ACMT Group of Colleges

Polytechnic – 2nd Year/ 3rd Sem

Diploma in Civil Engineering

Basic Civil Engineering

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Part-1
BUILDING MATERIALS

1.Brick

Bricks are prepared by moulding clay in rectangular blocks of uniform size and then drying and burningthese blocks. In order to get a good quality brick, the brick earth should contain following constituents.

Constituents of Good brick earth

Silica

- Brick earth should contain about 50 to 60 % of silica.
- It prevents cracking, shrinking and warping of bricks.

Alumina

- Good brick earth should contain about 20% to 30% of alumina.
- It imparts plasticity to earth, for moulding operation.
- If present in excess, then the raw brick shrink and warp during drying.

Lime

- The percentage of lime should be in the range of 5% to 10% in a good brick earth.
- It causes silica in clay to melt on burning and thus helps to bind it.

Iron oxide

- A good brick earth should contain about 5% to 7% of iron oxide.
- It imparts red color to the bricks.
- It improves impermeability & gives hardness.

Size of brick

Conventional / Traditional bricks: Size 23 cm x 11.4 cm x 7.6 cm...Standard / Modular: Size: 19 cm x 9cm x 9 cm. With mortar joints the size of these bricks will be 20cmx 10cmx 10cm...

Qualities/characteristics of bricks-

1. Hardness
2. Soundness
3. Fire resistance
4. Strength.
5. Water absorption.
6. Efflorescence.
7. Texture
8. Thermal Conductivity

Classification of Bricks as per common practice:

Bricks, which are used in construction works, are burnt bricks. Unburnt bricks (dried in sunlight) usedfor filling works. Classified into four categories on the basis of its manufacturing and preparation,

First Class Bricks:

These bricks are table moulded and of standard shape and they are burnt in kilns. The surface and edgesof the bricks are sharp, square, smooth and straight.

Second Class Bricks:

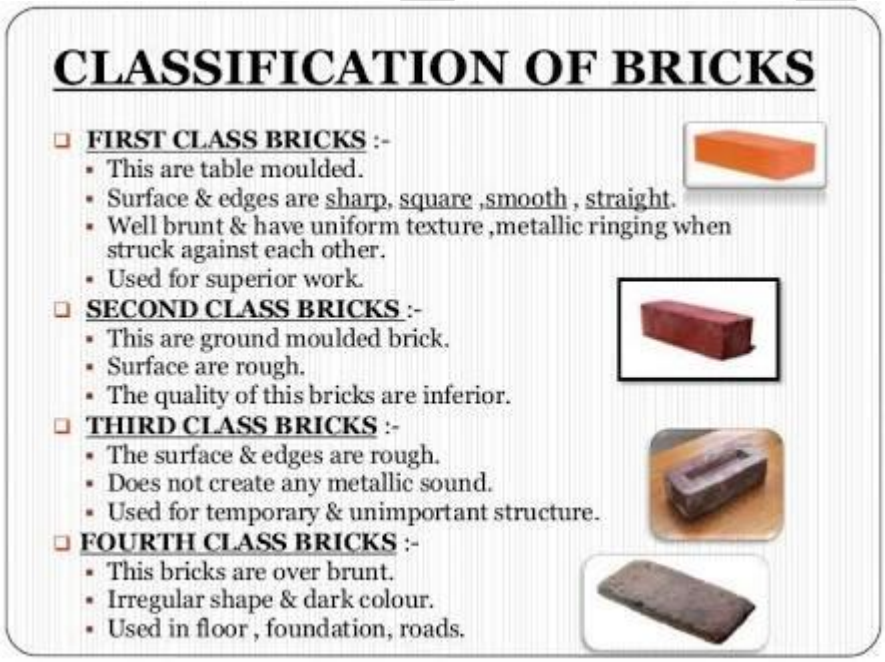
These bricks are ground moulded & they are burnt in kilns. The surface of these bricks is rough andshape is slightly irregular. May have hair cracks and their edges may not be sharp & uniform.

Third Class Bricks:

These bricks are ground moulded & they are burnt in clamps. They have rough surfaces with irregular& distorted edges. They are used for temporary structures & at places where rainfall is not heavy.

Fourth Class Bricks:

These are over burnt bricks with irregular shape and dark color. These bricks are used as aggregate forconcrete in foundations, floors, roads due to the fact that the over burnt bricks have compact structure



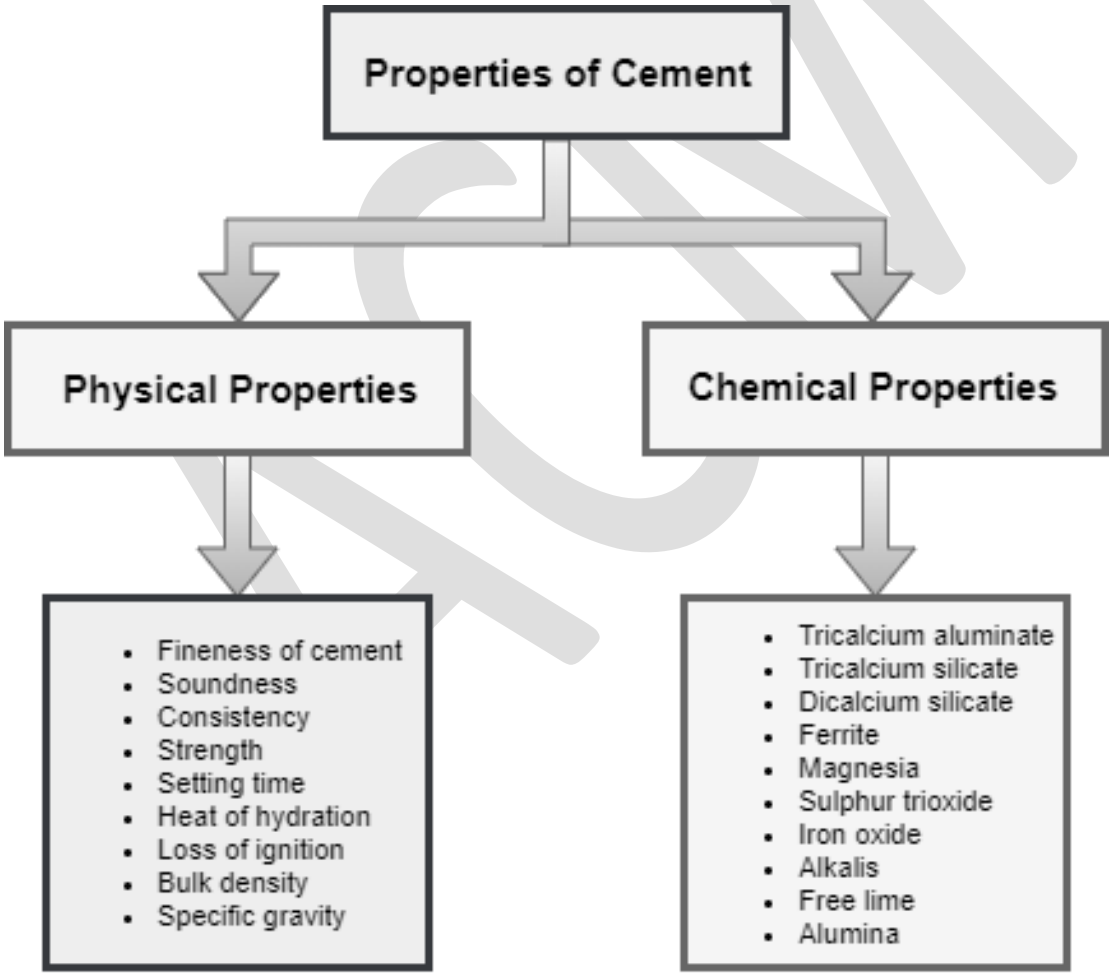
Uses of bricks:

- A fire brick is used for lining the interiors of ovens, chimneys and furnaces.
- Broken brick are used as ballast material for railway tracks, and also as a road metal.
- Extensively used for construction of load-bearing walls and partition walls.
- Used for face-work when artistic effect is required.

2.CEMENT

Cement is a binder, a substance that sets and hardens and can bind other materials together. The cement isobtained by burning a mixture of calcareous (calcium) & argillaceous (clay) material at a very high temperature and then grinding the clinker so produced to a fine powder ***Ordinary Portland cement***- It consists of dry powder of very fine particles & forms a paste when mixed with water. This paste coats all the aggregates together as well as hardens & forms a solid mass. It holds Adhesion & cohesion properties. Chemical reaction like heat of Hydration occurs when mixed with water

Properties of Cement:-



Grades of cement- 33, 43, 53. **Unit** –N/mm2.

Uses of Cement- Cement is used widely for the construction of various structures. Some of them are

(i) Cement slurry is used for filling cracks, in concrete structures.

(ii) Cement mortar is used for masonry work, plastering and pointing.

(iii) Cement concrete is used for the construction of various structures like buildings, bridges.Water tanks, tunnels, docks, harbors, Preparation of foundation etc.

(*v*)For manufacturing cement pipes, railway sleepers, and precast structures

Boque`s compounds –

S.No.	Chemical Name	Chemical Formula	Notation	Percentage (%)
1	Tri calcium Silicate	3CaO, SiO2	C3S	30-50
2	Di calcium Silicate	2CaO, SiO2	C2S	20-45
3	Tri calcium Aluminate	3CaO, Al2O3	C3A	8-12
4	Tetra-calcium Alumino – ferrite	4CaO, Al2O3, Fe2O3	C4AF	6-10

Ingredients /constituents of cement

	percentage	Constituents	Function
Sio_2	17% - 25%	Silica(C2S& C3S)	Imparts strength. Excess increases setting time too
Al_2O_3	**3 to 8%**	Alumina	imparts to set quickly
Cao	62 - 67%	Lime	It provides strength. Excess lime causes to expand & Disintegrate
Fe_2O_3	0.50 to 6%	Iron oxide	Provide color, hardness & strength
MgO	0.10 to 4 %	Magnesia	Provides, hardness &color. excess makes unsound

$CaSo_4$	4 %	(gypsum)	Increase the initial setting time of concrete
So_3	1-2.75%	Sulphure trioxide	Making sound cement.

Different Types of cement & their uses

Rapid hardening Portland cement

- It contains more C_3S are less C_2S than the O.PC
- Its 3 days strength is same as 7 days strength of O.P.C. Used in concrete where form work are removed at an early stage.

Low heat Portland cement

- Heat generated in O.PC at 3days 80cal/gm. While in low heat cement it is 50 cal./gram of cement.

  Reduce and delay the heat of hydration. Used in massive concrete construction like gravity dams

Sulphate resisting Portland cement

- It is used in construction exposed to severe sulphate action by water and soil in places likecanals linings, culverts, retaining walls,
- Maximum % of C3A below 6% which increases power against sulphate.

Blast Furnace Slag cement

- For this cement, the slag as obtained from blast furnace is used
- The clinkers of cement are ground with about 60 to 65 percent of slag.
- It proves to be economical, as slag is a Waste product, is used in its manufactures.

Pozzolanic cement

- As per Indian standard, the proportions of Pozzolana may be 10 to 25 % by weight.
- It imparts higher degree of water tightness
- used in marine structures, sewage works, & for laying concrete under water

White Portland cement

- Grey color is due to presence of Iron Oxide. Hence in White Cement FeO_2 is limited to 1%.
- It is quick drying, possesses high strength and has superior aesthetic values.
- White Cement are used in Swimming pools, painting furniture, moulding sculptures & statues.

3. CONCRETE

Concrete is a composite material composed mainly of binding material, water, aggregate, and cement.

This can be easily moulded to desired shape and size before it loses plasticity and hardens. Often, additives and reinforcements are included in the mixture to achieve the desired physical properties of the finished material.

Constituents of Concrete and their Requirements

The materials that go to form concrete are:

1. ***Binding material***, which is cement or lime. - Cement or lime binds aggregate by virtue of its inherent properties of setting or hardening in combination with water. It helps to fill the voids and gives density to the concrete. stone dust, als added in mortar
2. ***Fine aggregate***, which is sand or stone dust.- dust serves to fill the voids in coarse aggregate and reduce the quantity of cement. It prevents shrinkage & cracks when mortar sets.
3. ***Coarse aggregate*** which are broken stone or broken brick. - Forms the main hulk of concrete aroundthe surfaces of which the binding materials adhere in the form of a film.
4. ***Water***- suitable for drinking. Free from harmful ingredients such as oil, alkali, acid. It activates the hydration of cement.

A small quantity of admixtures like air entraining agents, water proofing agents, workabilityagents etc. may also be added to impart special properties to the plain concrete mixture.

Grades of concrete & their uses-

Sl. No	Grade of Concrete	Mix Ratio	Compressive Strength		Category
			MPa	psi	
1	M5	1:5:10	5	725	Normal Grade Concrete
2	M7.5	1:4:8	7.5	1087	
3	M10	1:3:6	10	1450	
4	M15	1:2:4	15	2175	
5	M20	1:1.5:3	20	2900	
6	M25	1:1:2	25	3625	Standard Grade Concrete
7	M30	Design Mix	30	4350	
8	M35	Design Mix	35	5075	
9	M40	Design Mix	40	5800	
10	M45	Design Mix	45	6525	
11	M50	Design Mix	50	7250	High Strength Concrete Grade
12	M55	Design Mix	55	7975	
13	M60	Design Mix	60	8700	
14	M65	Design Mix	65	9425	
15	M70	Design Mix	70	10150	

Sl.no	Concrete Grade	Applications	Type
1	M10	Non-structural works, patio slabs and pathways	Domestic and Commercial
2	M15	Pavement kerbs and floor blinding	Domestic and Commercial
3	M20	Foundations and domestic floors, driveways, internal slabs and workshop bases	Domestic
4	M25	Multi-purpose concrete mix, all-purpose use	Domestic and Commercial
5	M30	Pathways and roadways, More durable and weather resistant	Commercial
6	M35	Commercial structures, external wall and slab construction, structural piling	Commercial
7	M40	Commercial construction sites, foundation and beam for structural support and roads. Most durable compared to the above ratios. Can withstand chemical corrosion.	Commercial

Grades	***Proportion of concrete***	***Uses***
M5	1:5:10	Strong walls &foundations
M7.5	1:4:8	Mass concretes like dam, foundation course for walls, for making concrete blocks.
M10	1:3:6	Culverts, retaining walls, Flooring, Piers, abutments
M15	1:2:4	PCC
M20	1:1.5:3	RCC works- machine foundation, stairs, beams
M25	1:1:2	Water retaining structures, pile, footings for steel columns
M30	Design mixes	Heavy loaded RC columns, RCC arches
M35	Design mix	Pressed concrete

Properties of Concrete-

Concrete has completely different properties when it is the plastic stage and when hardened. The properties of green concrete include: Workability, Segregation, Bleeding, and Harshness.

1.Workability:-

Workability is often referred to as the ease with which a concrete can be transported, placed and consolidated without excessive bleeding or segregation.

2.Segregation :-

Segregation can be defined as the separation of the constituent materials of concrete. A good concrete is one in which all the ingredients are properly distributed to make a homogeneous mixture. There are considerable differences in the sizes and specific gravities of the constituent ingredients of concrete. Therefore, it is natural that the materials show a tendency to fall apart.

3.Bleeding:-

Bleeding in concrete is sometimes referred as water gain. It is a particular form of segregation, in which some of the water from the concrete comes out to the surface of the concrete, being of the lowest specific gravity among all the ingredients of concrete.

When the surface is worked up with the trowel, the aggregate goes down and the cement and water come up to the top surface. This formation of cement paste at the surface is known as "Laitance**"**

The properties of hardened concrete are: **Strength, Resistance to wear, Durability, and Impermeability.**

Plain Cement Concrete

Plain concrete is a hard mixture of cement, fine, coarse aggregate & water. It is strong in compression butvery weak in tension

Reinforced Cement Concrete

Concrete is good in resisting compressive stress but very weak in resisting tensile stresses. Hencereinforcement is provided in the concrete wherever tensile stress is expected. Since elastic modulus & tensile strength of steel is quite high compared to concrete, the force & bond developed in steel is high. A cage of reinforcements is prepared as per the design requirements, kept in the form work and then green concrete is poured. After the concrete hardens, the form work is removed. The composite material of steeland concrete, now called R.C.C. acts as a structural member.

PCC	RCC
Suitable for compression onlyBears Less loads Doesn't withstand fire & weatherLow tensile strength & ductility Volume instability Internal stress developed due to linearexpansion	Can resist tensile as well as compressive forcesefficiently. Bear heavier loads Resistant to erosion & abrasion Stress can be transmitted to steelGood ductile property Impermeable to moisture so used for waterretaining structures

Uses of R.C.C.

R.C.C. is used as a structural member wherever bending of the member is expected. The Commonstructural elements in a building where R.C.C. is used are: Footing & Columns

R.C.C. is used for the construction of storage structures like: Water tanks & Dams

R.C.C. is used for building tall structures like Multistorey buildings, Chimneys, towers

R.C.C. is used for paving High ways, City roads, Airport.

4.STEEL

Steel is an alloy of ferrous metal with 0.25 to 1.5 per cent of carbon. Higher the carbon content, harder isthe steel. Steel bars of circular cross sections are used as reinforcement to strengthen concrete structures.

Types of reinforcement bars

Plain steel bars- Round sections. Composed of Mild steel and medium tensile steel. Plain steel bars –

5mm to 32mm. Designated as Fe-250. Used as window bars, for grills and for making steel gates

High yield strength bars /TOR Steel- provided with ribs deformation on surface so that bond betweenconcrete and steel improves. These bars are available in diameters 8 to 40 mm...

High tensile bars are used as reinforcement in pre-stressed concrete

Uses of Mild Steel:

(i) Round bars are extensively used as reinforcement in R.C.C. works.

(ii) Rolled sections like I, T, L, C, plates etc. are used to build steel columns, beams, trusses etc.

(iii) Tubular sections are used as poles and members of trusses.

(iv) Plain and corrugated mild steel are used as roofing materials.

(v) Mild steel sections are used in making parts of many machineries .

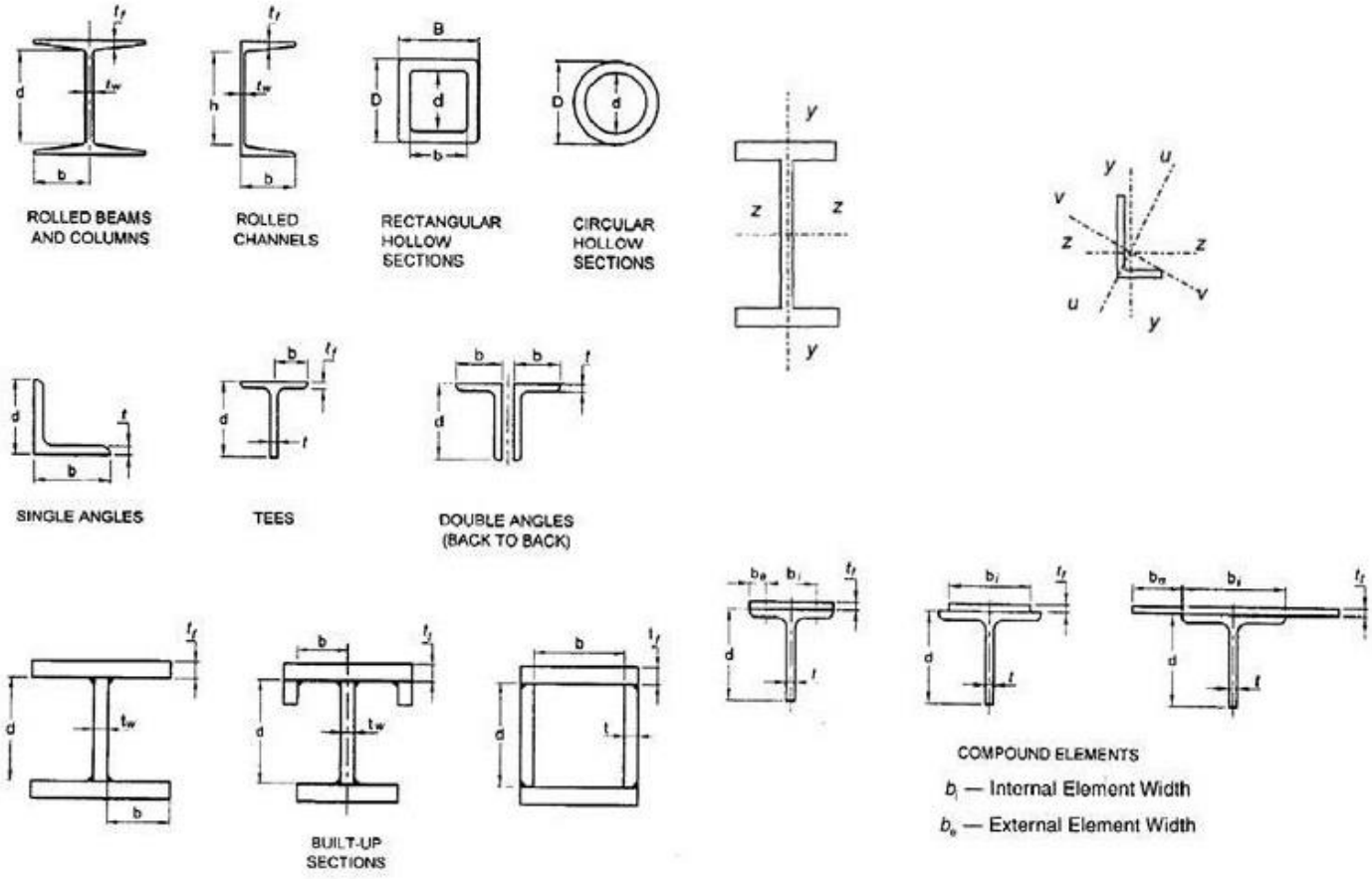
Structural Steel Sections / Market Forms of Steel

- **Rolled steel bar section:**
  - Indian Standard Round Bars (ISRO):
    - Designated as ISRO 10 (round bars having diameter 10mm)
    - Available in diameter varying from 6mm to 25mm.
  - ***Indian Standard square bars*** *(ISSQ):*
    - Designated as ISSQ 10 (square bars of size 10mm)
    - Used for grillwork, handrails for staircases etc.
- **Rolled Steel Plate Section (ISPL):**
  - Designated as ISPL 500 x 5 (500mm width and 5mm thickness)
  - Used for construction of water tanks & other storage structures, base plate for foundations

- **Rolled Steel Angle Sections (ISA)**- Designated as ISA and width and length of legs
  - Equal angle sections- i) Two legs will be equal in length

    ii) Available in sizes varying from 20mm x 20mm x 3mm to 200mm x 200mm x 25mm
  - **Unequal angle sections- i)** Two legs will be unequal in length.

    ii) Available in sizes varying from 30mm x 20mm x3mm x 3mm to 200mm x 150 mm x 18mm
- **Rolled steel Tee sections:**
  - Available in sizes varying from 20mm x 20mm x 3mm to 150mm x 150mm x 10mm.
  - Widely used as members of the steel roof truss and form built – up sections
  - Different types available are: Indian Standard Normal Tee (ISNT), Indian Standard HeavyTee (ISHT)
- **Rolled Steel Channel Sections:**
  - Consists of a web and two equal flanges.Designated by height of web and width of flange
  - Available in sizes varying from 100mm x 45mm to 400mm x 100mm.
  - Widely used for beams and columns
- **Rolled Steel I – Sections**
  - Consists of 2 flanges connected by a web. Designated of overall depth & width of flange.
  - Available in sizes varying from 75mm x 50mm to 600mm x210mm
  - Different types are: Indian Standard junior beam (ISJB), Indian Standard Light Beam(ISLB), Indian Standard Medium Beam (ISMB)



DIFFERENCE B/W MILD STEEL & HYSD BARS

MILD STEEL BARS	(HYSD)/ TOR STEEL
• malleable and ductile, elastic • Plain steel bars – 5mm to32mm • Yield strength – 250 N/mm^2 & Young's modulus is 2×10^5 • Equally strong in tension & in compression. • Specific gravity-7.8	• Cold twisted deformed bars • Tor steel bars – longitudinal ribs in the formof continuous helix • High yield strength • Mean diameters – 8mm to 40mm • Can be bent 180' without cracks • Designated as Fe415,Fe500, Fe550 • Note- (No. indicates the tensile strength)

5.Sand

- Sand is used for making concrete, mortars, and plasters and also for filling under floor, basements.
- The main impurities present in the sand are clay, silt, salts, mica and organic matter

Sand is a type of naturally occurring material that is of a granular, loose, fragmented composition, consisting of particulate matter such as rock, coral, shells, and so on. Sand is typically finer than gravel but coarser than silt.

The precise composition of sand varies depending on its source and the conditions prevalent at that location. In in-land continental regions, the predominant constituent of sand is silica (silicon dioxide), typically in the form of quartz. Sand that has been created over millions of years by such things as coral and shellfish is typically aragonite, which is a form of calcium carbonate.

Uses of sand

Sand is very commonly used in construction, often providing bulk, strength, and stability to other materials such as asphalt, concrete, mortar, render, cement, and screed. Sand is also used as a base layer is known as 'blinding', which is laid above a layer of hardcore to provide a clean, level, and dry surface for construction works. It can also be used in its raw form as a decorative material in landscaping.

Sand is used in liquid form to manufacture glass and is also used for molding metal casting. It can be used as an abrasive in the process of sandblasting which cleans structural elements, steelwork, and so on. Sandpaper is also made using sand.

Types of sand

The different classifications of sand are:

1.Particle size: 0.6-2 mm (coarse sands), 0.2-0.6 mm. (medium sands), 0.06-0.2 mm (fine sands).

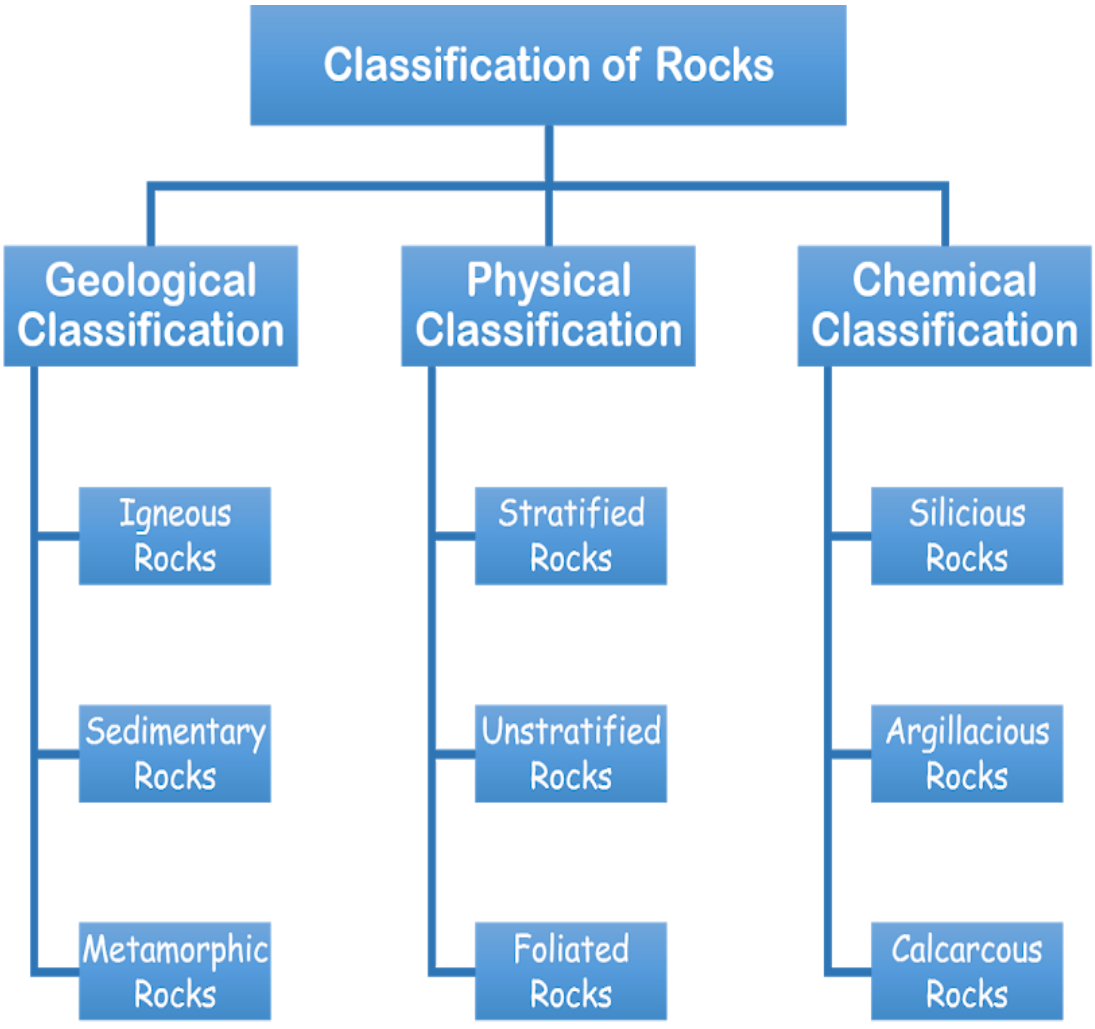
2. Particle shape: Angular, sub-angular, rounded, flat, elongated.

3. Texture: Rough, smooth, or polished.

5. Composite soil types: Classified as 'sandy gravel' or 'gravelly sand'. Clayey composites are described as plastic or cohesive. Silty composites are described as non-plastic or of low plasticity.
6. Structure: Homogenous, inter-stratified, heterogeneous, or weathered.

6.Stones

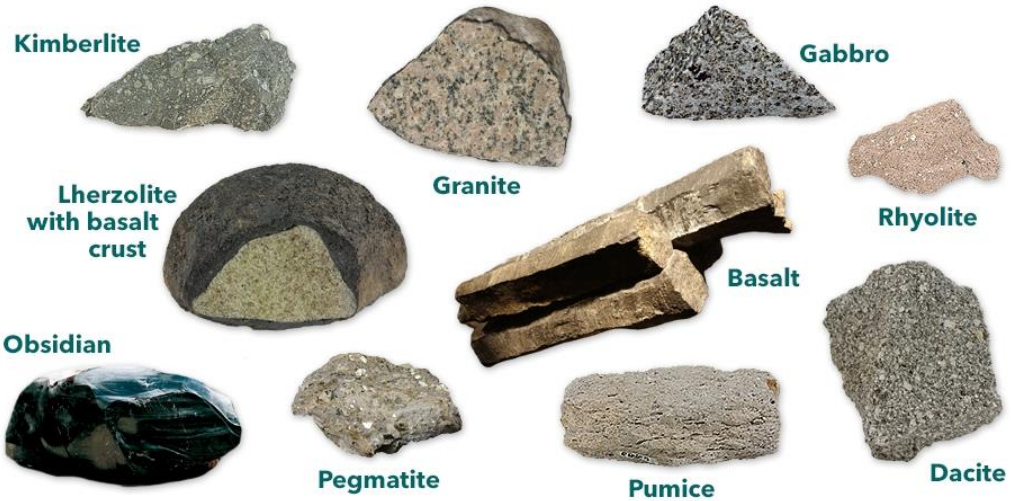
Stones are naturally occurring rocks of igneous, sedimentary or metamorphic origin



Classification of Rocks

- Geological Classification
  - Igneous rocks
    - Formed by cooling of molten lava
    - Un-stratified rocks
    - E.g. Granite, Basalt, Trap
  - Sedimentary Rocks
    - Formed from weathering deposits (sediments)by wind or water
    - Stratified rocks
    - Solidified to rocks due to compaction caused intense pressure from overlaying sediments.
    - E.g. Sandstone, Gypsum, Lime stone, peat
  - Metamorphic rocks
    - Changed from igneous or sedimentary rocks
    - Foliated ricks
    - Changed due to intense heat or pressure inside earth
    - E.g. Marble, Slate, Laterite Gneiss, Quartzite

1.Igneous rocks **are formed from melted rock deep inside the Earth.**



2.Sedimentary rocks **are formed from layers of sand, silt, dead plants, and animal skeletons.**

3.Metamorphic rocks **formed from other rocks that are changed by heat and pressure underground.**

Parameters in selection of a good construction stone:

Being cheap, hard, durable and naturally good looking stones are often used in construction.
There are several properties of stones that are controlling their types and qualities.
The criteria of selection is based normally on the following general parameters:
1.Chemical composition of stone
2.Strength and hardness
3.Durability
4.Resistance to fire
5.Bio-Deterioration
6.Appearance
7.Susceptibility to being quarried in large sizes.

Uses of Building Stones:-

Marble, granite and sandstone are used for facing work of buildings. Limestone and sandstone are used for general building works. Fine-grained granite, marble, and soft sandstone are used for Carvings and ornamental works. Compact limestone and sandstone are used for Fire-resistant masonry.

7.CEMENT MORTAR

Mortar is an intimate mixture of binding material, fine aggregate and water. When water is added to the dry mixture of binding material (cement) and the inert material, binding material develops the property that binds not only the inert material (sand) but also the surrounding stones and bricks. Other mortars commonly used are lime mortar and mud mortar.

Properties of Cement Mortar

Good building mortar should have following properties:

1. It should be easily workable,
2) gain sufficient strength for the work.
3. It should join the bricks or stones to give a tight joint.
4. A mix richer than 1:3 is prone to shrinkage.
5. Well-proportioned mortar provides impervious surface.

Preparation of mortar

For preparing mortar, first a mixture of cement and sand is made thoroughly mixing them in drycondition. Water is gradually added and mixed with shovels.

The cement to sand proportion recommended for plastering concrete 1:3 & Masonry works 1:6 to 1:8 **Curing-** Cement gains the strength gradually with hydration. Hence it is necessary to see that mortar iswet till hydration has taken place. The process to ensure sufficient moisture for hydration after layingmortar/concrete is called curing. Curing is ensured by spraying water. Curing normally starts 6–24 hoursafter mortar is used. It may be noted that in the initial period water requirement is more for hydration andgradually it reduces . Curing is recommended for 28 days.

Part-2

Building Construction

1.Components of a Residential Building

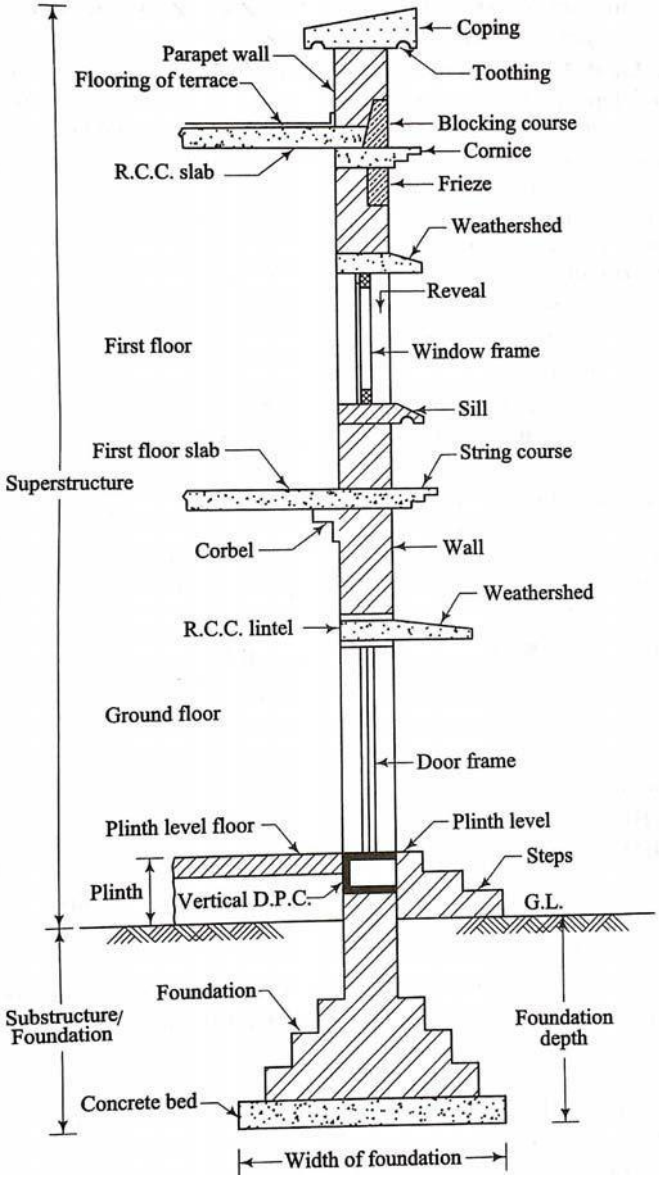


Figure1.Components of a residential building

Usually a building is divided into three parts:

A. Substructure

i. Foundation

ii. Plinth

A. Superstructure

- Foundation 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.

- Plinth is the building above the ground level and up to the floor level immediately above the ground.
- Superstructure is the part of the building constructed above the plinth level.
-
- The Table 1.1 gives the functions of different structural components of a building.
-
- *Table 1. Important building components and their functions*
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Building Component	Function (s)
Foundation	**Transmits the loads**; supports the superstructure; provides stability. Provides safety against scouring
Plinth	Helps in transmitting loads from superstructure to substructure; **Protects** the building from moisture rainwater, dust, insects, termite, etc.
Wall	Supports beam and slab; transmits the loads. Provides **partition**, privacy and safety; Protects building against heat, cold, rain, noise, fire, etc.
Column	**Supports** beam and slab Transmit the loads
Floor	Gives a plane and **levelled surface** for the occupants, furniture, the equipment, etc.
Roof	Covers the top of the building Gives **protection** against rain, heat, snow. Sound, wind, etc.
Door	**Permits entry, exit**, light and ventilation to the building Imparts safety and privacy to the building
Window	Gives nice scenic view to the building Permits **light and ventilation**
Step	For access in building from GL to upper floors
Stair	For **vertical circulation** among the floors in the building
Lintel, Arch	Gives support to the wall **above the openings** in wall
Sill	It gives support to the **bottom of window openings**
Beam	**Supports the slab** Transmits loads coming from slab to column or wall
Weather shed (Sun shade)	**Protects the walls** of the buildings from sun, heat and rain

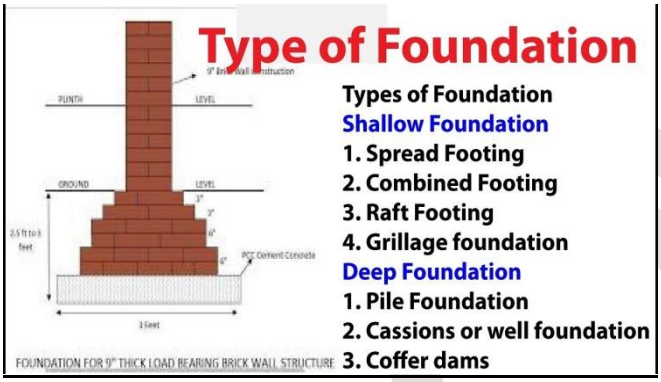
Parapet	Provides **boundary to the terrace** and encloses it

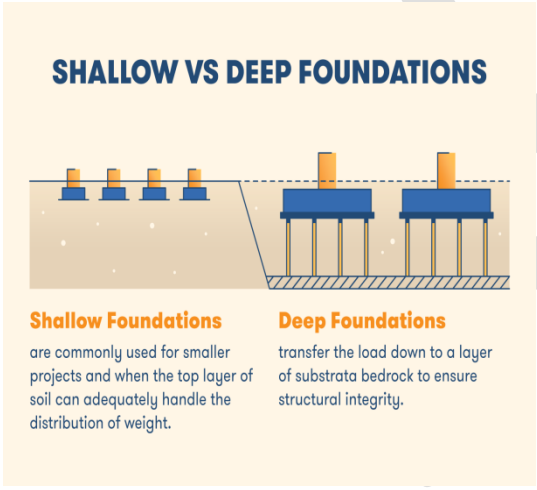
Purpose/ Functions of Foundation–

- When depth of foundation is less than or equal to the width, then shallow foundation.
- type of foundation Used when earth directly beneath structure has sufficient bearing capacity
- cheaper than deep foundation & Easier construction

- Deep foundations have depth more than width
- Used when the soil near the ground surface Is weak
- Costly **&** Construction is difficult

Types of foundation:-





Strap Footing/ Cantilever Footing

- These are Isolated footings connected by a strap beam
- This type of foundation is provided when the distance between the columns is large.

Combined Footing

- When a footing is constructed for two or more columns is known as combined footing. The aim isto get uniform pressure distribution under the footing.

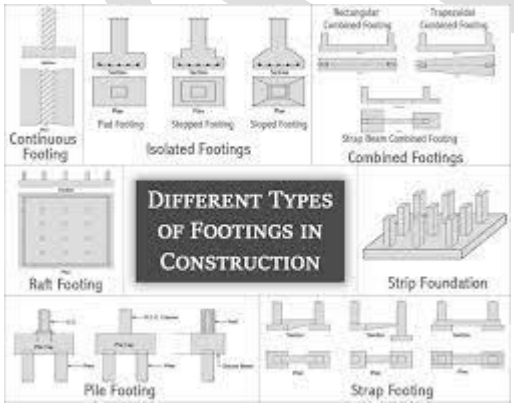
- Adopted when end column is near a property line so that its footing cannot spread in that direction.

Inverted arch footing

- These are constructed between two walls at the base. In this, end columns are to be designed toresist outward pressure caused by arch action.
- It is commonly used for bridge piers, tanks& support for drainage works

Well Foundation

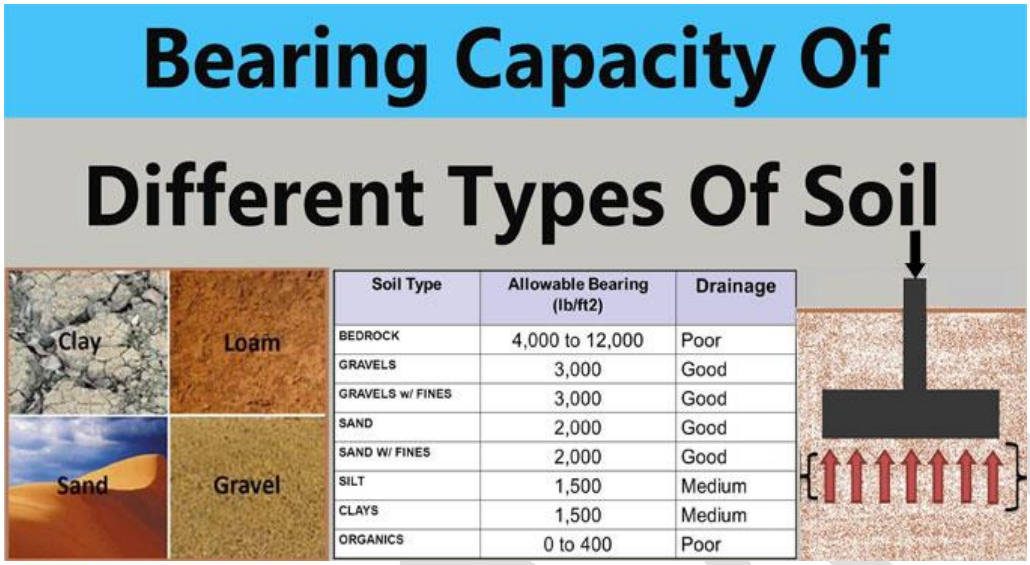
- Well foundation is a box like structure mainly used for the bridge construction
- They are hollow from inside which should be filled with sand and plugged at the bottom withconcrete.



Importance of determining Bearing capacity of soil

The selection of a suitable foundation is an important task for any structure. The type, depth, shape & size of foundation are to be determined so that it can safely transmit the load to the soil. The loads

from a structure are finally transmitted to the soil & hence, it is important to study strength and behavior of the soil. The supporting power of soil without any failure is called bearing capacity



Soil Type	Allowable Bearing (lb/ft2)	Drainage
BEDROCK	4,000 to 12,000	Poor
GRAVELS	3,000	Good
GRAVELS w/ FINES	3,000	Good
SAND	2,000	Good
SAND W/ FINES	2,000	Good
SILT	1,500	Medium
CLAYS	1,500	Medium
ORGANICS	0 to 400	Poor

Requirements of Good Foundation:-

Foundations should be constructed to satisfy the following requirements

The foundations shall be constructed to sustain the dead and imposed loads and to transmit these to the sub-soil in such a way that pressure on it will not cause settlement which would impair the stability of the building or adjoining structures.

Foundation base should be rigid so that differential settlements are minimized, Specially for the case when super-imposed loads are not evenly distributed.

Foundations should be taken sufficiently deep to guard the building against damage or distress caused by swelling or shrinkage of the sub-soil.

Foundations should be so located that its performed may not be affected due to any unexpected future influence.

Foundations should be such that it can easily carry dead load and imposed load of the structure and transfer the loads to the soil.

Foundation base should be strong enough to reduce the unequal settlement of soil if imposed load is not distributed equally to the soil.

It should have a definite depth so that structure may not be damaged due to expansion or compression of soil volume beneath the foundation.

Foundation should be strong and designed with safety factor so that structure may not be damaged due to unexpected effects.

2.BRICK MASONRY

The art of laying bricks in mortar in a proper systematic manner gives homogeneous mass which can withstand forces without disintegration, called brick masonry.

Header: A brick laid with its length perpendicular to the direction of wall. The course of brick work in which all the bricks are laid as headers is known as header course.

Stretcher: A brick laid with its length parallel to the direction of wall. The course of brick work in which all the bricks are laid as stretchers is known as stretcher course.

Quoins: it is a corner angle on face side of a wall. These are stones used for corners of walls of a structure.

Bat: it is the portion of brick cut across the width.

Closer: it is the portion of the brick cut length wise in such a manner that its one long face remains uncut.

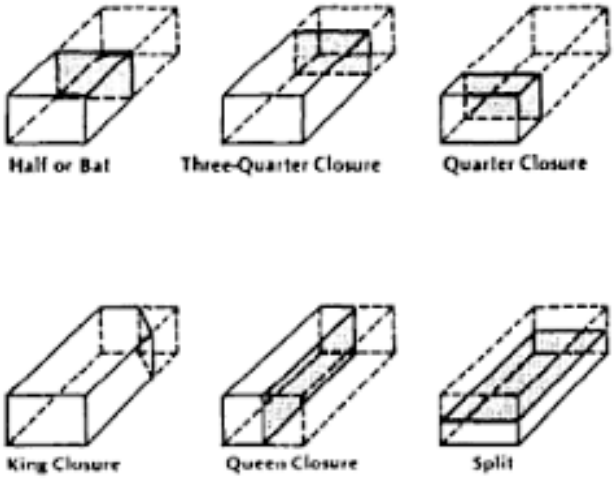
Queen closer: It is the portion of brick obtained by cutting a brick length wise into two portions.

King Closer: these are the portions of a brick obtained by cutting off the triangular piece between the center of one end and the center of one side.

Bevelled Closer: it is that portion of a brick in which the whole length of the brick is beveled for maintaining half width at one end and full width art the other.

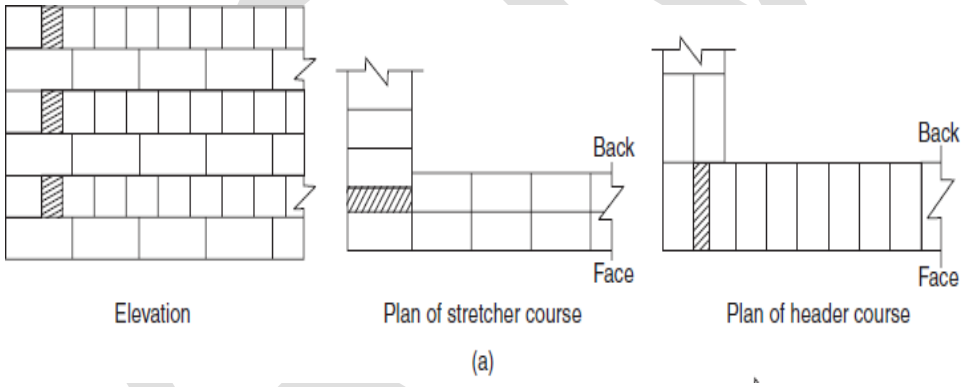
Types of bond- Stretcher bond, header bond, English bond, Flemish bond,

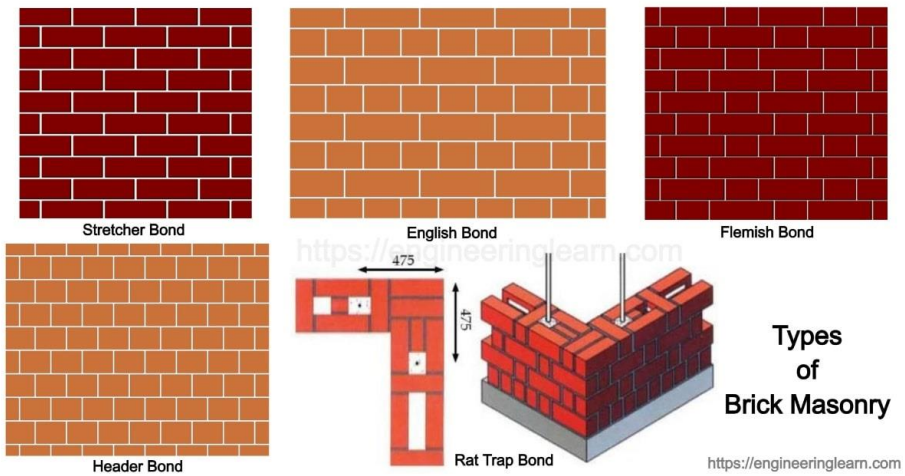
Flemish bond- In this type of bond each course comprises of alternate header and stretcher [Fig-4]. Alternate courses start with stretcher and header. To break the vertical joints queen closers are required, ifa course starts with header. Every header is centrally supported on the stretcher below it.



English bond

- In this, alternate courses consist of either headers or stretchers in elevation.
- This is considered to be the strongest bond. Hence it is commonly used bond for the walls of allthicknesses
- To avoid continuity of the vertical joints, queen closers are provided





3.Stone Masonry

Stone masonry is a type of building masonry construction that uses stones and mortar. This construction technique is used for **building foundations, floors, retaining walls, arches, walls and columns**.

Classification of Stone Masonry

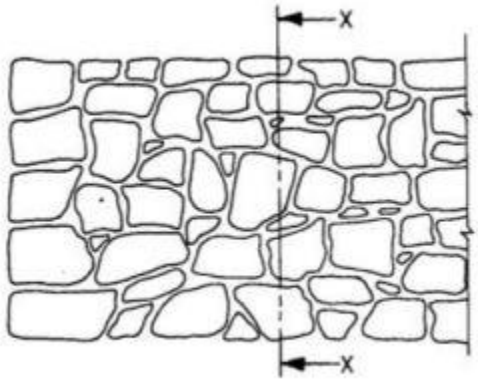
The two main classifications of Stone Masonry are:

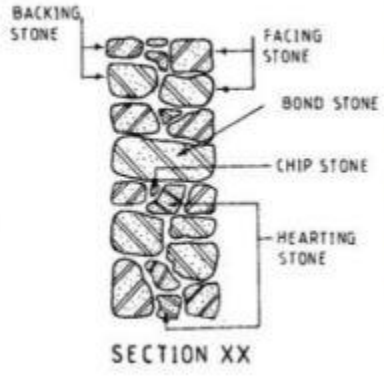
1. Rubble Masonry
2. Ashlar Masonry

1. Rubble Masonry

This is the stone masonry type where stones employed are either undressed or roughly dressed. These masonry constructions do not have a uniform thickness. The strength of the rubble masonry is dependent on the:

- Quality of Mortar Used
- Use of Long through stones
- Proper filling of mortar between the stone spaces and joints





2. Ashlar Masonry

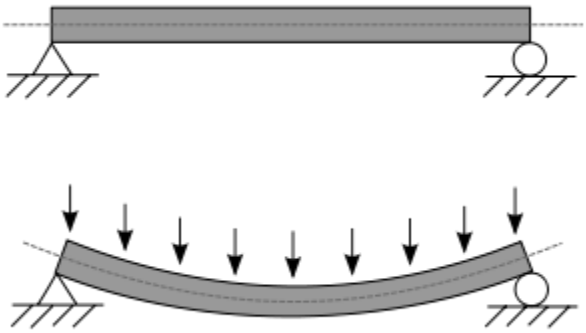
Ashlar masonry is constructed using accurately dressed stones that possess uniform and fine joints. The thickness of the joints ranges about 3mm which is arranged in various patterns. The size of the stone blocks must be in proportion with the thickness of the walls.

Ashlar fine

Ashlar rough

4.Beam

A **beam** is a structural element that primarily resists loads applied laterally to the beam's axis (an element designed to carry primarily axial load would be a strut or column).

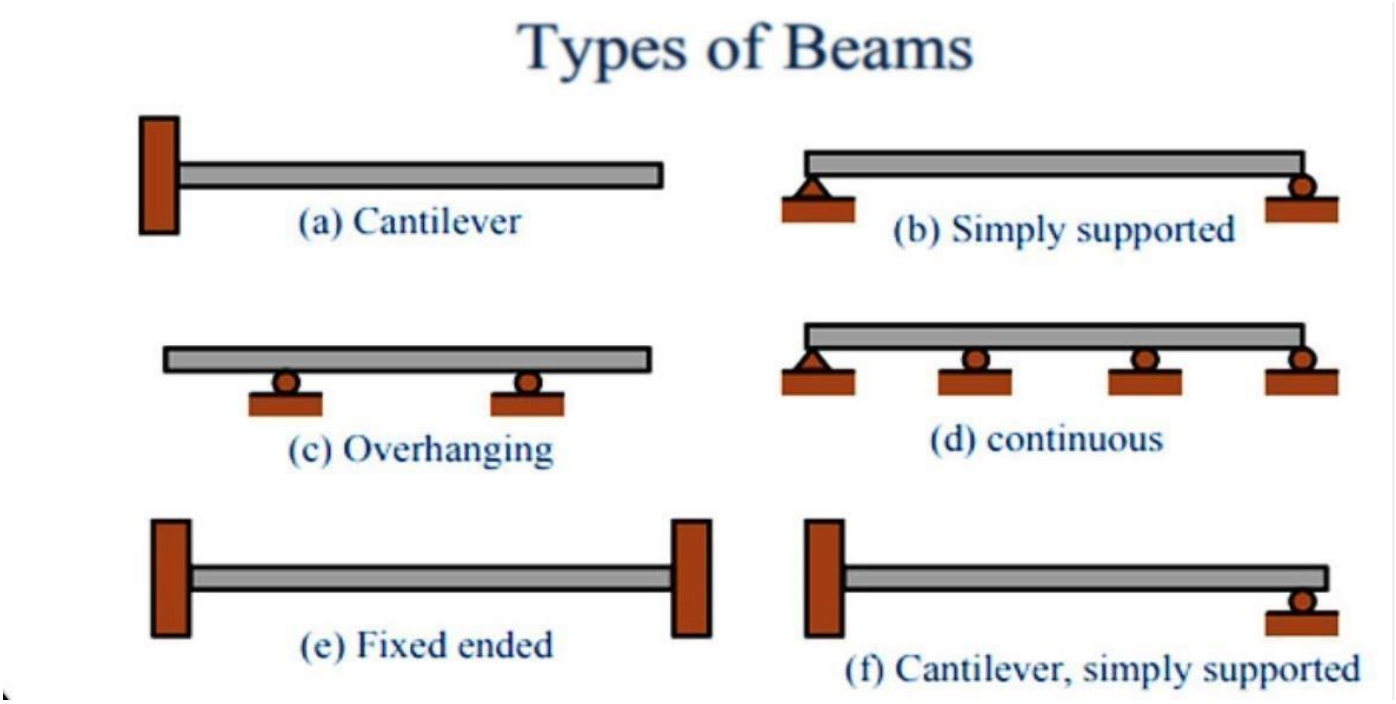


A statically determinate beam, bending (sagging) under a uniformly distributed load

Types of Beams:-

1. **Simply supported** – a beam supported on the ends which are free to rotate and have no moment resistance.
2. **Fixed** – a beam supported on both ends and restrained from rotation.
3. **Over hanging** – a simple beam extending beyond its support on one end.
4. **Double overhanging** – a simple beam with both ends extending beyond its supports on both ends.
5. **Continuous** – a beam extending over more than two supports.
6. **Cantilever** – a projecting beam fixed only at one end.
7. **Trussed** – a beam strengthened by adding a cable or rod to form a truss.

TYPES OF BEAMS

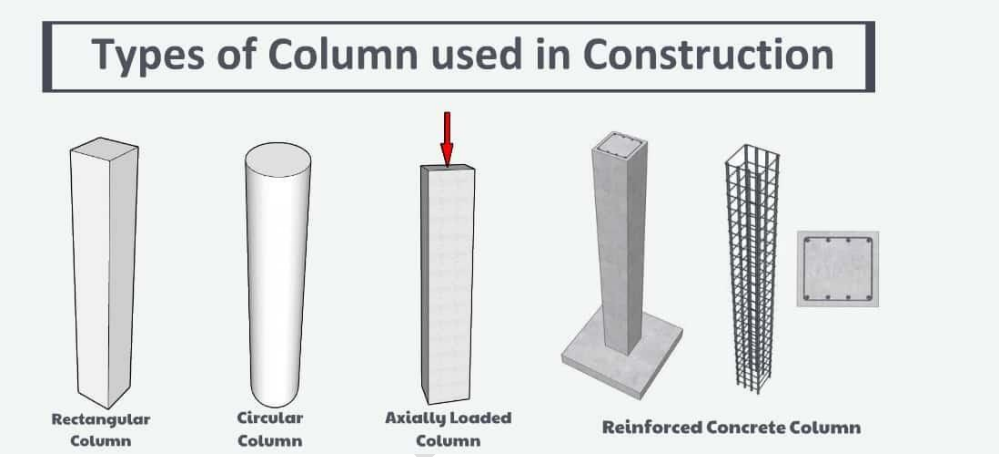


5.Column

A column or pillar in architecture and structural engineering is **a structural element that transmits, through compression, the weight of the structure above to other structural elements below**. In other words, a column is a compression member.

Types of Columns In Civil Engineering

- Square or Rectangular Column.
- Circular Column.
- L and T shaped Column.
- Tied Column.
- Spiral Column.
- Composite Column.
- Axially Loaded Column.
- Uniaxial Eccentrically Loaded Column.



6.Lintels

A **lintel** or lintol is a type of beam (a horizontal structural element) that spans openings such as portals, doors, windows and fireplaces.

Types of Lintel

1. Timber lintel
2. Stone lintel
3. Reinforced concrete lintel
4. Brick lintel
5. Reinforced brick lintel
6. Steel lintel

7.ROOFS

- Uppermost part of building as a structural covering & Protect building from weathering agencies

Requirements

- Should be durable, waterproof, fire resistant
- Should have adequate strength and stability, thermal and sound insulation properties

TYPES OF ROOF

1. Flat Roof- Used in plains where rainfall is less and climate is moderate. Over-head water tanks and other services can be located easily. Leakage problem may occur at latter date also due to development of cracks. Once leakage problem starts, it needs costly treatments
2. Pitched Roof- The slope of roof shall be more than 10°.The sloping roofs are preferred in large spanned structure like workshops, factory etc They are used in places where rainfall is more. Drainage is excellent
3. Curved Roof- They have top surface curved. Such roofs are provided to get architectural effects. It includes shells, domes, folded slab etc. Such roofs are more suitable for public buildings like libraries, theatre etc

Trussed Roof

- A roof truss is a frame work of members arranged in triangles to form a roof system made either of steel or timber

Purlins- these are horizontal steel members to support roofing

material of a roof.

Rise- it is vertical distance between top of ridge & wall plate.

Principal rafter- this is the inclined member running from ridge to the eaves

Roof Coverings

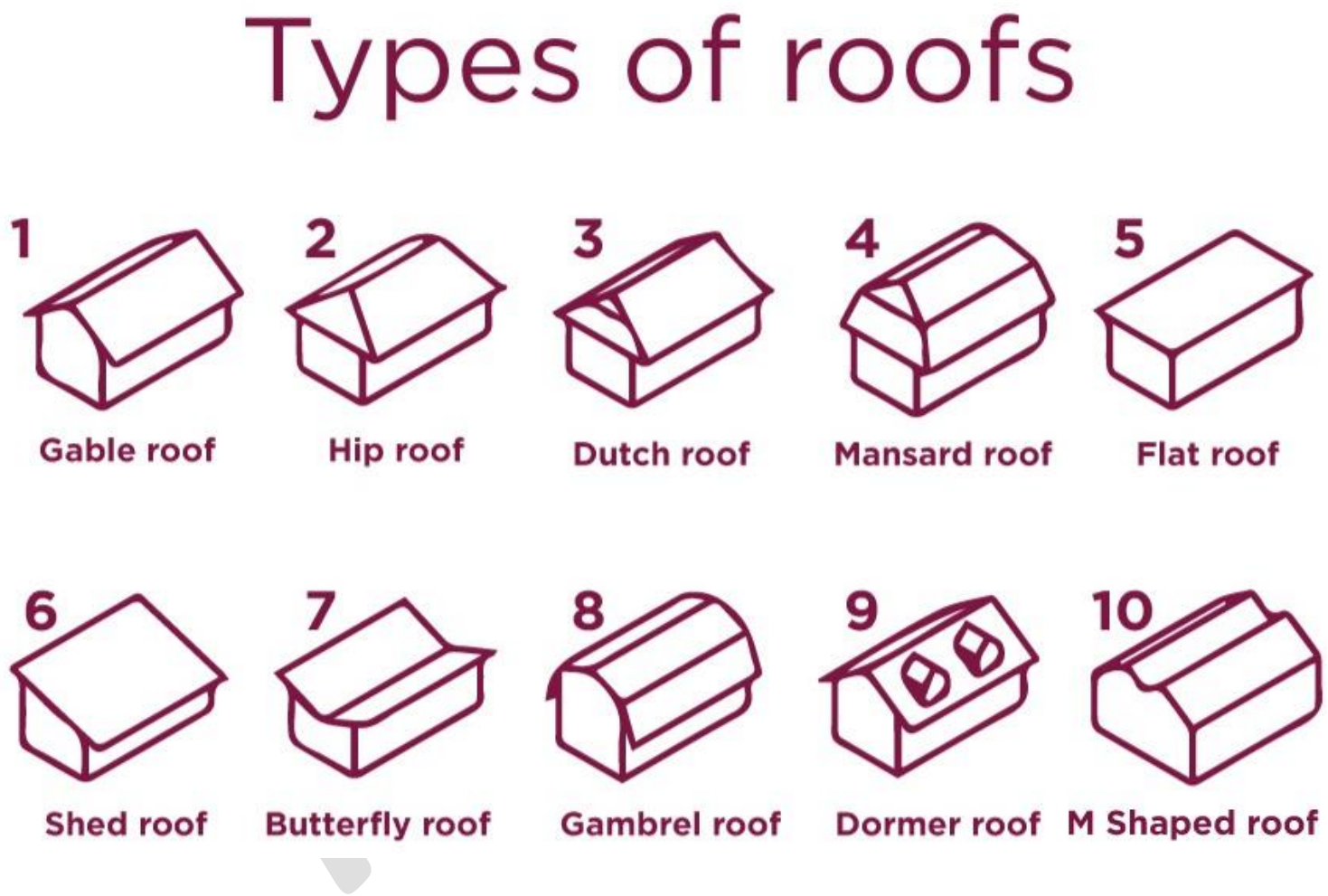
Materials which gives a protective surface to the roofing structure. The **function** is only to prevent ingress or egress of heat & moisture into the building. Various types of coverings depending on :-The character of the building, type of the roofing structure, Local conditions, cost, etc.

TYPES OF ROOF COVERINGS

1. **Thatch Roofing-** This is the cheapest roof covering ,commonly used in villages. It is light in weight, but is highly combustible. It absorbs moisture and will decay easily
2. **Wood**- thin, tapered pieces of wood primarily used to cover roofs and walls of buildings to protect them from the weather
3. **Tile Roofing** - Made of a ceramic material and is hard and brittle, poorly suited for places where tree limbs can fall on a house's roof.
4. **Asbestos Cement Sheet(AC Sheet)** - These are widely used sheets for industrial buildings, factories, theatre etc. They are manufactured from asbestos mixed with O.PC. They are cheap, light weight & durable
5. **Galvanized Iron Sheets(G I Sheets)** – These are iron sheets galvanized with zinc to prevent corrosion. They are stronger than AC Sheets but are costly

6. **Aluminium Sheets** – They are long lasting, economical and corrosion free sheets It is light in weight with better appearance. They are mainly used for industrial buildings and for temporary construction

7. **Fibre Glass Sheets(FRP Sheets) -** Fibre reinforces polymer sheets are made with glass or any suitable fibre with a suitable resin. They are UV protected, non combustible, light weight and durable sheets.



8.FLOORS

Selection criteria/requirements

- Should have Adequate strength and stability, fire resistance, Sound insulation, Damp resistance,Thermal insulation, Less Initial Cost , good Appearance, Cleanliness, Durability

TYPES OF FLOORS

- Depending upon the position of floors, it can be classified as- 1. Ground Floor, 2. Basement Floor , 3.Upper Floors
- Upper floors can be classified based on the material of construction as-

Jack Arch Floor

- Floors used in older days
- It consist of I Section of steel supported on walls and the gap b/w I section is filled with concretearch

RCC Floor

- They are most commonly used in the construction
- The thickness of slab depends on the super imposed load
- For larger span(>4m) and for greater loads, RCC beam and slab construction is adopted

Flat Slab Floor

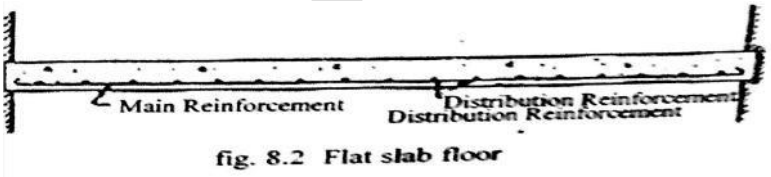


fig. 8.2 Flat slab floor

- In this, the load of reinforced slab is transferred directly to the supporting wall without beam

Precast concrete floor-

With advancement in technology, it is possible to Cast suitable elements of floors with concrete andplace it over walls or beams. Precast units are jointed & grouted with mortar at site. No formwork required

TYPES OF FLOORING

1. Mud Flooring

- Used for unimportant buildings, particularly in villages.
- Merits - Cheap, hard and fairly impervious. Good thermal insulation.
- demerits - For proper maintenance, the floors are required to be given a wash of cow dung plasteronce a week

2. Brick Flooring

- Used in places where heavy articles are to be stored e.g. warehouses, stores and godowns
- Used in alluvial places like U.P. where stone is scarce and well burnt bricks are readily available.
- Merits- Durable and hard, Non-slippery and fire resistant. Initial cost is less.
- demerits -It is absorbent

3. Mosaic Flooring:

- Made of small pieces of broken tiles of glazed/cement/marble arranged in different pattern
- Tiles used are available in a variety of patterns and colours .
- Commonly used in operation theatres, temples, bathrooms and superior type of building floors

4. Tiled Flooring:

- Constructed from square or any other shape made of clay, cement or terrazzo.
- Available in sizes from 20cmx20cm to 120cmx 120cm.
- Merits- Quick laying of floors. Easily repaired.
- Demerits- Initial cost is high. On becoming wet, provides a slippery surface.

5.- Timber Flooring

- Not used much for residential buildings in India because it is costly.
- Used for carpentry halls, dancing halls, auditoriums etc.

Demerits- Entire area below the floor is covered with an impervious material *to prevent dampness*

9.PLASTERING

Applying mortar coats on surfaces of walls, columns, ceiling to get smooth finish is termed as plastering

Purpose / objective of Plastering

1. **T**o conceal defective workmanship in masonry or concrete
2. **T**o give even, smooth surface to avoid catching of dust.
3. **T**o preserve & protect the wall from rain water and other atmospheric agencies.

Types of Plastering- Depending upon the binding material

- **Cement Plastering, Mud Plastering, Lime Plastering, Lime cement plaster**

Lime plastering

- Lime plaster is a mixture of calcium hydroxide and sand (or other inert fillers) in 1: 1 ratio. Carbon dioxide in the atmosphere causes the plaster to set by transforming the calcium hydroxide intocalcium carbonate (limestone).

Cement plastering

- Cement and sand in required proportions (1 : 3 or 4) are first thoroughly mixed in dry conditionsand then water is added to form a paste of required consistency.
- This prepared mortar should be consumed within 30 minutes after the addition of water.

Procedure /method for cement plastering

PLASTERING METHOD

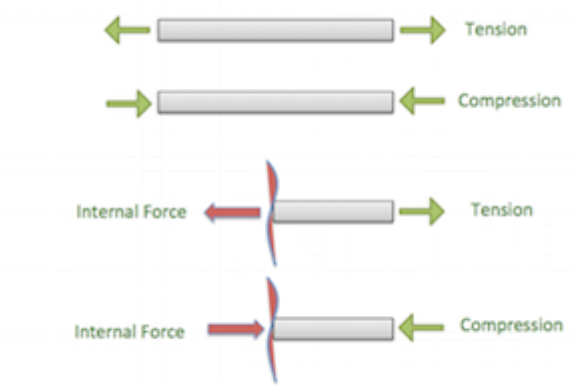
1. Ensure the wall surface is clean and free from dust, and any loose part of mortar/plaster from brick laying process. Sprinkle water over the surface to ensure better sticking of the plaster.
2. Mix appropriate amount and ratio of cement with lime, water and sand. This is done inside the bucket, with the help of the electric mixer.
3. Using trowel, scoop an amount of plaster which could be hold by the hawk.
4. Then collect half that amount from the hawk, onto the trowel, using a slice (into the middle) and then a flick of the wrist to scoop it up, with the mortar mixture facing upwards.
5. Then starting at the bottom of the wall, use nice and smooth strokes with the trowel and press the mortar onto the wall and try and distribute the plaster on the trowel evenly over a certain area.
6. Always keep that trowel at a slight angle when laying up (applying) plaster or the trowel will "stick" in one spot on the wall, by the suction effect that the wall has when the plaster is drying. (Suction defined as capillary suction)

Part-3

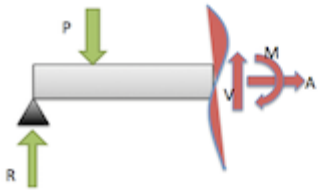
1.Mechanics

a branch of physical science that deals with energy and forces and their effect on bodies .

Internal forces:- are produced from the external forces acting on structure members such as poled, beam or column. Generally, we have three types of internal forces: axial, shear and moment.



R + P + M + H + Q + N = Zero



R + P + V + M + A = Zero

External forces :- are forces caused by **external agent present outside of the system**.
Examples of external forces include **dead loads**, such as the weight of the structure itself and the non-structural materials it supports, and live loads, which include moving loads, such as occupants, goods, and furniture, as well as wind loads, seismic loads, and impact loads, among others

What are the 4 external forces?

For our purposes, we will simply say that external forces include **the applied force, normal force, tension force, friction force, and air resistance force**.

Stress

In mechanics, stress is defined as a force applied per unit area. It is given by the following formula:

$$\sigma = F/A$$

where, σ is the stress applied, ***F*** is the force applied and ***A*** is the area of force application. The unit of stress is N/m2N/m2.

Types of Stress

Stress applied to a material can be of two types as follows:

Tensile Stress

Tensile stress is the force applied per unit area, increasing a body's length (or area). Objects under tensile stress become thinner and longer.

Compressive Stress

Compressive stress is the force applied per unit area, which decreases the length (or area) of a body. The object under compressive stress becomes thicker and shorter.

Strain

Strain is the amount of deformation experienced by the body in the direction of force applied, divided by the initial dimensions of the body.

The following equation gives the relation for deformation in terms of the length of a solid:

$$\epsilon=\delta l/L$$

where, $\epsilon\epsilon$ is the strain due to stress applied, $\delta l\delta l$ is the change in length and L is the original length of the material.
The strain is a dimensionless quantity as it just defines the relative change in shape.

Types of Strain

Strain experienced by a body can be of two types depending on stress application as follows:

Tensile Strain

Tensile strain is the change in length (or area) of a body due to the application of tensile stress.

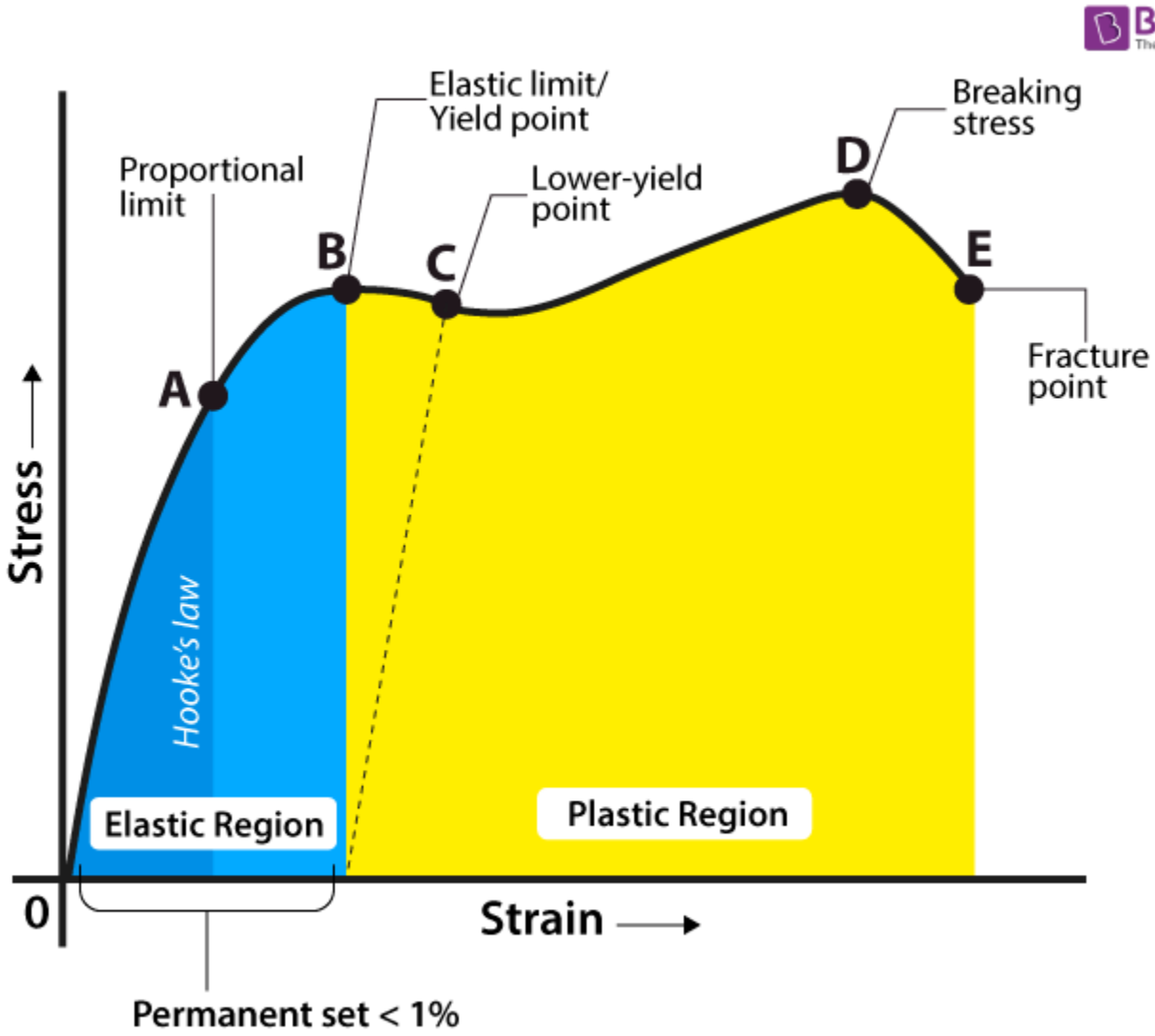
Compressive Strain

Compressive Strain is the change in length (or area) of a body due to the application of compressive strain.

Stress-Strain Curve

When we study solids and their mechanical properties, information regarding their elastic properties is most important. We can learn about the elastic properties of materials by studying the stress-strain relationships, under different loads, in these materials.

The material's stress-strain curve gives its stress-strain relationship. In a stress-strain curve, the stress and its corresponding strain values are plotted. An example of a stress-strain curve is given below.



Explaining Stress-Strain Graph

The different regions in the stress-strain diagram are:

(i) Proportional Limit

It is the region in the stress-strain curve that obeys Hooke's Law. In this limit, the stress-strain ratio gives us a proportionality constant known as Young's modulus. The point OA in the graph represents the proportional limit.

(ii) Elastic Limit

It is the point in the graph up to which the material returns to its original position when the load acting on it is completely removed. Beyond this limit, the material doesn't return to its original position, and a plastic deformation starts to appear in it.

(iii) Yield Point

The yield point is defined as the point at which the material starts to deform plastically. After the yield point is passed, permanent plastic deformation occurs. There are two yield points (i) upper yield point (ii) lower yield point.

(iv) Ultimate Stress Point

It is a point that represents the maximum stress that a material can endure before failure. Beyond this point, failure occurs.

(v) Fracture or Breaking Point

It is the point in the stress-strain curve at which the failure of the material takes place.

Hooke's Law

In the 19th-century, while studying springs and elasticity, English scientist Robert Hooke noticed that many materials exhibited a similar property when the stress-strain relationship was studied. There was a linear region where the force required to stretch the material was proportional to the extension of the material, known as Hooke's Law.

Hooke's Law states that the strain of the material is proportional to the applied stress within the elastic limit of that material.

Elastic body in mechanics

A solid body for which the additional deformation produced by an increment of stress completely disappears when the increment is removed. Also known as elastic solid.

In physics and materials science, **elasticity** is the ability of a body to resist a distorting influence and to return to its original size and shape when that influence or force is removed. Solid objects will deform when adequate loads are applied to them; if the material is elastic, the object will return to its initial shape and size after removal. This is in contrast to *plasticity*, in which the object fails to do so and instead remains in its deformed state.

Bridge

A bridge is a structure that is **built over a railway**, river, or road so that people or vehicles can cross from one side to the other. ... A bridge between two places is a piece of land that joins or connects them.

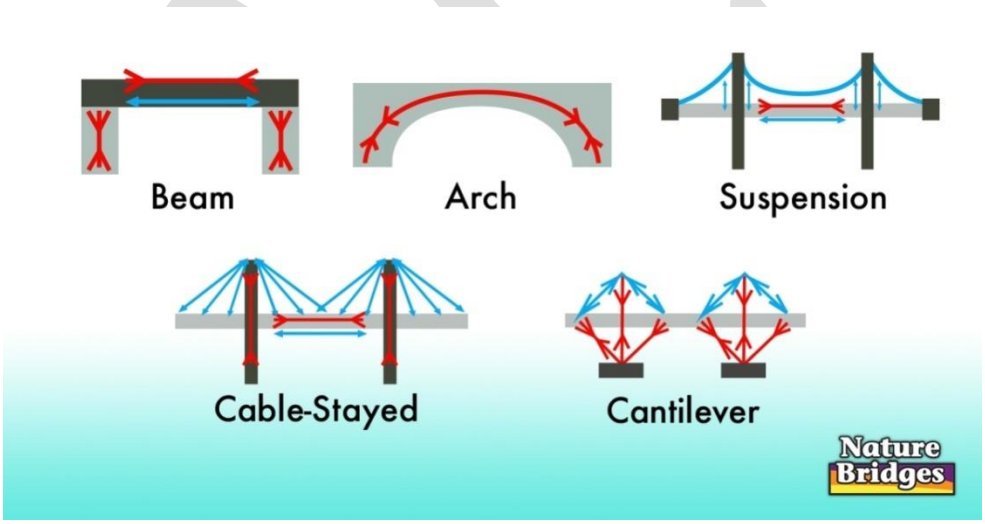
1 : a structure built over something (as water, a low place, or a railroad) so people can cross.

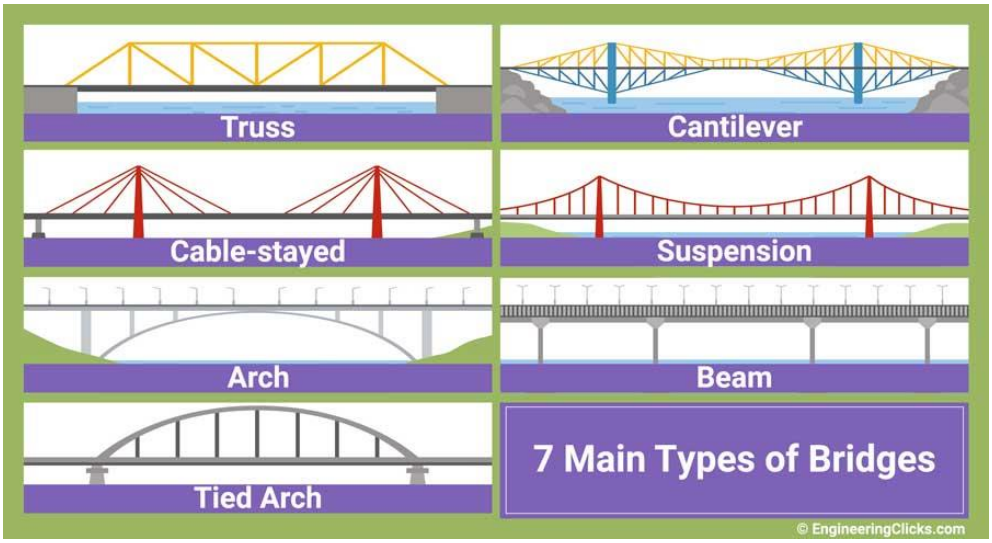
2 : the place on a ship where the ship is steered.

3 : something that joins or connects : something **like a bridge the bridge of the nose** a bridge between cultures.

Types of Bridges

- Beam Bridge. A beam bridge is known for being the simplest and most cost-effective bridge to build. ...
- Cantilever Bridges. ...
- Suspension Bridges. ...
- Arch Bridge. ...
- Short-Span Bridge. ...
- Beam Bridge. ...
- Cantilever Bridges. ...
- Suspension Bridges.

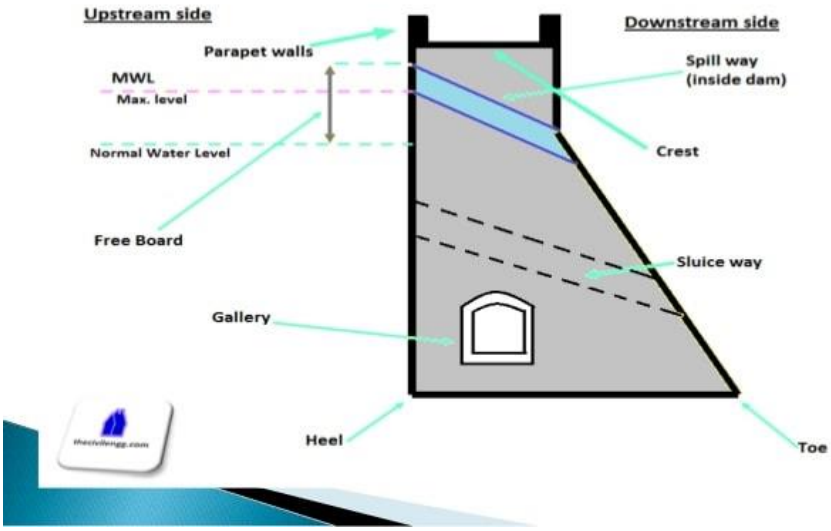



Truss
Cantilever
Cable-stayed
Suspension
Arch
Beam
Tied Arch
7 Main Types of Bridges
© EngineeringClicks.com

Dam

structure built across a stream, a river, or **an estuary to retain water**. Dams are built to provide water for human consumption, for irrigating arid and semiarid lands, or for use in industrial processes.
A dam is **a barrier that stops or restricts the flow of surface water or underground streams**. ... Dams generally serve the primary purpose of retaining water, while other structures such as floodgates or levees (also known as dikes) are used to manage or prevent water flow into specific land regions.

STRUCTURE OF DAM :



the purpose of dam:-A dam is a structure built across a stream or river **to hold water back**. Dams can be used to store water, control flooding, and generate electricity.

Dams are classified on the basis of following types:

} By structure

}By material.

} **Arch dams**

} Gravity dams

} Arch – Gravity dams

}Embankment dams.

} Situated at narrow canyon with steep side walls

} Constant angle dams are more common than constant radius

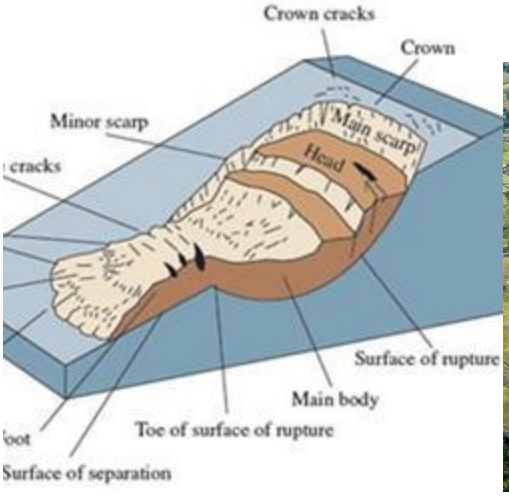
} Double curvature

} Require good rock foundation.

Uses of Dam:-structure built across a stream, a river, or an estuary to retain water. Dams are **built to provide water for human consumption**, for irrigating arid and semiarid lands, or for use in industrial processes.

Landslide

its also called landslip, **the movement downslope of a mass of rock, debris, earth, or soil** (soil being a mixture of earth and debris). Landslides occur when gravitational and other types of shear stresses within a slope exceed the shear strength (resistance to shearing) of the materials that form the slope.



Types of Landslides

They can occur because of various reasons. We can classify them into four categories which are mentioned below:

- **Falls Landslides**

  It means falling of some material or debris or rocks etc. from a slope or a cliff which leads to a collection of this debris at the base of the slope.

- **Topple Landslides**

  These can occur because of some fractures between the rocks and the tilt of the rocks because of gravity without collapsing. Here, we see the forward rotational movement of the material.

- **Slides**

  It is a kind of landslide when a piece of the rock slides downwards and gets separated from it.

- **Spread**

  It happens on flat terrain and gentle slopes and can occur because of softer material.

Causes of Landslide

Landslides are caused by various factors which are mentioned below:

- It can be caused because of heavy rain.
- Deforestation is also one of the main reasons for landslides because trees, plants, etc. keep the soil particles compact and due to deforestation the mountain slopes lose their protective layers because of which the water of the rain flows with unimpeded speed on these slopes.
- It can be caused by earthquakes as well.

  For example, in the Himalayas, the tremor occurred because earthquakes unstabilized the mountains which leads to landslides.
- Volcanic eruptions in specific regions can also cause landslides.
- Landslides often occur in mountain regions while making roads and construction, a large number of rocks has to be removed which can cause landslides over there.
- In the regions of North East India, landslides occur because of shifting agriculture.
- Due to the increasing population, a large number of houses are being created which leads to the creation of a large amount of debris which can cause landslides.

Effects of Landslide

Let us look at the effects of landslide in points:

Landslides can disturb the social and economic environment with the number of other damages which are mentioned below:

Short Term Impacts

- The natural beauty of the area is damaged.
- Loss of life and property
- Road blocks

- Destruction of railway lines
- Channel blocking because of the falling of rocks.
- It leads to the diversion of river water which can cause floods as well.

Long Term Impacts

- Landscape changes can be permanent.
- The loss of fertile land or cultivation land.
- Erosion and soil loss can lead to environmental problems.
- Population shifting and migration.
- Effects on the sources of water.
- Some roads can be damaged or closed permanently.

Prevention and Mitigation

The following measures can be taken in this regard:

- The country should identify the vulnerable areas and actions should be taken in this regard on a priority basis.
- Early warning systems and monitoring systems should be there.
- Hazard mapping can be done to identify the areas which are more prone to landslides.
- Restriction on the construction in the risky areas should be imposed.
- Afforestation programs should take place.
- Restricting development in landslide areas and protecting the existing ones.
- The country should specify codes or standards etc. For the construction of the buildings and other purposes in such areas of risk.
- Insurance facilities should be taken by the people to deal with the loss.
- Terrace farming should be adopted in hilly areas.
- Response teams should be quick to deal with landslides if they occur.

Part-4

SURVEYING

Surveying is the art of and science of determining the relative positions of various points or stations on the surface of the earth by measuring the horizontal and vertical distances, angles, and taking the details of these points and by preparing a map or plan to any suitable scale."

Leveling is a branch of surveying which deals with the measurement of relative heights of different pointson, above or below the surface of the earth. Thus in leveling, the measurements (elevations) are taken in the vertical plane

Objective of Surveying-

- to prepare a map or plan of areas to show positions of objects on surface of earth
- To layout alignments of different engineering features such as buildings, roads, railways, dams,reservoir, canals, tunnel, airports, bridges etc.

Purpose /uses of surveying-

- Preparation military map, geological map, archaeological map etc.
- Layout of alignment of engineering structures
- Measurement of quantities in cutting & filling
- for finding capacity of reservoir
- For setting out work and transferring details from the map on the ground

Purpose of Leveling-

i) To determine difference in levels/ objects

ii) To establish pints or erect machinery or construct building components at a prefixed level

Primary Classifications/ Divisions of Surveying-

- Plain Surveying- The plain surveying is that type of surveying in which earth surface is consideredas a plane. In such surveying a line joining any two stations is considered to be straight. The triangle formed by any three points is considered as a plane triangle, and the angles of the triangle are considered as plain angles. Surveying is carried out for a small area of less than 250 km^2. It is carried out by local or state agencies like, Irrigation department, Railway department.
- **Geodetic Surveying**- The geodetic Surveying is that type of surveying in which the curvature of the earth is taken into account. It is generally extended over larger areas. The line joining any two stations is considered as curved line. The triangle formed by any three points is considered to be spherical and the angles of the triangle are considered to be spherical angles. Geodetic surveying is carried out for a larger area exceeding 250 km^2

Classification based on Purpose

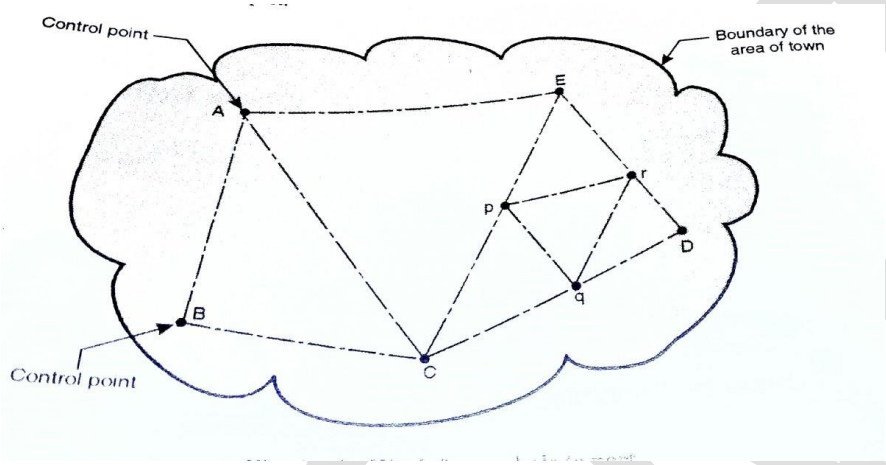
- **Geological Survey:**
  In this both surface and subsurface surveying are conducted to locate different minerals and rocks. In addition, geological features of the terrain such as folds and faults are located.
- **Mine Survey** - includes include both surface and underground surveys. It is conducted for theexploration of mineral deposits and to guide tunneling and other operations associated with mining
- **Archaeological Survey**- It is conducted to trace relics of past civilization, kingdoms, forts,temples, etc.
- **Military Survey**- It has a very important and critical applications in the military. It is conducted tolocate strategic positions for the purpose of army operations.

Classification of Surveying based on instruments used-

Chain Survey, Compass Survey, Plane Table Surveying, Theodolite Survey, Tachometry Survey,Leveling Survey, Photogrammetric Survey, EDM Survey

Principles of Surveying – Following two main principle of surveying.

1) **To work from whole to the part.:-**Before starting the actual survey measurements, the surveying is to work from around the area to fix the best positions of survey lines and survey stations.



2) **To locate a new station by at least two measurement (linear or angular) from fixed reference point**:-

According to the second principle, **the new stations should always be fixed by at least two measurements (linear or angular) from fixed reference points**. Linear measurements refer to horizontal distances measured by chain or tape.

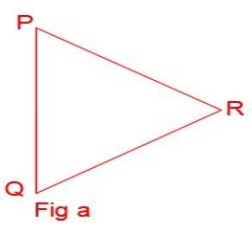


Fig a

Fig b

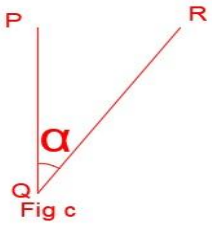


Fig c

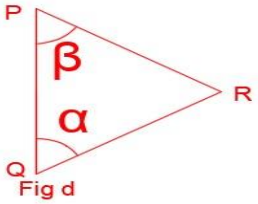


Fig d

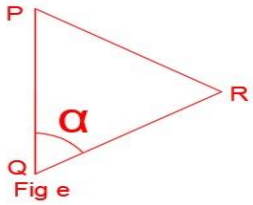


Fig e

Measurement of Distances:-In surveying, the distance between two points is understood to mean the **horizontal distance**, regardless of the relative elevation of the two points. Frequently, the lay of the land between the two points is not uniform, or the elevation of the two points is very different.

Linear Measurements

- Horizontal distance
- Vertical Distance

Angular Measurements

- Horizontal angle
- Vertical angle

In Surveying all measurements are horizontal, can be inclined; reduce to horizontal and vertical components in plotting. Distance between 2 points on a plan or map is always horizontal distance irrespective of their elevation, (distance between their projection on horizontal plane).

How are these Measured and which instrument should I use?

Distances (Horizontal)

Chaining, Taping (steel tape), tachometry (theodolite), electronic (EDM, GPS)

Angles

Tachometry (theodolite, total station),

Heights

Leveling Equipment (level, theodolite, total station)

METHOD OF DETERMINING DISTANCE

•The horizontal or linear distance between two points is the distance between the plumb line through the points.
•The cost of making a measurement increase with the desired precision of the work.
There are three main types of horizontal or linear distance measurement.
1. Direct Method.
2. Optical Method.
3. Electronic Method.

1. Direct Method:- This method is most common method for linear measurement. In this method the distance are measured actual on the ground.List of Instrument used for direct measurement.
By chain or Tape or other Instruments directly
(i) Passometer:- The passometer is used counting the number of steps automatically by some mechanical device.

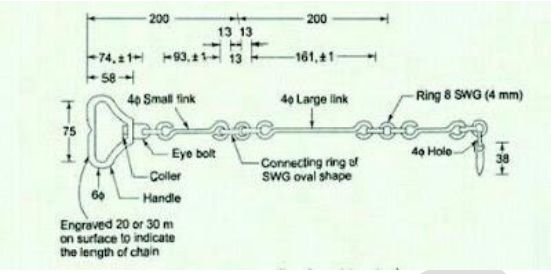
(ii) speedometer:- This is used in automobile for recording distance.

(iii) Perambulator:- This instrument a wheel fitted with a fork and handle and shows a distance per revolution.

(iv) Chain:-This is an accurate and common method of measuring distance in this method the distance is measured in the field by chain or tape. A metric chain divided into 100 links is made of galvanized mild steel wire 4mm in diameter. The ends of each link are bent into loops and connected together by means of three oval rings. Which afford flexibility.

Chaining and Taping

- Most Common method is the method of measuring distance with a Chain or Tape, Called Chaining.
- For Ordinary work (less Precision) Chain is used.
- For Great Accuracy Steel Tape is used.
- To measure distances with Chain is called Chaining while to measure distances with Tape is called Taping
- Chain is composed of 100-150 pieces of galvanized mild steel called LINKS.
- Links are connected to each other through oval ring for flexibility.
- End Provided with Brass handle to drag chain, Outside of handle is ZERO.
- Length Measured from outside of one handle to outside of other handle.
- Metallic tags are attached to specified distances.



3. Optical Method:-In this method, the distance is not measured in the field. It is computed indirectly. The principal of optics is used to determine the distance observations are taken through a telescope fitted with a stadia diaphragm in the transit theodolite.
   Optical Method:-Tacheometer
   The tachometer is a branch of an angular survey in which the horizontal and vertical distance of points is obtained by instrumental observation. It is the most rapid and less accurate. It is used where the chaining and leveling are difficult and inaccurate.
   3.Electronic Method:-Electronic method is more accurate and has high precision. This method is more rapid. Distance is measured with instruments that rely on propagation, reflection, and subsequent reception of either radio or light waves. Modern E.D.M instruments,

   basically two types:

i. Electro-optical instruments:- which use light waves measuring distances such as Geodimeter, Makometer, Total station
Total station:-Now days commonly use of measurement of distance, surveying, and leveling. It consists of an EDM electronic theodolite as one unit.it also includes a data collector that automatically collects field data and transfers them to a computer that processes the observed data. It is a high precision instrument.

ii Microwave instruments:-which use radio waves for measurements of distance, such as Electrotape,, Diameter and Micro chain.

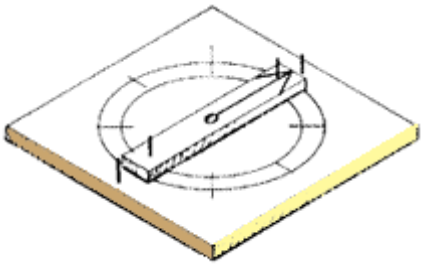
Measurements of Angles:-Theodolite for Measurement of Angles in Surveying

A theodolite is a precision instrument that is used to measure the angle in the horizontal and vertical planes. Theodolite is most commonly used in surveying. But they are also used in the areas of metrology and rocket launch technology.

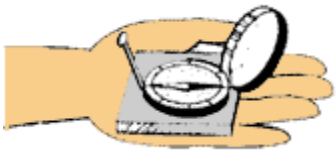
Horizontal angle measurement methods

Method	Horizontal angle	Accuracy	Remarks	*Equipment*[2]
Home-made graphometer	Medium to large	Low	Best for 40-80 m For angles greater than 10 For angles greater than 10 No magnetic disturbance	Graphometer
Magnetic compass	Medium to large	Medium	Best for 40-100 m For angles greater than 10 No magnetic disturbance	Compass
Compass or protractor	All sizes	Low to medium	Dry weather only	Simple compass, protractor, drawing sheet
Plane-table	All sizes	Low to medium	Dry weather only	Plane-table drawing paper

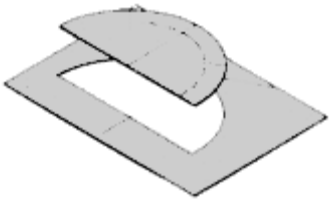
Right-angle method	Small	Medium to high	Perpendicular to be set out	Measuring line
Theodolite or transit	All sizes	High	Useful on long distances	Transit level with graduated horizontal circle
Miscellaneous	Right-angle only	Medium to high	Adapt method to length of perpendicular	Various

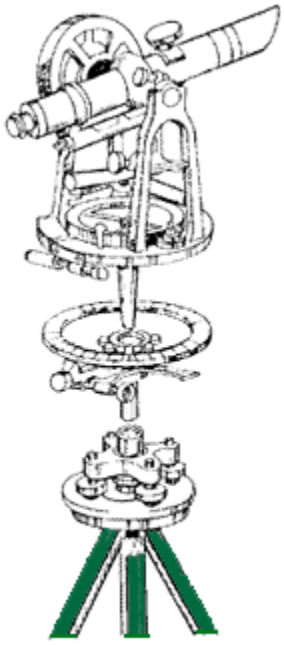


Magnetic compass



Protractor





Théodolite

Plane-table

What is the compass surveying?

Compass surveying is **a type of surveying in which the directions of surveying lines are determined with a magnetic compass**, and the length of the surveying lines are measured with a tape or chain or laser range finder. The compass is generally used to run a traverse line.

What is compass surveying used for?

Compass surveying is an important branch of surveying which is usually adopted in **determining the position of an object both by angular and linear measurements**. Here angular measurements are taken using a compass and linear measurements are determined using chain or tape.

What are the types of compass survey?

The main types of compasses that are used in compass surveying are: **Prismatic Compass**. **Surveyor's Compass**.

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Temporary Adjustments for Prismatic Compass

- Centering.
- Levelling.
- Focusing the Prism.

- What is difference between prismatic compass and surveyor compass?
- Difference between Prismatic compass and Surveyor compass?

  ...

  Welcome back.

Prismatic compass	Surveyor compass
Graduation in prismatic compass are marked from 0∘ to 360∘	Surveyor compass is divided into four quadrant and graduation are marked from 0∘ to 90∘ in each quadrant.

What are the instruments used in compass surveying?

The various instruments used in the compass survey are :

- Prismatic compass.
- Tape.
- Ranging rods.
- Tripod.
- Arrows.
- Plumb Bob.

Bearing:- In land surveying, a bearing is **the clockwise or counterclockwise angle between north or south and a direction**. For example, bearings are recorded as N57°E, S51°E, S21°W, N87°W, or N15°W.

There are four types of bearings most commonly used in land navigation:

- true bearings.
- grid bearings.
- magnetic bearings.
- compass bearings.

Bearing :
The horizontal angle between the reference meridian and the survey line is termed as bearing of the survey line.

Magnetic Bearing:
The magnetic needle of the compass always points towards the magnetic north-south (N-S) direction indicating earth's magnetic axis. Since this direction is same at all the places on the earth's surface, it is universally used as the reference direction. The angle made by survey line in a clockwise direction with reference to magnetic N-S line is termed as magnetic bearing of the line. The value of magnetic bearing ranges from 0 o to 360° .

True Bearing:
The geographical north of earth is different from the magnetic north. Hence, the angle which the survey line makes with the true geographical north is termed as true bearing of the survey line.

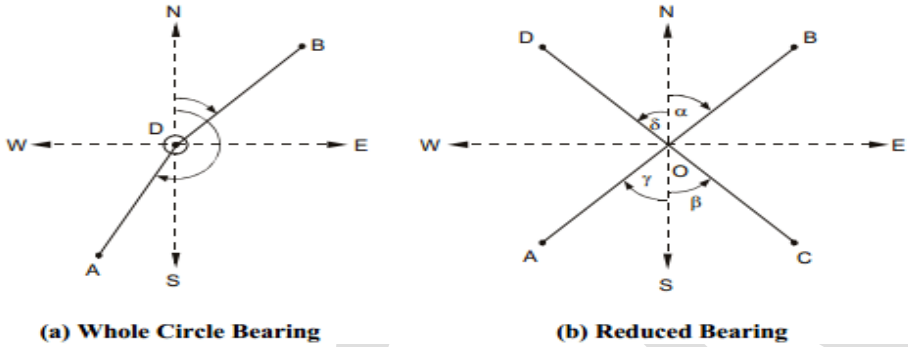
Arbitrary Bearing:
It is the horizontal angle which a survey line makes with any arbitrary meridian, which is any convenient direction towards a permanent and prominent mark or signal, such as a church spire or top of a chimney. Such bearings are used to determine the relative position of line in a small area.

Whole Circle Bearing (WCB):
The complete circle of angular measurement starts with north as 0 ° and ends at north at 360° . The bearing of line directly obtained by magnetic needle ranging from 0 o to 360 ° is called whole circle bearing .

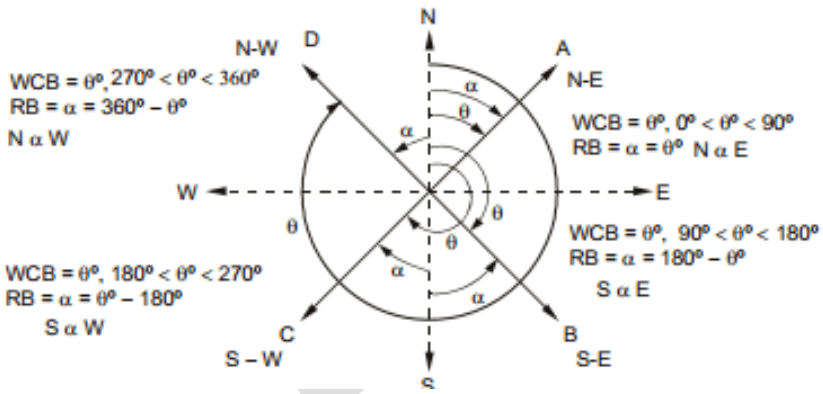
Reduced Bearing (RB):
The more convenient way to comprehend the direction of a survey line is to represent the bearing on a quadrantal system. The angle is measured with respect to N–S line towards east or west as shown in Figure 3.1(b). The relationship between WCB and RB is shown in Figure 3.1(c).

Fore Bearing (FB):
The angle measured in the direction of survey line from starting survey station to the next station is called fore bearing. In Figure 3.1(d), if the bearing of line AB is measured from A towards B, it is known as forward bearing or fore bearing.

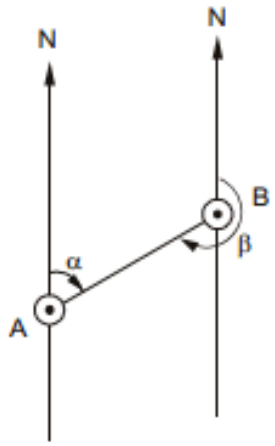
Back Bearing (BB):
It is the bearing of the survey line taken from the forward survey station to the preceding station from which the fore bearing was taken earlier. In Figure , if the bearing of same line AB is measured from B towards A, it is known as backward bearing or back bearing.



(a) Whole Circle Bearing **(b) Reduced Bearing**



(c) Relationship between WCB and RB



∠NAB = α = Fore Bearing
∠NBA = β = Back Bearing
∴ Fore Bearing – Back Bearing = 180°

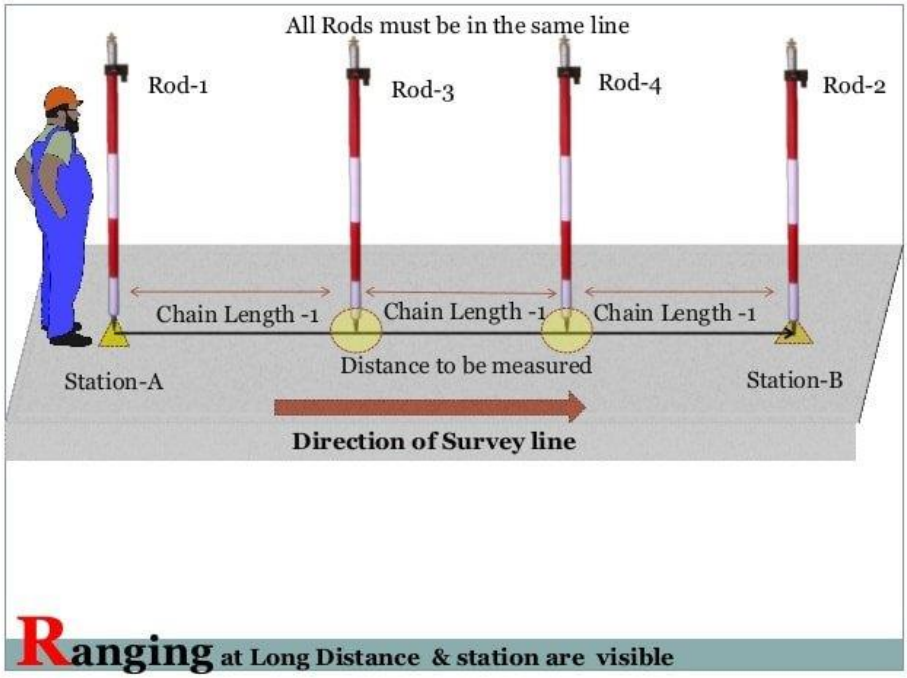
(d) Fore Bearing and Back Bearing

Bearing of a Survey Line

Ranging- When a survey line is longer than a chain length, it is necessary to align intermediate points on chain line so that the measurements are along the line. The process of locating intermediate points on survey line is known as ranging.

There are two methods of ranging.

1. Direct ranging and
2. Reciprocal ranging



a. Direct Ranging

Direct ranging is the method of ranging that is adopted when the two survey stations are inter-visible i.e. the two endpoints of the survey line are visible.

In general, direct ranging can be further grouped into the following:

i. Ranging by Eye

It is the type of method of direct ranging that is done simply by the aid of the eyes of the surveyor.

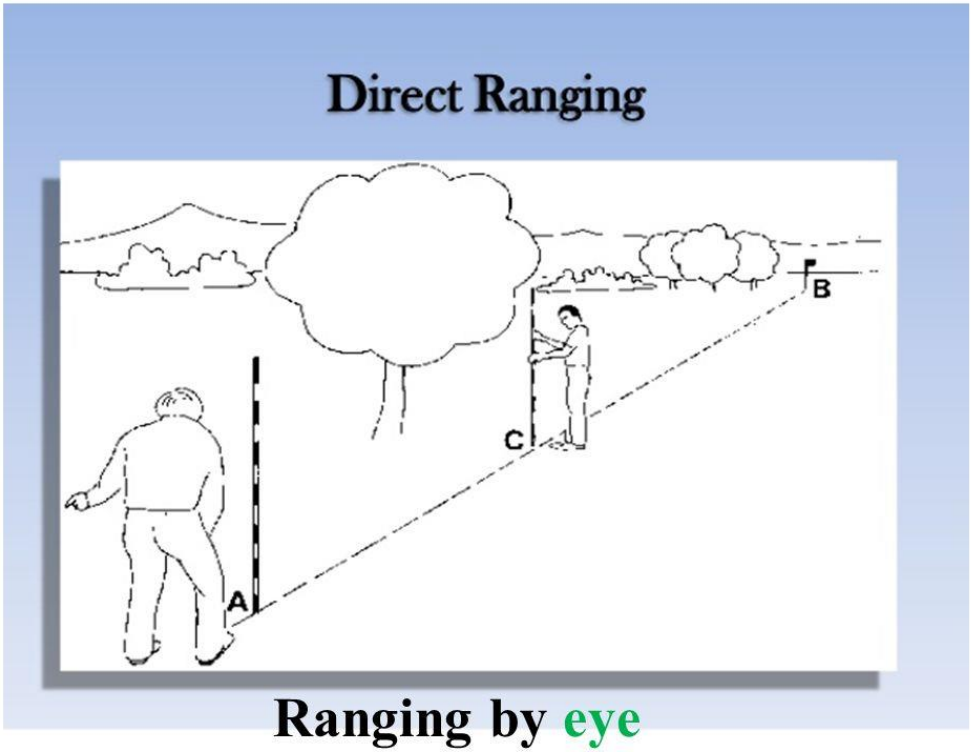
As shown in the figure below, let A and B be the two inter-visible points at the ends of the survey line.

The surveyor then stands with a ranging rod at point A concerning point B.

Then, another person takes the ranging rod and fixes or establishes an intermediate point between the line AB. Let the intermediate point established be C.

It must be noted that the distance of the intermediate point is not greater than one chain length from the first point A of the survey line.

The surveyor at point A then signals another person at the intermediate points so that the ranging rod is in perfect line with the endpoints A and B. Hence, the intermediate points are determined.



ii. Ranging by Line Ranger

Ranging by Line Ranger is the type of direct ranging method in which the intermediate points are fixed directly utilizing an instrument known as **line ranger**.

The **line ranger** is an instrument that has either two plane mirror arrangements or two isosceles prisms that are placed one over the other.

The arrangement and silvering of the diagonals of the prism are done such that they reflect incident rays.

Let us consider two endpoints of a survey line namely A and B as shown in the figure below.

At first, the surveyor places two rods at points A and B.

Let C be the intermediate point to be fixed. The surveyor then holds the line ranger at the intermediate point C simply by eye judgment.

Then, the lower prism of the ranger receives the rays coming from point A. This ray is reflected by the diagonal towards the observer.

Similarly, the upper prism of the ranger receives the rays coming from point B. This ray is then reflected by the diagonal towards the observer.

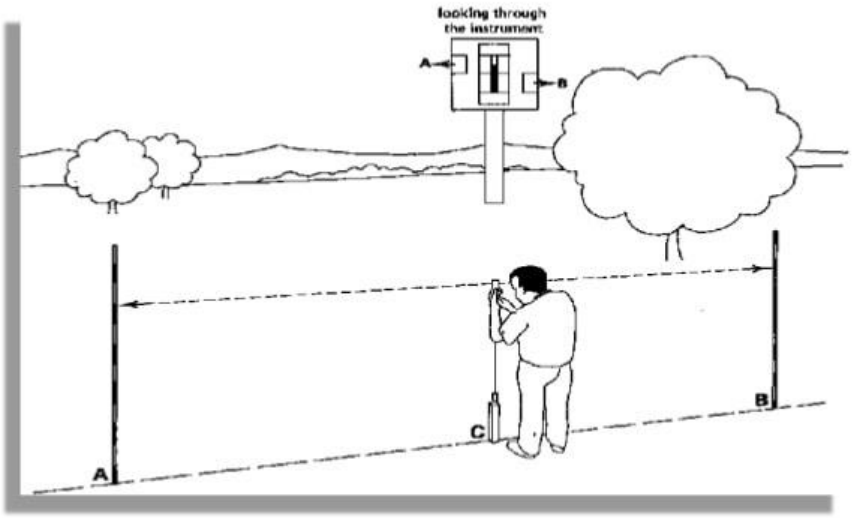
Thus, the observer can sight both the images of the ranging rods at points A and B.

The images of the ranging rods are not in the same vertical line initially. Hence, the surveyor then moves the line ranger till the two images of the ranging rods lie in the same vertical line.

Once the images are in the same line, point C is transferred to the ground utilizing the plumb bob.

The major advantage of this method over the eye judgment method is that this method can be conducted easily by one person. The accuracy achieved by this method is also higher.

Ranging by Line Ranger



b. Indirect Ranging

Indirect Ranging is the method of ranging that is used when the two endpoints of the survey line are either not inter-visible or the two points are at a very long distance.

As shown in the figure below, first of all, the two intermediate points M_1 and N_1 are located close to the chain such that from point M_1 both N_1 and B are visible.

Similarly from N_1 both M_1 and A must be visible.

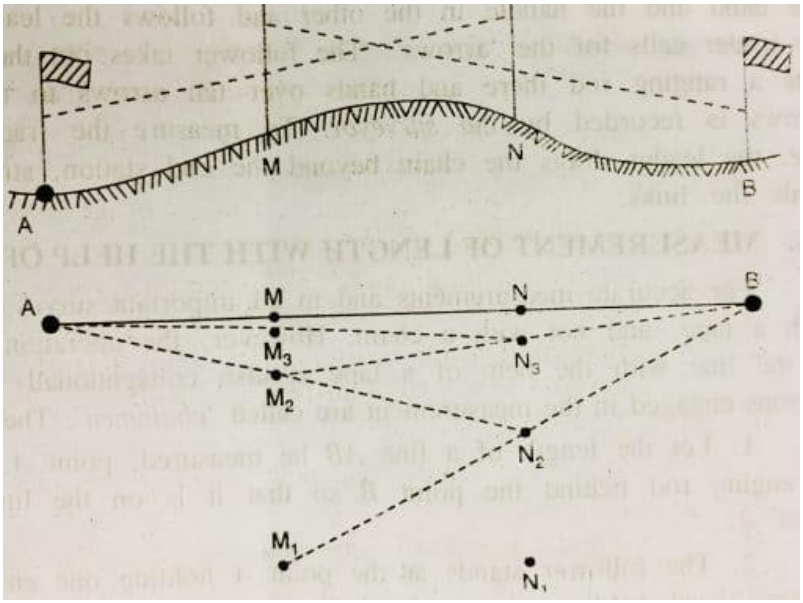
Then, two ranging rods are placed at the points M_1 and N_1. Then, the surveyor at M_1 signals the surveyor at N_1 to move to the new point N_2.

It must be noted that the new point N_2 must be in line with the line M_1B. Likewise, the surveyor at point N_2 signals the surveyor at M_1 to move to a position M_2.

It must be noted that the new point M_2 is in line with the line N_2A. Finally, the two surveyors are at points M_2 and N_2.

This process is then repeated continuously until the points M and N are in line with the actual survey line AB.

After the final points, M and N are fixed, other successive points are easily fixed by direct ranging.



3. Sources of Errors in Ranging in Surveying

a. Improper adjustment of ranging rods between two points of the survey line.

b. Inaccurate readings in hilly regions due to too many undulations.

Instruments are used for horizontal measurement / chaining

Chains, Tapes, Arrows, Ranging rods and offset rods, Laths & Whites, Pegs, Plumb bob, Cross staff **Ranging rods** are used for ranging some intermediate points on the survey line. Ranging rods are circularrods 2 to 3 m in length and are painted with characteristic red & white bands

Cross staff - Used for setting out right angles to a chain line is called cross staff. Main parts are a frameor box with two pairs of vertical slits & a pole to mount it. Different type's are- open cross staff, French cross staff, adjustable cross staff

Tapes are used where greater accuracy of measurements are required, such as setting out of buildings androads they are 15m or 30m long C*lassified based on the materials such as* Fiber Tape-

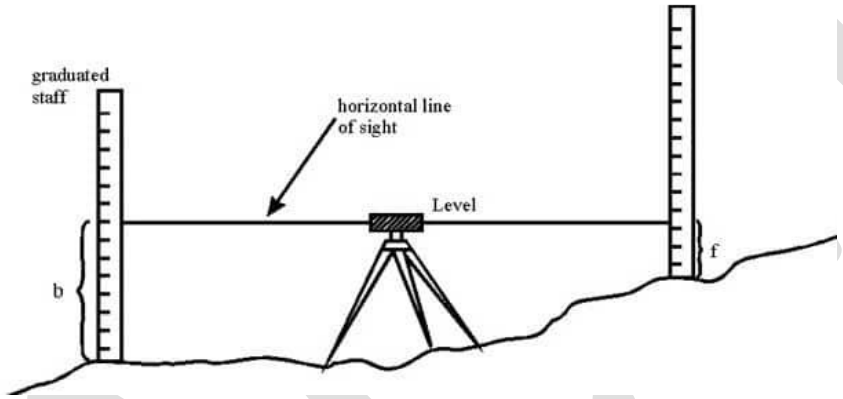
- Cloth or linen tape- made up of linen cloth with brass handle Cloth tapes are not used for accurate measurements because: 1) Length of cloth tape is gets altered by stretching. 2) Cloth tape is easyto twist and tangle. easily affected by dampness
- Metallic Tape- it is linen tape reinforced with brass to prevent stretching or twisting of fibers Metallic tapes are particularly useful in cross-sectioning

- Steel tape- wound on a corrosion resisting metal case
- Invar Tape it is made of alloy of steel 64% & nickel 36% errors due to temperature are minimum used for high precision work.

Levelling:- Leveling is **a branch of surveying in civil engineering to measure levels of different points with respect** to a fixed point such as elevation of a building, height of one point from ground etc.

Levelling is one of the most important parts of surveying before starting the construction of roads, dams, or any other structures.

It is a branch of surveying which deals with the measurement of the elevation of the point with respect to the datum level above or below the surface of the ground.



Levelling terms

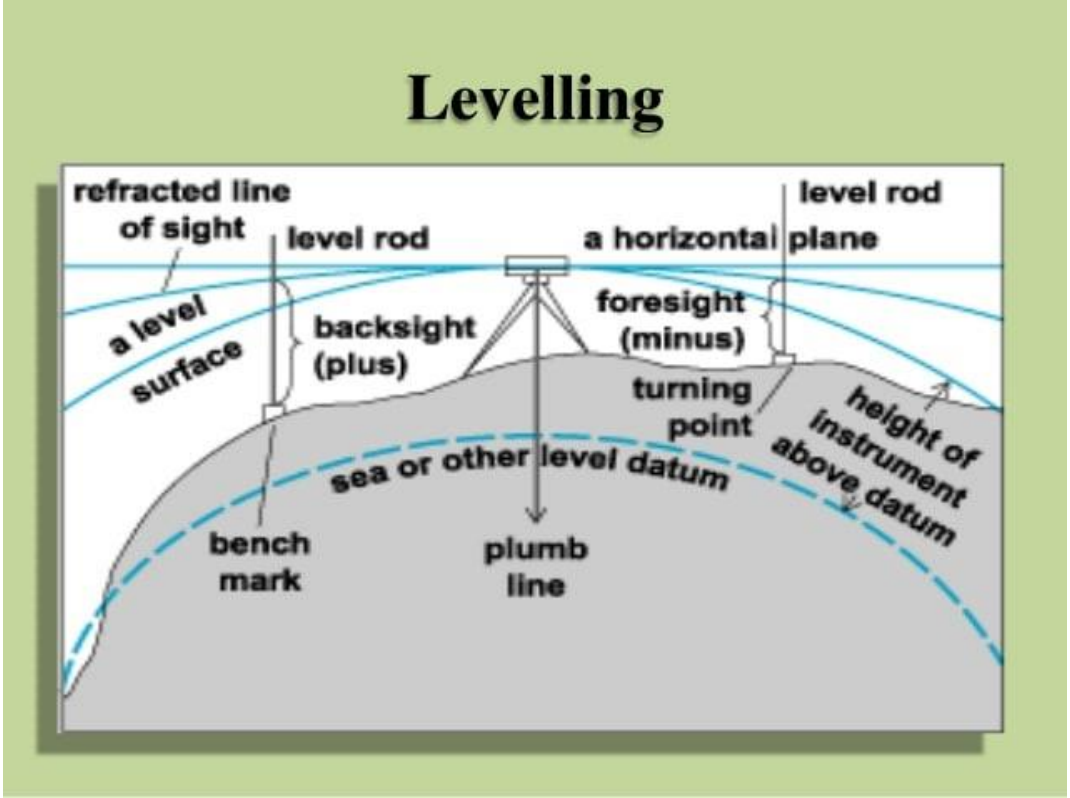
- **line of collimation-** it is a line joining intersection of cross hairs of diaphragm to the opticalCentre of object glass & its continuation it is as known as line of sight
- **Datum surface**-. Imaginary level surface with reference to which vertical distance of points aremeasured .In India mean sea level is considered as datum of zero elevation
- **Elevation.** The distance measured along a vertical line from a vertical datum to a point or object
- **Benchmark (BM)** - A relatively permanent object, natural or artificial, having a marked point whose elevation above or below a reference datum is known or assumed. Types are - GTS benchmark, Permanent bench mark, Arbitrary

benchmark, Temporary benchmark

- **Height of instrument**: It is the elevation of the plane of sight with respect to assumed datum. It is also known as plane of collimation.
- **Back sight (BS)**: It is the first sight taken on the level staff, of a known elevation with the intention to obtain the elevation of plane of collimation. It is called PLUS sight because it is addedto elevation of that point to get height of instrument or plane of collimation.

Intermediate sights (IS): These are the sight taken after back sight and before sighting the final point. These are called MINUS sights. These are subtracted from plane of collimation to find the reduced level of different points.

- **Fore sight (FS):** The last reading taken from the instrument before shifting instrument. This is also a MINUS sight.
- **Change point (CP)** or turning point (TP): The point at which both BS and FS are taken.
- **Reduced level(RL):** The elevations of the points with respect to assumed datum.



Instruments essentially required in levelling

(i) Leveling instrument

(ii) Levelling staff

***Levelling Instrument*:**

Instrument used to furnish horizontal Line of sight for observing staff readings & determining RL Simplest form of levelling instrument is dumpy level. The different parts of levelling instrument are,

Components of Dumpy Level

(a) Telescope

(b) (b) Eye-piece

(c) (c) focusing knob

(d) (d) level tube

(e) (e) cross bubble

(f) (f) foot screws

(g) (g) levellinghead

(h) (h) diaphragm

(i) ray shade

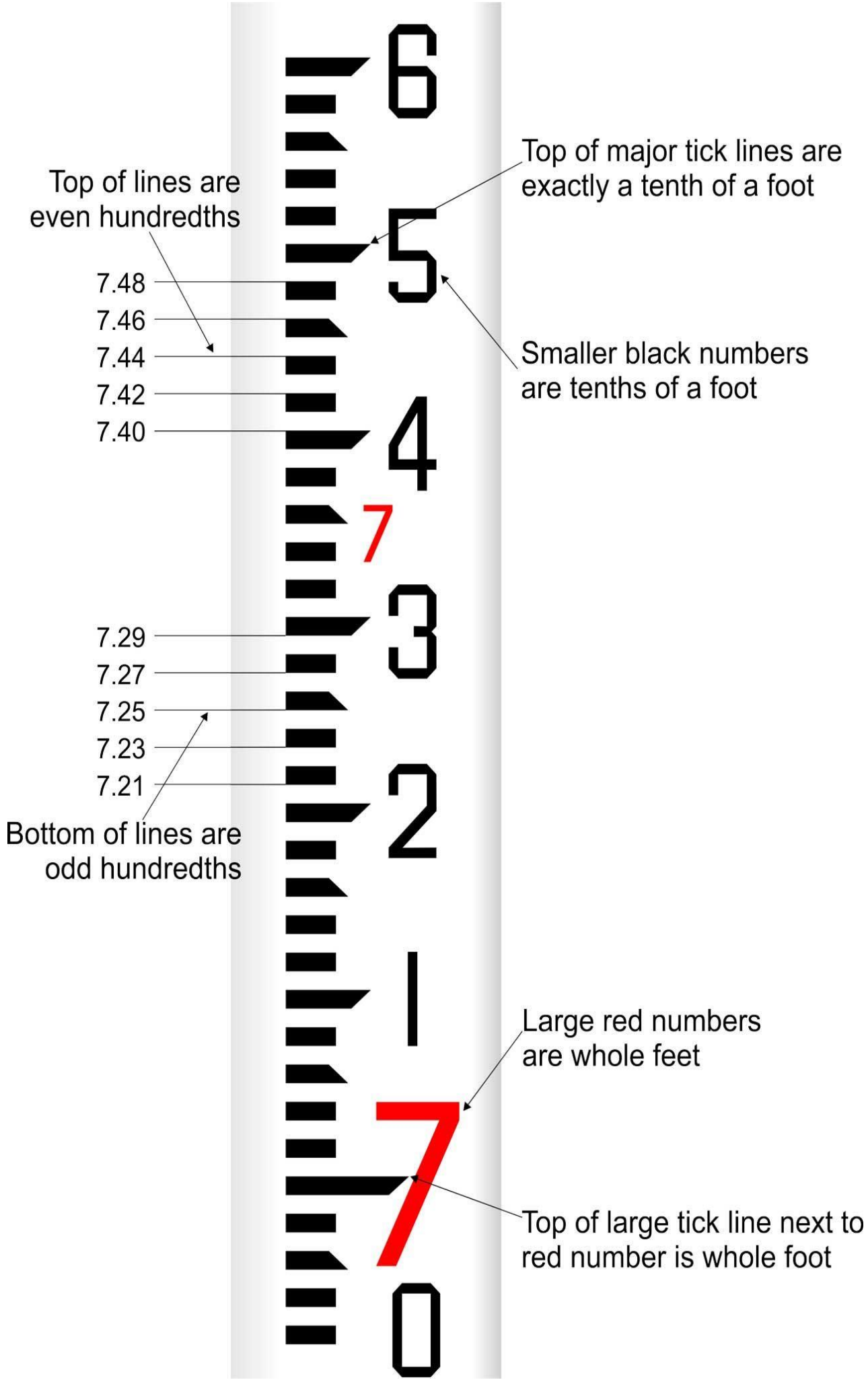
Types of level-

Dumpy level,
Tilting level,
Automatic level

Dumpy level- it is a simple, compact & stable instrument. Telescope is rigidly fixed to its support .henceit cannot be rotated abut its horizontal axis

***Levelling staff*:** It is an important accessory used with levelling instrument at the time of conducting levelling survey. Reading is taken on the levelling staff held properly at the point concerned by viewing through the telescope of the levelling instrument.

- Usually 4 m levelling staff may be used of folding type or telescopic type
- Types are – self reading staff & target staff.


Top of major tick lines are exactly a tenth of a foot
Top of lines are even hundredths
7.48
7.46
7.44
7.42
7.40
Smaller black numbers are tenths of a foot
7.29
7.27
7.25
7.23
7.21
Bottom of lines are odd hundredths
Large red numbers are whole feet
Top of large tick line next to red number is whole foot

Basic Principle of Leveling-

- Measures height differences between points
  - Along a line
  - Several points from one occupation

Types of levelling-

1. Simple levelling,
2. Differential levelling,
3. Fly levelling,
4. Profile levelling,
5. Crosssectional levelling,
6. Reciprocal levelling

There are two methods for obtaining the elevations at different points:

1. Height of instrument (or plane of collimation) method ,
2. Rise and fall method

Temporary adjustments of levelling

These adjustments can be performed at every setup of instrument setting up of level

- Setting up of the level
- Levelling of telescope
- Elimination of parallax- i) Focusing of the object glass
  ii) Focusing of the eyepiece

THE End