AARUPADAI VEEDU INSTITUTE OF TECHNOLOGY

DEPARTMENT OF CIVIL ENGINEERING

17CVCC83- SURVEYING PRACTICAL – I LAB

LAB MANUAL

*NAME:*_____

REGISTER NUMBER: _____

*YEAR/SEM.:*_____

ACADEMIC YEAR:

HoD/Civil Engg.

SURVEYING PRACTICAL – I

SYLLABUS

LIST OF EXPERIMENTS

1. Study of chains and its accessories
2. Aligning, Ranging and Chaining
3. Chain Traversing
4. Compass Traversing
5. Plane table surveying: Radiation
6. Plane table surveying: Intersection
7. Plane table surveying: Traversing
8. Plane table surveying: Resection – Three point problem
9. Plane table surveying: Resection – Two point problem
10. Study of levels and leveling staff
11. Fly leveling using Dumpy level
12. Fly leveling using tilting level
13. Check leveling
14. Study of Theodolite

STUDY OF CHAINS AND ITS ACCESSORIES

Objective: **Date:**

The chain surveying is done for the following purposes:

- To secure the necessary data for making a plan
- To secure data for exact description of the boundaries of a place of land
- To determine its area.
- To divide a place of land into a number of units.

Instruments:

- Chain
- Tape
- Arrows
- Ranging rods
- Cross staff
- Plumb bob
- Hammer (or) Wooden mallet
- Offset rods
- Pegs
- Optical square

Description of instruments:

- ***Chain:***

It is used to measure the distance between two points on the ground. The chain is composed of 100 (or) 150 pieces of galvanized mild steel wire 4mm in diameter called links. The ends of each link are bent into a loop and connected together by means of three rings. The ends of the chain are provided with brass handles for dragging the chain on the ground, each with a swivel joint so that the chain can be turned round without twisting. The length of the chain is measured from the outside of one handle to the outside of the other. Metallic tags are fixed at various distinctive points of the chain to facilitate quick reading of a chain in surveying measurements.

Types of chains:

Generally chains are of two types

1) Metric chains,
2) Non-metric chains.

a) Metric chains:

etric chains are either 20m (or) 30m in length. One metre is divided into 5 links each of 0.2m. The least count of metric chain is 0.2m. The length of the link is the distance between the centers of the two consecutive middle rings. To enable the reading of fractions of a chain without much difficulty, tallies are fixed at every five – meter length for chains of 20m and 30m lengths. (See.Fig.1) Small brass rings are provided at every meter length, except where tallies are attached. In metric chains readings are started from ends, increasing towards the centre. The tallies in the chain are as shown in fig below.

b) Non – metric chains:

In this type of chains other than metrics unit are used. Nowadays metric chains are used everywhere, therefore this type of chains become obsolete. Generally these chains are 2 types.

1) Engineer's chain
2) Gunter's chain

Engineer's chain:

The Engineer's chain is 100ft. long and consists of 100links, each link being 1ft long. It is used in all engineering surveys.

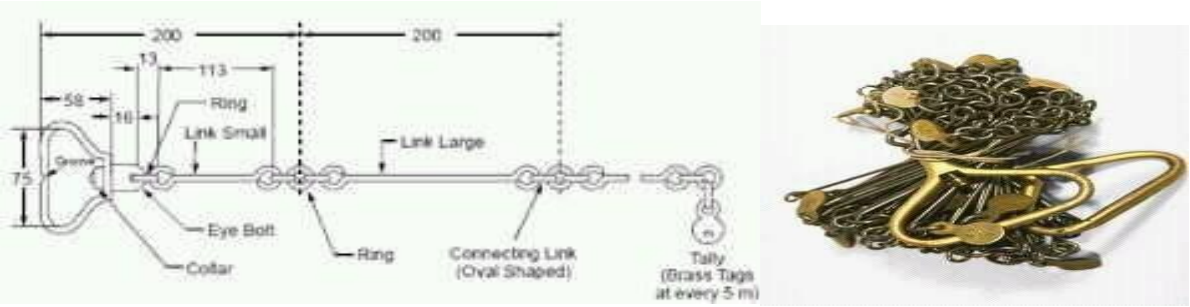
Gunter's chain:

The Gunter's chain is 66ft. long and is divided into 100 links each 0.66ft long. It is very convenient for measuring distances in miles and furlongs.

10 Gunter's chain = 1 furlong

50 Gunter's chain = 1 mile

10 square Gunter's chain = 1 acre



1.(a). Metric Chain

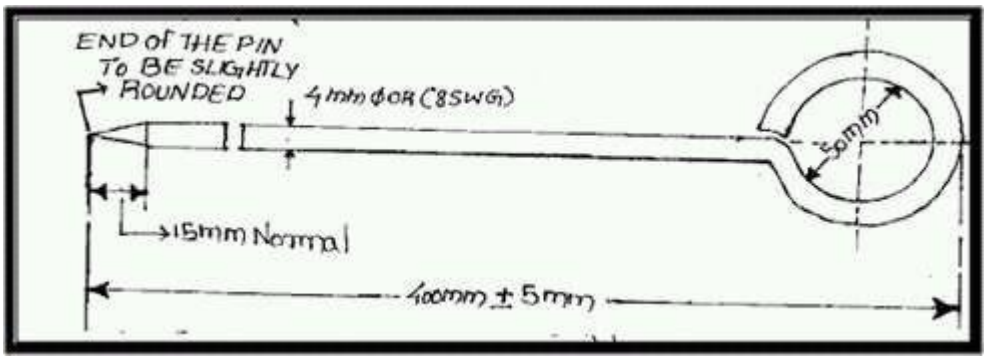
- ***Tape:***

Tapes are used to measure the lengths to decimal places accuracy. It is also used to measure the offset distance from main survey line. Tapes are made of various materials and are, therefore divided into 4 classes,

i. Cloth (or) Linen tape
ii. Metallic tape
iii. Steel tape
iv. Invar tape

- ***Arrows:***

It is used to mark the points on the ground or to mark the end of each chain during the chaining process. It is made of hardened and tempered. steel wire 4mm in diameter and length of 400mm. These are pointed at one end whereas a circular ring is formed at its other end as shown in fig. It is important to mark the chain lengths in chaining operation. In general, ten arrows are given to one chain.

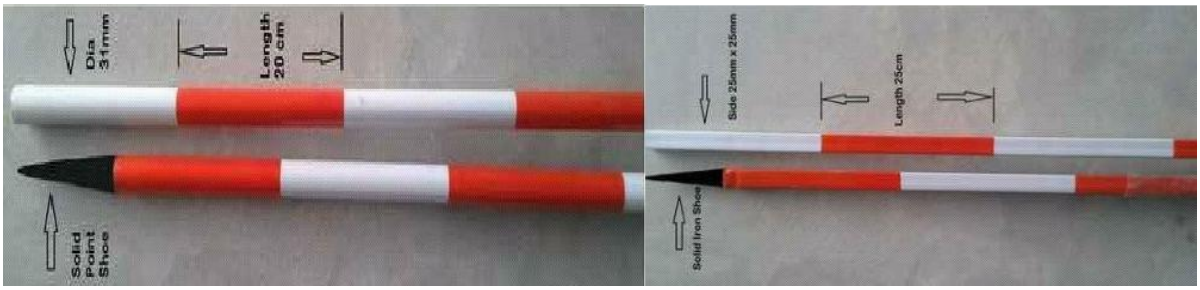


1.(b). Details of Arrows

- ***Ranging Rod:***

These are made of well seasoned straight grain timber (or) steel tubular rods. These are used for marking a point in such a way that the position of point can be clearly and exactly seen from some distance away. These are 3cm to 5cm in diameter and 2 or 3m long. To fix the ranging rod on ground its bottom end is pointed by providing cross-shoe. These are painted with alternate bands of either red and white or white and black of 200mm length. Sometimes these are used to mark the permanent points. In order to make them visible at a distance, they are painted alternatively black and white (or) red and white successively. When they are at a considerable distance, red and white (or) while and yellow flags about

25cm square should be fastened at the top.



1.(c). Ranging rods

- ***Cross staff:***

This instrument is used for finding the foot of the perpendicular from a given point to a line, and setting out a right angle at a given point on a line. To set out a right angles the following two type of cross staffs are used.

i. Open cross staff

ii. French cross staff

iii. Adjustable cross staff

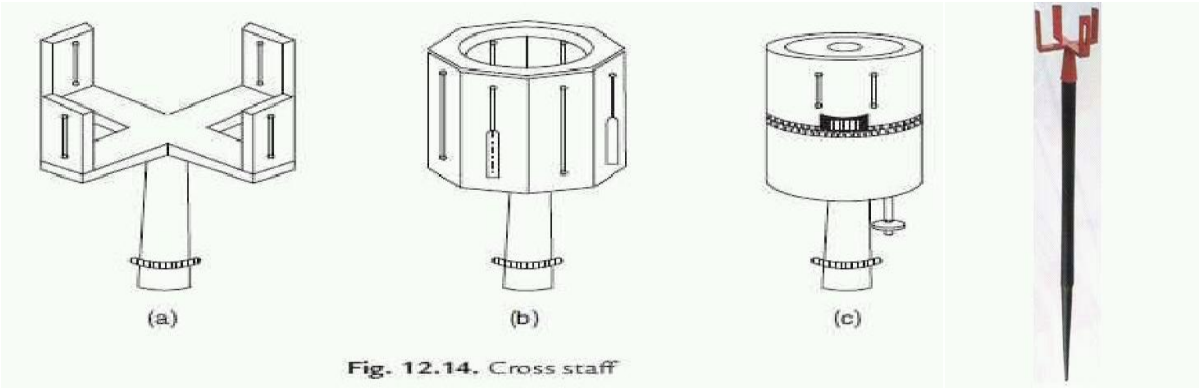


Fig. 12.14. Cross staff

- ***Plumb bob:***

It is used while measuring distances on sloping ground and transfer to the leveled ground. It is made of steel in a conical shape with a thread connected at the centre. It is generally used for centering.

- ***Hammer:***

It is used to give blows to fix the peg on the ground.

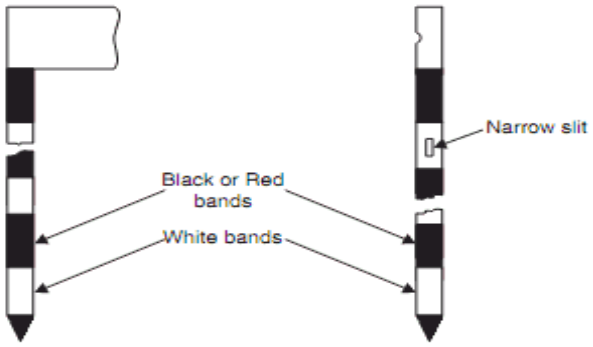
1.(d). i.Plumb bob

1.(d). ii.Hammer

1.(d). iii.Peg

- ***Offset rod:***

It is similar to the ranging rod but is usually 3m long. The top is provided with a stout open ring recessed hook for putting or pulling the chain through a hedge or other obstruction.



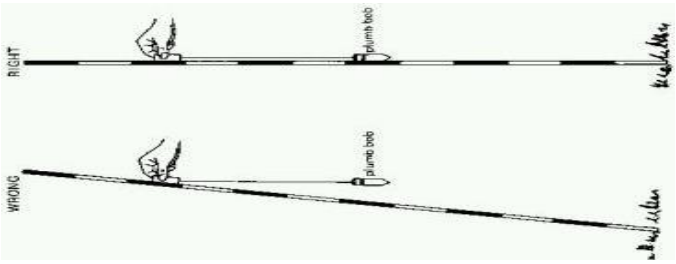
1.(e).i.Ranging rod 1.(e).ii.Offset rod

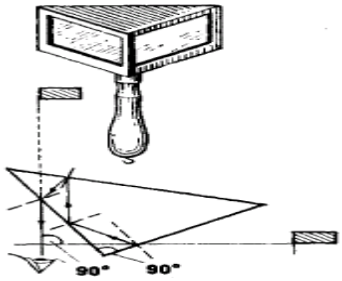
- ***Pegs:***

There are used to mark definite points on the ground. These are made of hard timber and are tapered at one end. They are usually 15cm length with 3 to 5cm diameter circular in shape (or) 3 to 5cm square in shape. The pointed end of peg is covered by iron shine for easy driving into the ground.

- ***Optical square:***

It is used to set out right angles. It is a small compact hand instrument. It consists of a circular metal box about 5cm in diameter and 1.25cm deep. It is protected by a metal cover, which slides round so as to cover the openings and thus protects the mirrors from dust when not in use. H and I are the two mirrors placed at an angle of 45˚ to each other.





1.(f).i.Ranging rod position 1.(f).ii.Optical square

Result:

The various instruments used in **Chain Surveying** and their uses are studied.

CHAINNING A LINE BY DIRECT RANGING

Objective: **Date:**

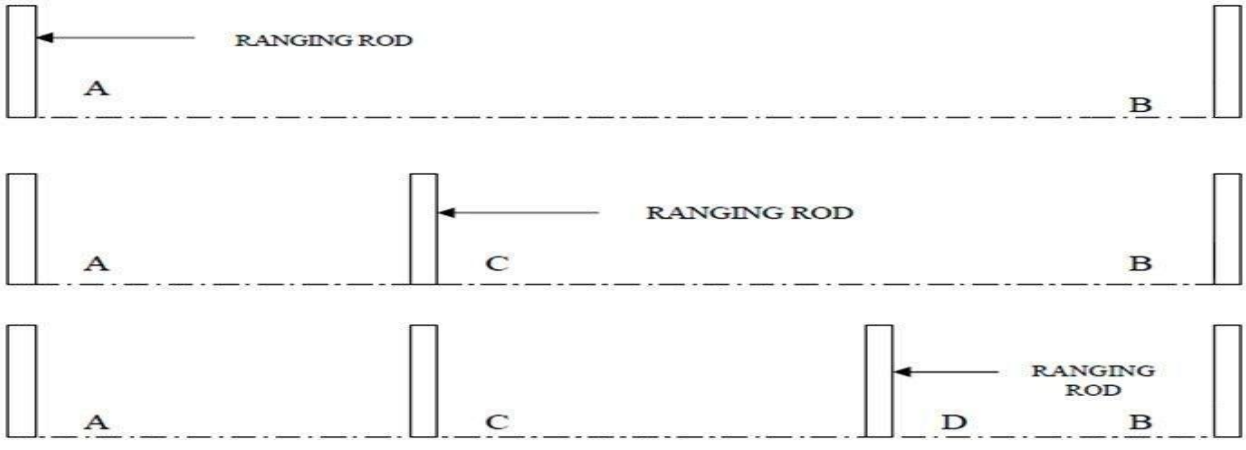
To measure the distance between two points on a level ground by ranging.

Instrument:

- Chain 20m/30m - 01 Nos
- Arrows - 10 Nos (1 Set)
- Wooden Pegs - 02 Nos
- Ranging rods - 04 Nos

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 taken another ranging rod and stands between A & 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 one line.
- Now the leader and follower measure the distance by measuring along A, C, D, and B.



Result:

The **length of line AB** by chaining is_____**Metres.**

CHAINNING A LINE BY INDIRECT RANGING

Objective: **Date:**

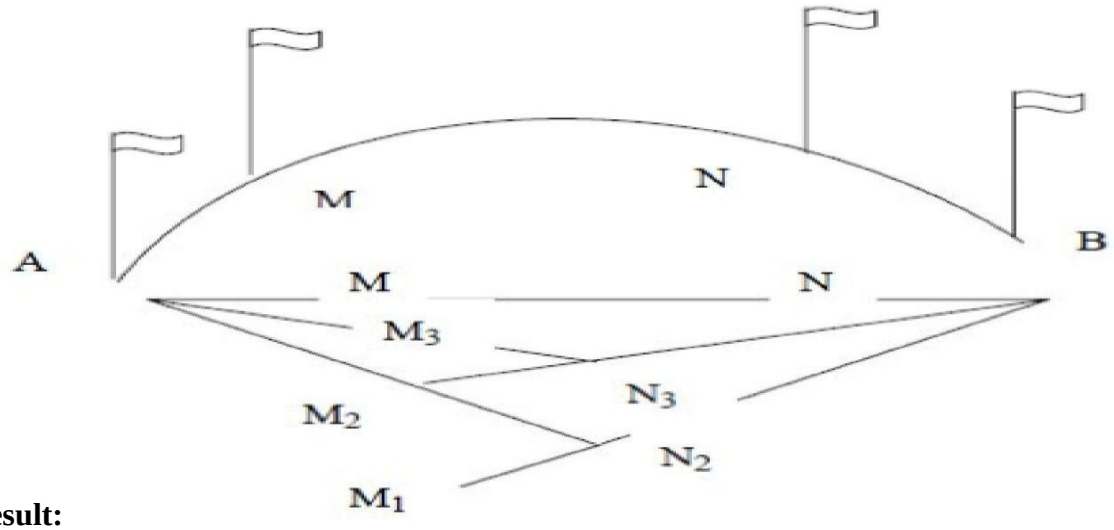
Chaining a line when a hill or high ground intervenes, preventing inter-visibility of ends of line.

Instrument:

- Chain 20m/30m - 01Nos
- Arrows - 10 Nos (1 Set)
- Ranging rods - 04 Nos

Procedure:

- Fix the two ranging rods at the given stations A and B which are not inter-visible due to
- rise in the ground level.
- Select two intermediate points M_1 and N_1 such that from each point both A and B are visible. The person at M_1 directs the person at N_1 to move to a new position N_2
- in line with M_1B.
- The person at N_2 then directs the person at M_1 to move to a new position M_2 in line with N_2A. The person at M_2 directs the person at N_2 to a new position N_3 in line
- with M_2B.
- The person at N_3 directs the person at M_2 to a new position M_3 in line with N_3A.
- 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.



Result:

The **length of line AB** by chaining is_____**Metres.**

CHAIN TRAVERSING
MEASUREMENT OF AREA BY CHAIN TRIANGULATION

Objective: **Date:**

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

Instruments:

- Chain 20m/30m - 01 Nos
- Arrows - 10 Nos (1 Set)
- Ranging rods - 06 Nos
- Wooden pegs - 05 Nos

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 (Δ) $= \sqrt{(\square - \square)(\square - \square)(\square - \square)}$

Where, $S = \frac{1}{2}(a+b+c)$ & a,b,c are the sides of triangle.

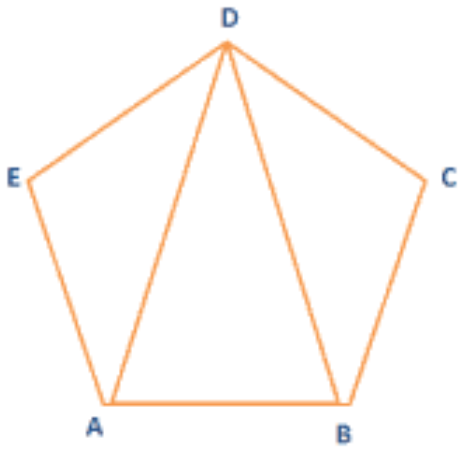


Fig.2. Chain Traversing

Result:

The **area** of the given field =_____**Square Metre.**

CHAIN TRIANGULATION AROUND A BUILDING

Objective: **Date:**

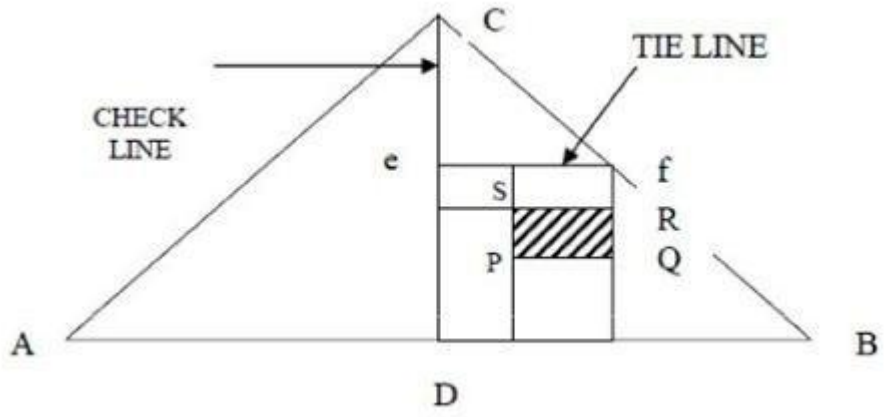
To chain around the building to cover small area by chain triangulation.

Instruments:

- Chain 20m/30m - 01 Nos
- Tape 20m/30m - 01m Nos
- Arrows - 10 Nos (1 Set)
- Ranging rods - 06 Nos
- Wooden pegs - 05 Nos
- Cross staff - 01 Nos

Procedure:

- Select three survey stations A, B and C such that from each survey station the other two stations are visible.
- Fix the ranging rods at 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.



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

Result:

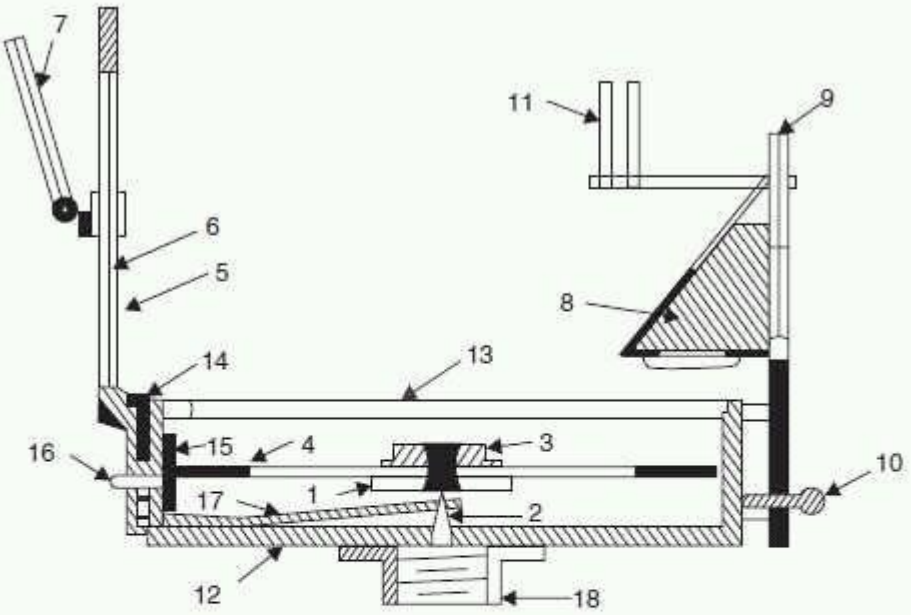
From the recorded measurements of the building area is plotted.

STUDY OF PRISMATIC COMPASS

Objective: **Date:**

To identify different parts of prismatic compass and to know their functions.

DESCRIPTION OF INSTRUMENTS



1. Needle
2. Pivot
3. Agate cap
4. Graduated disc
5. Slit metal frame
6. Horse hair
7. Mirror
8. Reflecting prism with cap
9. Eye vane
10. Focussing stud
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

Fig. 13.1. Prismatic compass

- ***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 clockwise 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.

Result:

The prismatic compass with its **components** was studied.

SETTING UP THE COMPASS – OBSERVATION OF BEARINGS

Objective: **Date:**

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

Instruments:

- Prismatic compass with tripod
- Ranging rod

Procedure:

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

a) Station (or) Temporary Adjustment:
   - Centering
   - Levelling

b) Permanent Adjustment:
   - Adjustment's of Levels
   - Adjustment's of Sight vane
   - Adjustment's of Prism
   - Adjustment's of Needle
   - Adjustment's of pivot needle

Temporary adjustments are those adjustments which have to be made at every setup of the instrument. The following station adjustments are to be done at each station, where the compass is setup.

a) 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 as.So that it falls on the top of the peg.

b) LEVELLING:

- Levelling is the process of marking the compass exactly horizondal.
- Level the compass by means of ball and socket arrangements.
- When the compass is levelled. The aluminum ring swing freely.

c) FOCUSING:

- To adjust the height of the prism so that the observations can be read clearly.

d) BEARING OBSERVATION:

- 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’ & ‘OC’

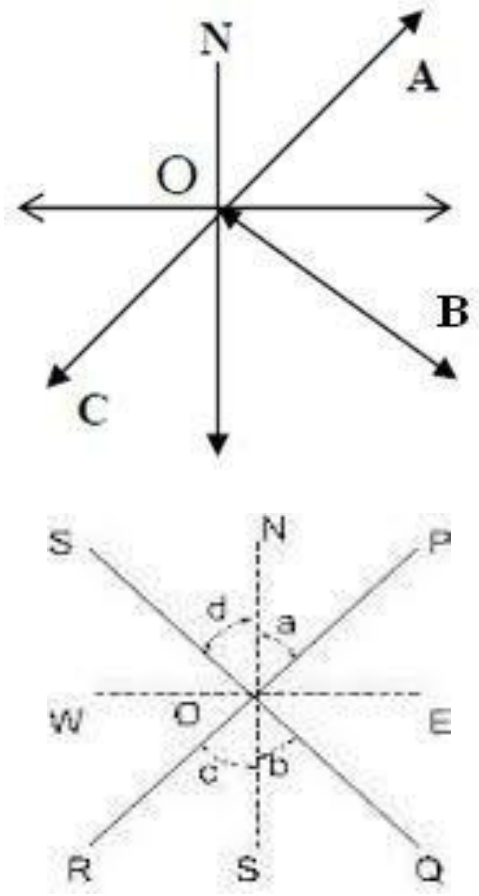


Fig.3.Bearing observation

Observation & Tabulation:

SL.NO	STATION	SIGHTED TO	W.C.B

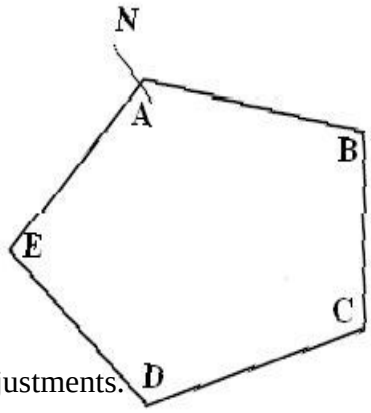
Result:

The whole circle bearing is 360º for given field. Hence proved.

COMPASS TRAVERSING

Objective: **Date:**

To conduct compass survey along the closed traverse.



Instruments:

- Prismatic compass
- Chain
- Ranging rods

Procedure:

- Fix the closed traverse ABCDE.
- Set up the compass at the station 'A'. Perform the temporary adjustments.
- Sight the object at 'B' and note down the FB of line AB and measure the distance. Sight the object at E and note down the BB of EA.
- Sight the instrument to station 'B' performs all the temporary adjustments. Sight the object at 'A' and take the 'BB' of 'AB'.
- Take 'FB' of 'BC' and measure the length of 'BC'.
- Check whether the difference of 'FB' and 'BB' is 180º or not, at all stations.
- Continue the same process all at other stations.

Formula:

Included angle = B.B of previous line – F.B of next line.

Observation & Tabulation:

SL.NO	LINE	FORE BEARING	BACK BEARING	INCLUDED ANGLE

Check:

The sum of the included angles should be equals to (2n-4) x 90º (IA = 360º - EA)

Where 'n' is number of sides of the traverse.

Result:

The included angle of the traverse are found out and the closing error is_____.

STUDY OF PLANE TABLE AND ACCESSORIES

Objective: **Date:**

Study of plane table equipment and accessories.

INTRODUCTION TO PLANE TABLE

Plane table surveying is a graphical method of surveying in which field work and plotting are done simultaneously in the field.

The plain table consists of the following:

- Drawing board mounted on a tripod
- Straight edge called an alidade.

The Drawing Board:

The board is made of well-seasoned wood and varies in size from 40cm x 30 cm to 75cm x 60cm or 50 – 60 cm square.

The Alidade:

The alidade consists of metal or box wood straight edge or ruler about 50cm long. The be welled edge of the alidade is called the fiducially edge.

ACCESSORIES TO THE PLANE TABLE

- ***Trough compass*:** The compass is used to mark the direction of the meridian on the paper.
- ***U- frame or Plumbing fork*:** U frame with a plumb bob used for centering the table.
- ***Water Proof Cover*:** Water Proof cover protects the sheet from rain.
- ***Spirit level or level tube*:** A level tube is used to level the plane table.
- ***Drawing sheet*:** The drawing sheet is fixed on the top of the drawing board.
- ***Pencil and eraser*:** A pencil is used for constructing lines and eraser is used for erasing lines after completion of the plan.

SETTING UP THE PLANE TABLE

The setting up the plane table includes the following three operations.

- Centering the plane table
- Leveling the plane table
- Orientation of plane table

Centering The Plane Table :

The table should be set up at a convenient height for working say about 1m. The legs of tripod should be spread well apart and firmly fixed in to the ground. The table should be approximately leveled by tripod legs and judging by the eye. Then the operation of centering is

carried out by means of U-frame and plumb bob. The plane table is exactly placed over the ground station by U-frame and plumb bob.

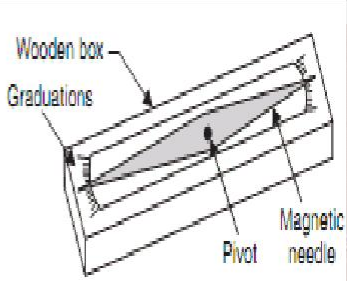
Leveling The Plane Table :

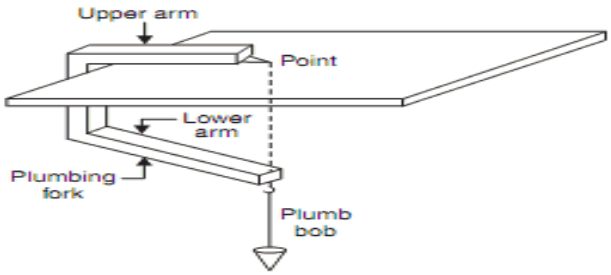
The process of leveling is carried out with the help of level tube. The bubble of level tube is brought to center in two directions, which are right angles to each other. This is achieved by moving legs.

Orienting The Table :

The process of keeping the plane table always parallel to the position, which is occupied at the first station, is known as orientation. When the plane table is oriented, the lines on the board are parallel to the lines on the ground.

Fig.4. Plane Table





Result: The plane table with its accessories was studied.

SETTING OF THE PLANE TABLE AND PLOTTING BY RADIATION METHOD

Objective: **Date:**

Setting up the plane table and plotting a few objects by radiation method.

Instruments:

- Plane table with accessories
- Tape 20m/30m
- Ranging rods

Radiation :

The plane table is set up over only one station from which the whole traverse can be commanded. It is suitable for survey of small areas.

Procedure:

- Select a point "O" so that all points to be located are visible from it. Set up the table at "O", level it, and do centering.
- Select A Point "O" on the sheet so that it is exactly over station "O" on the ground. Mark the direction of the magnetic meridian
- Centering the alidade on "O" bisects the objects of traverse A, B, C and D.
- Measure the distances OA, OB, OC and OD and plotted to convenient scale to locate a, b, c and d respectively
- Join the points a, b, c and d on the paper.

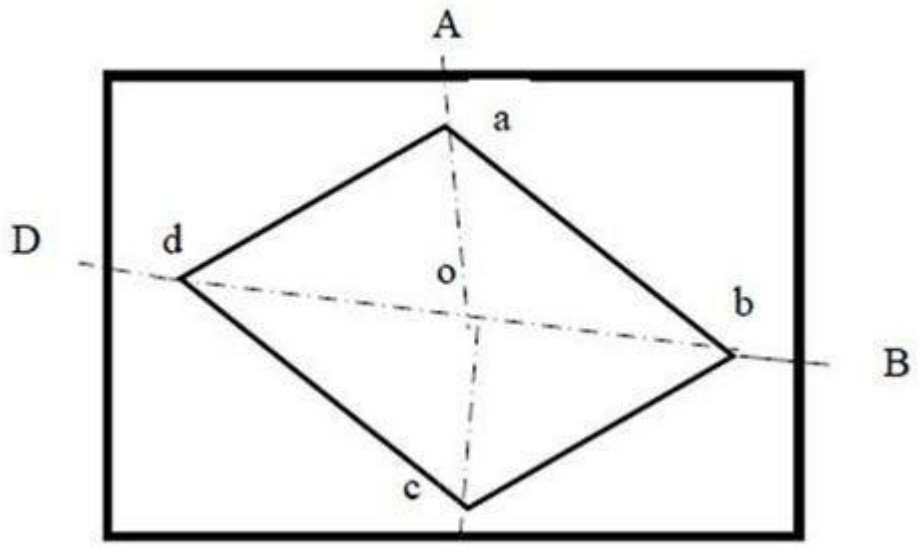


Fig.6.Plane table – Radiation method

Result:

The out line of the profile is **plotted and the perimeter** of profile is_____**Metre.**

PLANE TABLE SURVEYING BY INTERSECTION METHOD

Objective: **Date:**

Plotting building and other features of the compass by Intersection method.

Instruments:

- Plane table with accessories
- Tape 20m/30m
- Ranging rods

Procedure:

- Select two points P and Q such that the points (building corners) to be plotted are visible from their stations.
- Set the table on P and locate on the sheet. Followed by it, pivot on P bisect Q draw a ray.
- Measure the distance PQ and locate Q on the sheet to a convenient scale.
- Now PQ is known as the base line. Pivot 'p' bisects the inaccessible objects A and B (building corners) and draw rays.
- Shift the table to 'a' such that q is over Q and do temporary adjustments.
- Place the alidade along QP and the rotate the table till p is bisected clamp table.
- Pivot on Q bisects the objects A and B and draw rays.
- The instruction of rays drawn from P and Q will give the points A and B.
- To check the accuracy measured AB and compare with plotted distance AB.
- The same procedure is applied for other features of the campus. Each point is bisected from two stations.

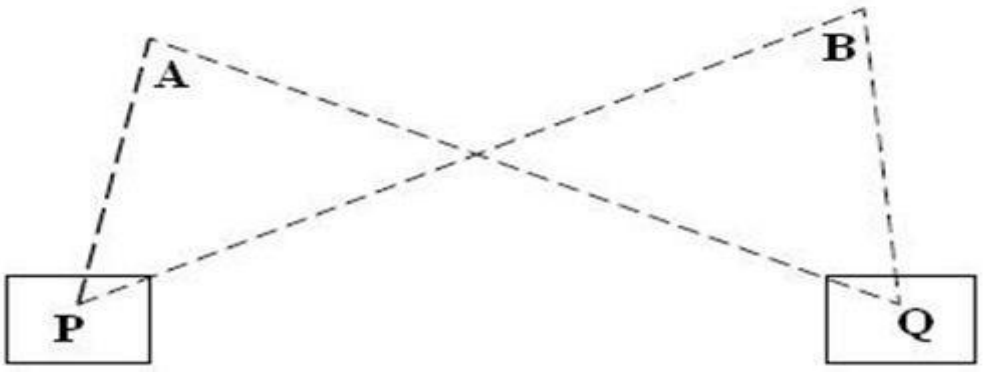


Fig.7.Plane table – Intersection method

Result:

The objects are plotted on drawing sheet and the distance the given points are measured.

TRAVERSING ON AREA BY PLANE TABLE

Objective: **Date:**

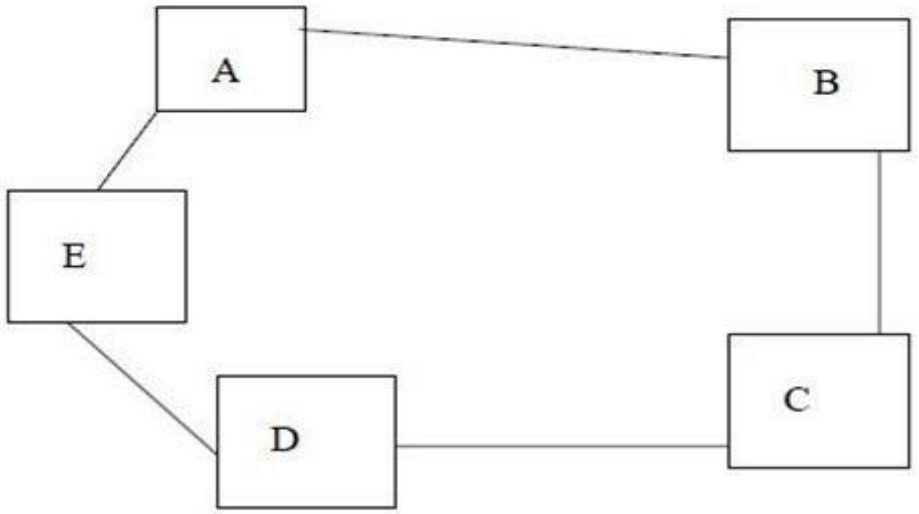
Traversing method is used for running survey lines of a closed or open traverse.

Instruments:

- Plane table with accessories
- Tape 20m/30m
- Ranging rods

Procedure:

- Select the traverse stations A, B, C, D, E etc on the ground.
- Set the table on starting station ‘a’ and perform temporary adjustments. Mark the magnetic meridian and locate A on the sheet as ‘a’.
- Pivot on ‘a’ bisect the next station B and draw a ray
- Measure the distance AB and locate ‘b’ on the sheet with a suitable scale.
- Shift the table to next station B, set the table over B, and do temporary adjustments. Place the alidade along ‘ba’ and bisect A for doing orientation of plane table.
- Pivot on b bisect c draw a ray
- Measure the distance BC and locate ‘c’ on the sheet with the suitable scale.
- Report the same procedure at every successive station until the traverse is completed.



Result:

The traverse is a closed one and its plotted on drawing sheet.

PLANE TABLE SURVEYING IN TWO POINT PROBLEM (RESECTION)

Objective: **Date:**

To determine the position of the station occupied by the plane table by using two point problem.

Instruments:

- Plane table with accessories
- Tape 20m/30m
- Ranging rods

Procedure:

- Choose an auxillary point 'D' near 'C'. Set the table at 'D' such that 'ab' approximately parallel to AB.
- Keep the alidade at 'a' and sight 'A' and draw a resector. Draw resection from 'b' by sighting 'B' to intersect the previous line at'd'. Transfer the point'd' to the ground and drive a peg.
- Keep the alidade at'd' and sight 'c' and draw a ray or line. Mark a point 'c1' on the line to represent the distance 'DC'.
- Shift the table to 'C', orient the table by taking back sight to 'D' and centre it with reference to 'c1'.
- Keep the alidade pivoted at 'a' and sight it to A. Draw a ray to intersect the previously dawn ray from 'D' in 'C'.
- Pivoting the alidade about 'C' and sight 'B'. Draw a ray to intersect the ray drawn from 'D' to 'B' at 'b'.
- In order that ab and 'ab' to coincide keep a pole 'p' in the line 'ab' at a great distance. Keeping the alidade along 'ab' rotate the table till 'p' is bisected clamp the table.
- After orientation draw a resection from 'a' to 'A' and another from 'b' to 'B'. The intersection of which will give the position 'c' occupied by the plane table.

Result:

Thus the position of station occupied by the plane table is determined.

PLANE TABLE SURVEYING IN THREE POINT PROBLEM USING BESSEL'S SOLUTION

Objective: **Date:**

To determine the position of the station occupied by the plane table using three point problem using Bessel's graphical solution.

Instruments:

- Plane table with accessories
- Tape 20m/30m
- Ranging rods

Procedure:

- Let ABC be the three points where distance are known. The table is set at 'P'. The table is oriented approximately so that abc is parallel to ABC.
- Keep the alidade on the line in 'a' and rotate the table till 'A' is bisected. Then clamp the table.
- Pivoting the alidade on the line 'b' sight to'T' and draw the ray 'xy' along the edge of the alidade.
- Keep the alidade along 'ab' sight 'B' and rotate till B is bisected. Clamp the table.
- Pivot the alidade about a sight to 'C'. Draw a ray along the edge to intersect the ray 'xy' at 'c'.Join ccT.
- Keep the alidade along ccT rotate the table till CT is bisected. Clamp the table. The table is correctly oriented.
- Pivoting the alidade about 'b' sight to BT . Draw a ray to intersect ccT
- At P. Similarly if the alidade is pivoted about a and A is sighted the ray will pass through the point 'p' if the survey is accurate.

Result:

Thus the position of station occupied by the plane table is determined by three point problem using "Bessel's" Graphical Solution.

STUDY OF LEVELS AND LEVELLING STAFF

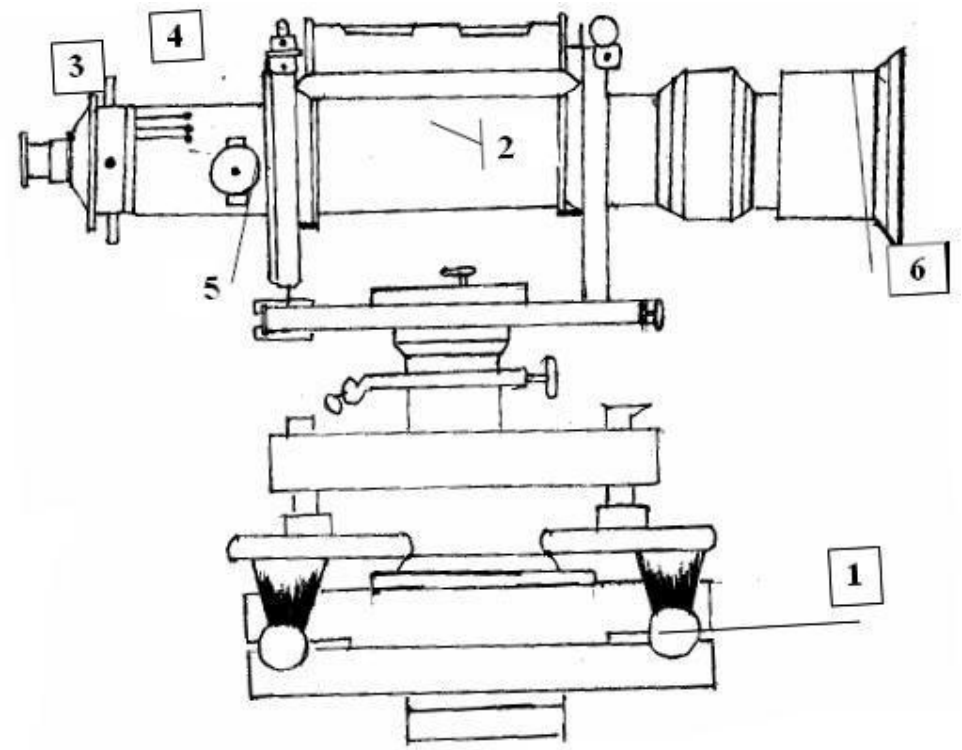
Objective: **Date:**

Study of components of dumpy level and leveling staff.

Instruments:

- A Level with accessories
- Levelling staff.

DESCRIPTION OF INSTRIMENT



1.Levelling head 2.Telescope 3.Eye-piece

4.Diaphragm 5.Focusing screw 6.Ray-shade

Telescope:

It contains of 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.

The Levelling Staff :

It is used for measuring the vertical distance of the points above or below the horizontal line of sight.

Fig.8.Levelling Instrument & Levelling staff.

Result: Detailed study was made about level and levelling staff.

FLY LEVELLING IN REDUCED LEVEL BY H.I. METHOD

Objective: **Date:**

To find the difference in elevation and calculate the reduced level of various points by H.I method.

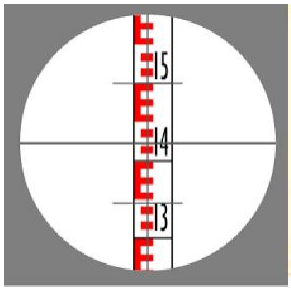
Instruments:

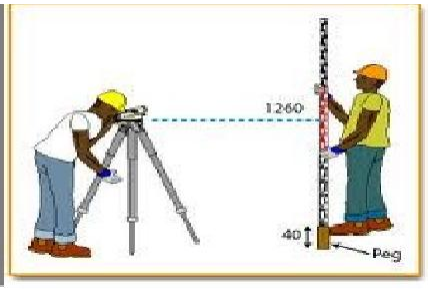
- Dumpy level with tripod (or) Tilting level
- Levelling staff.

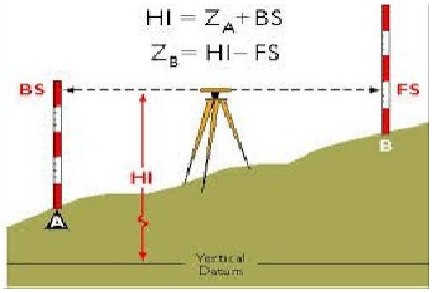
Procedure:

- The field procedure and reduction of Levels of points are same as for Fly leveling.
- The instrument position marked (1) is selected such that it can be observe staff reading on the maximum number of points 1, 2, 3,…… The points are shown on plan in and in elevation as marked 1, 2, 3 respectively in figure along with the bench mark marked BM.
- The instrument is setup and leveled up over the station point.
- Observe the reading on the staff held at B.M. Let us express the reading in accordance with the convention a when "a" is the staff reading on the point for the position of the instrument.
- If the R.L of B.M is "h" and a is the staff reading on the BM. The first staff reading which is termed as back-sight or B.S. Then the height of instrument position(1) may be designated as H.I (1) = h + a1 BM (OR) H.I = R.L + B.S.

Fig.9.(a).Dumpy level (b).Tilting level







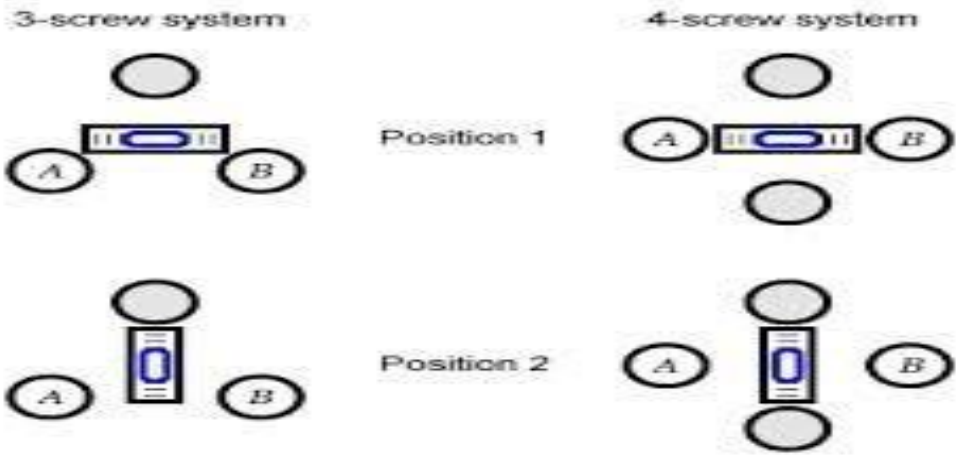


Fig.10. Permanent Adjustment

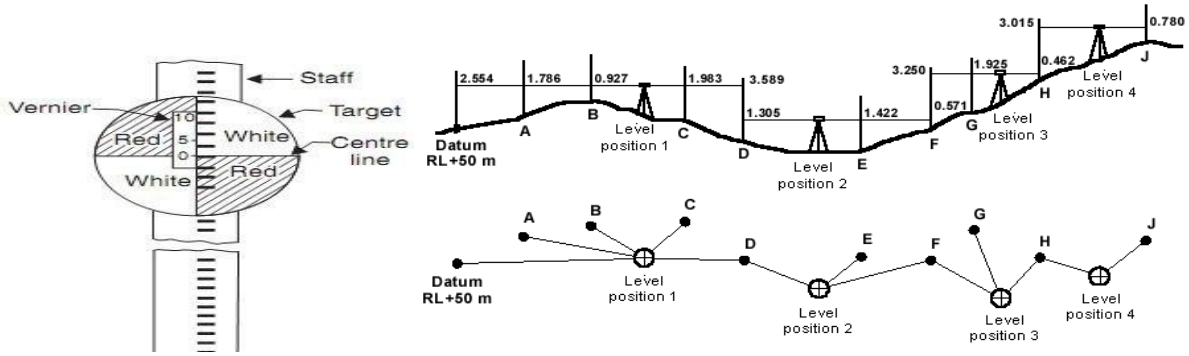
Observation & Tabulation:

SL.NO	STATION	READINGS			HEIGHT OF INSTRUMENT	REDUCED LEVEL	REMARKS
		BS	IS	FS			

$\sum$ □□ = $\sum$ □□ =

Check:

$\sum$ □□ – $\sum$ □□ = **Last RL – First RL**



Result: Difference in elevation between A and B_____**Metre.**

FLY LEVELLING IN REDUCED LEVEL BY RISE AND FALL METHOD

Objective: **Date:**

To find the difference in elevation and calculate the reduced level of various points by Rise and Fall method.

Instruments:

- Dumpy level with tripod (or) Tilting level
- Levelling staff

Procedure:

- The field procedure and reduction of Levels of points are same as for Fly leveling.
- The instrument position marked (1) is selected such that it can be observe staff reading on the maximum number of points 1, 2, 3,…… The points are shown on plan in and in elevation as marked 1, 2, 3 respectively in figure along with the bench mark marked BM.
- The instrument is setup and leveled up over the station point.
- Observe the reading on the staff held at B.M. Let us express the reading in accordance with the convention a when "a" is the staff reading on the point for the position of the instrument.
- If the R.L of B.M is "h" and a is the staff reading on the BM. The first staff reading which is termed as back-sight or B.S. Then the height of instrument position(1) may be designated as H.I (1) = h + a1 BM (OR) H.I = R.L + B.S.

Observation & Tabulation:

SL.NO	STATION	READINGS			RISE	FALL	REDUCED LEVEL	REMARKS
		BS	IS	FS				

∑□□ = ∑ □□ =

Check: ∑□□ − ∑□□ = ∑□□□□ - ∑□□□□ = **Last RL − First RL**

Result:

Difference in elevation between A and B =_____**Metre.**

PROFILE LEVELLING (LONGITUDINAL SECTION)

Objective: **Date:**

To plot the profile of the longitudinal section for an existing road, embankment, etc.

Instruments:

- Levelling instrument with tripod
- Levelling staff
- Ranging rod
- Chain (or) Tape

Procedure:

- Fix the center line of the ground by ranging.
- Set up the instrument at suitable interval over the position and to all the initial adjustment.
- Place the staff at suitable interval of over the center line and rate down the readings of all staff points.
- If necessary shift the instrument to some other place and take B.S as well as F.S at change points.
- Find the reduced level of all points.
- Measure the horizontal distance between the staff point by using chain or tape.
- Take drawing sheet or graph and plot horizontal distance in X-axis and RL in Y-axis in suitable scale.
- Thus get the plot for the longitudinal section of the given ground or road for a particular length.

Observation & Tabulation:

SL.NO	DISTANCE	READINGS			HEIGHT OF INSTRUMENT	REDUCED LEVEL	REMARKS
		BS	IS	FS			

Result: The longitudinal section for the given road is thus plotted.

STUDY OF THEODOLITE

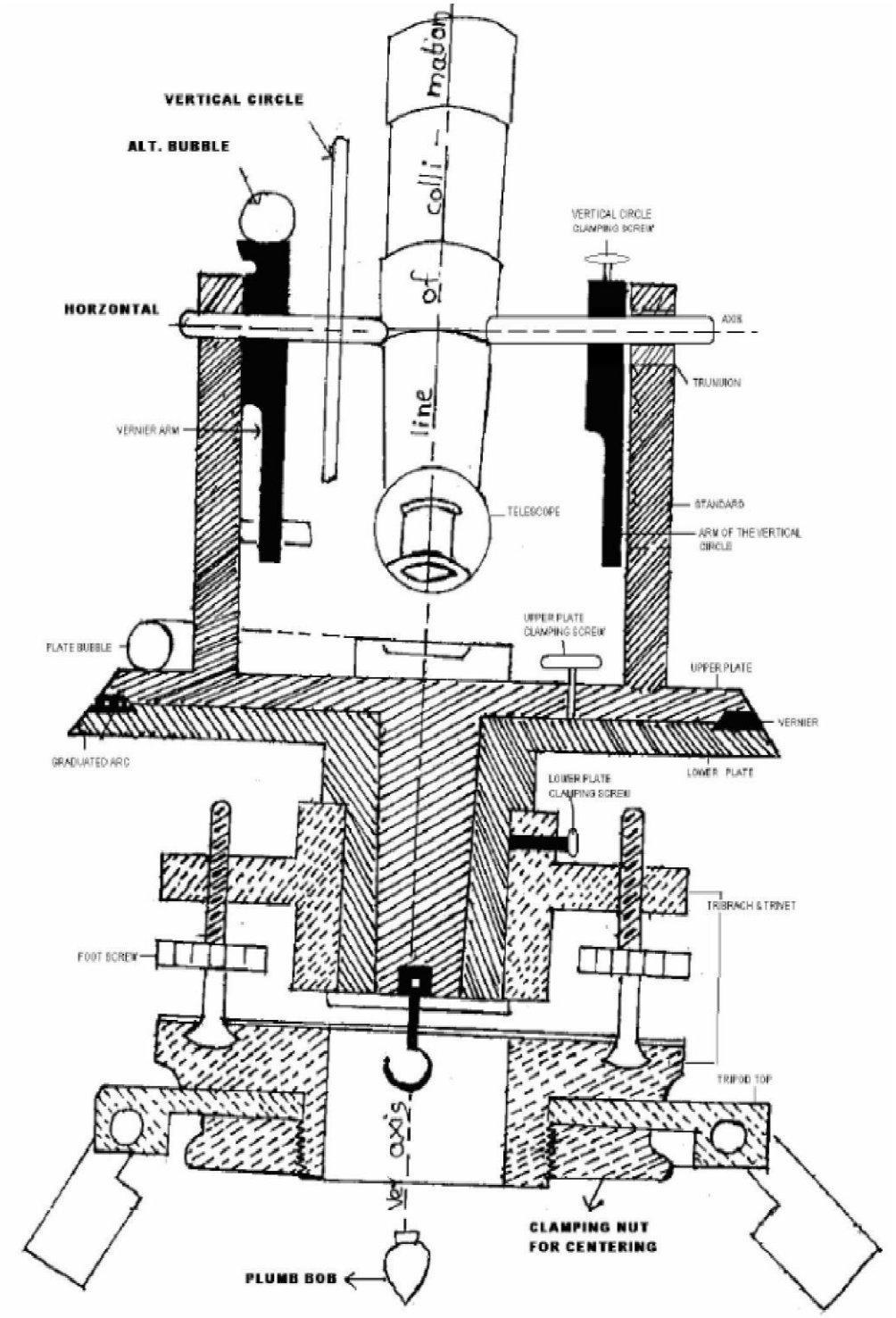
Objective: **Date:**

To study different parts of transit Theodolite and Temporary adjustments.

Instruments:

- Transit theodolite

DESCRIPTION OF EQUIPMENT



Vertical Axis: It is the axis about which the telescope can be rotated in a horizontal plane.

***Horizontal Axis*:** It is the axis about which the telescope can be rotated in a vertical plane.

Line Of Collimation: It is the imaginary line joining the intersection of the cross hairs of the diaphragm to the optical center of the object glass and its continuation.

***Axis Of The Telescope*:** It is the line joining the optical center of the object glass to the center of the eye-piece.

***Axis Of The Level Tube*:** It is the straight line tangential to the longitudinal curve of the level tube at the center of the tube.

***Centering*:** The process of setting the theodolite exactly over the station mark is known as centering.

***Transiting*:** It is the process of turning the telescope in vertical plane through 180º about the trunnion axis

***Telescope*:** It consists of eye-piece, object glass and focusing screw and it is used to sight the object.

***Vertical Circle*:** It is used to measure vertical angles.

Levelling Head: It consists of two parallel triangular plates called tribrach plates. Its uses are

- To support the main part of the instrument.
- To attach the theodolite to the tripod.

***Lower Plate*:** It consists of lower clamp screw and tangent screw.

***Upper Plate*:**The upper plate is attached to the inner axis and it carries two verniers. It consists of an upper clamp screw and tangent screws. These screws are used to fix upper plate with lower plate accurately.

***Foot Screws*:**These are used to level the instrument

Plumb Bob: It is used to center theodolite exactly over the ground station mark.

***Swinging The Telescope*:** It means turning the telescope about its vertical axis in the horizontal plane. A swing is called right or left according as the telescope is rotated clockwise or counter clockwise.

***Face Left*:** If face of the vertical circle is to the left side of the observer, then the observation of the angles taken is known as face left observation.

***Face Right*:** If the face of the vertical circle is to the right side of the observation, then the observation of the angles taken is known as face right observation.

***Changing Face*:** It is an operation of bringing the face of the telescope from left to right and vice-versa.

TEMPORARY ADJUSTMENTS

There are three temporary adjustments of a theodolite. These are

- Setting up the theodolite over a station.
- Leveling up.
- Elimination of parallax.

Setting Up:

It includes two operations

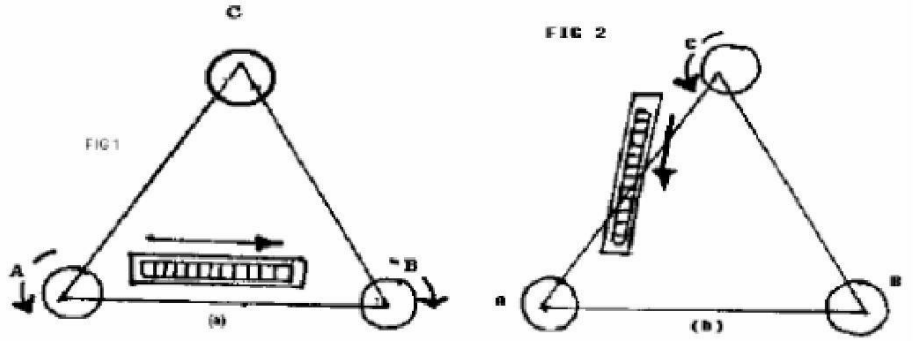
- Centering a theodolite over a station: Done by means of plumb bob.
- Approximately leveling it by tripod legs only: Done by moving tripod legs radially or circumferentially.

Leveling Up:

Having centered and approximately leveled the instrument, accurate leveling is done with the help of foot screws with reference to the plate levels, so that the vertical axis shall be truly vertical.

To level the instrument the following operations have to be done.

- Turn the upper plate until the longitudinal axis of the plate level is roughly parallel to a line joining any two of the leveling screws (A & B).



- Hold these two leveling screws between the thumb and first finger of each hand uniformly so that the thumb moves either towards each other or away from each other until the bubble comes to the center.

- Turn the upper plate through 90º i.e until the axes of the level passes over the position of the third leveling screw 'C'.

- Turn this leveling screw until the bubble comes to the center.

- Rotate the upper plate through 90º to its original position fig(a) and repeat step(2) till

the bubble comes to the center.

- Turn back again through 90º and repeat step 4 .
- Repeat the steps 2 and 4 till the bubble is central in both the positions.

Now rotate the instrument through 180º. The bubble should be remaining in the center of its run, provided it is in correct adjustment. The vertical axis will then be truly vertical.

ELIMINATION OF PARALLAX

Parallax is a condition arising when the image formed by the objective is not in the plane of the cross hairs. Unless parallax is eliminated, accurate sighting is not possible. Parallax can be eliminated in two steps.

A) focusing The Eye-Piece:

Point the telescope to the sky or hold a piece of white paper in front of the telescope. Move the eyepiece in and out until a distant and sharp black image of the cross-hairs is seen.

B) Focusing The Object:

Telescope is now turned towards object to be sighted and the focusing screw is turned until image appears clear and sharp.