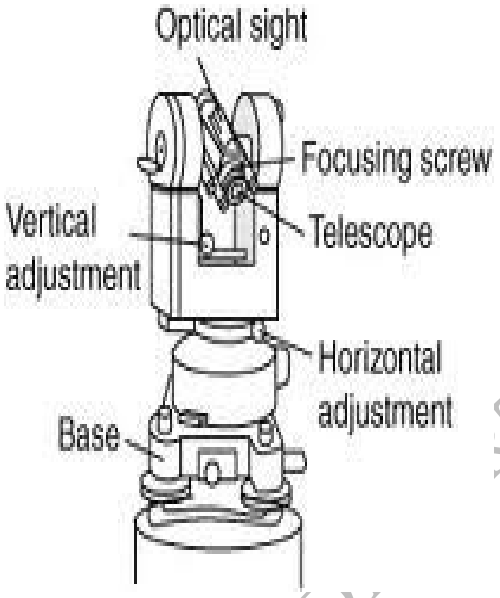
EXPERIMENT NO -……

STUDY OF PARTS OF A THEODOLITE AND THEIR USES

AIM:- To study the various parts of a theodolite and their uses.
Instruments required: Theodolite, Tripod

The theodolite is one of the most precise surveying instruments and is suitablefor measurement of angles in horizontal as well as vertical planes.



PARTS OF VERNIER THEODOLITE

THE LEVELING HEAD: this usually consists of a tri-batch and trivet carrying one foot screw on each of its three arms.

THE TWO SPINDLES: The theodolite has an outer axis and an inner axis of rotation which are both coincident with the vertical axis of the instruments.

THE LOWER PLATE AND UPPER PLATE: the outer axis is attached to the lower plate which is also called the scale plate. This plate is circular in shape and beveled at the edge. It is graduated from 00 to 3600 in the clock wise direction. The inner axis is attached to the upper plate which is also known as the vernier plate. The upper clamp and upper tangent screw facilitate fixing it to the lower plate at any desired position.

PLATE LEVEL TUBES: two level tubes are provided on the vernier plate at right angles to one another. These are known as Plate level.

STANDARDS: A pair of uprights or standards is placed on the vernier plate they support thehorizontal axis they are in the shape of letter A.

TELESCOPE: the telescope is fixed to a transverse horizontal axis also known as trunion
axis. It rests in bearings on the standards. The telescope can be rotated in a vertical plane aboutthe horizontal axis.

VERTICAL CIRCLE: A vertical graduated circle is rigidly attached to the telescope and rotatesalong with it. It is graduated from 00 to3600 continuously or from 00 to 900 in each quadrant.

T-FRAME: Its horizontal arm called index bar has two verniers, one at each end. The vertical legcalled the clipping arm has clips screws at its lower end.

CAMPASS: the tubular compass contains a magnetic needle fitted in a metal tube. When thepointer lines exactly midway between these two vertical lines, the magnetic will be defined.

PLUMB BOB: the Plumb bob is suspended from the hook fitted to the bottom central vertical axis.

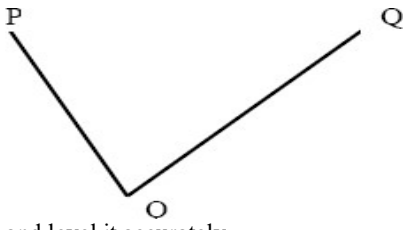
EXPERIMENT NO – ……
MEASUREMENT OF HORIZONTAL ANGLES BY REPETITION METHOD

Aim: To measure the horizontal angle by the method of repetition.

Instruments required: Theodolite, Tripod, Tape, Ranging Rods, Arrows, Plumb Bob.

Principle:
The method of repetition is used to measure a horizontal angle to a finer degree ofaccuracy than that obtainable with the least count of the vernier. By this method, an angle is measured two 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 when sighting at the previous station. Thus anangle reading is mechanically added several times depending upon the number of repetitions.

Procedure:
To measure the angle OPQ



1. Set the instrument at O and level it accurately.
2. With the instrument on the left face, set vernier A to 0^0 and with the aid of the lower clampand tangent screw bisect signal P. note the reading of verniers A and B.
3. Unclamp the upper clamp and turn the instrument clock-wise towards Q and bisect itaccurately. Note the reading of verniers A and B.
4. Unclamp the lower clamp and turn the telescope clock-wise to sight P again and bisect itaccurately. Note the reading of verniers A and B.
5. Unclamp the upper clamp and turn the telescope clock-wise and sight R and bisect itaccurately by upper tangent screw.
6. Repeat the procedure until the angle is repeated the required number of times. Theaverage angle with face left will be equal to final reading divided by three.
7. Change face to right and repeat the above procedure.
8. The average horizontal angle is then obtained by taking the average of the two anglesobtained with face left and face right.

Observation table

Station	Sight to	Left face 0^0 right swing					Right face 0^0 left swing					Average horizontal angle
		A	B	Mean	Included angle	Average included angle	A	B	Mean	Included angle	Average included angle	
	A											
	B											

Result: Average horizontal angle by repetition method is ----------

EXPERIMENT NO-……
TEMPORARY ADJUSTMENT OF A THEODOLITE

Aim:-Temporary Adjustment of a theodolite

Theory:-There are three temporary adjustments of a theodolite. These are

1. Setting up the theodolite over a station.
2. Leveling up.
3. Elimination of parallax.

SETTING UP:

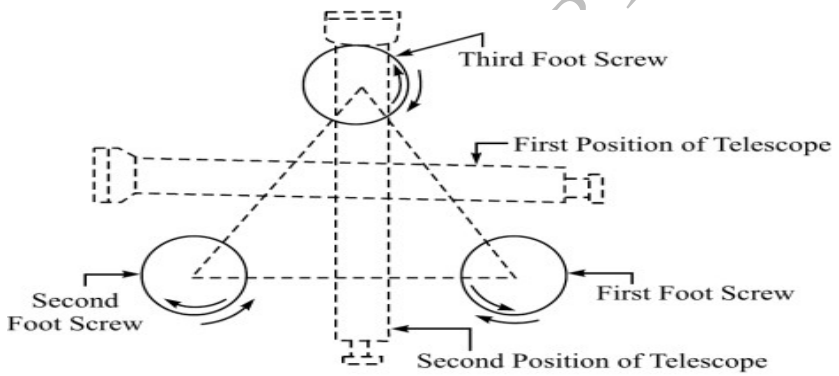
It includes two operations

1. Centering a theodolite over a station: Done by means of plumb bob.
2. 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).



Levelling of Foot Screws

Hold these two leveling screws between the thumb and first finger of each hand uniformlyso that the thumb moves either towards each other or away from each other until the bubblecomes to the center.

Turn the upper plate through 90º i.e until the axes of the level passes over the position ofthe 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 thebubble 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 ofits 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 canbe eliminated in two steps.

FOCUSSING 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.

FOCUSSING THE OBJECT:

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

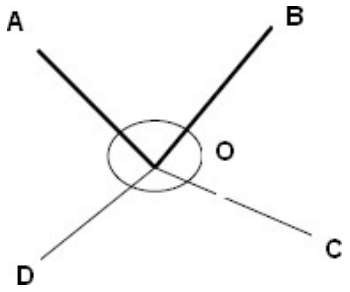
EXPERIMENT NO – ….
MEASUREMENT OF HORIZONTAL ANGLES BY REITERATION METHOD

Aim: To measure the horizontal angle by the method of reiteration .

Instruments required: Theodolite, Tripod, Tape, Ranging Rods, Arrows, Plumb Bob.

Principle:
The method known as direction method or reiteration method or method of series is suitable for the measurements of the angles of a group having a common vertex point. Several angles are measured successively and finally the horizon is closed.

Procedure:
To measure angles AOB, BOC, COD etc.,



1. Set the instrument over O and level it. Set one vernier to zero and bisect point.
2. With the instrument on the left face, loose the upper clamp and turn the telescope clock-wise to point B and bisect it accurately by upper tangent screw. Read both the verniers. The mean of the vernier readings will give the angles AOB.
3. Similarly bisect successively C, D etc., thus closing the circle. Read both the verniers at each bisection. Since the graduated circle remains in a fixed position throughout the entire process by taking the difference between two consecutive readings.
4. On final sight to A, the reading of the vernier should be the same as the original setting. If not the reading and find the error due to slips etc., and if the error is small, distributeit equally to all angles. If large, repeat the procedure and take a fresh set of readings.
5. Change face to right and repeat the above procedure.

Observation table:-

Instrument at	Sight to	Left face right swing					Right face left swing					Average horizontal angle
		A	B	Mean	Included angle	Average included	A	B	Mean	Included angle	Average included angle	
	A											
	B											
	C											
	D											
	E											

Included angle	Face left	Face right	Average horizontal angle

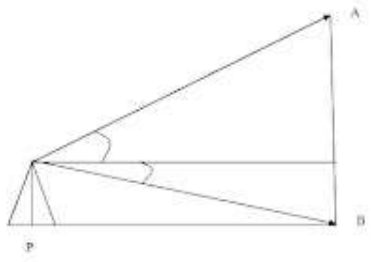
Result: Average horizontal angle AOB, BOC, COD etc., by reiteration method is ----------

EXPERIMENT NO – ……..
MEASUREMENT OF VERTICAL ANGLES

Aim: To measure the vertical angle between the given stations and the horizontal instrument axis about the instrument station as the vertex.

Instrument and Accessories Required:Theodolite, Pegs,Arrows, Tape,etc.

Procedure:



1. The theodolite is mounted on the tripod stand.
2. The theodolite is centered over an arbitrarily selected station P from where the given stations can be sighted without any obstruction and the instrument is levelled using the foot screws and booth the plate bubble and the altitude bubble are brought to the centre of their run.
3. The theodolite is set on the face right mode and the vernier A on the horizontal circle is initially set at 0°00’00” . The line of sight is made horizontal by setting both the vernier C and D on the vertical circle at 0°00’00” .
4. The vertical clamp screw is unclamped and the telescope is raised or lowered in a vertical plane and the given station is sighted and the central horizontal cross hair is made tangential to a specific mark on the given station and the vertical angles on both the vernier C and D are observed.
5. The vernier A is then initially set at 90°00’00” and the same vertical angle is observed by repeating the above procedure.
6. The theodolite is then set on the face left mode and the vernier A on the horizontal circle is initially set at 180°00’00” .
7. The line of sight is made horizontal by setting both the vernier C and D on the circle at 0°00’00” and the vertical angle to the given station is observed by repeating the above procedure.
8. The vernier A is then initially set at 270°00’00” and the same vertical angle is observed by repeating the above procedure.
9. The observations are recorded in the field book.
10. The actual vertical angle which is mean of vertical angles on the verniers C and D is computed for each initial setting of vernier A.
11. The average of the four mean values of the vertical angles observed one each for the four initial setting of vernier A is determined as the result.

Observation Table

Inst Station	Object	Face	Angle	Readings on Vernier						Mean			Mean Angle Observed			Remark
				C			D									
				°	‘	“	°	‘	“	°	‘	“	°	‘	“	
P	A	Left	APC													Elevation
		Right	APC													
P	B	Left	BPC													Depression
		Right	BPC													

Result: The vertical angle between the given station and the horizontal instrument axis about the instrument station as the vertex is determined
Angle APC =
Angle BPC =

EXPERIMENT NO – …..
DETERMINATION OF CONSTANTS OF TACHEOMETER

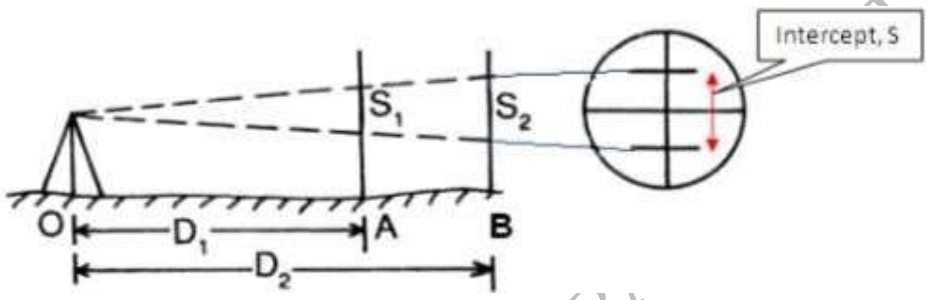
Aim: To determine the multiplying and additive constant of a given theodolite.

Instruments required: theodolite, tape, ranging rods, leveling staff, arrows etc.

Procedure:

1. Stretch the chain in the field and drive pegs at 10m, 20m interval.
2. Set the theodolite at the zero and do the temporary adjustments.
3. Keep the staff on the pegs and observe the corresponding staff intercepts with horizontal site.
4. 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.
5. Solve the successive pairs of equations to get the value of k & C and find out the average ofthese values.

Observations and calculations:



Instrument Station	Staff Station	Distance	Stadia Reading			Stadia Intercept (S)
			Top	Middle	Bottom	

D = KS + C
D1 = K.S1 + C (1)
D2 = K.S2 + C (2)
Solve Two Equations & find K & C

RESULT: Multiplying constant, K =
Additive constant, C =

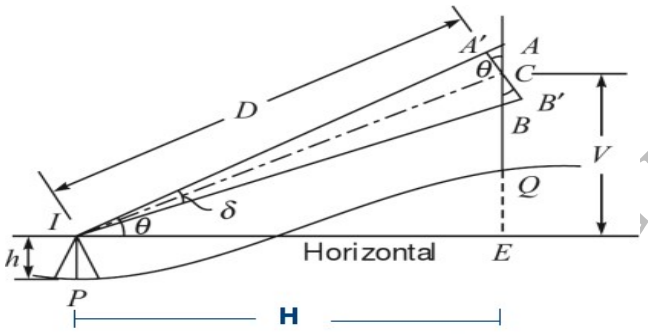
EXPERIMENT-....
DETERMINE THE DISTANCE AND RL OF A POINT WHEN LINE OF SIGHT IS HORIZONTAL

AIM:-:Determination of elevation of points by Tacheometric surveying

EQUIPMENT:Tacheometer with tripod, Tape,-Leveling staff, Ranging rods

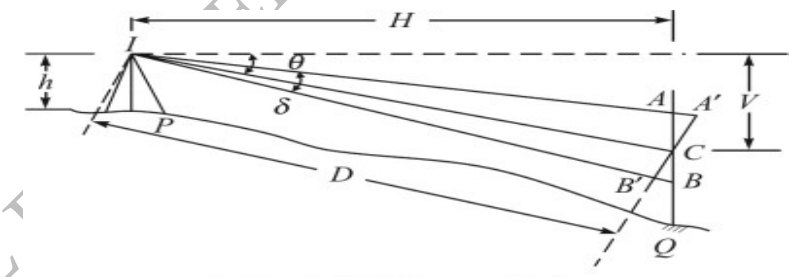
THEORY:
The Tacheometer is an instrument which is generally used to determine the horizontal as well as vertical distance . it can also be used to determine the elevation of various points which cannot be determine by ordinary leveling. When one of the sight is horizontal and staff held vertical then the RLs of staff station can be determined as we determine in ordinary leveling .But if the staff station is below or above the line of collimation then the elevation ordepression of such point can be determined by calculating vertical distances from instrument axis to the central hair reading and taking the angle of elevation or depression made by lineof sight to the instrument made by line of sight to the instrument axis.

Procedure:
1. Set up the instrument in such a way that all the point should be visible from the instrumentstation.
2. Carryout the temporary adjustment and set vernier zero reading making line of sight horizontal.
3. Take the first staff reading on Benchmark and determine height of instrument.
4. Then sight the telescope towards the staff station whose R.Ls are to be calculated. Measure the angle on vernier if line of sight is inclined upward or downward and also note the three crosshair readings.
5. Determine the R.Ls of various points by calculating the vertical distance



Inclined sight (elevation)

$$H = D\cos\theta = KS\cos^2\theta + C\cos\theta$$
$$V = \frac{1}{2}KS\sin 2\theta + C\sin\theta$$
$$\text{R.L. of } Q = \text{R.L. of } P + h + V - CQ$$



Inclined sight (depression).

$$D = KS\cos\theta + C$$
$$H = D\cos\theta = KS\cos^2\theta + C\cos\theta$$
$$V = D\sin\theta = KS\sin\theta\cos\theta + C\sin\theta$$
$$\text{R.L. of } Q = \text{R.L. of } P + h - V - CQ$$

EXPERIMENT-……
SETTING OUT CURVE FROM OFFSET OF LONG CHORD

AIM:- Determine the data for setting out curve from offset of long chord

Equipment:-Theodolite, Tripod Stand, Cross-Staff, Ranging Rods, Pegs, Chain and Tape.

Principle:
Setting out a curve by method of offsets from long chord is linear method. It involves setting out the normal offsets of the long chord at specified intervals and joining them.

The length of offsets at any distance 'x' from the mid points of the long chord is given by

O_x= - $\sqrt{R^2 - x^2}$ $\sqrt{R^2 - \left(\frac{L}{2}\right)^2}$

Where Ox = length of offset at a distance 'x' from the mid of longchord. X= specified distance between offsets.
L= length of the long chord.
R= Radius of the curve

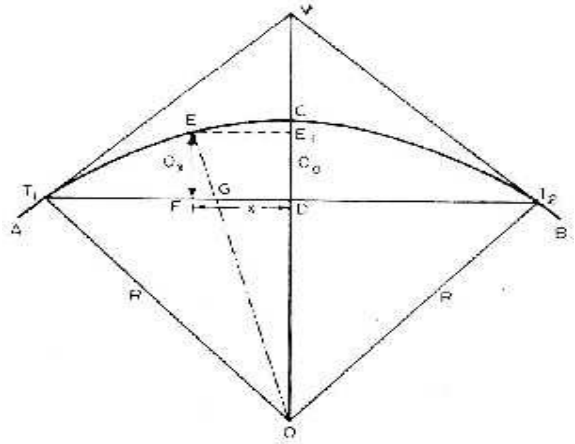
O_o= R- $\sqrt{R^2 - \left(\frac{L}{2}\right)^2}$ mid ordinate

Usually, the offsets from the mid of long chord towards the end are setout and the curve is symmetric over the central offset line.

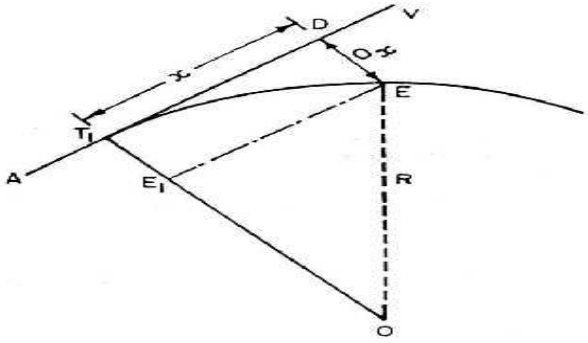
Procedure:

1. The obtained length of long chord is first setout on the field by proper ranging and mid point is established (Fig.10)
2. The length of offsets at mid length is to be setout. For this, a person holds the cross-staff at required point and aligns the slit with the end station ranging rods. At this instant another person looks through the normal slit and guides a person with a ranging rod to come into its view thus along this line normal to long chord, the calculated offset is setout.
3. The cross staff is shifted to next point distance 'x' as specified and above step is repeated the offset corresponding to that distance is set out from that point.
4. Pegs are marked at the end of the offsets, the joining of which completes the setting.

Observations and Calculations:
Distance (X m) = Ordinate (Y m) =



Setting Out By Ordinates from the Long Chord



Setting Out By Perpendicular Offsets

Result: The simple curve is setout by the method of offsets from long chord in the field.

Precautions
1. Level the instrument accurately.
2. Center the instrument precisely.
3. Keep ranging rod straight.
4. Measure the length accurately by the tape.

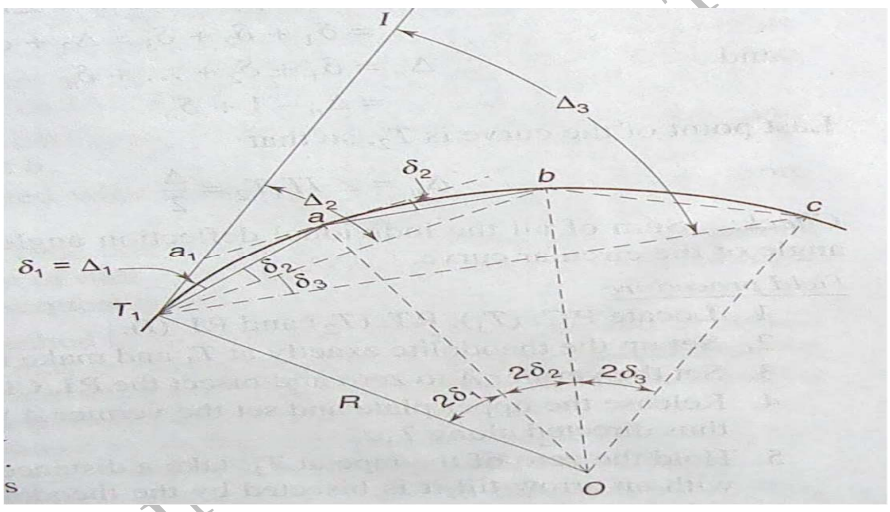
EXPERIMENT-….
CURVE SETTING- RANKINE'S METHOD

AIM: To set out a simple curve RANKINE'S method

INSTRUMENTS REQUIRED: Cross staff, arrows, compass, tape, tripod etc.

PROCEDURE:

1. Locate P.C. (T1), P.T (T2) and P.I. (I).
2. Set up the theodolite exactly at T1 and make its temporary adjustments.
3. Set up vernier A to zero and bisect the P.I Clamp the lower plate.
4. Release the upper plate and set the vernier A to readΔ1. The line of sight is thus directed along T1a.
5. Hold the zero tape at t1, take a distance C1 (T1a) and swing the tape with an arrow till it isbisected by the theodolite. This establishes the first point in the curve.
6. Set the second deflection angle Δ2. On the scale so that lime of sight is set along T1b.
7. With zero of the of the tape held at a and an arrow at the other end (chord distance=ab), swing the tape about a, till the arrow is bisected by the theodolite at b, this establishes thesecond point b on the curve.
8. The same steps are repeated till the last point T2 is reached.



CALCULATIONS:

Now for the first tangential angle δ_1, from the property of cirle

Arc T_1 a= R X 2 δ_1 radians

Assuming the length of the arc is same as that of its chord, if C_1 is the length of the first chord i.e. chord T_1 a then

$\delta_1 = \frac{C1}{2R}$ Radians

$= 180^0 \frac{C1}{2\pi}$ degrees

$= 180^0 \frac{60\,XC1}{2\pi R}$ minutes

$= 1718.9^0 \frac{C1}{R}$ minutes

Note:- the units of measurements of chord and that of the radius of the curve should be same

Similarly tangential angles for chords of nominal length C

Δ=1718.9 C/R minutes

RESULT: The curve is plotted by using RANKINE'S method.

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