AS-2928

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Paper III: Forest Engineering and Surveying

Time:3 hours Max.marks:60

Note: Section A is compulsory. Attempts any Four question in section B

SECTION –A

Q1A. Multi Choice Question [1×1]

1. In Plane table survey requisite accessories are:
   (a) Alidade (b) Trough compass
   (c) Prismatic compass (d) Both a and b

   Ans: (d) Both a and b
2. If the area has been measured with an incorrect chain , the true area is calculated by following formula:
   (a) True Area=$(L'/L)^2$*measured area (b) True Area=$(L'/L)^2$*measured length
   (c) True Area=(L'/L)*measured area (d) None
   Ans: True Area=$(L'/L)^2$*measured area
3. Some imaginary lines drawn like contours line on map called:
   (a)Agonic line (b) Isogonic line
   (c) Tie line (d) None
   Ans: (b) Isogonic line
4. Intermediate support to the super structure of the bridge is:
   (a)Pier (b)Abutment
   (c) Wing Wall (d) All
   Ans: (a)Pier
5. Sources of lime are:
   (a)Lime stone (b)Sea shell/Corals
   (c) Tufa (d) All
   Ans: (d) All

Q1.(B) Fill in the blanks: [1×1]

1. A representation of the whole or part of the earth's surface in miniature known as--**Map**-.
2. Angles are neither very acute nor very obtuse known as **Well Conditioned Triangle**.
3. Ratio of the rise and fall corresponding to the length of the road termed **Gradient**.
4. **Wing Wall** to be provided where culverts located in an erodible river bank.
5. **Map** is a conventional delineation of the earth's surface on a flat sheet.

Q1.(C) Write short notes on any five the following question [5 X 2 = 10]

1. **Offsets-**Offsets are lateral measurement from the chain line taken to the object such as corners of building, fences and hedges, bank of streams, trees and poles etc.
2. **Line ranger-**A line Ranger is a small reflecting instruments used for fixing intermediates points in line with two distinct station.
3. **Traverse-**Method of survey there area to be surveyed gone over suitable traverse station and the scale decided.
4. **Azimuth**-The azimuth of a line is its direction as given by the angle between the meridian and the line measured in a clockwise direction ,usually from the south branch of the meridian.
5. **Blue printing-** Printing done the ink made by potassium ferricyanide and ferric ammonium citrate in well sized unsensitised tracing paper and this paper placed over the coloured light .The blue print paper is washed with water. Thus a white pattern on a blue background is produced. This process in known as Blue Printing.
6. **Grouting-**Filling ups joints in the interiors of wall with thin mortor.

SECTION-B [1×10]

Q.2 Sketch and describe the prismatic compass .What are the sources of error to which compass observation are liable and what precaution should be taken to guard against them.

Ans. Compass surveying is a branch of surveying in which directions of surveying lines are determined with a compass and the length of lines are measured with a tape or chain. In compass surveying,"Traverse" consists a series of straight lines connected together to form a open or a closed polygon.**Compass Traverse-**In Compass Traverse the direction of the traverse lines are determined with a magnetic compass. The magnetic Compass may termed as "PRISMATIC COMPASS"

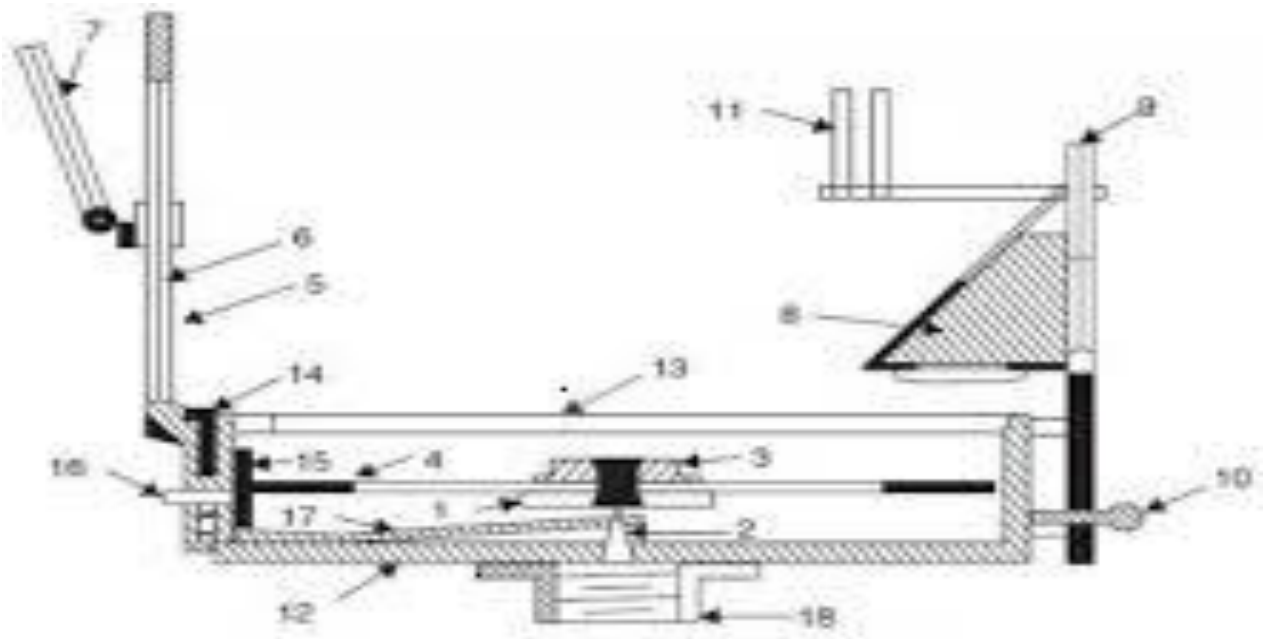
PRISMATICCOMPASS:

The prismatic compass is one of the magnetic compass in which there is a prism for taking observations. The prismatic compass is generally smaller in size than a surveyor compass. The prismatic compass is used to determine the whole circle bearing of the lines. It consists of circular box, about 85 to 100 mm in diameter. The box is made up of brass or a non metallic material. At the centre of the box there is a hard steel Pivot which supports the magnetic needle. The needle used in a prismatic compass is board of form. The box is fitted with a glass disc at its top. When the compass is not in use, the box is covered with the brass disc.

The prism when carried on a mounting frame which can be raised or lowered for focusing of the prism. The image of the graduations is viewed through a small circular aperture in the prism mounting. Just above the aperture there is an narrow slit or a small V-cut used as an eye vane. The object vane consists of a metal frame hinged to the box. It has a vertical hair. The object vane is usually provided with a hinged mirror so that the object which are either too low or high can be sighted by inclining the mirror. Dark coloured glasses are provided near the eye vane which can be interposed between the eye and the prism when sighting illuminous objects or the sun.

when the instrument is not in use, the object vane is folded on the glass cover. In this process, the lifting pin is pressed which lifts the needle off the pivot and holds it against the glass cover. Thus undue wear of the pivot is prevented. TOo dampen the oscillations of the needle and to bring it to rest quickly, a light spring brake is fitted inside the box. A brake pin provide below the base of the object vane when

pressed comes into contact with the edge of the aluminum ring and stops its oscillations. The prismatic compass is mounted on the tripod while taking readings.



1. Needle
2. Pivot
3. Agate cap
4. Graduated disc
5. Brass metal frame
6. Horse hair
7. Mirror
8. Reflecting prism with cap
9. Eye vane
10. Focussing slot
11. Dark sunglasses
12. Box
13. Glass cover
14. Lifting pin
15. Light spring
16. Brake pin or knob
17. Lifting lever
18. Support to fit on tripod

Adjustments of Prismatic Compass:

The following are the adjustments usually necessary in the prismatic compass:

- Centering
- Leveling
- Focusing the prism.

CENTERING:

- The center of the compass is placed vertically over the station point by dropping a small piece of stone below the center of the compass, it falls on the top of the peg marking that station.

LEVELLING:

- By means of ball and socket arrangement the Compass is then leveled the graduated ring swings quite freely. It may be tested by rolling a round pencil on the compass box.

FOCUSSING THE PRISM :

- The prism attachment is slid up or down focusing till the readings are seen to be sharp and clear.

- Observing Bearing: The compass centered over station A of the line AB and is leveled.
- Having turned vertically the prism and sighting vane, raise or lower the prism until the graduations on the rings are clear and look through the prism.

- Turn the compass box until the ranging rod at the station B is bisected by hair when looked through the prism.
- Turn the compass box above the prism and note the reading at which the hair line produced appears to cut the images of the graduated ring which gives the bearing of line AB.

- Fore Bearing & Back Bearing-Every line has two bearings one observed at each end of the line.
- The bearing of the line in the direction of progress of the survey is called Fore Bearing (FB), while the bearing in the opposite direction is called Back Bearing (BB).
- Therefore BB of a line differs from FB by exactly 180^o.

Errors in Compass observations-

The errors may be classified as

- Instrumental errors
- Personal errors
- Errors due to natural causes

1.Instrumental errors-They are those which rise due to the faulty adjustments of the instruments. They may be due to the following reasons:

- The needle not being perfectly straight.
- Pivot being bent
- Sluggish needle
- Blunt pivot point
- Improper balancing weight
- Plane of sight not being vertical
- Line of sight not passing through the center of graduated ring

2.Personal errors-They may be due to the following reasons:

- Inaccurate leveling of the compass box.
- Inaccurate centering.
- Inaccurate bisection of signals.
- Carelessness in reading and recording.

3.Natural Errors-They may be due to following reasons:

- Variation in declination
- Local attraction due to proximity of local attraction forces.
- Magnetic changes in the atmosphere due to clouds and storms.
- Irregular variations due to magnetic storms etc.

Q.3 (i) The length of a line measured with a 20m chain was found to be 634.4 m. It was afterwards found that the chain was 0.05 m too long. Find the true length of the line.

Ans. True Area=$(L'/L)^2$*measured length

Given L'=20.05 m.

L=20 m.

measured length=634.4 m.

True Length=$(20.05/20)^2$*634.4 m.

True Length=535.99 m.

Q3 (ii)Describe how you would range a chain line between two points which are not inter-visible.

Ans. When the end stations between which a straight line is to be laid, are not inter visible, indirect method of ranging is being adopted. It is being carried out either by reciprocal method or by random line method. The ranging in which intermediate points are interpolated by **reciprocal** ranging or running an auxiliary line.

Indirect ranging is done where end points are not visible and the ground is high . shows the field operations involved in reciprocal ranging. Let A and B are the two end points whose distance is required to be found and are not inter visible. To fix the intermediate points in a straight line between these points, two more points say C and D are chosen in such a way that D & B are visible from C and C & A from D. Then, direct ranging is being carried out alternatively along DCA and CDB for a number of times so that ACDB line a straight line.

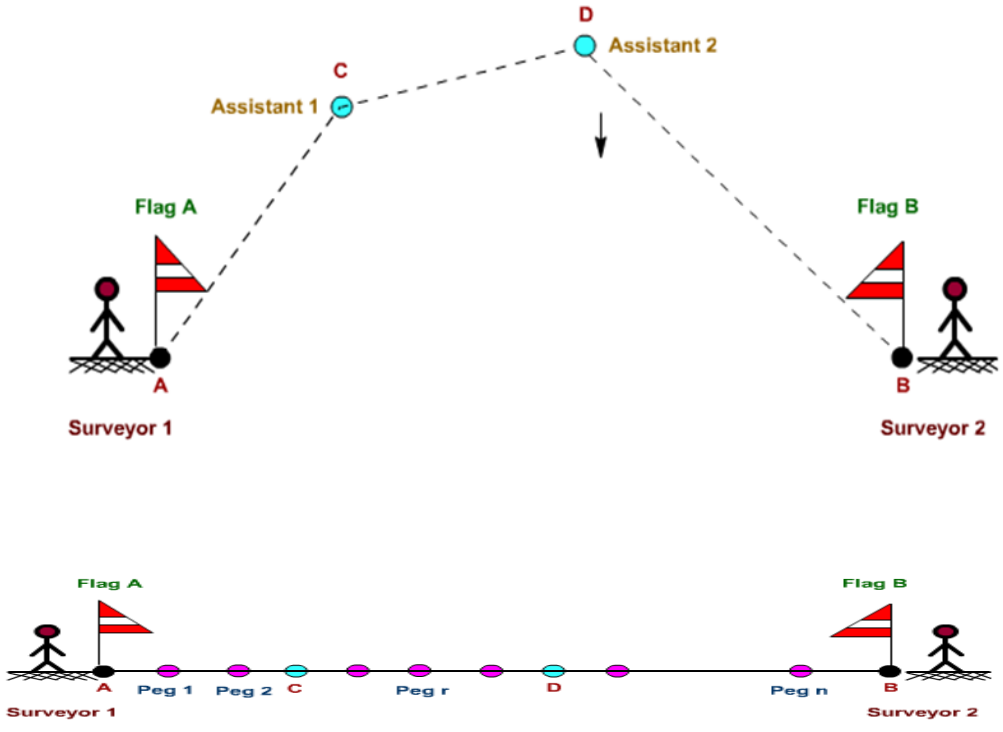


Figure 8.2 Reciprocal Ranging

Q4. Write in detail the physical properties consider for checking the strength of different building material and its suitability in construction of forest building.

Ans. Building materials have an important role to play in this modern age of technology. Although their most important use is in construction activities, no field of engineering is conceivable without their use. Also, the building materials industry is an important contributor in our national economy as its output governs both the rate and the quality of construction work. There are certain general factors which affect the choice of materials for a particular scheme. Perhaps the most important of these is the climatic background. Obviously, different materials and forms of construction have developed in different parts of the world as a result of climatic differences. Another factor is the economic aspect of the choice of materials. Following physical properties consider for checking the strength of different building material:

PHYSICAL PROPERTIES

Density (ρ) is the mass of a unit volume of homogeneous material denoted by

$$\rho = \frac{M}{V} \text{ g/cm}^3$$

where M = mass (g)

V = volume (cm^3)

Density of some building materials is as follows:

Material	*Density (g/cm^3)*
Brick	2.5–2.8
Granite	2.6–2.9
Portland cement	2.9–3.1
Wood	1.5–1.6
Steel	7.8–7.9

Bulk Density (ρ_b) is the mass of a unit volume of material in its natural state (with pores and voids) calculated as

$$\rho_b = \frac{M}{V} \text{ kg/m}^3$$

where M = mass of specimen (kg)

V = volume of specimen in its natural state (m^3)

Density Index (ρ_o) is the ratio,

$$\rho_o = \frac{\text{bulk density}}{\text{density}}$$

$$= \frac{\rho_b}{\rho}$$

It indicates the degree to which the volume of a material is filled with solid matter. For almost all building materials ρ_o is less than 1.0 because there are no absolutely dense bodies in nature.

Specific Weight (γ) also known as the unit weight, is the weight per unit volume of material,

$$\gamma = \rho g$$

where

γ = specific weight (N/m^3)

ρ = density of the material (kg/m^3)

g = gravity (m/s^2)

Specific Gravity **(G_s)** of solid particles of a material is the ratio of weight/mass of a given volume of solids to the weight/mass of an equal volume of water at 4°C,

$$G_s = \frac{\gamma_s}{\gamma_w} = \frac{\rho_s}{\rho_w}$$

where

ρ_s = density of solids
ρ_w = density of water (at 4°C, ρ_w = 1g/cc)
γ_s = unit weight of solids
γ_w = unit weight of water (at 4°C, γ_w = 9.8 kN/m^3)

True or Absolute Specific Gravity **(G_a)** If both the permeable and impermeable voids are excluded to determine the true volume of solids, the specific gravity is called true or absolute specific gravity.

$$G_a = \frac{(\rho_s)_a}{\rho_w}$$

where

$(\rho_s)_a$ = absolute density of solids in vacuum

Apparent or Mass Specific Gravity **(G_m)** If both the permeable and impermeable voids are included to determine the true volume of solids, the specific gravity is called apparent specific gravity. It is the ratio of mass density of fine grained material to the mass density of water.

$$G_m = \frac{\rho}{\rho_w}$$

Hygroscopicity is the property of a material to absorb water vapour from air. It is influenced by air-temperature and relative humidity, pores—their types, number and size, and by the nature of substance involved.

Water Absorption denotes the ability of the material to absorb and retain water. It is expressed as percentage in weight or of the volume of dry material:

$$W_w = \frac{M_1 - M}{M} \times 100$$

$$W_v = \frac{M_1 - M}{V} \times 100$$

where

M_1 = mass of saturated material (g)
M = mass of dry material (g)
V = volume of material including the pores (mm^3)

Water absorption by volume is always less than 100 per cent, whereas that by weight of porous material may exceed 100 per cent.

Fire Resistance is the ability of a material to resist the action of high temperature without any appreciable deformation and substantial loss of strength. Fire resistive materials are those which char, smoulder, and ignite with difficulty when subjected to fire or high temperatures for long period but continue to burn or smoulder only in the presence of flame, e.g. wood impregnated with fire proofing chemicals. Non-combustible materials neither smoulder nor char under the action of temperature. Some of the materials neither crack nor lose shape such as clay bricks, whereas some others like steel suffer considerable deformation under the action of high temperature.

Refractoriness denotes the ability of a material to withstand prolonged action of high temperature without melting or losing shape. Materials resisting prolonged temperatures of 1580°C or more are known as refractory.

High-melting materials can withstand temperature from 1350–1580°C, whereas low-melting materials withstand temperature below 1350°C.

Chemical Resistance is the ability of a material to withstand the action of acids, alkalis, sea water and gases. Natural stone materials, e.g. limestone, marble and dolomite are eroded even by weak acids, wood has low resistance to acids and alkalis, bitumen disintegrates under the action of alkali liquors.

Weathering Resistance is the ability of a material to endure alternate wet and dry conditions for a long period without considerable deformation and loss of mechanical strength.

Water Permeability is the capacity of a material to allow water to penetrate under pressure. Materials like glass, steel and bitumen are impervious.

Frost Resistance denotes the ability of a water-saturated material to endure repeated freezing and thawing with considerable decrease of mechanical strength. Under such conditions the water contained by the pores increases in volume even up to 9 per cent on freezing. Thus the walls of the pores experience considerable stresses and may even fail.

Heat Conductivity is the ability of a material to conduct heat. It is influenced by nature of material, its structure, porosity, character of pores and mean temperature at which heat exchange takes place. Materials with large size pores have high heat conductivity because the air inside the pores enhances heat transfer. Most materials have a higher heat conductivity than drier ones. This property is of major concern for materials used in the walls of heated buildings since it will affect dwelling houses.

Thermal Capacity is the property of a material to absorb heat described by its specific heat. Thermal capacity is of concern in the calculation of thermal stability of walls of heated buildings and heating of a material, e.g. for concrete laying in winter.

Q5. Mention the method and important consideration of site selection of the construction of roads in forest area.

Ans. The road in and adjoining the forest area are called as forest roads. Forest roads serve as a main communication channel between forest personal and other people.It facilitates transport of material from forest to users.

Characteristics of Forest Roads

- The surface should be impervious hard ,durable and non-sliperry nature.
- Gradient of the roads should not to be too steep.
- Surface of the road should have least coefficient of friction for vehicle movement .

- It should easy to clean and repair.

Classification of Forest Roads

A. Based on the Function

i. **Main motorable roads**-Which connect head quarters,division,range office and blocks.It is mostally metalled.

ii. **Branch jeepable roads-** Which connecting interiors forest with the headquarters .It is not metallede .It also connect main road with rest houses,plantation etc.

iii. **Bridle path-**Which is uses by humen being for ladening of animals mainly by moving feet . It is narrow and so steep in gradient.

iv. **Inspection path-** It connects site from which extensive view of a forest area can be seen.

B.Based on the period of use-

i. Temporary Roads-Which are useble only for few seasons .

ii. Fair weather roads-Useble only during the normal weather condition.

iii. Permanent roads- It laid with great care as it is maintained permanently .Alignment is done carefully by considering all possible alternate route.

The cross section of roads has following features:

1. Sealing coat
2. Outer coat
3. Inner coat
4. Soling
5. Sub base
6. Sub grade

Construction of Road

Road construction is a tedious job that require contant attension and more information. The following steps are involved in road alignment

A.Preliminary reconnaissance –

- First contour map of the area is procured
- Area is visited in order to familiarize with ground feature.
- All possible route are marked.
- Rulling gradient was fixed.
- Key plan are prepared.

B.Road Alignment-

- Main roads are laid out in central part from which fedder roads are connected.
- Unnecessary crossing of rivers ,streams and drainage channel are avoided.
- The alignment is laid possibly on high ground to keep roads dry.
- Private land hold are avoided.
- In hilly area heavy rocks and landslides is avoided.
- Zig-zag bends are avoided.
- Halting places on regular intervals are provided.

C.Road Design-

1. Land requirement - for roads-It should consider width of road,shoulder,slopes cutting and embankment,drainage ,side width for staking of material and possible widening in future.

2.Width of roads-It depends nature and intensity of traffic on the roads,availability and cost of land ,available financial resources and objectives of roads.

Road type	**Main forest roads**	**Jeepable roads**	**Bridle path**
Single line			
Standard	3.5	3.0	2.0
Recommended	4.0	3.5	2.5
Double line			
Standard	7.0	6.0	3.0
Recommended	7.5	6.5	3.5

3. Gradient design-It should be as gentle as possible and should not exceeds the ruling gradient. Roads form in full cutting is given a maximum gradient of 1 in 100 to ease of drainage.

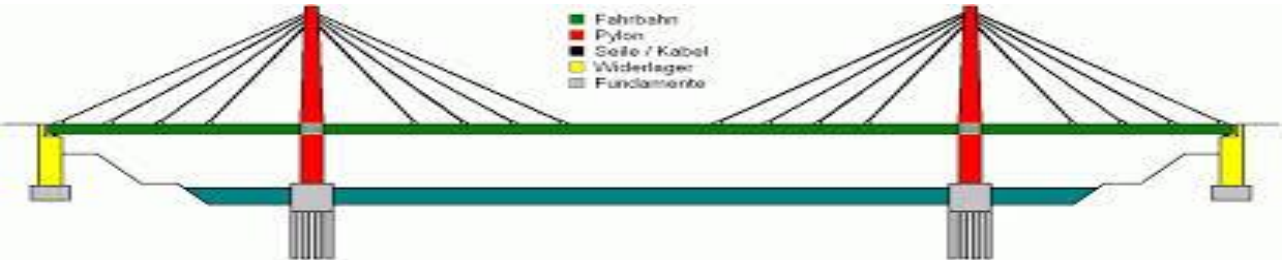
4. Earthen work for roads-The cutting and embankments along the center line of roads are designed in a way that the earth obtained from a cutting is used for embankment .

Type of cutting /soil type	Slope of cutting
Ordinary soil	1:1
Clay soils	Flatter slopes
Steep cutting	2:1, 3:1, 4:1
Rock cuts	1:1.5

Proper drainage should be provided .Curve setting ,Brest wall and Wing wall also constructed.

Q6. Write note on:

i. Cantilever Bridges- A cantilever bridge is a bridge built using cantilevers, structures that project horizontally into space, supported on only one end. For small footbridges, the cantilevers may be simple beams; however, large cantilever bridges designed to handle road or rail traffic use trusses built from structural steel, or box girders built from prestressed concrete. The steel truss cantilever bridge was a major engineering breakthrough when first put into practice, as it can span distances of over 1,500 feet (460 m), and can be more easily constructed at difficult crossings by virtue of using little or no false work.



Advantages-The parts of a cantilever bridge are: the outer beams, the cantilevers and the central beam. A cantilever bridge is a variation of the simple beam bridge. A cantilever is a long arm that is fastened at one end and is free to move at the reverse end.

Disadvantages-There are many advantages along with many disadvantages of a cantilever bridge. The very foundation to such a bridge begins with a disadvantage. They fact that they are built to carry large objects over great bodies of water; high risk and difficult construction.

ii. Suspension Bridge-A Suspension bridge is a type of bridge in which the deck (the load-bearing portion) is hung below suspension cables on vertical suspenders. Outside Tibet and Bhutan, where the first examples of this type of bridge were built in the 15th century, this type of bridge dates from the early 19th century.[3][4] Bridges without vertical suspenders have a long history in many mountainous parts of the world.

This type of bridge has cables suspended between towers, plus vertical *suspender cables* that carry the weight of the deck below, upon which traffic crosses. This arrangement allows the deck to be level or to arc upward for additional clearance. Like other suspension bridge types, this type often is constructed without false work.

The suspension cables must be anchored at each end of the bridge, since any load applied to the bridge is transformed into a tension in these main cables. The main cables continue beyond the pillars to deck-level supports, and further continue to connections with anchors in the ground. The roadway is supported by vertical suspender cables or rods, called hangers. In some circumstances, the towers may sit on a bluff or canyonedge where the road may proceed directly to the main span, otherwise the bridge will usually have two smaller spans, running between either pair of pillars and the highway, which may be supported by suspender cables or may use a truss bridge to make this connection. In the latter case there will be very little arc in the outboard main cables.

Economic Advantages

- The area spanned by a suspension bridge is very long in proportion to the amount of materials required to construct bridges.

Height Advantages

- Built over waterways, suspension bridges can be built high, allowing the passage of tall ships unhindered by the bridge.

Construction Advantages

- During construction, temporary central supports do not need to be built, and access to the construction is not required from beneath. This means busy roadways and waterways do not need to be disrupted.

Disadvantages-

1.Considerable stiffness or aerodynamic profiling may be required to prevent the bridge deck vibrating under high winds.

2. The relatively low deck stiffness compared to other (non-suspension) types of bridges makes it more difficult to carry heavy rail traffic where high concentrated live loads occur.

3. Some access below may be required during construction, to lift the initial cables or to lift deck units. This access can often be avoided in cable-stayed bridge construction.
4.When built in soft ground, suspension bridges require extensive and expensive foundation work to combat the effects of the heavy load on foundation towers.

5.Flexibility can be a disadvantage to suspension bridges, which can flex under heavy, concentrated loads. Suspension bridges are not generally used for regional rail crossings that carry maximum weight loads, causing added stress on the bridge.

Q7. Define 'Map' .Write in detail the Importance of map in Forestry.

Ans. A **map** is a visual representation of an area – symbolic depiction highlighting relationships between elements of that space such as objects, regions, and themes. Many maps are static two-dimensional, geometrically accurate (or approximately accurate) representations of three-dimensional space, while others are dynamic or interactive, even three-dimensional. Although most commonly used to depict geography, maps may represent any space, real or imagined, without regard to context or scale. It is a reproduction of same portion of the earth surface.

Characteristics of Map

- All object on the map are the same relative position as on the ground.
- All angles between the line drawn on the map are a equal to the angle between corresponding lines drawn on the ground.

Types of Map

• **Political Map:** A political map does not show any topographic features. It instead focuses solely on the state and national boundaries of a place.

• **Physical Map:** A physical map is one that shows the physical landscape features of a place. They generally show things like mountains, rivers and lakes and water is always shown with blue. Mountains and elevation changes are usually shown with different colors and shades to show relief.
• **Topographic Map:** A topographic map is similar to a physical map in that it shows different physical landscape features. They are different however because they use contour lines instead of colors to show changes in the landscape.
• **Climate Map:** A climate map shows information about the climate of an area. They can show things like the specific climatic zones of an area based on the temperature, the amount of snow an area receives or average number of cloudy days. These maps normally use colors to show different climatic areas.
• **Economic or Resource Map:** An economic or resource map shows the specific type of economic activity or natural resources present in an area through the use of different symbols or colors depending on what is being shown on the map.
• **Road Map:** A road map is one of the most widely used map types. These maps show major and minor highways and roads (depending on detail) as well as things like airports, city locations and points of interest like parks, campgrounds and monuments. Major highways on a road map are generally red and larger than other roads, while minor roads are a lighter color and a narrower line.

• **Thematic Map:** A thematic map is a map that focuses on a particular theme or special topic and they are different from the six aforementioned general reference maps because they do not just show natural features like rivers, cities, political subdivisions, elevation and highways. If these items are on a thematic map, they are background information and are used as reference points to enhance the map's theme. of a reference.

Importance of Map in Forestry

"Maps are the Eye and Ears of the foresters". Because maps are very important and useful documents to meet day to day requirement in forestry .Maps are used for following purposes-

a. **Protection Purposes-**Forest maps give records of boundaries ,encroachments and illicit possession, are checked and detected by map. Accuracy of boundary pillar can be verified by map.
b. **Management purposes-**
   i. Working Plan Maps-These are prepared by working plan officers generally 1/50000 scale.
   ii.Stock Map-These are prepared by working plan officers generally on 1/15000 scale .
   iii.Control Maps-The purpose of these maps is to show the progress of various forestry operation and excercse ceck and control on such operation. The control map are also prepared for following purposes-
      - Records of forest fire.
      - Felling of all kind.
      - Artificial and natural regeneration.
      - Cutting of fire lines and fire tracts.
      - Control burning.
      - Progress of soil conservation operation.

c.**Miscellaneous purposes**-Large scale Topo survey sheets are useful for:

- Demarcation of forest areas coupe and boundries.
- Provisional alignment of roads, irrigation channel.
- Provisional planning of various operation depending on topography.

- General idea of topography and natural features as also the direction of slopes etc.

Q8. Write in brief the ideal properties of Brick and the process of manufacturing it.

Ans. A brick is a block made of clay burnt in a kiln. It is one of the primary building materials known to mankind. Over time, bricks have appeared, gained prominence, lost importance and then come to the forefront again with various styles of architecture. Burnt bricks were used in ancient Indian, Babylon, Egypt and Roman civilizations. They are still being used as filler materials for framework structures as well as to construct load bearing structures. Down the ages, there have been various interesting historic and cultural references to bricks.

• Bricks were predominantly used in the Indus valley civilisation. In fact, the civilisation was first discovered when; ancient bricks being used to build railway ballast came to the notice of a passing archaeologist.

• While the Taj Mahal was built in white marble, it had extensive scaffolding made entirely out of brick which was pulled down after completion.

Making the Brick

The process of making a brick has not changed much over the centuries or across geographies. Traditionally the main steps followed to make a brick are explained below.

1. Material Procurement: The clay is mined and stored in the open. This makes the clay soft and removes unwanted oxides.

2. Tempering: This clay is then mixed with water to get the right consistency for moulding. Mixing is done manually with hands and feet. Sometimes and in certain areas, animal driven pug mills are used.

3. Moulding: A lump of mix is taken, rolled in sand and slapped into the mould. Initially moulds were made of wood, now metal moulds are used. Sand is used so the brick does not stick to the mould.

4. Drying: The mould is emptied onto the drying area, where the bricks are arranged in a herring bone pattern to dry in the sun. Every two days they are turned over to facilitate uniform drying and prevent warping. After two weeks they are ready to be burnt.

5. Firing: The green bricks are arranged in a kiln and insulation is provided with a mud pack. Fire holes left to ignite the kiln are later sealed to keep the heat inside. This is maintained for a week. Firing like other operations also depends on the knowledge and experience of the brick maker.

6. Sorting: After the kiln is disassembled, the bricks are sorted according to colour. Colour is an indication of the level of burning. Over burnt bricks are used for paving or covering the kiln while slightly under burnt bricks are used for building inner walls or burnt once again in the next kiln.

Though the overall method remains the same, there are certain regional variations considering the local soil and climatic conditions. In different areas, different soil types are used with respect to local situation. The three general approaches for firing bricks include using a massive fire, a massive volume and insulation. In Africa and South America, a massive fire using wood fuel is built, and insulated with mud or grass. In India and Mexico, they fire large volumes together and the volume itself acts as an insulator to prevent escape of heat. Fuel ranges from wood to coal to biomass to even garbage and trash in the absence of others.

Brick Kilns

Brick Kilns can be classified as intermittent and continuous. Clamps, Scotch, Scove and Downdraft

kilns are intermittent while the Bull Trench (BTK), Hoffman, Zig-zag, Tunnel and Vertical Shaft Brick Kilns (VSBK) are continuous. The continuous kilns are more efficient as they have heat recovery features from both the heat in fired bricks and flue gases unlike the intermittent ones.

Uses-

Bricks are used for building, block paving and pavement. In the USA, brick pavement was found incapable of withstanding heavy traffic, but it is coming back into use as a method of traffic calming or as a decorative surface in pedestrian precincts.