ELEMENTS OF CIVIL ENGINEERING

UNIT-I

LEARNING MATERIAL

- Civil engineering is an engineering discipline that deals with the design. Construction and maintenance of the built structures such as buildings, bridges, roads, railways, canals, dams, reservoirs, and spillways.
- Civil engineering is the oldest engineering discipline after military engineering, and was defined to distinguish non-military engineering from military engineering.
- It is traditionally broken into several sub-disciplines including structural, geotechnical, water resource, environmental, transportation, construction and management, municipal or urban, coastal engineering, and surveying.
- Many of the civil engineering developments have become essential in subsequently developed disciplines of engineering.

Civil engineering is a broad field in engineering which includes the following:

1. Surveying
2. Building materials
3. Construction technology
4. Geotechnical engineering
5. Structural engineering
6. Hydraulics
7. Water resources and irrigation engineering
8. Transportation engineering
9. Environmental engineering

Surveying:

- Surveying is a preliminary process required for planning of any

construction and developmental activities.

- A surveyor is the person who measures dimensions that usually occur on the earth's surface using surveying equipment's. These measurements are represented graphically in the form of survey maps.
- Survey maps provide the relative positions of various objects of the area in the horizontal as well as vertical directions.
- Earlier, conventional instruments such as chain, tape, compasses, theodolites and levels were used for various measurements in surveying. With computerization, electronic distance measurement (EDM), total stations, GPS (global positioning system) surveying and laser scanning have supplemented (and to a large extent supplanted) the traditional optical instruments.
- This information is then used by civil engineers, contractors and even realtors to design from, build on, and trade, respectively. Elements of a building or structure must be correctly sized and positioned in relation to each other and to site boundaries and adjacent structures.

Building Materials:

- Conventional materials used for the construction of houses and other buildings are stones, bricks, timber and lime concrete.
- The invention of cement and concrete has facilitated in building durable structures.
- Reinforced concrete which is composite construction of steel and concrete has helped in building large structures.
- Steel, aluminum, glass, plastics, glazed tiles, plaster of paris, linoleum, paints and varnishes have improved the quality and appearance of buildings.
- Improved versions of many building materials keep on appearing in the market regularly. A civil engineer has to make use of all these materials judiciously.

Construction technology:

- Construction technology involves study on methods of construction and construction equipment's that facilitate in efficient and economic construction processes.
- It includes planning and execution of the designs from transportation, site development, hydraulic, environmental, structural and geotechnical

engineers.

- The modern trend is towards constructing lighter and taller buildings which is always a big challenge in the era of financial crunch.
- To achieve it successfully there is a need to have sophisticated equipment's.
- Excavation of foundation is also a challenging task in an area surrounded by existing buildings and a busy road. All of these factors should be considered while estimating the cost of the construction project.

Geotechnical engineering:

- All structures have to finally transfer the load acting on them to soil or earth safely.
- Properties of soil change from place to place. In fact, at same place it may not be uniform at different depth and in different seasons. Hence, it becomes essential for a civil engineer to properly investigate soil and decide the safe load that can be spread on the soil.
- This branch of study in civil engineering is called geotechnical engineering. Apart from finding safe bearing capacity for foundation of buildings, geotechnical engineering involves various studies required for the design of pavements, tunnels, earthen dam, canals and earth-retaining structures. It also includes the study of ground improvement techniques.

Structural engineering:

- Structural engineering is concerned with the analysis and design of various components of a structure for the possible forces that are coming on it.
- This involves identifying the loads which act upon a structure and the forces and stresses which arise within the structure due to those loads, and then designing the structure to successfully support and resist those loads.
- Further, the structure should be safe fulfilling successfully the functions (to be serviceable) and at the same time its components should be as small as possible.
- Disasters due to earthquakes have made civil engineers to study earthquake forces and build earthquake resistant structures. It needs the knowledge of structural dynamics.

- A civil engineer has to give not only a safe structure but also an economical structure. This needs the study of mathematical optimization techniques.
- All these aspects of analysis and design fall under the structural engineering field.

Hydraulics:

- Water is an important resource for all living beings. The study of mechanics of water and its flow characteristics is called hydraulics. It is related with the design of pipelines, water distribution systems, etc.

Water Resources and Irrigation Engineering :

- The requirement of water in cities for domestic purpose and for industries is continuously increasing. Rural areas also need water for agriculture.
- Hence, civil engineers have to look for new water resources and plan for storing them. The branch of civil engineering concerned with the collection and management of water is known as water resources engineering.
- It includes both the prediction and management of the quality and the quantity of water in both underground (aquifers) and above ground (lakes, rivers, and streams) resources. Water stored in reservoirs by building bunds and dams should be brought to agricultural fields through canals and distributaries. Study connected with this aspect is known as irrigation engineering.

Transportation Engineering:

- For the growth of a nation, the transportation facility forms an important requirement.
- It is concerned with provision of safe and economic communication for the movement of people and goods.
- It involves design and construction of roads with suitable surface finishes, cross drainage works, intersections, culverts, bridges and tunnels, etc.
- On the other hand, railways is another long-way transport facility. Design, construction and maintenance of railway lines are parts of transportation engineering.
- Globalization has resulted into requirement of airports and harbors.

- For proper planning of these transport facilities, traffic survey is to be carried out. Carrying out traffic survey and then planning, designing, construction and maintenance of roads, railways, bridges, tunnels, airports and harbors is known as transportation engineering.

Environmental Engineering:

- Environmental Engineering deals with the supply of potable water to the people, disposal of properly treated waste, and control of environmental pollution.
- Technology of purification of water and its supply to domestic locations is known as water supply engineering.
- Waste waster and solid waste generated at the domestic and industrial locations should be treated and disposed of so that they do not create health hazards. This branch of civil engineering is known as sanitary engineering.
- Apart from tackling solid and waste water disposal, civil engineers have to tackle air pollution problem. Due to industrialization air pollution is becoming a major problem. During the last century, environmental pollution has resulted in global warming (by 4°C).
- Further, environmental engineering also deals with the gathering of information on the environmental consequences of proposed actions and the assessment of effects of proposed actions for the purpose of assisting society and policy makers in the decision making process.
- Hence, environmental engineering is emerging as an important field of study in civil engineering.

Infrastructure:

- It typically refers to the technical structures that support a society, such as roads, water supply and sanitation, power grids, telecommunications, and so on.
- When considered functionally, infrastructure facilitates production of goods and services; for example, roads enable transport of raw materials to a factory, and later the distribution of finished products to markets.
- In some contexts, the term infrastructure may also include basic social services, such as schools and hospitals.

Role of Civil Engineer in Society/ Infrastructure development:

A Civil engineer has to conceive, plan, estimate, get the approval, create and

maintain all civil engineering activities. A civil engineer has a 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) Construct suitable structures for 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) Construct canals and distributaries to take water to agricultural fields.

(vii) Purify and supply water to the needy areas such as houses, schools. and offices.

(viii) Provide and maintain communication systems such as math, 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 industrialization has put heavy responsibilities on civil engineers to preserve and protect environment.

Effect of Infrastructure Facilities on Socio-economic Development of a Country:

Civil engineering activities in the infrastructural development include:

(i) Good planning of towns and extension areas in cities. Each extension area should be self-sufficient in accommodating offices, educational institutions, markets, hospitals, recreational facilities and residential accommodation.
(ii) Assured water supply.
(iii) A good drainage system.
(iv) Pollution free environmental conditions.
(v) A well planned and built network of roads and road crossings.
(vi) Railways connecting all important cities and towns.

Airports and harbours of national and international standards

ELEMENTS OF CIVIL ENGINEERING

UNIT-II

LEARNING MATERIAL

UNIT-II

SURVEYING

Definition: 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.

Classification of surveying:

I. Plane Surveying

II. Geodetic Surveying

Plane Surveying: It is that type of survey in which the mean surface of the earth is considered as a plane and the spherical shape of the earth is ignored.

Geodetic Surveying: It is that type of survey in which the spherical shape of the earth is taken into account.

Surveying may be classified based on three points:

a) Nature of the field of survey

b) Objective of survey and

c) Instruments used

a) Nature of the field of survey: It is further classified into three types

i) Land Survey

ii) Marine or Hydrographic survey

iii) Astronomical survey

i. Land Surrey: It involves measurement of various objects on land.

This type of survey may be further classified as given below:

1) Topographic Surveys: They consist of measurement of various points to plot natural features such as rivers. Streams, lakes, hills and forests as well as manmade features like roads, railways, towns. Villages and canals.

2) Cadastral Surveys: These surveys are for marking boundaries of municipalities, states, etc. The surveys made to mark properties of individuals also come under this category.

3) City Surveys: The surveys made in connection with the construction of streets, water supply and sewage lines fall under this category.

ii. **Marine or hydrographic Surreys:** The survey conducted to find depth of water at various points in bodies of water like sea, river and lakes fall under this category of surveying.

iii. **Astronomical Surreys:** Observations made to heavenly bodies like sun and stars to locate absolute position of points on the earth and for the purpose of calculating local times is known as astronomical survey.

On the basis of objective of surveying, the classification can be as

1. Engineering survey,
2. Military survey.
3. Mines survey.
4. Geological survey and
5. Archaeological survey.

Engineering Survey: The objective of this type of surveying is to collect data for designing roads, railways. Irrigation, water supply and sewage disposal projects.

Military Survey: This survey is meant for working out points of strategic importance.

Mine Survey: This is used for exploring mineral wealth

Geological Survey: This survey is for finding different strata in the earth's crust.

Archaeological Survey: This survey is for unearthing relics of antiquity.

Classification Based on Instruments Used

Based on the instruments used Surveying may be classified into the following:

1. Chain Survey
2. Compass Survey
3. Plane Table Survey
4. Theodolite Survey

5. Tachometric Survey
6. Modem Survey using electronic equipment like distance metres and total stations
7. Photographic and Aerial Survey

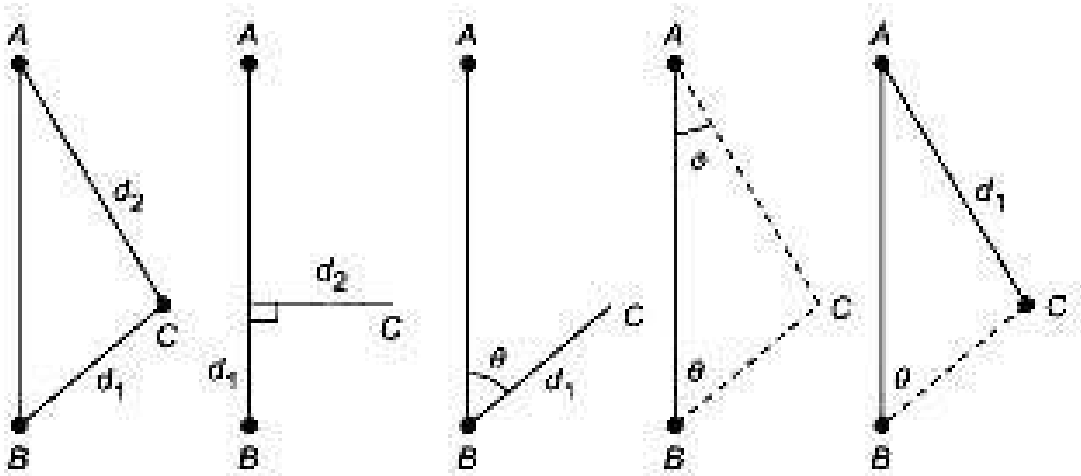
Fundamental principles of surveying:

I. Work From Whole to Part
II. Locating a point in plain survey with respect to two reference points

I Work from whole to part:

- In surveying large areas, systems of control points are identified and they are located with high precision.
- Then secondary control points are located using less precise methods.
- With respect the secondary control points details of the localized areas are measured and plotted.
- This is called working from whole to part. This principle in surveying helps in localising the errors.

II Locating a point in plain survey with respect to two reference points:



Linear Measurement:

There are various methods of making linear measurements and their relative merit depends upon the degree of precision required. They can be mainly divided into three heads

1. Direct measurements.

2. Measurements by optical means.

3. Electro-magnetic methods.

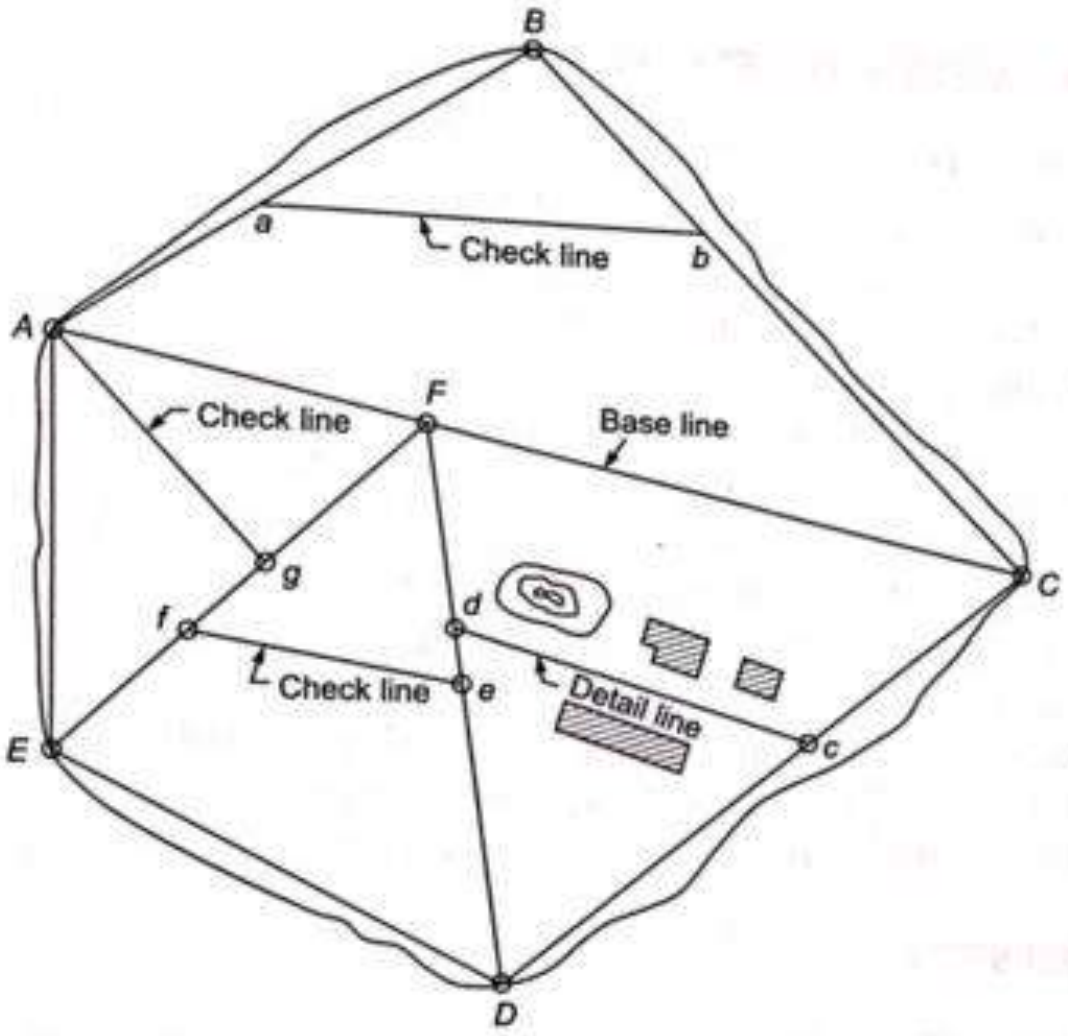
Direct measurements: In the case of direct measurements, distances are actually measured on the ground with help of a chain or a tape or any other instrument

Measurements by optical means: In the optical methods, observations are taken through a telescope and calculations are done for the distances, such as in tacheometry or triangulation.

Electro-magnetic methods: In the electro-magnetic methods, distances are measured with instruments that rely on propagation, reflection and subsequent reception of either radio waves, light waves or infrared waves.

Chain Surveying:

- Chain survey is the most common survey usually done in all the engineering projects for the preparation of the plans.
- In this, only linear measurements are taken in the field and no angular measurements are to be taken.
- In this, chain is the main instrument used for the measurement of the linear distances and hence it is known as chain survey.
- The principle of chain survey is to provide a skeleton or framework consisting of a number of connected triangles. Triangle is the only simple figure that can be plotted from lengths of the sides measured in the field.



- 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 arc denoted as a, b, c ...etc. or as 1, 2, 3 etc
- Base Line: It is the most important line and is the longest line.
- Check Lines: The lines which are run in the field to check the accuracy of the work are called check lines. If the measured line agrees with the length scaled off the plan, the survey is correct.

Selection of Stations:

(i) A station selected should be visible from at least two more stations.

(ii) If possible should have one or two base lines which run on level ground and through the middle of the area.

(iii) Main frame should have as few lines as possible.

(iv) All triangles should be well-conditioned.

(v) Each triangle should have at least one check line.

(vi) The lines should be provided to avoid long offsets.

(vii) Avoid obstacles to ranging and chaining.

(viii) As far as possible survey lines should be on the level ground.

(ix) To avoid trespassing the main survey line should fall within the boundaries of the area to be surveyed.

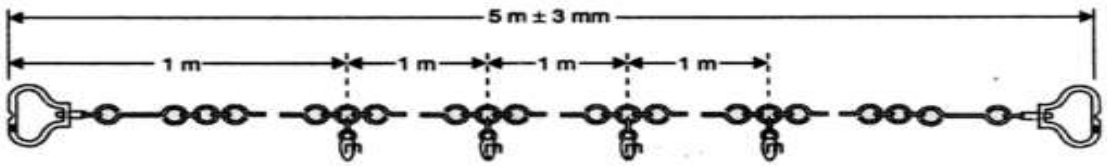
Instruments used in chain surveying

1. Chain
2. Tape
3. Arrows
4. Ranging Rods
5. Ranging Poles
6. Plumb-bob
7. Pegs
8. Offset rods
9. Plaster's laths and whites

Chain: Chains are formed of straight links of gal-vanished mild steel wire bent into rings at the ends and joined each other by three small circular or oval wire rings.

These rings offer flexibility to the chain. The ends of the chain are provided with brass handle at each end with swivel joint, so that the chain can be turned without twisting.

The length of a link is the distance between the centres of two consecutive middle rings, while the length of the chain is measured from the outside of one handle to the outside of the other handle.



Tape: Tapes are used for more accurate work and are more suitable for measuring small distances. Depending on the material used tapes can be classified as

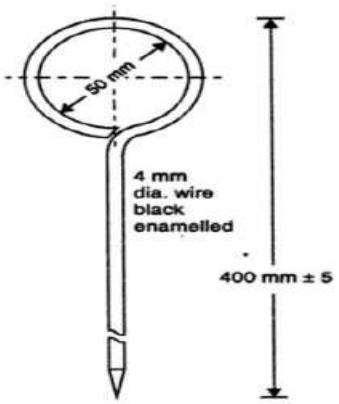
i) Linen or cloth type

ii) Metallic tape

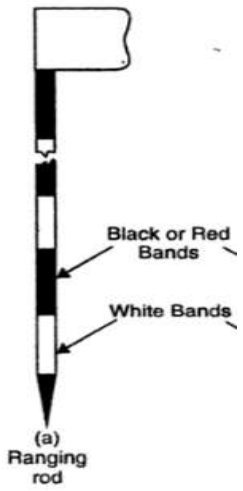
iii) Steel tape

iv) Invar tape

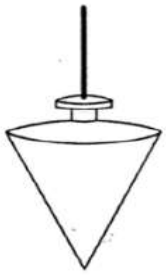
Arrows: When the length of the line to be measured is more than a chain length, there is need to mark end of a chain length. Arrows are used for this purpose. They are made of 4mm diameter tempered steel wire one end sharpened and other end bent into loop. Usual length of arrow is 400mm.



Ranging rods: For ranging intermediate points along the line to be measured 2 to 3 m long rods are used. The rods are usually in circular section with 30mm diameter. They are painted with colour bands of red and white or with black and white. They are easily visible up to a distance of 200m. If distance is more they are provided with 200mm square multicoloured flags at their top.



- **Ranging Poles:** Ranging poles are similar to ranging rods except that these are longer in length and grater in diameter. These are used for ranging the very long lines in an undulating ground. The length of ranging poles vary from 4m to 8m and the diameter varies from 6 to 10cm.
- **Plumb-bob:** In measuring horizontal distances along sloping ground plumb bobs are required to transfer the points to ground. They are also used to check the verticality of ranging poles



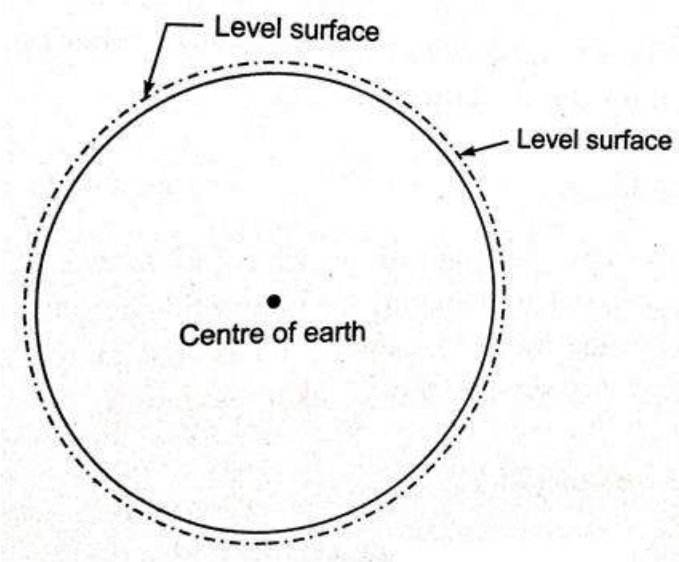
- **Laths and whites:** Laths are 0.5 to 1m long sticks of wood. These are used for marking chain lines and station points while doing survey work on the ground. This is used in the areas where the surface of ground is covered with the vegetables, grass etc and pegs are not visible.

Levelling:

- Levelling is the art of determining the elevation of given points above or below a datum line or establishing given points of required heights above or below the datum line.

Purpose

- To align plinth level of buildings or to align canal, Sewage or road to locate dam or to determine capacity of tanks.



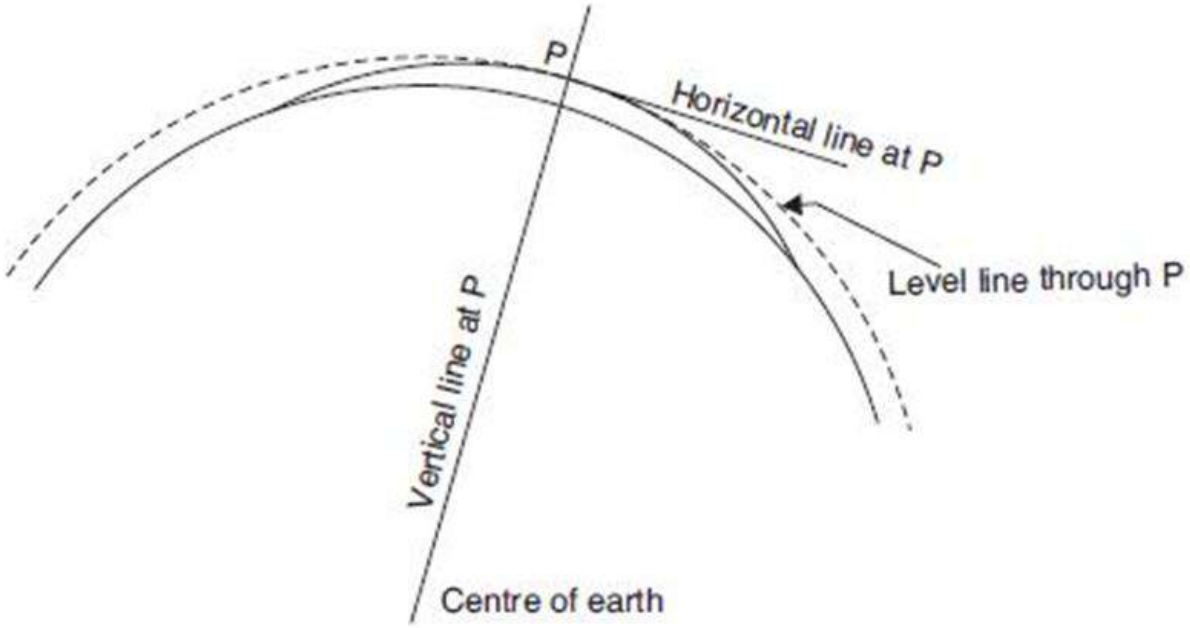
Level Surface: Any surface parallel to the mean spheroid of the earth is called level surface and the line drawn on the level surface is known as a level line.

Horizontal surface: Any surface which is tangential to the level surface at any point is known as horizontal surface.

Horizontal line: Any line lying in the horizontal surface is a horizontal line

Vertical line: Any line normal to the level line is a vertical line

Vertical surface: The surface which contains the vertical line is a vertical surface



Terms used in levelling

Datum: "It is an arbitrary level surface from which elevation of points may be referred". In India mean sea level is considered as datum of zero elevation it is situated at Karachi.

Mean Sea Level: It is the average height of sea for all stages of tides it is derived by averaging the hourly tide height over a period of 19 years.

Elevation or Reduced level: It is height or depth of any point above or below any datum. It is denoted as R.L.

Station: It is the point, the elevation of which is to be determined

Benchmark: It is a fixed reference point of known elevation with respect to datum

Line of collimation: Imaginary line that passes through levelling instrument at cross hairs.

Height of instrument: It is the elevation of line of collimation with respect to datum.

Back sight: It is a staff reading taken at a known elevation. It is the first reading taken after set up of instrument.

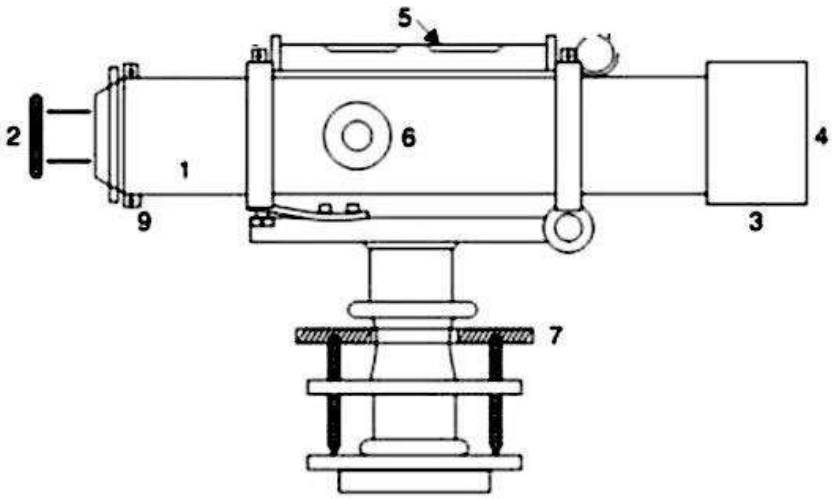
Fore sight(F.S.): It is the last staff reading taken denoting the shifting of the instrument.

Intermediate sight.(I.S.): It is staff reading taken on a point whose elevation is to be determined. All staff reading between B.S. and F.S. are Intermediate sight.

Change Point (T.P): It is a point on which both fore and back sight are taken.

Levelling staff: It is a straight rectangular rod having graduations, the foot of the staff representing zero reading. During levelling the staff is held vertically at the point and from level horizontal sight is taken.

Parts of Dumpy Level:



1. Telescope
2. Eye-Piece
3. Ray Shade
4. Objective End
5. Longitudinal Bubble
6. Focusing Screws
7. Foot Screws

Telescope: Telescope is used to observe the distant object through line of sight provided by its arrangement

The important parts of telescope are as follows

Eye piece: Eye piece is used by the observer's eye to view the distant object. It contains magnifying glass which magnify the observing image and also the cross hairs of diaphragm.

Objective lens: Objective lens are provided at the other end of the telescope. The objective lens consists of two parts, the front part consists convex type lens and the back part consists concave lens. So, the image obtained from the objective lens is always inverted.

Diaphragm: Diaphragm is provided in front of the eye piece. It contains cross hairs made of dark metal which are arranged in perfect perpendicular positions. These cross hairs are used by the eye piece to bisect the objective through objective lens.

Focusing screw: Focusing screw is used to adjust the focus if cross hairs and the image clarity.

Ray shade: Ray shade is used to prevent the objective lens from sunlight or any other light rays which may cause disturbance to the line of sight.

Bubble tubes: Bubble tubes are provided to check the level of the instrument.

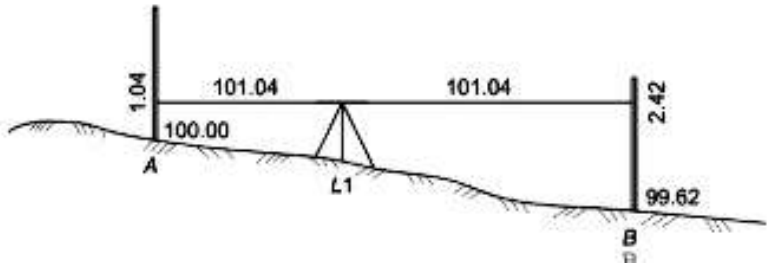
Foot screws: Foot screws are provided to regulate the tribrach position and hence the instrument can be leveled which is known by observing the bubble tube.

Types of Levelling:

1. Simple levelling
2. Differential levelling
3. Profile Levelling

Simple levelling

When difference in levels of two nearby points is required it is obtained by simple levelling. The two points am so near that with one setting of the level the readings on the two points can he obtained Fig. shows one such case. The reduced level of A is 100.00 m and RL. of B is required



R.L of A= 100.00 m and back sight is 1.04m

∴ Height of instrument (HI) = RL of A+ BS

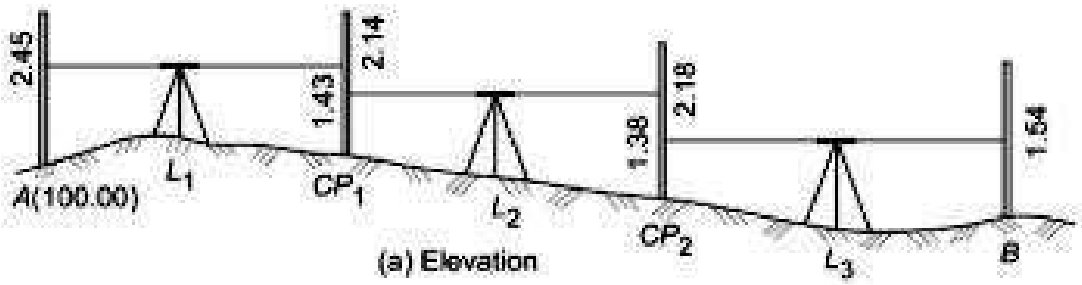
= 100.00+1.04= 101.04m

Fore sight on B= 2.42m

∴ R.L of B= H.I-2.42 = 101.04-2.42= 99.62m

Differential levelling:

If the distance between the two points A and B is too large, it may not be possible to take the reading from a single setting of the instrument. The elevation of B w.r.t. A can he found by differential levelling. In such cases instrument is set at more than one point, each shifting facilitated by taking a change point. Fig. shows a scheme of such levelling.



(a) Elevation

Instrument was set at L_1 and back sight of 2.45 m was taken to A. The fore sight on change point CP_1 was 2.14 m. Then instrument was shifted to L_2. Back sight to CP_1 was 1.43 m and fore sight to CP_2 was 2.18 m. After shifting instrument to L_3, back sight to CP_2 was 1.38 m and fore sight to B was 1.54 m. If the RL of A is 100.00 m, we have to find RL of B. Looking at figure the following calculations can be easily carried out:

RL of A = 100.00 m

Back sight on A = 2.45 m

$\therefore$ HI of L_1 = 100 + 2.45 = 102.45 m

Fore sight to CP_1 = 2.14 m

$\therefore$ RL of CP_1 = 102.45 – 2.14 = 100.31 m.

Back sight to CP_1 from L_2 = 1.43 m

$\therefore$ HI at L_2 = 100.31 + 1.43 = 101.74 m.

Fore sight to CP_2 = 2.18 m

$\therefore$ RL of CP_2 = 101.74 – 2.18 = 99.56 m.

Back sight of CP_2 from L_3 = 1.38 m

$\therefore$ HI at L_3 = 99.56 + 1.38 = 100.94 m.

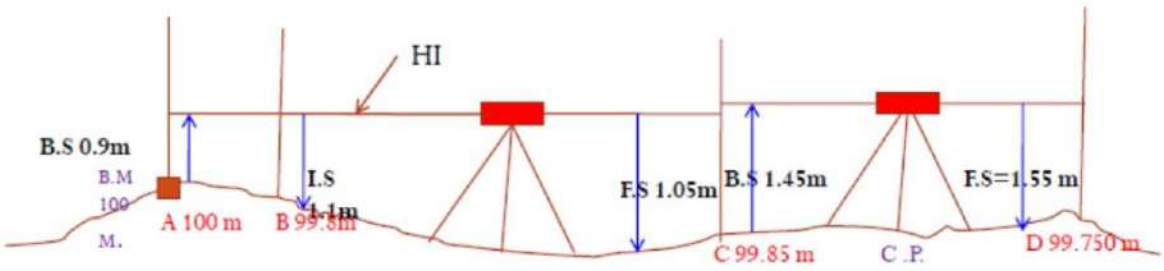
Fore sight to B = 1.54 m

$\therefore$ RL of B = 100.94 – 1.54 = 99.4 m

Methods of Reduced Levels:

- Height of instrument Method
- Rise and fall method

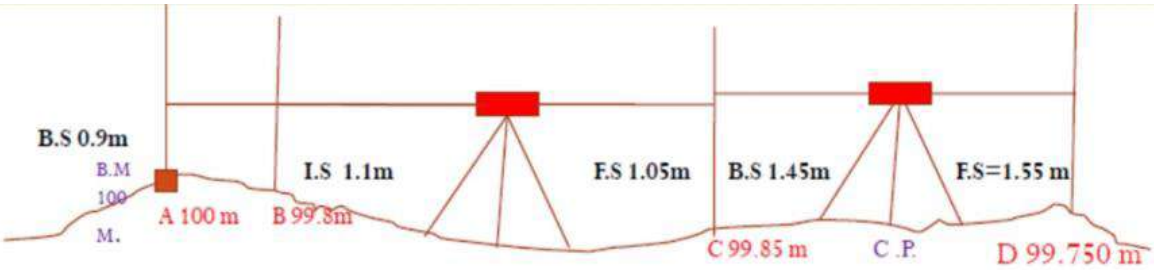
Height of instrument Method: In any particular set up of an instrument height of instrument, which is the elevation of the line of sight, is determined. The elevation of unknown points can be obtained by subtracting the staff readings at the desired points from the height of instrument. This is the basic behind the height of instrument method for reduction of level.



STATION	B.S	I.S	F.S	H.I	R.L	REMARK
A	0.9			100.9	100.00	B.M
B		1.1			99.800	
C	1.450		1.05	101.3	99.850	C.P.
D			1.550		99.750	

Rise and Fall Method

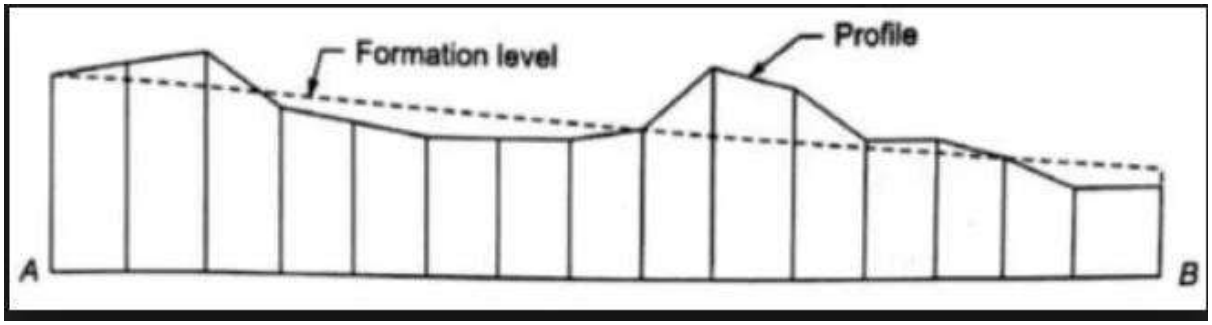
• This method consists of determining the difference of level between consecutive points by comparing each point with immediate preceding point.



Station	B.S	I.S	F.S	Rise	Fall	R.L	Remark
A	0.9					100.00	B.M
B		1.1			0.2	99.800	
C	1.450		1.05	0.05		99.850	C.P.
D			1.550		0.1	99.750	

Profile Levelling: This type of levelling is known as longitudinal sectioning. The reduced levels of various points at regular intervals are found along a line

or along a set of lines. Then the engineers draw the sectional view of the ground to get the profile.



Compass Surveying:

- Chain surveying can be used when the area to be surveyed is comparatively small and is fairly flat.
- But when the area is large, undulated and crowded with many details, triangulation (which is the principle of chain survey) is not possible. In such an area, the method of traversing is adopted.

Traversing:

- In Traversing, the framework consists of a number of connected lines.
- The length are measured by a chain or a tape and the directions measured by angle measuring instruments.
- In one of the methods, the angle (direction) measuring instrument is the compass.
- Hence, in compass surveying directions of survey lines are determined with a compass and the lengths of the lines are measured with a tape or a chain.
- This process is known as Compass Traversing

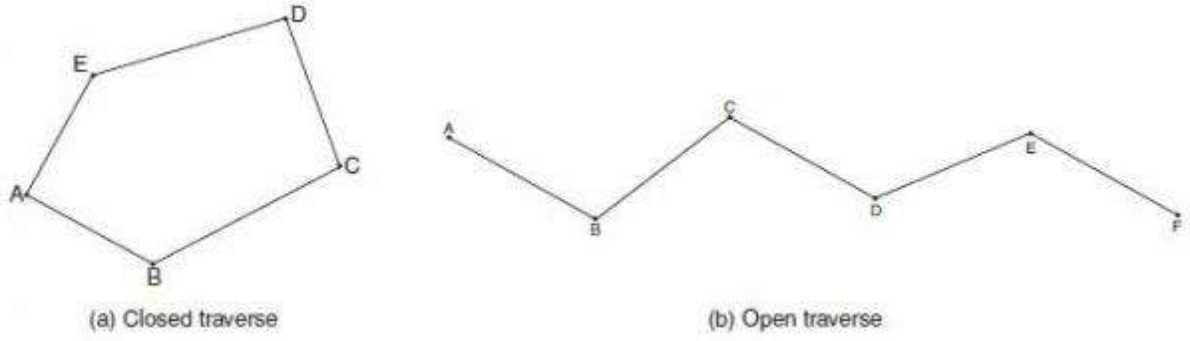
Closed Traverse:

• A traverse is said to be closed when a complete circuit is made i.e. when it returns to the starting point forming a closed polygon as shown in figure. Or when it begins and ends at points whose positions on the plan are known.

• Sum of angles for a closed traverse = (2N ± 4) 90°

• Where N = No. of sides of closed traverse. +ve sign for exterior angles and —ve sign for the interior angle

Open traverse: An open traverse does not return to the starting point. It consists of series of line expanding in the same direction.



Principle of Compass Survey:

- The Principle of Compass Survey is Traversing; which involves a series of connected lines the magnetic bearing of the lines are measured by prismatic compass and the distance (lengths) are measured by chain.
- Such survey does not require the formulation of a network of triangle.
- Compass surveying is recommended when the area is large, undulating and crowded with many details.
- Compass surveying is not recommended for areas where local attraction is suspected due to the presence of magnetic substances like steel structures, iron ore deposits, electric cables conveying currents, and so on.

Definitions

- **Bearing:** The bearing of a line is he horizontal angles established with reference to a some fixed line, called Meridian.
- **Meridian:** Meridian is a fixed direction on the surface of the earth. The bearings of the survey lines are measured with reference to the meridians.

- **True meridian:** It is a line or plane passing through the true north pole and south pole.
- **True bearing:** The horizontal angle made by a survey line with reference to the true meridian is called true bearing of a line.
- **Magnetic meridian:** It is the direction established, by a freely suspended magnetic needle, unaffected by magnetic substances.
- **Magnetic bearing:** The horizontal angle made by a survey line with reference to magnetic meridian is called magnetic bearing of a line.
- **Arbitrary meridian**: Sometimes for the survey of a small area convenient direction is assumed as a meridian, known as arbitrary meridian.
- **Arbitrary bearing:** The horizontal angle made by a survey line with reference to arbitrary meridian is called arbitrary bearing of a line

Types of Compass:

1. Prismatic compass
2. Surveyor compass

COMPARISION BETWEEN PRISEMATIC AND SURVEYOR COMPASS.

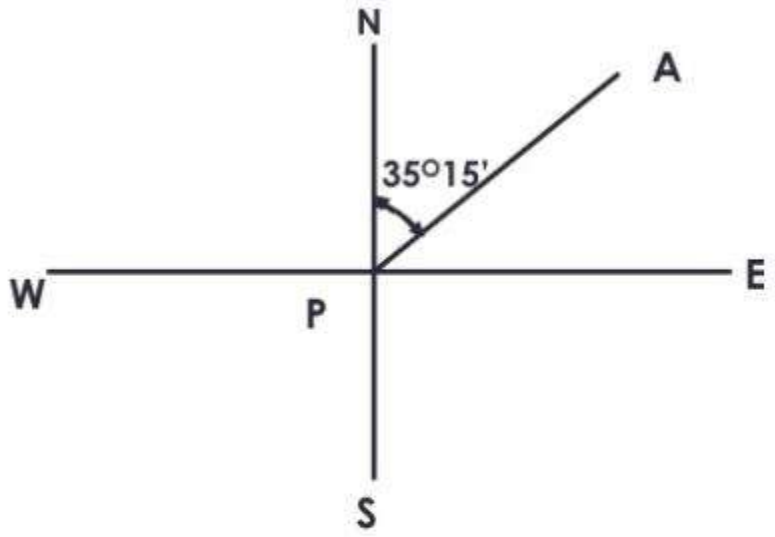
Sr. No.	Base Of Comparison	Prismatic Compass	Surveyor Compass
1	First look	Prism at one end and silt on other	No prism only Silt at both end
2	Use of Tripod Stand	May or may not use along, Steady hold in hand also give good results	Use of Tripod stand is necessary
3	Observation/ Readings	Taken with help of prism provided by eye silt	Directly read from top of compass
4	Magnetic Needle	Does not act as Index	Act as index
5	Graduation	WCB system	QB system
6	Graduation marking	Appear inverted from top, Zero at South & 180 degrees at North	Mark directly zero at North and 90 degrees at East
7	Graduated circle	Attached with needle, Does not rotate with line of sight	Permanently attached with box, rotates with line of sight

Designation of magnetic bearing:

Whole Circle Bearing System: In the whole circle bearing system (W.C.B), the bearing of a line is always measured clockwise from the north point of the reference meridian towards the line right round the circle. The angle measured is called whole circle bearing (W.C.B). It may have any values between 0° and 360°. The bearings observed with the prismatic compass are the whole circle bearings.

Quadrantal Bearing System: In a Quadrantal bearing system. the bearing of a line is measured clockwise or anticlockwise from the north or the south point whichever is nearer the line, towards the east or west. In this system the bearing is reckoned from 0° and 90° in each quadrant. The bearings observed with the surveyor's compass are the quadrantal bearing.

To find QB from WCB

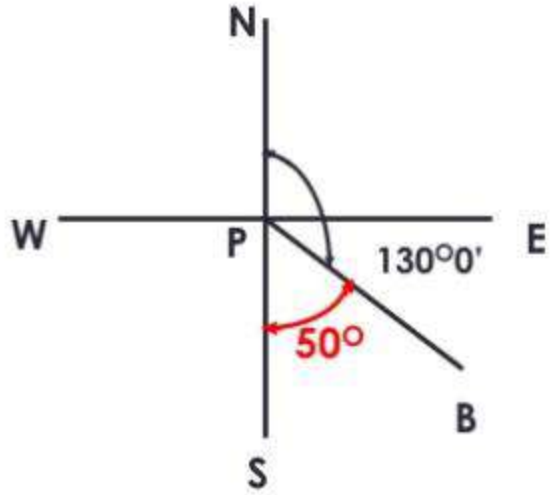


Solution :

Line PA lies in 1st quadrant.

Quadrant Bearing bearing of PA = N 35° 15′ E

To find QB from WCB

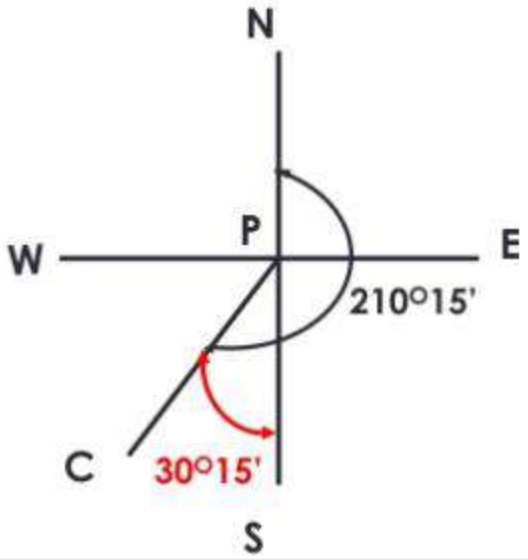


Solution :

Line PB lies in 2nd quadrant.

Quadrant Bearing of PB = S 50° 00′ E

To find QB from WCB

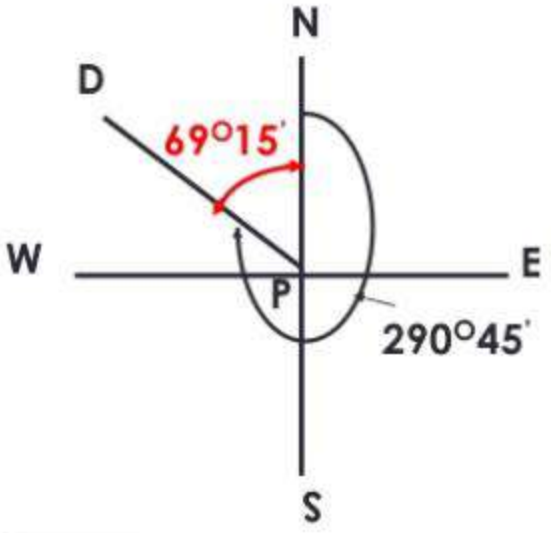


Solution :

Line PC lies in 3rd quadrant.

Quadrant Bearing of PC = S 30° 15′ W

To find QB from WCB



Solution :

Line PD lies in 4th quadrant.

Quadrant Bearing bearing of PD = N 69° 15′ W

Rule:

Case	W.C.B between	Rule of R.B	Quadrant
I	0º and 90º	= W.C.B	N-E
II	90º and 180º	=180º - W.C.B	S-E
III	180º and 270º	=W.C.B - 180º	S-W
IV	270º and 360º	= 360º - W.C.B	N-W

ELEMENTS OF CIVIL ENGINEERING

UNIT-III

LEARNING MATERIAL

UNIT-III

BUILDING MATERIALS

Clay Bricks:

- By heating the clay products to about 1100°C, its constituents fuse and because of the affected chemical changes, the product becomes hard, brittle and a strong and stable clay product most suitable as a primary building unit for construction

Rocks and stones:

Rocks and stones consists of same material. Rocks are made of smaller stones and stones are made from rocks.

Rocks are hard materials that are found on the earth's crust. The rocks can be found above the ground as well as below the ground. A stone is formed from rocks after it has been trimmed or dresses or polished into tiny pieces.

A stone is defined as a natural hard substance formed from minerals and earth material

Mortar:

Mortar is a material used in masonry construction to fill the gaps between the bricks and blocks used in construction.

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.

Lime:

- Until the invention of Portland cement lime was used as the chief cementing material in building construction both for mortar and plasters.
- Lime is obtained by burning limestone at a temperature of about 800°C

Cement

- Definition : " It is defined as the bonding material having cohesive and adhesive properties which makes it capable to unite the different construction materials and form the compacted assembly."

Clay Bricks:

- One of the oldest building material brick continues to be a most popular and leading construction material because of being cheap, durable and easy to handle and work with.
- In primitive ages sun dried clay bricks were used. Egyptians were probably the first to use the burnt clay bricks.
- By heating the clay products to about 1100°C, its constituents fuse and because of the affected chemical changes, the product becomes hard, brittle and a strong and stable clay product most suitable as a primary building unit for construction

Uses:

- used for building-up exterior and interior walls, partitions, piers, footings and other load bearing structures.

CHARACTERISTICS OF GOOD CLAY BRICKS

- Size and Shape: The bricks should have uniform size and plane, rectangular surfaces with parallel sides and sharp straight edges.
- Colour: The brick should have a uniform deep red or cherry colour as indicative of uniformity in chemical composition and thoroughness in the burning of the brick.
- Texture and Compactness: The surfaces should not be too smooth to cause slipping of mortar. The brick should have uniform texture.
- Hardness and Soundness: The brick should be so hard that when scratched by a finger nail no impression is made. When two bricks are struck together, a metallic sound should be produced.
- Water Absorption: should not exceed 20 per cent of its dry weight when kept immersed in water for 24 hours.
- Crushing Strength: should not be less than 10 N/mm^2.

Classification of Clay Bricks

First class bricks :

- Water absorption should be 12 -15% of its dry weight.
- Crushing Strength should not be less than 10 N/mm^2.

Second class bricks :

- Small cracks are permitted
- Water absorption should be 16 -20% of its dry weight
- Crushing Strength should not be less than 7 N/mm^2.

Third class bricks :

Under burnt, light colored, producing dull sound when struck against each other.

Water absorption should be 25% of its dry weight.

Fourth class bricks :

Over burnt and badly distorted in shape and size.

CHARACTERISTECS OF GOOD BUILDING STONES

Appearance: For face work it should have fine, compact texture; light-coloured stone is preferred as dark colours are likely to fade out in due course of time.

Structure: A broken stone should not be dull in appearance and should have uniform texture free from cavities, cracks, and patches of loose or soft material. Stratifications should not be visible to naked eye.

Strength: A stone should be strong and durable to withstand the disintegrating action of weather. Compressive strength of building stones in practice range between 60 to 200 N/mm^2

Weight: It is an indication of the porosity and density. For stability of structures such as dams. Retaining walls, etc. heavier stones are required, whereas for arches, vaults, domes, etc. light stones may be the choice.

Seasoning: The stone should be well seasoned.

Weathering: The resistance of stone against the wear and tear due to natural agencies should be high.

Workability: Stone should be workable so that cutting, dressing and bringing it out in the required shape and size may not be uneconomical.

Fire Resistance: Stones should be free from calcium carbonate, oxides of iron, and minerals having different coefficients of thermal expansion.

Specific Gravity: The specific gravity of most of the stones lies between 2.3 to 2.5.

Uses:

1) Building foundations, walls, piers, pillars, and architectural works.
2) Lintels, beams ,Arches, domes etc.,
3) Cladding Works
4) Dams, light houses, monumental structures.
5) Paving jobs
6) Railway, ballast, black boards and electrical switch boards

Lime

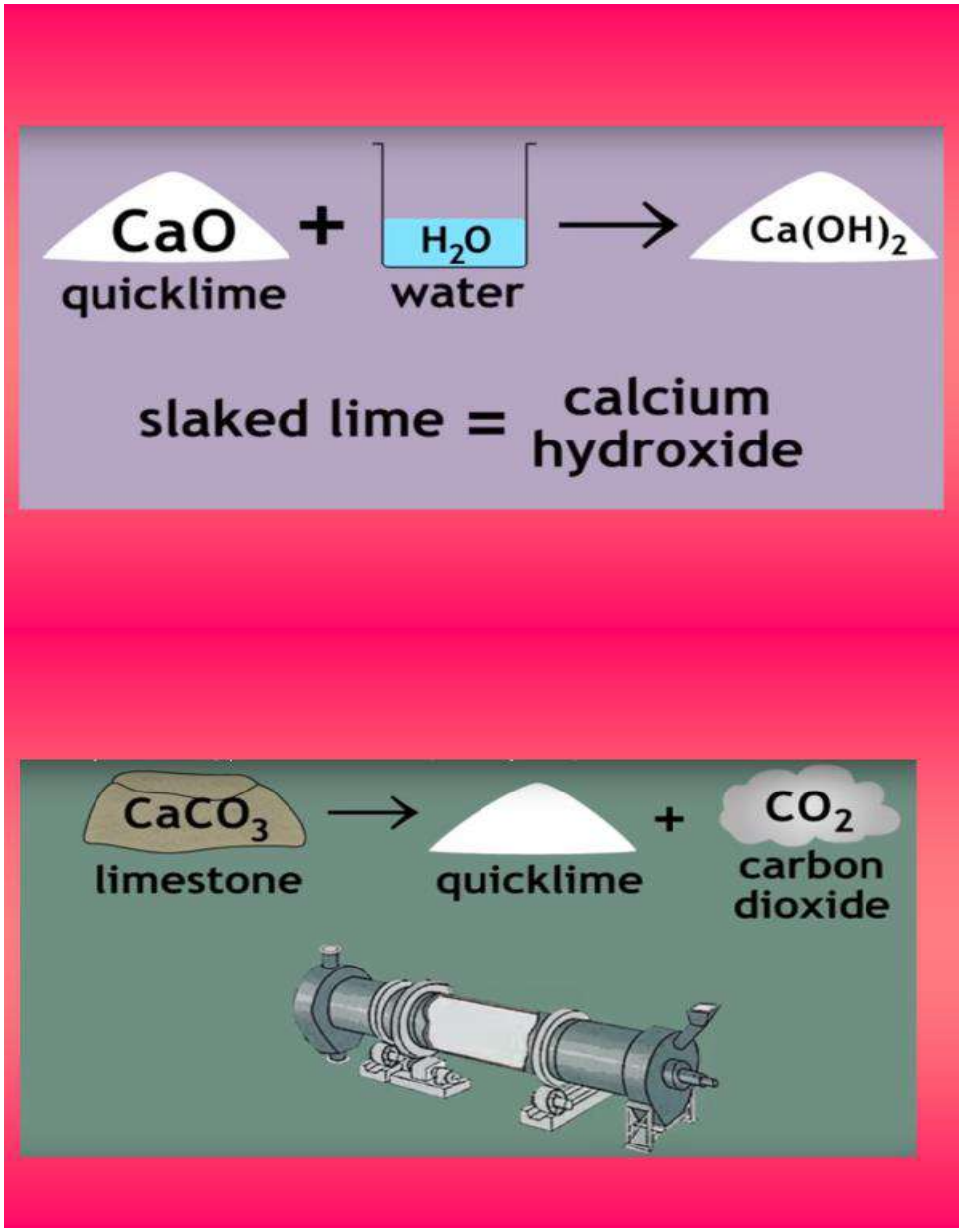
Until the invention of Portland cement lime was used as the chief cementing material in building construction both for mortar and plasters.

The raw material for the manufacture of lime (CaO) is calcium carbonate. Lime is obtained by the calcination of lime stone.

Lime is obtained by burning limestone at a temperature of about 800°C.

Quick lime

- Quick lime is the lime obtained after the calcination of limestone.
- It is also called as caustic lime, it is capable of slaking with water
- The specific gravity of pure lime is about 3.40



Fat Lime

- This lime is also called as high calcium lime, pure lime, rich lime or white lime.
- It is prepared by calcination of pure carbonate of lime which is composed of 95% of calcium oxide.

Hydraulic Lime

- This lime is also known as water lime as it sets under water.
- It contains clay and some amount of ferrous oxide.
- It is obtained by calcination of Kankar

Characteristics of Lime:

1. Lime possesses good plasticity and is easy to work with
2. It stiffens easily and is resistant to moisture
3. The excellent cementitious properties make it most suitable for masonry work
4. The shrinkage on drying is small because of its high water rententivity.

Cement

- Definition : " It is defined as the bonding material having cohesive and adhesive properties which makes it capable to unite the different construction materials and form the compacted assembly."
- **Types of Cement : -**
- Ordinary Portland Cement
- Rapid Hardening Cement
- Sulphate Resisting Cement
- Pozzolona Portland Cement

Ordinary Portland Cement

- It is called Portland cement because on hardening (setting) its colour resembles to rocks near Portland in England.
- It was first of all introduced in 1824 by Joseph Asp din, England.
- Most important type
- Classified into three grades, namely 33 grade, 43 grade and 53 grade.

- The chief chemical components of OPC

  1. Calcium 2. Silica 3. Alumina 4. Iron

Rapid Hardening Portland Cement

- It is similar to ordinary cement but with higher tri-calcium silicate (C3S) content and finer grinding.
- It gains strength more quickly than OPC, though the final strength is only slightly higher.
- This type of cement is also called High Early Strength Portland Cement.
- The one day strength of this cement is equal to the three day strength of OPC with the same water-cement ratio.

Portland Pozzolana Cement (PPC):

This type of cement is most common type available now in market. This is made by blending 10-25% reactive pozzolana like flyash or calcined clay with OPC Addition of pozzolana makes cement sensitive to curing and it requires longer curing than OPC.

Sulphate-resisting Portland Cement

- This cement has better resistance to sulphate attack than OPC.
- The percentage of tricalcium aluminate (C3A) is limited to 3.5 %.
- SRPC is obtained by the addition of extra iron oxide. This results in the cement being darker than OPC.
- Applications include foundations in sulphate-bearing soils, in marine structures since sea water contains sulphates

Ingredients of Cement Concrete:

- Concrete and cement are not the same thing, cement is actually just a component of concrete.
- Concrete is made up of three basic components: water, aggregate (rock, sand, or gravel) and Portland cement.

- Cement, usually in powder form, acts as a binding agent when mixed with water and aggregates.
- This combination, or concrete mix, will be poured and harden into the durable material with which we are all familiar
- There are three basic ingredients in the concrete mix: Portland Cement Water Aggregates (rock and sand)

Requirements of Water

- Used in mixing and curing.
- Potable water should be used.
- Sea water is not permitted.
- pH value of water should not be less than 6.

Fine aggregate

- Size less than 4.75mm
- Includes natural sand or crushed stone with most particles passing through a sieve.
- Obtained from pits, lake, river or sea-shore**.**

Coarse aggregate

- Size more than 4.75mm.
- Includes gravels and crushed stones.
- Obtained by crushing various types of granites, hard limestones and sand stones.

Aggregate

A combination of different sizes and shapes normally of stones. Maximum size is 75 mm.

CLASSIFICATION OF AGGREGATES

- ACCORDING TO GEOLOGICAL ORIGIN
  - Natural Aggregate
  - Artificial Aggregate

- ACCORDING TO SIZE
    - Fine Aggregate
    - Coarse Aggregate
    - All-in-Aggregate
    - Single-size-Aggregate
- ACCORDING TO SHAPE
    - Rounded Aggregate
    - Irregular Aggregates
    - Angular Aggregate
    - Flaky and Elongated Aggregate
- BASED ON UNIT WEIGHT
    - Normal- weight Aggregate
    - Heavy- weight or High-Density Aggregate
    - Light-weight Aggregate

Characteristics of aggregates

Strength: The average value of crushing strength of aggregate is 200N/mm^2

Hardness: It is the ability of the aggregate to with stand load or applied pressure.

Abrasion value should not be more than 30% for aggregates used for wearing surfaces and 50% for non wearing surfaces.

Toughness: It is the resistance offered against impact.

The aggregate impact value should not exceed 45% by weight used in concrete for non wearing surfaces and 30% for wearing surfaces.

Durability: It is the ability of the aggregate to with stand external or internal damaging attack or in other words the soundness of aggregate.

CLASSIFICATION OF BUILDINGS

Buildings arc classified based on occupancy and types of construction. For the purpose of the Code, the following shall be the occupancy classification and types of construction.

Occupancy Classification

a) Residential;

b) Educational;

c) Institutional;

d) Assembly;

e) Business;

f) Mercantile (will include both retail and wholesale stores) relating to trade or commerce; commercial.

g) Industrial (will include low, moderate and high fire hazards):

h) Storage; and i) Hazardous.

Group A: Residential Buildings

Any building providing sleeping and living accommodations to related or unrelated groups of people, with or without cooking or dining facilities is called as a residential building.

- This Occupancy shall be subdivided as follows:
- **A1:Single Family Dwelling**
- **A2:Two Family Dwelling**
- **A3:Flats or Apartments**
- **A4:Mess, Boarding Houses, Dormitories and Hostels**
- **A5:Hotels and Lodging Houses**

Group B : Educational Buildings

Any building in which education, training and care are provided to children or adults is called as educational building.

- This Occupancy shall be subdivided as follows:

B1: Educational Facilities up to Higher Secondary level

B2: Facilities for Training for Above-secondary level

B3: Pre-school Facilities

Group C : Institutional Building:

- Any building in which institutional care to the occupants such as medical or nursing care for persons suffering from illness or infirmity

due to mental condition are provided such buildings are called as institutional buildings.

- This occupancy shall be subdivided as follows:

C1 :Hospital

C2: Institution for care of Children

C3:Custodial Institution

C4: Penal Institution

- **Group D: Assembly Building**

Any building in which groups of people assemble for recreation, social, religious, political, cultural, travel and similar purposes are called as assembly buildings.

This Occupancy shall be subdivided as follows:

D1:Large Assembly with Fixed seats

D2: Small Assembly with Fixed seats

D3:Large Assembly without Fixed seats

D4:Small Assembly without Fixed seats

Group E: Business Building

Any building which is used for any business transaction other than mercantile is called as business building.

This Occupancy shall be subdivided as follows:

E1: Office

E2: Research and Testing Laboratories

Group F: Mercantile Building

Any building which is used for display and sale of merchandises is called as mercantile building.

This Occupancy shall be subdivided as follows:

F1:Small Shops and Market

F2:Large Shops and Market

Group G: Industrial Buildings

Any buildings in which products or material of all kinds are fabricated, assembled or processed is called as industrial building. For example assembly plants, power plants, gas plants etc.

Group H: Storage Buildings:

Any building used primarily for storage or sheltering of goods, wares, merchandises, vehicles or animals.

Group I : Hazardous Buildings

Any Building used as storage, industrial, research and other facilities dealing with hazardous material in excess quantity or any micro-biological facilities shall be categorized in this occupancy group

Components of a Building

- A building can be broadly divided in two parts

1. Substructure and
2. Superstructure

Substructure:

The substructure is the lower portion of the building, which is located below ground level which transmits the load of the superstructure to the subsoil. It includes Foundations

- Foundations: The basic function of foundation is to

a) Transmit the load from building to the subsoil, in such a way that Settlement are within permissible limit.

b) The soil does not fail in shear

c) Reduce the load intensity

d) Even distribution of load

e) Provide level surface

- **Superstructure:**
- The superstructure is that part of the building which is above the ground and which serves the purpose of building's intended use. It includes
- Walls
- columns
- Beams
- Floors
- Roofs and slabs
- Steps and stairs
- Doors and Windows
- Building finishes
- Wall: The walls are building blocks of bricks or stones. They divide the building space into various space into various rooms. They support slabs and beams. They safely transmits the loads coming on them from beams and slabs to the foundation. They provide privacy and protection against heat, cold, rain, noise, dust winds. They offer resistant to firewalls may be of Brick masonry and Stone masonry.
- Columns: Columns are vertical members along which beams and slab/roof is supported. They are square, rectangular and circular in shape in C/S.
- Beams: Beams are horizontal members above which the slabs are provided. The beams are instead supported on walls and columns .They are generally 20, 39, 45, 60 cm thick and deep members as per structural design.
- Floor: A floor is a plane area to support occupants, furniture's, and equipment's.
- Roof: The upper most part of the building constitutes the roof .The Slab and roof encloses the space and offers protection from rain, heat, snow, wind, sound, fire. Slabs are 10, 12, 15 cm thick.

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- **Roof:** The upper most part of the building constitutes the roof .The Slab and roof encloses the space and offers protection from rain, heat, snow, wind, sound, fire. Slabs are 10, 12, 15 cm thick.
- Steps and Stairs :Steps and stairs are to be provide access between different levels. Stairs should be properly located to provide easy access and fast services to the building.
- Doors and windows A door provides a connecting link between rooms, allowing easy free movement in the building.
- Windows are opening provided in walls. Doors and windows provide lighting and ventilation. They provide resistance to weather, sound and heat. They provide security and privacy.
- **Building finishes**
- Floor Finishes
- Wall Finishes
- Ceiling Finishes
- Roof Finishes Types

ELEMENTS OF CIVIL ENGINEERING

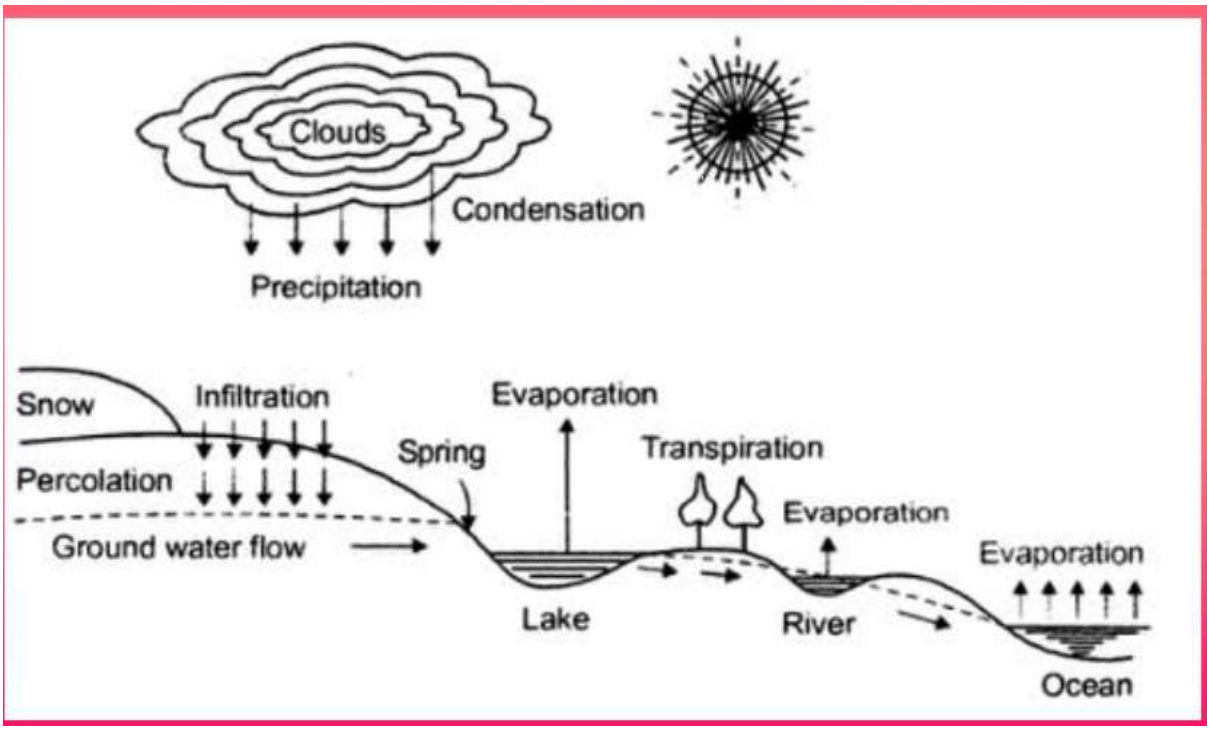
UNIT-IV

LEARNING MATERIAL

UNIT-IV

Hydrology: Hydrology is the science which deals with the occurrence, distribution and movement of water on the earth, including that in the atmosphere and below the surface of the earth. Water occurs in the atmosphere in the form of vapour, on the surface as water, snow or ice and below the surface as ground water occupying all the voids within a geologic stratum.

Hydrologic cycle



Except for the deep ground water, the total water supply of earth is in constant circulation from earth to atmosphere, and back to the earth. The earth's water circulatory system is known as the hydrologic cycle. Hydrologic cycle is the process of transfer of moisture from the atmosphere to the earth in the form of precipitation, conveyance of the precipitated water by streams and rivers to

ocean and lakes etc., and evaporation of water back to atmosphere.

The hydrologic cycle consists of the following process 1. Evaporation and Transpiration (E) the water from the surfaces of ocean, rivers, and lakes and also from the moist soil evaporates. The vapours are carried over the land by air in the form of clouds. Transpiration is the process of water being lost from the leaves of the plants from their pores. Thus, the total evaporation (E), inclusive of the transpiration consists of: (i) Surface evaporation. (ii) Water surface evaporation: (a) From river surface; (b) From oceans, (iii) Evaporation from plants and leaves (transpiration), and (iv) Atmospheric evaporation.

Precipitation (P): Precipitation may be defined as the fall of moisture from the atmosphere to the earth surface in any form. Precipitation may be two forms : a) Liquid precipitation : i.e. rainfall b) Frozen Precipitation : Snow 3. Run Off (R): Run off is that portion of precipitation that is not evaporated. When moisture falls to the earth's surface as precipitation, a part of it is evaporated from the water surface, soil and vegetation and through transpiration by plants, and the remainder precipitation is available as run off which ultimately runs to the ocean through surface or sub-surface streams. Thus run off may be classified as follows: (1) Surface run off: Water flows over the land and is first to reach the streams and rivers, which ultimately discharge the water to the sea. (2) Inter-flow or sub-surface run off: A portion of precipitation infiltrates into surface soil and depending upon the geology of the basins, runs as sub-surface runoff and reaches the streams and rivers. (3) Ground water flow or base flow: It is that portion of precipitation, which after infiltration, percolates down and joins the ground water reservoir which is ultimately connected to the ocean Thus, the hydrologic cycle may be expressed by the following simplified equation:

PRECIPITATION = EVAPORATION + RUN OFF

(P) (E) (R)

Dams: Dam is a solid barrier constructed at a suitable location across a river valley to store flowing water. Storage of water is utilized for following objectives:

- Hydropower
- Irrigation
- Water for domestic consumption
- Drought and flood control

- For navigational facilities
- Other additional utilization is to develop fisheries

Classification of dams: Based on use, dams are classified as follows i) Storage dam, (ii) Diversion dam, (iii) Detention dam.

Storage dam: This is the most common type of dam normally constructed. Storage dam is constructed to impound water to its upstream side during the periods of excess supply in the river (i.e. during rainy season) and is used in periods of deficient supply. Behind such a dam, a reservoir or lake is formed. The storage dams may be constructed for various purposes, such as for irrigation, water power generation or for water supply for public health-purposes, or it may be for a multipurpose project. A storage dam may be constructed of wide variety of materials, such as stone, concrete, earth and rockfill etc.

Diversion dam.: The purpose of a diversion dam is essentially different. While a storage dam stores water at its upstream for future use, a diversion dam simply raises water level slightly in the river and thus provides head for carrying or diverting water into ditches, canals, or other conveyance systems to the place of use.

A diversion dam is, therefore, of smaller height and no reservoir is formed to store water.

The common examples of diversion dams are weirs and barrages. During the floods, water passes over or through these diversion dams while during periods of normal flow, the river water, partly or wholly, is diverted to irrigation channel etc. A diversion dam may be constructed for irrigation or municipal or industrial uses.

Detention dam: A detention dam is constructed to store water during floods and release it gradually at a safe rate, when the flood recedes. By the provision of artificial storage during the floods flood damage downstream is reduced.

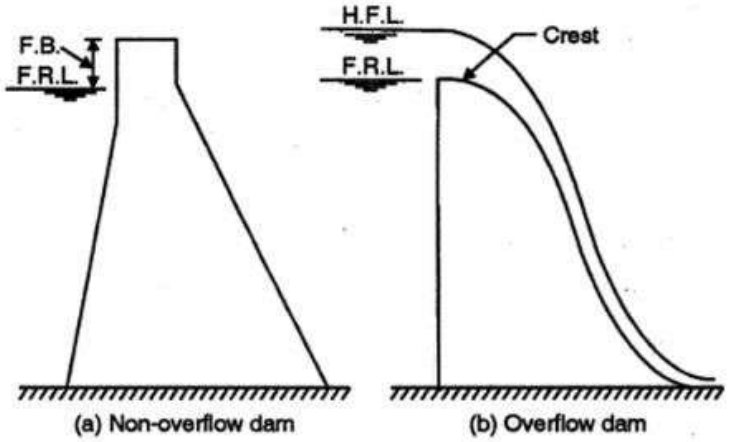
There are usually two types of detention dams. In the first type discussed above, water is temporarily stored and released through a suitable outlet structure.

In the other type of detention dam, water is not released and no outlet structure is provided. Instead, water is held in the reservoir as long as is possible. This held water seeps into pervious banks and foundation strata.

Due to this seepage of water, water-level in wells in the adjoining area is increased and lift 'irrigation may be possible. Also, irrigation may be done in the river bed itself at the downstream side. The seepage water may be sufficient for the growth of the crop and no additional surface watering may be necessary. Such a detention dam is sometimes called water-spreading dam or dike, and is similar to a weir in constructional features.

CLASSIFICATION OF DAM ACCORDING TO HYDRAULIC DESIGN

i) Non- over flow dam ii) Over flow dam



CLASSIFICATION ACCORDING TO MATERIAL

According to this most common classification, the dam may be classified as follows:
1. Rigid dams. 2. Non-rigid dams Rigid dams.
Rigid dams are those which are constructed of rigid materials such as masonry, concrete, steel or timber. Rigid dams may be further classified as follows:
1. Solid masonry or concrete gravity dam.
2. Arched masonry or concrete dam.
3. Concrete buttress dam.
4. Steel dam.
5. Timber dam.
Non-rigid dams: Non-rigid dams are those which are constructed of non-rigid

materials such as earth and/or rockfill. The most common types of non-rigid dams are 1. Earth dam. 2. Rockfill dam. 3. Combined earth and rockfill dam.

Advantages of Gravity dams

1.Gravity dams are relatively more strong and stable than earth dams. They are particularly suited across gorges having very steep side slopes where earth dam, if constructed, might slip.

2.Gravity darns are well adapted for use as an overflow spillway crest. Earth dams cannot be used as overflow dams.

3.Gravity dams can be constructed of any height, provided suitable foundations are available to bear the stresses. The height of an earth dam is usually limited by the stability of its slopes requiring a very wide base width.

4.Gravity darn is specially suited to such areas where there is likelihood of very heavy downpour. The slopes of earth dam might get washed away in such a situation.

5.A gravity dam requires the least maintenance.

6.The failure of a gravity dam, if any, is not sudden. It gives enough warning time before the area to downstream side is flooded due to the damage to the gravity darns. On the contrary, an earth dam generally fails suddenly.

7.A gravity dam is cheaper in the long run since it is more permanent than any other type. Thus the benefit-cost ratio of such a dam is always higher.

Disadvantages of Gravity dams

•Disadvantages. The disadvantages of gravity dam, as compared to an earth dam are as follows :

1.Gravity dams can be constructed only on sound rock foundations. They are unsuitable on weak foundations or on permeable foundations on Which earth dams can be constructed with suitable foundation treatment.

2.The initial cost of a gravity dam is always higher than an earth dam. Hence, where funds are limited and where suitable materials are available for the construction of an earth dam, the earth dam may be preferred.

3.If mechanised plants, such as manufacturing and transporting mass

concrete, curing of concrete etc. are not available, a gravity dam may take more time to construct.

4.Gravity dame require skilled labour or mechanised plants for its construction.

5.It is very difficult to allow subsequent rise in the height of a gravity dam, unless specific provisions have been made in the initial design.

Advantages of Arch Dams:

1.Arch dams are particularly adapted to the gorges where the length is small in proportion to the height.

2.For a given height, the section of an arch dam is much lesser than a corresponding gravity dam. Hence, an arch dam requires less material and is, therefore, cheaper.

3.Because of much less base width, the problems of uplift pressure are minor.

4.Since only a small part of water load is transferred to the foundation by cantilever action, an arch dam can be constructed in moderate foundations where gravity dam requiring sound foundation rock may be unsuitable.

Disadvantages of arch dams

1.It requires skilled labour and sophisticated form work. The design of an arch dam is also quite specialized.

2.The speed of construction is normally slow.

3.It requires very strong abutments of solid rock capable of resisting arch thrust. Hence, it is not suitable in the locations where strong abutments are not available. Unfortunately, only few sites are suitable for this type of darn.

Advantages of Buttress Dams

1.A buttress dam is less massive than a gravity dam. Hence, the foundation pressures are less in the case of a buttress dam, and it can be constructed even on weak foundations on which the gravity dam cannot be supported.

2.The amount of concrete used in buttress dam is about 1/2 to 1/3 of the

concrete used in gravity dam of the same height.

3.In the case of gravity dam, the height of the dam can raised only by the provision of crest shutter at overflow section. However in the case of a buttress darn, further raising of the height is possible and convenient by extending buttress and slab.

4.Power houses and water treatment plants can be housed in between, buttresses, thus saving some cost of construction

Disadvantages of Buttress Dams

1. Skilled labour requirements

2. Deterioration of upstream concrete surface has serious effects on buttress dams with very thin concrete face.

3. Buttress dam is more susceptible to willful damage.

Check Dams: A small dam designed to retard the flow of water and sediment in a channel, used especially to control soil erosion. Small barrier constructed in a gully or other small watercourse to decrease flow velocity, minimize channel scour, and promote deposition of sediment.

Advantages :

- They store surface water for use both during and after the monsoon.
- They help in ground water recharge of the area. Recharge of water helps in raising the water table in the area. Which enhances availability of water ensures the increases of agricultural yield by multi-cropping.
- Check dams can be used as a pisciculture.

ELEMENTS OF CIVIL ENGINEERING

UNIT-V

LEARNING MATERIAL

UNIT-V

Water Supply, Sanitary and Electrical Works in Building. Water supply, sanitation and drainage of a building are called plumbing services. In buildings, adequate water supply should be available to meet the demand of the occupants. Sources of water are public water supply, surface water and ground water. Transmission and distribution of water to buildings are done through pipes that are connected to storage tanks. The used water from the buildings is the waste water which has to be properly drained and disposed. The various fittings needed to use water and drainage of used water is commonly known as sanitary fittings, wash hand basins, bathtubs, water closets, lavatories.

Water supply system: Water is available from municipal water supply stored in over ground or underground water tanks. The places where municipal water supply is not available, sources will be open wells or shallow or deep tube wells. The first step of water supply is to store water from sources in an elevated storage tank on the top of the building. If the sources are on or below the ground, water has to be lifted through pumping process. Choice of pumps for lifting depends on the suction head, i.e. difference between the water level in the source and the centre line of the pump. In no case, it should not be more than 10m if centrifugal pump is used. For raising water from ground level storage, centrifugal pump is a better alternative for residential buildings. If the source is deep underground tube well, submersible pump is preferred. Stored water in the elevated storage tank can flow down and feed the fixtures.

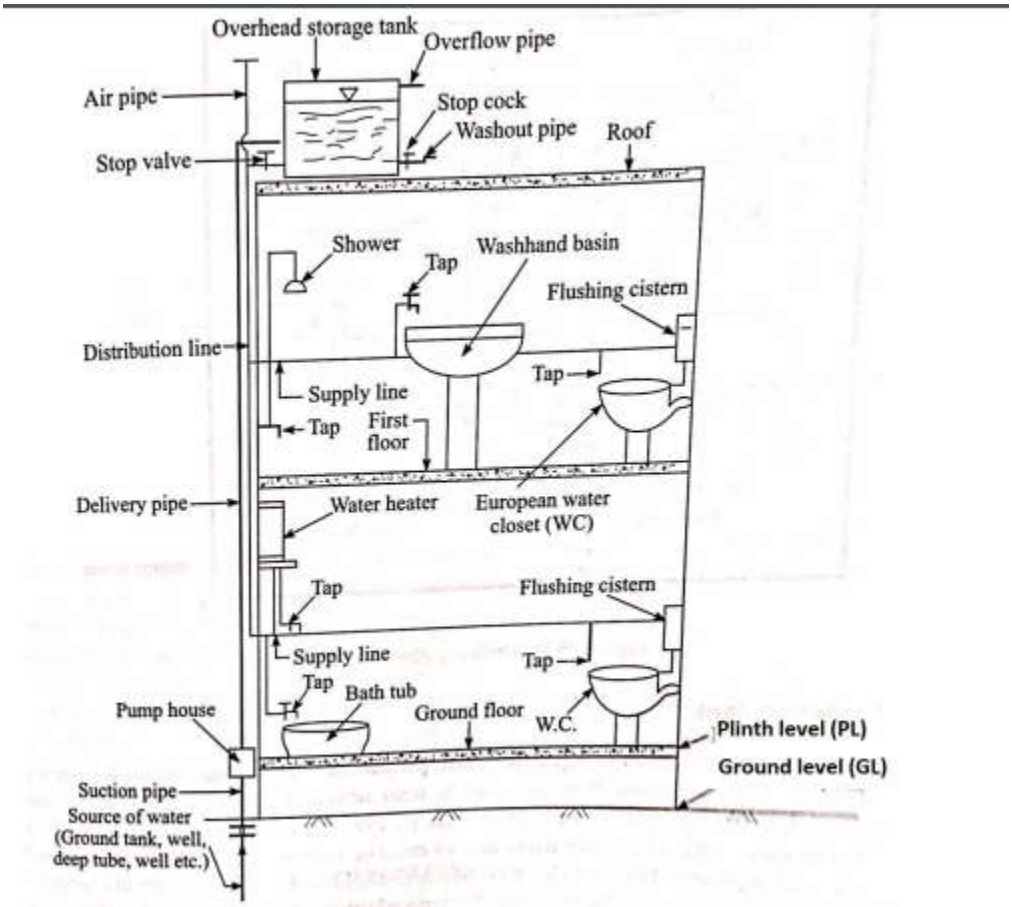
Precaution in laying the pipes/ General considerations

There is no cross section anywhere between a pipe carrying possible water and the pipe carrying used or waste water. There should be no back flow from any cistern or appliance towards the source of supply. Water supply pipes and waste water pipes should not be laid close to each other. The pipe should be properly protected against any damage. To achieve this, underground pipe line should be enclosed in a cement mortar bata so that rusting of soil bacteria is prevented. In unfeed system, pipe should carry water under adequate pressure.

For this layout of pipe should be simple and direct as far as possible. The pipes should be laid out as straight as possible.

Materials for service pipes: The pipe leading from the distribution main of the municipal water supply to the plumbing system of the house is known as the service main. The following materials are commonly used for service pipes. i) Copper or brass pipe ii) Galvanized iron iii) Lead pipe iv) Polyethene pipe

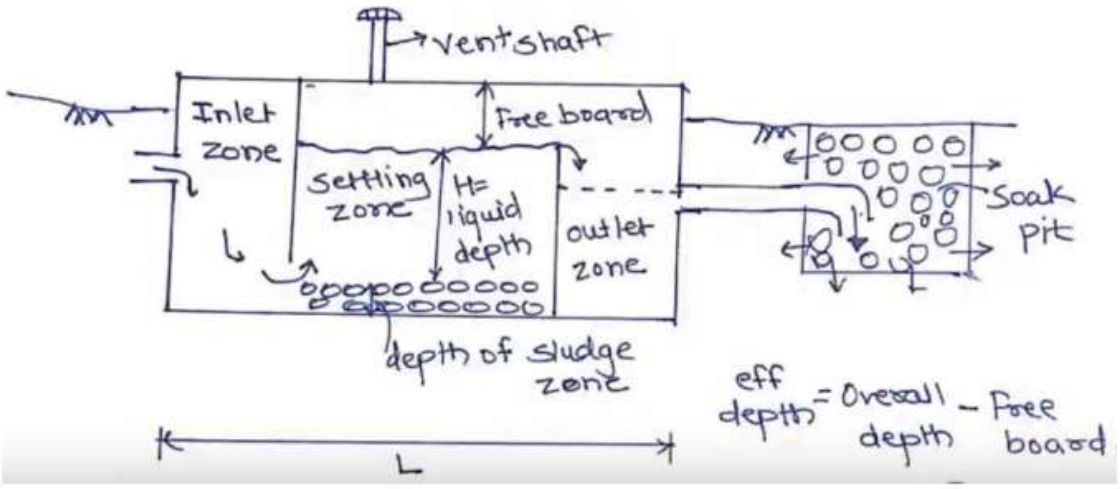
Water supply layout of a building: A typical sketch of water supply layout for a domestic two storied building is shown in the figure. The figure shows how water from a source is pumped to the overhead storage tank on the top floor and is distributed to each floor to be used by the occupants through shower, wash basin, flushing tank, water heater, bath tub and so on.



HOUSE DRAINAGE: The procedure adopted to drain away the waste water

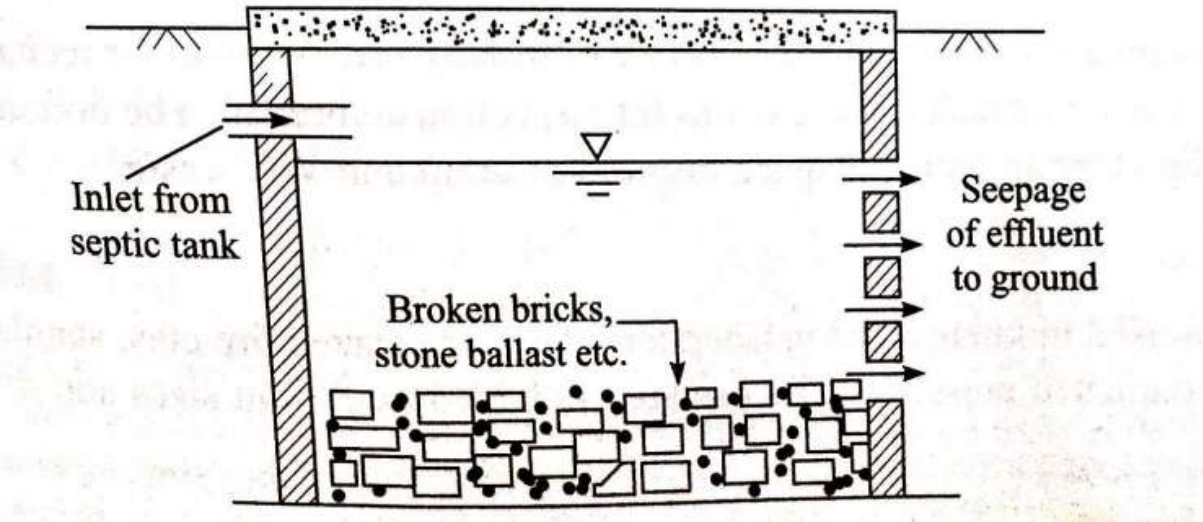
from the bathroom and kitchen and rain water from the building area through open drain or pipe to a public sewer, is termed as house drainage. It is always mandatory in a municipal area to provide house drainage and to connect it to public sewer.

Septic Tank: Septic tank is commonly used to store the waste product or foul sewage disposed from water closet and urinal of a building. It is also used to treat sewage from isolated group of country houses. Accordingly, it is designed for ten users, twenty users, and twenty five users and so on. The capacity of the tank increases as the number of users increases. The tank produces septic action by anaerobic bacteria where proteins, fatty matter, carbohydrates, and cellulose present in the sewage are broken into simpler compounds. The effluent from the tank is discharged normally to a soak pit constructed close to the septic tank. This effluent should never be discharged to open drains. Outlet should be slightly lower than the inlet. If the tank begins to over flow, it is either filled up or soak pit gets clogged. Cleaning and checking of both the septic tank and soak pit is necessary to overcome the problem.



Soak Pit: A soak pit used most commonly in a residential building to receive effluent from septic pit. The bottom of the pit is unlined. Walls of the pit are made with bricks. Open holes in the three sides of brick walls are provided. No such holes are provided in the wall towards entry of effluent from septic tank. Effluent seeps through the open spaces and gets absorbed in the ground. The unlined bottom of soak pit is filled with second class broken bricks or stone ballasts. Each house has one soak pit whose life span is 25 to 30years. Seepage capacity decreases with time, if pit gets filled up, to top cover is removed and thoroughly cleaned for future use.

Soak Pit



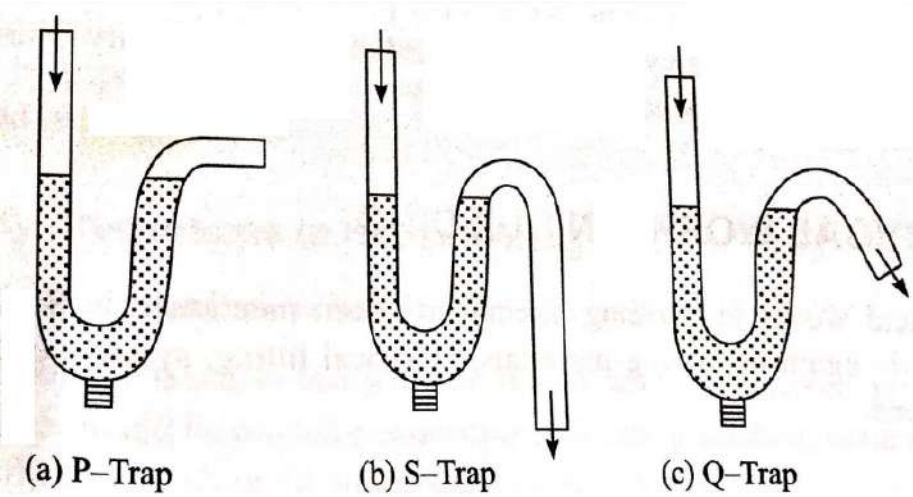
Sanitary Fittings and Appliances Sanitary Fittings and Appliances Sanitary fittings are generally made of fire clay, earthen ware and china ware. •These fittings are in the form of water closets (W.C.), wash hand basins, sinks, flushing tanks, bath tubs, ventilation pipe, lavatory basins, inspection chamber, etc. Water closets (WC) Water closets are of two designs—oriental or Indian type of the squatting type, and European design of the sitting type. The oriental type is fitted just on the floor level. It requires less water for flushing and cleaning purposes. European type WC is of sitting type above the floor level at about 40 cm to 45 cm height. They are mostly siphon vortex type.

Bath tubs They are made of cast iron or steel coated with enamel. Tubs are provided with holes for fixing hot and cold water inlets and waste pipes. The tub is fitted with short legs for its support. Wash hand basin It is made of pottery or porcelain ware. Sometimes, they also used pressed steel, plastic and porcelain enameled cast iron (IC) Inspections chambers are small chambers made of usually bricks square or rectangular size. They are provided near septic tanks, house drains for inspection and repair. The bottom of the chamber is given a steep slope to facilitate quick disposal of drain and WC waste. Sink is a basin used in kitchen and in laboratory. They are made of stainless steel, metal, porcelain or enameled pressed steel. They are available in different sizes and shapes. Urinals are of two types: bowl type and slab or stall type. The first type is used for residential building while the second type is used in public buildings. Automatic flushing cisterns are provided.

TRAPS

A trap is a device which is used to prevent sewer gases from entering the buildings. Common Gases that are Produced in a Sewage System are Methane. Hydrogen Sulfide Nitrogen, Carbon Monoxide

Traps are an integral part of a modern sanitary system. The traps should be of a self-cleansing pattern. Traps for use in domestic waste should be convenient for cleaning. A good trap should maintain an efficient water seal under all conditions of flow.



GULLY TRAP These traps are constructed outside the building to carry waste water discharge from washbasin, sinks, bathroom etc. and are connected to the nearest building drain/sewer so that foul gases from sewer do not come to the house.

INTERCEPTING TRAP: This trap is provided at the last main hole of building sewerage to prevent entry of foul gases from public sewer to building sewer. • It has a deep-water seal of 100 mm.

GREASE TRAP: This trap is a device to collect the grease contents of waste and can be cleaned from the surface. • This is generally used in food processing unit.

SILT TRAP: Large and heavier particles or silt enter the house drain and municipal sewers. Silt transportation requires higher velocity and steep slope. As it is not possible to provide steep slope all along, a chamber is constructed where heavy silts get deposited due to low velocity. Thus, silts are trapped and removed manually from time to time

ELECTRICAL WORKS IN BUILDING Wiring Materials The most commonly used materials of house wiring are main switches, MCB, distribution box, PVC wire of appropriate size, earthing wire, switch boxes of different sizes made of wood or covered with ebonite or sunmica, switches, plugs, junction box, fuse etc.

Electrical Fittings: The electrical fittings used in the building are bulbs of various watts, ceiling fans, kitchen exhaust fan, tube lights, power saving lights, call bell, night lamps, various type of decorative and fancy wall and ceiling light fittings, etc.

Safety Precautions in House Wiring following safety precautions are to be taken in house wiring: (a) Care should be taken so that live line should not remain naked anywhere in the house. (b) Earth line should be properly connected and finally earthing plate should be embedded to a sufficient depth in the moist earth. Good earthing is always necessary. (c) Before supplying electricity, it should be checked that no wire is earthed. (d) No live electric gadget should be touched. (e) Experienced electrician should always be employed to wire a house.

ELEMENTS OF CIVIL ENGINEERING

UNIT-VI

LEARNING MATERIAL

UNIT-VI

HIGHWAY ENGINEERING

Introduction: The major modes of transportation are highways or roadways, railways, waterways and airways. Apart from the above modes of transportation, other modes are cable cars, monorails, aerial ropeways, pipelines, belt conveyors, elevators etc. Transportation by road is most important mode which is used by one and all, i.e., nearest to all. The science and technology dealing with roadways is called road engineering or highway engineering. This mode offers lot of flexibility for travel like selection route, direction, time and speed. Road transport is a must in order to avail the other modes like airways, waterways and railways. Thus, road or highway engineering is the most important mode of transportation.

Historical Background Of Road or Highway: The Romans are considered to be the pioneers in the construction of road although traces of hard surfaces resembling to road surface have been found in Mesopotamia in the period of about 3500 BC. The excavation of Mohenj odaro and Harappa as early around 2500 BC revealed the prehistoric road construction in India. The Emperor Ashoka in the fifth century AD constructed many roads in his kingdom for the travelers. During Roman Empire, an extensive road construction was made in Rome The Appian Way of 580 km long built in 312 BC is an example of road building technique by the Romans. In France, Pierre Tresaguet in the year 1764 developed few improved methods of road construction and during the regime of Napoleon major development roads took place. John Macadam, Surveyor General of Roads in England in 1827 developed a new method of road construction. The roads constructed by various methods developed by him are still known as Water Bound Macadam (WBM), Penetration Macadam (PM), Bituminous Macadam (BM) roads. Macadam's method of construction was scientific and hence it is still popular in other countries with slight modification.

Highway planning in India: Out of different roads he developed, Water Bound Macadam (WBM) road is popular even in India. In India, roads were improved to a major extent during Mughal period. During British rule in India, Lord Dalhousie, who was the Governor General, founded Public Works Department

(PWD) that exists till today. Many more developments in India on road or highway engineering had taken place owing to M.R.Jayakar Committee in 1927, Indian Road Congress (IRC) in 1934, Nagpur Road Congress in 1943, establishment of Central Road Research Institute (CRRI) in New Delhi in the year 1950, National Highway Act in 1956, Highway Research Board in 1973 and National Transport Policy Committee in 1978.

Classification of Roads: The classification of roads mainly depends on traffic volume, load to be transported, locations and functions. Based on the traffic volume, roads are classified as heavy, medium and light traffic roads. Similarly, based on the load transported, they are classified as class I, class II or class A, class B, etc. The acceptable classification is based on locations and functions. The Nagpur Road Congress classified the roads on the bases of locations and functions as: (a) National highways (NH) (b) State highways (SH) (c) Major district roads (MDR) (d) Other district roads (ODR) (e) Village roads (VR)

National Highways (NH) These are main roads running throughout the whole country connecting capitals of the states, major ports, foreign highways, large industrial and tourists plots including roadways essential for strategic movements for defence of the country. It has been agreed that NH should be constructed by central government with collaboration of state PWD. National highways should be the frame of entire road communications of the country. All highways may be of different specifications. All of them are assigned different names like NH-1, NH-2, and NH-37, NH-49 and so on.

State Highways (SH) The arterial roads of the state connecting the national highways of nearby states, district head quarters, and important cities within the state are called state highways. They serve as the main arteries for the traffic to and from the district roads. Their geometric design specifications and design speed are more or less to NH.

Major District Roads (MDR) These are important roads of the districts connecting areas of production, markets. They also connect each other or with main highways of the districts. The geometric design specifications and speed are lower than NH or SH.

Other District Roads (ODR) These are roads connecting rural areas of production, outlets to market centres, circle head quarters, block development centres and to other main roads. Their design specifications are lower than MDR.

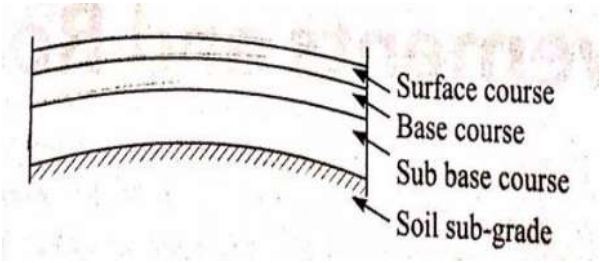
Village Roads (VR) These roads connect villages or group of villages. They also

connect nearest roads of higher category like MDR. They are also very important for farms established in village areas.

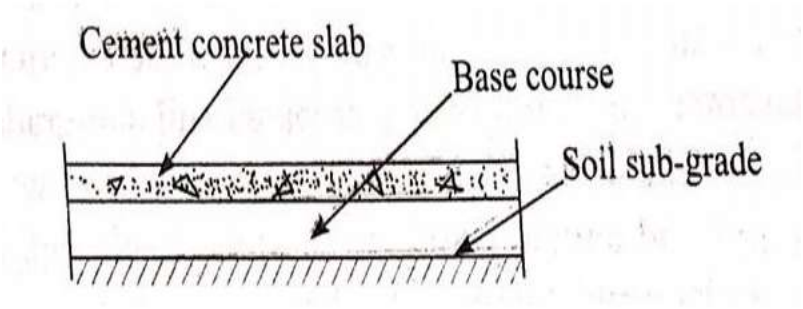
Pavement or carriage way is that part of road or high way which supports the wheel loads imposed on it from traffic moving over it. It should be strong enough to resist the stresses that are being developed due to traffic.

TYPES OF PAVEMENT: Pavements are classified from the point of structural behaviour as: (a) Flexible pavement (b) Rigid pavement (c) Semi-rigid pavement (d) Composite pavement

Flexible Pavement: Flexible pavement, has low flexural strength. The external load in this ,pavement is largely transmitted to the sub-grade by lateral distribution with increase in depth. The thickness of the pavement is so designed that stresses in the subgrade soil are kept within its bearing capacity. The typical flexible pavement has the following components, and they are shown in Figure (a) Soil sub-grade (b) Sub-base course (c) Base course (d) Surface course



Rigid Pavement Rigid pavement derives its capacity to withstand load from flexural strength or rigidity. The stresses developed are not transmitted to the lower layers like flexible one. The top layer is of plain cement concrete which withstand stresses up to about 400 N/cm2 . . Rigid pavement is made of Portland cement concrete. The rigid pavement doesn't get deformed under wheel load like flexible pavement.



COMPARISON OF FLEXIBLE AND RIGID PAVEMENTS:

Design of rigid pavement is based-scientific design pavement design where as flexible pavement is mostly empirical in nature.

Life of rigid pavement is more than the flexible

Maintenance of well designed rigid pavement is low here as flexible pavement needs frequent maintenance

Initial cost of rigid pavement is much more than the flexible one

Selection of type of pavement depends on

availability of materials of construction

Surface characteristics play another role of selection of type of pavement.

A good cement surface is smooth, free from pot holes and corrugations. Flexible pavement does not possess the above facilities.

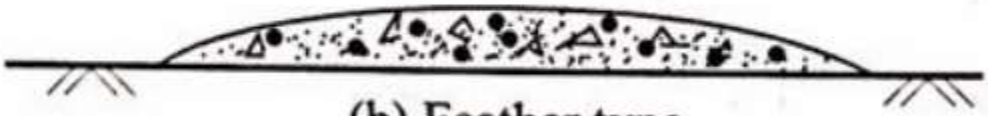
Impervious layer of the pavement is essential for the subgrade. Preference will always be the rigid pavement as concrete is impervious.

Traffic dislocation during construction for about a month takes place as concrete requires minimum 28 days for curing and setting. In flexible pavement, traffic is allowed to move on the pavement once it is rolled.

Earth Roads • These are the low cost or cheapest type of road made of locally available natural soil. • The camber provided in earth road is usually steep which ranges from 1 in 20 to 1 in 33 although it is better to have slope 1 in 20 to prevent erosion by rain water. • As the surface is pervious, large cross slope keeps the pavement free from water standing thereby softening surface is prevented. • Construction steps require clearing of site, centre line and road edges marking, excavation and filling the soil to bring it to the desired level and slope and shaping of sub-grade.

Gravel Roads • Gravel roads are superior to earth road as they can carry heavier traffics. Gravels are used to construct the carriage way. • The camber used is from 1 in 25 to 1 in 30. • A gravel road does not become slippery when wetted by rain. • There are two types of gravel road. One is trench type and other is feather edge type as shown in Figure.

(a) Trench type



(b) Feather type

In the trench type, sub-grade is prepared by excavating a shallow trench and feather type is constructed over the sub-grade with varying thickness. Trench is better as the gravel used is nicely confined in it.

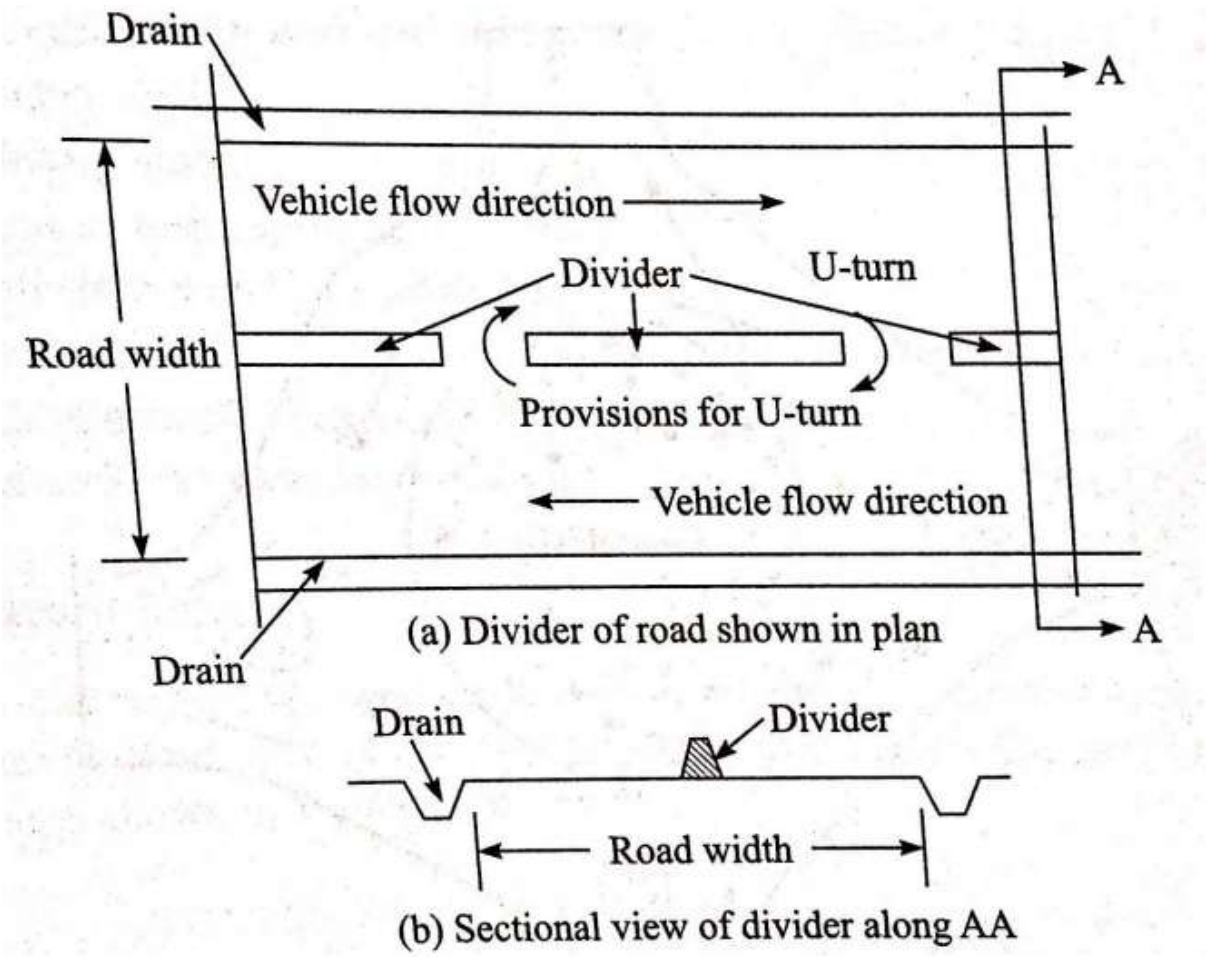
Water Bound Macadam •Water Bound Macadam (WBM) Road WBM road is known after John Macadam, Surveyor General of Roads in England in 1827, who was the first to introduce this particular road. • The roads whose wearing course consists of clean crushed aggregates mechanically interlocked by rolling and bound together with filler material and layer and laid on a well compacted base course is called water bound macadam road. • The strength of a water bound macadam course is due to the mechanical interlocking of the aggregate particles and the cohesion between the aggregate particles due to cementious film of soil moisture binder. •The WBM roads are in use in our country both as a finished pavement surface for minor roads and as a good base course for superior pavements carrying heavy traffic.

Bituminous Roads • This road is common in India and also in abroad. • Over the existing stabilized gravel or stone pavement, a thin bituminous layer is laid as a wearing coat. • A thin layer of bituminous binder is sprayed over this cleaned surface before construction of any type of bituminous layer. This is called interface treatment which is essential to provide the necessary bond between the old and new layer. • After that bituminous layer is laid and roller is used for compaction and binding with the sub-grade pavement.

TRAFFIC CONTROL MECHANISMS OR DEVICES • The various aids and devices used to control, regulate and guide traffic are called traffic control mechanisms or devices. The most common devices or mechanisms are divider, islands, signals and signs. In addition to this road lights are quite essential in guiding traffics during night.

DIVIDERS • Divider is a separator of road for vehicles moving from opposite direction in order to avoid any collision with traffics of lanes separated by divider. • It is a masonry structure constructed in the middle of the road to divide the road into two portions for vehicles coming from opposite directions. • It is very much essential in the busiest zone of city. • Provisions are made for U-turn of vehicles proving gaps in

the dividers at some design length. • In national highway having more than one lanes in both sides, divider is called usually a separator of about 8 m wide. The divider in city road is rectangular or trapezoidal in shape with usual base width from 1 m to 1.5 m



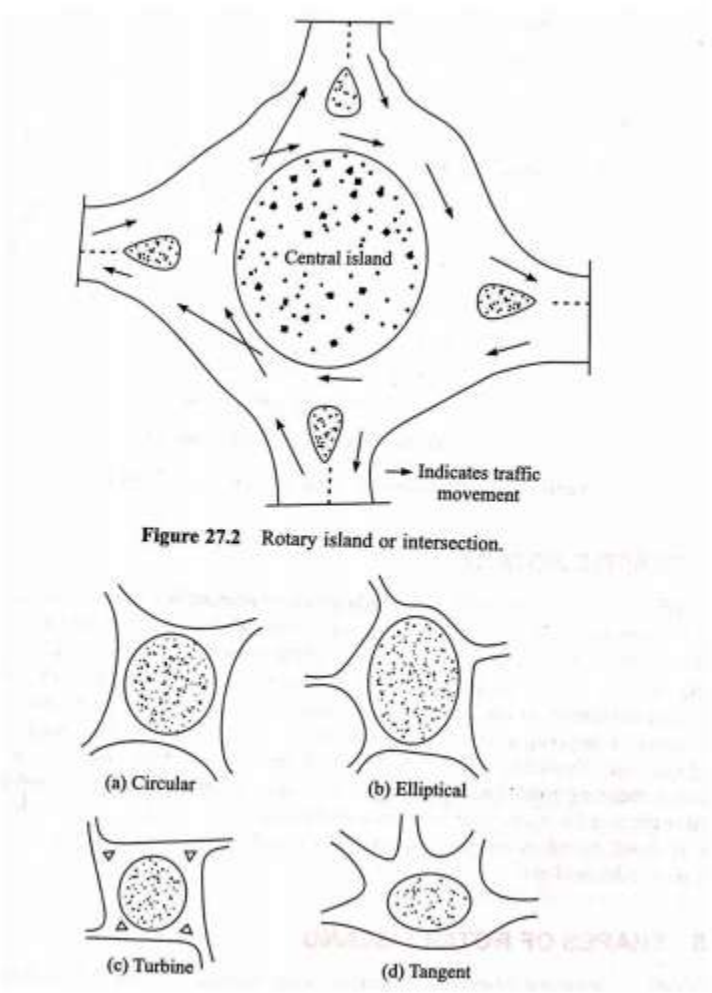
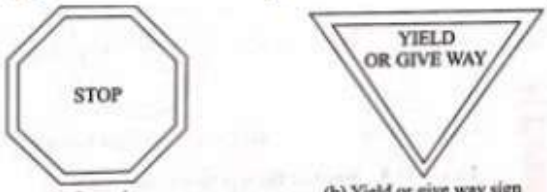


Figure 27.2 Rotary island or intersection.

TRAFFIC ROTARY • A traffic rotary or rotary intersection is an enlarged road intersection where all converging vehicles are forced to move round a large central island in clockwise direction before they can weave out of traffic flow into their respective directions radiating from the central island. • Figure is an example of rotary island where vehicles from four roads are converging. • The arrow indicates direction of movement of the vehicles. • The main objective of providing a rotary is to eliminate the necessity of stopping even crossing streams of vehicles and to reduce their area of conflict. • All vehicles are allowed to merge into the stream around the rotary and then to diverge out to the desired radiating road. Thus, crossing of vehicles is avoided. • Merging of vehicle takes place towards right and diverging operation towards the left • Design factors of rotary depend on speed, shape of island, its radius, entrance and exit curves and on many other points which is outside the scope of this discussion.

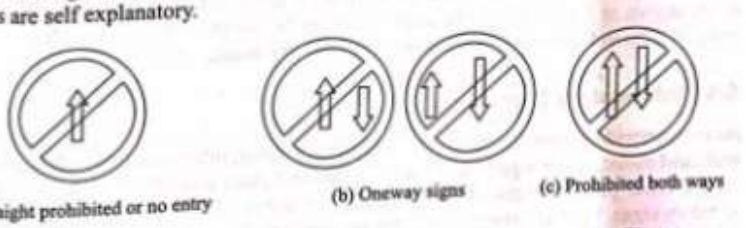
Regulatory road signs



(a) Stop sign (b) Yield or give way sign

Figure 27.4 Stop and give way sign.

ome other regulatory signs used in traffic control mechanisms are also shown in Figure 2
igures are self explanatory.



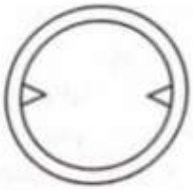
ı) Straight prohibited or no entry (b) Oneway signs (c) Prohibited both ways

(d) Right turn prohibited (e) Left turn prohibited (f) U-turn prohibited

Regulatory road signs

(g) Speed limit

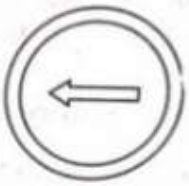
(h) Stopping or standing



(i) Width limit

(j) No overtaking

(k) No parking



(l) Compulsory left

(m) No parking

(n) Compulsory right turn ahead