BASIC CIVIL ENGINEERING

For 1st Semester Code (RBC1B002)

For 2nd Semester Code (RBC2B002)

BASIC CIVIL ENGINEERING 2-0-0

For 1st Semester Code (RBC1B002)
For 2nd Semester Code (RBC2B002)

MODULE-I (6 classes)

Introduction and Scope of Civil Engineering. Broad disciplines of Civil Engineering; Importance of Civil Engineering, Early constructions and developments over time, Development of various materials of construction and methods of construction.

Building Material and Building Construction:

Bricks: Brick as a construction material and its importance, qualities of a good brick, Stone: classification, composition and characteristics, Cement: Classification, tests for cement, uses of cement, types of cement, Concrete: Quality of mixing water, Workability, Compaction of concrete, concrete mix design, Grade and strength of Concrete. Fundamentals of R.C.C. and Prestressed concrete. Types of steels used in civil engineering works.
Building Components and their basic requirements, Mortar, Stone masonry, brick masonry, roof, floors.

MODULE-II (6 classes)

Surveying: Linear measurement and chain survey: Use of chains and tapes for measurement of correct length of lines, direct and indirect ranging,Compass surveying: Use of prismatic compass, bearing of a line. Local attraction, Introduction to modern surveying instruments EDM and Total Station.

MODULE-III (6 classes)

Fundamental of soil and its classification, Foundations: Types of shallow and deep foundations with neat sketches. Fundamentals of Irrigation Engineering. Introduction of Hydraulics structure like canals, siphons, weirs, dams etc.

MODULE-IV (6 classes)

Transport, Traffic and Urban Engineering: Introduction to planning and design aspects of transportation engineering, different modes of transport, highway engineering, rail engineering, airport engineering, traffic engineering, urban engineering

TEXT BOOKS

i. Basic Civil Engineering, S. Gopi, Pearson
ii. Building Construction, Sushil Kumar, Standard Publishers Distributors
iii. Surveying and Levelling by R. Subramanian, Oxford University Press

REFERENCE BOOKS

i. Engineering Materials, S.C. Rangwala, Charotar Publishing House
ii. Building Material and Construction, G C Sahu, Joygopal Jena, McGrow Hill
iii. Surveying Vol-1 by R Agor, Khanna Publishers
iv. Basic Civil Engineering, M.S. Palanichamy, McGraw Hill

MODULE-I

MODULE-I

CIVIL ENGINEERING

Civil Engineering is that field of engineering concerned with planning, design and construction for environmental Control, development of natural resources, buildings, transportation facilities and other structures required for health, welfare, safety, employment and pleasure of mankind". Fredrick .S. Merit Hand book for Civil Engineers.

The main scope of civil engineering or the task of civil engineering is planning, designing, estimating, supervising construction, managing construction, execution, and maintenance of structures like building, roads, bridges, dams, etc. • One who designs and maintains works of public utility is known as civil engineer. Civil engineer should have qualities like scientific attitude, imaginative and intuitive approach, He should have good analysis and decision power. He should be able to solve engineering problems, by using mathematical modeling, scientific principles and laboratory techniques using computer and information technology. He should be able to use operation research techniques for solution of management problems.

BROAD DISCIPLINES OF CIVIL ENGINEERING

- Surveying & levelling
- Building, Planning and construction
- Advanced Construction
- Structural Engineering
- Geotechnical Engineering
- Water Resources Engineering
- Transportation Engineering
- Environmental Engineering
- Town Planning

SURVEYING & LEVELLING:

Surveying includes measurements of distances and angles in horizontal and vertical planes, while leveling is the measurement of heights in vertical plane.

• Chain, compass, level and theodolite are the instruments used for surveying. Surveying fixes the relative positions of different points on the basis of surface of earth.

• It also includes measurements of areas and volumes. Basic aim of surveying is to prepare a map of the area to some scale.

• Surveying is carried out to fix the alignment of road, railway canal. It is also useful in selecting the site for the construction of structures. Modern surveying instruments like Electronic total station and Geographical Positioning System(GPS) are the modern electronic digital instruments for survey works. Remote sensing and Geographical Information system(GIS) are adopted for surveying and planning of many civil engineering projects.

BUILDING PLANNING & CONSTRUCTION:

• Civil engineers are concerned with many types of structures of which buildings are of prime importance.
• Buildings are planned according to the fundamental principles of planning & bylaws of local municipal bodies.
• Building planning requires basic knowledge of principles of architecture. Buildings may be residential or public building like school, colleges, government office, hospitals, etc. they are designed according to need of specific occupants and purposes.

ADVANCED CONSTRUCTION

• Construction of dams, bridges, tunnels, ports, requires several advanced techniques of construction. Under water construction requires specific type of equipment. Pile foundations or well foundations are generally provided for foundation of bridges across rivers in alluvial soil.
• Large scale earthworks in excavation requires equipment's like power shovel, dragline, bulldozers, etc. For massive concrete work in dam concrete mixing plant is required to be erected at the dam site. Construction of power station, off shore oil rigs, ports, tunnels etc., come under category of advanced construction.

STRUCTURAL ENGINEERING

• This Branch of civil engineering deals with structural analysis and design of structures. Structural analysis is done to calculate stresses in structural components, on the basis of loads, acting on structures.
• Sections of structural elements like beams, columns, slabs, etc. are designed. Structural analysis requires much calculation, hence advanced computing software's are used to carry out structural analysis and design.
• It includes design of reinforced cement concrete (RCC) and steel structures. Design of Multistoried buildings, towers, retaining walls, water tanks, bridges require skills and knowledge of structural engineering.

GEOTECHNICAL ENGINEERING

• Geotechnical engineering is that field of civil engineering which deals with soil investigation and design of proper foundations of structures.
• Soil investigation includes collection and testing of soil samples.
• Geotechnical engineering includes measurement of soil parameters and safe bearing capacity. It also includes construction and design of simple foundations, pile foundations, well foundations, caissons, coffer dams, construction of foundation of dams, construction of tunnels, sub base of road, earthen dams, earth related constructions. Sound knowledge of geology and geotechnical engineering is necessary for construction of earth related structures.

WATER RESOURCE ENGINEERING

• Water resource engineering means measurements, utilization and development of water resources for agriculture, municipal and powergeneration purpose.
• It mainly includes irrigation engineering, design of hydraulic structures like dams, canals, etc. Water resource engineering deals with planning designing and developing water resources by constructing several hydraulic structures like dams, barrages, hydropower stations, canal and pipe networks etc.

• It also includes watershed planning, water harvesting techniques, soil conservation and soil reclamation. Hydrology is also a part of water resource engineering. Hydrology includes study of sources of water, measurement of rainfall, study of rainfall, runoff, flood control.

TRANSPORTATION ENGINEERING

• Transportation means movement of passengers and goods by means of vehicles on land, ship on water and aircrafts in air.
• Transportation Engineering is that branch of Civil engineering which deals with planning, designing and construction of roads, bridges, railways, tunnels, harbours, ports, docks, runways, and airports.
• As for development of any nation good transportation network is of prime importance. Study of various construction materials used in construction of roads, traffic engineering are also considered under transportation Engineering.

ENVIRONMENTAL ENGINEERING

• Environmental Engineering deals with pollution control and public health engineering. Different types of pollutions are water, air, noise and otherpollution.
• Due to large scale industrialization, population growth, rapid urbanization and several other human activities like construction, mining, transportation, environment gets polluted.
• Environmental engineering deals with technologies & facilities which are engaged in reducing pollution. Environmental engineering includes design, construction and maintenance of water treatment plant, waste water treatment plant, water distribution network and sewerage system, it also deals with solid waste management in towns and cities. Public health engineering includes water treatment, water distribution network, & solid waste management.

TOWN PLANNING

• Town planning means planned & controlled growth of town by dividing town in to different land use zones and regulating building construction to provide better environment for the people of the town.
• In the town planning areas of town are divided into residential, commercial, recreational and industrial zones, which is called zoning.
• Floor space index, and other byelaws are fixed to guide and regulate the building construction. • For towns and cities master plan for town planning schemes are prepared to accommodate future growth of town in better way. Planning of very large area covering several towns and villages is known as regional planning.

IMPORTANT OF CIVIL ENGINEERS

A civil engineer has to conceive, plan, estimate, get approval, create and maintain all civil engineering activities. Civil engineer has very important role in the development of the following infrastructure:
(i) Measure and map the earth's surface.
(ii) Plan new townships and extension of existing towns.
(iii) Build the suitable structures for the rural and urban areas for various utilities.
(iv) Build tanks and dams to exploit water resources.
(v) Build river navigation and flood control projects.
(vi) Build canals and distributaries to take water to agricultural fields.

(vii) Purify and supply water to the needy areas like houses, schools, offices etc.
(viii) Provide and maintain communication systems like roads, railways, harbours and airports.
(ix) Devise systems for control and efficient flow of traffic.
(x) Provide and maintain solid and waste water disposal system.
(xi) Monitor land, water and air pollution and take measures to control them. Fast growing industrialisation has put heavy responsibilities on civil engineers to preserve and protect environment.

BUILDING MATERIAL AND BUILDING CONSTRUCTION

BRICKS:

A brick is building material used to make walls, pavements and other elements in masonry construction. Traditionally, the term brick referred to a unit composed of clay, but it is not used denote any rectangular units laid in mortar. • Bricks are one of the oldest and first building materials (except wood) were made of mud, molded by hand and dried in the sun for days until they were strong enough for use, dating back to 7000BC.

Brick is a man-made building material used to make walls, pavements and other elements in masonary construction.

Bricks are the small rectangular blocks typically made of fired or sun-dried clay. The bricks are obtained by moulding clay in rectangular blocks of uniform size and then by drying and burning these blocks. As bricks are of uniform size, they can be properly arranged and further, as they are light in weight, no lifting appliance is required to them. The bricks don't require dressing and the art of laying bricks is so simple that the brickwork can be carried out with the help of unskilled labours.

- One of the oldest construction material
- Most popular and leading construction material

REASON:

- Low cost
- Durable
- Light weight
- Easy to work with

ADVANTAGES :

- Better Thermal Insulation
- Economical
- Masonry is easier, faster and stronger
- Bricks have greater fire resistance
- Its size enables easy handling and placement in walls
- It can be easily adapted to small scale and large scale structure to give pleasing appearance and texture.
- It enhances good sound absorption

  Very low maintenance cost is required

DISADVANTAGES :

- Time consuming construction
- Cannot be used in high seismic zones
- Very less tensile strength
- Since bricks absorbs water easily , therefore it causes fluorescence when not exposed tom air
- Rough surfaces of bricks may causes mould growth if not properly cleaned

Composition Of Brick:

Ingredient	**Percentage in brick**
Silica (SiO_2)	55%
Alumina (Al_2O_3)	30%
Iron Oxide (Fe_2O_3)	8%
Magnesia (MgO)	5%

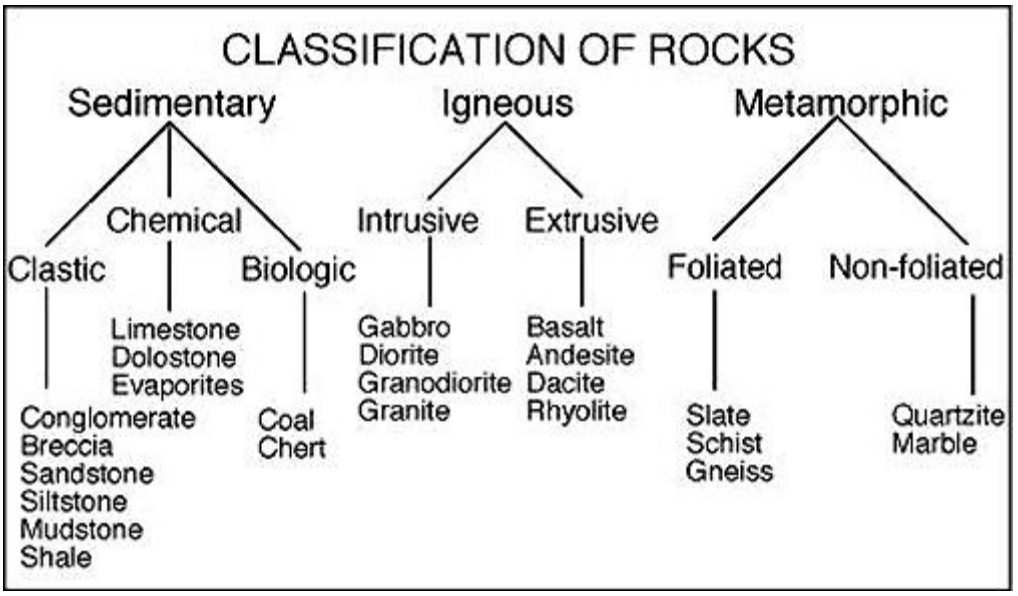
QUALITIES OF GOOD BRICKS:

- The bricks should be table-mounted, well burnt in kilns, copper-coloured, free from cracks and with sharp & square edges. The colour should be uniform and bright.
- The bricks should be uniform in shape and should be of standard size.
- The bricks should give a clear metallic ringing sound when struck with each other.
- The bricks when broken or fractured should show a bright homogeneous and uniform compact structure free from voids.
- The bricks shouldn't absorb water more than 20 percent by weight for first class bricks and 22 percent by weight for second class bricks, when soaked in cold water for a period of 24 hours.
- The bricks should be sufficiently hard. No impression should be left on brick surface, when it is scratched with finger nail.
- The bricks should not break into pieces when dropped flat on hard ground from a height of about one meter.
- The bricks should have low thermal conductivity and they should be sound-proof.
- The bricks, when soaked in water for 24 hours, should not show deposits of white salts when allowed to dry in shade.
- No brick should have the crushing strength below 5.5 N/mm^2.

STONE

This is classification of rocks based on their origin and formation.

- Igneous
- Sedimentary
- Metamorphic



CHEMICAL COMPOSITION OF ROCKS

Siliceous stone has as its main element, silica or silicon dioxide (SiO^2). Most stone from volcanoes is siliceous. This type of stone also includes compressed sediments of siliceous stone, like sandstone.
Argillaceous stone has as its main element alumina AlO_2). It along with its compounds, comes from feldspar in the crust. When these meet up with the atmosphere, they change into clay-like compounds.
Calcareous stone is made up mostly of calcium carbonate ($CaCO_3$), or lime. Lime comes from the bodies of sea creatures, whose skeletons have accumulated at the bottom of the seas.

CHARACTERISTICS OF ROCKS

1. **STRENGTH**

When stones are to be used in large structures, it becomes necessary to check the compressive strength of stones.Compressive strength of building stones generally fall within the range of 60 to 200 N/mm².

2. **DURABILITY**

Building stones should be capable to resist the adverse effects of natural forces like wind, rain and heat. It must be durable and should not deteriorate due to the adverse effects of the above natural forces.

3. **HARDNESS**

When stones are used in floors, pavements or aprons of bridges, they become subjected to wearing and abrasive forces caused by movement of men or machine over them. So it is required to test hardness of stone.

4. TOUGHNESS

Toughness of stones means it ability to resist impact forces. Building stones should be tough enough to sustain stresses developed due to vibrations. The vibrations may be due to the machinery mounted over them or due to the loads moving over them. The stone aggregates used in the road constructions should be tough enough.

5. SPECIFIC GRAVITY

The more the specific gravity of stone, the more heavier and stronger the stone is.
Stones having higher specific gravity values should be used for the construction of dams, retaining walls, docks and harbours. The specific gravity of good building stone is between 2.4 and 2.8.

6. POROSITY AND ABSORPTION

If stones used in building construction are porous then rain water can easily enter into the pore spaces and cause damage to the stones.
Water absorption of stone is directly proportional to the porosity of rock. If a stone is more porous then it will absorb more water and cause more damage to stone.
Maximum limit of Water Absorption is 3 to 10 %

7. DRESSING

Giving required shape to the stone is called dressing. It should be easy to dress so that the cost of dressing is reduced. However, the care should be taken so that, this is not be at the cost of the required strength and the durability.

8. APPEARANCE

In case of the stones to be used for face works, where appearance is a primary requirement, its colour and ability to receive polish is an important factor.

9. SEASONING

Good stones should be free from the quarry sap. Lateritic stones should not be used for 6 to 12 months after quarrying. They are allowed to get rid of quarry sap by the action of nature. This process of removing quarry sap is called seasoning.

10. WORKABILITY

Stone should be workable. Stone is said to be workable when the work involved in stone working (such as cutting, dressing & shaping) is economical and easy to conduct.

11. COST

Cost is an important consideration in selecting a building material. Proximity of the quarry to building site brings down the cost of transportation and hence the cost of stones comes down.

12. FIRE RESISTANCE

Stones should be free from calcium carbonate, oxides of iron, and minerals having different coefficients of thermal expansion. Igneous rock show marked disintegration principally because of quartz which disintegrates into small particles at a temperature of about 575°C. Limestone, however, can withstand a little higher temperature; i.e. up to 800°C after which they disintegrate.

CEMENT

A cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete.

Classification of Cement:

1. Natural cement
2. Artificial cement

1. Natural Cement:

It is manufactured from stones containing 20 to 40 percent of clay, the remainder being carbonate of lime mixed with carbonate of magnesia. The stones are first burnt and then crushed. It possesses a brown color and sets rapidly when mixed with water. It doesn't find much use in India.

2. Artificial Cement:

It may be Portland cement or special cement. Portland cement is so-called because a paste of cement with water after it sets hard, be like in color and hardness a Portland stone, a limestone extracted in Dorset. It is prepared in different varieties.

The following tests are conducted on cement in the laboratory are as follows:

Fineness Test.
Consistency Test.
Setting Time Test.
Strength Test.
Soundness Test.
Heat of Hydration Test.
Tensile Strength Test.
Chemical Composition Test.

USES OF CEMENT :

Following are the different uses of cement:

1. It is utilized in cement mortar for masonry work, plastering, pointing, etc.
2. It is utilized for preparing joints for pipes, drains, etc.
3. It is utilized in concrete for placing floors, roofs, and constructing lintels, beams, stairs, pillars, etc.
4. It is utilized for manufacturing precast pipes, piles, fencing posts, etc.
5. It is utilized in the construction of important engineering structures such as bridges, culverts, dams, tunnels, lighthouses, etc.
6. It is utilized in the formation of footings, water-tight floors, footpaths, etc.
7. It is employed for the construction of wells, water tanks, tennis courts, lamp posts, telephone cabins, roads, etc.

TYPES OF CEMENT :

Following are the various types of cement available in the market:
1. Portland Cements:

(a) Ordinary Portland Cement
(b) Modified Portland Cement
(c) Rapid hardening Portland Cement
(d) Extra Rapid hardening Cement
(e) Low heat Portland Cement
(f) Sulphate resisting Portland cement
(g) Water-repellent Portland Cement
(h) Water-proof Portland Cement

2. Other Varieties of Cement

(a) High Alumina Cement
(b) Quick setting Cement
(c) Blast Furnace slag Cement
(d) White Cement.
(e) Colored cement
(f) Acid resistance Cement
(g) Expanding Cement
(h) Hydrophobic cement
(i) Portland Pozoolna Cement
(j) Super sulphated Cement
(k) Masonry Cement

Portland Cements

a. Ordinary Portland Cement:
This is by far the most common cement in use.It has a better rate of strength development and heat generation. It has sufficient resistance to dry shrinkage and cracking, but has less resistance to chemical attack.

Uses:

- It is admirably suitable for use in general concrete construction when there is no exposure to sulphates in the soil or groundwater.
- It is used in small structures where the heat of hydration will not cause any defect.

Modified Portland Cement

This cement, on the setting, develops less heat of hydration than ordinary portland cement.

Uses:

Due to lower heat of hydration, it can be employed in hot climates and for construction of heavy abutments, large piers, retaining walls, etc, where sulphate content is not high.

Rapid Hardening Cement

It is also known as high early strength cement. It has a huge proportion of lime and other components are the same as for Ordinary Portland Cement. It is prepared more carefully and burnt at a higher temperature than that of ordinary Portland Cement. The strength developed at the age of 3 days is of the same order as the 7 days strength of Ordinary Portland Cement with the same water-cement ratio. The increased rate of gain of strength of this cement is achieved by a higher C_3S content and by finer grinding of the cement clinker. It is ground finer and has a specific surface not less than 3250 cm^2/g. It is lighter than Ordinary Portland Cement. The curing period is short; hence it is economical.

Uses:

It is used here a rapid strength development is required.

Example: When the framework is to be removed quickly for re-use, or where sufficient strength for further construction is wanted as quickly as practicable.

Extra Rapid Hardening Cement

This type of cement is obtained by inter-grinding calcium chloride with rapid hardening Portland cement. The quantity of calcium chloride should not exceed 3%. Its strength is about 25% higher than that of rapid hardening cement at 1 or 2 days and 10 to 20 % higher at 7 days.

Uses:

It is suitable for cold weather concreting, or when a very high early strength is required but when it is inadvisable to use aluminous cement.

Low Heat Portland Cement

It contains a low percentage (about 5%) of tricalcium silicate (C_3S) which hydrates quickly and a higher percentage (about 46%) of dicalcium silicate (C_2S) which hydrates slowly. It contains less time than ordinary cement; other materials remain the same as in the case of Ordinary Cement. It possesses low compressive strength. The initial setting time is about one hour and the final setting time is about 10 hours.

Uses:

During the setting action of cement, a considerable amount of heat is produced, to reduce the amount of heat, this type of cement is used. It is mainly used for mass concrete work.

Sulphate Resisting Portland Cement

In this cement, the percentage of tricalcium aluminate (C_3A) is kept below 5 % and it increases by resisting power against sulphates. The heat formed by such type of cement is not much bigger than that of low heat cement. Theoretically, it is an ideal cement but because of the special requirement for the composition of the raw materials used in its manufacture, sulphate-resisting cement cannot be easily and cheaply made.

Uses:

It is used at places where sulphate action is severe.It is employed for structures that are likely to be damaged by severe alkaline conditions such as canal linings, culverts, siphons, etc.

Water-repellent Portland Cement:

It contains a small percentage of water-proofing materials uniformly mixed with cement and is manufactured under the name " A quacrete". The cement is formed with ordinary or rapid hardening cement and white cement.If such cement is used in concrete, considerable care is needed to avoid a reduction in strength.

Uses:

It is chiefly used in water-tight concrete and water-tight renderings to check moisture penetration in basements etc and for colored rendering and stucco.

Water-Proof Portland Cement:

These types of cement are prepared by mixing with ordinary or rapid hardening cement, a small percentage of some metal stearate (Ca, Al, etc) at the time of grinding.Concrete made with such cement is more resistant to penetration by water and some oils than that made from ordinary cement.It is also adequately resistant to the corrosive action of acids and alkalies or other harmful salts usually present in industrial waters.

Uses:

It is used for the construction of water retaining structures like tanks, reservoirs, retaining walls, swimming pools, dams, bridges, piers, etc.

OTHERS VARIETIES OF CEMENT

High Alumina Cement:

It is quick-setting cement of chocolate color. It is manufactured from bauxite and limestone in special reverberatory furnaces. It contains nearly 35 percent of alumina and the ratio of alumina to lime lies between 0.55 and 1.3.

Advantages:

1. It resists the action of acid and high temperature and doesn't expand on the setting.
2. Its initial and final hardening times are 13/4 hours and 4 to 5 hours respectively. It, therefore, permits more time for mixing and placing operations.
3. It sets quickly and attains has higher ultimate strength in a low period. Its strength after 1 day is about 40 $N/mm^2$and after 3 days is about 50 N/mm^2.
4. It is completely resistant to the action of sulphates.
5. It offers excellent resistance to fire.
6. It is not affected by frost since it evolves great heat during the setting.
7. It is not necessary to grind it to fine powder since its setting action mainly depends on the chemical reactions.

Disadvantages:

1. It is unsuitable for mass concrete construction as it develops considerable heat on the set.
2. It is much costlier than ordinary portland cement.
3. Extreme care has to be taken to ensure that it doesn't come in contact with even traces of lime or ordinary cement.

Uses:

1. Its field of application includes works in chemical plants and furnaces.
2. It is employed in colder regions having temperatures 18°C or below and during wartime emergencies.
3. It is used in underwater construction.

Quick Setting Cement

It contains less percentage of gypsum and is ground much fine than ordinary Portland cement.
The sitting action accelerated by adding a small percentage of aluminium sulphate, during grinding. It is very expensive as compared to ordinary Portland cement. Its initial and final hardening times are 5 minutes and 30 minutes respectively.

The setting action of such a cement starts within 5 minutes and it becomes stone-hard in less than half an hour.

Uses:

Due to its quick setting property, it is used in works where concrete is to be placed underwater or in running water.

Blast Furnace Slag Cement

- It is made by inter-grinding portland cement clinker and granulated blast-furnace slag, the proportion of the latter not exceeding 65% of the weight of the mixture.
- It has lower evolution of heat.
- It is more resistant to attacks by weathering agencies.
- It is cheaper than ordinary portland Cement.
- Its color is blackish grey.
- Its initial setting time is not less than 30 minutes.
- Its final setting time is not more than 10 hours.

Uses:

- It can be used in mass concrete structures (since its heat of hydration is lower than that of ordinary portland cement).
- However, in cold weather, the low heat of hydration of blast-furnace slag cement, coupled with moderately low rate strength development can lead to frost damage.
- This cement should not be used in thin RCC structures since early strength is less.
- Because of its fairly high sulphate resistance, this type of cement is frequently used in seawater construction.

White Cement:

- White Portland Cement is made from raw materials containing very little iron oxide, magnesium oxide.
- China clay is normally utilized together with chalk or limestone free from impurities.
- Oil is utilized as a fuel in the kiln to neglect contamination by coal ash.
- Since iron acts as a flux in clinkering, its absence necessitates high kiln temperatures but sometimes cryolite is added as a flux.

- Contamination of the cement with iron during grinding has also to be avoided.
- For this problem, rather inefficient pebble grinding is utilized in place of a usual ball mill, although nickel and molybdenum alloy balls have been considered.
- The cost of grinding is expensive and this, coupled with the huge expensive raw materials, makes white cement rather expensive.

Features:

- It dries quickly.
- It owns high strength.

- It contains superior aesthetic beauty.
- It should not be set earlier than 30 minutes.
- It should be carefully transported and stored in a closed container only.

Uses:

1. It is used for floor finish, plasterwork, ornamental work, etc.
2. Miscellaneous applications of white cement include swimming pools (where it replaces the use of glazed tiles with colored shades usable underwater), molding sculptures and statues, painting garden furniture, etc.
3. It is also employed for ready mixed concrete and precast concrete blocks.

Coloured Cement

Colored cement is prepared by adding 5 to 15% of a suitable coloring pigment before the cement is finally ground.

– Iron oxide is added to give red and yellow colors.

– Chromium oxides provide the green color.

– Cobalt oxide provides a blue color.

Colored cement is also known as "Colourcrete".

These are much costlier than ordinary cement.

Uses:

These types of cement are widely used for the finishing floors, external surfaces, artificial marble, stair treads, textured panel faces, window sill slabs, etc.

Acid Resistance Cement:

An acid resistance type of cement contains:

1. Acid-resistant aggregates such as quartz, quartzites, etc,
2. Additive such as sodium fluosilicate (Na_2SiF_6), and
3. The aqueous solution of sodium silicate or soluble glass.

– The addition of additive sodium fluosilicate accelerates the hardening process of soluble glass and also increases the resistance of cement to acid.

– The soluble glassworks as the binding material of acid-resistant cement.

It cannot resist the action of water well.

Its water resistance can be increased by adding 0.5% of linseed oil or 2% of cresit and it is then known as acid and water-resistant cement.

Uses:

It is used for acid-resistant and heat-resistant coatings of installations of the chemical industry.

Expanding Cement:

It is formed by adding an expanding medium like sulpho-aluminate and a stabilizing agent to the ordinary cement.

This cement expands whereas other types of cement shrink.

Uses:

It is used for the construction of water retaining structures.
It is also employed for repairing damaged concrete surfaces.

Hydrophobic Cement

It contains admixtures (examples, acidol, naphthene soap, oxidized petrolatum, etc.) that form a thin film around the cement grains and decrease the melting ability of cement grains.

In this type of cement, in the initial stage, the gain in strength is less as hydrophobic films on cement grains prevent the interaction with water. However, after 28 days, its strength is similar to that of ordinary portland cement.

Uses:

When this cement is used in the preparation of concrete, the fine pores in the concrete are uniformly distributed and thus the frost resistance and water resistance of such concrete are increased considerably.

i. Portland Pozzolana Cement
It is an interground blended mixture of cement and pozzolana.

Pozzolana is natural or artificial material containing silica and alumina in a reactive form.

Pozzolanic materials most commonly met with are volcanic ash, pumic, opaline shales and cherts, burnt clay, fly ash, etc.

In the manufacture of cement, about 25% of pozzolanic material is added to the ordinary cement clinkers, and the mix is thoroughly ground.

Advantages:

1. It own higher tensile strength.
2. Evolves less heat during setting.
3. Attains compressive strength.
4. Offers great resistance to expansion.
5. Imparts a higher degree of water-tightness.
6. Imparts plasticity and workability to mortar and concrete prepared from this type of cement.
7. Offers higher resistance to chemical attack and the action of seawater.
8. Not costly

Disadvantages:

1. Less compressive strength in early days.
2. Less resistance to erosion and weathering action.

Uses:

1. It is mainly used for hydraulic structures such as dams, weirs, etc.
2. It can also be used for sewage works and for laying concrete underwater.

Supersulphate Cement

It is made by intergrinding a mixture of 80 to 85 % of granulated slag with10 to 15% of calcium sulphate and about 5% portland cement clinker and ground to a fineness of 4000 to 5000 cm^2/g.

It is very much resistant to the sea-water.
It can resist the highest concentration of sulphates generally found in soil or groundwater.
It also offers resistance to peaty acids and oils.
The heat of hydration of this type of cement is low.
Its compressive strength should not be less than 15N/mm², 22 N/mm², and 30 N/mm² after 3 days, 7 days, and 28 days respectively.
This type of cement should not be mixed with other cement.
It combines chemically with more water than is needed for the hydration of portland cement, so that concrete with a water-cement ratio less than 0.5 should not be made and mixes richer than 1:6 are not approved.
It has been utilized for the undersides of bridges, over railways tracks, and for concrete sewers, carrying industrial effluents.

Uses:

1. Supersulphated cement can be used in all cases where normal types of cement are used except in very hot weather.
2. It is used in a variety of aggressive conditions, for example, marine works, mass concrete jobs to resist the attack of aggressive water; reinforced concrete pipes in groundwater, concrete construction in sulphate-bearing soils.

Masonry Cement

It is prepared by intergrinding a mixture of portland cement clinkers with inert materials such as limestone, dolomite limestone, and dolomite gypsum and an air-entraining plasticizer in suitable proportion.
Its initial and final setting times are 90 minutes and 24 hours respectively.
Its compressive strength is 2.5 N/mm² for 7 days.
Because of its property of producing a smooth, plastic, cohesive, strong yet workable mortar when mixed with fine aggregate, masonry cement is superior to lime mortar, Lime-cement mortar, and cement mortar.

CONCRETE

Concrete is a composite material composed of fine and coarse aggregate bonded together with a fluid cement (cement paste) that hardens (cures) over time.

QUALITY OF MIXING WATER:

Generally, quality of water for construction works are same as drinking water. This is to ensure that the water is reasonably free from such impurities as suspended solids, organic matter and dissolved salts, which may adversely affect the properties of the concrete, especially the setting, hardening, strength, durability, pit value, etc. The water shall be clean and shall not contain sugar, molasses or gur or their derivatives, or sewage, oils, organic substances. If the quality of water to be used for mixing is in doubt, cubes of 75 mm in cement mortar 1:3 mix with distilled water and with the water in question shall be made separately. The latter type of cubes should attain 90% of the 7 days' strength obtained in cubes with same quantity of distilled water. Alternatively, the water shall be tested in an approved Laboratory for its use in preparing concrete / mortar. The water quality for construction shall be tested or monitored regularly, as it affects the overall strength of concrete. For plain and reinforced cement concrete permissible limits for solids shall be as follows:

Type of Solid in water	Permissible Limits for Construction
Organic matter	200 mg/l

Inorganic matter	3000 mg/l
Sulphates (SO4)	500 mg/l
Chlorides (Cl)	a) 1000 mg/l for RCC work and, b) 2000 mg/l for PCC work
Suspended matter	2000 mg/l

Limits of Alkalinity:

To neutralize 200 ml of sample should not require more than 10 ml of 0.1 normal HCI using methyl orange as an indicator.

Limits of Acidity:

To neutralize 200 ml sample of water should not require more than 2 m of 0.1 normal NaOH (Caustic soda). The pH value of water shall generally be not less than 6.

WORKABILITY:

workability defined as the ease with which the concrete is mixed, transported, placed and compacted.

But in its true sense the segregation and bleeding should not occur during the transportation and placing i.e., the constituent materials from the concrete washes out due the insufficient water cement ratio or due the lack of experience in mix design or due the insufficient rotation of drum in RMC vehicle during the transportation of concrete or even due the insufficient compaction after the application of concrete layer. If the concrete is not workable then the constituent materials wash out through the process of segregation and bleeding result in deterioration of concrete within the few days of application of concrete layer because of week bond between aggregates and the cement material. Hance in order to get an durable concrete layer work ablity play's an significant role.

COMPACTION OF CONCRETE

• Compaction of concrete is process adopted for expelling the entrapped air from the concrete
• In the process of mixing, transporting and placing of concrete air is likely to get entrapped in the concrete.
• It has been found from the experimental studies that 1% air in the concrete approximately reduces the strength by6%.
• I f we don’t expel this air, it will result in to honeycombing and reduced strength.

Different Methods Of Concrete Compaction

1)Hand Compaction Rodding Ramming Tamping
2)Compaction by Vibration

- Internal vibrator
- Formwork Vibrator
- Table Vibrator
- Plat form vibrator
- Surface vibrator .

Hand Compaction

• Hand compaction is used for ordinary and unimportant structures. Workability should be decided in such a way that the chances of honeycombing should be minimum. The various methods of hand compaction are as given below:

❖Rodding It is a method of poking with2m long, 16mm dia. rod at sharp corners and edges. The thickness of layers for rodding should be 15 to 20cm.

❖Ramming

• It is generally used for compaction on ground in plain concrete. It is not used either in RCC or on upper floors.

❖Tamping

• It is a method in which the top surface is beaten by wooden cross beam of cross section 10cm x10cm. both compaction and levelling are achieved s simultaneously. It is mainly used for roof slabs and road pavements.

Compaction by Vibration

• Vibration is imparted to the concrete by mechanical means. It causes temporary liquefaction so that air bubbles come on to the top and expelled ultimately. Mechanical vibration can be of various types as given under.

❖ Internal Vibration

It is most commonly used technique of concrete vibration. Vibration is achieved due to eccentric weights attached to the shaft. The needle diameter varies from 20 mm to 75 mm and its length varies from 25cm to 90cm. the frequency range adopted is normally 3500 to 5000 rpm. The correct and incorrect methods of vibration using internal vibration needles are shown below.

External Vibration

• This is adopted where internal vibration can't be used due to either thin sections or heavy reinforcement. External vibration is less effective and it consumes more power as compared to the internal vibration. The formwork also has to be made extra strong when external vibration is used

Table Vibration

• It is mainly used for laboratories where concrete is put on the table

Platform Vibration

• It is similar to table vibrators but these are generally used on a very large scale

Surface Vibration • These are also called screed board vibrators. The action is similar to that of tamping. The vibrator is placed on screed board and vibration is given on the surface. It is mainly used for roof slabs, road pavements etc., but it is not effective beyond 15 cm depth.

CONCRETE MIX DESIGN

• Concrete Mix Design means, determination of the proportion of the concrete ingredients i.e., Water, which Fine Aggregate, would produce Coarse concrete Cement, Aggregate possessing workability, specified strength and durability properties such as with maximum overall economy.

Types of Concrete Mixes

1. Nominal Mixes – These mixes are of fixed cement-aggregate ratio. These offer simplicity and under normal circumstances. Have a margin of strength above that specified. 2. Standard Mixes – The minimum compressive strength has been included by IS-456:2000 in many specifications. These mixes are termed standard mixes. E.g.: M10, M15, M20, etc. 3. Designed Mixes In these mixes the performance of the concrete is specified by the designer but the mix proportions are determined by the producer of concrete, except that the minimum cement content can be laid down.

Methods of Concrete Mix Design

• American Concrete Institute Method (ACI Method)

• Road Note Number 4 Method
• DOE Method
• Indian Standard Method (IS Method)

Mix Design (IS 10262 - 2009) DATAREQUIRED

a) Grade designation;
b) Type of cement;
c) Maximum nominal size of aggregate;
d) Minimum cement content;
e) Maximum water-cement ratio;
f) Workability;
g) Exposure conditions as per Table 4 and Table 5 of IS 456;
h) Maximum temperature of concrete at the time of placing;
j) Method of transporting and placing;
k) Early age strength requirements, if required;
m) Type of aggregate;
n) Maximum cement content; and
p) Whether an admixture shall or shall not be used and the type of admixture and the condition of use.

Grade and strength of Concrete:

Grades of concrete are defined by the strength and composition of the concrete, and the minimum strength the concrete should have following 28 days of initial construction. The grade of concrete is understood in measurements of MPa, where M stands for mix and the MPa denotes the overall strength.

Grade of Concrete	Minimum compressive strength N/mm^2 at 7 days	Specified characteristic compressive strength (N/mm^2) at 28 days
M15	10	15
M20	13.5	20
M25	17	25
M30	20	30
M35	23.5	35
M40	27	40
M45	30	45

REINFORCED CEMENT CONCRETE(RCC)

The cement concrete in which reinforcement is embedded for taking tensile stress is called reinforced cement concrete. In this type of concrete, the steel reinforcement is to be used generally in the form of round bars,6mm to 32mm dia. This concrete is equally strong in taking tensile, compressive and shear stresses. Usual proportions of ingredients in a reinforced concrete are 1part of cement:1-2parts of sand:24parts of crushed stones or gravel. USES: RCC is commonly used for construction of slabs, beams, columns, foundation, precast concrete.

PRE-STRESSED CEMENT CONCRETE (PCC)

The cement concrete in which high compressive stresses are artificially induced before their actual use is called pre-stresses cement concrete. in this type of cement concrete, the high compressive stresses are induced by pre-tensioning the reinforcement before placing the concrete, and the reinforcement is released when final setting of the concrete take place. • Uses: This concrete can take up high tensile and compressive stresses without development of cracks. The quantity of reinforcement can be considerably reduced by using this concrete.

STEEL

➢ Steel is basically an alloy of iron and carbon with a small percentage of other metals such as nickel, chromium, aluminium, cobalt, molybdenum, tungsten etc.

➢ Steel is a hard ductile and malleable solid and is probably the most solid material after plastic and iron.

➢ If we draw a comparison between iron and steel, we find steel in many ways even better than iron. Steel may not be as strong as iron is but it far more resistant and does not corrode and does not get rusted like iron does.

➢ There are many different types of steel classified on the basis of the type of metal used and the percentage content of the metal in the particular type of steel.

TYPES OF STEEL:

Below given are some commonly used types of steel:

➢ High-Carbon Steel: Carbon steel is simply composed of iron and carbon with a more percentage of carbon in it than the iron. It is probably the most commonly

➢ Mild Steel: It is composed of iron and carbon but it has a very low content of carbon.

➢ Medium Carbon Steel The medium carbon steels has a normal content of carbon that means that they are not as hard as the high carbon and neither are they as strong the Mild carbon steel. ➢ Stainless Steel: Stain less steel is the most resistant and commonly used steel of all the types. It apart from carbon contains 11%chromium and some amount of nickel. It is probably the most resistant steel of all the types. The stainless steel in particular is resistant to any sort of external attack. Even a scratch cannot stay on the surface of stainless-steel.

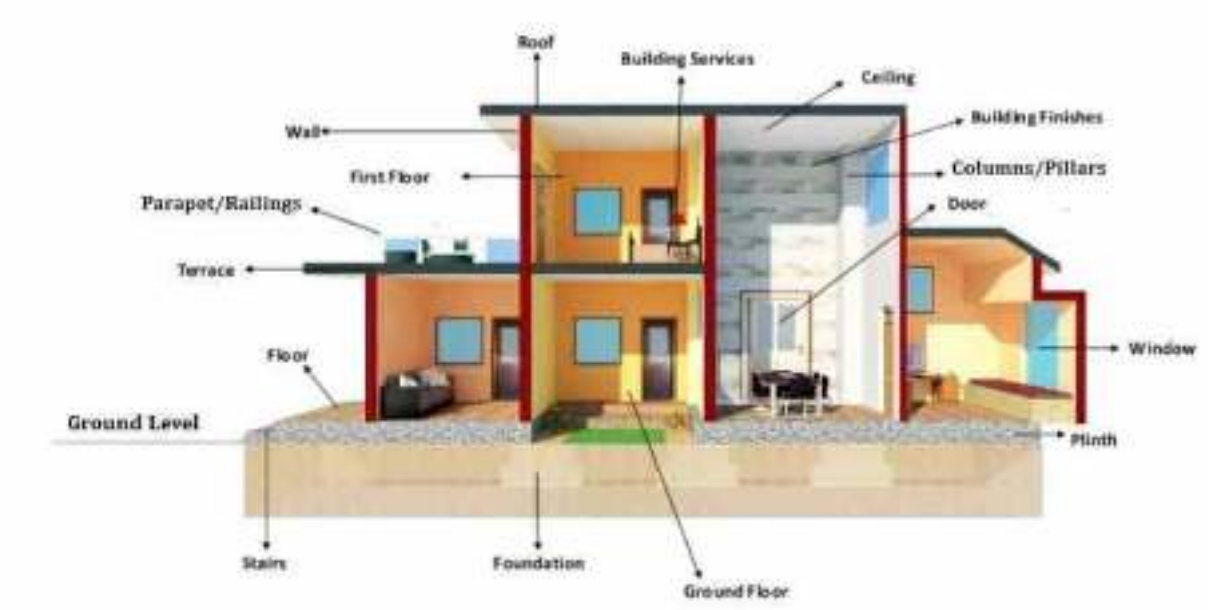
➢High Speed Steel High speed steel is an alloy of steel which may consists of either of the following metals: tungsten, cobalt, molybdenum or chromium. High speed steel is probably the toughest of all the types. The term high speed is given to it due to the fact that it has the ability to cut the metals.

➢Cobalt Steel Cobalt is much like the high speed steel with an excess of cobalt present in it. ➢Nickel Chromium Steel Nickel chromium steel is has is a special type of steel which apart from being strong s also shock resistant

➢Aluminium Steel Aluminium steel is smooth steel with a high content of aluminium. Because of its strong and smooth surface, it is used in the making of furniture.

➢Chromium Steel Chromium steels have a high content of chromium and are resistant to corrosion. They are very strong, tensile and elastic in nature.

COMPONENTS OF A BUILDING STRUCTURE



A building has two basic parts:

(i) Substructure or foundations, and

(ii) Supers1ructure.

SUB-STRUCTUREOR FOUNDATION is the lower portion of the building, usually located below the ground level, which transmits the loads of the super-structure to the supporting soil. A foundation is therefore that part of the structure which is in direct contact with the ground to which the loads are transmitted.

SUPER-STRUCTURE is that part of the structure which is above ground level, and which serves the purpose of its intended use. A part of the super-structure, located between the ground level and (he floor level is known as plinth.

Plinth is therefore defined as the portion of the structure between the surface of the surrounding ground and surface of the floor, immediately above the ground.

Mentioned below are the 12 basic components a building structure.

1. Roof
2. Parapet
3. Lintels
4. Beams

5. Columns
6. Damp proof course (DPC)
7. Walls
8. Floor
9. Stairs
10. Plinth Beam
11. Foundation
12. Plinth

1. Roof

The roof forms the topmost component of a building structure. It covers the top face of the building. Roofs can be either **flat or sloped** based on the location and weather conditions of the area.

2. Parapet

Parapets are short walls extended above the roof slab. Parapets are installed for flat roofs. It acts as a safety wall for people using the roof.

3. Lintels

Lintels are constructed above the wall openings like doors, windows, etc. These structures support the weight of the wall coming over the opening. Normally, lintels are constructed by reinforced cement concrete. In residential buildings, lintels can be either constructed from concrete or from bricks.

4. Beams and slabs

Beams and slabs form the horizontal members in a building. For a single storey building, the top slab forms the roof. In case of a multi-storey building, the beam transfers the load coming from the floor above the slab which is in turn transferred to the columns. Beams and slabs are constructed by reinforced cement concrete (R.C.C).

5. Columns

Columns are vertical members constructed above the ground level. Columns can be of two types: Architectural columns and structural columns. Architectural columns are constructed to improve the building's aesthetics while a **structural** column takes the load coming from the **slab** above and transfers safely to the foundation.

6. Damp Proof Course(DPC)

DPC is a layer of waterproofing material applied on the basement level to prevent the rise of surface water into the walls. The walls are constructed over the DPC.

7. Walls

Walls are vertical elements which support the roof. It can be made from stones, bricks, concrete blocks, etc. Walls provide an enclosure and protect against wind, sunshine, rain etc. **Openings** are provided in the walls for ventilation and access to the building.

8. Floors

The floor is the surface **laid on the plinth level**. Flooring can be done by a variety of materials like **tiles, granites, marbles, concrete**, etc. Before flooring, the ground has to be properly compacted and leveled.

9. Stairs

A stair is a **sequence of steps** that connects different floors in a building structure. The space occupied by a stair is called as the stairway. There are different types of stairs like a wooden stair, R.C.C stair etc.

10. Plinth Beam

Plinth beam is a beam structure constructed either at or above the ground level to take up the load of the wall coming over it.

11. Plinth

The plinth is constructed above the ground level. It is a cement-mortar layer lying between the substructure and the superstructure.

12. Foundation

The Foundation is a structural unit that uniformly distributes the load from the superstructure to the underlying soil. This is the first structural unit to be constructed for any building construction. A good foundation prevents settlement of the building.

MORTAR

Mortar is **a material used in masonry construction to fill the gaps between the** bricks and blocks. Mortar is a mixture of **sand, a binder such as cement or lime, and water** and is applied as a paste which then sets hard.

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**. The stones used for masonry construction are natural rocks

BRICK MASONARY

STRETCHER COURSE:

A brick, laid with its length horizontal and parallel with the face of the wall or other masonry member is called a “Stretcher” and a course, in which, all the bricks are laid as Stretchers is called a “Stretching course” or “Stretcher course”.

HEADER COURSE:

A brick laid, so that only its end shows on the face of a wall is called a "Header" and a course, in which all the bricks are laid as headers, is known as "Heading Course" or "Header course“.

BOND:

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

The bonds in brick masonry is **developed by the mortar filling between layers of bricks and in grooves when bricks are laid adjacent to each other and in layers in walls**. Mostly used material for bonds in brick masonry is cement mortar. Lime mortar and mud mortar are also used.

MODULE-II

What is Surveying ?

Surveying is the art of making measurements of objects on, above or beneath the ground to show their relative positions on paper.
The relative position required is either horizontal, or vertical, or both.

Why we do surveying ?

1. Maps prepared for marking boundaries of countries, states, districts etc., avoid disputes.
2. Locality plans help in identifying location of houses and offices in the area.
3. Topographic maps showing natural features like rivers, streams, hills, forests help in planningirrigation projects and flood control measures.
4. For planning and estimating project works like roads, bridges, railways, airports, water supplyand waste water disposal surveying is required.

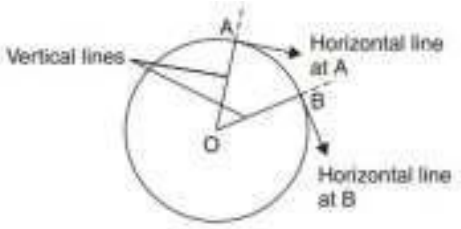


Fig. 11.1. Vertical and horizontal lines

The earth may be treated as a sphere, shows a circular plane passing through a point A on the earth surface.

The gravitational force is always directed towards the centre of the earth. The *plumb-line* shown in Fig. is a *vertical line*. (2 marks)
Line perpendicular to vertical line (tangential to earth surface) is known as horizontal line. (2 marks)
In surveying all measurement at any point are in the direction of these two lines

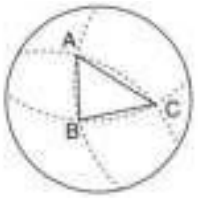


Fig. 11.2. Plane and spherical triangles

If the area to be surveyed is small, the curvature of the earth may be neglected and all plumb lines treated as the same vertical. Hence, the lines normal to plumb line at any point in the area are treated as the same horizontal.
All triangles in the area may be treated as plane triangles.

(2 marks - Define Plane surveying)
The survey in which earth curvature is neglected is called *Plane Surveying*. For small survey area, curvature of earth is neglected.

(2 marks - Define Geodetic surveying)
The survey in which earth's curvature is considered is known as *Geodetic Surveying*. For large suvey area, we cannot ignore earth's curvature in measurement.

(2 marks- Basic fundamental principle in surveying ?)
To get accurate results in surveying one should follow the following fundamental principles :-
1) Work from whole to part
2) Take extra care in fixing new control points

Locating Point C with respect to Point A and B

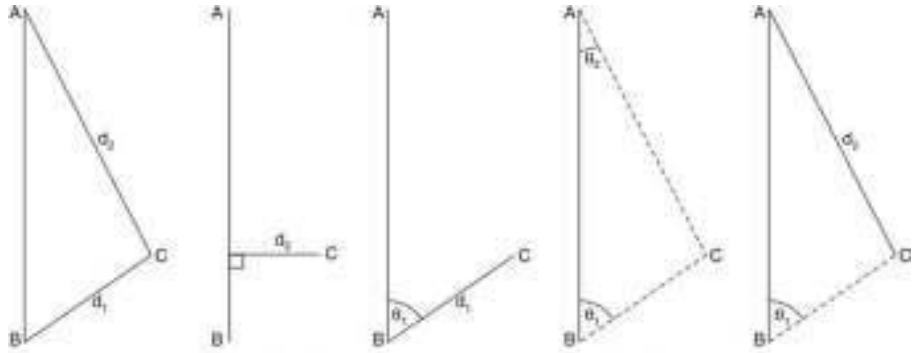


Fig. 11.3. Locating point C w.r.t. points A and B

What is Scale ?(2 marks)
It is not possible and also not desirable to make maps to one to one scale. While making maps all distances are reduced by a fixed proportion. That fixed proportion is called ***scale of the map.***
Thus, if 1mm on the paper represents 1 metre on the ground, then the scale of the map is
1 mm = 1 m or 1 mm =1000 mm or 1 : 1000.

What is Representative factor (RF) (2 marks)
To make scale independent of the units it is preferable to use ***representative factor (RF)*** which may be defined as the ratio of one unit on paper to the number of units it represent on the ground.
Thus 1 mm = 1 m is equivalent to RF = 1 / 1000

Classification of surveying
Based on the instruments used, surveying may be classified as:

(i) Chain survey

(ii) Compass survey
(iii) Plane table survey
(iv) Theodolite survey
(v) Tacheometric survey
(vi) Modern survey using electronic distance meters and total station
(vii) Photographic and Aerial survey

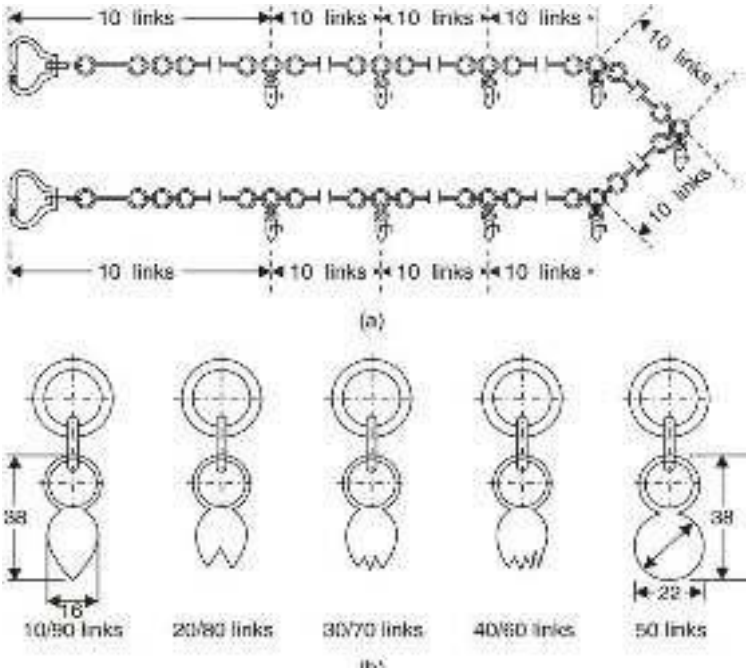
Method of preparing a plan using only linear measurements is by conducting **chain surveying**. (2 marks)
Measurement of distances using chain or tape is termed as **chaining.** (2 marks)

Instruments Used in Chain Survey: (4 marks)

(i) Chain (or) Tape
(ii) Arrows
(iii) Pegs
(iv) Ranging Rods
(v) Offset Rods
(vi) Plasterer's laths and whites
(vii) Plumb bob

1. Chain

- They are formed of straight links of Galvanized mild steel wires.
- To facilitate easy reading of the chain, brass tallies are provided.
- It is to be noted that length of a link is the distance between centres of two consecutivemiddle rings.
- the length of the chain is from outside of one handle to the outside of the other handle.



Types :

Metric chain, Surveyor's chain, Engineer's chain
Metric chains are of 20 m length. They have 100 links with talleys at every 2 m. Each link is of 0.2 m length.

Tapes : Depending upon the materials used, they are classified as:
(i) cloth or linen tape
(ii) metallic tape
(iii) steel tape and
(iv) invar tape.

Cloth or linen tape

- 12 to 15 mm wide cloth or linen is varnished and graduations are marked.
- They are provided with brass handle at the ends. They are available in length of 10 m, 20m, 25 m and 30 m.

These tapes are light and flexible. However because of the following disadvantages theyare not popular:

(i) Due to moisture they shrink.
(ii) Due to stretching they extend.
(iii) They are not strong.
(iv) They are likely to twist.

Metallic Tape

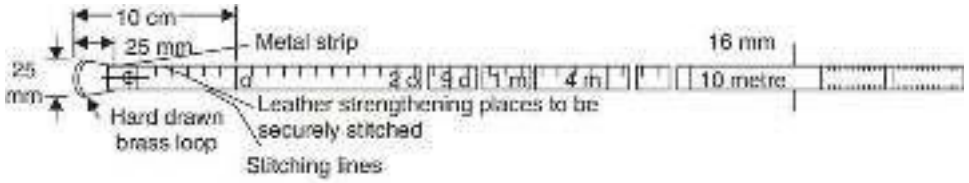
- They are made up of varnished strip of waterproof linen inter-wooven with small wires ofbrass, copper or bronze.
- Tapes of length 10 m, 20 m, 30 m and 50 m are available in a case of leather or corrosionresistant metal fitted with a winding device.
- These tapes are light, flexible and not easily broken.
- These tapes are commonly used in surveying.
- 

Fig. 12.2. Metallic tape

Steel Tape

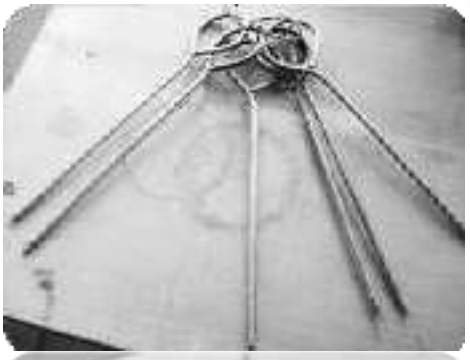
- A steel tape consists of 6 to 10 mm wide strip with metal ring at free end and wound in aleather or corrosion resistant metal case.
- Steel tapes are superior to metallic tapes as far as accuracy is concerned.
- They should be oiled regularly to prevent corrosion.

INVAR Tape

- *Invar is an alloy of nickel (36%) and steel.*
- It's coefficient of thermal expansion is low. Hence errors due to variation in temperaturedo not affect measurements much.
- The width of tape is 6 mm.
- It is available in length 30 m, 50 m and 100 m.
- It is accurate but expensive.

2. Arrows

- When the length of the line to be measured is more than a chain length, there is need tomark the end of the chain length.
- Arrows are used for this purpose.



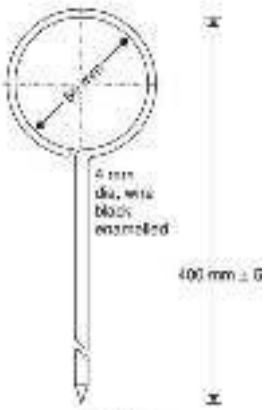


Fig. 12.5. Arrows

3. Pegs

- Wooden pegs are used to mark the positions of the survey stations or the end points of asurvey line
- The pegs are made of hard wood of 25 mm × 25 mm section, 150 mm long with one endtapered
- When driven in ground to mark station points they project about 40 mm

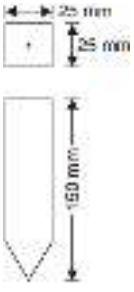


Fig. 12.6. Pegs

4. Ranging Rods and Ranging Poles

- For ranging intermediate points along the line to be measured, ranging rods and rangingpoles are used.
- Ranging rods are 2 to 3 m long and are made of hard wood. They are provided with ironshoe at one end
- They are usually circular in section with 30 mm diameter and are painted with 200 mmcolour bands of red and white or with black and white.
- Ranging poles are similar to ranging rods except that they are longer.
- Their length varies from 4 m to 8 m and diameter from 60 mm to 100 mm.

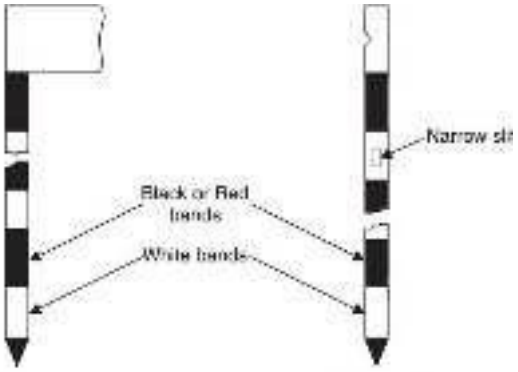


Fig. 12.7 Ranging rod Fig. 12.8. Offset rod

Offset rod

- These rods are also similar to ranging rods and they are 3 m long. They are made up ofhard wood and are provided with iron shoe at one end.
- A hook or a notch is provided at other end.
- At height of eye, two narrow slits at right angles to each other are also provided for usingit for setting right angles.

5. Laths

- Laths are 0.5 to 1.0 m long sticks of soft wood.
- They are sharpened at one end and are painted with white or light colours.
- They are used as intermediate points while ranging or while crossing depressions.

6. Whites

- Whites are the pieces of sharpened thick sticks cut from the nearest place in the field. Oneend of the stick is sharpened and the other end is split.
- White papers are inserted in the split to improve the visibility.
- Whites are also used for the same purpose as laths.

7. Plumb Bob

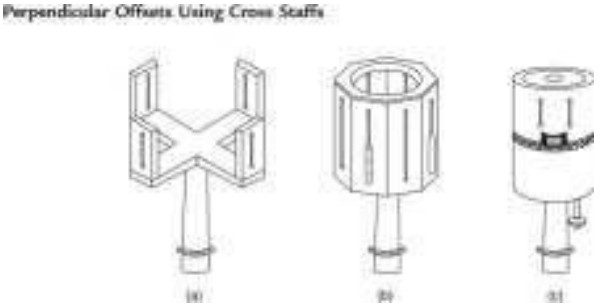
- They are also used to check the verticality of ranging poles

- It is further used in the primary adjustments of all the surveying instruments.

8. Cross staff:

- The cross staff is used for

a) Finding out foot of the perpendicular from a given point to a line
b) Setting right angle at a given point on a line



(Q. List cases where chain Surveying is suitable ? (marks-4))

Chain survey is suitable in the following cases:

(i) Area to be surveyed is comparatively small
(ii) Ground is fairly level
(iii) Area is open and
(iv) Details to be filled up are simple and less.

In chain surveying only linear measurements are made i.e. no angular measurements are made. Since triangle is the only figure that can be plotted with measurement of sides only, in chain

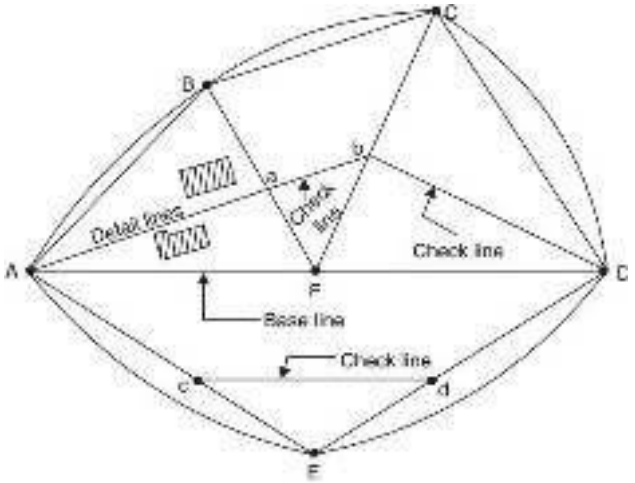


Fig. 12.11. Network of triangles

surveying the area to be surveyed should be covered with a network of triangles.
(definitions- 2 marks each)

Station: Station is a point of importance at the beginning or at the end of a survey line.

Main station: These are the stations at the beginning or at the end of lines forming main skeleton. They are denoted as A, B, C etc.

Subsidiary or tie stations: These are the stations selected on main lines to run auxiliary/secondary lines for the purpose of locating interior details. These stations are denoted as a, b, c, ...,etc., or as 1, 2, 3, ... etc.

Base line: It is the most important line and is the longest.

Usually it is the line plotted first and then frame work of triangles are built on it.

Detail lines: If the important objects are far away from the main lines, the offsets are too long, resulting into inaccuracies and taking more time for the measurements.

In such cases the secondary lines are run by selecting secondary stations on main lines. Such lines are called detail lines.

Check lines: These are the lines connecting main station and a substation on opposite side or the lines connecting to substations on the sides of main lines.

The purpose of measuring such lines is to check the accuracy with which main stations are located.

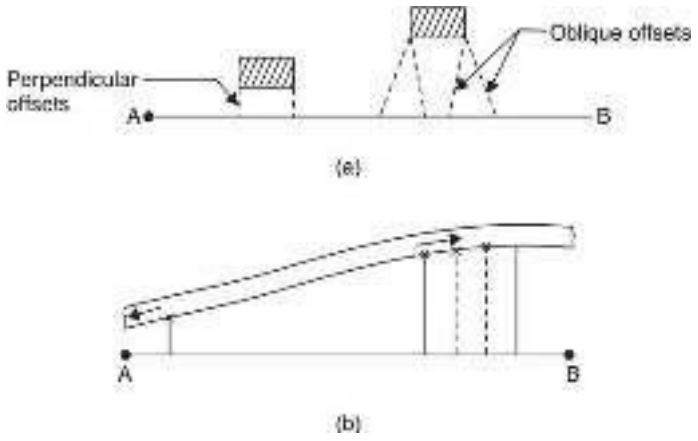
Offsets

Lateral measurements to chain lines for locating ground features are known as offsets.

For this purpose :-

1) perpendicular or

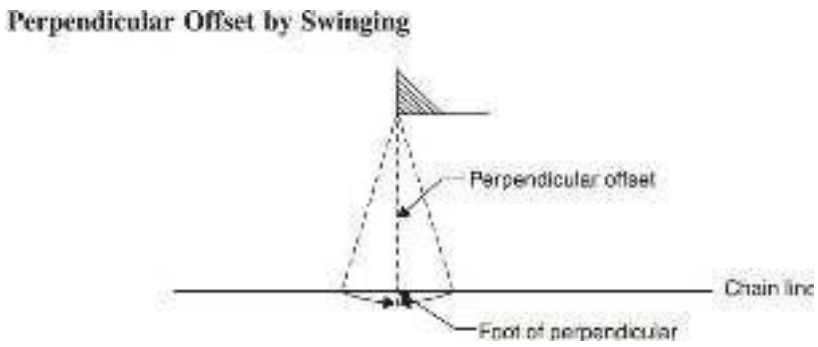
2) oblique offsets may be taken.



For setting perpendicular offsets any one of the following methods are used:

(i) Swinging

(ii) Using cross staffs



The following points should be considered in selecting station points: (4 Marks)

(i) It should be visible from at least two or more stations.
(ii) As far as possible main lines should run on level ground.
(iii) All triangles should be well conditioned (No angle less than 30º).
(iv) Main network should have as few lines as possible.
(v) Each main triangle should have at least one check line.
(vi) Obstacles to ranging and chaining should be avoided.
(vii) Sides of the larger triangles should pass as close to boundary lines as possible.
(viii) Tresspassing and frequent crossing of the roads should be avoided.

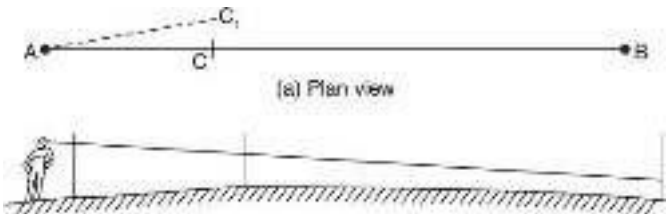
RANGING

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 viz., direct ranging and reciprocal ranging.

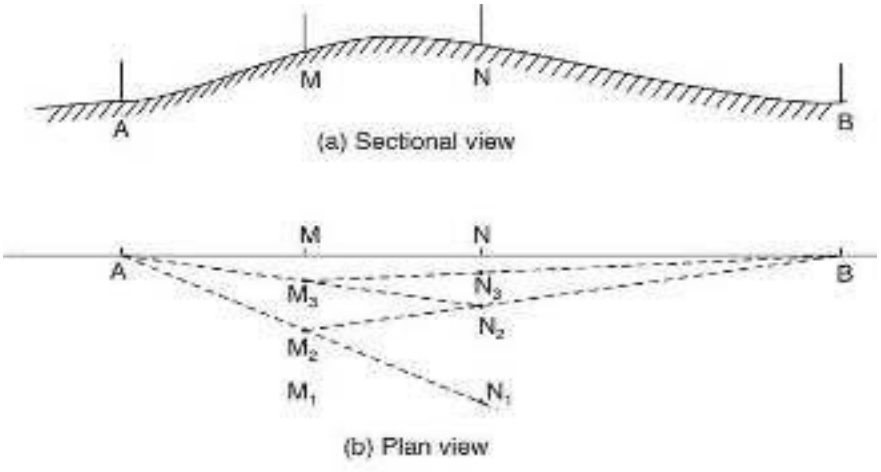
Direct Ranging

If the first and last points are intervisible this method is possible.



Indirect or Reciprocal Ranging

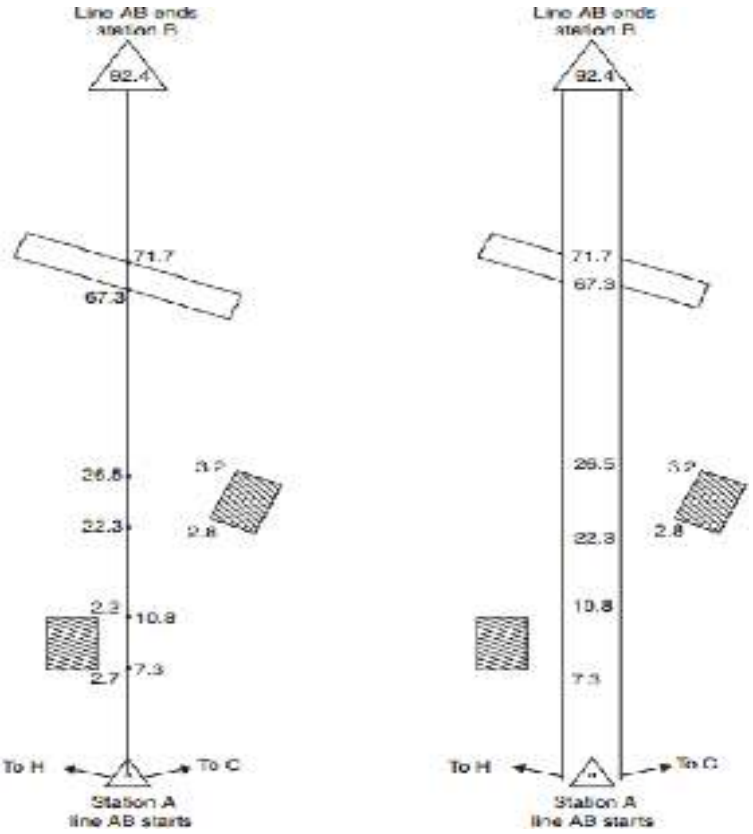
Due to interfering ground, if the ranging rod at B is not visible from station A, reciprocal ranging may be used.



- Due to intervening ground, if the ranging rod at B is not visible from station A, reciprocal ranging may be resorted. Figure shows this scheme of ranging.
- It needs two assistants one at point M and another at point N, where from those pointsboth station A and station B are visible. It needs one surveyor at A and another at B.
- To start with M and N are approximately selected, say M1and N1. Then surveyor nearend A ranges person near M to position M2such that AM2N1 are in a line.
- Then surveyor at B directs person at N, to move to N2 such that BN2M2 are in a line.
- The process is repeated till AMNB are in a line.

Field book

- All observations and measurements taken during chain surveying are to be recorded in astandard field book.
- There are two forms of the book (i) single line and (ii) double line.
- The pages of a single book are having a red line along the length of the paper in the middle ofthe width. It indicates the chain line.
- All chainages are written across it.
- The space on either side of the line is used for sketching the object and for noting offset distances. In double line book there are two blue lines with a space of 15 to 20 mm is themiddle of each book.
- The space between the two lines is utilised for noting the chainages.



ERRORS IN CHAINING

(i) Personal errors

(ii) Compensating errors, and

(iii) Cumulating errors.

Personal errors

Wrong reading, wrong recording, reading from wrong end of chain etc., are personal errors. These errors are serious errors and cannot be detected easily.

Care should be taken to avoid such errors.

Compensating Errors

(i) Incorrect marking of the end of a chain.

(ii) Graduations in tape may not be exactly same throughout.

These errors may be sometimes positive and sometimes negative.*Cumulative Errors*

The errors, that occur always in the same direction are called cumulative errors.

(i) Bad ranging

(ii) Bad straightening

(iii) Erroneous length of chain

(iv) Temperature variation

(v) Variation in applied pull

(vi) Non-horizontality

(vii) Sag in the chain.

Toposheets or Topographical Maps

- Topographical map is also known as Topographical Survey Sheet or Toposheet.
- It is a multipurpose map drawn on large scale and covers a small area.
- It shows both natural features such as relief, drainage, vegetation, etc. and man madefeatures such as roads, railways, canals, etc.
- It shows even the small features in good details because it is drawn on a large scale.
- Importance
- The are used by large number of professionals including military personnels,administrators,planners,researchers,travellers, etc.
- Most of the military operations are based on the study of topographical maps.
- Future planning of any area also depends upon the study of these maps.

Topographical Maps of survey of India

- The survey of India department was established in 1767 with headquarters at 1767. Thisdepartment has published many series of toposheets.
- International Series: This is drawn on 1:10,00,000 scale and is also known as one to onemillion sheet. Each sheet has 4* latitude and 6* longitude. Heights are shown in metres.
- India and Adjacent countries: They are also drawn on 1:10,00,000 scale. Longitude- 4* and Longitude-4*. They have been given serial numbers like 45,46,47 etc which are known as index numbers. This series forms the base for other series.
- Topographical Maps of survey of India
- Quarter Inch to Mile series: I Inch = 4 miles or 1:2,53,440
- Each 1:1 million sheet is divided into 16 parts and each part is labelled from A to P eg. 63A, 63B, 63C etc. Their latitudinal and longitudinal extent is 1* and they are known as degree sheets. The new editions of these sheets have been published in metric scale, 1:2,50,000 scale. Their contour interval is 100 metres.
- Topographical Maps of survey of India
- 1:25,000 series- Each Sheet of 1:50,000 series is further divided into 4 parts. Two partsalong latitude and two parts along longitudes.
- They are numbered according to direction, such as 63K/12/NW, 63K/12/NE, 63K/12/SW, 63K/12/SE.

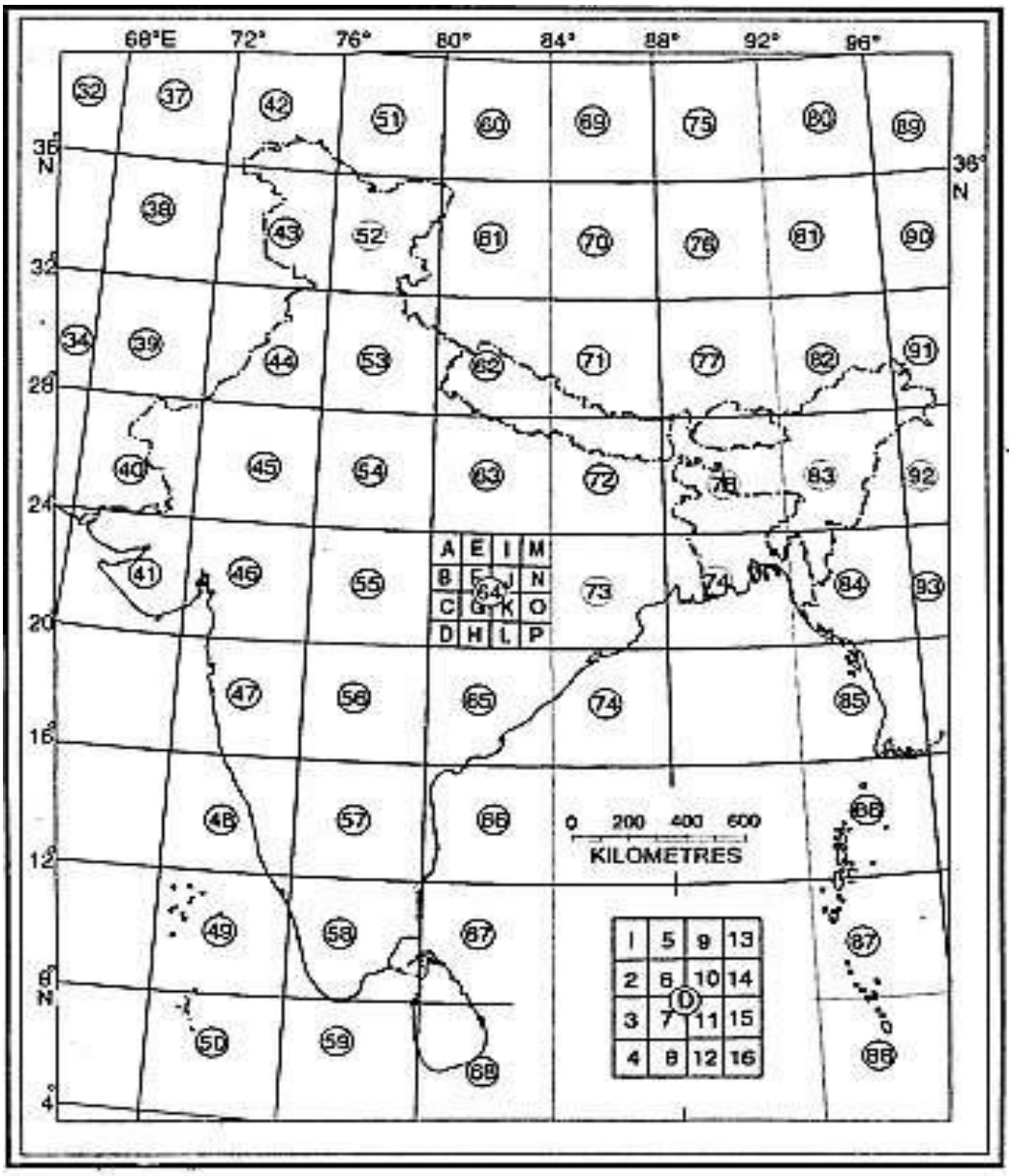


FIG. 6.1. REFERENCE MAP OF TOPOGRAPHIC SHEETS PUBLISHED BY THE SURVEY OF INDIA

CONVENTIONAL SYMBOLS

- If coloured plans are to be made, the code recommends light washes of the followingshades:
- For roads – Burnt sienna
- For buildings – Light grey
- For compound walls – Indigo
- For water – Borders edged with Prussian blue
- For trees – Green.

Chain line	Road under railway

Lighthouse. Lightship. Buoys: lighted: unlighted. Anchorage...

Mine. Vine on trellis. Grass. Scrub....

Palms: palmyra: other. Plantain. Conifer. Bamboo. Other trees

Boundary. international....

Boundary state: demarcated: undemarcated...

Boundary district; subdivn, tahsil or taluk; forest...

Boundary pillars surveyed, unlocated; village trijunction...

Heights triangulated; station; point, approximate... △ 200 . 200 .200

Bench-mark: geodetic; tertiary: canal... . BM 63.3 . BM 63.3 . 63

Post office. Telegraph office. Combined office. Police station... PO TO PTO PS

Bungalows: dak or travellers; inspection. Rest-house... DB IB (Canal) RH (Forest)

Road, metalled : according to importance; distance stone 20

Roads unmetalled : according to importance, bridge

Cart-track. Pack-track and pass. Foot-path with bridge

Streams : with track in bed; undefined. Canal

Dams : masonry or rock filled; earthwork. Weir

River dry with water channel; with islands and rocks. Tidal river

Swamp. Reeds

Wells : lined; unlined. Spring. Tanks : perennial; dry

Embankments : road or rail

Railway, broad gauge : double; single with station; under construction RS

Railway other gauges : double; single with distance stone; under constrn. 8

Light Railway or tramway. Telegraph line. Cutting with tunnel

Contours. Cliffs

Sand features (1) flat (2) sand hills (permanent) (3) dunes (shifting) 1 2 3

Towns or villages : Inhabited; Deserted Fort X

What is compass survey.

- ✓ Chain Survey can be used when the area to be surveyed is comparatively small and fairlyflat.
- ✓ When large areas are involved, methods of chain surveying alone are insufficient and onehas to use a combination of many surveys.
- ✓ Compass Survey is one such type of survey in which the angles or direction of survey lines are measured.

Instruments used

- ✓ Surveyor's Compass
- ✓ Prismatic Compass
- ✓ Sextant
- ✓ Theodolite

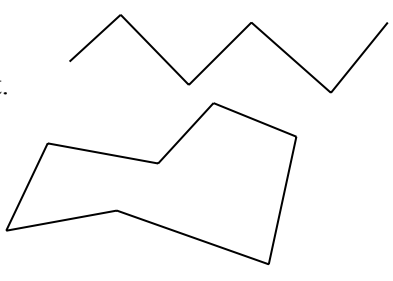
1. Tape
2. Ranging rods
3. Tripod
4. Arrows

Compass is an instrument which can be used to measure the direction of a survey line with respect to magnetic north-south.The magnetic north-south direction which is the reference direction is called **meridian** (reference direction) and the angle between the line and the meridian is called **bearing.**

Traverse Survey:

Traverse- A series of connected straight lines is called as traverse. It is of two types:

1) Open Traverse
   Starting and End point are different.



2) Closed traverse.
Starting and End point are same

Prismatic Compass:

1. Graduation circle is fixed to broad type needle . Hence, it will not rotate with theline of sight.
2. There is a prism at viewing end.
3. Sighting and reading can be done simultaneously.
4. Graduations are marked inverted since its
5. reflection is read through prism.
6. The reading is taken through a prism.

Prismatic Compass

Note: Surveyor's Compass is not in syllabus but comparision should be studied.

Table 13.1. Differences between prismatic and surveyors compass

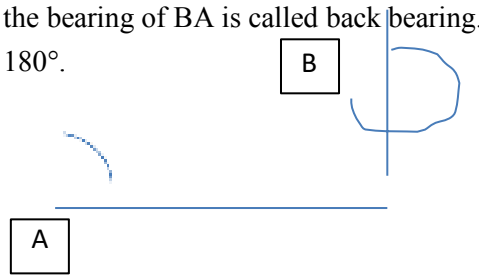
Sr. No.	*Prismatic Compass*	*Surveyors Compass*
1.	Graduation circle is fixed to broad type needle. Hence, it will not rotate with the line of sight.	Graduation circle is fixed to the box. Hence, it rotates with the line of sight.
2.	There is a prism at viewing end.	At viewing end there is no prism. There is only a slit.
3.	Sighting and reading can be done simultaneously.	Sighting and viewing cannot be done simultaneously.
4.	The magnetic needle do not act as an index.	Magnetic needle acts as index while reading.
5.	The graduations are in whole circle bearing.	The graduations are in quadrantal system.
6.	Graduations are marked inverted since its reflection is read through prism.	Graduations are marked directly. They are not inverted.
7.	The reading is taken through a prism.	The reading is taken by directly viewing from top glass.
8.	Tripod may or may not be used. It can be held on a stretched hand also.	Tripod is essential for using it.

The direction shown by a freely suspended and properly balanced magnetic needle is called **magnetic meridian** and the horizontal angle made by a line with this meridian is known as **magnetic bearing.**

The points of intersection of earth's axis with surface of the earth are known as geographic north and south pole. The line passing through geographic north, south and the point on earth is called **true meridian** at that point and the angle made by a line passing through that point is called **true bearing.**

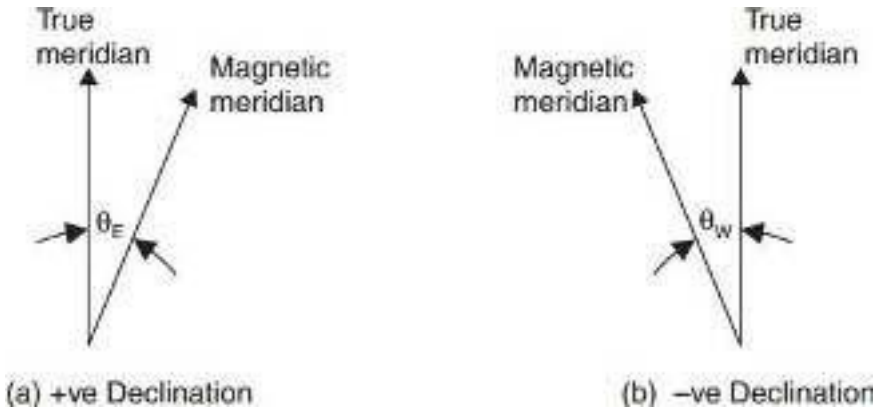
All bearings are angles where as all angles are not Bearings

While traversing along lines A, B, C, D ..., the bearing of lime AB is called fore bearing of AB and the bearing of BA is called back bearing. Fore bearing and back bearing differ by 180°.



Angle of Declination

The magnetic meridian and the true meridian may not coincide with each other in a place. The horizontal angle between these two meridians is known as magnetic declination. The magnetic north at a place may be towards east or west of true north . If it is towards east, it is known as eastern or +ve declination. Western declination is known as –ve declination.



True Bearing = Magnetic Bearing + - Angle of Declination (+ve for east , -ve for west)

Example 3.6 The magnetic bearing of line PQ is 124°35′. Find its true bearing, if the magnetic declination is 10°10′W.

Solution True bearing of line = magnetic bearing ± magnetic declination E/W.
Since, magnetic meridian is to the west.

$$\text{True bearing} = 124°35' - 10°10'$$
$$= 114°25'$$

Example 3.7 The magnetic bearing of line PQ is S40°E and the magnetic declination is 8°5′E. What is the true bearing of the line?

Solution The W.C.B. of line PQ = 180° – 40° = 140°
True bearing of PQ = magnetic bearing ± magnetic declination E/W
= 140° + 8°5′
= 148°5′

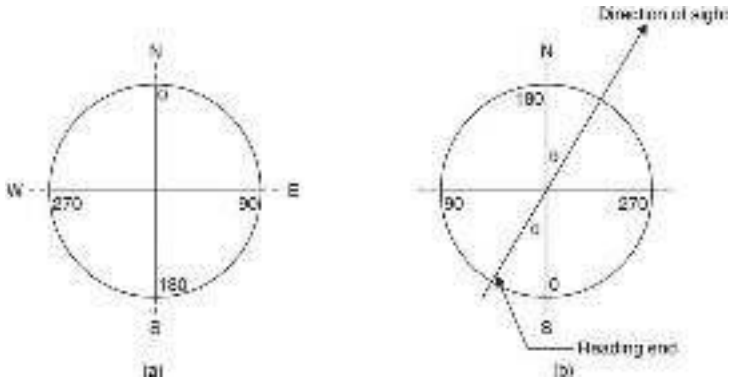
Angle of Dip

The vertical angle between the horizontal and the direction shown by a perfectly balanced and freely suspended needle is known as the magnetic dip at that place.Its value is 0° at equator and 90° at magnetic poles.

Whole Circle Bearing

In **whole circle bearing (WCB)** the bearing of a line at any point is measured with respect to a meridian.

Its value varies from zero to 360°, increasing in clockwise direction.
Zero is north direction, 90° is east, 180° is south and 270° is west. This type of bearing is used in *prismatic compass.*

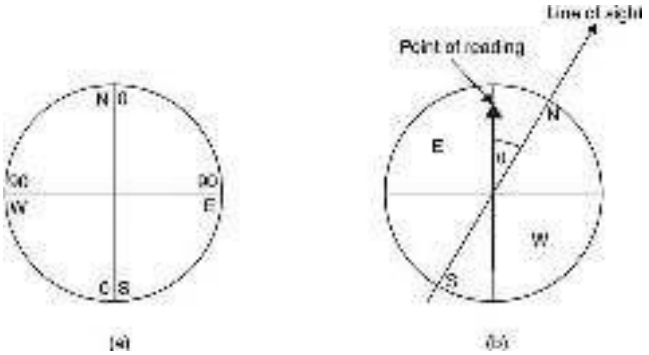


Reduced Bearing or Quadrantal Bearing (QB)

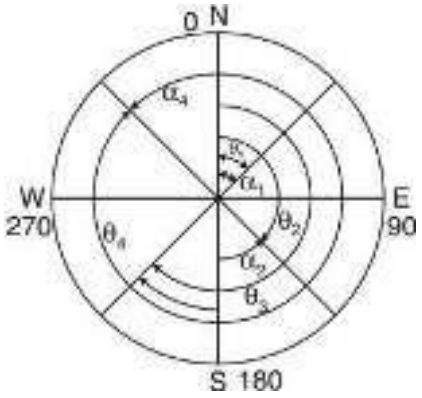
In reduced bearing (RB) system, bearings are measured from north or south direction towards east or

west. Hence, angles are from 0 to 90°. This system of measuring bearings is used in *Surveyor's compass* and it is also known **as Quadrantal Bearing (QB).**

The bearing measured is designated with letter N or S in the beginning to indicate whether it is from north or south. The letter E or W written after the angle indicates whether the bearing read is towards east or west, respectively.



The conversion of the bearing from one system to the other system can be easily carried out by drawing a sketch to indicate WCB or RB as shown



It may be observed that conversion table is as given below:

Quadrant in which bearing lies	*Conversion relation*
NE	$\theta = \alpha$

■ **Example 13.1:** *Convert the following reduced bearings into whole circle bearings:*

(i) N 65° E *(ii) S 43° 15′ E*

(iii) S 52° 30′ W *(iv) N 32° 42′ W*

Solution: Let 'θ' be whole circle bearing.

(i) Since it is in *NE* quadrant,

$$\theta = \alpha = \mathbf{65°}$$ **Ans.**

(ii) Since it is in south east quadrant

$$43° 15' = 180° - \theta$$

or $$\theta = 180° - 43° 15' = \mathbf{136° 45'}$$ **Ans.**

(iii) Since it is in SW quadrant

$$52° 30' = \theta - 180°$$

or $$\theta = 180° + 52° 30' = \mathbf{232° 30'}$$ **Ans.**

(*iv*) Since it is in NW quadrant,

$$32° 42' = 360° - \theta$$

or $$\theta = 360° - 32° 42' = \mathbf{327° 18'}$$ **Ans.**

■ **Example 13.2:** *The following fore bearings were observed for lines, AB, BC, CD, DE, EF and FG respectively. Determine their back bearings:*

(*i*) *148°* (*ii*) *65°*

(*iii*) *285°* (*iv*) *215°*

(*v*) *N 36° W* (*vi*) *S 40° E*

Solution: The difference between fore bearing and the back bearing of a line must be 180°. Noting that in WCB angle is from 0° to 360°, we find back bearing = fore bearing ± 180°

+ 180° is used if θ is less than 180° and

– 180° is used when θ is more than 180°.

Hence

(*i*) BB of AB = 145° + 180° = 325°

(*ii*) BB of BC = 65° + 180° = 245°

(*iii*) BB of CD = 285° – 180° = 105°

(*iv*) BB of DE = 215° – 180° = 35°

In case of RB, back bearing of a line can be obtained by interchanging N and S at the same time E and W. Thus

(*v*) BB of EF = S 36° E

(*vi*) BB of FG = N 40° W.

For BB of CD,DE can also be found out by adding 180 degrees and if it exceeds 360 degrees than substract 360 from the answer.

BB of CD = 285 +180 =465 – 360 = 105 BB of
DE = 215+180=395-360=35

Computation of Internal Angles

At any point, if bearings of any two lines are known, the angle between these two lines can be easily found by drawing a neat sketch, and then noting the difference.

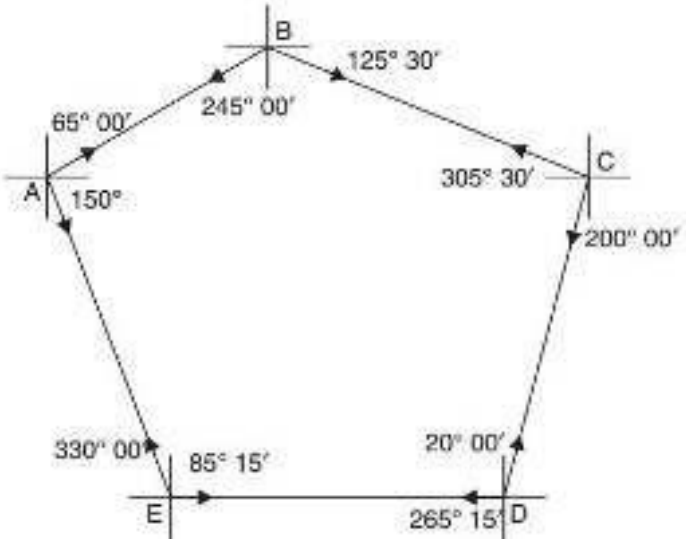
Question Based on Whole Circle Bearing

■ **Example 13.3:** *In a closed traverse the following bearings were observed with a compass. Calculate the interior angles.*

Line	*Fore bearing*
AB	*65° 00′*
BC	*125° 30′*
CD	*200° 00′*
DE	*265° 15′*
EA	*330° 00′*

Solution: We first find the back bearing of different lines
For finding back bearing- Add 180 degrees to forebearing reading. If it is greater than 360 degrees than subtract 360 degrees from answer.

Line	*Fore bearing*	*Back bearing*
AB	65° 00′	245° 00′
BC	125° 30′	305° 30′
CD	200° 00′	20° 00′
DE	265° 15′	85° 15′
EA	330° 00′	150° 00′



Referring to figure:

$\angle A = 150° 00' - 65° 00' = \mathbf{85° 00'}$

$\angle B = 245° 00' - 125° 30' = \mathbf{119° 30'}$

$\angle C = 305° 30' - 200° 00' = \mathbf{105° 30'}$

$\angle D = (360° - 265° 15') + 20° 00' = \mathbf{114° 45'}$

$\angle E = (360° - 330° 00') + 85° 15' = \mathbf{115° 15'}$

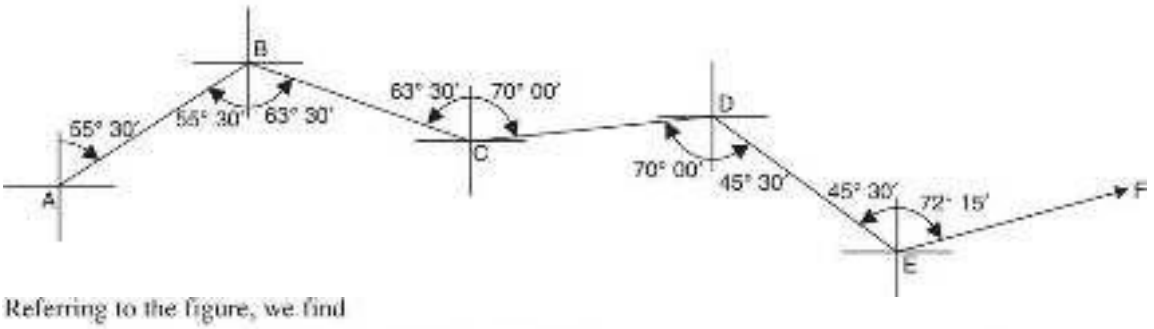
Question Based on Reduced Bearing

Q. The angles observed with a surveyor compass in traversing the lines AB, BC, CD, DE and EF are as given below. Compute the included angles and show them in a neat sketch.

Line	*Fore bearing*
AB	*N 55° 30′ E*
BC	*S 63° 30′ E*
CD	*N 70° 00′ E*
DE	*S 45° 30′ E*
EF	*N 72° 15′ E*

Solution: First Find Back bearing of lines by simply Changing N to S, E to W .
It should be noted that 180 degrees should not be added in Questions of Reduced Bearing readings.

Line	*FB*	*BB*
AB	N 55° 30′ E	S 55° 30′ W
BC	S 63° 30′ E	N 63° 30′ W
CD	N 70° 00′ E	S 70° 00′ W
DE	S 45° 30′ E	N 45° 30′ W
EF	N 72° 15′ E	S 72° 15′ W.



Referring to the figure, we find

$\angle B = 55° 30' + 63° 30' = \mathbf{119° 00'}$ **Ans.**

$\angle C = 63° 30' + 70° 00' = \mathbf{133° 30'}$ **Ans.**

$\angle D = 70° 00' + 45° 30' = \mathbf{115° 30'}$ **Ans.**

$\angle E = 45° 30' + 72° 15' = \mathbf{117° 45'}$ **Ans.**

Local Attraction

- A freely suspended and properly balanced magnetic needle is expected to showmagnetic meridian.
  However, local objects like electric wires and objects of steel attract magnetic needle towards themselves.
  Thus, needle is forced to show slightly different direction. This disturbance is called local attraction.

- The list of materials which cause local attraction are:
  (i) magnetic rock or iron ore,
  (ii) steel structures, iron poles, rails, electric poles and wires,
  (iii) key bunch, knife, iron buttons, steel rimmed spectacles, and
  (iv) chain, arrows, hammer, clearing axe etc.

- Detecting Local Attraction
  For detecting local attraction it is necessary to take both fore bearing and back bearing for each line.
  If the difference is exactly 180° , the two stations may be considered as not affected by local attraction.
  If difference is not 180° , better to go back to the previous station and check the fore bearing. If that reading is same as earlier, it may be concluded that there is local attraction at one or both stations.

- if the sum of the interior angles of a closed traverse does not provide (2n - 4) right angles [where n is the number of sides in the traverse], then there is a possibility oflocal attraction during the observation of the traverse.

Method I:

- It may be noted that the included angle is not influenced by local attraction as both readings are equally affected.

- Hence, first calculate included angles at each station, commencing from the unaffected line and using included angles, the corrected bearings of all lines may becalculated.

Question. In a closed traverse, the following bearings were observed, with a compass. Calculate their interior angles and then compute the corrected magnetic bearings:

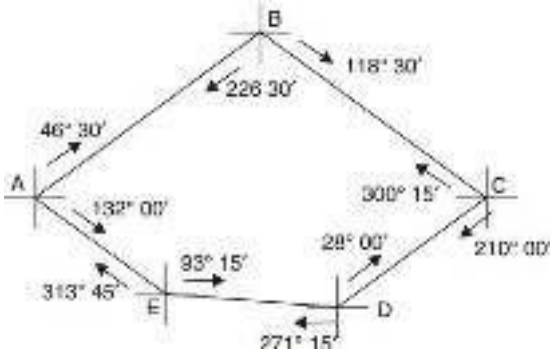
Line	*FB*	*BB*
AB	*46° 30'*	*226° 30'*
BC	*118° 30'*	*300° 15'*
CD	*210° 00'*	*28° 00'*
DE	*271° 15'*	*93° 15'*
EA	*313° 45'*	*132° 00'*

Solution: Step 1 : Find line which has zero local attraction . This is done by finding difference of Back Bearing and Forebearing of line.

We find that Line AB has zero local attraction.

FB of AB – BB of BA = 226* 30’ – 46* 30’ = 180*

Step 2: Find Internal Angles from the observed readings given in question.



Correct bearing of AB = 46° 30′

Correct bearing of BA = 226° 30′

From the figure,

$$\angle A = 132° 00' - 46° 30' = 85° 30'$$

$$\angle B = 226° 30' - 118° 30' = 108° 00'$$

$$\angle C = 300° 15' - 210° 00' = 90° 15'$$

$$\angle D = (360° - 271° 15') + 28° 00' = 116° 45'$$

$$\angle E = (360° 00' - 313° 45') + 93° 15' = 139° 30'$$

Total Interior Angle $= \angle A + \angle B + \angle C + \angle D + \angle E$

$= 540° 00'.$

Sum of Internal angles should be equal to = (2n-4) x 90 = (2 x 5 – 4) x 90 = 540 degrees

The angles found will always be correct.

Step 3:

Start from the Line having Zero Local Attraction :
In this case Line AB has Zero Local Attraction.
Draw Line AB , then write Fore Bearing of AB and Back Bearing of BA.

Since, stations A and B are not affected by local attraction, correct bearings are:

Bearing of AB $= 46° 30'$

Bearing of BA $= 46° 30' + 180° 00' = 226° 30'$

Subtract Angle B from Back Bearing BA to Find Fore bearing of Next line that is BC.
Continue above steps for all lines.

Bearing of BC $= 226° 30' - \angle B = 226° 30' - 108° 00' = 118° 30'$

Bearing of CB $= 118° 30' + 180° 00' = 298° 30'$

Bearing of CD $= 298° 30' - \angle C = 298° 30' - 90° 15' = 208° 15'$

Bearing of DC $= 208° 15' - 180° 00' = 28° 15'$

Bearing of DE $= 28° 15' - \angle D = 28° 15' - 116° 45'$

$= -89° 30' = -88° 30' + 360° 00' = 271° 30'$

Bearing of ED $= 271° 30' - 180° 00' = 91° 30'$

Bearing of EA $= 91° 30' - \angle E = 90° 30' - 139° 30'$

$= -48° 00' = -48° 00' + 360° = 312° 00'$

Bearing of AE $= 312° 00' - 180° 00' = 132° 00'$

[Checked. It should be equal to the observed bearing, since station E is not affected].

- 2nd Method

In this method, errors due to local attraction at each of the affected station is found starting from the bearing of a unaffected local attraction, the bearing of the successive lines are adjusted.

Correction = Correct reading – Observed reading

Solve Above Question by 2nd Method.

Solution: Since, the difference between FB and BB of line AB is exactly 180°, stations A and B are not affected by local attraction. Hence, corrections to the observed bearings at A and B are zero.
Hence reading of AB, AE from station A, And reading of BA and BC from Station B will considered to be correct.

Station	Line	Observed Bearing	Correction	Correct Bearing
A	AE	132° 00′	0	132° 00′
	AB	46° 30′	0	46° 30′
B	BA	226° 30′	0	226° 30′
	BC	118° 30′	0	118° 30′
C	CB	300° 15′	- 1° 45′	298° 30′
	CD	210° 00′	- 1° 45′	208° 15′
D	DC	28° 00′	0° 15′	28° 15′
	DE	271° 15′	0° 15′	271° 30′
E	ED	93° 15′	- 1° 45′	91° 30′
	EA	313° 45′	- 1° 45′	312° 00′

Since, the difference between FB and BB of line AB is exactly 180°, stations A and B are not affected by local attraction. Hence, corrections to the observed bearings at A and B are zero.

∴ Correct bearing CB	= 118° 30′ + 180° 00′ = 298° 30′
But observed bearing	= 300° 15′
Hence correction at station C	= 298° 30′ – 300° 15′ = – 1° 45′
∴ Correct bearing of CD	= 210° 00′ – 1° 45′ = 208° 15′
Correct bearing DC	= 208° 15′ – 180° 00′ = 28° 15′
Observed bearing of DC	= 28° 00′
∴ Corrections required at D	= 28° 15′ – 28° 00′ = 0° 15′
∴ Correct bearing of DE	= 271° 15′ + 0° 15′ = 271° 30′
Correct bearing of ED	= 271° 30′ – 180° 00′ = 91° 30′
But observed bearing of ED	= 93° 15′
∴ Correction for observations at E	= 91° 30′ – 93° 15′ = – 1° 45′
∴ Correct bearing of EA	= 313° 45′ – 1° 45′ = 312° 00′
∴ Correct bearing of AE	= 312° 00′ – 180° 00′ = 132° 00′. **[Checked]**

Example 3.11 **The bearings observed in traversing with a compass at a place where local attraction was suspected are given below:**

Line	Fore Bearing	Back Bearing
AB	S45°30′E	N45°30′W
BC	S60°00′E	N60°40′W
CD	N03°20′E	S05°30′W
DA	S85°00′W	N83°30′E

At what stations do you suspect local attraction? Find the corrected bearings of the lines.

Solution **The numerical value of the fore and back bearings of the line AB is the same. Hence stations A and B are free from local attraction and therefore F.B. of BC observed at station B is accepted to be correct.**

Convert the quadrantal bearings to W.C.B.

AB	134°30′	314°30′
BC	120°00′	299°20′
CD	03°20′	185°30′
DA	265°00′	83°30′

F.B. of BC		120°00′	(correct)
Add 1		+ 180°00′	
Correct B.	=	300°00′	
Observed B.B.	=	299°20′	
Error at C	=	– 40′	
Correction at C	=	+ 40′	
Observed F.B. of C		3°20′	
Correction		+ 40′	
Correct F.B. of CD		4°00′	
Add 180°		180°00′	
Correct B.B. of CD	=	184°00′	
Observed B.B. of CD		185°30′	

Error at D		1°30′
Correction at D	=	– 1°30′
Observed F.B. of DA		265°00′
Correction at D		– 1°30′
Correct F.B. of DA	=	263°30′
Subtract 180°		180°00′
Correct B.B. of DA	=	
Observed B.B. of DA	=	

Bearings corrected for local attraction are:

Line	F.B.	B.B.	Line	F.B.	B.B.
AB	134°30′	314°30′	AB	S45°30′E	N45°30′W
BC	120°00′	300°00′	BC	S60°00′E	N60°00′W
CD	4°00′	184°00′	CD	N4°00′E	
DA	263°30′	83°30′	DA	S83°30′W	

Example 3.12 The following bearings were taken in running a closed compass traverse while surveying in Jhunsi, Allahabad:

Line	F.B.	B.B.
AB	48°25′	230°00′
BC	177°45′	356°00′
CD	104°15′	284°55′
DE	165°15′	345°15′
EA	259°30′	79°00′

(i) State the stations which are affected by local attraction and by how much.

(ii) Determine the correct bearings.

(iii) [illegible]

Solution Since F.B. and B.B. of line DE differ by 180°, the stations D and E are free from local attraction. Hence, fore bearing of EA is assumed to be correct.

F.B. of EA		259°30′	(correct)
Subtract 180°		− 180°00′	
Correct B.B. of EA		79°30′	
Observed B.B. of EA		79°00′	
Error at A		− 30′	
Correction at A	=	+ 30′	
Observed F.B. of AB		48°25′	
Correction		+ 30′	
Corrected F.B. of AB		48°55′	
Add 180°		180°00′	
Correct B.B. of AB		228°55′	
Observed B.B. of AB		230°00′	
Error at B		1°05′	
Correction at B	=	− 1°05′	
Observed F.B. of BC		177°45′	
Corrected F.B. of BC	=	176°40′	
Add 180°		180°00′	
Correct B.B. of BC	=	356°40′	
Observed B.B. of BC		356°00′	
Error at C		− 40′	
Correction at C	=	+ 40′	
Observed F.B. of CD		104°15′	
Corrected F.B. of CD	=	104°55′	
Add 180°		+ 180°00′	
Correct B.B. of CD	=	284°55′	
Observed B.B. to CD	=	284°55′	(checked)

The stations affected by local attraction are A, B and C, and by − 30′, + 1°5′ and − 40′, respectively.

Bearings corrected for local attraction are:

Line	F.B.	B.B.
AB	48°55′	228°55′
BC	176°40′	356°40′
CD	104°55′	284°55′
DE	165°15′	345°15′
EA	259°30′	79°30′

Table 3.2 Comparison of chain surveying and compass surveying

S.No.	*Chain surveying*	*Compass surveying*
1.	Chain is mainly used for linear measurements.	Compass is mainly used for angular measurements.
2.	The framework consists of triangles, the sides of which are measured by chain. No angular measurements are done.	The Framework consists of a series of connected lines. The lengths of the lines are measured by chain and the angles by compass.
3.	It is easy in performance and the calculations for plotting the area are simple.	It is difficult in performance and the calculations for plotting are also difficult.
4.	Only tape corrections are required.	Tape corrections as well as compass corrections are required.
5.	It is cheap.	It is expensive.
6.	It is done for a small and fairly level area with simple details.	It is done for large areas with rough ground having many details.

WHAT IS EDM???

- Electronic distance measuring instrument is a surveying instrument for **measuring distance electronically** between two points through **electromagnetic waves**.
- The method is used when the direct distance measurement cannot be implemented in difficult terrains with large amount of inconsistency in the terrain or large obstructions exist.
- EDM has an accuracy of 1 in 10^5, having a distance range of 100km.
- In this method instruments are used to measure distance that rely on propagation, reflection and reception of electromagnetic waves.

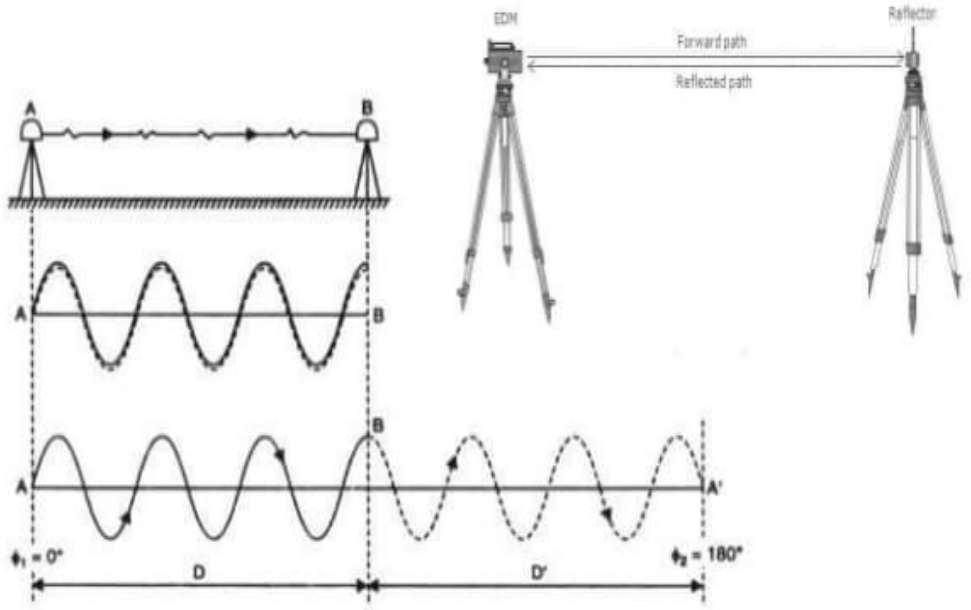
Principle of EDM

- Among these waves microwaves, infrared waves and visible light waves are useful for the distance measurement.
- It is essential to know the fundamental principle behind EDM to work with it. The electromagnetic waves propagate through the atmosphere based on the equation:

$$V = f.\lambda = \left(\frac{1}{T}\lambda\right)$$

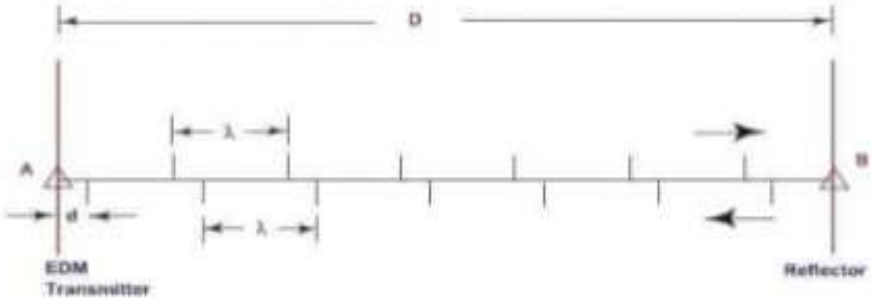
$$f = 1/T;\ (T = Time\ in\ seconds)$$

- Where 'v' is the velocity of electromagnetic energy in meters per second(m/sec); f is the modulated frequency in hertz (Hz)



- Ray AB is the survey line to me measured, having a length of D.
- The EDM equipment is placed at ends A and B. A transmitter is placed at A and a receiver is placed at B.
- the transmitter lets propagation of electromagnetic waves towards B. A timer is also placed. At the instant of transmission of wave from A the timer at B starts and stops at the instant of reception of incoming wave at B.
- This enable us to know the transit time for the wave from the point A to B.
- From the transit time and known velocity, the distance can be easily measured.

Now to solve the problem arise due to difficulty in starting the timer at B, a reflector can be placed as shown below instead of a receiver at B.



What is a Total Station?

- **Total station** is a surveying equipment combination of **Electromagnetic Distance Measuring Instrument** and **electronic theodolite.**
- It is also integrated with microprocessor, electronic data collector and storage system.
- The instrument can be used to measure horizontal and vertical angles as well as sloping distance of object to the instrument.

INTRODUCTION TO TOTAL STATION

- The total station is an improvised version of modern surveying instruments such as EDM – Electronic distance measurement, auto level and digital level.
- Total station is a combination of an electronic theodolite and an electronic distance meter (EMD).
- This combination makes it possible to determine the coordinates of reflector by aligning the instrument's cross hair on the reflector and simultaneously measuring the vertical and horizontal angles and slope distances.
- On board micro-processor in the instrument, takes care of recording, readings and the necessary computations. The data can be easily transferred to a computer where it can be used to generate map.

ADVANTAGES OF TOTAL STATION

- Most accurate and user friendly.
- Gives position of a point (x, y and z) w. r. t. known point (base point).
- EDM is fitted inside the telescope.
- Digital display.
- On board memory to store data and compatibility with computers.
- Measures distance and angles and displays coordinates,
- Auto level compensator is available.
- Can work in lesser visibility also.
- Can measure distances even without prismatic target for lesser distances.
- Is water proof.
- On board software are available.
- Total solution for surveying work.