Department of Civil Engineering

LAB MANUAL

CE6407 SURVEY PRACTICAL – II
# CE2259 SURVEY PRACTICAL – II

## INDEX

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STUDY OF THEODOLITE

Exp no: Date:

Aim:
To study about the Temporary and Permanent adjustments of a Theodolite.

Instrument used:
Theodolite

Procedure:

ADJUSTMENTS OF THEODOLITE

The Theodolite should be properly adjusted to obtain accurate observations. The adjustments are mainly of two types. They are as follows:

1. Permanent adjustments and
2. Temporary adjustments.

1. Permanent adjustments

The permanent adjustments are to be done to maintain the required standard relationship between the fundamental lines (axes) of a Theodolite. The fundamental lines are as follows:

a. Vertical axis
b. Horizontal axis or trunnion axis
c. Line of collimation or line of sight
d. Axis of plate level
e. Axis of altitude level.

**Required relations between the fundamental lines (axes)**

i) The axis of plate level must be perpendicular to the vertical axis.
ii) The line of collimation must be perpendicular to the horizontal axis
iii) The horizontal axis must be perpendicular to the vertical axis.
iv) The axis of the altitude level must be parallel to the line of collimation.
v) The vernier reading of vertical circle must read zero when the line of collimation is horizontal.

The permanent adjustments of a Theodolite are:

- Adjustment of plate level.
- Adjustment of line of sight
- Adjustment of horizontal axis
- Adjustment of altitude bubble and vertical index frame.

2. Temporary adjustments

The adjustments which are carried out at every setting of the instrument before the observations are referred as temporary adjustments. There are three types of temporary adjustments as follows.
a. Setting up
b. Levelling up
c. Elimination of parallax.

a) Setting up
This adjustment includes the following two operations.

i. Centering the Theodolite over the instrument station.

ii. Approximate leveling of Theodolite with the help of the tripod legs only.

Centering
It is the operation by which the vertical axis of the theodolite represented by a plumb line is made to pass through the mark of instrument station on the ground.

Approximate levelling
The approximate leveling may be done with the reference to a small circular bubble provided on the tribrach or by eye judgements.

b) Levelling up
The operation of making the vertical axis truly vertical is known as leveling of the Theodolite. After the centering and approximate leveling an accurate leveling is to be done with the help of foot screws.

i) First the telescope is to be kept parallel to any of the two foot screws as in the figure.

ii) The bubble of plate level is to be brought to the centre of its run by turning the foot screws either inwards or outwards simultaneously.

iii) Then the telescope is to be turned through 90°, so that it lies over the third foot screw (i.e perpendicular to the first position)

iv) The bubble is to be brought to the centre of its run by turning the third foot screw either clockwise or anticlockwise.

v) Then the telescope is brought back to its original position (position at (i)) and the position of bubble is checked whether it remains in the center or not.

vi) If the bubble is not in centre the above operations are repeated till the bubble retain at centre in both the positions.

c) Elimination of parallax.
An apparent change in the position of an object caused by the change in position of the observer’s eye is known as parallax. This can be eliminated in two steps.

i) Focusing the eye piece for distinct vision of the cross hairs.
ii) Focusing the objective to bring the image of the object in the plane of cross hairs.

i) Focusing the eye piece
   The telescope is to be pointed towards the sky or a sheet of white paper is to be hold in front of the objective.

   The eye piece is to be moved in or out by rotating it gradually until the appearance of cross hairs becomes sharp and distinct.

ii) Focusing the objective
   Telescope is to be directed towards the object. Focusing screw is to be turned until the appearance of the object becomes sharp and clear.
Result:

Thus the study about the Temporary and Permanent adjustments of a Theodolite is practiced.

MARKS out of 10: 

Signature of the staff in-charge
Measurement of Horizontal Angle (General Method)

**TABULATION:**

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<thead>
<tr>
<th>Instrument Station</th>
<th>Sight to</th>
<th>A</th>
<th>B</th>
<th>Mean</th>
<th>Horizontal angle</th>
<th>A</th>
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Expt. No.2  MEASUREMENT OF HORIZONTAL ANGLES  Date: -----------
BY GENERAL METHOD

AIM
To measure the horizontal angle by General method with the use of Theodolite.

APPARATUS USED
1. Theodolite, 2. Ranging rods, 3. Pegs or Arrows.

PROCEDURE

1. Theodolite is set over an instrument station (O) exactly and all the temporary adjustments are done.
2. Vertical circle is placed left to the observer (face left observation).
3. Vernier A is set to Zero with the help of upper clamp screw and tangent screws.
4. Readings of Vernier A and B are noted.
5. Upper clamp is clamped. Lower clamp is loosened and the telescope is turned towards “P”. Lower clamp is clamped and the point “P” is bisected exactly using tangent screws.
6. Both the vernier A and B are read and noted (Must be equal to 0° and 180° respectively).
7. Upper clamp is unclamped and the telescope is turned clockwise and “Q” is bisected.
8. Upper clamp is clamped and “Q” is bisected exactly using tangent screws.
9. Both the verniers are read. Mean of the readings provide an approximate included angle of POQ.
10. The reading of vernier A gives directly the angle POQ, and 180° is subtracted by the reading of vernier B. The mean value of two readings gives the angle POQ with one face.
11. The face is changed by transiting (Face right observation) and the whole process is repeated. Mean value of ∠ POQ is obtained with other face.
12. The average horizontal angle is obtained by taking the mean of the values obtained with the two faces.
Calculation:
13. The face is changed by transiting (Face right observation) and the whole process is repeated. Mean value of $\angle POQ$ is obtained with other face.

14. The average horizontal angle is obtained by taking the mean of the values obtained with the two faces.

RESULT:

The horizontal angle measured at O between P and Q i.e $\angle POQ$

a) With face left:-

b) With face right:-

c) Average:-

MARKS out of 10: Signature of the staff in-charge
Measurement of Horizontal Angle (Repetition Method)

<table>
<thead>
<tr>
<th>Instrument Sight to</th>
<th>Face:</th>
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<th>Face:</th>
<th>Swing:</th>
<th>Avg. Horizontal angle</th>
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</table>
Expt No.3  MEASUREMENT OF HORIZONTAL ANGLES  Date: --------------
BY REPETITION METHOD

AIM
To measure the horizontal angle by Repetition method with the use of Theodolite.

APPARATUS USED
1. Theodolite, 2. Ranging rods, 3. Pegs or Arrows.

PROCEDURE

1. Theodolite is set over an instrument station (O) exactly and all the temporary adjustments are done. Vertical circle is placed left to the observer (face left observation).
2. Vernier A is set to Zero with the help of upper clamp screw and tangent screws. Readings of Vernier A and B are noted.
3. Upper clamp is clamped. Lower clamp is loosened and the telescope is turned towards “P”. Lower clamp is clamped and the point “P” is bisected exactly using tangent screws.
4. Both the vernier A and B are read and noted (Must be equal to 0° and 180° respectively). Upper clamp is unclamped and the telescope is turned clockwise and “Q” is bisected.
5. Upper clamp is clamped and “Q” is bisected exactly using tangent screws. Both the verniers are read. Mean of the readings provide an approximate included angle of POQ.
6. The reading of vernier A gives directly the angle POQ, and 180° is subtracted by the reading of vernier B. The mean value of two readings gives the angle POQ with one face.

Calculation:
7. Lower clamp is unclamped and the telescope is turned anticlockwise to sight P again. Lower clamp is clamped and P is bisected exactly using tangent screws.
8. Upper clamp is loosened and the telescope is turned clockwise and Q is bisected. Upper clamp is clamped and Q is bisected exactly using tangent screws. The vernier now read twice the value of angle POQ.
9. Last two steps (7&8) are repeated once again to get the thrice value of angle POQ.
10. Finally obtained reading is divided by 3 to get the mean value of angle POQ.
11. The face is changed and the whole process is repeated. (Face right observations).
12. Average value of two horizontal angles obtained with face left and face right observations is determined.

RESULT:

The horizontal angle measured at O between P and Q. i.e \( \angle POQ \)

a) With face left:

b) With face right:

c) Average:

MARKS out of 10: Signature of the staff in-charge
Measurement of Horizontal Angle (Reiteration Method)

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Expt No.4  MEASUREMENT OF HORIZONTAL ANGLES  Date: -------------

BY REITERATION METHOD

AIM  
To measure the horizontal angle by Reiteraion method with the use of Theodolite.

APPARATUS USED  
1. Theodolite, 2. Ranging rods, 3. Pegs or Arrows.

PROCEDURE

1. Theodolite is set over an instrument station (O) exactly and all the temporary adjustments are done. Vertical circle is placed left to the observer (face left observation).
2. Vernier A is set to Zero with the help of upper clamp screw and tangent screws. Readings of Vernier A and B are noted.
3. Upper clamp is clamped. Lower clamp is loosened and the telescope is turned towards “P”. Lower clamp is clamped and the point “P” is bisected exactly using tangent screws.
Calculation:
4. Upper clamp is loosened and the telescope is turned clockwise to bisect R. Lower clamp is clamped and R is bisected exactly using tangent screws. Both the verniers are read and noted.
5. The same procedure is repeated for all other points.
6. The face is changed and all the above steps are repeated. (Face right observations).
7. Reading from Q is subtracted by reading R to get included angle QOR. Reading from R is subtracted by reading S to get included angle ROS.
8. The same procedure is followed to get readings of all other included angles.

RESULT:

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<tr>
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MARKS out of 10: Signature of the staff in-charge
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Expt No.5  MEASUREMENT OF VERTICAL ANGLES  Date: ---------------

AIM
To measure the vertical angle between two objects with the use of Theodolite.

APPARATUS USED
1. Theodolite, 2. Ranging rod, 3. Peg or an Arrow.

PROCEDURE

a. Angle of Elevation

1. Theodolite is set up, centered and leveled with reference to the plate bubble.
2. Telescope is placed horizontally by setting the reading of 0°0’0” in the verniers of C and D.
3. Levelling process is carried out with the help of foot screws and the altitude bubble is brought in its central run.
4. Vertical circle clamp is loosened and the telescope is directed upwards to bisect P.
5. Vertical circle clamp is clamped and the point P is exactly bisected using vertical tangent screws.
6. Both the verniers of C and D are read and noted. Mean of the two verniers provide the vertical angle HOP.
7. Face is changed and all the above steps are repeated to get one more vertical angle HOP.
8. Average of the vertical angles taken to get an accurate vertical angle.
9. The same procedure may be adopted to determine the angle of depression HOR by directing the telescope downwards.

b. Angle of Depression
Calculation:
RESULT:
1. The observed angle of Elevation is ----------------------
2. The observed angle of Depression is ----------------------

MARKS out of 10: ___________________________ Signature of the staff in-charge
Expt No.6  THEODOLITE TRAVERSING –  Date:-
INCLUDED ANGLE METHOD

AIM
To determine the lengths and included angles between the lines of closed traverse with the use of Theodolite.

APPARATUS USED
1. Theodolite, 2. Ranging rods, 3. Pegs or Arrows.

GENERAL
This method is normally provided for closed traverse. In this method included angle between two successive lines is measured.

PROCEDURE
1. The instrument is set up over the station “P” and all the temporary adjustments are made. Telescope is oriented along the magnetic meridian and the magnetic meridian of PQ is measured.

2. The reading of 0°0’0” is set at vernier A by using upper clamp and tangent screw and the face of Theodolite is kept as left.

3. The telescope is brought back in the line of PT with the help of lower clamp and tangent screw, the reading in vernier A is kept as 0°0’0” and the reading in vernier B is kept as 180°0’0”.

4. Upper clamp is loosened and the telescope is turned clockwise and “Q” is bisected. Upper clamp is clamped and “Q” is bisected exactly using tangent screws.

5. Both the verniers of A and B are read and noted. Mean of the two verniers is determined as an included angle QPT.

6. Face is changed and all the above steps are repeated to determine one more included angle QPT. The average of the two included angle QPT is measured.

7. The Theodolite is shifted to second station Q. The station P is bisected and the whole process is repeated to get an included angle of RQP.

8. Similarly included angles at R, S and T are measured.

9. Lengths of traverse lines PQ, QR, RS, ST and TP are measured using a tape or chain.
Theodolite Traversing (Included Angle Method)

**TABULATION:**

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<th>B</th>
<th>Mean</th>
<th>Horizontal angle</th>
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<th>B</th>
<th>Mean</th>
<th>Horizontal angle</th>
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</table>
Calculation:
RESULT:
1. The included angle between the lines

<table>
<thead>
<tr>
<th>i)</th>
<th>Face Left</th>
<th>ii)</th>
<th>Face Right</th>
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<tbody>
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MARKS out of 10: Signature of the staff in-charge
Expt No. 7
THEODOLITE TRAVERSING – DEFLECTION ANGLE METHOD

AIM
To measure the deflection angles between the lines of open traverse with the use of Theodolite.

APPARATUS USED
1. Theodolite, 2. Ranging rods, 3. Pegs or Arrows.

GENERAL
Direct (or) Deflection angle is the angle measured clockwise (or) to the right from the previous line to the following line. This method is generally used in open traverse.

PROCEDURE
1. Theodolite is set up over P.
2. Magnetic bearing of line PQ is measured.
3. Theodolite is shifted to Q. Vernier A is set to zero using upper clamp and its tangent screw.
4. Telescope is back sighted to P. Vernier A still read zero.
5. Upper clamp is loosened and the telescope is turned clockwise to bisect “R”. Upper clamp is clamped.
6. Both the verniers are read and noted. Mean of the two verniers A and B give the direct angle PQR.
7. Face is changed and again the direct angle PQR is measured.
8. Average of two values is the required direct angle PQR.
9. Similarly all the other direct angles are measured.
10. The lengths of traverse lines are measured and the details are noted.
## Theodolite Traversing (Deflection Angle Method)

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Calculation:
RESULT:
1. The deflection angle between the lines
   \[ \angle PQ = \]
   \[ \angle QR = \]
   \[ \angle RS = \]
   \[ \angle ST = \]

2. Length of lines
   i) PQ =
   ii) QR =
   iii) RS =
   iv) ST =

MARKS out of 10: Signature of the staff in-charge
Expt No.8  HEIGHTS AND DISTANCES - SINGLE PLANE METHOD.  Date--

AIM
To determine the height of the given object when the base is inaccessible using single plane method.

APPARATUS USED
1. Theodolite, 2. Chain (or) Tape 3. Ranging rods, 3. Pegs or Arrows.

PROCEDURE
1  Theodolite is set over an instrument station (A) exactly and all the temporary adjustments are done.

2  The verniers C and D are set to read zero by means of vertical circle clamping screw and tangent screw. (Telescope is held at horizontal position).

3  Back sight reading is taken on BM.

4  Telescopic clamping screw is unclamped and the telescope is turned in the vertical plane to sight the object “P”. Vertical angle α₁ is noted.

5  Another station “B” is selected at a distance of “d” from A. The line AB is called as Base line.

6  Theodolite is shifted to B and the above procedure is repeated at the station B also.

7  The distance between the station A and P is determined using the following equation

\[ D = \frac{d \tan \alpha_2 \pm h}{\tan \alpha_1 - \tan \alpha_2} \]

Note:-  i) “+” ve sign is to be used in numerator when \(a < b\)

ii)“-” ve sign is to be used in numerator when \(a > b\)

iii) \(h = 0\) when \(a = b\).

8  Vertical distance \(V_1\) is calculated using the following equation

\[ V_1 = D \tan \alpha_1. \]

9  R.L of point “P” is determined as follows:

R.L of point “P” = R.L of B.M + a + V₁

(or)

R.L of B.M + b + V₂
Calculation:
HEIGTHS AND DISTANCES - SINGLE PLANE METHOD.
TABULATION:-

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- Instn: Instrumentation station
- Sight to: Sight to which the instrument is set
- C, D, Mean: Observed values
- Vertical angle: Calculated vertical angles
- A, B, Mean: Observed horizontal angles
- Horizontal angle: Calculated horizontal angles
RESULT:

The height of the given object “P” is determined as \(--------\) m when the base is inaccessible, using single plane method.

MARKS out of 10: 

Signature of the staff in-charge
Expt No.9  

**TACHEOMETRY - STADIA SYSTEM**

**AIM**
To determine the distance and elevation of a point using tacheometric stadia system.

**APPARATUS USED**
1. Tacheometer, 2. Levelling staff, 3. Pegs or Arrows.

**PROCEDURE**
1. Tacheometer is set over an instrument station (O) exactly and all the temporary adjustments are done.

2. The verniers C and D are set to read zero by means of vertical circle clamping screw and tangent screw (Telescope is held at horizontal position).

3. Back sight reading is taken on BM.

4. Telescopic clamping screw is unclamped and the telescope is turned in the vertical plane to sight the leveling staff which is placed over the object “P”. Vertical angle $\alpha$ is noted. Staff intercept (S) is also determined.

5. The horizontal distance between O and P is determined as follows:
$$OP = D = KS \cos^2 \alpha + A \cos \alpha$$

6. Difference in elevation between O and P is determined as follows:
$$V = \frac{KS \sin(2\alpha)}{2} + A \sin \alpha$$

7. R.L of point “P” is determined as follows:
$$R.L \text{ of point “P”} = R.L \text{ of Line of collimation} + V - h$$
# Tacheometry - Stadia System

**Tabulation:**

<table>
<thead>
<tr>
<th>Instrument Station</th>
<th>Sight to</th>
<th>Face:</th>
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<th>Stadia Readings</th>
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Staff Reading on Bench Mark =
Calculation:
RESULT:

i) Horizontal distance between O and P =

ii) Difference in elevation between O and P =

iii) R.L of “P” =

MARKS out of 10: Signature of the staff in-charge
AIM
To determine the distance and elevation of a point using tangential tacheometric system.

APPARATUS USED
1. Tacheometer, 2. Levelling staff, 3. Pegs or Arrows.

PROCEDURE
1. Tacheometer is set over an instrument station (O) exactly and all the temporary adjustments are done.

2. The verniers C and D are set to read zero by means of vertical circle clamping screw and tangent screw. (Telescope is held at horizontal position).

3. Back sight reading is taken on BM.

4. Telescopic clamping screw is unclamped and the telescope is turned in the vertical plane to sight the leveling staff which is placed over the object “Q”.

5. Upper target reading (R₁) is bisected exactly with the help of telescope clamping screw and its tangential screw. Vertical angle α₁ is noted.

6. Similarly the lower target reading (R₂) is bisected and Vertical angle α₂ is noted.

   From the geometry of the figure, difference in elevation are determined as follows:-
   
   \[ MN = D \tan \alpha_1 \]
   
   \[ MB = D \tan \alpha_2 \]

7. The horizontal distance between O and Q is determined as follows:-

   \[ D = \frac{S}{\tan \alpha_1 - \tan \alpha_2} \]

8. R.L of point “Q” is determined as follows:

   R.L of point “Q” = R.L of Line of collimation + MB - R₂

   (or)

   = R.L of Line of collimation + MN - R₁
Calculation:
### TACHEOMETRY – TANGENTIAL SYSTEM

**TABULATION:**

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<th>Instrument Station</th>
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*taff Reading on Bench Mark =*
RESULT:

i) Horizontal distance between O and Q =
ii) Difference in elevation between O and Q =
iii) R.L of “Q” =

MARKS out of 10:  
Signature of the staff in-charge
Expt No.11  TACHEOMETRY – SUBTENSE SYSTEM  

AIM

To determine the distance between any two points using a substance bar.

APPARATUS USED


GENERAL

Subtense method is an indirect method of distance determination. This method essentially consists of measuring the angle subtended by two ends of a horizontal rod of fixed length, called subtense bar.

PROCEDURE

1. Two targets of subtense bar are connected at its ends by invar wires with slight tension to minimize the effect of variations in temperature.

2. The subtense bar is mounted on tripod and centered over the required station.

3. The bar is leveled by centering a circular level bubble using three leveling screws.

4. The bar is then oriented perpendicular to the line to be measured by sighting through a small telescope attached to the midpoint of the bar.

5. Tacheometer is set over an instrument station (O) exactly and all the temporary adjustments are done. The reading of 0°0’0’’ is set at vernier A by using upper clamp and tangent screw and the zero reading is placed along the line from O to one of the targets of subtense bar.

6. Upper clamp is loosened and the telescope is tilted to bisect the other target of subtense bar to determine the horizontal angle of θ.

7. The length of subtense bar is taken as “s”. The horizontal distance between O and the subtense bar is determined as follows:

\[ D = \frac{1}{2} s \cot \frac{\theta}{2} \]
TACHEOMETRY – SUBTENSE SYSTEM

TABULATION:

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<th>Instrument Station</th>
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RESULT:

Horizontal distance between O and the Subtense bar =

MARKS out of 10: 

Signature of the staff in-charge
AB, BC, etc - centre line
1-2, 2-3, etc. - Excavation line
L, M, N, etc - Masonry pillars
Expt No.12  SETTING OUT WORKS - FOUNDATION MARKING.  Date: ---------------

AIM
To set out the foundation marking for the proposed construction of building.

APPARATUS USED

GENERAL
The operation of the marking on the site the centre lines of the foundation of a building is called setting out. Setting out of a foundation is the first step in the construction of any structure.

PROCEDURE
1. A centre line sketch of the building is prepared. (The centres of cross walls are also to be indicated.)
2. The base line is set out with reference to given reference points.
3. The ends of the centre line of the walls, points A and B from the base line are marked.
4. As the end marks A,B,C,etc. are disturbed during excavation, stakes are fixed at L,M,N etc., a little away (about 2 to 3 m) for end mark and tied accurately using a string.
5. The centre line for all other walls AD,BC,etc. are marked by dropping perpendicular. For small buildings the perpendiculars may be set out by using a chain or a tape by ‘3-4-5’ method. For an important and big building when sides are long a Theodolite may be employed to accurately set out the perpendiculars and to range the lines.
6. For every wall, the pegs are driven a little away for marking the end and tied accurately using a string.
7. Diagonals are measured and checked with their corresponding calculated lengths.
8. Width of foundation from the centerline are marked and the corners 1,2,3,4,5 etc., are fix up. Pegs are driven at these corners. The cord is stretched and lime is spread along the chords.

RESULT:
Thus the trench plan being marked on the ground, and excavation may be started.

MARKS out of 10:  Signature of the staff in-charge
Expt No.13

SETTING OUT WORKS

SIMPLE CURVE (RIGHT-HANDED)

AIM
To set out a simple curve by an angular method by using a Theodolite (Rankine’s method of Deflection angles).

APPARATUS USED
1. Theodolite, 2. Chain (or) Tape, 3. Ranging rods, 4. Pegs or Arrows.

GENERAL
Curves are provided in traffics for the line of communication like highways, railways and canals, etc. to have a gradual change in direction. Generally, circular curves are provided even though the parabolic curves may also be employed. A simple curve is an arc of a circle connecting two straights.

PROCEDURE
1. Tangent length \((t)\) is determined using the following formula:

\[
t = R \tan \left( \frac{\Phi}{2} \right)
\]

2. Length of the curve \((l)\) is determined using the following formula

\[
l = \frac{\pi R \Phi}{180}
\]

3. Chainage of \(T_1\) is determined as follows:

Chainage of \(T_1\) = Chainage of point of intersection (P.I) - Tangent length \((t)\).

4. Chainage of \(T_2\) is determined as follows:

Chainage of \(T_2\) = Chainage of \(T_1\) + Length of the curve \((l)\).

5. Tangent points \(T_1\) and \(T_2\) are located on the field.

6. Lengths of first sub chord, normal chords and last sub chord are calculated so that the pegs are at full chain stations.

7. Tangential angles \(\delta_1, \delta_2, \delta_3 \ldots \ldots\) etc and total Deflection angles \(\Delta_1, \Delta_2, \Delta_3 \ldots \ldots\) etc are calculated as follows.

\[
\delta = \frac{1719C}{R} \text{ minutes}
\]

\[
\Delta_1 = \delta_1, \Delta_2 = \Delta_1 + \delta_2, \Delta_3 = \Delta_2 + \delta_3 \ldots \ldots \text{ and } \Delta_n = \Delta_{n-1} + \delta_n
\]
Calculation:
Note: - The total deflection angle $\Delta_n= \Phi/2$ Where, $\Phi$ is the deflection angle of the curve or central angle of the curve.

8. Theodolite is set up at the point of curve $T_1$ and levelled.

9. Vernier A is set to zero and upper clamp is clamped. Lower clamp is loosened and intersection point B is bisected exactly using the lower tangent screw. Thus the line of sight is maintained in the direction of $T_1B$ and the vernier A kept zero.

10. Upper clamp is loosened and the deflection angle $\Delta_1$ is set at vernier A. The line of collimation is now directed along the chord $T_1D$, and the upper clamp is clamped.

11. Zero end of the Tape is held at $T_1$ and an arrow is placed at a distance equal to first chord length of $T_1D = C_1$ on the tape. Tape is swung around $T_1$ till the arrow is bisected by the line of sight. Thus the first point D is established on the curve. First peg is fixed at D.

12. Upper clamp is loosened and the deflection angle $\Delta_2$ is set at vernier A. The line of collimation is now directed along the chord $T_1E$, and the upper clamp is clamped.

13. Zero end of the Tape is held at D and an arrow is placed at a distance equal to second chord length of $DE = C_2 = C$ on the tape. Tape is swung around D till the arrow is bisected by the line of sight. Thus the first point E is established on the curve. Second peg is fixed at E.

14. The same procedure is repeated till the last point is reached. As a check, the location of last point is verified whether it coincide the tangent point $T_2$ fixed already from the P.I or not.

Note:-

In the case of left handed curves, the vernier should be set to $(360^\circ-\Delta_1)$, $(360^\circ-\Delta_2)$, $(360^\circ-\Delta_3)$ etc to obtain successive points on the curve after sighting the intersecting point with both the plates clamped at zero.

RESULT:

Thus the simple curve is set using Rankine’s method of Deflection angles.

MARKS out of 10: Signature of the staff in-charge
Expt No.14  SETTING OUT WORKS – TRANSITION CURVE  Date: ---------------

AIM

To set out a Transition curve by using a Theodolite.
APPARATUS USED
1. Theodolite, 2. Chain (or) Tape, 3. Ranging rods, 4. Pegs or Arrows.

GENERAL
A transition curve is provided in between the straight and the circular curve to permit the gradual elevation of the outer edge and it provides gradual introduction of cant or super elevation (raising the outer edge over the inner). At the same time it also permits gradual change of direction from straight to the circular curve and vice versa.

PROCEDURE
1. The deflection angle (Δ) between the tangents, The radius (R) of the circular curve, The length (L) of the transition curve, and the chainage of the point of intersection (l) of the tangents are given.
2. Spiral angle is determined using the following formula
   \[ \Delta_s = \frac{L}{2R} \]
3. Shift is determined as follows:
   \[ S = \frac{L}{24R} \]
4. Total tangent length is determined using the following formula
   \[ T_t = (R+S) \tan \frac{\Delta}{2} + \frac{L}{2} \]
5. Length of the circular curve is determined as follows:
   \[ l_c = \frac{\pi R (\Delta - 2 \Delta_s)}{180} \]
6. Chainages of various points are determined as follows:
   Chainage of T = Chainage of I - T_t
   Chainage of D = Chainage of T + L
   Chainage of D' = Chainage of D + l
   Chainage of T' = Chainage of D' + L
7. Lengths of the normal chords are fixed as 10 m for the transition curve and 20 m for circular curve.

Calculation:
8. Lengths of the sub chords are calculated after knowing the chainages of salient points.
9. Deflection angles for transition curve are determined as follows:-
\[ \alpha = \frac{1800l^2}{\pi RL} \text{ minutes} \]

\( l \) is measured from the tangent point T. The deflection angle at the junction of the transition curve and the circular curve for \( l = L \), is

\[ \alpha_n = \frac{1800L}{\pi R} \]

As a check, \( \alpha_n \) should be equal to \( \frac{\Delta_3}{3} \)

For circular curve the deflection angles are determined from the formula

\[ \delta = \frac{1719C}{R} \text{ minutes} \]

Where \( C \) is the length of the chord, and \( \delta \) is the tangential angles from the tangent at D.

10. Total Deflection angles \( \Delta_1, \Delta_2, \Delta_3, \ldots \) etc are calculated as follows.

\[ \Delta_1 = \delta_1, \Delta_2 = \Delta_1 + \delta_2, \Delta_3 = \Delta_2 + \delta_3 \ldots \ldots \ldots \] and \( \Delta_n = \Delta_{n-1} + \delta_n \)

As a check, \( \Delta_n \) should be equal to \( \frac{1}{2}(\Delta - 2\Delta_i) \)

11. Tangent point (T) is located by determining its chainage from the point of intersection (I). Similarly the other tangent point (T') is located by measuring the total tangent length (T') along the forward tangent length from P.I.

12. A theodolite is set up at T, the vernier A is set to zero and I is bisected. The points on the transition curve are located from the computed deflection angles for the first sub-chord and normal chords.

13. The last deflection angles for the transition curve should be equal to \( \frac{\Delta_1}{3} \) and the perpendicular offset from the tangent TI, should be equal to 4S. The distance to each of the successive points on the transition curve is measured from T.

14. Having laid the transition curve, the theodolite is shifted to D, after setting up and leveling the vernier set to read the angle \( (360^\circ - \frac{2}{3}\Delta_i) \) for a right-hand curve and \( \frac{2}{3}\Delta_i \) for a left-hand curve.

15. Back sight is taken on T and the telescope is rotated in azimuth by an angle \( \frac{2}{3}\Delta_i \) till zero reading is obtained on the circle. In this position the telescope is directed along DD_1. On transiting the telescope, the line of sight is directed along the tangent D_1D with reference to which the deflection angles of the circular curve have been calculated.
16. After the orientation of line of sight the reading on the circle is zero. The vernier is set to the calculated deflection angles for the circular curve and the points on it are located in usual way. For the last point D’ of the circular curve, the last deflection angle must be equal to $\frac{1}{2} (\Delta - 2\Delta_s)$. 

17. The other transition curve is set out from T’ in the similar manner as the first is set out from T. the point D’ set out from T’ must be the same as already set out from D.
RESULT:

Thus the transition curve is set using the theodolite with the method of Deflection angles.

MARKS out of 10: Signature of the staff in-charge
Expt No.15  

AZIMUTH BY THE EX-MERIDIAN OBSERVATION ON THE SUN 

Aim:

To find the angle between the observes meridian and the vertical circle through the body.

General:

The required altitude and the horizontal angles are those to the sun’s centre. Hence the hairs should be set tangential to the two limbs simultaneously. The opposite limbs are then observed by changing the face as shown in figure.

Procedure:

1. Set the instrument over the station mark and leveling very accurately.
2. Clamp both the plates to zero and sight the reference mark (RM).
3. Turn to the sun and observe and altitude and horizontal angle with the sun in quadrant 1 of the cross hair system.
   
   The motion in the azimuth is slow and the vertical hair is kept in contact by the upper tangent screw, the sun being allowed to make contact with the horizontal hair the line of observation is also noted.

4. Using two tangential screw as quickly as possible, bring the sun in to the quadrant 3 of the cross hairs and again read the horizontal and vertical angles. Observe also the chronometer time.
5. Turn the RM. Reverse the face and take another side to RM.
6. Take two more observations of the sun precisely in the same way as in steps 3 and 4 above, but this time with the sun is quadrant 2 and 4. Note the time of each observations.
7. Finally bisect the RM to see that the reading is zero.

During the above four observations (two with face left and two with face right)
Calculation:
Result:

Azimuth of the given line =

MARKS out of 10: Signature of the staff in-charge
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Expt No.16

Study of Total Station

Date: ---------------

General:

Total station is a combination of Electronic Theodolite and Electronic Distance Meter (EDM) in one unit. This instrument directly measures 3D co-ordinates, slope, horizontal and vertical distances. This has large internal memory of 3000 points to store field datas and can be directly down loaded to the computer from the instrument through interface cable.

Electronic Distance Meter:

This is used to measure directly, to an acceptable accuracy, the distance between any tow intervisible points in the survey system. The technique of EDM eliminates the need for chaining or taping.

Principle of EDM:

The basic principle is the indirect determination of the time required for a light beam to travel between two stations and by using frequency the distance is displayed.

Basic Functions of EDM:

1. It generates the carrier and measuring wave frequencies.
2. It modulates and demodulates the carrier wave.
3. It measures the phase difference between the transmitted and received waves.
4. It displays the result of measurement.

Result:

Thus the study about the Total station is practiced.

MARKS out of 10: 

Signature of the staff in-charge