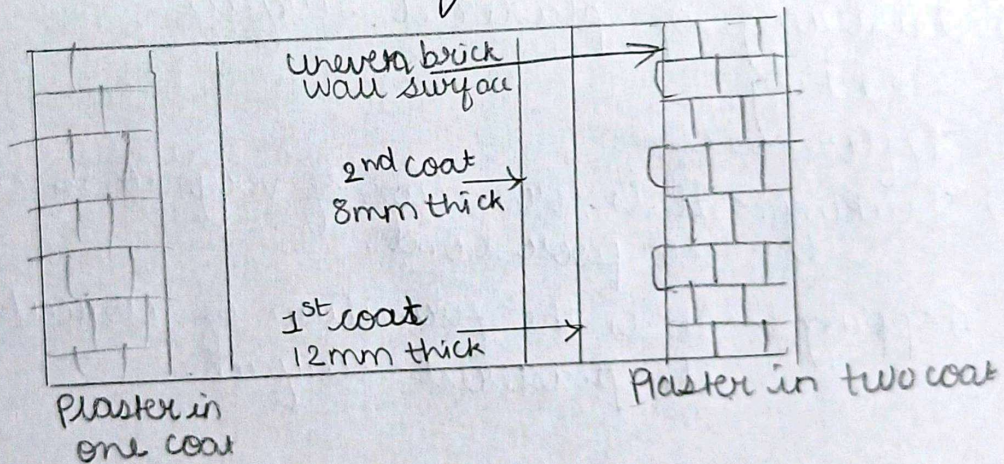
① Background :- It is the surface to which first coat of plastering is to be applied.

② Blistering :- This is development of local swelling on the finished plaster surface due to residual unslaked lime.

③ Cracking :- This is the development of one or more fissures (crack) in the plaster.

④ Dabbing coat :- This is the process of filling up hollow spaces in the solid background before applying plaster.

- ⑤ **Finishing coat** :- It is the final coat of plaster. It is also known as setting coat or skimming coat.
- ⑥ **Gauging** :- It is the process of mixing of various constituents of plaster.
- ⑦ **Grinning** :- It is the reflection or appearance on the surface of plaster of the pattern of joint or similar pattern on the background.
- ⑧ **Undercoats** :- These are coats of plaster under finishing coat.
- ⑨ **Hacking** :- The process of making the background rough to act as key of plastering is called hacking.



Special Material used in Plastering :-

Acoustic Plaster :- It contains gypsum applied on final coat.
— Sound insulation ★

Barium Plaster :- It is made up from cement, sand and barium sulphate and provided in x-ray room ★

Asbestos Marble Plaster :-

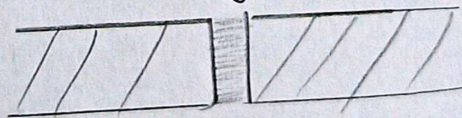
- This plaster is made of asbestos cement finely crushed marble.
- It gives marble like finish.

Defects in Plastering :-

- (i) Blistering of plastered surface.
- (ii) Cracking
- (iii) Efflorescence
- (iv) Flaking :- It is formation of very loose mass due to poor bond.
- (v) Popping :- It is the formation of conical holes in the plastered surface.

Pointing :-

The term pointing is applied on the finishing of mortar joint in masonry.



Ratio :- [1:2] [Lime : Sand]
[1:3] [Cement : Sand]

Difference between plastering and pointing

Plastering

- It covers the whole surface.
- It protects the whole surface from atmospheric effect
- Multiple coating may be applied.

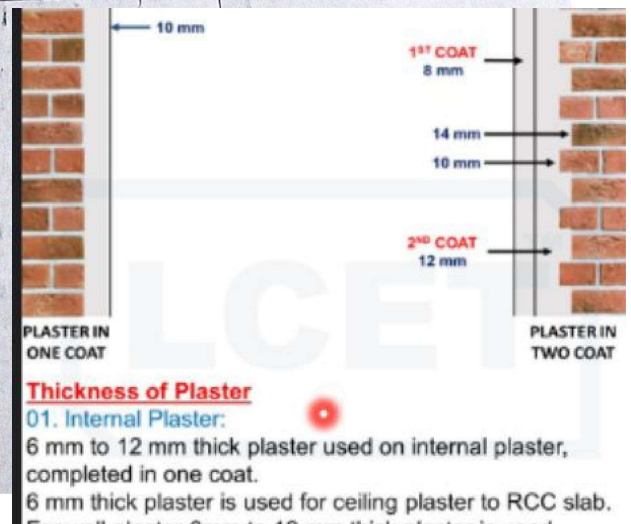
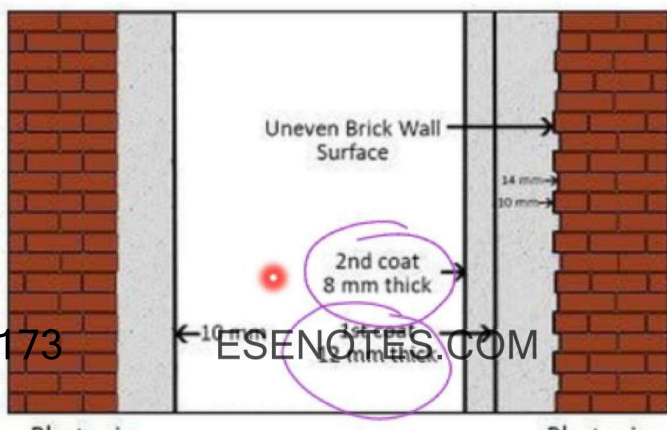
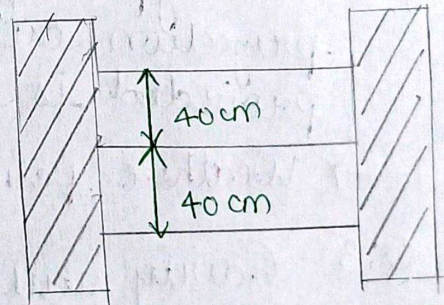
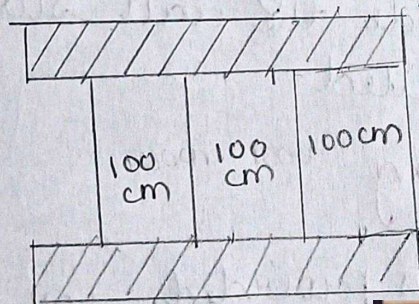
Pointing

- It covers only joints of bricks.
- It protects the brick mortar used in bonding bricks.
- Apply only a single coat.

Hollow walls :-

→ cavity material

- Hollow walls की minimum width या thickness 10cm से कम नहीं होनी चाहिए।
- Cavity walls को आपस में tie rod के द्वारा बाँधा जाता है। maximum horizontal distance 100cm (1m) से अधिक नहीं होनी चाहिए।
- दो tie rods की max^m vertical should not be more than 40cm (0.40m).



Cavity आरंभ (start) करने की location :-

- Flat roof वाले घरों में cavity DPC level के 15cm नीचे से start की जाती है। और parapet के top तक cavity रखी जाती है।
- Sloped roof वाले भवनों में cavity DPC level के 15cm नीचे से start करके eaves तक cavity रखी जाती है।

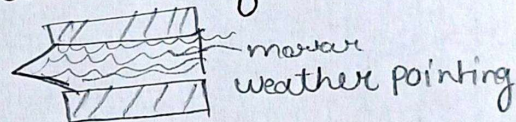
^{imp} # Advantage of cavity / hollow walls :-

- Sound proof
- Heat proof
- Damp proof.

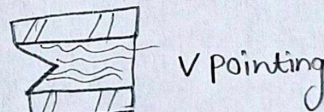
Q:1 The wall provided for dividing one room from another is known as —

→ Partition wall.

Q:2 The type of pointing in which V-sharped projection outside the wall surface is provided is called .



→ Weather pointing



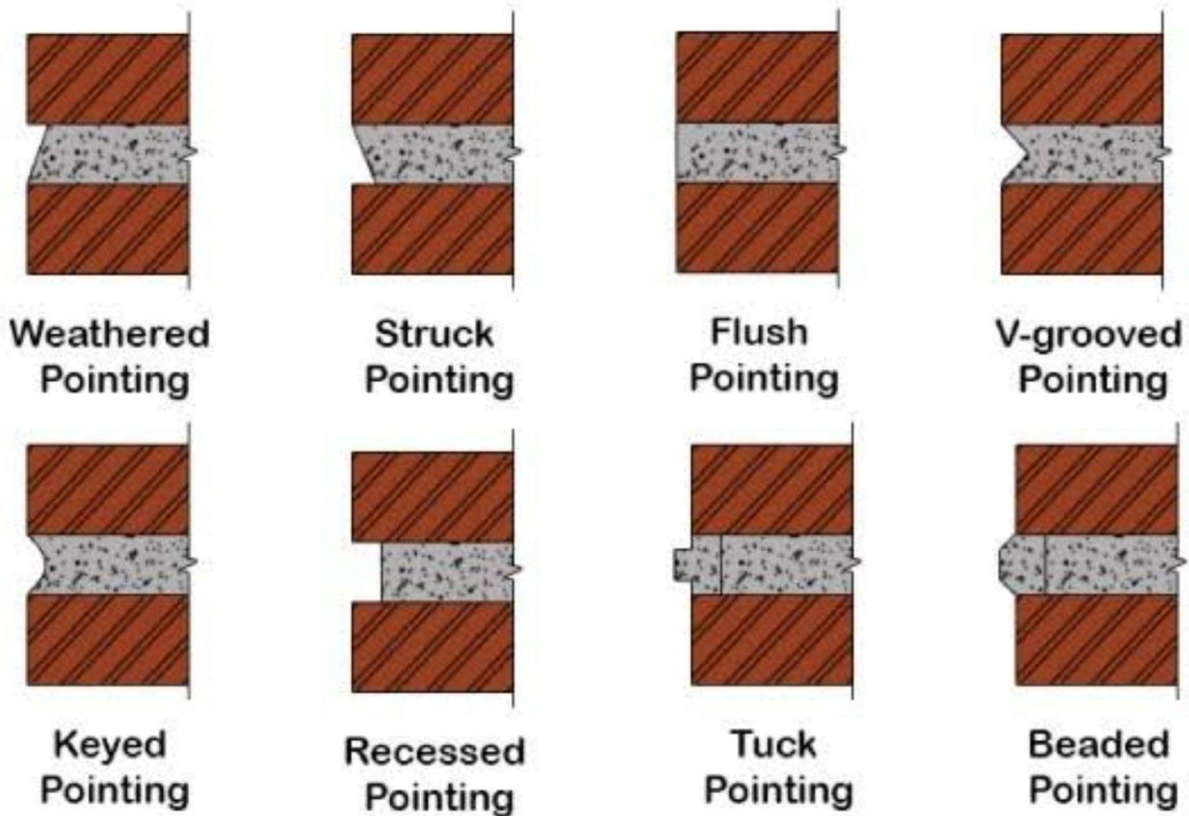
Q:3 Cavity wall is provided for

→ Sound insulation, Prevention of dampness, heat insulation → All of the above.

Q:4 The construction of a temporary structure req. to support an unsafe structure is called

→ Shoring

Types of Pointing



Q:5 Which of the following is done in case of building new work underneath the existing structure without disturbing its stability?

→ Underpinning

Q:6 which type of scaffolding is used for painting and repair works inside the room upto a height of 5 meters.

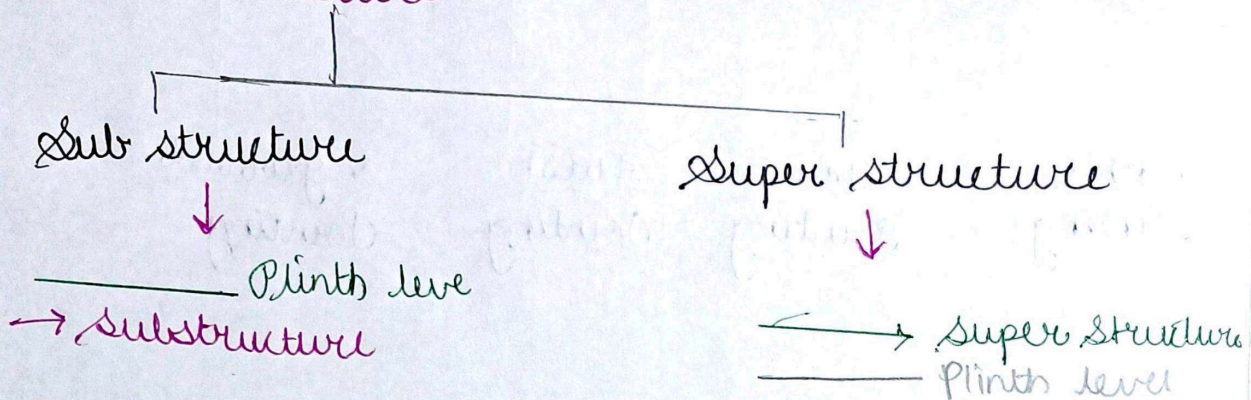
→ Trussle scaffolding

Q:7 — scaffold consist of ladder or tripod carrying a working platform

→ Trussle

Foundation

Structure

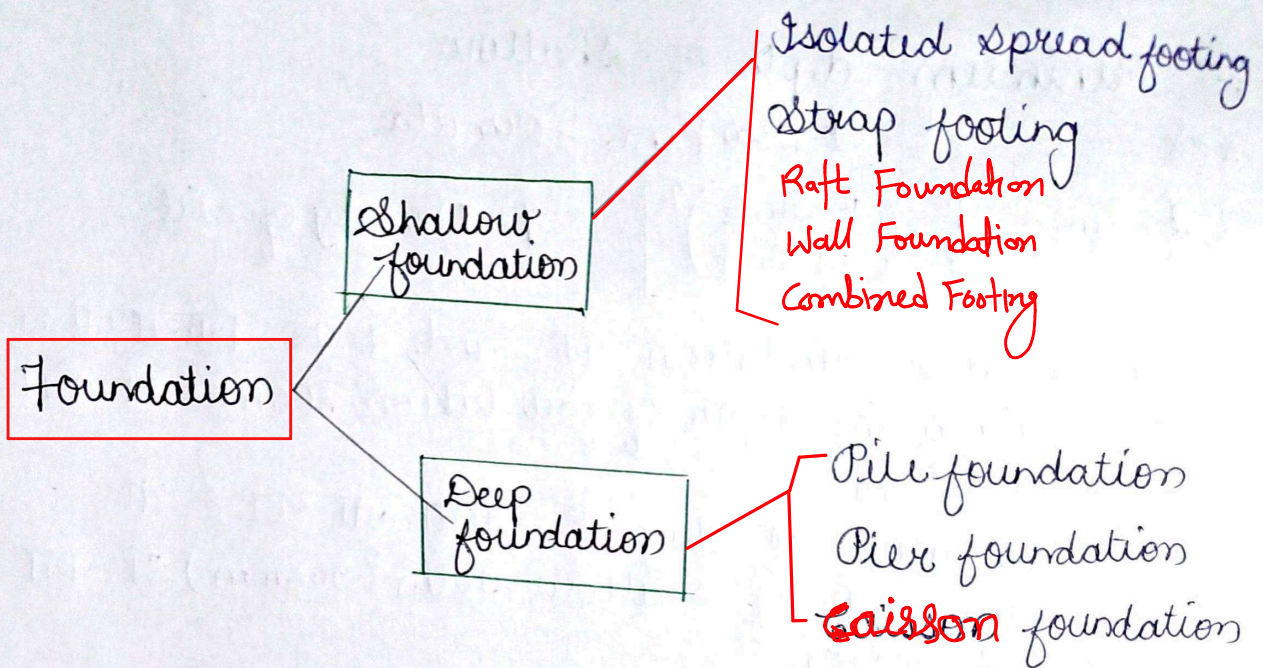


Maximum total and minimum differential settlement for different types soil and different types of foundation:~

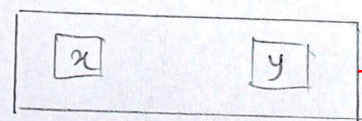
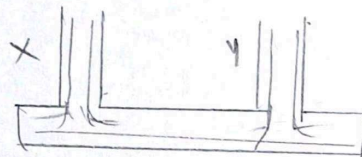
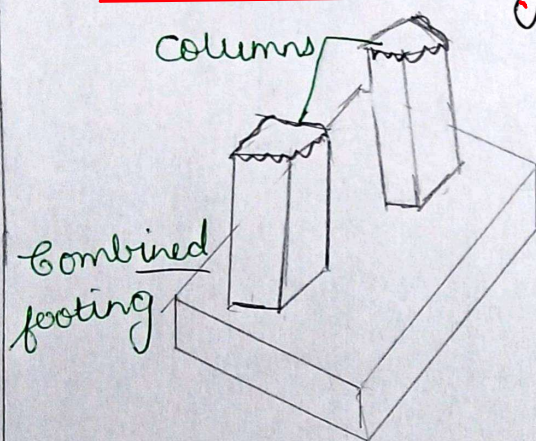
Type of soil	Max ^m Total settlement		Max ^m Differential settlement	
	Isolated footing	Raft or mat footing	Isolated footing	Raft or mat footing
Sand	40mm	40-65mm	25mm	25mm
Clay	65mm	65-100mm	40mm	40mm

Classification of foundation:~

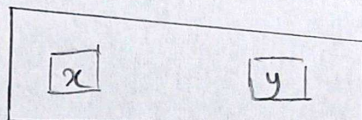
- Shallow foundation
($D \leq B$)
(Depth of foundation $\leq$ width)
- Deep foundation
($D > B$)



Combined Footing



→ Rectangular



→ Trapezoidal

combine footing
↓
shape

Rectangular

↓
दोनों column

पर Equal
Load Formation

Trapezoidal

↓
Unequal Load
Formation on
Both Columns

Minimum depth of shallow

→ Rankine formula

$$D_{\min} = \frac{P}{\gamma} \left(\frac{1 - \sin \phi}{1 + \sin \phi} \right)^2$$

γ = Density of soil

- यदि shallow foundation को sand पर बनाया जा रहा है तो minimum depth of foundation 800mm से कम नहीं होनी चाहिए।
- यदि foundation को clay पर बनाया जा रहा है तो minimum depth of shallow 90cm (900mm) से कम नहीं होना चाहिए।

Q1:- English bonds used in bricks is .

→ Very cheap

~~Costly~~
Economical

Q:2 The vertical member used in the door frame is called

→ Post

Q:3 Which of the stone masonry is the cheapest roughest and poorest form?

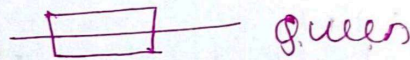
→ Dry rubble masonry.

Q:4 What is the portion of the brick without a triangular corner equal to half the width and half the length called?

→ King closer



King



Queen

Q:5 A roof which slopes in four directions is called.

→ Flipped roof

Q:6 Type of stone masonry without any mortar

→ Dry rubble masonry

Q:7 Which of the following flooring is commonly used in rural India, due to its easy construction and availability?

→ Mud flooring

*Q:8 The structure provided to support the weight of the walls above doors & window is.

→ Lintel.

Q:9 The window provided on the sloping roof of a building is called -

→ **Dormer window**

Q:10 — formwork is used when it is required for more no. of repetitions.

→ **Steel**

Q:11 Flight in a staircase is defined as the distance between.

→ **Two consecutive landings in a staircase.**

Q:12 — are provided as a protective coatings to walls as its top to prevent seepage of water.

→ **Coping.**

Q:13 What is a mullion in a window shutter?

→ **Vertical member running through shutter of window.**

Q:14 The common type of staircase in buildings with two consecutive 90° directions changes at mid landing slab level is: ~

→ **Dog legged staircase**

Q:15 For polishing mosaic floors we use

→ **Oxalic acid**