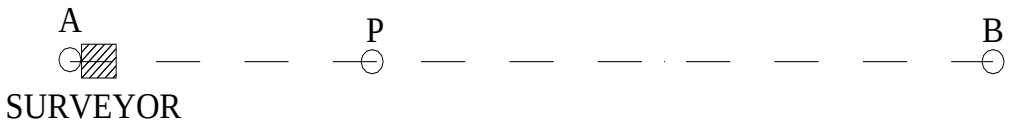


Fig. 1.1 Direct ranging

Experiment No. 1 **Date: __ /__ / __**

MEASUREMENT OF DISTANCE

Exercise : 1.1

Case 1: Horizontal plane

Aim: To measure distance between two points using direct ranging (Fig. 1.1)

Instruments used:

Sl. No.	Particulars	Quantity
1.	Chain	01
2.	Tape	01
3.	Ranging Rods	03
3.	Arrows	Few

Theory: Measurement of distance between two points, which are at a large distance , involves two steps namely ranging and chaining. Ranging is a process of locating points on a given straight line. There are two methods of ranging, namely direct ranging and indirect ranging. Direct ranging may be done with eye judgment or by using instrument like line ranger.

Chaining is a process of measuring a distance either by a chain or a tape.

Procedure:

Let A and B be the two points at the ends of a survey line. One ranging rod is erected at the B while surveyor stands with another ranging rod at point A. The assistant then goes with another ranging rod and establishes the rod at a point approximately in the line with AB at a distance not greater than one chain length from A. Surveyor at A signals the assistant to move transverse to the chain line, till he is in line with A and B. Similarly, other intermediate points can be established. Now measure the distance between the points A and B.

RESULTS:-

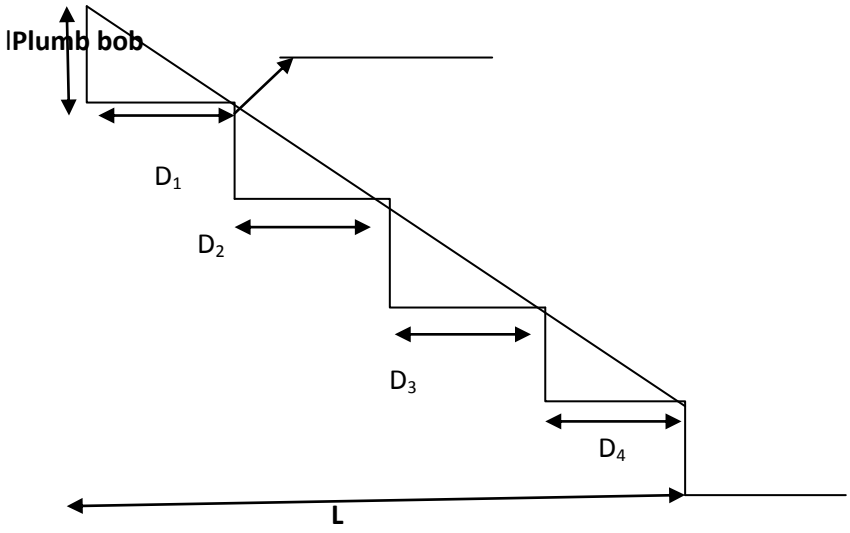


Fig. 1.2Indirect ranging (Stepping method)

$L = D_1+D_2 + D_3+D_4$

Where, L = Total horizontal distance

D = horizontal distances between the intervals

Case 2: Sloping ground

Aim: To measure distance between two points using direct ranging (Fig. 1.2)

Instruments used:

Sl. No.	Particulars	Quantity
1.	Chain	01
2.	Tape	01
3.	Ranging Rods	03
3.	Arrows	Few

Theory:

Procedure:

RESULTS:-

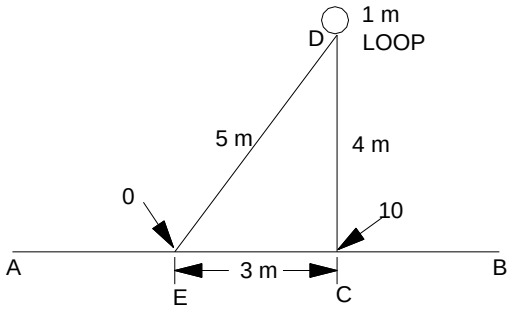


Fig. 1.3 First method (3-4-5 method)

Date: __ /__ / __

ERECTION OF PERPENDICULAR

Exercise : 1.2

Aim: To erect perpendicular from a given chain line to a given point using chain and tape only.

Instruments used:

Sl. No.	Particulars	Quantity
1.	Chain	01
2.	Tape	01
3.	Ranging Rods	03
3.	Arrows	few

Procedure:

Let AB be the given chain line and C be the given point on AB at which it is desired to erect a perpendicular.

First method (3-4-5 method) :(Fig 1.3)

1. Establish a point E at distance of 3m from C.
2. Put the zero end of the tape at E and the 10m end at C.
3. The 5m and 6m marks are brought together to form a loop of 1m.
4. Fastening the ends E and C stretch the tape tightly.
5. The point D is thus established.
6. Join DC, and point D gives the position of the perpendicular CD at C on the chain line AB.

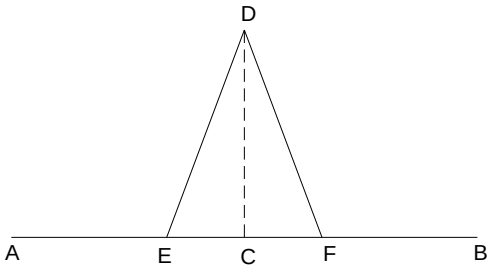


Fig.1.3Second method

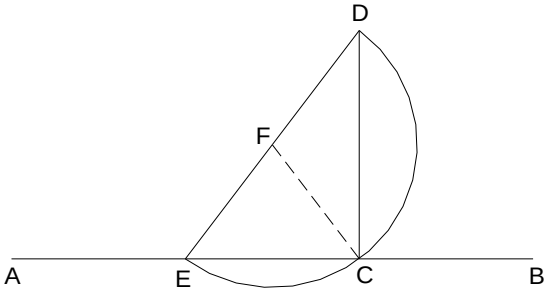


Fig. 1.4 Third method

Second method: (Fig 1.4)

1. Select E and F equidistant from C.
2. Hold zero end of the tape at E and hold the 10 m end at F.
3. Pick up 5 m mark, stretch the tape tight and establish D.
4. Join DC, and point D gives the position of the perpendicular CD at C on the chain line AB.

Third method: (Fig 1.5)

1. Select any point F out side the chain, preferably at 5 m distance from C.
2. Hold the 5 m mark at F and zero end of the tape at C, with F as center draw an arc to cut the chain line at E.
3. Join EF and produce it to D such that EF = FD = 5 m.
4. Thus, point D will lie at the 10 m mark of the tape laid along EF with its zero end at E.
5. Join DC, and point D gives the position of the perpendicular CD at C on the chain line AB.

Results:

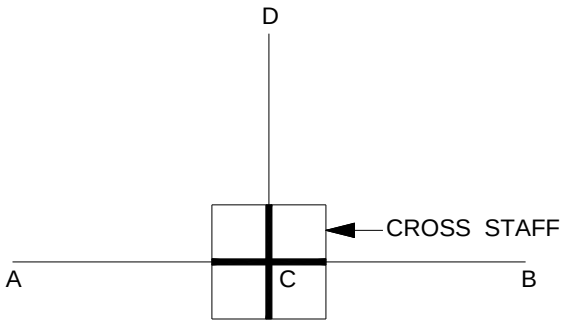


Fig. 1.5 Cross – Staff

Exercise 1.3 **Date: __ /__ / __**

Aim: To erect perpendicular from a given chain line to a given point using Cross - Staff.

Instruments used:

Sl. No.	Particulars	Quantity
1.	Chain	01
2.	Tape	01
3.	Ranging Rods	03
3.	Arrows	few

Theory: Cross staff consists of a wooden block of about 150mm square and about 35mm thick**.** The block has on its top surface, two grooves or slits at perpendicular to each other. The grooves are about 10mm deep. The wooden block is fixed at the top of a vertical pole or rod

Procedure:(Fig 1.4)

Let AB be the given chain line and C be the given point on AB at which it is desired to erect a perpendicular Erect ranging rods at both the ends of the chain line AB.

The cross - staff is set up at a point C on the chain line from which the perpendicular is to erect.

Now cross - staff is then turned until one line of sight posses through the ranging rod at the end of the chain line.

The line of sight through the other two vanes will be a line at right angles to the chain line AB and a ranging rod may be established in that direction at D.

Join C and D. CD will be the perpendicular to the chain line AB.

Results:

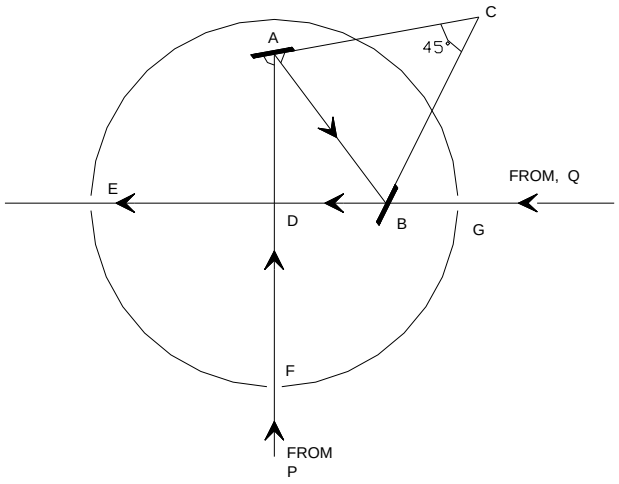


Fig. 1.6 Optical square

Exercise –1.4 **Date: __ /__ / __**

Aim: To erect perpendicular from a given chain line to a given point using Optical square.

Instruments used:

Sl. No.	Particulars	Quantity
1.	Chain	01
2.	Tape	01
3.	Ranging Rods	02
3.	Arrows	few
4.	Optical square	01

Theory: Optical Square is a compact instrument used for setting out perpendicular to the chain line. It consists of a horizon glass H, which is half silvered and half unsilvered and an index glass which is fully silvered. These two glasses are placed at an angle 45° inside the circular box .The box has three openings .One is circular for eye and the other diametrically opposite to this is rectangular is located perpendicular to the line of sight. Fig shows sectional plan of optical square. The optical square works on the following principal.

"If a ray of light undergoes two successive reflections, the angle between the incident ray and the last reflected ray is twice the angle between the mirrors"

In the optical square, as the angle between the mirrors is 45°, the last reflected ray is perpendicular to the incident ray

Procedure: (Fig 1.7) Let AB be the given chain line and C be the given point on AB at which it is desired to erect a perpendicular.

1. To set a right angle on a chain line AB the instrument is held on the line with its center on the point C at which perpendicular is erected.
2. The slits F and G are directed towards the ranging rod fixed at the end of the chain line.
3. The surveyor (holding the instrument) then directs the person, holding a ranging rod and stationing in a direction roughly perpendicular to the chain line to move till the two images coincide.

Results:

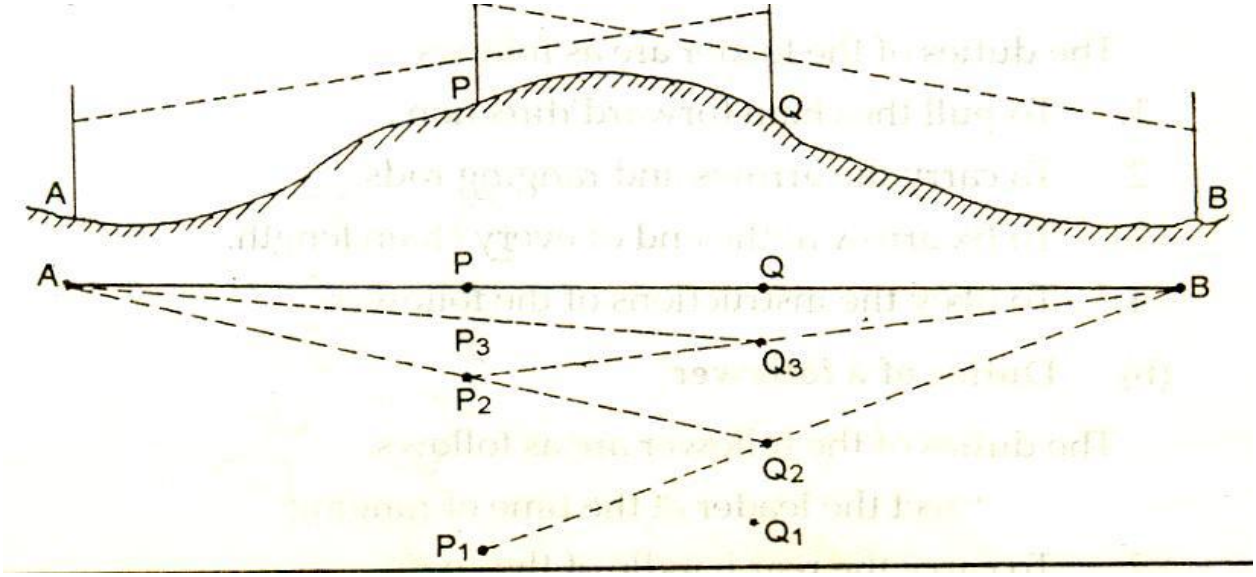


Fig. 2.1Reciprocal ranging

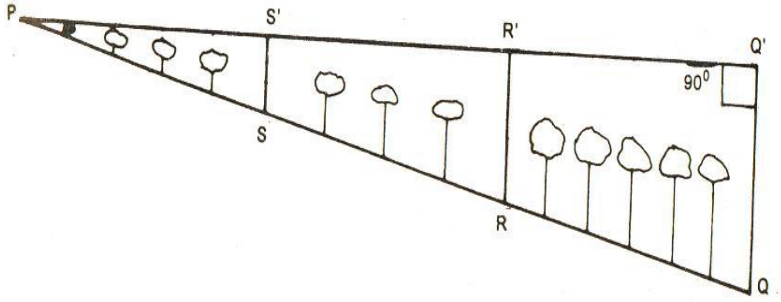


Fig. 2.2Randomline

Experiment No. 2 **Date: __ /__ / __**

OBSTACLES IN CHAINING AND RANGING

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.

PROCEDURE: 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.

1. Obstacles to ranging but not chaining. E.x (High level ground)
2. Obstacles to chaining but not ranging. E.x(Pond,river)
3. Obstacles to both chaining and ranging. E.x(building)

I) OBSTACLES TO RANGING BUT NOT CHAINING;-

This type of problem comes, when a rising ground or a forest area interrupts the chain line. The end station 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-1: Both the stations are visible from intermediate points on the line (reciprocal ranging)

1. In this case reciprocal ranging is adopted and chaining is done by stepping method
2. A and B are two end stations, which are not inter visible due to a hill in between them.
3. Select two intermediate points P_1 and Q_1, such that from each station point A and B are visible.
4. Two persons take up the positions P_1 and $Q_l$with ranging rods.
5. First the person standing at Pl directs the person at $Q_l$to come in line of P_l B, and his new position will be Q_2.
6. Now, the person standing at Q_2, directs the person at pi, to come in line of Q_2 A, and his new position will be P_2.

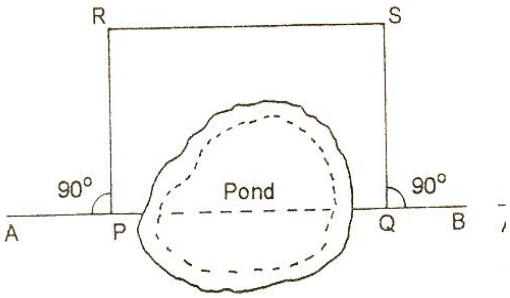


Fig. 3.3Method (a)

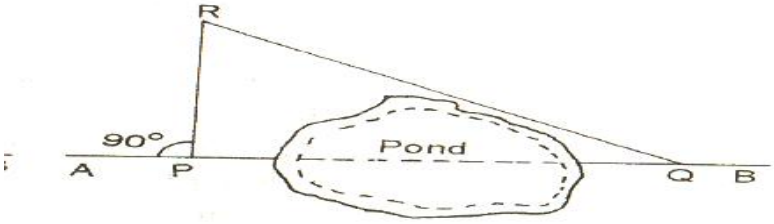


Fig. 2.4 Method (b)

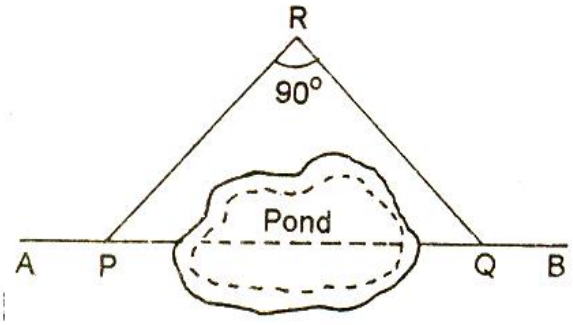


Fig. 2.5Method (c)

7. Now, 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.
8. 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.
9. Distance AB = AP+PQ+QB

Case-2: 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.

1. In fig let PQ be the line in which P and Q are not visible from intermediate Point on it.
2. Through P draw a random line PQ in any convenient direction but as nearly to Towards Q as possible.
3. The points Q should be so chosen that, Q1 is visible from Q and Q,Q1 is in random Line.
4. Measure QQ1 select points S1 and R1 on random line and erect perpendicular SS1 and RR1 on it.
5. Make SS1= PS1/PQ1 x QQ1 And RR1= PR1/PQ1 x QQ1
6. Join SR and prolong.

II) **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.

CASE1: Following are the methods.

Method (a):

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

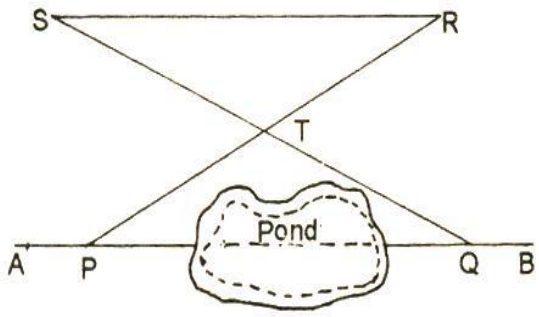


Fig. 2.6Method (d)

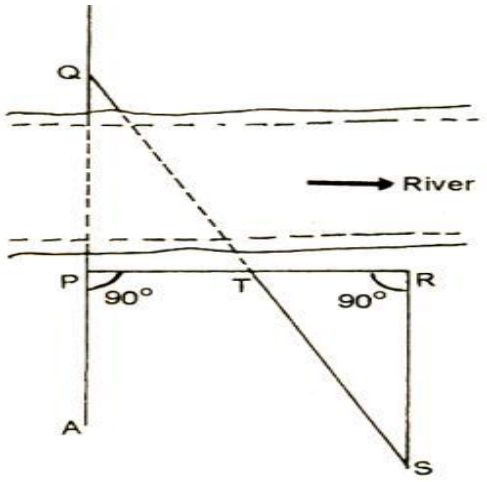


Fig. 2.7Method (e)

Method (b):

1. Set out AC perpendicular to chain line as shown in fig (b)
2. Measure AC and BC
3. The length AB is calculated from the relation

$$AB=\sqrt{BC^2-AC^2}$$

Method (c):

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

Method (d):

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

CASE2: Following are the methods.

Method (e)

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

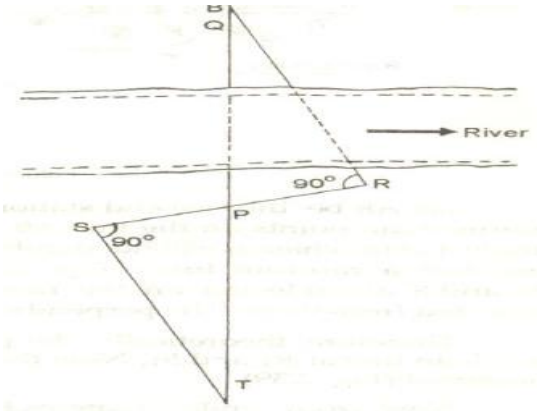


Fig. 2.8 Method (f)

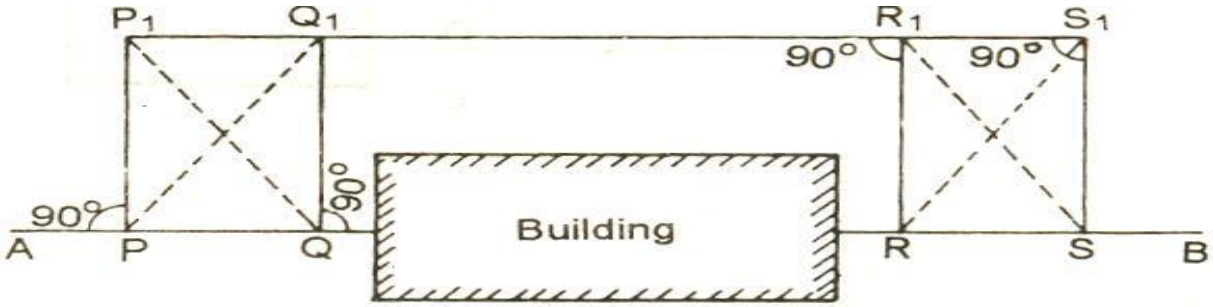


Fig. 2.9 Method (g)

Method (f):

1. Locate a point R in such a way that it makes 90^0 with PQ.
2. Range S in line with PR and make PS = PR.
3. At S erect a perpendicular ST to cut the line AB at T.
4. Then PQ =PT.

III) **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 determine the distance across it.

Method (g);

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

Method (h):

1. Select a point A and erect a perpendicular AC of any convenient Length.
2. Select another point B on chain line such that AB=AC.
3. Join B and C and prolong it. To any convenient point D.
4. At D set a right angle DE such that DE=DB.
5. 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
6. Join GE which will be in range with chain line. Refer the fig (h)
7. Measure CF then AG=CF.

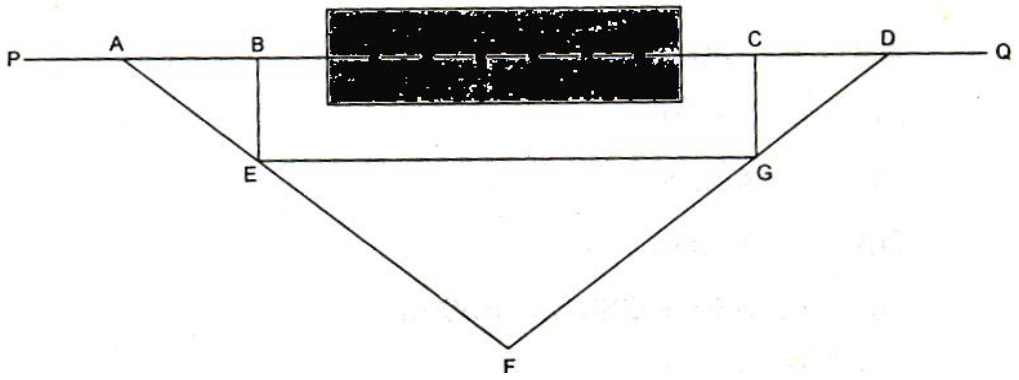


Fig. 2.10 Method (h)

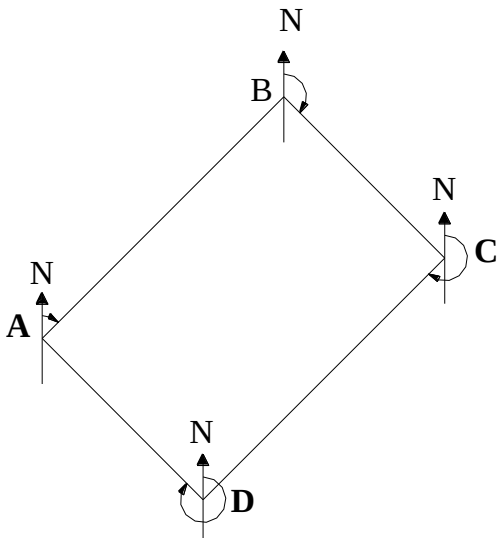


Fig. 3.1 Construct of rectangle using compass

SETTING OUT OF GEOMETRICAL FIGURES USING PRISMAIC COMPASS

Exercise – 3.1 **Date: __ /__ / __**

Aim: Construct the Rectangle in the field using chain and compass

Instruments used:

Sl. No.	Particulars	Specification	Quantity
1.	Chain		01
2.	Tape		01
3.	Ranging Rods		02
3.	Arrows		few
4.	Prismatic Compass		01

Procedure: (Fig 3.1)

1. Calculate the necessary data to construct the Rectangle in field using the following relations

   Sum of all Included Angle = (2n - 4) 90°/n

   Where n = Number of sides

   Each Included Angle = Sum of all Included Angle/ Number of sides

   Deflection Angle = 180°- Included Angle

   Bearing of any line = Fore bearing of previous line + Deflection Angle

   Bearing of AB = Given

   Bearing of BC = Bearing of AB + Deflection Angle

   Bearing of CD = Bearing of BC + Deflection Angle

   Bearing of DA = Bearing of CD + Deflection Angle

   CHECK: Bearing of AB - 360° = Given Bearing of AB

2. Set the compass at A and set given bearing of AB by turning the compass, with the zero end of the tape pointed at A and an arrow held at a distance equal to length of AB, swing the tape around A till the arrow is bisected by the cross-hairs. Thus the point B is fixed.
3. Now shift the compass to other stations (such as B , C and D) and repeat the step-2 till the points C and D are fixed.
4. Join the points A, B, C and D. Thus the Rectangle is formed.

Results:

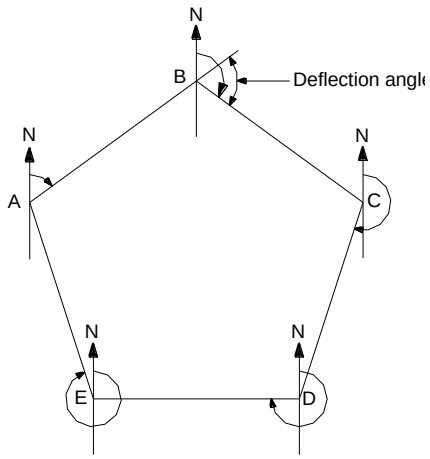


Fig. 3.2 Construct of pentagon using compass

Exercise – 3.2 **Date: __ /__ / _**

Aim: To Construct Pentagon in the field using prismatic compass.

Instruments used:

Sl. No.	Particulars	Specification	Quantity
1.	Chain		01
2.	Tape		01
3.	Ranging Rods		02
3.	Arrows		few
4.	Prismatic Compass		01

Procedure :(Fig 3.2)

1. Calculate included interior angle using the following relation.

Included interior angle = $\frac{(2n-4)90^\circ}{n}$

Where n = Number of sides

Included Interior Angle = 108°

Deflection Angle = 180°- Included Interior Angle

= 180-108 =72°

Bearing of AB = 50°

Bearing of BC = Bearing of AB + Deflection Angle

Bearing of CD = Bearing of BC + Deflection Angle

Bearing of DE = Bearing of CD + Deflection Angle

Bearing of EA = Bearing of DE + Deflection Angle

2. Set the compass at A and set given bearing of AB. Fix the ranging rod along the bearing of AB at B at a distance 10m from A.
3. Now shift the compass to other stations such as B , C, D and E and repeat the step-2 to get points C, D and E respectively.
4. Join the points A, B, C, D and E. Thus the Pentagon is formed.

Results:

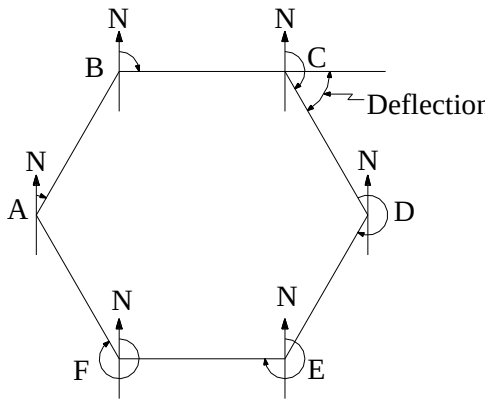


Fig. 3.3 Construct of hexagon using compass

Exercise – 3.3 **Date: __ /__ / _**

Aim: To Construct Hexagon in the field using prismatic compass.

Instruments used:

Sl. No.	Particulars	Specification	Quantity
1.	Chain		01
2.	Tape		01
3.	Ranging Rods		02
3.	Arrows		few
4.	Prismatic Compass		01

Procedure: (Fig 3.3)

1. Calculate included interior angle using the following relation.

$$\text{Included interior angle} = \frac{(2n-4)90^\circ}{n}$$

Where n = Number of sides

Included Interior Angle = 120°

Deflection Angle = 180°- Included Interior Angle

= 180° -120° =60°

Bearing of AB = 50°

Bearing of BC = Bearing of AB + Deflection Angle

Bearing of CD = Bearing of BC + Deflection Angle

Bearing of DE = Bearing of CD + Deflection Angle

Bearing of EF = Bearing of DE + Deflection Angle

Bearing of FA = Bearing of EF + Deflection Angle

2. Set the compass at A and set given bearing of AB. Fix the ranging rod along the bearing of AB at B at a distance 10m from A.

3. Now shift the compass to other stations such as B , C, D, E and F and repeat the step-2 to get points C, D , E and F respectively.

4. Join the points A, B, C, D, E and F. Thus the Hexagon is formed.

Result:

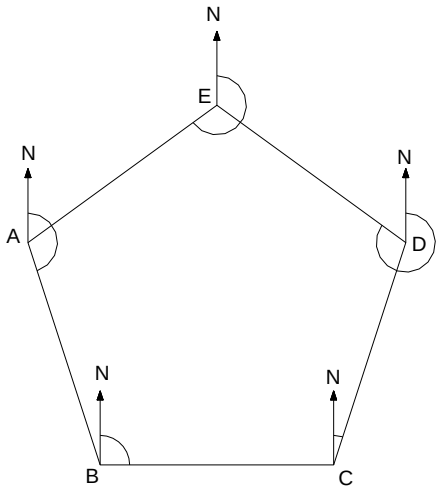


Fig. 4.1 Compass traverse

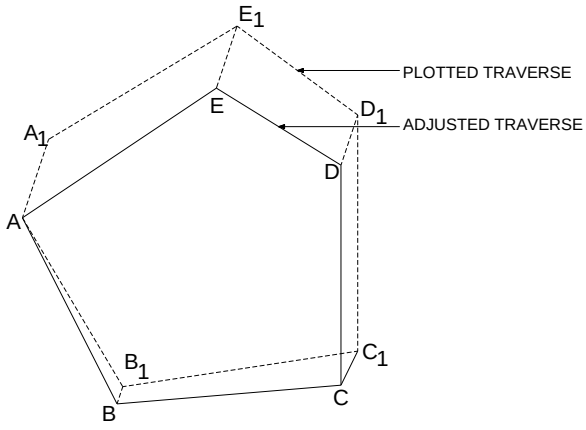


Fig. 4.2 Plotted and adjusted traverse

Experiment No. 4 **Date: __ /__ / __**

COMPASS SURVEYING

Aim: Measurement of bearings of a closed traverse and adjustment of closing error by Bowditch's method.

Instruments used:

Sl. No.	Particulars	Quantity
1.	Chain	01
2.	Tape	01
3.	Ranging Rods	01
3.	Arrows	02
4.	Prismatic Compass	01

Theory: Prismatic compass is an instrument used to measure the bearings of the lines. The bearing of a line is the angle made by that line with magnetic north.There is two systems of designating the bearings. They are whole circle bearing system (WCB) Quadratic bearing system (QB). Prismatic compass gives the bearing in WCB system. It consists of a circular box of about 85 to 100mm dia. In the center of the box, there is a board magnetic needle balanced on a hard steel pointed pivot. The needle carries a aluminum ring graduated to degrees and half degree. The graduation starts from 360° at north or 270° at east. The readings are engraved inverted. The box is fitted with a glass disc at its top .The sighting vane consists of 45° reflecting prism with its horizontal and vertical faces slightly convex so as to magnify the image of graduations. The graduations after reflection appear to be erect. The prism on the mounting frame can be raised or lowered for focusing of prism. The image of the graduations is viewed through a small circular aperture in the prism mounting. Just above the aperture , there is a narrow slit used as eye vane. Dark colored glasses are provided near the eye vane for sighting vane or eye vane. It consists of a metal frame hinged to the box having a vertical cross hair. It is usually provided with a hinged mirror, so that the objects which are either too low or too high can be sighted by inclined mirror. The line sight is the line joining the slit in eye vane and vertical cross hair of object vane. When the instrument is not in use the object vane is folded on glass over. In this process the lifting pin is pressed which lifts the needle off the pivot. TO dampen the oscillations of the needle and to bring it to rest a spring brake is provided. It operates when the brake pin is pressed.

When the compass is not in use, the box is covered with a brass lid. While taking readings, the compass is mounted on the light tripod

A traverse is a series of connected lines whose length and directions are measured in the field. The traverse may be open or closed. In closed traverse if plotting is made from the observed values of lengths and directions, sometimes the last point does not coincide with the starting point. Such a closed traverse is said to have closing error. Such traverses are to be adjusted before plotting by Bowditch's rule and transit rule.Bowditch's rule and transit rule use the concept of latitude and departure. Latitude is the distance of that line measured parallel to NS direction and obtained by the relation L= l cosθwhere l is the length of the line and θthe reduced bearing of that line. Departure is the distance of that line measured perpendicular to NS direction by the relation D= l sinθ

Procedure: (Fig 3.1)

1. Let ABCDE be the closed traverse shown the fig.
2. The distances AB, BC, CD, DE and EX are measured accurately with the tape
3. The prismatic compass is placed centrally over the station. At the same time it is also leveled. The line of sight is turned to sight the ranging rod at B, Te FB Ab is recorded.The line of sight is turned to sight the ranging rod at E & the BB of EA is noted.
4. Similarly keep the compass at
    - B, BB of AB & FB of BC are noted
    - C, BB of CB & FB of CD are noted
    - D, BB of CD & FB of DE are noted
    - E, BB of ED & FB of EA are noted
5. The traverse is then checked for local attraction and corrected.Then it is checked for closing error.If any , it is adjusted by Bowditch rule and Transit rule as given below

Bowditch Rule

Correction to latitude of any side=$C_L = \pm \sum L \times \frac{\text{Length of that side}}{\text{Perimeter of Traverse}}$

Correction to Departure of any side=$C_D = \pm \sum D \times \frac{\text{Length of that side}}{\text{Perimeter of Traverse}}$

Transit Rule

Correction to latitude of any side=$C_L = \pm \sum L \times \frac{\text{Latitude of that line}}{\text{Arithmetic sum of latitudes}}$

Correction to Departure of any side=$C_D = \pm \sum D \times \frac{\text{Length of that side}}{\text{Arithmetic sum of departure}}$

Note: If error is negative, Correction is positive and vice versa

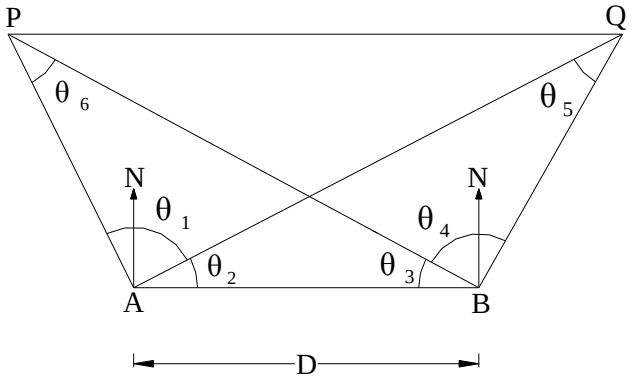


Fig. 5.1 Plan view of station points A & B and inaccessible points P & Q

Experiment No. 5 **Date: __ /__ / _**

DETERMINATION OF DISTANCE BETWEEN INACCESSIBLE POINTS

Aim: To determine the distance between two inaccessible points by using chain and compass.

Instruments used:

Sl. No.	Particulars	Quantity
1.	Chain	01
2.	Tape	01
3.	Ranging Rods	03
3.	Arrows	Few
4.	Prismatic Compass	01

Procedure: (Fig 4.1)

Set the compass over the station A and make temporary adjustments.

(i) Establish a point B almost parallel to the line PQ at certain distance "D" from A such that the triangles formed are well conditioned.

(ii) Measure the bearings of lines AP, AQ and AB bisecting the points P,Q and B.

(iii) Shift the instrument to station B and measure the bearings of lines BA, BP and BQby bisecting points A, P and Q.

Calculations: From measured bearings calculate the angles θ_1, θ_2, θ_3,θ_4, θ_5 and$\theta_6$using following equations

θ_1 = Bearing of line AQ + (360 – Bearing of line AP)

θ_2 = Bearing of line AB – Bearing of line AQ

θ_3 = Bearing of line BP – Bearing of line BA

θ_4 = Bearing of line BQ + (360 – Bearing of line BP)

Now, in the triangle AQB, θ_5=180- (θ_2 + θ_3 + θ_4)

In the triangle ABQ, applying sine rule,

Distance AQ = AB * Sin ($\theta_3 + \theta_4$)/ Sin θ_5

In the triangle ABP, θ_6=180-(θ_1+θ_2+θ_3)

Distance AP = AB*Sin θ_3 / Sin θ_6

Lastly, from the triangle APQ, applying cosine rule,

$$PQ = \sqrt{(AP^2 + AQ^2 - 2 \times AP \times AQ \times Cos\,\theta_1)}$$

Results:

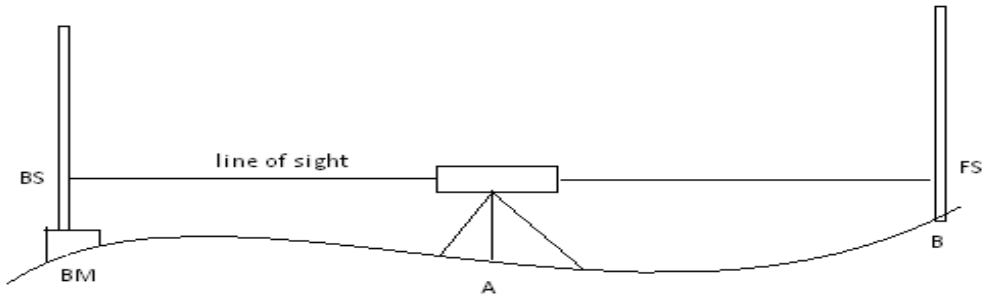


Fig. 6.1Simple Leveling

Observations and tabulations:

Simple leveling

Station	B. S.	F. S.	H.I	R. L.	Remarks
					B.M.
	∑ B.S.	**∑ F.S**			

Experiment No : 6 **Date: __ /__ / __**

SIMPLE LEVELING

Aim: To determine the reduced level of points using dumpy level

Instruments used:

Sl. No.	Particulars	Quantity
1.	Dumpy level	01
2.	Tripod	01
3.	Levelling Staff	01

Procedure:

1. The instrument is set up at a convenient point A (Fig 6.1), and back sight is taken on the staff held on the temporary bench mark of assumed RL. The height of the instrument is determined by adding BS reading to the RL of TBM.
2. The staff is now kept at the destination point and reading is taken. This reading is entered in FS column.
3. Arithmetic check is made using the following equation.

$\sum$B.S. - $\sum$ F.S. = Last R.L. – First R.L

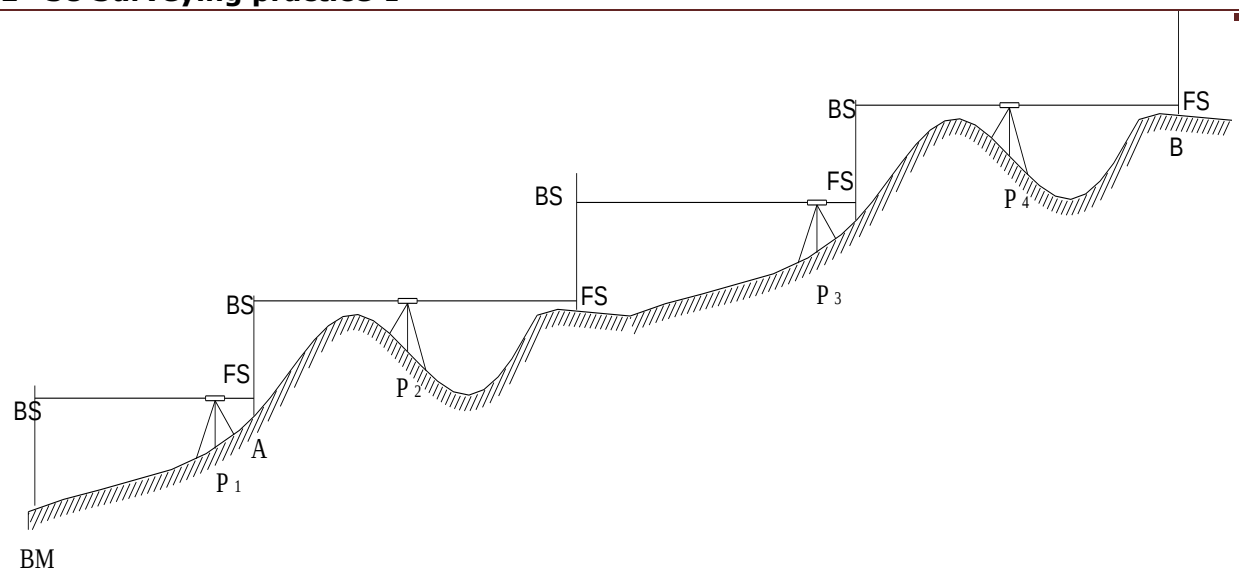


Fig. 7.1 Differential leveling.

Station	B. S.	I. S.	F. S.	H.I	R. L.	Remarks
						B.M.
	∑ B.S.		**∑ F.S**			

Experiment No : 7 **Date: __ /__ / __**

DIFFERENTIAL LEVELING

Aim: To determine difference in elevation between two points using differential leveling

Instruments used:

Sl. No.	Particulars	Quantity
1.	Dumpy level	01
2.	Tripod	01
3.	Levelling Staff	01

Procedure:

1. The instrument is set up at a convenient point P_1(Fig 7.1) and back sight is taken on the staff held on the temporary bench mark of assumed RL. The height of the instrument is determined by adding BS reading to the RL of TBM.

2. The staff reading is taken at the starting point and is entered in fore sight column. The R.L. of the starting point is determined by subtracting staff reading fromheight of the instrument.

   R.L. of starting point = Height of the instrument – Fore sight

3. The instrument is shifted to the position P_2 and staff reading is taken at starting point and is entered in back sight column in level with fore sight reading from previous station in the level book. The new height of the instrument is determined.

4. Above procedure is repeated for rest of the points.

5. Arithmetic check is made using the following equation.

   $\sum$B.S. - $\sum$ F.S. = Last R.L. – First R.L.

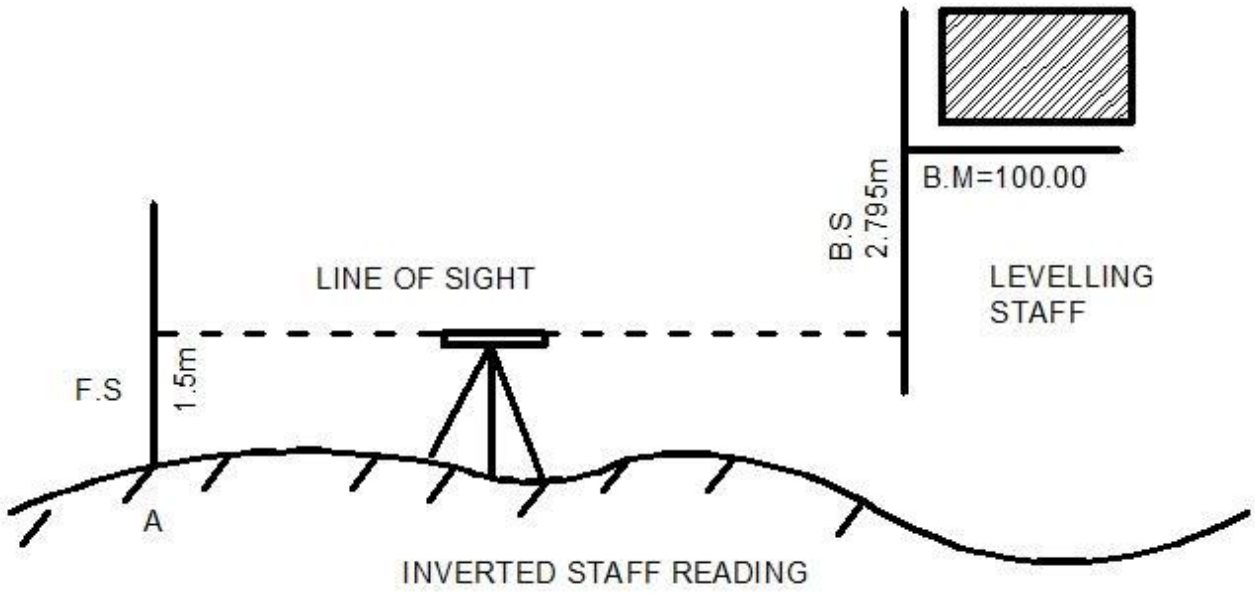


Fig. 9.1 Inverted leveling.

Sl No	Back Sight (BS)	Intermediate Sight (IS)	Fore Sight (FS)	Height of the Instrument (HI)	Reduced Level (RL)	Remarks

Date: __ /__ / __

INVERTED LEVELING

Exersice No: 7.1

Aim: To Determination the RL of an object above the plane of collimation using inverted leveling.

Instruments used:

Sl. No.	Particulars	Quantity
1.	Dumpy level	01
2.	Tripod	01
3.	Levelling Staff	01

Theory: When the B.M of staff station is above the line of collimation (or line of sight) the staff is held inverted on the point and reading is taken .This reading being negative is entered in the level field book with minus sign, or to avoid confusion, 'Staff inverted' should be written in the remarks column against the entry of the reading.

Procedure:

1. Setup the tripod at the convenient plane surface & fix the dumpy level on it.
2. Temporary adjustments are done and the instrument is leveled by using the bubble tube.
3. After leveling the instrument, the leveling staff is held on the given bench mark which is above the line of sight. Here the staff is held inverted as the object lies above the line of sight of the instrument.
4. The reading is entered in BS column with a negative sign.
5. Required numbers of intermediate staff readings are taken in the direction of last point.
6. The RL of the given point is calculated by plane of collimation method.

Result:

The RL of the given point with respect to the bench mark which is above the line of sight is _____

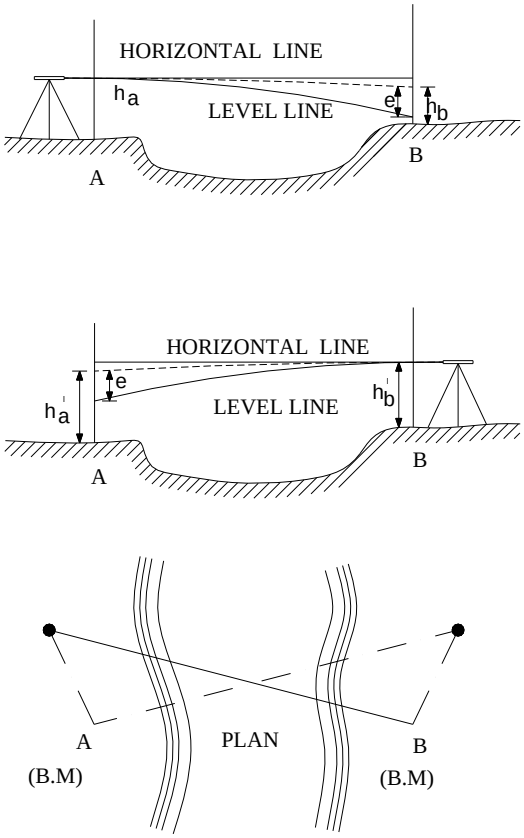


Fig. 8.2 Reciprocal leveling.

Tabulations and Calculations:

Instrument at	Staff reading on		Remarks
A			
B			

Experiment No : 8 **Date: __ /__ / __**

RECIPROCAL LEVELING

Aim: To determine the difference in elevation between two pointsusingreciprocal leveling and determination of collimation error**.**

Theory: When it is necessary to carry leveling across a river or any other obstacle requiring a long sight between two points so situated that no points for the level is found in between them, in that cases reciprocal leveling may be used (if the width of is small) to obtain accuracy and to eliminate the following:

1. Error in the instrument adjustment;
2. Combined effect of earth's curvature and the refraction of the atmosphere; and
3. Variation in the average refraction.

Let A and B be the points on the opposite banks of a river. The following procedure is used.

Instruments used:

Sl. No.	Particulars	Quantity
1.	Dumpy level	01
2.	Tripod	01
3.	Levelling Staff	01

Procedure:

1. Drive pegs at A and B. Set up the instrument near the peg A. Take readings h_a and h_b on the staffs held at A and B respectively. The reading h_a will have to taken through the objective if instrument is very near to A.
2. Shift the instrument to near the peg B. Take readings h_a^1 and h_b^1 on the staffs held at A and B respectively. The reading h_b^1 will have to taken through the objective if instrument is very near to B.

3. Determine the true difference in elevation using following relation

$$\text{True Difference in elevation} = \frac{1}{2}[(h^1_a - h^1_b) + (h_a - h_b)]$$

4. Determine the total error **e** using following relation

$$\mathbf{e} = \frac{1}{2}[(h^1_a - h^1_b) - (h_a - h_b)]$$

The total error can be expressed as

$$e = e_l + e_c - e_r$$

where e_l = collimation error, assumed positive when the line of collimation is inclined upwards

e_c = error due to curvature = - 0.0785 d^2

e_r = error due to refraction = 0.0112 d^2

d = distance between two points A and B

5. Determine the collimation error $\mathbf{e_l}$ using following relation

$e_l = e - 0.0673\ d^2$

SL No	BS	IS	FS	HI	Distance			RL	Remarks
					Left	Center	Right		

Experiment No : 9 **Date: __ /__ / __**

PROFILE AND CROSS SECTION LEVELING

Aim: To conduct profile leveling and cross sectioning,plotting using excel

Theory: It is the operation to determine the elevations of points, which are equally spaced along a given alignment to know the profile of the ground. The purpose of profile levelling is to determine the depth of cut or height of embankment for a given gradient selected. It is very useful for projects like constructions and design of sewers, pipelines, Highways, Railways, Canals, etc.

Instruments used:

Sl. No.	Particulars	Quantity
1.	Dumpy level	01
2.	Tripod	01
3.	Levelling Staff	01
4	Chain	01
5	Tape	01
6	Compass	01
7	Arrows	few
8	Ranging rods	few

Procedure: Following procedure is adopted in Profile leveling along a given alignment.

1. Lay the chain on the ground and stretch it.
2. Locate the points on the chain line at equal distance in the longitudinal direction and transverse direction using cross staff.
3. Setup the tripod at the convenient plane surface & fix the dumpy level on it.
4. Temporary adjustments are done and the instrument is leveled by using the bubble tube.

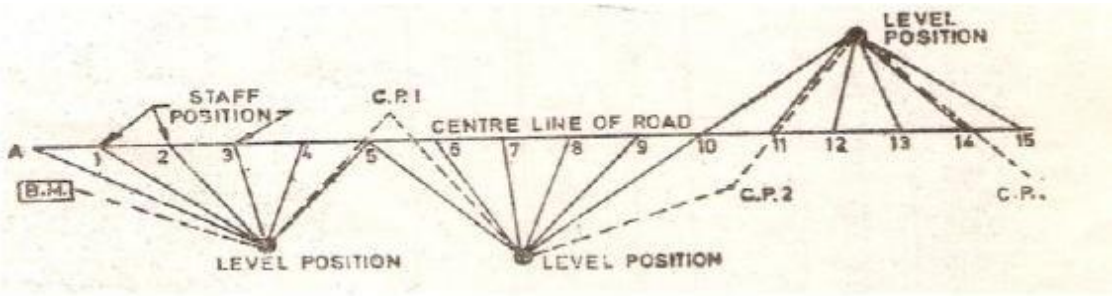


Fig. 9.1 Profileleveling.

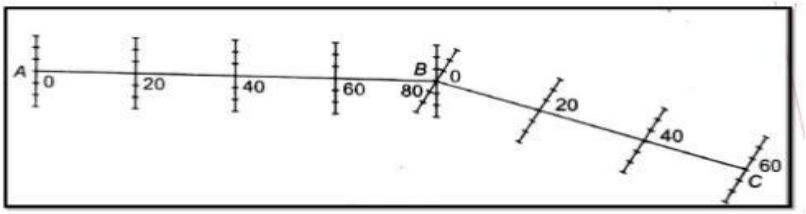
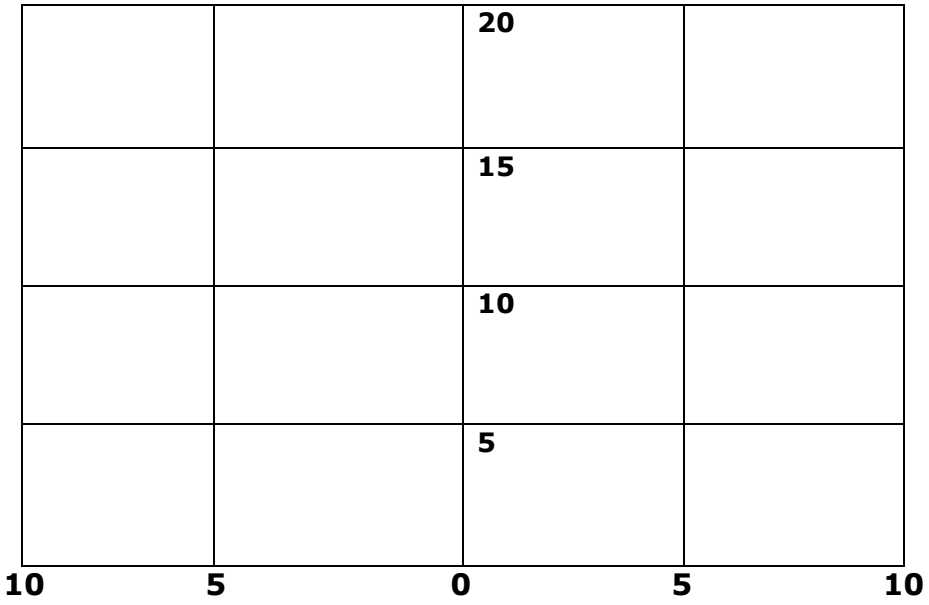


Fig. 9.2 Cross-sectional leveling.

5. After leveling the instrument, the leveling staff is held on the given bench mark.
6. Take the levels at the marked points on the chain line along the longitudinal and and transverse direction and enter the readings in respective columns.
7. Shift the level if required. The procedure is repeated until we reach the last point.
8. The longitudinal and cross sections of the ground are plotted using excel.



Position of anchor point	Initial Reading	Final Reading	Value of N	Remark

Date: __ /__ / __

BLOCKLEVELING

Exersice No: 9.1

Aim: To conduct block leveling, preparation of contour plan using excels. Use of planimeter/graph and computations of Areas and volumes.

Instruments used:

Sl. No.	Particulars	Quantity
1.	Dumpy level	01
2.	Tripod	01
3.	Levelling Staff	01
4	Chain	01
5	Tape	01
6	Compass	01
7	Arrows	few
8	Ranging rods	few

Theory: CONTOURING: The elevation and depression the undulations of the surface of the ground are shown as map by interaction of level surface with by means of contour line. a contour may be defined as the line of intersection of a level surface with the surface of the ground.

Procedure:

1. Lay the chain on the ground and stretch it.
2. Locate the points on the chain line at equal distance in the longitudinal direction and transfers direction.
3. Setup the tripod at the convenient plane surface & fix the dumpy level on it.
4. Temporary adjustments are done and the instrument is leveled by using the bobble tube.
5. After leveling the instrument, the leveling staff held on the given bench mark.
6. Divide the total area into number of blocks having equal area.
7. The corners of the blocks are marked with arrows.
8. The elevations of the ground at the corners of squares are taken and enter in to tabular columns

SL No	BS	IS	FS	HI	Distance			RL	Remarks
					Left	Center	Right		

9. The systems of squares are potted on the drawing sheet. The respective RL shell be entered near each respective corners.
10. The contour of required RL's are plotted.

LOCATING CONTOURS:

This method is commonly used in rough survey, cross sections are run traverse to the contour line of road, and railway as canal and the point of change of slope (representations) are located. The cross-section line may be inclined at any angle To the centerline if necessary. The spacing of the cross sections depends upon the characteristics of the ground.

By interpolation of contour is meant the process of spacing the contour proportioning between the plotted ground points. Contour may be interpolated by

1) Estimation
2) Arithmetical calculations
3) Graphical method .in all these methods

It is assumed that the slope of the ground between any two random points is uniform.

RESULT: The contour of given land is drawn in excel sheet.

INTRODUCTION ON THEODOLITE

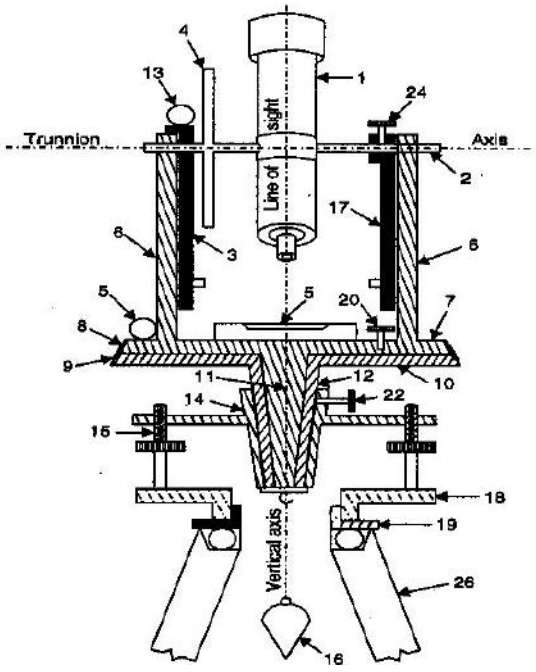
Theodolite is a survey instrument widely used in survey for its capability of being employed in the very accurate determination of horizontal and vertical angles.

There are two types of theodolite, namely:

1) Transit theodolite.

2) Non-transit theodolite.

Transit theodolite:A transit theodolite is one in which the line of sight is reversed by revelling the telescope through 180 ^{o} in the vertical plane. This complete revolution is known as transit theodolite.



Transit theodolite

Non-Transit theodolite:

A non-transit theodolite is either plain theodolite or Y- theodolite in which the telescope can not be rotated in a vertical plane through complete revolution.The transit is mainly used & non-transit theodolite is now become absolute.

The transit theodolite contents the following parts,

1. Telescope
2. Clamp screw
3. Focussing screw
4. Horizontal axis
5. tangent screw
6. standard
7. upper plate
8. Lower plate
9. inner axis
10. outer axis
11. Tribranch
12. foot screw
13. trivet
14. tripod stand
15. wing nut
16. plumb bob
17. plate bubble
18. index bar
19. tabular compass
20. altitude bubble
21. adjustable mirror
22. vertical circle

Trivet: Itis a circular plate having a central threaded hole for fixing the theodolite on the tripod stand by a wingnut.it is also called the base plate. Three foot screws are secured to this plate by means of a ball and socket arrangement**.**

Foot screws: These are meant for levelling the instrument the lower part of the foot screws are secured in the trivet by means of a ball and socket arrangements and the upper threaded part passes through the threaded hole in the tribranch plate.

Levelling head: The trivet, foot screws and the tribranch constitute a body which is known as the levelling head.

Spindles: The theodolite consists of two spindles or axes one inner and the other outer, inner axis is solid and conical and the outer is hallow. Two spindles are co-axial.

Lower plate: The lower plate is attached to the outer axis and is also known as the scale plate. It is bevelled and the scale is graduated from 0^{o} to 360^{o} in a clockwise direction each degree is again subdivided in to two, three or four divisions. Thus the value of one small division may be 30,20&15 respectively.

The lower plate is provided with a clamp screw and a tangent screw which control its movements when the clamp screw is tightened. This plate is fixed with the outer axis for fine adjustment of the

lower plate. The tangent screw is rotated to the extent required the size of the theodolite is designated according to the diameter of the lower plate.

Upper plate: The upper plate contains the vernier scales A & B. it is attached to the inner axis. Its motion is controlled by the upper clamp screw and upper tangent screw. When the clamp screw is tightened the vernier scales are fixed with the inner axis and for fine adjustment of the scale the tangent screw is rotated.

Plate bubble : Two plate bubbles are mounted at right angle to each other on the upper surface of the vernier plate. one bubble is kept parallel to the horizontal axis of the theodolite sometimes one plate bubble is provided on the vernier plate. The bubble is provided on the vernier plate the bubbles are meant for levelling the instrument at the times of measuring the horizontal angles.

Standard or A-frame: Two frames (shaped like the letter A) are provided on the upper plate to support the telescope, the vertical circle and the vernier scales. These frames are known as standards or A frames.

Telescope: The telescope is provided between the standards at right angles to the horizontal axis it can be rotated about its horizontal axis in a vertical plane. The telescope is provided with a focussing screw clamping screw and tangent screw.

Vertical circle: The vertical circle is rigidly fixed with the telescope and moves with it. It is divided in to four quadrant, each quadrant is graduated from 0 90 in opposite direction with the zero mark at the ends of the horizontal diameter through vertical circle.

The line joining the zero marks corresponding to the collimation. The sub divisions of the vertical circle are similar to these of the horizontal circle. The vertical circle can be clamped or finely adjusted with the help of the clamping screw and the tangent screw provided along with the telescope

Index bar or T-frame: The index bar is provided on the standard in front of the vertical circle. It carries two verniers(C&D) at the two ends of the horizontal arm the vertical leg of the index bar is provided with a clip screw at the lower end by means of which the altitude bubble can be brought to the centre.

Altitude bubble:A long sensitive bubble tube is provided on the top of index bar, the bubble it contains is known as the altitude bubble. This bubble is brought to the centre by the clip screw at the

time of measuring the vertical angle. A mirror is provided on the top of the bubble to help observe it when the instrument is set up above normal height.

Compass: Some times a circular box compass is mounted on the verneir scale between the standard in modern theodolites, an adjustable through compass or tabular compass can be fitted with a screw to the standard. The compass is provided for taking the magnetic bearing of a line.

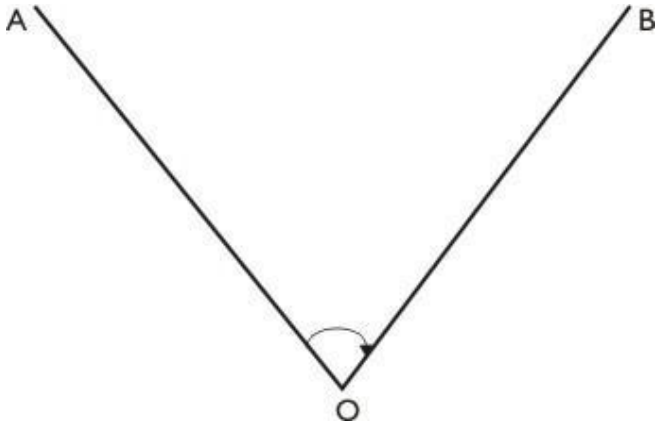


Fig: 10.1 Method of repetition

Instrument station	Sighted To	Face Left Swing Right												Face Right Swing Right												Average Horizontal Angle		
		A			B		Mean			No Of Repititions	Horizontal Angle			A			B		Mean			No Of Repititions	Horizontal Angle					
		°	'	"	'	"	°	'	"		°	'	"	°	'	"	'	"	°	'	"		°	'	"	°	'	"
	A																											
	B																											
	A																											
	B																											

Experiment No. 10 **Date: __ /__ / __**

MEASUREMENT OF HORIZONTALANGLES

Exercise 10.1 Method of Repetition

Aim: To measure the horizontal angles AOB w.r.t O by the method of repetition

Instruments used:

Sl. No.	Particulars	Quantity
1.	Theodolite	01
2.	Tripod	01
3.	Ranging Rods	02

Theory: Method of repetition is used to measure a horizontal angle to a finer degree of accuracy that is obtainable with the least count of the vernier.In this method, the angle is measured 2 or more times by allowing the vernier to remain clamped each time at the end of each measurement instead of setting it back to zero. Thus, an angle reading is added several times depending upon the number of repetitions. The average horizontal is then obtained by dividing the final reading by the number of repetitions.

Procedure:

1. Set up the instrument at O and level accurately
2. Adjust the plates such that the vernier A reads zero(vernier B shall read 180**°** if there is no instrumental error)**.** Bring the vertical circle to the left of the telescope.
3. Loose the lower clamp and turn the instrument towards A.Bisect A accurately using the lower tangent screw.(There shall be no change in readings as the upper plate is clamped).
4. Unclamp the upper clamp and rotate the instrument in the clockwise direction to bisect B. Clamp the upper clamp and use the upper tangent screw to bisect B accurately. Note the reading of vernier A & B to get the approximate value of angle AOB
5. Unclamp the lower clamp and turn the telescope clockwise to sight Aagain.Bisect A accurately using the lower tangent screw. The vernier readings will not change as the upper plate is clamped.

6. Unclamp the upper clamp and rotate the instrument in the clockwise direction to bisect B. Clamp the upper clamp and use the upper tangent screw to bisect B accurately.
7. Repeat the process till the angle is repeated the required number of times.
8. Change the face by transiting the telescope and repeat the whole process for the other face readings
9. The average horizontal angle is then obtained by taking the mean of the two readings with different faces

RESULTS:- The average horizontal angle = _____

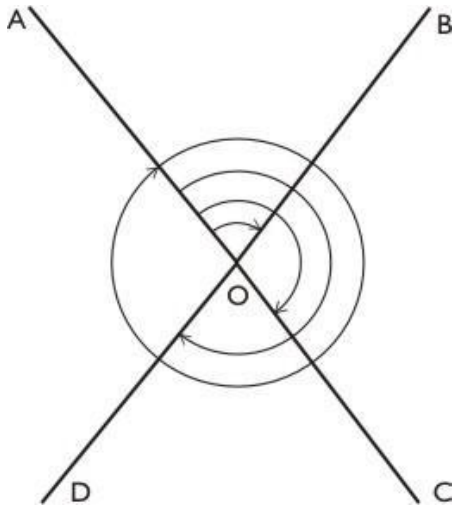


Fig 10.2 Method of Reiteration

Instrument station	Sighted To	Face Left Swing Right												Face Right Swing Right												Average Horizontal Angle		
		A			B		Mean			No Of Repititions	Horizontal Angle			A			B		Mean			No Of Repititions	Horizontal Angle					
		°	'	"	'	"	°	'	"		°	'	"	°	'	"	'	"	°	'	"		°	'	"	°	'	"

Exercise No. 10.2 **Date: __ /__ / __**

Aim: To measure the horizontal angles AOB, BOC, COD etc by the method of reiteration

Instruments used:

Sl. No.	Particulars	Specification	Quantity
1.	Theodolite		01
2.	Tripod		01
3.	Ranging Rods		04

Theory: This method is suitable for measurements of the angles of a group having a common vertex point. Several angles are measured successively and finally the horizon is closed (closing the horizon is the process of measuring the angles around a point to obtain a check on their sum, which should be 360°

Procedure:

1. Set up the instrument at O and level accurately
2. Adjust the plates such that the vernier A reads zero(vernier B shall read 180**°** if there is no instrumental error)**.** Bring the vertical circle to the left of the telescope.
3. Loose the lower clamp and turn the instrument towards A (or any other reference point).Bisect A accurately using the lower tangent screw.
4. Unclamp the upper clamp and rotate the instrument in the clockwise direction to bisect B. Clamp the upper clamp and use the upper tangent screw to bisect B accurately. Note the reading of vernier A & B the mean of the vernier readings will give angle AOB
5. Similarly bisect C and D successively, thus closing the circle. Each included angle is obtained by taking the difference between two consecutive readings
6. On the final sight to A, the reading of the vernier should be either 0° or 360°.If not note the vernier readings and find the error due to slip, and if the error is small distribute it equally to all the angles. If large repeat the procedure and take fresh readings.
7. Repeat the step with the other faces

Results: The average horizontal angle

AOB =_____BOC= _____COD=_____DOA=_____

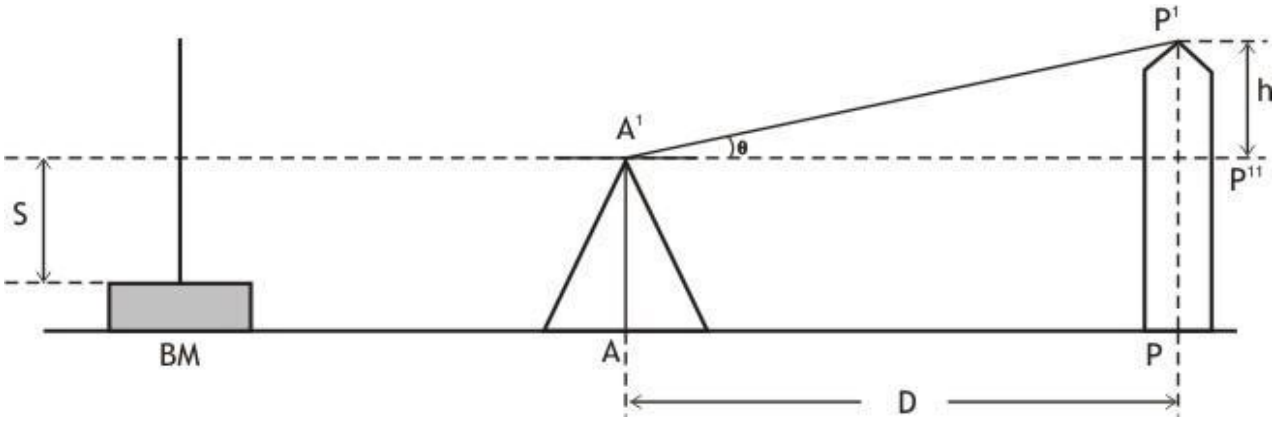


Fig 13.1 Single plane method (Base accessible)

Instrument At	Sighted To	Face : Left										Face : Right										Average vertical Angle		
		C			D		Mean			Vertical Angle			C			D		Mean			Vertical Angle					
		°	'	"	'	"	°	'	"	°	'	"	°	'	"	'	"	°	'	"	°	'	"	°	'	"
A	P′																									

Date: __ /__ / __

VERTICAL ANGLE

Exercise No. 10.3 SINGLE PLANE METHOD

Aim: To determine the elevation of an object using single plane method when base is accessible

Instruments used:

Sl. No.	Particulars	Quantity
1.	Theodolite	01
2.	Tripod	01
3.	Ranging Rods	few
4.	Tape	01
5	Leveling staff	01

Theory: The method is said to be a single plane method when the instrument station are in the same vertical plane as that of the elevated object

Procedure:

1. Identify the object whose elevation is to be determined
2. Identify the BM and record the RL of BM
3. Set up the instrument at station A and perform the temporary adjustments
4. Take the staff reading on BM keeping the telescope horizontal (vernier C and D reading zero)
5. Focus the telescope to the top of the object (P') and measure the angle of elevation ɵ (take face left and face right observations)
6. Measure the distance D accurately

Calculations:

Let

A = Instrument station

A' =Centre of the instrument

P' = Point to be observed

P" = Projection of P'

h = P"P'

s = Reading of staff kept on BM with line of sight horizontal

ɵ = Angle of elevation from A' to P'

h'=PP"

consider triangle A'P'P"

tanɵ= h/D

Therefore h= D tanɵ

RL of P' = RL of BM + s + D tanɵ

The height of the object = h'+ h

1. Staff reading s = _____m
2. Angle of elevation ɵ = _____ (average of both the face values)

Results: Level of top of the object when the base is accessible = _____m

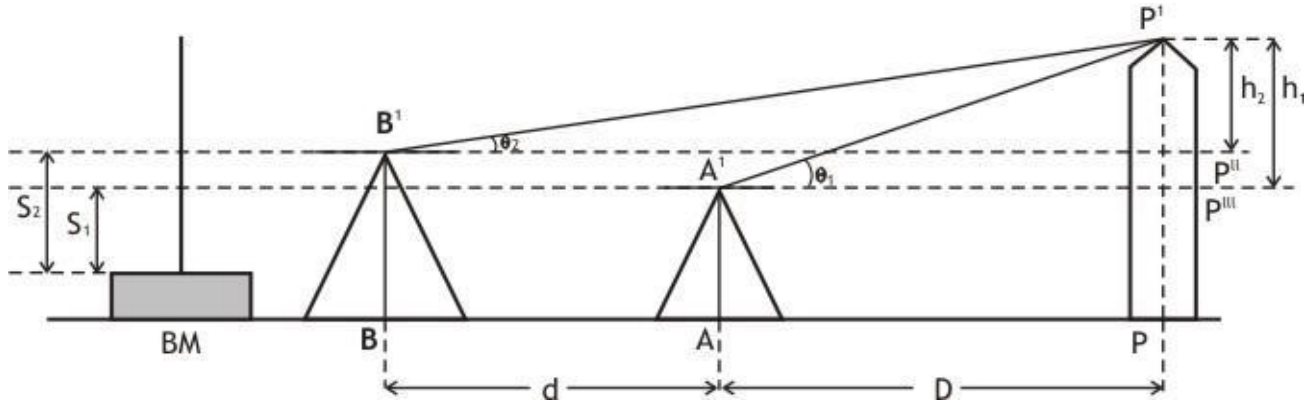


Fig 10.4 single plane method (base Inaccessible)

Instrument At	Sighted To	Face : Left										Face : Right										Average vertical Angle		
		C			D		Mean			Vertical Angle			C			D		Mean			Vertical Angle					
		°	'	"	'	"	°	'	"	°	'	"	°	'	"	'	"	°	'	"	°	'	"	°	'	"
A	P′																									
B	P′																									

Exercise No. 10.4 **Date: __ /__ / __**

Aim: To determine the elevation of an object using **single plane method** when base is **inaccessible**

Instruments used:

Sl. No.	Particulars	Quantity
1.	Theodolite	01
2.	Tripod	01
3.	Ranging Rods	few
4.	Tape	01
5	Leveling staff	01

Case 1 : when the instrument station near the object is at lower elevation than the other

Let h1 = P"P'

h2 = P"'P'

s1 = Reading of staff kept on BM from instrument station A

s2 = Reading of staff kept on BM from instrument station B

$\theta 1$ = Angle of elevation from A' to P'

$\theta 2$ = Angle of elevation from B' to P'

d= Horizontal distance between two instrument stations

D = Horizontal distance between A and P

Considering triangle A'P'P"

$\tan\theta 1 = h1/D$

$h1 = D \tan\theta 1$ →**(1)**

Considering triangle B'P'P"

$\tan\theta 2 = h2/(d+D)$

$h_2 = (d+D) \tan\theta_2$ →**(2)**

From (1) & (2)

$$D = (d\tan\theta 2 \pm s)/(\tan\theta 1 - \tan\theta 2) \rightarrow \mathbf{(3)}$$

RL of P' from A = RL of BM + s1+ h1

Check:RL of P' from B = RL of BM + s2+ h2

s is +ve when station A is lower than B

s is –ve when station A is higher than B

Procedure:

1. Identify the object whose elevation is to be determined
2. Set up the instrument at station A and perform the temporary adjustments. Take the staff reading on BM keeping the telescope horizontal as s1 (vernier C and D reading zero)
3. Focus the telescope to the top of the object (P') and measure the angle of elevation $\theta 1$ (take face left and face right observations)
4. Transit the theodolite to reverse the line of sight and fix a point B at a measured distance d.
5. Shift the instrument to B and perform the temporary adjustments. Take the staff reading on BM keeping the telescope horizontal as s2 (vernier C and D reading zero)
6. Focus the telescope to the top of the object (P') and measure the angle of elevation $\theta 2$ (take face left and face right observations)

Results:

RL of P' = _____m

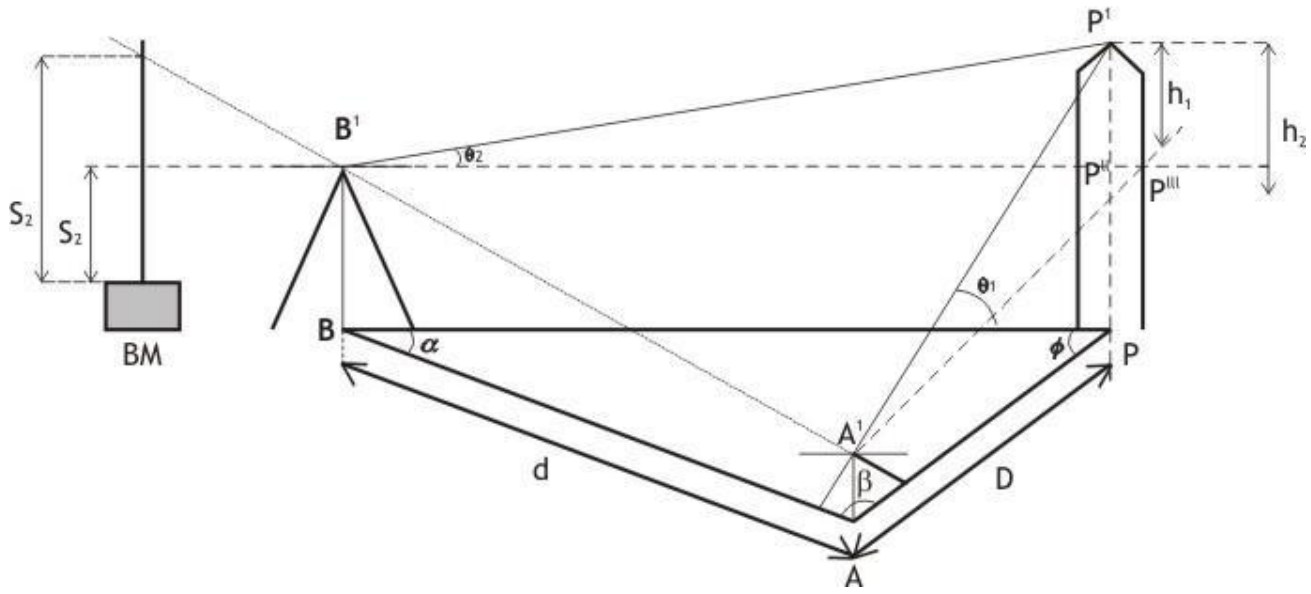


Fig:10.5 Double Plane Method

Instrument At	Sighted To	Face : Left Swing : Right											Face : Right Swing : Right											Average		
		A			B		Mean			Horizontal Angle			A			B		Mean			Horizontal Angle			Horizontal Angle		
		°	'	"	'	"	°	'	"	°	'	"	°	'	"	'	"	°	'	"	°	'	"	°	'	"

Instrument At	Sighted To	Face : Left										Face : Right										Average vertical Angle		
		C			D		Mean			Vertical Angle			C			D		Mean			Vertical Angle					
		°	'	"	'	"	°	'	"	°	'	"	°	'	"	'	"	°	'	"	°	'	"	°	'	"
A	P'																									
B	P'																									

Date: __ /__ / _

DOUBLE PLANE METHOD

Exercise No. 10.5

Aim: To determine the distance and difference in elevation between two inaccessible points using double plane method.

Instruments used:

Sl. No.	Particulars	Specification	Quantity
1.	Theodolite		01
2.	Tripod		01
3.	Ranging Rods		few
4.	Tape		01
5	Levelling staff		01

Theory: Method is said to be double plane when the instrument stations are not in same vertical plane as that of elevated objects

Let A & B = Instrument stations

P = Base of the object

$\theta 1$ = Angle of elevation from A' to P'

$\theta 2$= Angle of elevation from B' to P'

s1 = Reading of staff kept on BM from instrument station A

s2 = Reading of staff kept on BM from instrument station B

Considering triangle ABP

We have

α & β = Known(measured)

Therefore ø =(180- α - β)

Applying sine rule

AP/sin α =BP/sin β = AB/sin ø

But AB=d

Therefore

AP = d sin α/sin ø, BP = d sin β/sin ø

To determine the elevation of P'

RL of P' = RL of BM + s1 + AP tan ϴ1

RL of P' = RL of BM + s2 + BP tanϴ2

Procedure:

1. Set up the theodolite at A and measure distance d accurately to mark B
2. Measure angle BAP (β)
3. Sight p' and measure the vertical angle ϴ1
4. With the telescope horizontal take the staff reading s1 on the BM
5. Shift the instrument to station B and measure the horizontal angle PBA (α)
6. Sight P' and measure the vertical angle ϴ2
7. With the telescope horizontal take staff reading s2 on the BM

Results: RL of to of the object = _____m

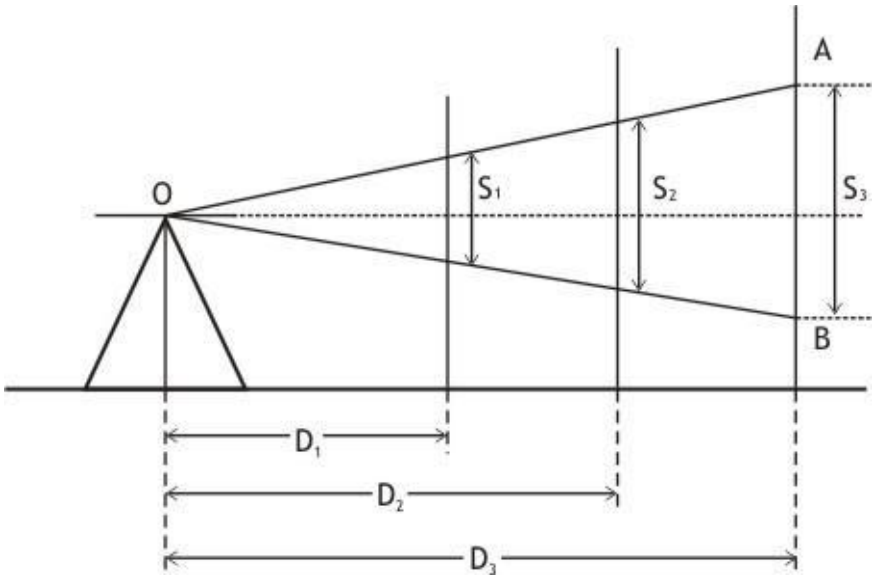


Fig: 12.1

Distance	Staff Reading		Staff Intercept	Multipying Constant K	Additive Contant C
	Upper Hair (m)	Lower Hair (m)			

Experiment No. 12 **Date: __ /__ / __**

TACHEOMETRY

Exercise No. 12.1

Aim: To determine the tacheometric constants using horizontal line of sight.

Instruments used:

Sl. No.	Particulars	Specification	Quantity
1.	Theodolite		01
2.	Tape		01
3.	Ranging Rods		03
4.	Arrows		few
5.	Leveling staff		01
6.	Chain		01

Procedure:

1. Measure a total distance of 80m on the ground and put pegs at 20m interval (on a fairly level ground)
2. Set the tacheometer at the zero chain age and do the temporary adjustments
3. Take the stadia readings keeping the levelling staff at 20m, 40m, 60m and 80m keeping the telescope horizontal thought

Calculations:

$D_1=Ks_1+C$

$D_2=Ks_2+C$ … so on

Solving any 2 equations we get set of K & C values.

Results: Average value of the tacheometric constants

K=_____

C=_____

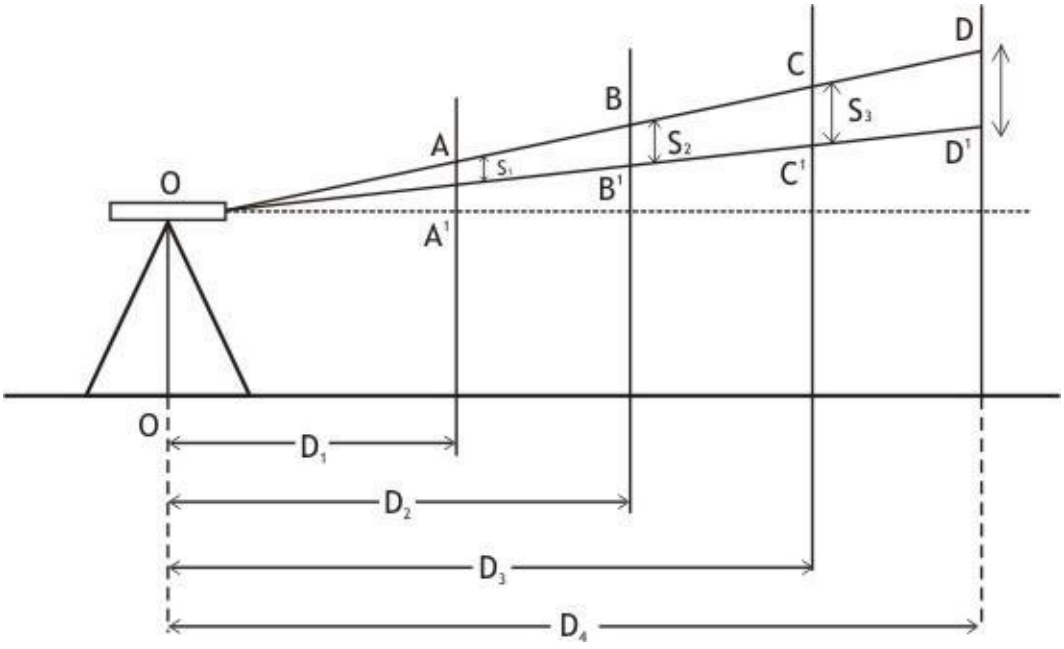


Fig4.2

Distance	Staff Reading		Staff Intercept	Multipying Constant K	Additive Contant C
	Upper Hair (m)	Lower Hair (m)			

Exercise No. 12.2 **Date: __ /__ / __**

Aim: To determine the tacheometric constants using inclined line of sight.

Instruments used:

Sl. No.	Particulars	Specification	Quantity
1.	Theodolite		01
2.	Tape		01
3.	Ranging Rods		03
4.	Arrows		few
5.	Leveling staff		01
6.	Chain		01

Procedure:

1. Measure a total distance of 80m on the ground and put pegs at 20m interval (on a fairly level ground)
2. Set the tacheometer at the zero chainage and do the temporary adjustments
3. Fix the telescope to some angle and take the stadia readings keeping the levelling staff at 20m, 40m, 60m and 80m.

Calculations:

$D_1 = Ks_1\cos^2\phi + \cos\phi$

$D_2 = Ks_2\cos^2\phi + \cos\phi$ … so on

Solving any 2 equations we get set of K & C values.