

CHAPTER ONE

THE STUDY OF THEODOLITE.

AIM: To familiarize with the different parts of Theodolite and their functions

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 COLLINATION: 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.

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 which is used to support the main part of the instrument and 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.

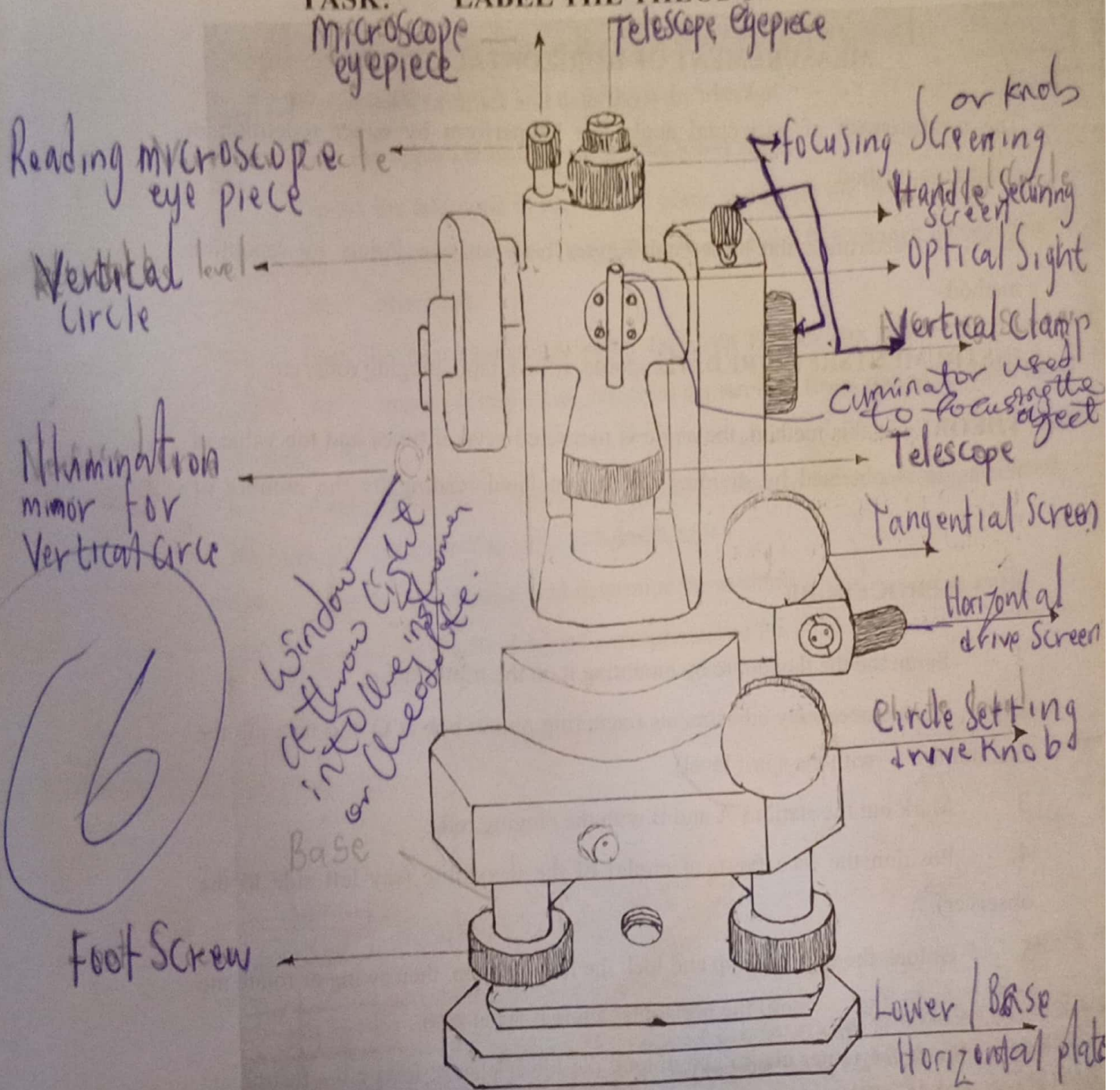
SWINGING THE TELESCOPE: It means turning the telescope about its vertical axis in the horizontal plane. A swing is called right or left according as the telescope is rotated clockwise or counter clockwise.

FACE LEFT: If face of the vertical circle is to the left side of the observer, then the observation of the angle taken is known as face left observation.

FACE RIGHT: If the face of the vertical circle is to the right of the observation of the angles taken is known as face right observation.

CHANGE FACE: It is an operation of bringing the face of the telescope from left to right and vice-versa.

TASK: LABEL THE THEODOLITE BELOW



the cross in collimator is used for alignment.

CHAPTER TWO

MEASUREMENT OF HORIZONTAL ANGLES

The measurement of horizontal angle can be performed by either repetition or reiteration method.

AIM: To determine the horizontal Angles between two Points by repetition method.

INSTRUMENTS REQUIRED: Theodolite, tripod, tape, ranging rods, etc.

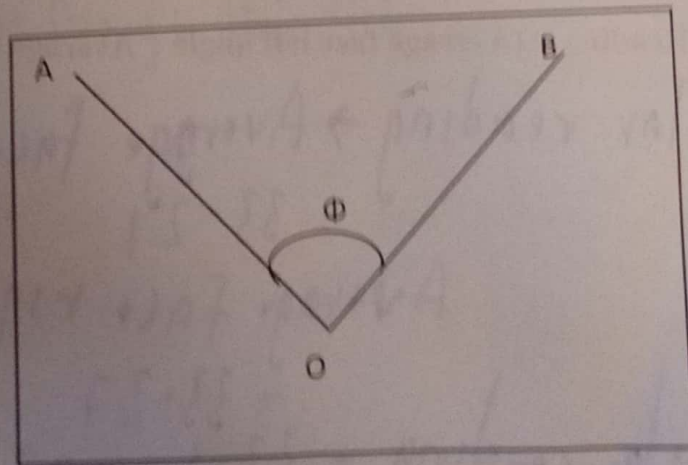
THEORY: In this method, the angle is measured several times and the value of the angle is obtained by dividing the accumulated reading by the number of repetitions.

FIELD PROCEDURE

1. Setup the theodolite by mounting it on the tripod stand.
2. Do the necessary adjustments (centering plumb bob at O and leveling the theodolite with the spirit level).
3. Mark out the stations A and B with the ranging rods.
4. Position the face (vertical circle) of the theodolite (say left side to the observer).
5. Unlock the upper clamp and lock the lower clamp, then swing or rotate the theodolite until the horizontal angle is set at zero.
6. Lock the upper clamp and unlock the lower clamp. Rotate the instrument and use the telescope to focus at station A while the horizontal angle is still at zero.
7. Lock the lower clamp and unlock the upper clamp. Use the telescope and swing right from station A to focus station B. Take the reading at B.

8. Angle AOB is the horizontal angular difference between angle at A and the angle at B (which is angle at B - angle at A (which is 0 initially)).
9. Repeat for four times and determine the average.
10. Lock the upper clamp and unlock the lower clamp.
11. Transit the telescope in the vertical plane and rotate the theodolite through 180° in the horizontal plane. This is done to achieve a face change (now facing right to the observer).
12. With the face changed to right, focus on B, lock the lower clamp and unlock the upper clamp swing left from station B to focus station A. Take the reading at A.
13. Angle BOA is the horizontal angular difference between angle at B and the angle at A (which is angle at A - angle at B).
14. Repeat for four times and determine the average.
15. Record the results obtained appropriately in the notebook.

TASK:



TABLE/RESULT:

STATION O	FROM A	TO B	ANGLE AOB
Face left	0.00°	33.33°	33.33°
Face left	0.00°	33.42°	33.42°
Face left	0.00°	33.05°	33.08°
Face left	0.00°	33°	33
Average			= 33.21°
	FROM B	TO A	ANGLE BOA
Face right	213°	179.5°	33.5°
Face right	212.58°	179.42°	33.16°
Face right	212.75°	179.5°	33.25°
Face right	212.67°	179.5°	33.17°
Average			= 33.27°

CALCULATION:

Angular Reading = (Average face left angle + Average face right angle)/2

Angular reading → Average face left angle
= 33.21

Average face right angle

= 33.27

Angular reading = $\frac{33.21 + 33.27}{2} = \frac{66.48}{2} = 33.24$

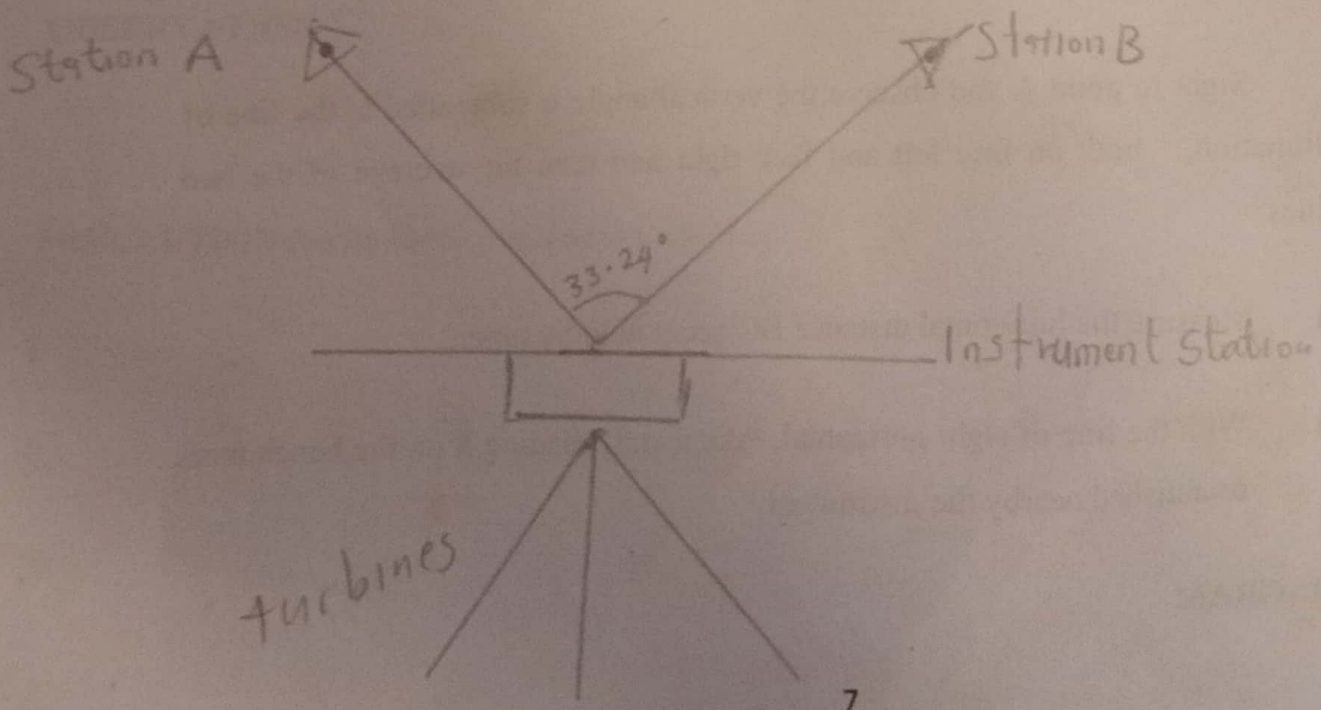
∴ Angular reading between A and B = 33.24

OBSERVATION:

When taking the reading of the face left, the angle reading scale was set to zero before the reading was taken. The average reading of the face left was found and calculated to be 37.27° . The angle between stations A and B was found to be 33.24° .

PRECAUTION (write three precautions taken)

- i. Ensure that the levelling screws was brought to middle of their run before setting the instrument on the station
- ii. I ensured that centring and levelling was done properly with the help of the tripod
- iii. I ensured that rough pointing was done by eye observation before sighting through the telescope



CHAPTER THREE

MEASUREMENT OF VERTICAL ANGLE

1. ELEVATION OF AN INACCESSIBLE POINT WHOSE BASE IS ACCESSIBLE: In order to determine the elevation of the point of a tower, pole or building etc. whose base is inaccessible, proceed as follows:

AIM: To determine the Elevation of an inaccessible point whose base is accessible.

INSTRUMENTS REQUIRED: Theodolite, tripod, tape, ranging rods, plumb bob etc.

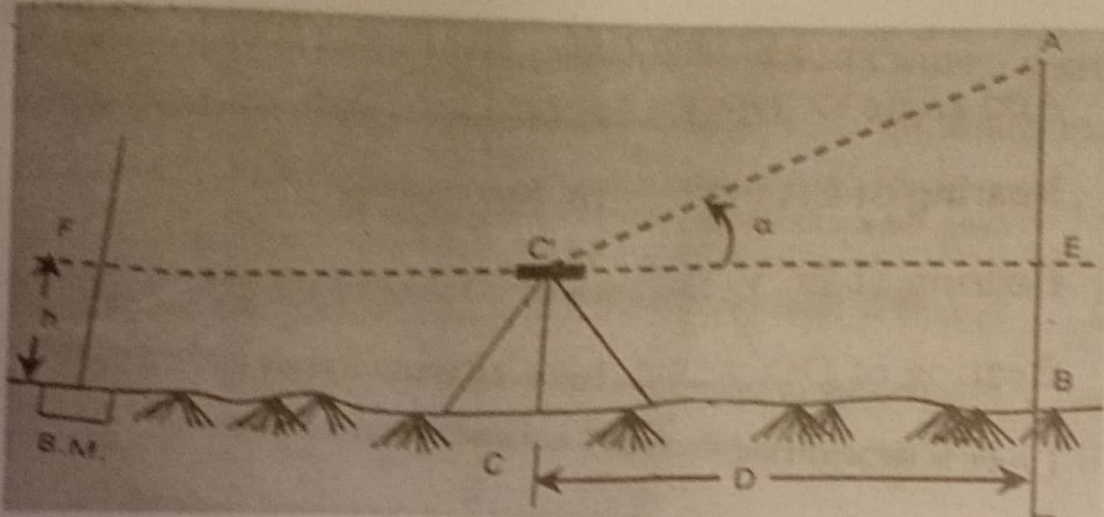
FIELD POCEDURE:

Let A be the inaccessible point whose elevation is required.

Let B be its projection on the ground which is accessible.

- i) Set up the theodolite at C, at a distance of say D meters from B and level it accurately by the altitude level.
- ii) Sight to point A and observe the vertical angle α subtended at the line of collimation, both on face left and face right and take the average of the two values.
- iii) Measure the horizontal distance BC accurately by tape.
- iv) With the line of sight horizontal, take a staff reading h on the bench mark established nearby the instrument.

DIAGRAM



TASK

CALCULATIONS:

$$AE = D \tan \alpha$$

$$\text{R.L of A} = \text{R.L of BM} + h + D \tan \alpha$$

OBSERVATION:

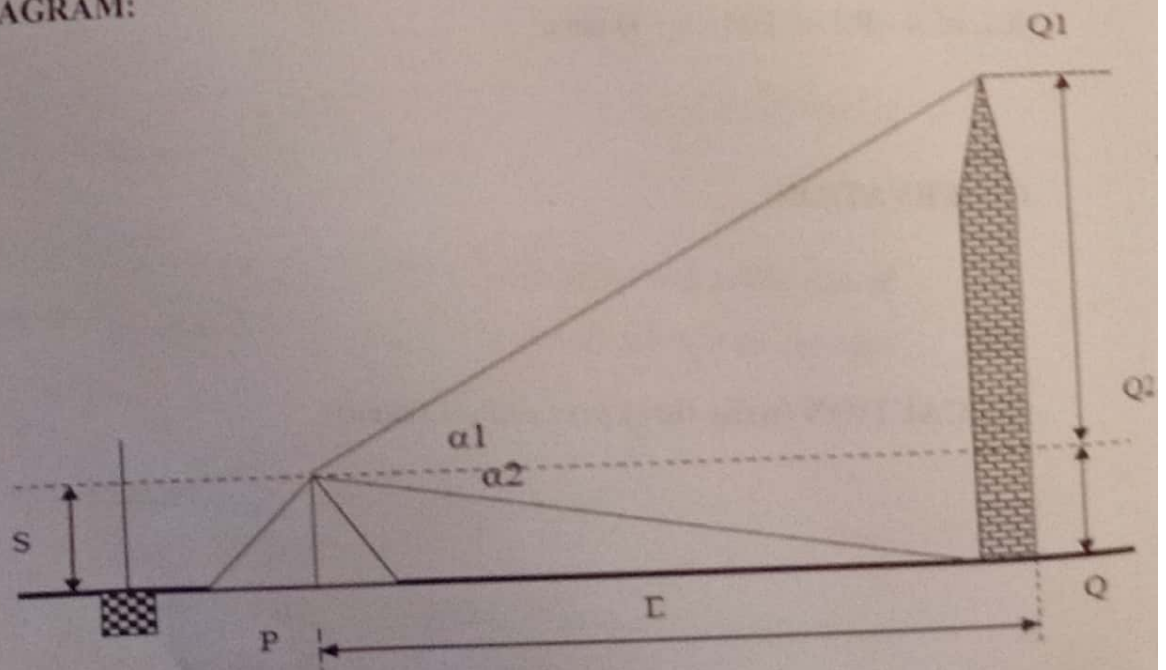
PRECAUTION (write three precautions taken):

- i.
- ii.
- iii.

FIELD PROCEDURE (SECOND METHOD WHEN BASE IS ACCESSIBLE):

- i. Setup the instrument at station P.
- ii. Perform all temporary adjustments.
- iii. Bring the line of collimation horizontal (vertical angle reading is zero).
- iv. Sight the top of the object (A), and read the vertical angle α_1 .
- v. Sight the bottom of the object B, and read the vertical angle α_2 .
- vi. Measure the Horizontal distance between the instrument station and the object (D).
- vii. Calculate the height of the object

DIAGRAM:



TASK:

$$S = Q_2$$

CALCULATION:

$$Q1 = D \tan \alpha_1 \text{ ----- (i)}$$

$$Q2 = D \tan \alpha_2 \text{ ----- (ii)}$$

The object height = $Q1+Q2$

OBSERVATION:

PRECAUTION (write three precautions taken):

- i.
- ii.
- iii.

CHAPTER FOUR

DETERMINATION OF CONSTANTS OF TACHEOMETER

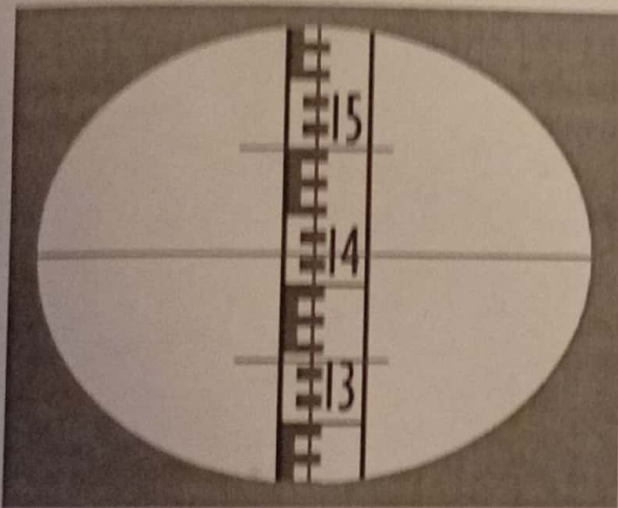
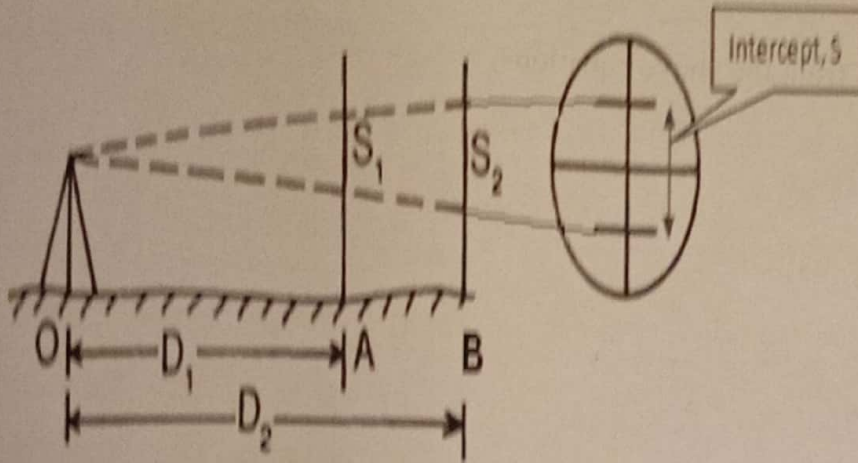
AIM: To determine the multiplying constant and additive constant of the given theodolite.

EQUIPMENTS: Theodolite, Ranging Rods, Leveling Staff, Tape.

FIELD PROCEDURE:

1. Setup the theodolite at the point O and do the temporary adjustments.
2. Measure $D_1=10\text{m}$, $D_2= 20 \text{ m}$ intervals from center of the theodolite and keep the staff on the measured intervals at A and B and observe the corresponding staff intercepts with the help of stadia or cross hair.
3. Substitute the values of distance (D) and staff intercept (s) for different points in the equation $D = ks + C$, where k & s are the tacheometric constants. K is the multiplying constant & C is the additive constant.
4. Solve the successive pairs of equations to get the value of k & C and find out the average of these values.

DIAGRAM:



TASK:

Instrument station	Staff station	Distance	Stadia reading			Stadia intercept(S)
			Top	Middle	Bottom	
O	A					
	B					

CALCULATION:

$$D=KS+C$$

$$D_1=K.S_1+C \text{ -----i}$$

$$D_2=K.S_2+C \text{ -----ii}$$

Calculate K and C from the above equations.

OBSERVATION:

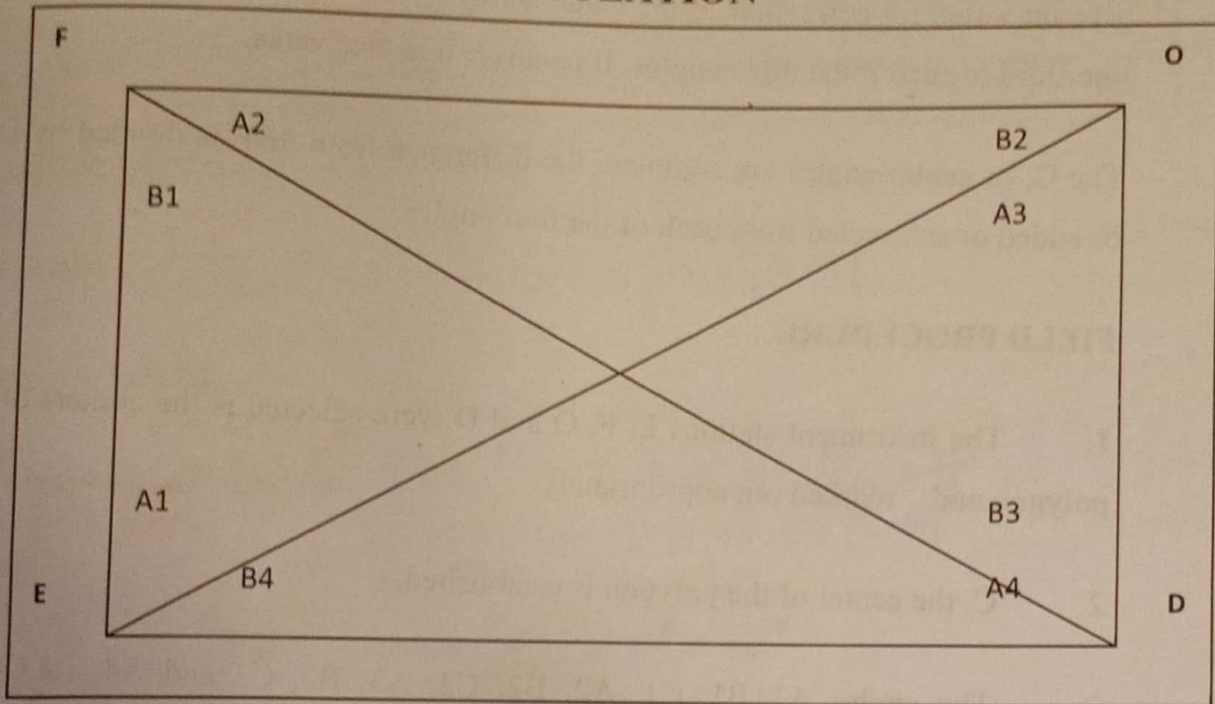
PRECAUTION (write three precautions taken):

i.

ii.

iii.

CHAPTER FIVE TRIANGULATION



Triangulation is a method of a controlled survey. In the simplest form of triangulation, the area is divided into a series of standard geometric shapes like polygons with central points, the corner of which forms a series of accurately located control stations. E F O D is a center point polygon. The marked angles are measured, and the lengths of all other sides of the entire triangulation are worked out from the observed lengths and angles after the necessary adjustments are made. These adjustments follow these rules:

1. Sum of angles at a point = 360°

$$C_1 + C_2 + C_3 + C_4 = 360$$

$\sum \Delta (C_1, C_2, C_3, C_4, \dots, C_n) = 360^\circ$

$$109 + 70.33 + 107.5 + 72.5 = \theta$$

2. Sum of angles in a triangle = 180°

$$359.33 = \theta$$

$\Delta A_1 + \Delta B_1 + \Delta C_1 = 180^\circ$

$$E_{mr} = 360 - \theta = 360 - 359.33$$

3. $\sum \text{LogSinA's} + \sum \text{LogSinB's} = \sum \text{LogSinC's}$

$$= 0.67$$

Correction $\frac{0.67}{4}$

$$\approx 0^\circ 10' 3''$$

Adjustment: The angles of each triangle is summed, the difference of 180 will give the value for correction. If the value is negative, you divide by three and add one-third to each of the three angles. If positive, it is vice versa.

The C, or center angles are summed, the difference from 360° is divided by four or added or subtracted from each of the four angles.

FIELD PROCEDURE

1. The instrument stations E, F, O and D were selected is the corners of the polygon and marked out appropriately.
2. C, the center of the polygon is established.
3. The angles A1+B1, C1, A2, B2, C2, A3, B3, C3 and A4, B4,C4 are measured using the theodolite and convenient method of angular measurement.
4. The average of the angular values obtained from the measurement are recorded.
5. The angles obtained were adjusted with the appropriate formula.

Station	Angle	Reading
E	A1	$35\frac{4}{6}^{\circ} = 35.66^{\circ}$
	B4	$54\frac{2}{6} = 54.33$
F	B1	$35\frac{2}{6} = 35.33^{\circ}$
	A2	$54\frac{4}{6} = 54.66$
O	A3	$35\frac{4}{6} = 35.66$
	B2	55
D	B3	$36\frac{5}{6} = 36.83^{\circ}$
	A4	$53\frac{1}{6} = 53.16$

C	C1	109°
	C2	$70\frac{2}{6} = 70.33^{\circ}$
	C3	$107\frac{3}{6} = 107.5^{\circ}$
	C4	$72\frac{3}{6} = 72.5^{\circ}$

Calculation: $\angle A_1 + \angle B_1 + \angle C_1 = \theta$

$$A_1 + B_1 + C_1 = \theta \Rightarrow 35.66 + 35.33 + 109 = 179.99$$

Error = $180 - \theta$

Correction = $((180 - \theta)/3)$ From angle $\angle A_2 + \angle B_2 + \angle C_2 = \theta$

$$54.66 + 55 + 70.33 = 179.99^{\circ}$$

$$\text{Error} = (180 - \theta) = 0^{\circ} 0' 36''$$

$$\text{Correction} = 180 - \theta / 3 = 0^{\circ} 0' 12''$$

OBSERVATION:

The error was gotten to be 0.01

The side from station E to station F was measured to be 19.8m while station F to station O was measure to be 14.30m

PRECAUTION:

- Ensured exact centring of instrument over station marked
- avoided error due to refraction, thus observation was made in the morning and in the evening
- increased precision by taking several readings.

$$\text{For } \angle A_3 + \angle B_3 + \angle C_3 = \theta$$

$$\rightarrow 35.60 + 36.83 + 107.6 = 180.03^{\circ}$$

$$\text{Error} = 180 - 179.99 = -0.03^{\circ}$$

$$\text{Correction} = 180 - \theta / 3 = 0 - 0^{\circ} 0' 36''$$

$$\text{For } \angle A_4 + \angle B_4 + \angle C_4 = \theta$$

$$53.66 + 54.33 + 72.5 = 179.99$$

$$\text{Error} = 180 - 179.99 = 0.01$$

$$\text{Refraction} = \frac{180 - \theta}{3} = \frac{0.01}{3}$$

$$17 = (3.333 \times 10^{-3}) = 0^{\circ} 0' 11.44''$$

Corrected Angle Reading

$$\begin{aligned} \text{For } \angle A_1 + \angle B_1 + \angle C_1 \\ &= (35.66^\circ + 0^\circ 0' 12'') + (35.33^\circ + 0^\circ 0' 12'') + (109^\circ + 0^\circ 0' 12'') \\ &= 35^\circ 39' 48'' + 35^\circ 20' 00'' + 109^\circ 00' 12'' = 180^\circ 00' 00'' \end{aligned}$$

$$\begin{aligned} \text{For } \angle A_2 + \angle B_2 + \angle C_2 \\ &= (54.66^\circ + 0^\circ 0' 12'') + (55^\circ + 0^\circ 0' 12'') + (70.33^\circ + 0^\circ 0' 12'') \\ &= 54^\circ 39' 48'' + 55^\circ 0' 12'' + 70^\circ 20' 00'' \\ &= 180^\circ 00' 00'' \end{aligned}$$

$$\begin{aligned} \text{For } \angle A_3 + \angle B_3 + \angle C_3 \\ &= (35.60^\circ - 0^\circ 0' 36'') + (36.83^\circ - 0^\circ 0' 36'') + (107.6^\circ - 0^\circ 0' 36'') \\ &= 35^\circ 35' 24'' + 36^\circ 49' 12'' + 107^\circ 35' 24'' \\ &= 180^\circ 00' 00'' \end{aligned}$$

$$\begin{aligned} \text{For } \angle A_4 + \angle B_4 + \angle C_4 \\ &= (53.16^\circ + 0^\circ 0' 12'') + (54.33^\circ + 0^\circ 0' 12'') + (72.5^\circ + 0^\circ 0' 12'') \\ &= 53^\circ 09' 48'' + 54^\circ 20' 00'' + 72^\circ 30' 12'' \\ &= 180^\circ 00' 00'' \end{aligned}$$