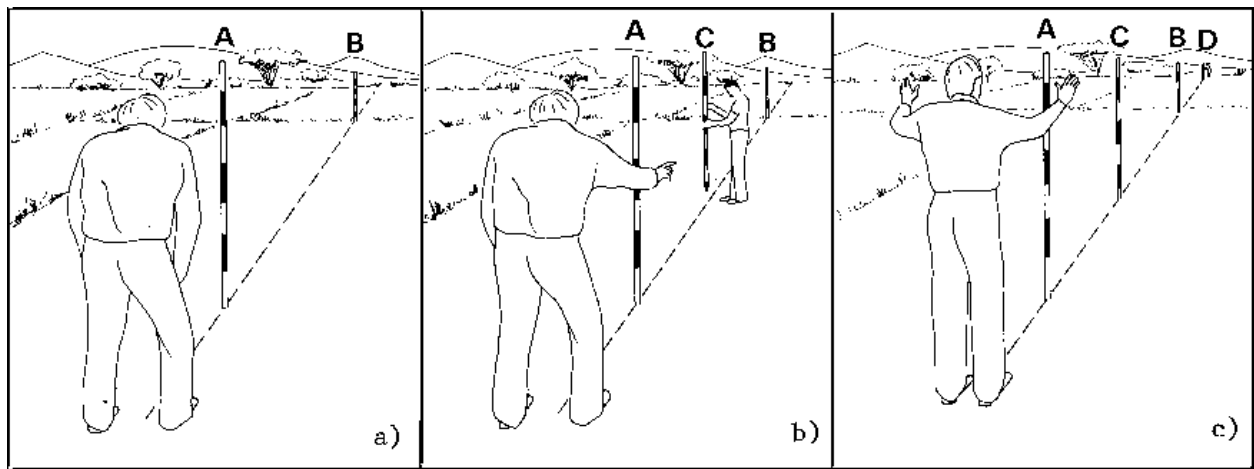


MANUAL
FOR
LABORATORY PRACTICAL AND DESIGN STUDIO I
(CVE 325, 2UNITS)



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PREPARING LABORATORY REPORTS

The following guideline is used to prepare laboratory reports.

- i. **Title:** This section contains the title of the test, the nature of the test and the specification number used.
- ii. **Scope of the test:** A brief statement of the purpose and significance of the test should be indicated.
- iii. **Apparatus:** Equipments used should be briefly described.
- iv. **Materials:** The materials used or tested should be described.
- v. **Theory:** This section summarizes the test/experiment or it gives us an overview of what the test is all about.
- vi. **Definitions and Process Terminology:** This section contains terminology and definition of specific words and test related terms.
- vii. **Procedure:** Clearly and concisely list the procedure in the order the test is carried out.
- viii. **Raw Data:** This section contains the raw data gotten from the test. All laboratory data shall be submitted in tabular form.
- ix. **Calculations and Results:** Observations relating to the behavior of the materials should be included. All equations or formulas used should be clearly indicated. Calculations should be properly checked. The results of the test should be summarized in tabular or graphical form.
- x. **Figures and Diagrams:** This section contains clear and concise diagrams and/or figures in accordance with the laboratory requirement. Figures including the equipment front and side views, parts and panels can be displayed in this section.
- xi. **Discussion:** There should be included a brief discussion in which attention is drawn to the silent facts shown by the tables and diagrams. The test results should be compared with the standard values.
- xii. **Conclusion:** Include modification procedures, calibration procedures and any additional information that will be helpful.
- xiii. **References (if applicable):** Include references to any manuals, documents or textbooks used in compiling the reports.

INTRODUCTION TO DESIGN STUDIO

Digital design is the method by which graphic designs and models are created using software applications in computers, tablets, digital drawing tools for print, web, television, electronic devices and other media of innumerable nature and varieties. Digital designs can include contents such as multimedia presentations, social media collateral, email and web ads, digital billboards and signage, pitch decks, 3D modeling and 2D animations. In Civil Engineering, digital design helps in planning, designing, documentation, modification, costing, modeling, optimization and implementation of designs etc. Examples of some of these software applications include Autocad, Autodesk, Archicad, Orion, Revit, Adobe Creative Suite etc.

What is CAD?

CAD stands for Computer Aided Design. CAD involves the use of computers (or workstations) to aid in the creation, modification, analysis and/or optimization of a design.

What is CAM?

CAM stands for Computer Aided Manufacturing. CAM is an application technology that uses computer software and machinery to facilitate and automate manufacturing processes. It involves the use of software to control machine tools used in manufacturing processes and also enables faster, accurate and more precise production of components. It refers to the use of a computer to assist in all operations of a manufacturing plant, including planning, management, transportation and storage.

What is CAE?

CAE stands for Computer Aided Engineering. CAE is the broad usage of computer software to aid in engineering analysis tasks. It includes Finite Element Analysis (FEA), Computational Fluid Dynamics (CFD), Multi-body Dynamics (MBD) etc.

Types of CAD Softwares:

- 2D Softwares
- 3D Softwares
- 3D Wireframe and Surface Modeling Softwares
- Solid Modeling Softwares

Uses of CAD:

- Modeling
- Drawing specification
- Designing
- Cost Analysis
- Documentation

Components of a typical CAD Software:

- Drafting screen
- Text input and measuring tools
- Drafting tools
- Layer list
- Block list

Benefits of CAD:

- Increase in productivity of the designer
- Improves the quality of the design
- Better communications
- Creating documentation of the design
- Creating database for manufacturing
- Saving design data and drawings
- Helps to minimize drafting errors during manufacturing
- Efficiency in the quality of design
- Saves time and money
- Improved accuracy in rendering designs and drawings

TERMINOLOGIES USED IN DESIGN STUDIO

ARIA (Accessible Rich Internet Applications): Semantics designed to properly convey appropriate information to persons with disabilities.

Alignment: Is the adjustment of arrangement or position in lines of a text or an image; left, right, centered etc.

Alpha Channel: Is the process of incorporating an image with a background to create the appearance of partial transparency. Alpha Channels are used to create masks that allow you to confine or protect parts of an image you want to apply colour, opacity, also, to make other changes.

Analog Proof (Prepress Proof): A Proof that uses inkjet, toner, dyes, overlays, photographic, film or other methods to give an idea of what the finished product should look like.

Animated GIF: A small animation based on continuous GIF images, giving the impression of movement or action.

Animation: Generating movement by displaying a series of images using frames.

Asymmetrical: This is when graphics and/or text are not identical on both sides of a central line.

Baseline: An imaginary line upon which letters sit and descenders extend below the baseline.

Bevel: A tool in design software for drawing angles or modifying the surface of work to a certain inclination.

Bezier Curve: A parametric curve that represents a vector path in computer graphics. They are frequently drawn using a pen tool and by placing anchor points which can be controlled to form shapes or lines.

Bitmap: A series of bits in a structure that represents a graphic image. The colour of each pixel is individually defined.

Bleed: When a graphic object extends through another in an unwanted manner. It is then trimmed so there is no chance for a white line on the edges.

Border: The decorative design or edge of a surface or line or area that forms its outer boundary.

Canvas Size: Allows you to change the complete size of the document without adjusting the components of the document.

Clipping Path: A tool that or shape used to cut out an image.

Cloning Pixels: A function that allows you to replicate pixels from one place to another.

Color Palette: A set of colours that make up the total range of colours used in graphic computers.

Contrast: The difference in colour found between the light and dark parts of an image.

Crop: A tool that removes portions of an image.

Die Cut: Is a die that cut shapes or holes in a wide range of material.

Dodge: This is when you lighten or reduce part of an image by shading.

Double Page Spread: A double page spread is a layout that extends across two pages.

DPI (Dots Per Inch): A term to describe the measure of sharpness within an image.

Drop Shadow: Is a visual effect added to an image to give the impression the image is raised above the image's behind by replicating the shadow.

Dummy: This is a display of the final product.

Duotone: A method of printing an image using two colours, usually black and a spot colour.

Element: Any distinct part of a layout such as a logo, headline, images or borders.

Embedding: Process of transferring all the data of a font or image into the file itself.

Emboss: To give a three dimensional effect to a text or an image by using highlights and shadows on the sides of the illustration.

Engraving: To print designs by cutting the surface of a metal plate.

EPS (Encapsulated Post Script): This is a graphics file format used to transfer PostScript documents that contain an image, within another PostScript document.

Etch: To imprint a design onto the surface of a plate by using a chemical such as acid.

Export: To save a file in a format usable by other programs.

Feathering: A tool used in graphic design software that makes the edges of an image appear softer.

Fill: A tool used to fill selected parts of an image with a selected colour.

Gatefold: The type of fold in which the paper is folded inward to form four or more panels.

Gradient: A function in graphic software that permits the user to fill an object or image with a smooth transition of colours.

Grayscale: Grayscale images consists of black, white, no colour and up to 256 shades of gray.

Grid: Is a two-dimensional format made up of a set of horizontal and vertical axis used to structure content.

Hard Copy: The permanent reproduction of the output of a computer or printer.

Header: The text which appears at the top of a printed page.

Headline: A large text illustrating the opening statement used in a layout.

High-Resolution Image: An image with an extreme level of sharpness/clarity.

HLS: A colour space that stands for hue, lightness and saturation.

HSB: A colour space that stands for hue, saturation and brightness.

Kerning: Modifying the horizontal space between letters.

Keyframe: Any frame in which a specific aspect of an item (its size, location, colour etc) is specifically defined.

Layers: The tools within graphic software that permits the user to gather, organize and re-edit their artwork.

Leading: Refers to the amount of added vertical spacing between lines of text.

DESIGN STUDIO - HOUSE PLAN

Aim: To design a house plan using autocad

Apparatus: Computer, Autocad software.

Theory: Autocad is a computer aided design program used to draft plans for a home. Its large set of features is easy to get lost in, if you're new to either home design or Autocad. For this reason, it is a good idea to sketch out your home design first before designing with the Autocad.

Procedure:

1. Open the Autocad (by double clicking on it) and create the outline of the house's exterior. Click the "Home" tab, then, click the "Draw" panel's "Rectangle" button.
2. Click near the upper-left corner of the drawing window and drag toward the lower-right corner. Release the mouse to complete the rectangle.
3. Define the top views of walls, beginning with clicking the Rectangle tool again. Click and drag inside the house outline to define walls that separate the house's rooms. If you're not sure how you want to define your rooms, draw a single rectangle that divides the house outline through its horizontal center. Ensure the rectangle length extends the full width of the house's outline and that its width is as small as possible.
4. Draw the floor plan for furnishings. Once you have defined the borders of each room, apply the rectangle tool to define the largest furnishings inside each room. For example, draw rectangles for the beds, sofas and dressers. To size these objects correctly, relate their largest dimensions to the room's largest dimension. For example, a plausible length for a bed will be somewhere between one-fourth and one-half the length of the room. Size the bed's width similarly, except base it on the bed's length not the room.
5. Add rectangles for each remaining item you want in the house, working from largest to smallest.
6. Begin visualizing your home in three dimensions: Enter "Orbit" at the command prompt at the bottom of the screen. Click and drag slightly up and left. This will move your viewpoint to one displaying the three dimensions of your house, once you make the home 3-D in the next step.
7. Click of of your house's walls to select it, then, enter "Extrude" at the command line. This command extends 2-D surfaces into 3-D objects. Size the wall to a height you desire, then click to end the extrusion. Repeat this step for each rectangle you drew, to make the house fully 3-D.
8. Complete your house plan by viewing it with shading: Select the "3D Realistic" item on the "View" panel's "Visual Styles" drop-down list.

Results: Print your diagram with a title block and proper scaling.

DESIGN STUDIO - RESIDENTIAL BUILDING

Aim: To design a residential building using Revit (Self-contain)

Apparatus: Computer, Revit software.

Theory:

This design entails modeling a residential building in 3-D. The process involves designing a floor plan, building walls, making openings for the door and windows, adding doors and windows, then, putting a roof on the building.

Procedure:

1. Set your units to architectural (DDUNITS). Create new layers for each type of objects you will draw (windows, doors, walls, roof etc).
2. Draw the bases of the walls using the dimensions given as 20' by 10'.
3. Create regions out of all your wall lines. Command : REG REGION : Select objects : <Select all the lines> (specify opposite corner) : Select objects : <ENTER>.
4. Extrude the walls. Command : EXT EXTRUDE (Current wire frame density : ISOLINES=4) : Select objects : <SELECT THE 3 REGIONS> (specify opposite corner) : Select objects : <ENTER> (Specify height of extrusion or [path]: 9' Specify angle of taper for extrusion <0>: <ENTER>).
5. Now, add doors. Start by drawing a rectangle from the middle of the outside wall and the other corner @6, 36. Then, extrude the rectangle up and subtract it from the wall.
6. Now, add windows. Repeat the procedure for door in step 5 above. Then, move the windows up 3'8" in the z-axis. Mirror the bottom left box to the opposite wall and the upper box to the inside wall. Next, subtract the four window openings from the walls.
7. Create a new layer for windows. Make the window 1" deep. Once again start with the rectangle at the base of the window opening, extrude it the height of the window opening and move it into the centre. Once you have one window made, copy it to the other openings.
8. Next, add the walls to make the right pitch for the roof. To achieve this, firstly, change the UCS. Start the UCS command and choose the 3point option. Then, press <ENTER>. Draw a LINE from the middle of the top outside of the wall up 6'. Then, draw a POLYLINE from one corner, to the next, to the top of the line and use the C option to close the polyline. Finally, EXTRUDE the triangle -6" and then, COPY the extruded object to the other side of the building. Erase the vertical line you drew. To finish the wall, perform a UNION between the triangular sections and the bottom wall.
9. Next, draw the roof. Firstly, change the UCS to align it with the slant of the roof.
10. Draw a rectangle from the top left corner of the triangular shape to the bottom of the opposite corner of the other triangular shape. Extrude the rectangle 6". Then, copy 12" down in the Y

axis and then, copy it 12” up in the Y axis. When you have the 3 sections UNION them into one object.

11. Change back to the WCS (UCS <ENTER><ENTER>) and mirror the roof object to the other side. Then, trim the excess pieces off the top of the roof where the two slabs intersect. This will be done using the SLICE command. Go to the SW isometric view. Start the slice command and select the roof section towards the back. Select any three points on the top of the roof section at the front. Switch to the NW isometric view and slice other roof sections in the same manner. Check to see that your roof looks correct and if it is, union the two roof objects.

Results: Print your diagram with a title block and proper scaling.

INTRODUCTION TO SURVEY EQUIPMENTS

Aim: To study various survey equipments

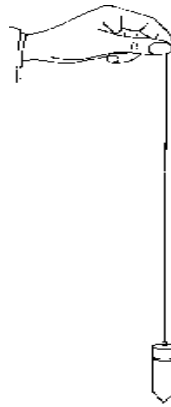
Survey equipments are divided into four categories:

1. Equipments used for linear measurements
 - a. Chain or tape
 - b. Arrows
 - c. Pegs
 - d. Ranging Poles
 - e. Offset Rods
 - f. Plumb Bob
 - g. Optical Square
 - h. Line Ranger
2. Equipments used in angular measurements
 - a. Compass
 - b. Theodolite
 - c. Total Station
3. Equipments used in vertical measurements
 - a. Leveling Staff
 - b. Dumpy Level
4. Equipments used for measurement of area
 - a. Planimeter

1. Plumb bob: A plumb-bob or a plummet is a weight, usually with a pointed tip on the bottom suspended from a string and used as a vertical reference line, or plumb-line. A plumb bob is used to check if objects are vertical. Plumb bobs may weigh as little as an ounce or as much as several pounds, depending upon the application. It consists of a piece of metal (called a bob) usually with a pointed tip, which is attached to a cord. While chaining along sloping ground, a plumb bob is required to transfer the points to the ground.

How to Use a Plumb Bob

To use this tool, the string is fixed at the point to be plumbed. The weight, or bob, is then allowed to swing freely; when it stops, the cord or object is vertical.

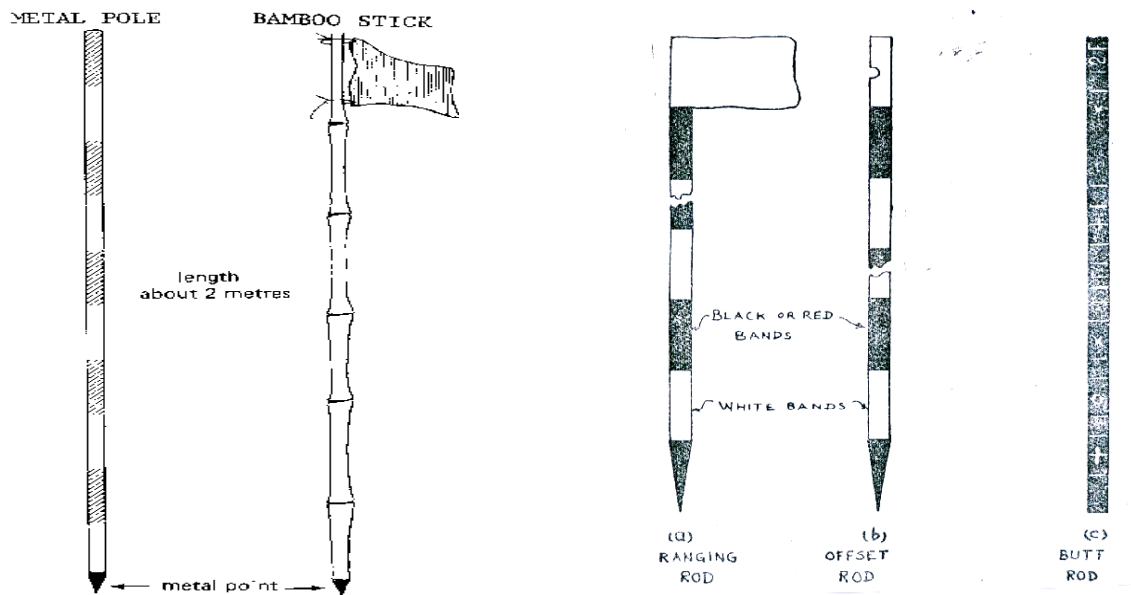


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Ranging poles are used to mark areas and to set out straight lines on the field. They are also used to mark points which must be seen from a distance, in which case a flag may be attached to improve the visibility. Ranging poles can also be home made from strong straight bamboo or tree branches. Ranging poles are usually painted with alternate red-white or black-white bands. If possible, wooden ranging poles are reinforced at the bottom end by metal points.

Features:

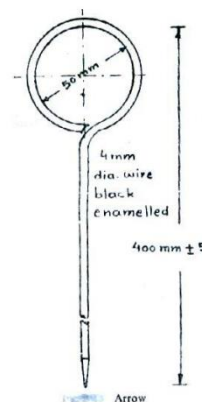
1. It can be either wood or metal
2. Its length ranges from 1.8m, 2.4m to 3.0m
3. It is either circular or octagonal in shape
4. It is pointed with different colours of black, red and white
5. The reason for painting with different colours is to enable it to be seen from a far.
6. It is used for marking spots or stations.
7. It can also be used for making straight lines.
8. It has a pointed end.
9. Its thickness ranges from 3 to 4cm.



2. Arrows: Arrows are made of good quality hardened steel wire of 4 mm diameter. The arrows are made 400 mm in length, are pointed at one end and the other end is bent into a loop or circle.

Features:

1. It is made of steel wires.
2. It is about 30cm long.
3. One end of the pin is curved into a ring.
4. During usage, a red cloth is tied to the ring end.
5. The red cloth enables the pin to be seen from afar.
6. It is used for marking off chain lengths as measured.
7. It can also be use for marking spots or stations.
8. It has a thin pointed end.



3. Chain: A chain is used to measure distance on the field. The chain is composed of 100 or 150 pieces of connected galvanized mild steel segments, 4mm in diameter and 20cm called links. The

ends of each link are bent into a loop and connected together by means of three oval rings. The ends of the chain are provided with handles for dragging the chain on the ground, each wire with a swivel joint so that the chain can be turned without twisting.

Usually, a chain has a total length of 20 meters, including one handle at each end. The length of the chain is measured from the outside of one handle to the outside of another handle.

Types of chains:

The following are the various types of chains used in surveying:

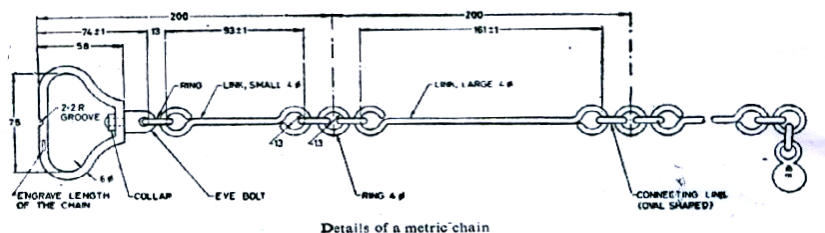
- 1) Metric chain
- 2) Gunter's chain or surveyors chain
- 3) Engineers chain
- 4) Revenue chain
- 5) Steel band or Band chain

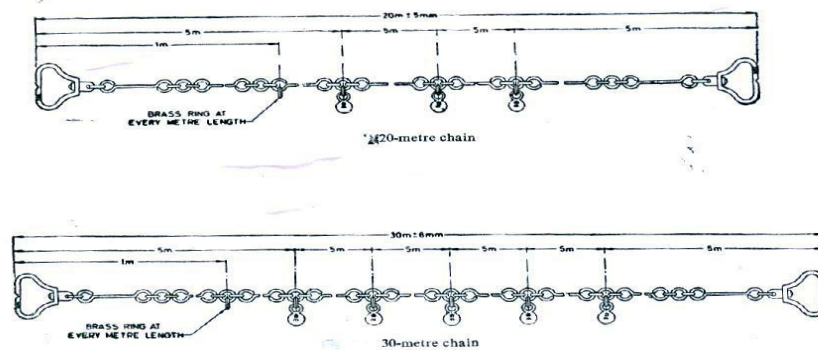
Features of a Metric chain:

1. Metric chains are made in lengths 20m and 30m.
2. Tallies are fixed at every five-meter length and brass rings are provided at every meter length except where tallies are attached.

Features of a Gunter's chain:

1. This is surveyor's chain that was used before tapes were discovered.
2. It is made of steel wires which are dumb-bell in shape.
3. Each chain is joined together by links of three small rings.
4. A Gunter's chain is about 66ft or 20.13m in length.
5. Each chain is made of about 100 links and each link is about 19.8cm or 7.92 inches.
6. It is used in taking detailed measurement of the length and breadth of land.
7. The handle at each end is made of brass.
8. A link is the distance between two central rings.
9. It is majorly used in taking short or detailed measurement of length and breadth.





4. Measuring tapes: Measuring tapes are made of steel, coated linen, or synthetic material. They are available in lengths of 20, 30 and 50 m. Tapes are graduated in centimeters, decimeters and meters are usually indicated on the tape.

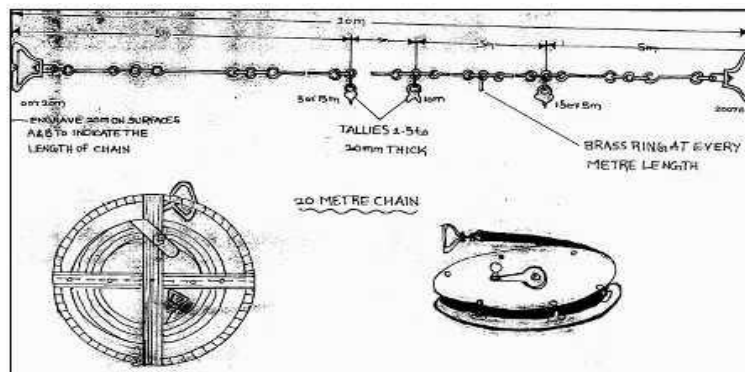
Among the different type of tapes, the metallic tapes are widely used in surveying. A metallic tape is made of varnished strip of waterproof line interwoven with small brass, copper or bronze wires. They are light in weight and flexible and are made to different lengths or sizes as 2m, 5m 10m, 20m, 30m, and 50m.

Types of tapes: The following are the various types of tapes

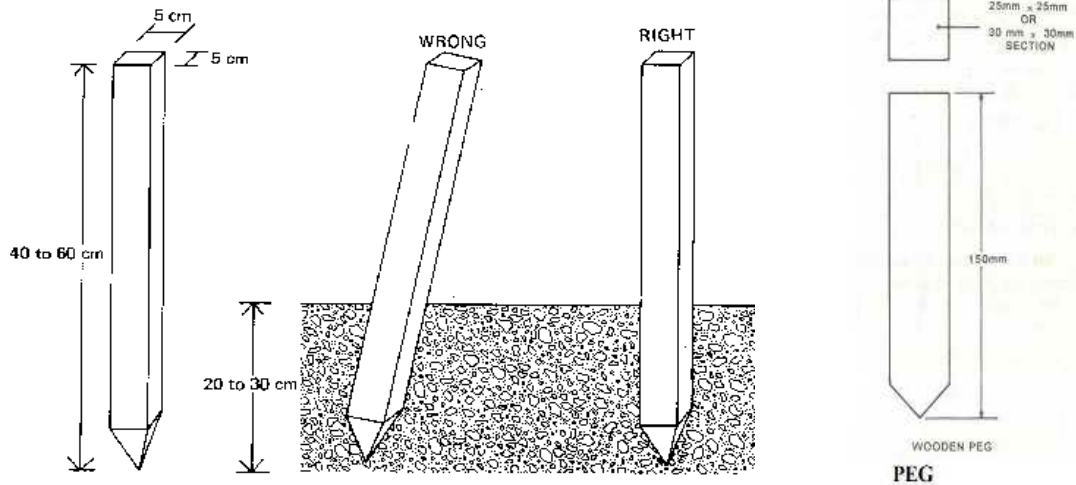
- i) Cloth tape
- ii) Metallic tape
- iii) Steel tape
- iv) Invar tape

Features:

1. There are steel tapes and linen tapes.
2. It is marked on one side in metric units and on the other side in imperial units.
3. It is of varying lengths and types.
4. It is used for taking measurements of length, breadth and height.
5. The tape is normally wound in a small case from where it is unwound for use.
6. It is used to form 3-4-5 methods of measurement.



5. Pegs: Pegs are used when certain points on the field require more permanent marking. Pegs are generally made of wood; sometimes pieces of tree-branches, properly sharpened, are good enough. The size of the pegs depends on the type of survey work they are used for and the type of soil they have to be driven in. The pegs should be driven vertically into the soil and the top should be clearly visible.



6. Cross staff:

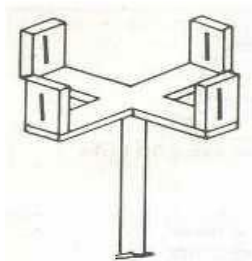
This is the simplest instrument used for setting out a right angle. The common forms of cross staff are:

- Open cross staff
- French cross staff

Cross Staff

Cross staffs are two types: -

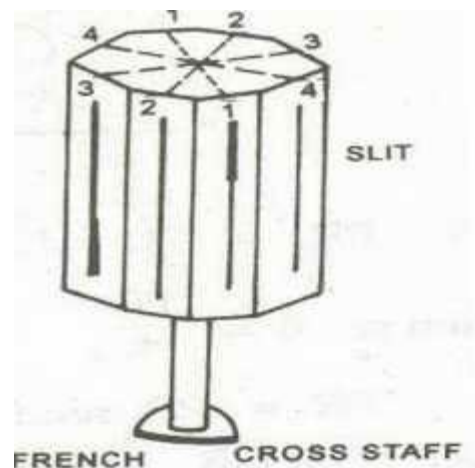
1. Open cross staff
2. French cross staff



Open Cross Staff



French Cross Staff



7. Offset rod:

The offset rod is used for measuring the off set of short lengths. It is similar to a ranging rod and is usually of 3m lengths.

Features:

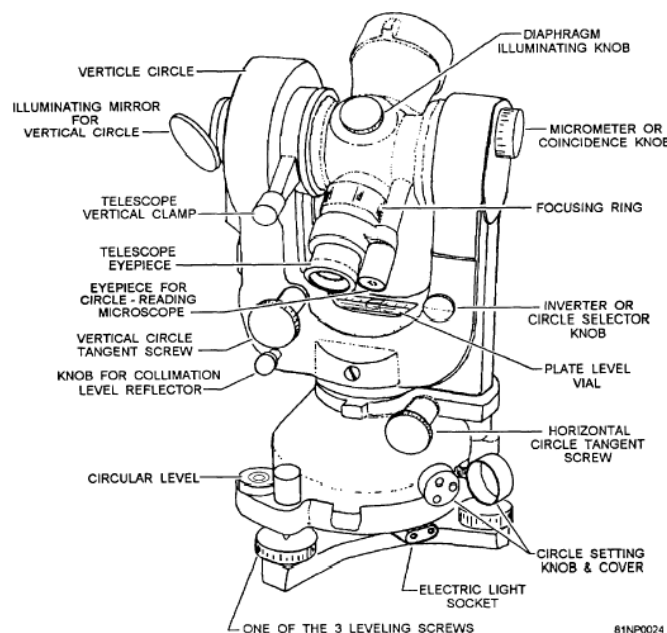
1. It is a graduated rod.
2. It is about 3m long.
3. A hook may be attached to the top, which helps in the pulling of chains through hedges.
4. It is used for taking short off-set measurements.
5. There is a telescopic link which is 0.3m (30cm) in length.

8. Theodolite:

A theodolite is a precision instrument for measuring angles in the horizontal and vertical planes. A modern theodolite consists of a movable telescope mounted within two perpendicular axes—the horizontal or trunnion axis, and the vertical axis. When the telescope is pointed at a desired object, the angle of each of these axes can be measured with great precision, typically on the scale of arcseconds.

Types of theodolite

1. Transit and non-transit theodolite
2. Vernier and Micrometer Theodolite
3. Electronic Theodolite
4. Optical Theodolite

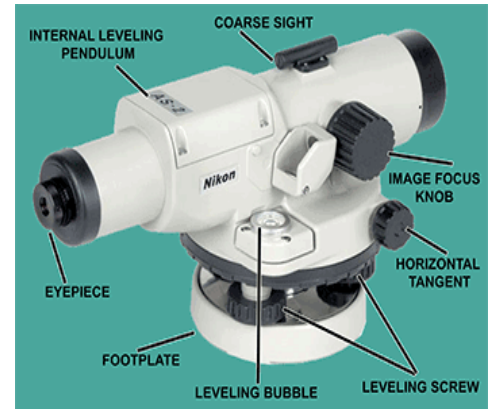


9. Dumpy Level:

A **dumpy level** is an instrument used to measure, transfer or set horizontal lines. It is an instrument that is often used in surveying buildings. A dumpy level is used to establish relative height, distance and bearings from different parts of a site. Using this instrument requires a certain amount of skill.

Uses of Dumpy Level

- Determining the height of a particular point.
- Determining differences in height between points.
- Drawing contours on a land.
- Providing data to calculate volumes for earthworks.
- Setting out level surfaces for construction.
- Setting out inclined surfaces for construction.



Setting up the dumpy level

- Choose a position for the dumpy with a good sightline to the datum and also to as much of the ground to be surveyed as possible. Further up the slope is more useful than too low down on the slope. Use the full height of the staff where possible.
- Set up the tripod – it has adjustable feet to allow it to be upright on uneven ground. Ensure the tripod is secure, its feet pressed into the ground if possible. Do not disturb the tripod until it is time to move it again.
- Attach the dumpy to the tripod.
- Level the dumpy using the spirit level – the bubble must be centered in its circle. Turn 2 of the adjustable screws towards or away from each other until the bubble is near the centre. Turn the dumpy 90° towards the untouched screw and adjust this till the bubble is centered.

COMPASS SURVEY

STUDY OF COMPASS USED IN COMPASS SURVEYING

Aim: To study the different types of compass used in compass surveying.

Instrument:

- Engineering Compass

Theory:

What is compass survey?

Compass survey is a method of surveying by taking bearings and linear distances to produce plan.

Bearing is measured using prismatic compass, while the linear distance is measured using measuring tape.

Compass surveying is recommended for use to survey a large area to include:

- The course of a river (or) coast line.
- An area crowded with many details and triangulation is not possible

Definition of a few compass terms:

1. MERIDIAN – it is the fixed direction in which the bearings of survey lines are expressed
2. BEARING – it is horizontal angle between the reference meridian and the survey line measured in clockwise or anticlockwise direction
3. TRUE MERIDIAN – The true meridian passing through a point on the earth surface is the line in which a plane passing through and the north and south poles, intersects the surface of the earth.
4. TRUE BEARING – The horizontal angle measured clockwise between the true meridian and the line is called true bearing of the line.
5. MAGNETIC MERIDIAN – the direction indicated by a freely suspended and balanced magnetic needle unaffected by local attractive forces
6. MAGNETIC BEARING – The horizontal angle which a line makes with the magnetic meridian.

SOURCES OF ERROR IN COMPASS WORK

- Instrumental errors
- Observational or personal errors
- Errors due to External Influences (natural causes)

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

Observational or 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.

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.

TYPES OF COMPASS:

There are two types of compass, namely:

1. Prismatic Compass (0 to 360 Degrees)
2. Surveyor's Compass (0 to 90 Degrees)

The working of a Prismatic compass involves the following three steps: centering, leveling and observation of bearing.

Fore Bearing and Back Bearing: 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° .

Designations of bearings

Bearings are expressed in the following ways;

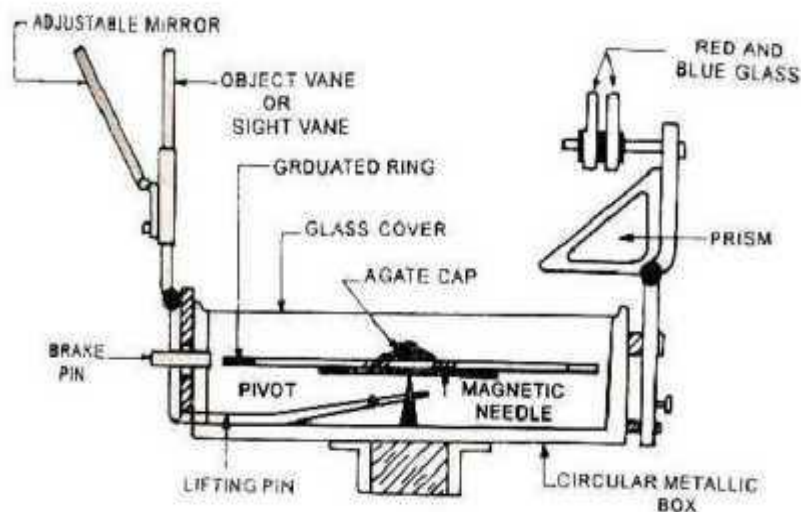
- **Whole circle bearing:** In this system, the bearing of a line is measured with the magnetic north in clockwise direction. The value of bearing thus varies from 0° to 360° .

- **Quadrant bearing:** In this system, the bearing of a line is measured eastward or westward from north or south whichever is near. The directions can be either clock wise or anti clockwise depending upon the position of the line. It will have value up to 90° .

DIFFERENCE BETWEEN THE PRISMATIC COMPASS AND THE SURVEYOR'S COMPASS.

1. Prismatic Compass
 1. The sighting of an object and reading of the bearing are done simultaneously
 2. This can be used without stand
 3. The graduated ring is attached to the magnetic needle
 4. Graduation are marked 0° and 360° in clockwise direction
 5. 0° is marked at south, 180° at north, 90° at west and 270° is marked at east.
 6. It measures or gives the whole circle bearing of a line.
2. Surveyor's Compass
 1. An object is sighted first and the bearing is then read by going vertically over the middle point
 2. This cannot be used without a stand
 3. The graduated ring and needle are free to move with respect to each other
 4. Graduation are marked 0° to 90° in each quadrant
 5. In this compass, east and west are interchanged
 6. It measures or gives the quadrant bearing of a line

DESCRIPTION OF THE PARTS OF A COMPASS



- | | |
|----------------------|--------------------|
| 1. Compass Box | 2. Magnetic Needle |
| 3. Graduated Ring | 4. Pivot |
| 5. Objective Vane | 6. Eye Vane |
| 7. Adjustable Mirror | 8. Spring Brake |
| 9. Brake Pin | 10. Lifting Lever |
| 11. Lifting Pin | 12. Prism |
| 13. Focusing Stud | 14. Glass Cover |
| 15. Prism Dust Cap | 16. Sun Glasses |

COMPASS BOX:

It is a circular box of diameter 85 to 110 mm having pivot at the center and covered with plain glass at top.

MAGNETIC NEEDLE:

It facilitates in taking the bearings of survey lines with reference to the magnetic north.

GRADUATED RING:

The bearings are marked inverted on the graduated Rings from 0° to 360° in a clock-wise starting 0° from south.

PIVOT:

Magnet is freely held with this.

OBJECT VANE:

It consists of prism with a sighting slit at the top. The prism magnifies and erects the inverted graduations.

BRAKE PIN:

It is pressed to stop the oscillations of the graduated ring.

LIFTING PIN:

On pressing it brings the lifting lever into action.

COLOUR GLASSES:

Red and blue glasses are provided with the prism to sight luminous objects

PRISMATIC COMPASS

Aim:

- To study the prismatic compass and
- To determine,
 - Fore and back bearing of line AB, BC, CA.
 - The included angles.

Apparatus: Tripod, prismatic compass, ranging rods, measuring tapes, wooden pegs, hammer.

Theory:

Fore Bearing: The bearing of a line measured in the direction of progress of survey is called Fore-Bearing.

Back Bearing: The bearing of a line measured in the opposite direction of progress of survey is called Back-Bearing.

Parts of a prismatic compass

Compass Box:

1. Circular 8 to 10 cm (80mm to 100mm) metallic
2. At the center of box pivot is provided.

Magnetic Needle and Graduated Ring:

1. On pivot the magnetic needle rests
2. Aluminum graduated ring is attached to needle
3. Graduated ring has 0 degree to 360 degrees clockwise
4. i.e. 00 at south, 900 at west, 1800 at north, 2700 at east
5. Least count is 30minutes

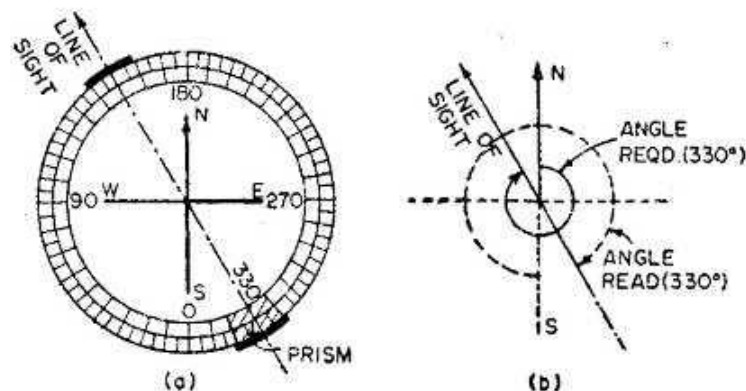
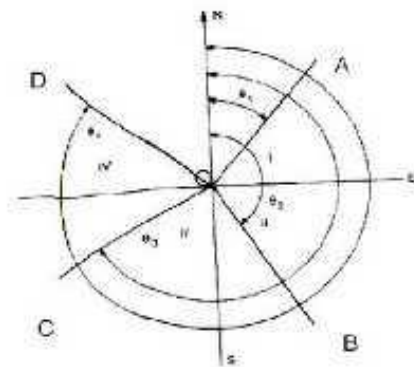


Fig. 5-13. System of Graduation in Prismatic Compass.

Sight Vane and Object Vane Of Compass:

- These are fixed diametrically opposite to the each other.
- Object vane consists of vertical hair attached to the frame
- Sight vane (or eye slit) consists of vertical slit cut into upper assembly of the prism unit.
Prism unit is hinged to the box
- Adjustments of Prismatic Compass
- Fixing the compass with tripod stand.
- Centering
- Leveling
- Adjustment of prism
- Observation of bearing
- Bearings are designated by two systems
- Whole Circle Bearing (WCB)
- Quadrantal Bearing or Reduced bearings(QB / RB)
- Whole circle bearing (W.C.B.)
- The bearing of a line measured from the north in clockwise direction.
- The value of WCB may vary from 00 to 3600

Sketch Of Whole Circle Bearing (W.C.B.)



WCB of OA = θ_1

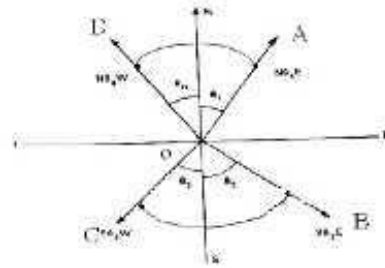
WCB of OB = θ_2

WCB of OC = θ_3

WCB of OD = θ_4

Fig.1

Sketch of Reduced (Quadrantal) Bearing

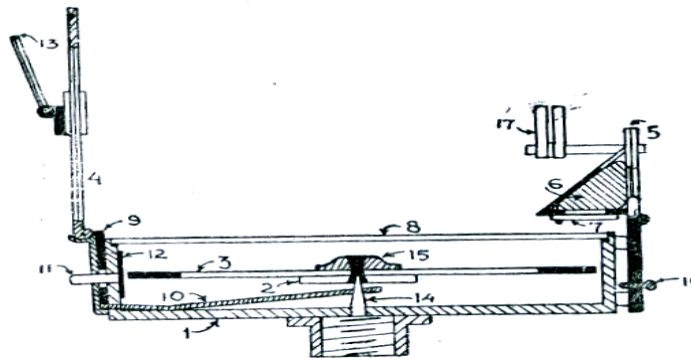


RB of OA = $N \theta_1^\circ E$

RB of OB = $S \theta_2^\circ E$

RB of OC = $S \theta_3^\circ W$

RB of OD = $N \theta_4^\circ W$



The Prismatic Compass		
1. Box	7. Prism Cap	13. Mirror
2. Needle	8. Glass Cover	14. Pivot
3. Graduated Ring	9. Lifting Pin	15. Agate Cap
4. Object Vane	10. Lifting Lever	16. Focusing Stud
5. Eye Vane	11. Brake-pin	17. Sun Glasses
6. Prism	12. Spring Brake	

PROCEDURE:

TEMPORARY ADJUSTMENTS OF A PRISMATIC COMPASS

The Prismatic Compass is set up at a point say station A.

The following temporary adjustments are needed to be carried out at each set up of Instrument.

- **Centering:** Centering is the process of keeping the instrument exactly over the station. It is carried out by dropping a piece of stone so that it falls on the top of the pegs fixed at station point.
- **Leveling:** Prismatic compass is leveled by means of ball and socket arrangement so that the graduated ring may swing freely.
- **Focusing the prism:** The reflecting prism is adjusted to the eye sight of the observer by raising or lowering then stud until the graduations are seen sharp and clear.

CALCULATION OF FORE AND BACK BEARING

- Suppose the bearing of line AB, BC, CA of a triangle is to be observed. Set up the instrument at station A and carry out all the temporary adjustments. Fix the ranging rod at B.
- Turn the prismatic compass until the ranging rod at station B is bisected by the horse hair when seen through the vertical slit above the prism.
- When the needle comes to rest bisect ranging rod at B exactly and note the reading. The reading observed is the Fore bearing of line AB i.e. Angle measured with respect to north.
- Now shift the prismatic compass at station B perform all temporary adjustments and from station B bisect station A towards backward, the reading observed in prismatic compass is the Back Bearing of line AB.
- Now from the same setup of the instrument Bisect station C and note down the reading of prismatic compass as fore-bearing of line BC. Transfer the instrument to station C to obtain back bearing of line BC. Similarly observe Fore Bearing and back bearing of line CA.
- Check the Difference of Fore bearing and back bearing of each line it should be equal to 180^0 .

OBSERVATION TABLE

STATION	LINE	LENGTH	F.B.	B.B.	DIFFERENCE	ANGLE	CORRECTION	CORRECTED ANGLE

CALCULATION AND RESULTS: TO FIND INCLUDED ANGLES

- Included Angles of a triangle are calculated from observed FB and BB of line AB, BC, CA.
- Included angle is determined by following formula.
- $\angle = \text{Back Bearing of Previous Line} - \text{Fore Bearing of next line i.e. for triangle ABC}$
 $\angle A = \text{BB of CA} - \text{FB of AB}$
 $\angle B = \text{BB of AB} - \text{FB of BC}$
 $\angle C = \text{BB of BC} - \text{FB of CA}$
- Check: Sum of all included angles Should be Equal to $(2n-4) \times 90^0$

CONCLUSION

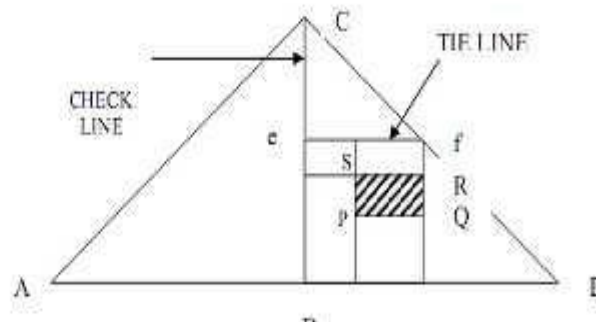
CHAIN TRIANGULATION AROUND A BUILDING

Aim: To chain around the building to cover small area by chain triangulation

Apparatus:

- Chain 20m / 30m 1 No.
- Arrows 10 Nos.
- Ranging rods 4 Nos.
- Pegs 4 Nos.
- Tape 20m/30m
- Cross staff 1 No.

SKETCH:



Procedure:

- Select three survey stations A, B and C such that from each survey station the other two Stations are visible.
- Mount ranging rods at survey stations A, B and C.
- Fix the intermediate stations along the chain line AB, BC and CA by ranging.
- Measure the offsets of the corners of the building either perpendicular or oblique.
- Each point requires two measurements from two definite reference points on the same line or from two adjacent chain lines.
- Measure the points which are very far away from the main chain lines from tie line i.e. the corners points of building R and S.
- Measure the check line CD.

Result:

From the recorded measurements of the building, calculate area.

Note:

The student should prepare a layout of the given area covering building roads etc

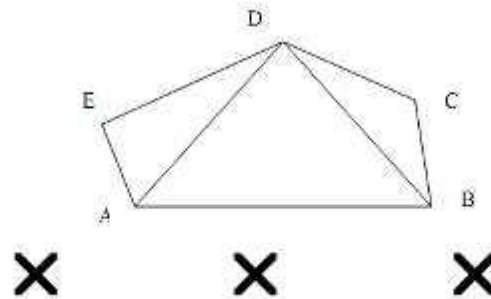
MEASUREMENT OF AREA BY CHAIN TRIANGULATION

Aim: To measure the area of the given field by chain triangulation.

Apparatus:

- Chain 20m / 30m 1 No.
- Arrows 10 Nos.
- Ranging rods 6 Nos.
- Pegs 5 Nos.

SKETCH:



PLOTTING OF CLOSED TRAVERSE BY COMPASS SURVEYING

Procedure:

- » Let ABCDE be the given field whose area is to be measured, fix the pegs at A, B, C, D & E.
- » Divide area into three triangles ADE, ABD and BCD by joining AD and BD.
- » Measure the lengths AB, BC, CD, DE, EA, AD and BD.
- » Calculate the area of the triangles.
- » The sum of the areas of the three triangles is the area of the given field.

FORMULA:

Area of the triangle $\Delta = \sqrt{s(s-a)(s-b)(s-c)}$

Where,

$$S = (a + b + c) / 2$$

A, b, c, are the sides of the triangle.

Result:

The area of the given field = _____ Square meter.

SETTING OUT STRAIGHT LINES AROUND A BUILDING

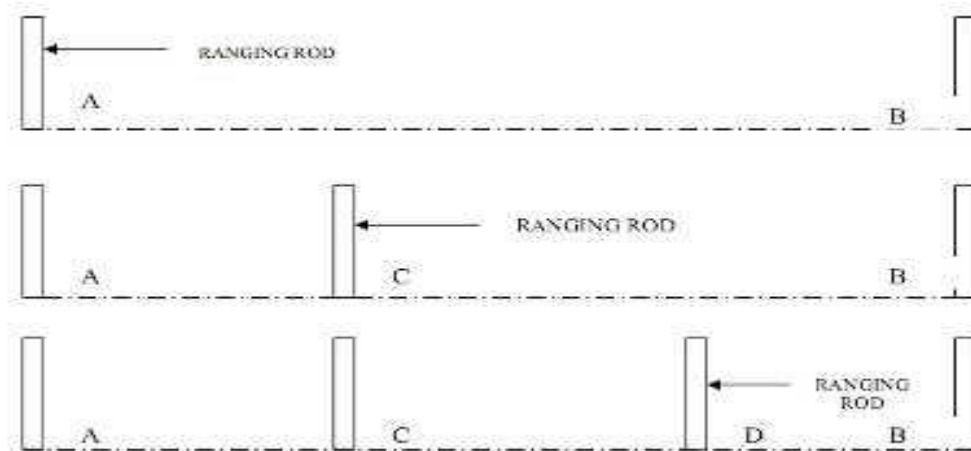
Aim:

To measure the distance between two points on a level ground by direct ranging

To set out straight lines around a building

To measure the offset distance from the building

Apparatus: ranging poles, chain, arrows, pegs, measuring tape.



Procedure:

- Fix the ranging rods at the two given stations, where pegs are already driven on the ground.
- The follower stands behind station A and directs the leader, with ranging rod to come in line with AB by signals of ranging.
- When the ranging rod comes in the line of AB the follower directs the leader to fix the ranging rod in position.
- Let the intermediate point be C which should be less than 20m / 30 m
- Now the leader takes another ranging rod and stands between A and B about 2/3 distance from A
- The follower directs the leader to come in line of AB by using signals of ranging.
- As and when the point is located in the line of AB the follower instructs to fix the ranging rod in position.
- Let the other intermediate position be D which is less than 20 m / 30 m from B
- Now A, B, C and D are in a straight line. Now the leader and follower measure the distance by measuring along A, C, D, B.

Results:

The distance between AB = _____ m.

The distance between AC = _____ m.

The distance between CD = _____ m.

The distance between DB = _____ m.

The offset distance is = _____ m.

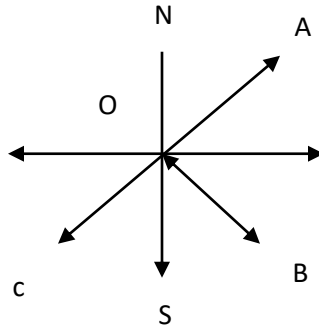
From the recorded measurements of the building, calculate area.

SETTING UP THE COMPASS – OBSERVATION OF BEARINGS

Aim: To perform station adjustments and to observe magnetic bearings using a prismatic compass.

Apparatus: Prismatic compass, Tripod and Ranging rods etc.

Sketch:



Procedure:

The following station adjustments are to be done at each station where the compass is set up.

1. CENTERING:

- Centering is the process of keeping the prismatic compass over the station point.
- By moving the legs of the tripod suitably, centering will be done.
- Centering is checked by dropping a stone so that it falls on the top of the peg.

2. LEVELING:

- Leveling is the process of making the compass exactly horizontal.
- Level the compass by means of a ball and socket arrangements.
- When the compass is leveled, the aluminum ring swings freely.

3. **FOCUSSING:** To adjust the height of the prism so that the observations can be read clearly.

4. OBSERVING BEARINGS:

- Set up the prismatic compass over station “O” and perform station adjustments.
- Rotate the compass till the line of sight bisects the object at “A”.
- Read the graduated ring through prism. The reading directly gives the magnetic bearing of “OA” in whole circle bearing system.
- Follow the same procedure to observe the magnetic bearings “OB” and “OC”.

Calculations and Results:

Tabular form

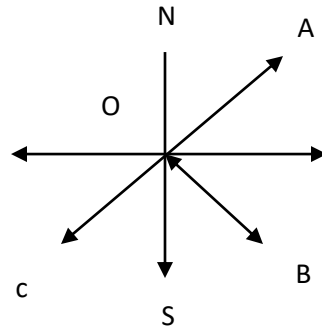
S/N.	STATION	SIGHTED TO	W.C.B.

TRAVERSING WITH PRISMATIC COMPASS AND CHAIN - CALCULATION OF INCLUDED ANGLES

Aim: To find the bearings of various station points and to calculate the included angles.

Apparatus: Prismatic compass, tripod, ranging rods etc.

Sketch:



Procedure:

- Let "O" be the instrument station selected from which other points are visible.
- Complete all station adjustments like setting, centering and leveling accurately.
- Sight the object "A" looking through the prism vane while the object vane is directed towards the object.
- Observe the bearing by looking through the prism. Enter the readings in a tabular form.
- Repeat the process at all objects stations B,C,D etc and enter the readings.

Formula:

Included angle: bearing of 2nd line bearing of first line. (If the value is more than 180°, then, subtract the value from 360°).

Calculations and Results:

Tabular form

S/N.	STATION	SIGHTED TO	W.C.B.

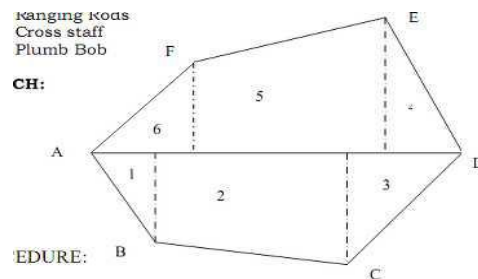
PLOTING OF LAND SURVEY - CHAIN AND CROSS STAFF SURVEYING CALCULATION OF AREAS

Aim:

Plotting of land survey – chain and cross staff surveying – calculation of areas.

Apparatus:

- Two Chains
- Arrows
- Ranging Rods
- Cross staff
- Plumb Bob



Procedure:

- Let A, B, C, D, E, F be the given field whose area is to be measured.
- Divide the area into right-angled triangles and Trapezoids and measure their bases and perpendiculars.
- Two instruments are required
- A cross staff to divide the area into triangles and trapezoids
- A chain to measure lengths of base and perpendiculars.
- Calculate the area of triangles and Trapezoids.
- The sum of the areas of 1, 2, 3, 4, 5 and 6 gives the area of the given field.

Formula:

Area of the right angled triangle = $\frac{1}{2}$ Base x Height

Area of Trapezoid = $\frac{1}{2} (a + b) h$

Where,

a, b are the parallel sides

h is the distance between the parallel sides.

Result:

The area of the measured field is m

PLOTTING OF PERPENDICULAR AND OBLIQUE OFFSETS

Aim: Plotting of perpendicular and oblique offsets

Apparatus:

- Metric chain
- Cross staff



Procedure:

- Run a chain line between the given station A and B
- Hold cross staff vertically on the chain line where the perpendicular from point “p” is expected to meet.
- Turn the cross staff until one pair of opposite slit is directed to a ranging rod fixed at B (forward point)
- Look through the other pair of slits and see that the point ‘p’ bisect to which the offset is to be taken.
- If not, the cross staff is moved in forward or backward on the chain line AB until the line of sight bisects the point ‘p’.
- Measure the perpendicular offset distance PQ.

Result:

- a. Perpendicular offset distance PQ = m
- b. Represent the accomplished task diagrammatically.

STUDY OF DUMPY LEVEL AND LEVELING STAFF

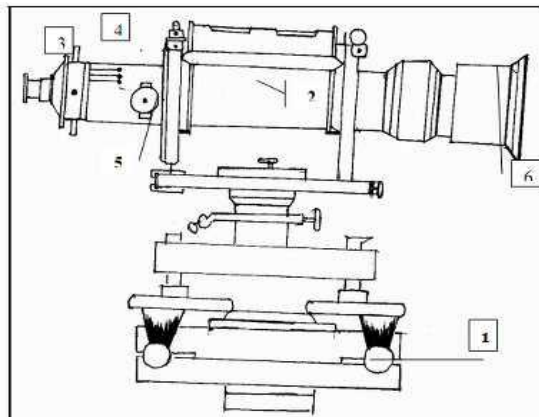
Aim: To study the components of a dumpy level and leveling staff.

Apparatus:

- Dumpy level
- Leveling staff

Theory:

DUMPY LEVEL



KEY

1. Leveling head
2. Telescope
3. Eye-piece
4. Diaphragm
5. Focusing screw
6. Ray-shade

MAJOR COMPONENTS OF A DUMPY LEVEL

TELESCOPE:

It contains two metal tubes, one of which slides within the other one-tube carries the object glass and the second one carries eyepiece and diaphragm.

FOCUSSING SCREW:

The telescope is focused by turning the focusing screw either forward or backward.

BUBBLE TUBES:

The telescope is attached with two bubble tubes. One is longitudinal and the other is cross bubble tube. These two are placed at right angles to each other.

DIAPHRAGM: It carries cross hairs.

TRIBRACH & TRIVET:

The telescope with vertical spindle is supported by two parallel triangular Plates. The upper plate is called tribrach and the lower plate is called trivet.

FOOT SCREWS:

By turning the foot screws, the tribrach can be raised or lowered to bring the bubble to the center of its run.

LEVELLING STAFF

It is used for measuring the vertical distance of the points above or below the horizontal line of sight. The different staves in use are;

- | | |
|-----------------------------|------------------|
| 1. Sop with telescope staff | 2. Folding staff |
| 3. Solid staff | 4. Target staff |

SOP WITH TELESCOPE STAFF:

It is usually arranged in three telescopic lengths. The staff is 4m long when fully extended. The top length 12.5m is solid slides into the central box of length 12.5m, which again slides in the bottom box of 1.50m long. The staff is provided with brass spring catches to keep the extended length in position. The meter numerals are marked on the left side and are red. The decimeter numerals are marked on the right side and are pointed in black. The background is painted in white. The smallest division on this staff is 5mm. The graduations are marked erect and are seen inverted when viewed through the Telescope.

FOLDING STAFF:

It is made of well-seasoned timber such as deodar, blue pine or aluminum. It is 4m long, 75mm wide, 18mm thick. It has two lengths of 2m each which are connected at the middle by a hinge so that the upper portion can be folded over the lower one. The minimum division on the staff is 5mm. lengths of meter in numerals are marked on the left and painted in black. The entire background is painted in white. The graduations are inverted and hence when viewed through the telescope, they appear erect.

SOLID STAFF:

It consist only one length and is usually 3m long. It is also graduated in Divisions of 5mm. This is used for precise leveling work.

TARGET STAFF:

It consists of two lengths, one sliding over the other. It is graduated from top downwards. The target is equipped with venire, which is adjusted by the staff man. The target is to be moved along the rod until its center is bisected by the line of sight. The target is then clamped and reading is taken. Target staves are used when the Sights are long, say more than 100m.

TEMPORARY ADJUSTMENTS OF DUMPY LEVEL

Aim: To obtain accurate results of leveling.

Apparatus:

- Dumpy level

Procedure:

Temporary adjustments are to be made at each setup of the instrument. The following are the temporary adjustments to be made.

- Setting up of the level
- Leveling up
- Elimination of parallax.

1. SETTING UP OF THE DUMPY LEVEL

- Release the clamp screw of the instrument
- Hold the instrument in the right hand and fix it on the tripod by turning round only the lower part with the left hand.
- Screw the instrument firmly.
- Bring all the foot screws to the center of its run.
- Spread the tripod legs well apart.
- Fix any two legs firmly into the ground by pressing them with the hand.
- Move the third leg to the right or left until the main bubble is approximately in the center.
- Then, move the third leg in or out until the bubbles of the cross-level is approximately in the center.
- Fix the third leg firmly when the bubbles are approximately in the centers of their run.

2. LEVELING UP

- Place the telescope parallel to a pair of foot screws.
- Bring the bubble to the center of its run by turning the foot screws equally either both inwards and both outwards.
- Turn the telescope through 90° so that it lies over the third foot screw.
- Turn this third foot screw so that the bubble corners to the center of its run.
- Bring the telescope back to the original position without reversing the eye-piece and object glass.
- Repeat the above operations until the bubble remains in the center of its run in both the positions.
- Turn the telescope through 180° and check whether the bubble remains central.

3. ELIMINATION OF PARALLAX:

- Remove the lid from the object glass.
- Hold a sheet of white paper in front of the object glass.
- Move the eyepiece in or out until the cross hairs are distinctly visible.
- Direct the telescope towards the staff.
- Turn the focusing screw until a clear and sharp image is formed in the plane of the cross hairs.

TABLE FOR HEIGHT OF INSTRUMENT (H.I.) METHOD

STATION	READINGS			HEIGHT OF INSTRUMENT	REDUCED LEVEL	REMARKS
	BACK SIGHT	INTER SIGHT	FORE SIGHT			

H.I. = R.M. of B.M. + B.S.

R. L. of other station points = H.I. – I.S. of F.S.

ARITHMETIC CHECK: $\sum B.S. - \sum F.S. = \text{Last R.L.} - \text{First R.L.}$

FOR RISE AND FALL METHOD

STATION	READINGS			RISE	FALL	R.L.	REMARKS
	BACK SIGHT	INTER SIGHT	FORE SIGHT				

ARITHMETIC CHECK: $\sum B.S. - \sum F.S. = \sum \text{Rise} - \sum \text{Fall} = \text{Last R.L.} - \text{First R.L.}$

DETERMINATION OF THE DISTANCE BETWEEN TWO INACCESSIBLE POINTS USING COMPASS

Aim: To determine the distance between two inaccessible points with compass.

Apparatus: Prismatic compass, arrows, tape, ranging rods, pegs

Procedure:

If there is an obstacle between two points say A and B due to which direct distance measurement is not possible then those points are known as inaccessible points and distance between them is to be determined indirectly by following the procedure described below.

- Let us say the inaccessible distance required is AB.
- Select line CD approximately parallel to AB of known length.
- Place prismatic compass at point C and center it and see to it that it is parallel to Ground surface.
- Measure bearing of line CA, CB and CD.
- Then, shift compass to point D and in similar way measure bearings of lines DA, DB and DC from observed bearing.
- Calculate the interior angles $\theta_1, \theta_2, \theta_3, \theta_4$.from properties of triangle calculate Angles θ_5 and
- Consider Triangle ADC and applying sine rule. We get

$$\frac{AC}{\sin \theta_3} = \frac{CD}{\sin \theta_5} = \frac{AD}{\sin (\theta_1 + \theta_2)}$$
- Calculate AC and AD.
- Link wise consider triangle BCD and apply sine rule.

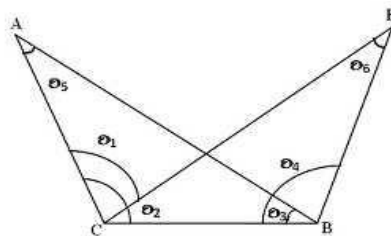
$$\frac{BC}{\sin (\theta_3 + \theta_4)} = \frac{CD}{\sin \theta_6} = \frac{BD}{\sin \theta_2}$$
- Calculate BC and BD.
- Then consider triangle ABC and apply cosine rule.

$$BC^2 + AC^2 - 2 \times AC \times BC \times \cos \theta_1.$$

$$AB = D = \sqrt{AD^2 + BD^2 - 2 \times AD \times BD \times \cos \theta_4}.$$

Bearing: Angle measured with reference to north.

Angle: Angle made by the two lines



SURVEYING A GIVEN AREA BY PRISMATIC COMPASS (CLOSED TRAVERSE) AND PLOTTING AFTER ADJUSTMENT

Aim: To run a closed traverse by prismatic compass and plot the same

Apparatus: Prismatic compass, tape, chain, arrows, pegs, ranging rods.

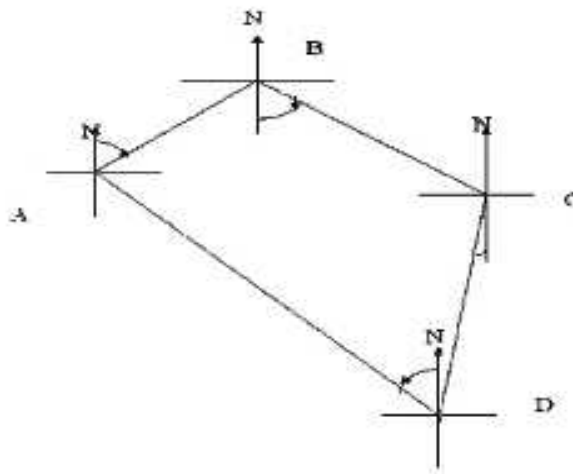
Theory:

Closed traverse is generally run around a structure. It is fined as a series of connected lines whose directions and lengths are determined precisely.

Procedure:

The following procedure is adopted to run a closed compass traverse.

- Let us say we have to run a closed compass traverse ABCDEA.
- Set the prismatic compass at point A. center it and level it.
- Take bearings of traverse lines AB and AE.
- Shift the compass to point B center it and level it. Take the bearings BC and BA.
- Link-wise complete the traverse as shown in the figure below.
- Measure the length of traverse line AB, BC, CD, DE, and EA.
- Record the observation in tabular form.
- Care must be taken to see that the stations are not affected by local attractions. If they are affected corrections to local attractions should be applied first and then, the traverse should be plotted with corrected bearings.
- Simplest method of plotting is angle and distance method with a protractor. If last point is falling short by some distance in meeting the first point then it means that there is a closing error. So, traverse should be adjusted by “Bow ditch’s graphical method”.



Calculations:

LINE	FORE BEARING	BACK BEARING	LENGTH (M)

Results:

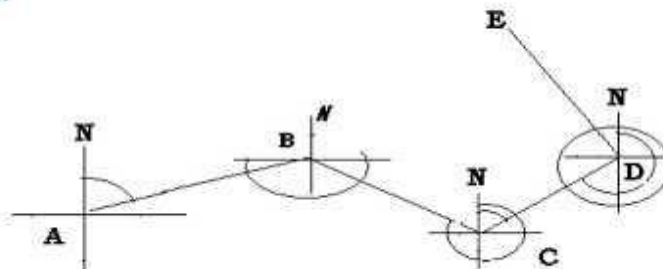
The adjusted traverse with bearings and length is to be shown on a Drawing sheet.

TRAVERSING WITH PRISMATIC COMPASS AND CHAIN, OPEN TRAVERSE AND RECORDING

Aim: To perform the compass survey in open traverse formed by series of connected straight lines.

Apparatus: Prismatic compass, tripod, tape, chain, arrows and ranging rods.

SKETCH:



Procedure:

- Set the instrument at the starting station 'A' and perform all the necessary adjustments.
- Sight the next station 'B', take fore bearing of 'AB' and measure the distance 'AB'.
- Take F.B of 'AE which provides check; similarly bearing of any line AC, CE, etc. also provides the check.
- Shift the instrument to subsequent station 'B' after fixing the instrument.
- Sight the previous station 'A' and observe the reading, which gives the B.B. of AB.
- Sight next station 'C' observe F.B of BC and measure the distance BC.
- Locate the details surrounding the traverse station if necessary, by taking Bearings or lengths or both from chains line.
- Repeat the process at every station.
- It is to be noted that first and last stations have only fore bearing and back Bearings respectively.
- Take back bearings of the first point from the last point.
- Enter the reading in a tabular form.

S/No.	LINE	LENGTH	F.B.	B.B.	REMARKS
1.					
2.					
3.					
4.					

Results:

The difference between fore bearing and back bearing of each line should be 180° , if no local attraction exists at either station.

Questions:

- What is the purpose of prismatic compass in surveying?
- State when do you go for compass surveying?
- For what a mirror is provided to the object vane?
- Where is the 180° marked on the graduated ring?
- What is the least reading that can be read from a compass?
- State the reason why the graduations of prismatic compass are written inverted.
- Define the whole circle bearing?
- Define the reduced bearing?
- Define fore bearing and back bearing?
- What is the difference between fore bearing and back bearing?
- The fore bearing of a line $60^\circ 30'$, find its back bearing?
- Convert $80^\circ 30'$, $130^\circ 40'$ into reduced bearing?
- Convert $52^\circ 30'$ into whole circle bearing?
- What is meant by traverse? Explain the check applied to a closed traverse?
- Define local attraction. How do you detect it?

CHAINING ACROSS OBSTACLES

Aim: To measure distance between two points by chaining across different types of obstacles encountered by indirect method.

Apparatus: Chain, tape, cross-staff, ranging rods, arrows.

Theory:

Obstacles to chaining prevent chainmen to measuring directly between two points and give rise to a set of problems in which distances are found by indirect Measurements.

Obstacles to chaining are of three kinds, namely:

- A. Obstacles to ranging but not chaining Ex :- (High level ground)
- B. Obstacles to chaining but not ranging Ex :- (Pond, river)
- C. Obstacles to both chaining and ranging Ex :- (building)

A) OBSTACLES TO RANGING BUT NOT CHAINING:

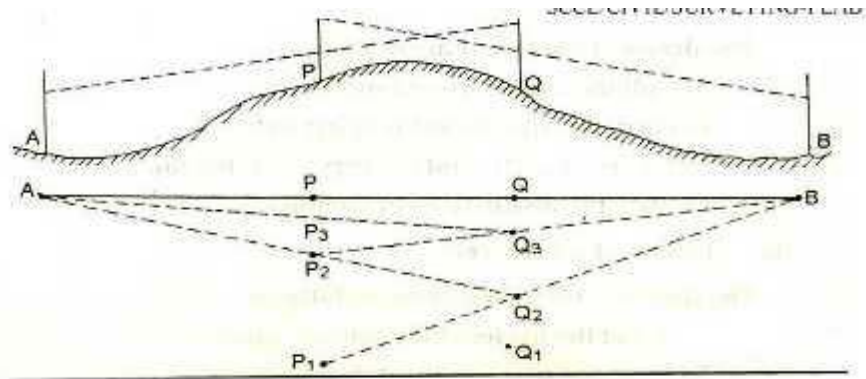
This type of problem comes, when a high ground or a forest area interrupts the chain line. The end stations are not inter-visible. There may two cases of this obstacle.

1. Both ends of line may be visible from intermediate points on line.
2. Both ends of line may not be visible from intermediate points on line.

CASE ONE: Both the stations are visible from intermediate points on the line

Procedure:

- In this case reciprocal ranging is adopted and chaining is done by stepping method.
- A and B are two end stations, which are not inter-visible due to a hill in between them.
- Select two intermediate points P_1 and Q_1 , such that from each station point A and B are visible.
- Two persons take up the positions P_1 and Q_1 with ranging rods.
- First the person standing at P_1 directs the person at Q_1 to come in line of $P_1 B$, and his new position will be Q_2 .
- Next, the person standing at Q_2 , directs the person at P_1 , to come in line of $Q_2 A$, and his new position will be P_2 .
- Next, the person standing at P_2 , directs the person at Q_2 , to come in line of $P_2 B$, and his new position will be Q_3 .
- This process is continued until the intermediate points P and Q are located in such a way that the person standing at P, see Q and B in the line, and the person standing at Q, see P and A in the line.
- Distance $AB = AP + PQ + QB$

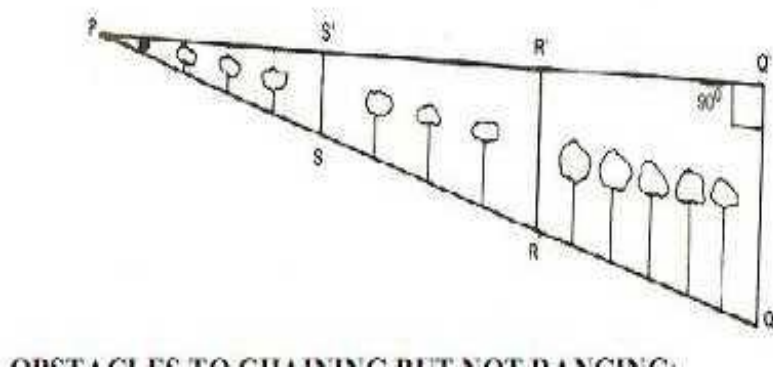


CASE TWO:

The end stations are not visible from the intermediate points on the line. This is the case when trees, bushes or jungle comes across the chain line. In this case the method of random line is most suitable.

Procedure:

- In the figure above, let PQ be the line in which P and Q are not visible from intermediate point on it.
- Through P draw a random line PQ in any convenient direction but as nearly to Towards Q as possible.
- The point Q should be so chosen that, Q₁ is visible from Q and Q, Q₁ is in random Line.
- Measure QQ₁ select points S₁ and R₁ on random line and erect perpendicular SS₁ and RR₁ on it.
- Make $SS_1 = PS_1/PQ_1 \times QQ_1$ and $RR_1 = PR_1/PQ_1 \times QQ_1$
- Join SR and prolong.



B) OBSTACLES TO CHAINING BUT NOT RANGING:

There may be two cases of this obstacle.

1. When it is possible to chain round the obstacle i.e. a pond.
2. When it is not possible to chain round the obstacle i.e. a river.

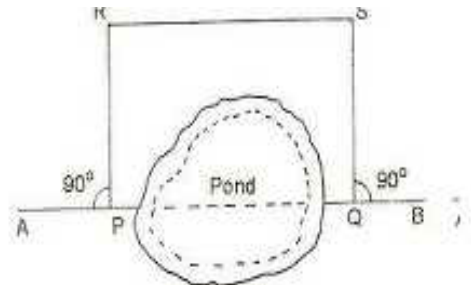
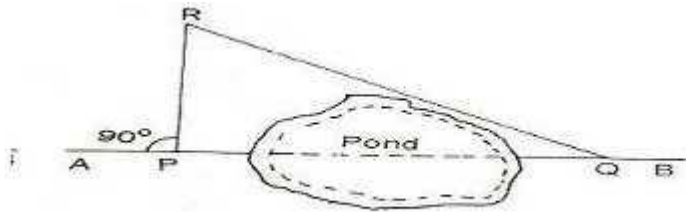
CASE (1): - Following are the methods.

Method (a):

- Select two points A AND B on either side.
- Set out equal perpendicular AC and BD as shown in fig (a)
- Measure CD=AB.

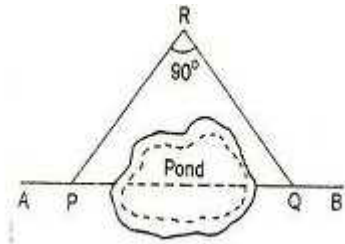
Method (b):

- Set out AC perpendicular to chain line as shown in fig (b)
- Measure AC and BC
- The length AB is calculated from the relation
 $AB = \sqrt{BC^2 - AC^2}$



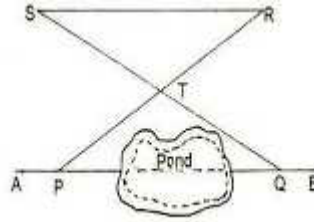
Method (c):

- By cross staff find a point C which subtends 90° with A and B as Shown In fig (C). AC and BC.
- The length AB is calculated from relation $AB = \sqrt{AC^2 + BC^2}$.



Method (d):

- Select any point E and range C in line with AE, making $AE = EC$
- Range D in line with BE and make $BE = ED$ as shown in fig (d).
- Measure CD then $AB = CD$.



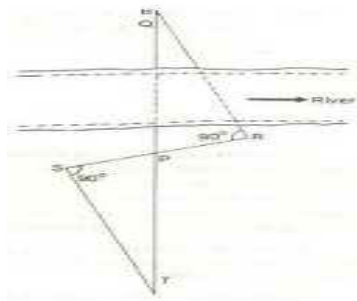
CASE (2): - Following are the methods.

Method (a):

- Select point B on one side and A and C on the other side.
- Erect AD and CE as perpendicular to AB and range B, D and E in One line as shown in fig (e).
- Measure AC, AD and CE.
- If a line DF is drawn parallel to AB cutting CE in F perpendicularly.
- The triangle ABD and FDE will be similar.

Method (b):

- Locate a point R in such a way that it makes 90° with PQ.
- Range S in line with PR and make PS = PR.
- At S erect a perpendicular ST to cut the line AB at T.
- Then PQ = PT



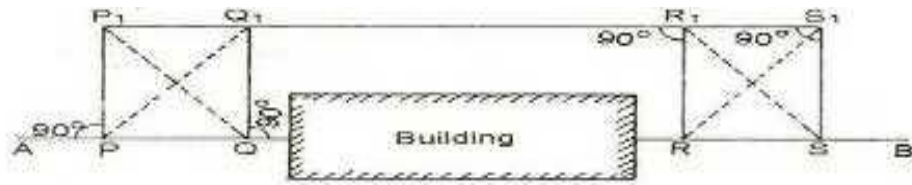
C) OBSTACLES TO BOTH CHAINING AND RANGING:-

A Building is the typical example of this type of obstacles. The problem lies in prolonging the line beyond the obstacle and determines the distance across it

Method (a):

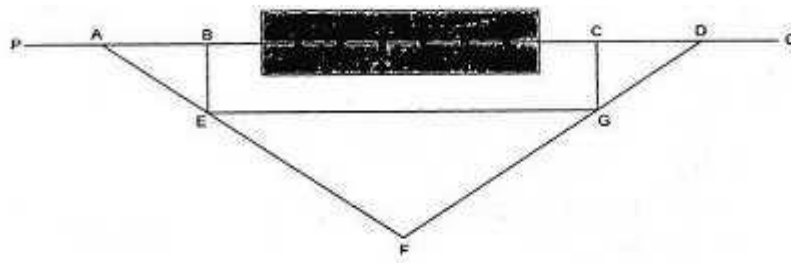
- Choose two points A and B to one side erect perpendicular AC and BD of equal length.
- Join CD and prolong It pass the obstacles.
- Choose two points E and F on CD and erect perpendicular EG and FH equal to AC or BD as shown in fig (g).
- Join GH and prolong it. Measure DE.

- $BG=DE$.



Method (b):

- Point A and erect a perpendicular AC of any convenient Length.
- Select other point B on chain line such that $AB=AC$.
- Join B and C and prolong it. To any convenient point D.
- At D set a right angle DE such that $DE=DB$.
- Choose another point F on DE such that $DF=DC$ with F as centre and AB as radius. Draw an arc with E as center draw another arc of same Radius to cut previous arc in G.
- Join GE which will be in range with chain line. Refer the fig (h).
- Measure CF then $AG=CF$.



Questions

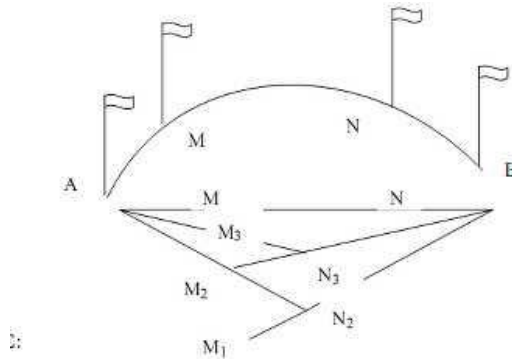
- 1) What is surveying?
- 2) What are the principles of surveying?
- 3) How many links are provided in a 20-meter metric chain?
- 4) Differentiate between ranging rod and offset rod.
- 5) Define the terms base line tie line and check line.
- 6) When is the reciprocal ranging adopted?
- 7) What is meant by perpendicular and oblique offset?
- 8) What are the instruments required for erecting perpendicular offset.
- 9) What is meant by survey station?
- 10) What is meant by ranging?

CHAINING A LINE BY INDIRECT RANGING

Aim: To chain a line across a hill or high ground that obstructs visibility of both ends of the line.

Apparatus:

- Chain 20m / 30m - 1 No.
- Arrows - 10 Nos.
- Ranging rods - 4 Nos.



Procedure:

- Fix the two ranging rods at the given stations A and B which are not visible due to raising ground.
- Select two intermediate points M1 and N1 such that from each point both A and B are visible.
- The person at M1 directs the person at N1 to move to a new position N2 in line with M1B.
- The person at N2 then directs the person at M1 to move to a new position M2 in line with N2A.
- The person at M2 directs the person at N2 to a new position N3 in line with M2B.
- The person at N3 directs the person at M2 to a new position M3 in line with N3A.
- The process is repeated till the points M and N are located in such a way that M finds the person at N in line with AB and the person at N finds the person at M in line with AB.
- After fixing the points M and N, other points are also fixed by direct ranging and the length of the line is measured.

Results:

Length of AM = ____ m.

Length of MN = ____ m.

Length of NB = ____ m.

Therefore distance of AB = distance AM + distance MN + distance NB

MEASUREMENT OF TRAVERSE LINES AND BEARINGS

Aim: Measuring the bearing of traverse lines, calculation of included angles and check.

Apparatus: Prismatic compass, pegs, ranging rods etc

Theory: Surveying which involves series of connected lines is known as traversing. The sides of traverse are known as Traverse legs.

Traverse stations should be selected such that;

- I) They are visible from each other
- II) They are as long as possible.
- III) The line joining them is as near the boundaries & objects to be located as possible.

Procedure:

1. In traversing with a compass free or loose needle method is employed to determine direction of survey line.
2. The compass is setup at each of the successive station and fore & back bearing of each line is determined.
3. All the readings are noted in the field book.
4. Each of the line is observed independently & errors are calculated.
5. The field work consists of primary survey, marking of stations, running of traverse lines.
6. Pick up all the details & note down in field in systematic manner.

S/N O.	STATIO N POINT	LIN E	FORE BEARIN G	BACK BEARIN G	DIFFEREN CE	CORRECTI ON AT STATION	CORRECT ED FORE BEARING

CORRECTED BACK	INCLUDED ANGLE	CORRECTION	CORRECTED ANGLE