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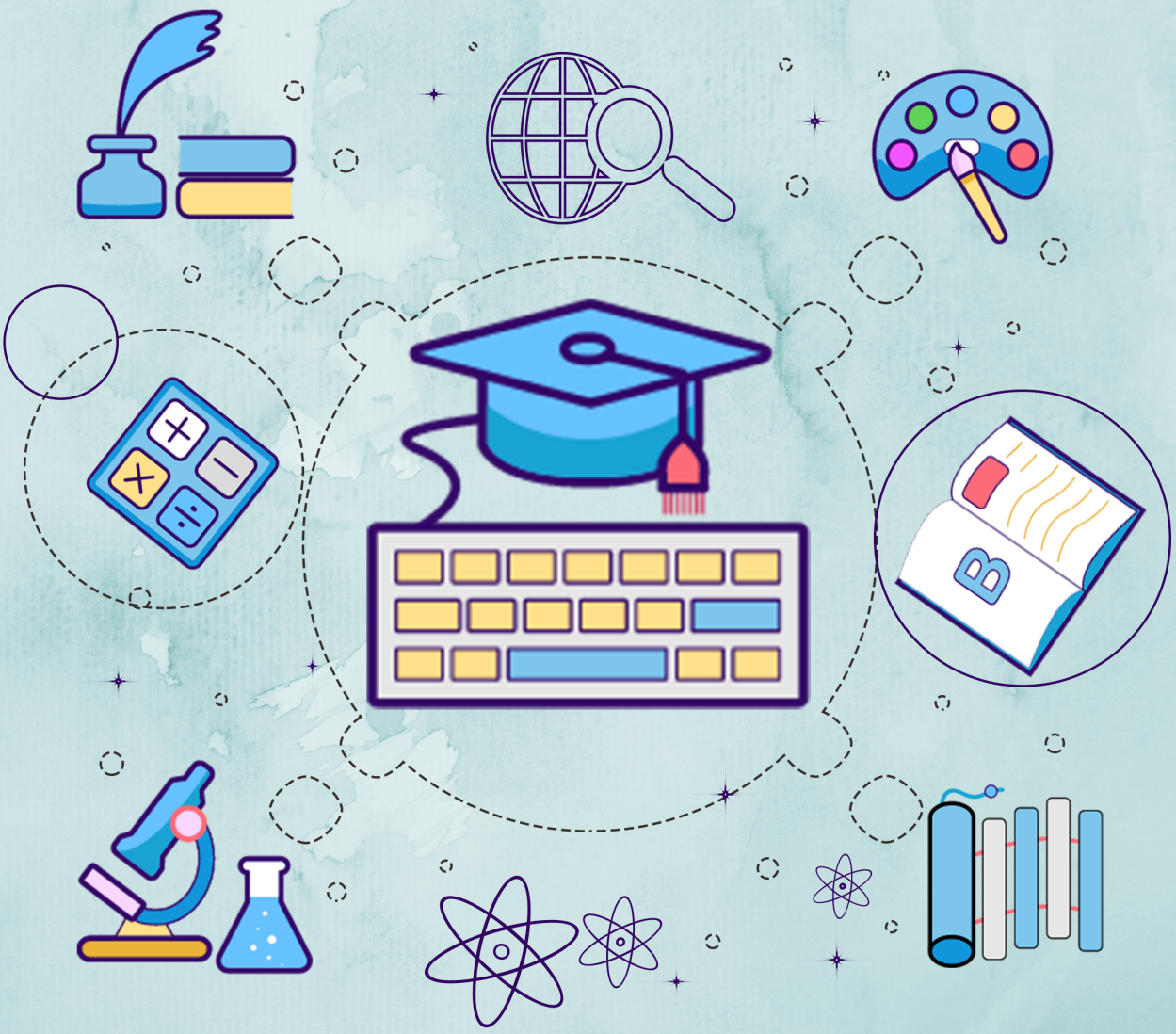

SYLLABUS | STUDY MATERIALS | TEXTBOOK

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BASICS OF CIVIL ENGINEERING

EST120

Module 3

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3/10/2019

BUILDING CONSTRUCTION

Foundation

- It is the part of a building constructed below ground level and which is in direct contact with sub-strata and transmits all the loads to the sub-soil.
- Also known as substructure.
- Foundation bed or foundation soil – soil ground on which the foundation rest.

Functions of Foundation

- It spread the load coming on it over a large area at uniform rate so that the pressure on the soil below the foundation does not exceed its allowable bearing capacity.
- Minimize chances of differential settlement.
- Provides stability against undermining or scouring by flood water or burrowing animals.
- Provides safety against sliding
- Provides a level surface for construction of super structure.
- Protection against soil movements.
- Even distribution of load.
- to give enough lateral stability to the

structures against various disturbing horizontal forces such as wind, rain, earthquake, etc.

Bearing Capacity:

Capacity of soil to support the loads applied to the ground without excessive settlement or failure.

Ultimate Bearing capacity/Gross bearing capacity:

The gross pressure intensity at which the soil fails is called Ultimate bearing capacity.

Safe Bearing capacity:

It is the maximum pressure which the soil can carry without the risk of shear failure.

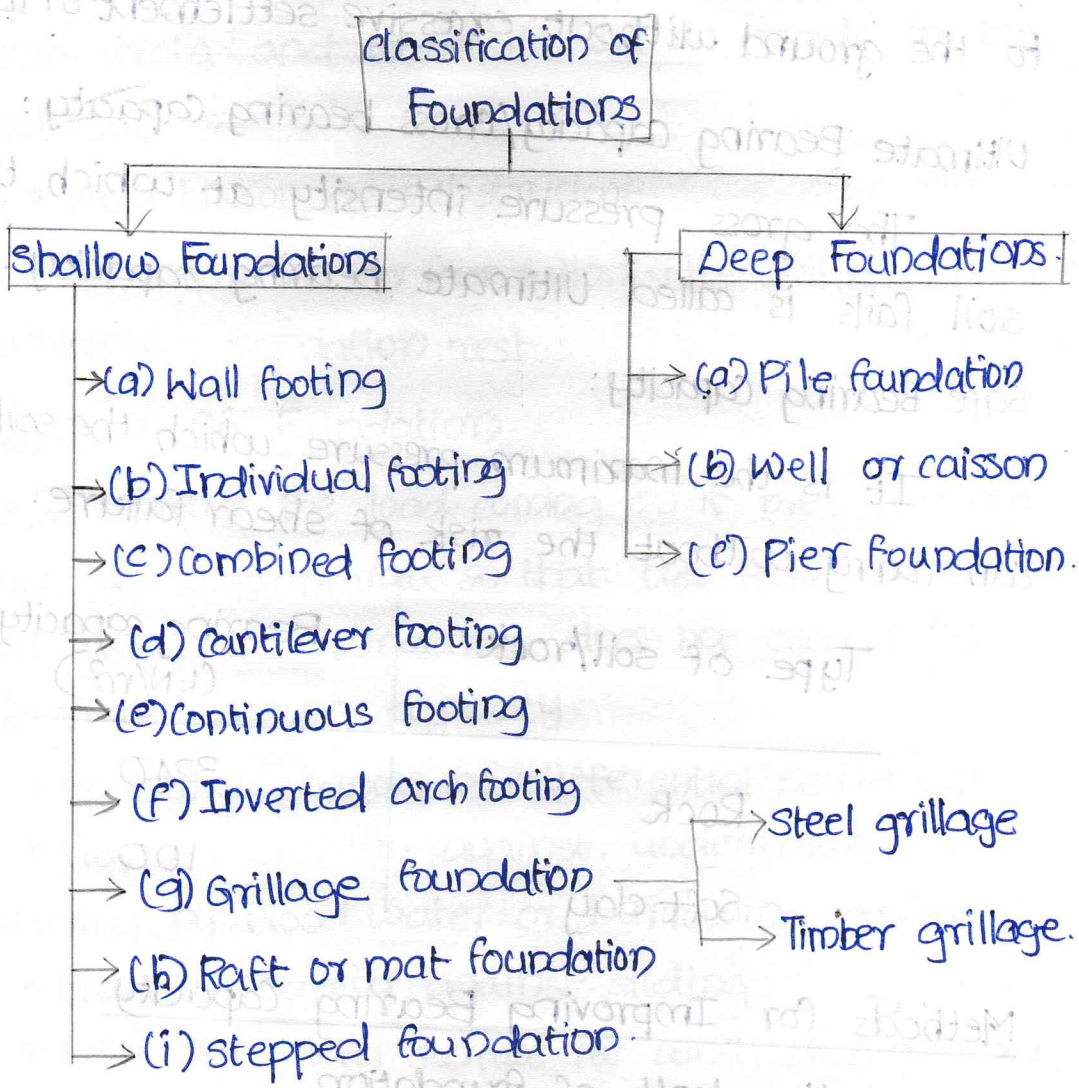
Type of soil/rock	Bearing capacity (kN/m^2)
Rock	3240
Soft clay	100

Methods for Improving Bearing Capacity

1. Increase the depth of foundation
2. By draining the soil.
3. By compacting the soil.
4. By grouting.

5. By confining the soil.
6. Chemical treatment.
7. Using geotextiles.

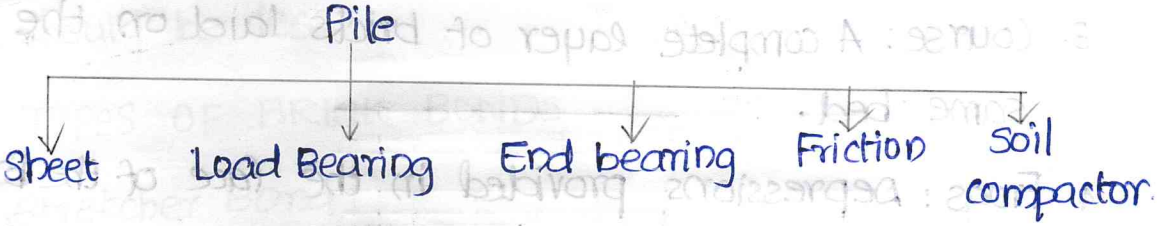
TYPES OF FOUNDATIONS



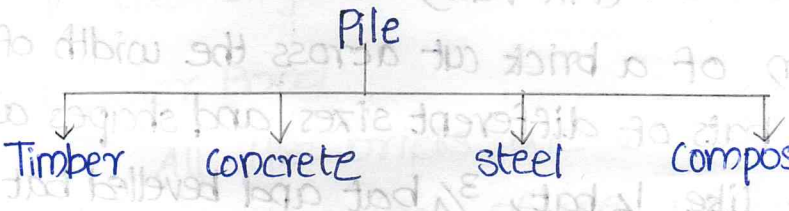
- In case of shallow foundation, a spread is given under the base of a wall or column. This spread is known as the footing.

Types of Pile foundation

(i) Based on function or use



(ii) Based on materials



BRICK MASONRY

Brick masonry is the art of building structures using bricks or the systematic arrangement of laying bricks and bonding them with mortar to form a unified mass, which can transmit the superimposed load without failure is termed as brick masonry.

Terms used in brick masonry

1. Header: The end surface of brick when it is laid flat is known as header (9x9cm).

2. Stretcher: The side surface of the brick visible in elevation when brick laid flat is known as stretcher (19x9 cm)

3. Course: A complete layer of bricks laid on the same bed.

4. Frogs: Depressions provided in the face of the bricks.

5. Bed: Bottom surface of brick when it is laid flat is known as bed (19x9 cm)

6. Bat:
   - Portion of a brick cut across the width of brick.
   - Brick bats of different sizes and shapes are available like ½ bat, ¾ bat and bevelled bat

7. Closer:
   - Portion of a brick cut longitudinally with one long face uncut
   - Used to close up the bond at the end of brick course to prevent vertical joining.

   (a) Queen closer.

Conditions for Good Bond

1. Length of one brick = 2(width of brick + thickness of mortar joint).
2. Overlap between two adjacent brick should be greater than or equal to one fourth the length of brick.

3. Vertical joints of alternate layers should lie along the same vertical line.

4. Number of brick bats used for construction should be less.

TYPES OF BRICK BONDS:

1. Stretcher Bond:

All bricks are laid with their lengths in the longitudinal direction of the wall.

2. Header Bond:

All the bricks are laid as headers towards the face of the wall.

3. English Bond:

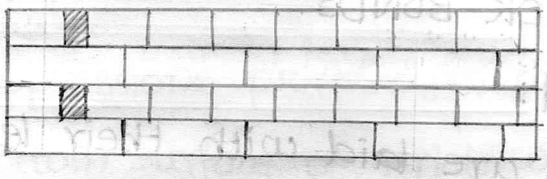
- Alternate courses of stretchers and headers are laid.
- Queen closer is placed after the first header in the header course.

4. Flemish Bond:

- Stretchers and headers are laid in the same course.
- Headers and stretchers appear in the same course alternately on the front and back faces.

16/10/2019

Q: Draw the elevation of a wall using English bond having one brick thickness.

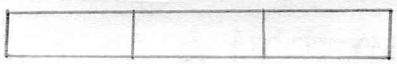


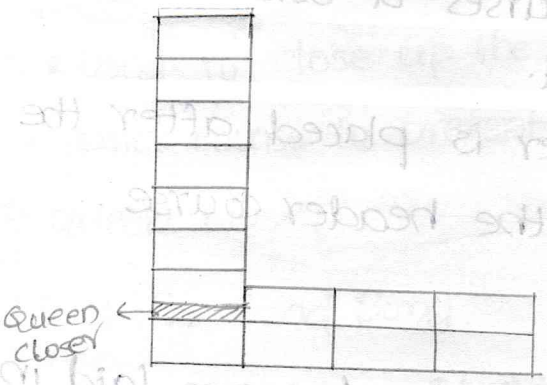
Dimension of stretcher = double the dimension of header.

Q: Draw the plan of stretcher and header.

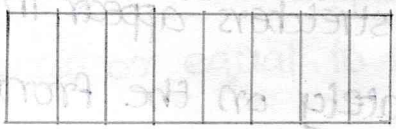
(Plan-view from top)

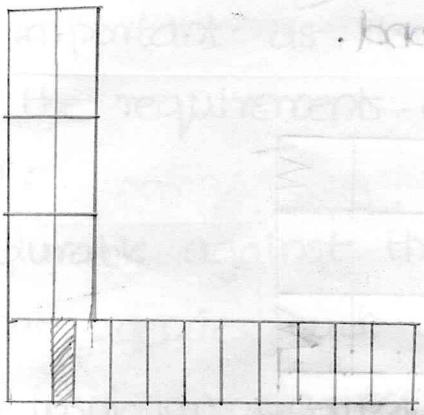
Stretcher:



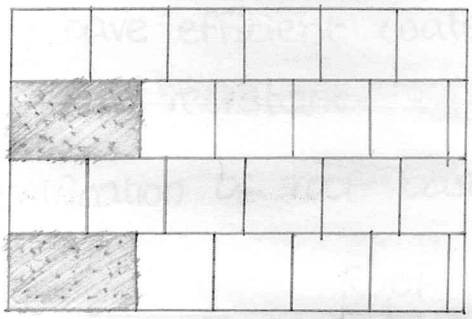


Header:

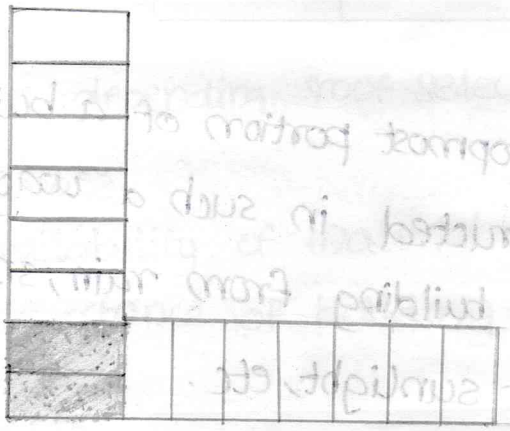




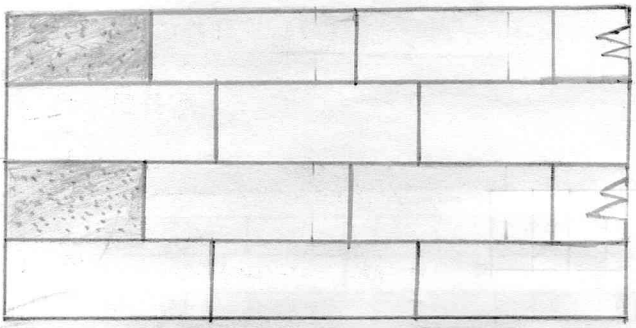
Elevation of Header Bond.



Plan Of Header Bond



Elevation of Stretcher Bond.



Plan of Stretcher Course.

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ROOFS

Roof is the topmost portion of a building and it is constructed in such a way as to give protection to building from rain, snow, hail, wind, direct sunlight, etc.

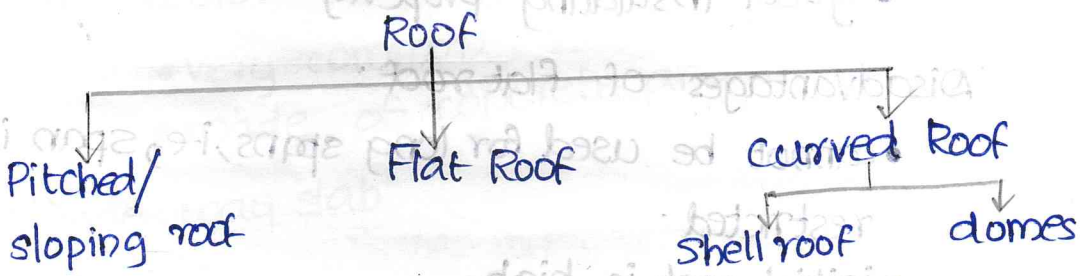
Requirements of a Good Roof

The design and choice of roof is also

as important as its foundation. Following are the requirements of a well planned roof:

- durable against the adverse effects of various agencies such as wind, rain, sun, etc.
- insulation against sound and heat.
- structurally stable.
- well-drained
- have efficient water-proofing arrangement.
- fire resistant.

Classification of roof based on shape



Factors depending roof selection:

- Climate
- Availability of material
- Importance of building

Functions:

- support
- enclose space

Flat Roofs:

Advantages of flat roof:

- does not require any false ceiling.
- construction and repair are simple.
- maintenance easy
- easier to make a flat roof fire resistance.
- provides architectural beauty
- construction work of upper floor can be easily started.
- more stable against high winds.
- can be used as terrace.
- good insulating property.

Disadvantages of flat roof:

- cannot be used for long spans, i.e, span is restricted.
- initial cost is high.
- not suitable for high rainfall region.
- difficult to trace and rectify the leakage in flat roof.
- Cracks may develop due to temperature variation.
- Proper surface slope is to be provided to drain off rain water.

- Progress of work - slow
- self weight - high, so, size of beams, columns, foundations etc are heavy.

Types Of Flat Roofs

Following are the different types of flat roofs:

1. Madras terrace roof
2. Bengal terrace roof
3. Punjab terrace roof
4. Reinforced cement concrete (RCC) Roofs.

RCC Roofs:

- very common
- made of concrete and steel.

(i) one way slab

- $\frac{l}{b} > 2$.
- reinforcement run parallel to shorter span.

(ii) two way slab

- $\frac{l}{b} < 2$
- reinforcement runs parallel to both sides of the room
- at corners suitable mesh reinforcement

to be provided to resist temperature stresses.

Pitched/Sloped Roofs:

- have sloping top surfaces
- used in coastal region where temperature is more or less equable, but for heavy rainfall.
- cheapest alternative
- preferred in large span structures such as workshops, factory buildings, in hilly regions.

Important Terminologies:

1. Barge boards
   - wooden planks or boards fixed on the gable end of a roof.
   - connect the ends of ridge, purlins and wall-plates.
2. Battens:
   - thin strips of wood which are fixed on the rafters or ceiling.
   - support the roof ceiling.
3. Cleats:
   - small blocks of wood which are fixed on

the trusses to prevent the sliding of purlins.

4. Dragon beam:

- The lower end of a hip rafter is generally supported on a diagonal piece of wood which is laid across the corner of the wall. This diagonal piece is known as a dragon beam.

5. Eaves:

- lower edges of a roof which are resting upon or projecting beyond the supporting walls.
- Eaves board or facia board:
  * a thin board of wood provided at the eaves to cover the ends of the common rafters.
  * usually 25mm thick and 250 mm wide.

6. Gable:

- Triangular upper part of a wall formed at the end of a pitched roof.

7. Hip:

- Angle formed at the intersection of two roof slopes.

8. Pitch:

- inclination of sides of a roof to the horizontal plane.
- expressed either in terms of degrees or as a ratio of rise to span.

9. Purlins:
- wooden members used to connect trusses.
- support common rafters.
- placed horizontally over the principal rafter.

10. Rafters:
- placed above the purlins.
- extend from the eaves to the ridge.
- Following are the various types of rafters:

a) Common rafters:
- intermediate rafters
- give support to the roof covering
- spacing: 30 to 45 cm.

b) Hip rafters:
- rafters provided at the junction of two roof slopes.

c) Jack rafters
- rafters shorter than common rafter.

d) Principal rafters
- top inclined member of truss.

11. Ridge :

- A wooden piece provided at the ridge line of a sloaping roof
- apex or head line of a sloping roof.
- also known as apex line.

12. Span :

- horizontal distance between the internal faces of walls or supports.
- Effective span - indicates the centre to centre distance between the supports.

13. Template:

- A bedding block is generally provided at the end of a truss. This block is known as a template.
- helps in spreading the load over a large area.

14. Truss:

- framework of triangles.
- designed to support the roof covering or ceiling over rooms.

15. Verge:

- Edge of a gable running between the eaves and ridge.

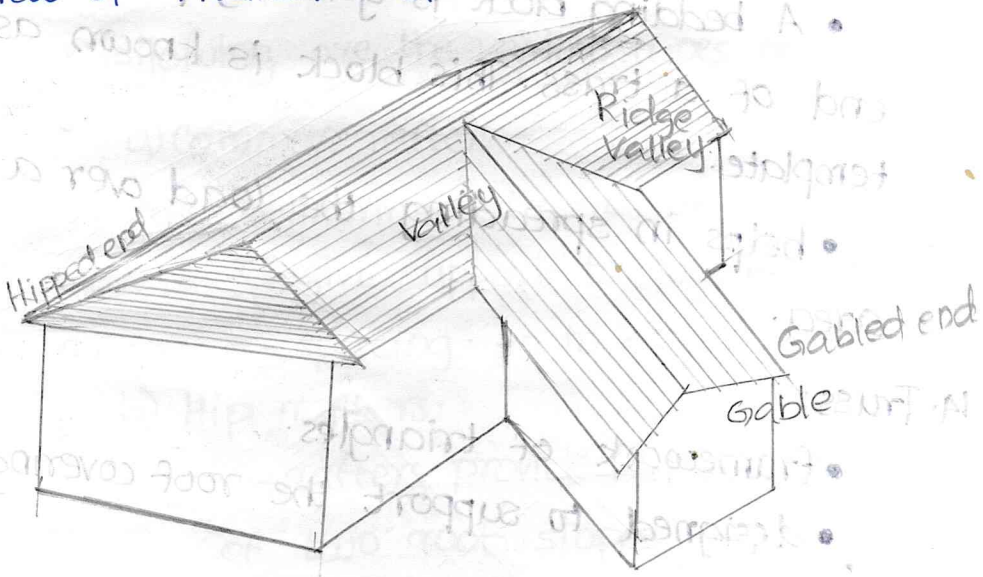
16. Valley: When two roof surfaces meet together at an angle less than 180°, a valley is formed.

17. Wall-plates:
- Long wooden members placed just above the wall to receive the common rafters.
- transfer load from common rafter to wall.

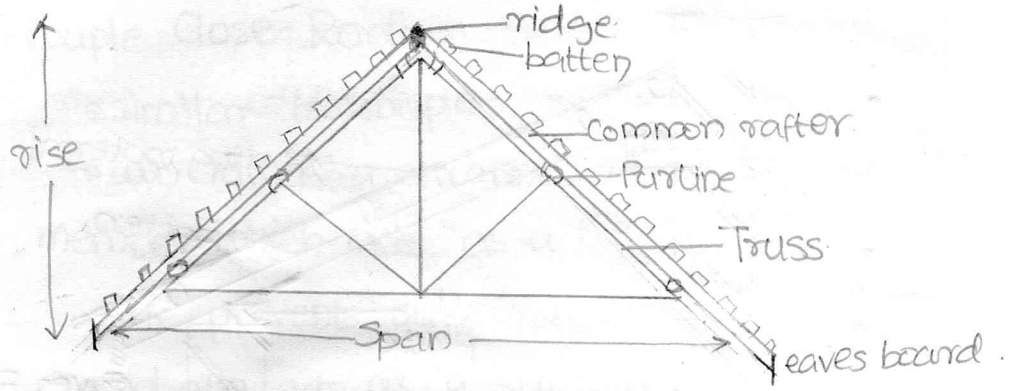
18. Rise:
Vertical distance between ridge and wall plate.

~~Types Of Pitched Roofs~~

View of Pitched Roof



Truss:



Types Of Pitched Roofs

- Pitched Roof
  - Single roof
  - Double or purlin roofs
  - Trussed roofs

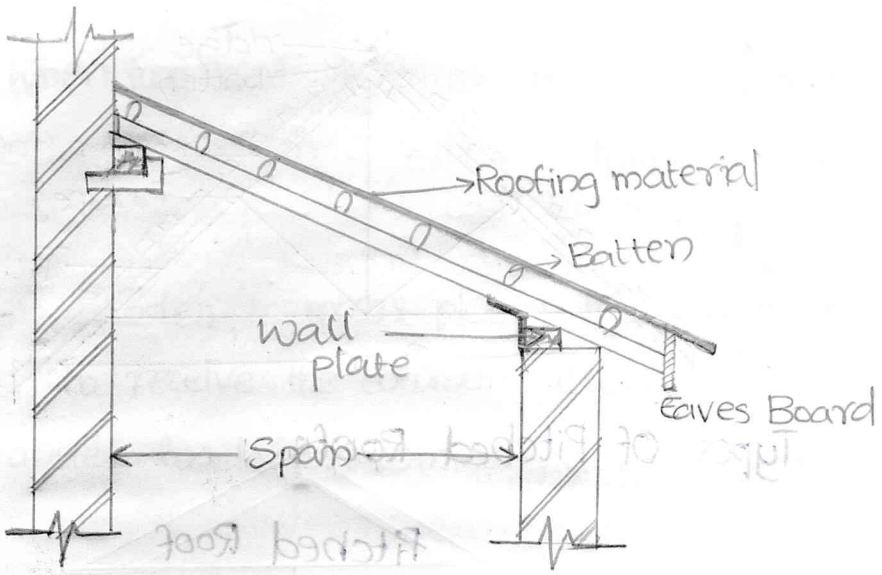
1. Single Roofs :

Common rafters are provided to each slope without any intermediate support.

- Single roofs
  - Lean-to roof
  - Couple roof
  - Couple-close roof
  - Collar beam roof

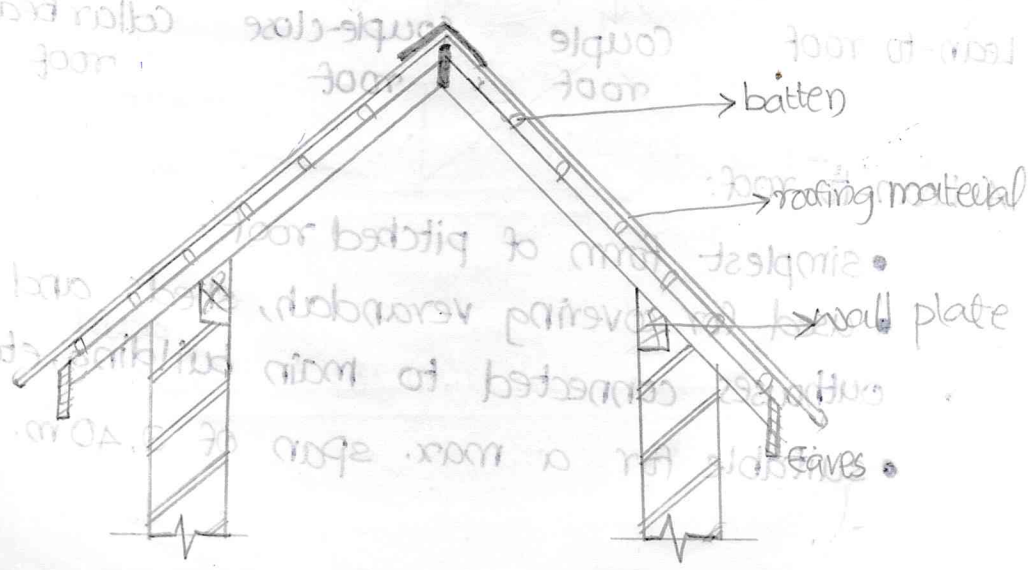
A. Lean-to-roof:

- simplest form of pitched roof.
- used for covering verandah, sheds and outhouses connected to main building, etc.
- suitable for a max. span of 2.40 m.



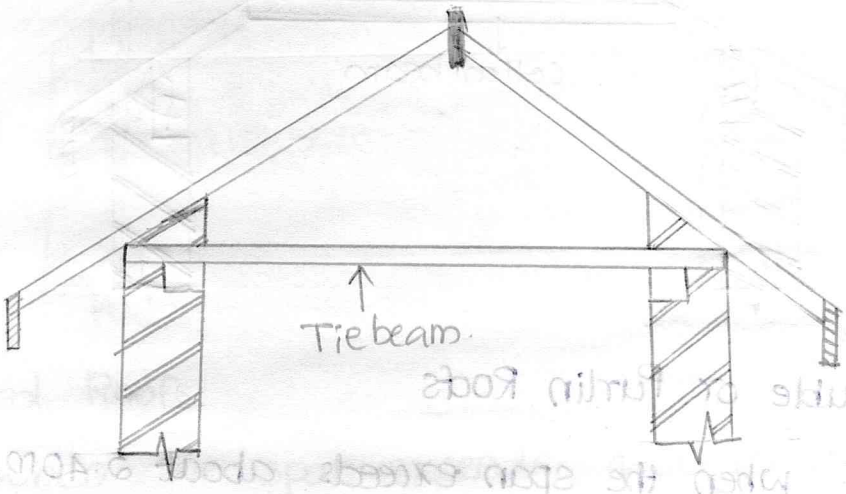
B. Couple Roof:

- formed by a pair of inclined rafters, centre ridge piece (at top) and wall plates (at bottom) for supporting the whole roof.
- battens are supported on common rafters and roofing material on battens.
- Span of couple roof is limited to 3.5m.



C. Couple Close Roof:

- similar to couple
- two rafters are connected by a wooden member which acts as a tie.
- Tie prevents outward spreading of roof and also act as a support for ceiling.
- Span upto 4.2 meters



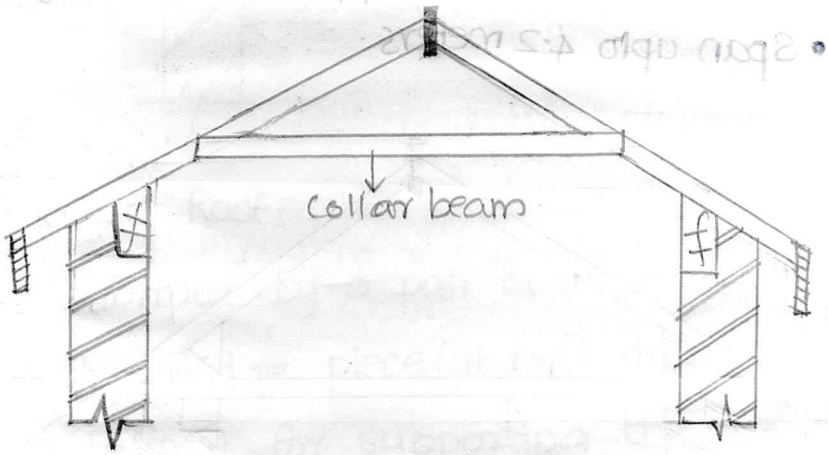
- For increased span or for greater rods, king rod is used.

D. Collar Beam Roof:

- modified form of couple-close roof.
- tie beam is raised and placed at a higher level.
- tie beam is known as a collar or collar beam.
- used to economise the space and to

increase the height of a room.

- usually fixed at one-third to one-half the vertical height from the wall to the ridge.
- Lower the collar, stronger the roof.
- Span 5m (4.8 m)



2. Double or Purlin Roofs

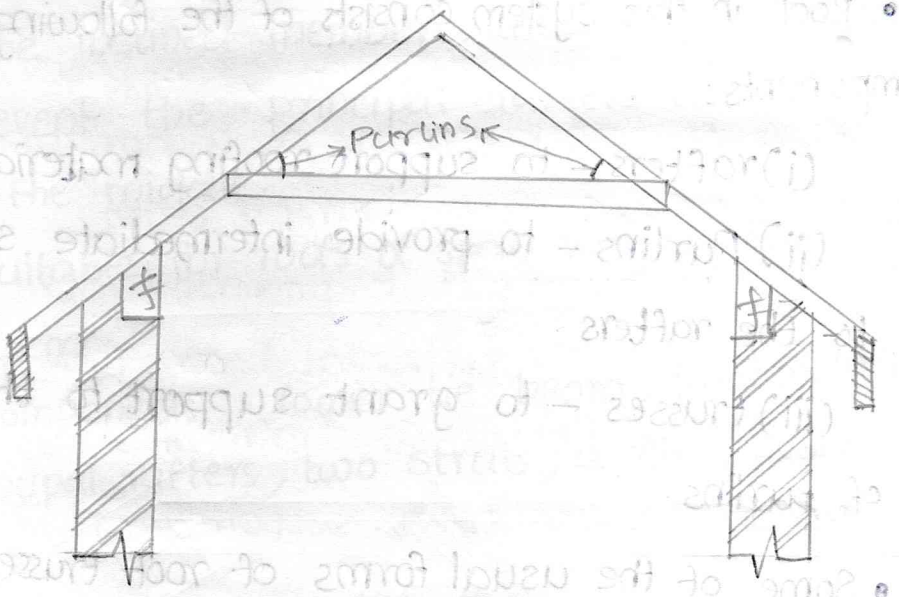
When the span exceeds about 2.40m, the necessary size for the rafters becomes uneconomical. Hence, in order to reduce the size of rafters, the intermediate supports called purlins are introduced under the rafters.

Each rafter is thus supported at three points:

- at the bottom on wall through wall plate.
- at top by ridge beam
- at centre by a purlin.

Such roofs with an intermediate purlin support is known as collar purlin roof or double roof.

Span - more than 5.5m



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3. Trussed Roofs:

- When the span exceeds 4.80 m and when there are no inside supporting walls or partitions for the purlins, the framed structures, known as the trusses, are used.
- Spacing of trusses depends upon:
  - load on the roof
  - position of cross-walls
  - span
  - material of the truss.

- Spacing is generally 3m for wooden trusses.
- Trusses carry the ridge piece and purlins on which the common rafters rest.
- Roof in this system consists of the following three components:

(i) rafters – to support roofing material

(ii) Purlins – to provide intermediate support to the rafters.

(iii) trusses – to grant support to the ends of purlins.

- Some of the usual forms of roof trusses are as follows:

(i) King-post truss

(ii) Queen-post truss

(iii) Mansard truss

(iv) Truncated truss

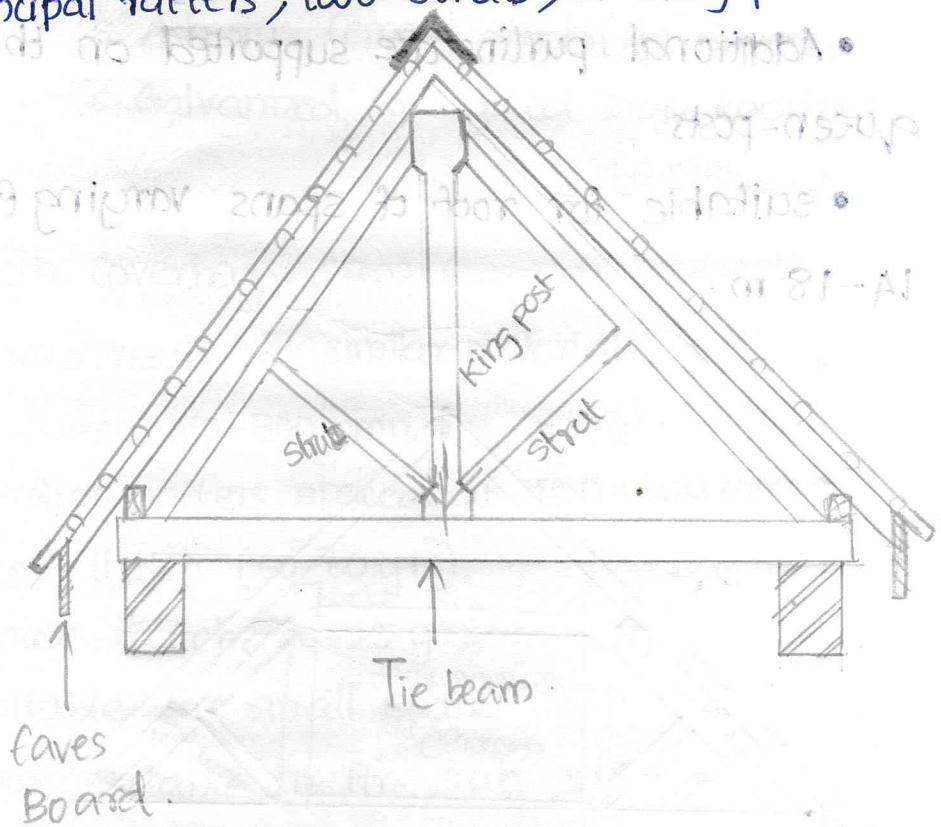
(v) Bel-fast truss

(vi) Steel trusses

(vii) Composite trusses.

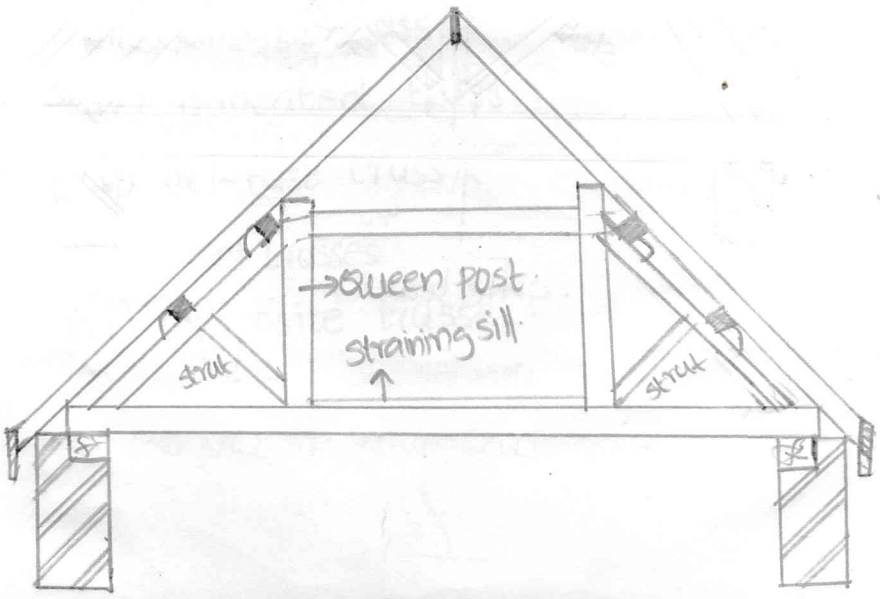
King-Post truss

- The central post known as a king-post, forms a support for the tie beam.
- The inclined members, known as the struts, prevent the principal rafters from bending in the middle.
- suitable for roofs of span varying from 5m to 8m.
- components : lower tie beam, two inclined principal rafters, two struts, a king post.



Queen-post truss:

- Differs from a king-post truss in having two vertical members known as queen posts.
- The upper ends of the queen-posts are kept in position by means of a horizontal member known as a straining beam.
- Foot of queen post is prevented from coming closer by another horizontal beam provided over the tie beam known as straining sill.
- Additional purlins are supported on the queen-posts.
- suitable for roof of spans varying from 14-18 m.



ROOF COVERING:

Roof covering is the material which gives a protective surface to the roofing structure.

Different types of roof covering materials available are:

1. Thatch
2. Shingle
3. Tiles
4. Slates
5. Asbestos Cement sheets (AC sheets)
6. Galvanized Corrugated Iron Roofing (GI sheets)

Thatch Covering:

- Straw, reeds or similar materials.
- thickness 150-300mm
- bamboo rafters spaced at 200-300 mm
- Reed thatch (50-60 yrs)
- Straw thatch (20-25 yrs)
- suitable for small spans.
- Poor resistance to fire, rats etc.

Shingles:

- Wood shingles are thin pieces of split or sawn wood.
- length : 300 – 400 mm
- width : 60 – 250 mm
- Common in hilly areas.
- Poor fire resistance.

Tiles:

- Good covering materials for sloped roof.
- made of clay, concrete, ceramics, etc.

Slates:

- sedimentary rock, grey in colour, split into thin sheets.
- length : 450 – 600 mm
- width : 200 mm – 300 mm
- thickness : 4 – 8 mm
- common in sloping roof.

Asbestos Cement Sheets (AC Sheets):

- Asbestos – magnesium silicate
- width : 1 to 1.2 m
- length : 1.75 to 3 m

- corrugated to get good strength.
- Poor thermal resistance.

Galvanised Iron Sheets (GI Sheets):

- Corrugated sheets
- Rust proof iron
- width: 1 to 1.2 m
- length: 1.65 m

Difference Between GI sheets and AC sheets

GI Sheets	AC Sheets
• Thin	• Not as thin as GI sheets.
• light weight.	• Slightly heavier
• Unbreakable and easy handling.	• chances of breaking cannot be ruled out.
• Chances of corrosion cannot be ruled out.	• No problem of corrosion.
• More noisy if something falls over them.	• Less noisy
• Low fire resistance	• Good fire resistance.
• Low resistance to acid.	• More resistance to acid.
• High initial cost.	• Less initial cost.

FLOORING:

In order to sub-divide the portion between the plinth level or basement level and roof level, the solid constructions are carried out. These constructions are known as the floors and the exposed top surfaces of floors are termed as the floorings.

Materials Used for Flooring

1. Brick:
   - Used for cheap construction
   - for places where heavy articles are to be stacked as in case of godowns, sheds, stores, etc.
   - non-slippery, durable, sufficiently hard and easily repairable.
   - Drawback: it absorbs water.
   - Brick flooring should be cured for a minimum period of 7 days before putting in use.

2. Concrete:
   - thickness of concrete layer – 40 mm
   - carried out in proportion of 1 part of cement, 2 parts of sand and 4 parts of coarse aggregate by volume.

• The square or diagonal lines are marked on the concrete surfaces when it is still wet. This type of construction is known as Indian Patent Stone and is widely used for cheap residential buildings.

3. Asphalt:

• Formerly, asphalt flooring was not favoured because of bad smell and ugly colour of the asphalt.

• At present, it can be carried out in a variety of colours and in different forms.

• Asphalt tiles produced from natural asphalt, bitumen, asbestos fibres and mineral pigments.

• water-proof, vermin-proof, dustless and jointless.

• used for surfaces subjected to heavy wear as in case of dairies, breweries, hospitals, shops, restaurants, etc.

4. Cork:

• Available in two forms – tiles and carpet.

• warm, non-slipping and attractive in appearance.

• used to obtain a noiseless floor as in case of hospitals, churches, art galleries, schools, offices, etc.

5. Glass:

- Used when it is desired to transmit light to the floor below or to admit light to the basement from the upper floor.
- can be placed in suitable framework so that the frame and glass can sustain the anticipated loads.
- Very costly, hence, not common.

6. Marble:

- used for superior work.
- in places where extraordinary cleanliness is required as in case of operation theatres, temples, kitchens, etc.

7. Linoleum:

- a mixture of linseed oil, gums and resins, pigments, wood flour, cork dust and other filling materials.
- thickness varies from 2mm to 6mm.
- attractive in appearance, cheap, durable, resilient, comfortable, moderately warm.
- can be easily cleaned.
- reduces noise to a considerable extent.

- Drawback: subjected to rotting when kept wet or moist for some duration of time. Hence, not recommended for basement floors.

8. Magnesite:
   - known as composition flooring or jointless flooring
   - consists of a dry mixture of magnesium oxide, a pigment and an inert material such as asbestos, wood flour or sawdust.
   - can be laid over stone, concrete or wooden floors.
   - cheap and can be laid over rough surface
   - used as flooring for schools, office buildings, light factories, etc.

9. Plastic:
   - Flooring material – Poly Vinyl Chloride (PVC)
   - PVC is fabricated in the form of tiles of different sizes and various colour shades.
   - resilient, smooth and good looking.
   - can be easily cleaned.
   - costly and can be easily damaged when it comes into contact with burning objects.
   - can be laid economically on concrete floors.

10. Rubber:

- mixture of raw rubber, fillers such as fibre, cork, etc. and pigments.
- small % of sulphur is added to accelerate the process of vulcanization.
- can be laid over any smooth and dry surface.
- elastic, attractive in appearance, noiseless, sanitary, comparatively warm and soft.
- affected by oil and grease.
- used for bathrooms, hospitals, X-ray rooms, etc.

Factors Affecting selection Of Materials

1. Initial cost
2. Durability
3. Hardness
4. Smoothness
5. Cleanliness
6. Appearance.
7. Sound insulation
8. Thermal insulation
9. Damp proof
10. Fire resistance
11. Maintenance

H.W BRICKS

Special types of Bricks:

Classification:

1. Face Bricks
2. Fire Bricks
3. Glazed or coloured bricks
4. Imitation bricks
5. Channel Bricks
6. Coping Bricks
7. Hollow Bricks
8. Paving Bricks
9. Perforated Bricks.

Classification:

1. First class bricks
2. Second class bricks
3. Third class bricks
4. Fourth class bricks.

Uses of Bricks

- First class and second class bricks - widely used for all sorts of sound work especially of permanent nature.
- For obtaining the architectural effects on

faces of structures where they are to be kept exposed for beauty.

- Third class and sun-dried bricks – used for construction work of temporary nature.
- Fourth class bricks – used as road metal and as aggregates in the foundation concrete.

Size Of Bricks

Standard size : 19cm x 9cm x 9cm

Nominal size : 20cm x 10cm x 10cm

Different tests for Bricks:

1. Absorption
2. Crushing strength
3. Hardness
4. Presence of Soluble Salts
5. Shape and Size
6. Soundness
7. Structure.

CLASSIFICATION OF BRICKS

Burnt Bricks:

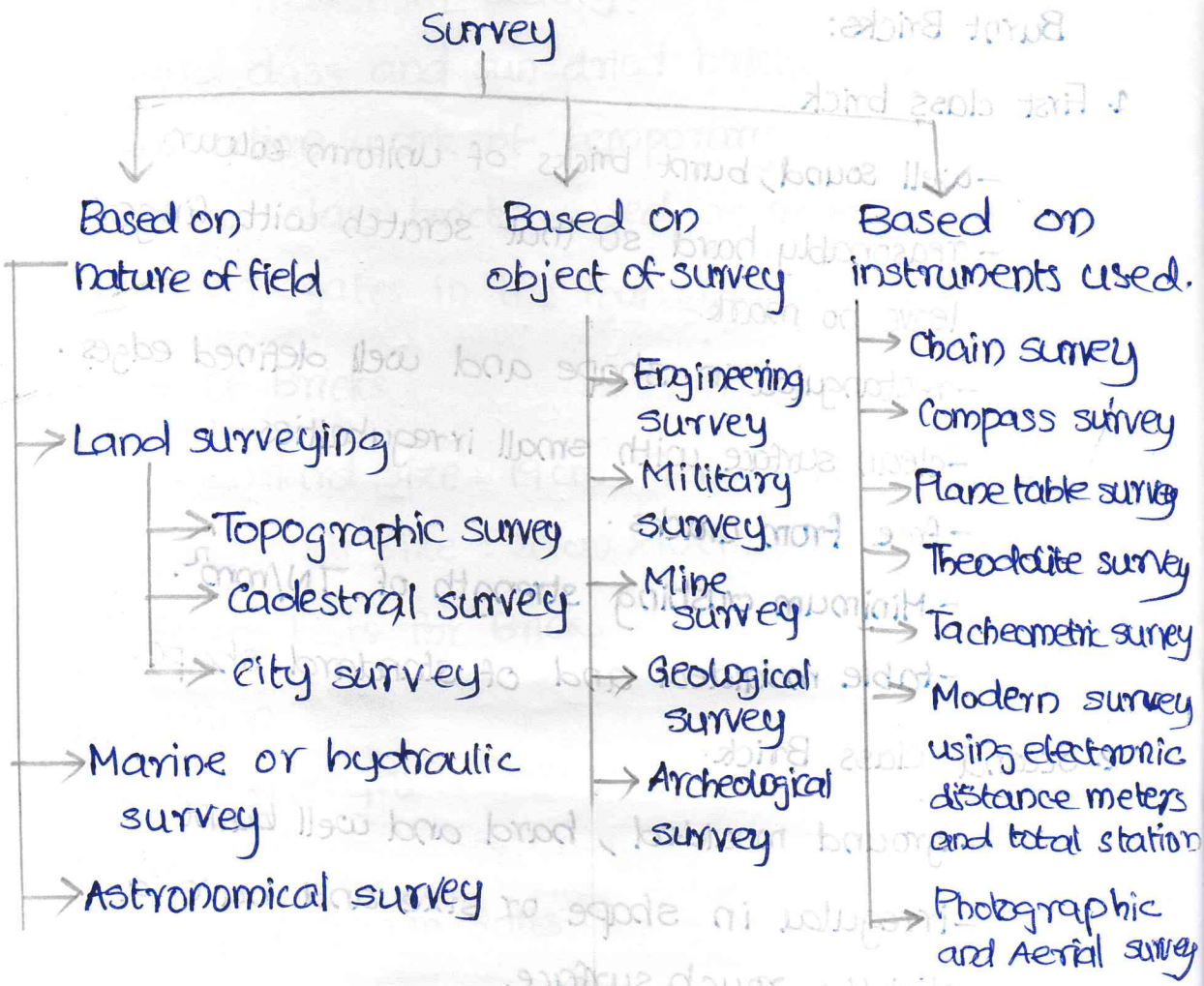
1. First class brick

- well sound, burnt bricks of uniform colour
- reasonably hard so that scratch with finger leave no mark.
- rectangular in shape and well defined edges.
- clean surface with small irregularities.
- free from cracks.
- Minimum crushing strength of 7N/mm^2.
- table moulded and of standard shape.

2. Second Class Brick.

- ground moulded, hard and well burnt
- irregular in shape or size and have a slightly rough surface.

CLASSIFICATION OF SURVEY.



OBJECT:

To show relative position of various objects of an area on paper and produce plan or map of that area.

USES OF SURVEY:

1. Plans prepared to record property lines of private public and government lands help in avoiding

controversies.

2. Maps prepared for marking boundaries of countries, states, districts etc. avoid dispute.
3. Locality plans help in identifying location of houses and offices in that area.
4. Road maps help travelers and tourists.
5. Topographic survey showing natural features like rivers, lakes, hills, forests etc.. helps in planning irrigation projects and flood control measures.
6. Marine survey helps in planning navigation routes and harbours.
7. For planning and estimating project works like roads, ~~rivers, etc.~~ bridges, railways, etc, survey is required
8. Military survey is required for strategic planning.
9. Mine survey is required for exploring the mine wealth.
10. Geological survey helps to determine different strata in the earth crust so that proper location is found for reservoirs.
11. Archeological surveys are useful for unearthing

the relics of antiquity.

12. Astronomical survey helps in the study of movements of planets and for calculating local and standard times.

Reconnaisance survey:

It is the first engineering survey which is carried out to study the details of the proposed project or scheme.

USES OF BRICK:

1. As building blocks
2. For lining of oven, furnaces and chimney.
3. For protecting steel columns from fire.
4. As aggregates in providing waterproofing for RCC roofs.
5. As pavers for footpath.

STRETCHER BOND

- All bricks are laid with their lengths in the longitudinal direction.
- Only stretchers are visible in elevation.
- Suitable for half-brick thick partition wall.
- Not suitable for thicker walls (due to lack of proper bond age across the wall).

HEADER BOND

- All bricks are laid as headers towards the face of the wall.
- Only headers are visible in elevation.
- Suitable for one-brick thick walls and also for the construction of curved walls.
- Not suitable for load bearing walls (no strength to transmit pressure in the direction of length of the wall).

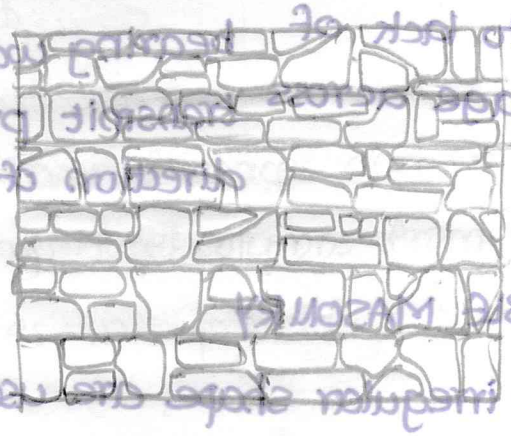
RANDOM RUBBLE MASONRY

- Stones of irregular shape are used but they are arranged so as to give a good appearance.
- Thickness of mortar joint < 12 mm.
- Chisel dressed face stones.
- Can be used for residential building, compound walls, garages, etc.
- Classified into:
  1. Coursed random rubble.

2. Uncoursed random rubble.

Coursed random rubble masonry

- In this masonry, stones are laid to maintain level courses.
- All courses are of approximately same height.
- In each course, headers of full course height and consisting of hammer dressed stones are placed at certain intervals, known as cross stones.

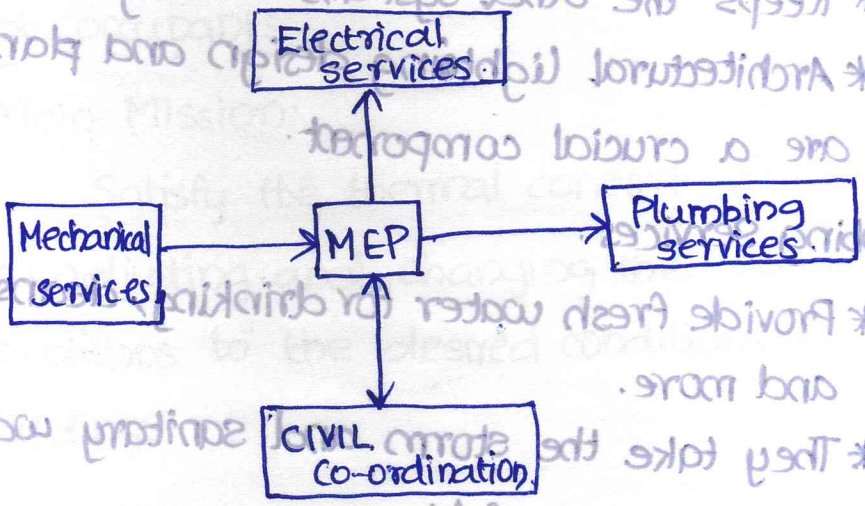


Uncoursed random rubble masonry

- Roughest and cheapest form of masonry.
- stones of different shapes and sizes are used as obtained from Quarry.
- They are arranged in such a way that the vertical joints won't coincide.

- Large stones are used at corners and jambs to increase strength.
- Built without dressing.

MEP.



- services and art of planning, designing and managing the MEP system of a building.
- central nervous system of a building.
- responsible for the "creature comfort" features of a structure and make a building livable and pleasant.

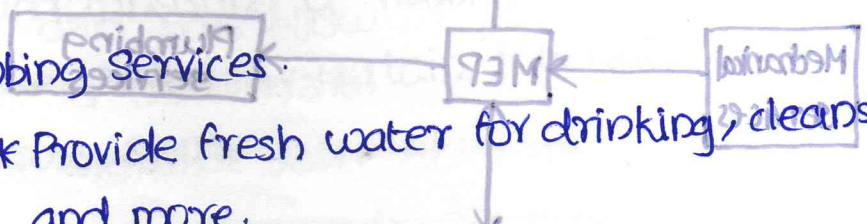
1. Mechanical Services

* Heating and cooling systems, make life inside more comfortable.
* Allow us to occupy building in hot

and cold, under all weather conditions.

2. Electrical System

* Keeps the lights on
* Keeps our devices powered
* Keeps the other systems running
* Architectural lighting design and plans are a crucial component.



3. Plumbing Services.

* Provide fresh water for drinking, cleansing and more.
* They take the storm and sanitary wash water away, safely.
* Plumbing Services:
  - Domestic water system
  - Flushing water System
  - Rain water System
  - Sewage water system
  - Water Treatment Plant
  - All piping and sanitary fixtures that provide water for any use.

HVAC SYSTEM

Heating, Ventilation and air conditioning (HVAC) system is designed to achieve the environmental requirements of the comfort of occupants.

* Main Mission:

Satisfy the thermal comfort of occupants by adjusting and changing the outdoor air conditions to the desired conditions of occupied buildings.

* Depend on:

1. Climate
2. Age of the building
3. Individual preferences of the owner of the building and a designer of project.
4. Project budget
5. Architectural design of the buildings.

* Basic components of HVAC system.

* Major classification is:

1. Central system
2. Decentralized or local system.