K.S. SCHOOL OF ENGINEERING & MANAGEMENT, BENGALURU 560109

DEPARTMENT OF CIVIL ENGINEERING

ENGINEERING SURVEY (BCV302)

IPCC

LABORATORY MANUAL

2023-2024

NAME:

USN:

SEMESTER:

K S SCHOOL OF ENGINEERING AND MANAGEMENT

Holiday Village Road, Vajarahalli Village, Mallasandra, off, Kanakapura Rd, Bengaluru, Karnataka 560109

VISION

To impart quality education in engineering and management to meet technological business and societal needs through holistic education and research.

MISSION

K. S. School of Engineering and Management shall,

- Establish state-of-art infrastructure to facilitate effective dissemination of technical and managerial knowledge.
- Provide comprehensive educational experience through a combination of curricular and experiential learning, strengthened by industry-institute interaction.
- Pursue socially relevant research and disseminate knowledge.
- Inculcate leadership skills and foster entrepreneurial spirit among students.

DEPARTMENT OF CIVIL ENGINEERING

VISION

To emerge as one of the leading Civil Engineering Department by producing competent and quality ethical engineers with strong foot hold in the areas of Infrastructure development and research.

MISSION

- Provide industry oriented academic training with strong fundamentals and applied skills.
- Engage in research activities in Civil Engineering and allied fields and inculcate the desired perception and value system in the students.

INDEX

INTRODUCTION

SURVEYING:

Surveying is defined as an art of determine the relative positions of points on, above or beneath the surface of the earth, with respect to each other, by measurement of horizontal and vertical distances, angles and directions.

Surveying may be classified into following types:

PLANE SURVEYING:

It is that type of surveying in which the mean surface of the earth is considered as a plane and the spheroidal shape is neglected.

GEODETIC SURVEYING:

It is that type of surveying in which the shape of the earth is taken into account. All lines lying in the surface are curved lines and the triangles are spherical.

CLASSIFICATION BASED ON EQUIPMENT USED:

CHAIN SURVEYING:

It is that type of surveying in which only linear measurements are made in the field. This type of surveying is suitable for surveys of small extent on open ground to serve data for exact description ofthe boundaries of a piece of land or to take simple details.

COMPASS SURVEYING:

It is that type of surveying where the horizontal angles are measured with the help of magnetic compass. The linear measurements are also required which are taken with a chain type.

PLANE TABLE SURVEYING:

In this type of surveying the map is prepared in the field itself by determining the directions of various lines making linear measurements and plotting the details on paper using a plane table.

Thisis a graphical method of surveying. A clinometer is used in conjunction with plane table to plot the contours of the area for filling in the details.

LEVELLING:

This type of survey is used to determine the elevations and relative heights of points with the help of an instrument known as level.

THEDOLITE:

In this type of survey, it is primarily used in traversing and triangulation for providing controls. The horizontal and vertical angles are measured with the help of theodolite.

TACHEOMETRIC SURVEYING:

This is a type of surveying in which the horizontal and vertical distances are determined by angular observations with a tacheometer. The chaining operations can be completely eliminated. This methodis resorted to a rough terrain where direct chaining or leveling operations are not possible or are verytedious.

MODERN SURVEYING:

This type of surveying is a method where surveying is carried out using modern surveying instrument; survey work will be precise, faster and less tedious.

EXERCISE-01

TAPES:

Tapes are measuring device used for measurement of survey lines and offsets on the field. Depending on the materials used they may be classified into the following types.

Cloth or linen Tape:

Cloth tapes of closely woven linen or synthetic material and is varnished to resist the moisture. These are available in length of 10-30m and width of 12-15mm.

Metallic Tape:

It is a linen tape with brass or copper wires woven into it longitudinally to reduce stretching. They are available in 20-30 m length.

Steel Tape:

These are 1-50m in length and are 6-10mm wide.

Invar Tape:

Made of an alloy of Nickel(36%) and Steel has very low coefficient of thermal expansion available in length of 30,50 and 100m and 6mm wide.

Laser distance meter:

Laser distance measurers work by sending pulses of laser light. The light reflects off a solid surface, and the measurer calculates the amount of time it takes for the reflection to return to the device. An internal processor calculates distance based on how long it takes the reflection to return.

To use a laser distance measure:

- Hold the device firmly against your chosen starting point. This may be a wall, floor or inside of a door frame. Make sure it is stable.

- Turn the laser distance measure on and point it where you would like to measure. Make sure it the laser is visible and is not directed at mirrors, windows or glass.
- Press the measure button.
- Keep the laser still until the measurement appears on the screen.

Distance measuring wheel

- Adjust handle to suitable level by twisting, pulling up and pushing down.
- Push the reset button to set the counter for zero.
- Walk moderately to the final measuring point.

LEVELLING

Definition of Levelling:

Leveling is the art of determining the relative heights of different points on or below the surface of the earth. The elevation of a point is the vertical distance above or below a reference surface called datum. The datum commonly used is the mean sea level (M.S.L). There for leveling deals with the measurements in a vertical plane.

The data obtained from the process of leveling will be useful in the following two perspective:

1. Establish points for various engineering purposes had decided elevation with respect to a given datum.
2. To workout the elevation of given objects relative to each other or with respect to a given datum.

Objects of leveling:

The following are the objects of leveling:

1. To determine the relative height of different object on or below the surface of the earth.
2. To fix benchmarks.
3. To find profile of a road or railway or canals etc. .
4. To show the contour of area.

Uses of leveling:

The following are the uses of leveling:

1. For preparing contour map to fix sites for reservoir, dams, barrages, etc.
2. For fixing the alignment of roads, railways, irrigation canals, etc.
3. For determining the reduced levels of different points on or below the surface of the earth.
4. For plotting a longitudinal section and cross sections of a project in order to determine the volume of earth work.
5. To prepare a layout map for water supply, sanitary or drainage connections.
6. To estimate the reservoir capacity.
7. For setting out grades for sewers, etc.

DEFINITIONS

1. **Level surface:** A level surface is any surface parallel to the mean spheroidal surface of the earth.
2. **Level line:** A level line is a line lying in the level surface. it is, therefore, normal to the plumb line at all points. As the level surface is a curved surface, the level line is also curve.
3. **Horizontal plane:** It is a plane tangential to the level surface at a point. It is also perpendicular to the direction of gravity.
4. **Horizontal line:** It is a straight line lying in the horizontal plane. It is tangential to the level line and perpendicular to the vertical line at that point.
5. **Vertical line or Plumb line**: It is a line indicated by are freely suspended plum bob. It is the line along the direction of gravity.
6. **Vertical plane:** Any plane passing through the vertical line is known as the vertical plane.
7. **Vertical angle:** The angle formed by the intersection of two lines in a vertical plane is known as a vertical angle.
8. **Datum surface or Datum line:** This is an imaginary level surface or level line from which the vertical distance of different points are measured. The datum commonly used this means sea level.
9. **Mean Sea level [M.S.L]:** The average height of the sea for all stages of the tides is known has mean sea level.
10. **Reduced level [R.L]:** The vertical distance of a point above or below the datum line is known has reduced level of that point. The reduce level of a point may be positive or negative according as the pointers above or below the datum.
11. **Line of collimation:** It an imaginary line passing through the intersection of the crosshairs add the diaphragm and the optical center of the object class and its continuation. It is also known as the line of sight.
12. **Axis of the telescope:** This axis is an imaginary line passing through the optical center of the object glass and the optical center of the eyepiece.
13. **Axis of bubble tube**: It this an imaginary line tangential to the longitudinal curve of the bubble tube at its middle point.
14. **Benchmarks [B.M]:** It is a fixed reference point of known elevation. This cell has reference point for finding the reduced level of new points or for conducting leveling operations in project involving roadways, railways etc.
15. **Focusing:** The operational setting the eye piece and the object class a proper distance apart for clear

vision of the object is known as focusing. This can be done by turning the focusing screw clockwise or anticlockwise.

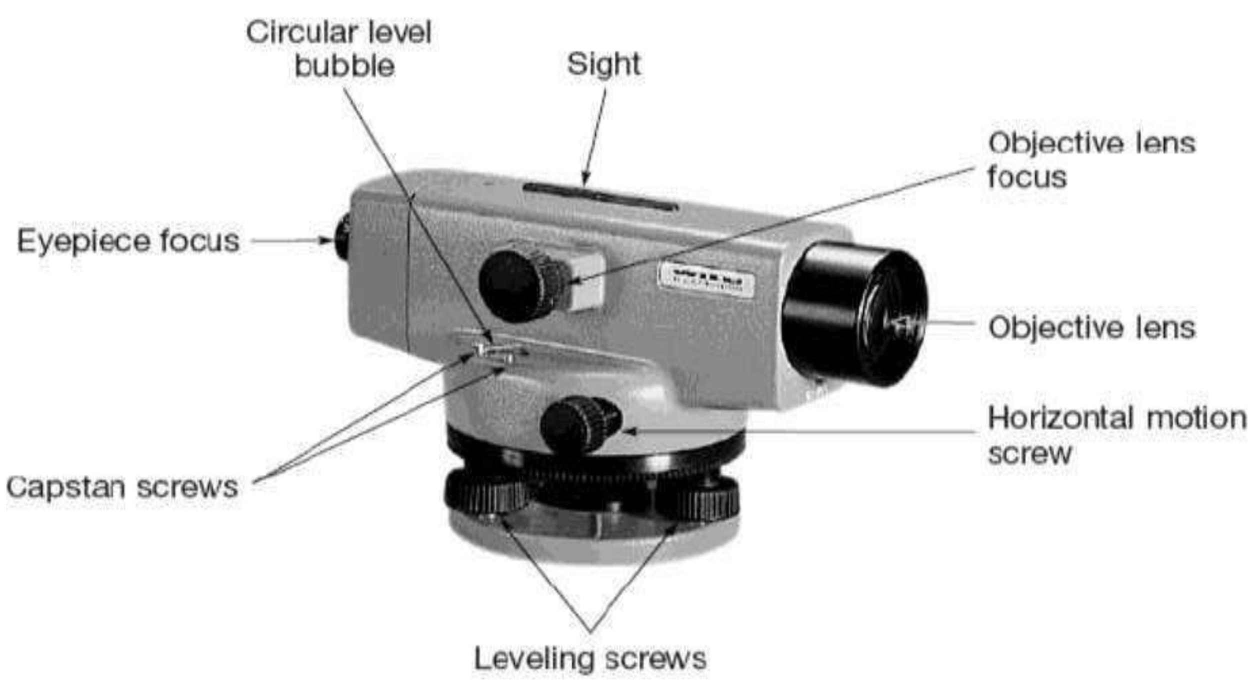
16. **Station:** In leveling, a station is that point where the leveling staff is held. It is the point whose elevation is to be determined or established for a given elevation.
17. **Balancing of sights:** When the distance of the points where back sight and foresight our speaker, kept approximately equal, it is known as balancing of sights. This is done to minimize the effect of instrumental and other errors.
18. **Sensitiveness of a level tube:** It is used to indicate the angular value of 1 division marked on the tube. Thus, the greater the moment of bubble for a given change in the angle, the more sensitivity is the tube.
19. **Parallax:** It is the apparent movement of the image related to the crosshairs when the image formed by the object does not fall in the plane of the diaphragm.
20. **Back Sight [B.**S]: It is a staff reading taken on a point of known elevation, as on a bench mark or a change point. It is also called as plus sight. It is the first staff reading taken after the level is set up and levelled.
21. **Fore Sight [F.**S]: It is a reading taken on the staff either held at the last point whose elevation is required or held at the change point just before shifting the instrument. The fore sight is used to determine the elevation of the staff station. It is also known as minus sight.
22. **Intermediate Sight [I.S]:** It is any other staff reading taken between the BS and FS in the same setup of the instrument. All readings taken between the back sight and the foresight are intermediate sight. It is also a minus sight. The intermediate sight is also used to determine the elevation of the staff stations.
23. **Change Point (C.P):** This point indicates the shifting of the instrument. At this point, an FS is taken from one setting and a BS from the next setting, therefore the change point both are the back sight and fore sight are taken.
24. **Height of the Instrument [H.I]:** When the levelling instrument is properly levelled, the RL of the line of collimation is known as the height if the instrument.

Height of the Instrument = Known elevation of the point + B.S

Differentiate between the Plane of collimation and Rise and Fall Method:

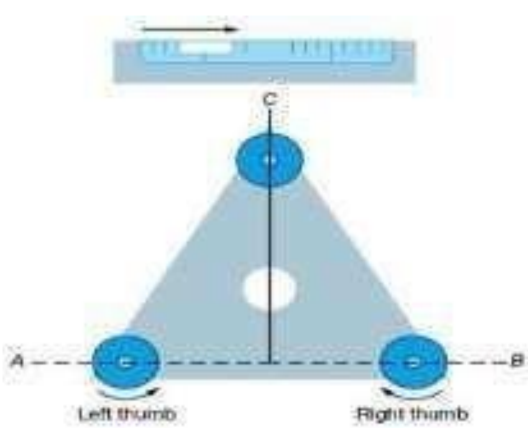
SL.No	Plane of Collimation	Rise and Fall Method
1	It is simple, quicker, and less tedious as it involves few calculations.	It is time consuming, more tedious and involves more calculations.
2	There is no check on the RL od intermediate points.	There is a check on the RL of intermediate points.
3	Errors in intermediate RLs cannot be detected	Errors in intermediate RLs can be detected as all points are correlated.
4	There are two checks on the accuracy of RL calculations.	There are three checks on the accuracy of the RL calculations.
5	This method is more suitable in the situations where it is required to take a number of readings from the same instrument setting such as for profile levelling, setting out the levels for the constructional work, etc.	This method is more suitable for differential levelling, check levelling and other important jobs.

EQUIPMENT FOR LEVILING



SETTING UP A LEVEL:

- Start by placing the tripod over the point with the legs spread and extended about halfway.
- You want to have the plate as level as possible.
- Mount the instrument in the center of the plate with the shape of the instrument bottom plate andthe tripod plate shape aligned
- Coarsely level the instrument by adjusting the leg length of the tripod. When looking at the level bubble, the bubble being to that side indicates the high side.
- Adjust the instrument by adjusting the leveling screws.
- The bubble is approximately centered by using the thumb and first finger of each hand to simultaneously adjust the opposite screws.
- Rotate the telescope by 90^0 and adjust the remaining leveling screw until it is precisely centered



Temporary adjustment of Auto level

The temporary adjustment of auto level consists of Setting, Leveling and Focusing.

Setting:

1. The tripod stand is set up at a convenient height having its head horizontal (through eye estimation).
2. The instrument is then fixed on the head by rotating the lower part of the instrument with right hand and holding firmly the upper part with left hand. Before fixing, the leveling screws are required to be brought in between the tribrach and trivet.
3. The bull's eye bubble (circular bubble), if present, is then brought to the centre by adjusting the tripod legs.

Leveling:

Leveling of the instrument is done to make the vertical axis of the instrument truly vertical. It is achieved by carrying out the following steps:

1. The level tube is brought parallel to any two of the foot screws, by rotating the upper part of the instrument.
2. The bubble is brought to the centre of the level tube by rotating both the foot screws either inward or outward. (The bubble moves in the same direction as the left thumb.)
3. The level tube is then brought over the third foot screw again by rotating the upper part of the instrument.
4. The bubble is then again brought to the centre of the level tube by rotating the third foot screw either inward or outward.
5. Repeat Step 1 by rotating the upper part of the instrument in the same quadrant of the circle and then Step 2.
6. Repeat Step 3 by rotating the upper part of the instrument in the same quadrant of the circle and then Step 4.
7. Repeat Steps 5 and 6, till the bubble remains central in both the positions.
8. By rotating the upper part of the instrument through 180°, the level tube is brought parallel to first two foot screws in reverse order. The bubble will remain in the centre if the instrument is in permanent adjustment.

Focusing:

Focusing is required to be done in order to form image through objective lens at the plane of the diaphragm and to view the clear image of the object through eye-piece. This is being carried out by removing parallax by proper focusing of objective and eye-piece.

1. For focusing the eye-piece, the telescope is first pointed towards the sky or by holding a white paper in front of the eye-piece. Then the ring of eye-piece is turned either in or out until the cross-hairs are seen sharp and distinct.
2. Focusing of eye-piece depends on the vision of observer and thus required whenever there is a change in observer.
3. For focusing the objective, the telescope is first pointed towards the object. Then, the focusing screw is turned until the image of the object appears clear and sharp and there is no relative movement between the image and the cross-hairs. This is required to be done before taking any observation.

EXERCISE-02

DETERMINATION OF REDUCED LEVELS OF POINTS USING DUMPY LEVEL/AUTO LEVEL (DIFFERENTIAL LEVELING)

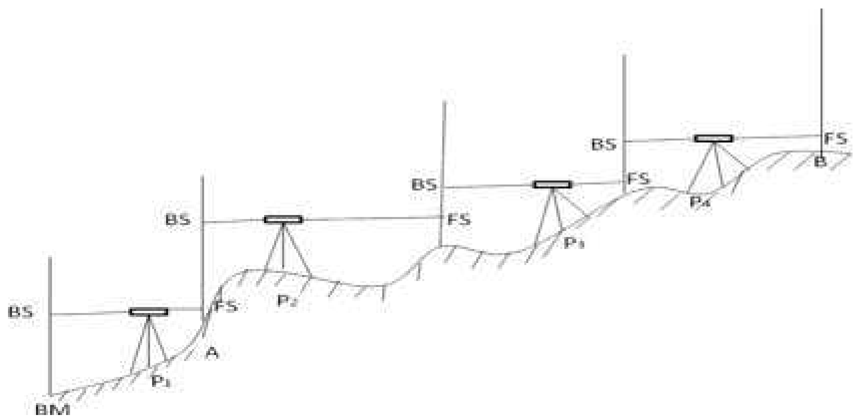
AIM:

Find out the elevation difference between two points using dumpy level by differential levelling.

INSTRUMENTS USED:

Dumpy level with tripod, leveling staff.

DIAGRAM:



PROCEDURE:-

1) Instrument level is setup at convenient positions near first point (say A).
2) Temporary adjustments should be done, (setting up, leveling up, elimination of a parallax) are performed.
3) First sight of B.M (point of known elevation) is taken and reading is entered in back Sight column.
4) Then second reading is taken by keeping leveling staff on first point as entered in Intermediate sight column.
5) If distance is large instrument is shifted, the instrument becomes turning point (or) changing point.
6) After setting up instrument at new position, performing temporary adjustment andTake back sight as turning point.

7) Thus turning point will have both back sight and fore sight readings.
8) Link wise the process is repeated till last point (say B) is reached.
9) The above procedure is shown in fig. Readings are entered in a tabular form is givenbelow and Reduced levels are calculate either by height of instrument method (or) Rise and fall method.

TABULAR COLUMN

ST.NOS	B.S (M)	I.S(M)	F.S(M)	H.I(M)	R.L	REMARKS

ARITHMETICAL CHECK;-

ΣB.S – ΣF.S =Last R.L-First R.L

RESULT;-

The difference between A and B by differential leveling is..______

THEODOLITE

DEFINITION OF THEODOLITE:

The theodolite is the most accurate instrument used mainly for measuring the horizontal and vertical angles. It can also be used for locating points on a line, prolonging survey lines, finding the difference in elevations, setting out of grades, ranging curves, etc.

TYPES OF THEODOLITE:

The following are the types of theodolites:

1. **Non-Transit theodolite:** The telescope cannot be revolved round the horizontal axis in the vertical plane. These instruments are compact in nature. Such theodolites are obsolete nowadays. Examples: Y-Theodolite.
2. **Transit theodolite:** The telescope can be rotated about its horizontal axis in a vertical plane by 180^0. All the modern theodolites are this type only. Hence transit theodolite name may be replaced by the theodolite.

Depending upon the facilities for providing for reading of observations the theodolites mayb classified as follows:

1. **Vernier Transit Theodolite:** This is the most common theodolite used. In this type vernier are provided for reading horizontal and vertical graduated circles. In this theodolite angles are read accurately up to 20".
2. **Optical Theodolite:** The precise optical theodolite uses an optical system to read both horizontal and vertical circles. They are more compact and light. The graduations are made on a glass circle and improved micrometers are used. Observer can take reading up to 1" or even less.
3. **Electronic Theodolite or Digital Theodolite:** This type of theodolite angles are displayed in the visual digital form. They are recently developed precise instruments. The readings can be read, recorded, stored, processed and displayed. The precision of this type of instrument varies in the order of 1" to 10".

FUNDAMENTAL AXES OF THEODOLITE:

The fundamental axes of theodolite instrument are:

1. The vertical axis.
2. The horizontal axis.
3. The line of collimation or the line of sight.
4. Axis of the altitude level tube.
5. Axis of the plat level.

The following are the relation between the fundamental axes are as follows:

1. Axis of the plate level must be perpendicular to the vertical axis.
2. Horizontal axis must be perpendicular to the vertical axis.
3. Line of collimation must be perpendicular to the horizontal axis.
4. Axis of the altitude level must be parallel to the line of collimation.
5. Vertical circle vernier must be zero when the line of collimation is horizontal.

DEFINITION AND TERMS:

1. **The Vertical axis:** The vertical axis is the axis about which the instrument can be rotated in a horizontal plane.

2. **The Horizontal axis:** It is the axis about which the telescope and the vertical circle rotate in the vertical plane.

3. **The Line of Collimation:** It is the line passing through the intersection of the horizontal and vertical cross hairs and the optical center if the object glass and its continuation. It is also called as the line of sight.

4. **The axis of the level tube:** It is a straight line tangential to the longitudinal curve of the level tube at its centre.

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

6. **Transiting:** It is process of turning the telescope in the vertical plane through 1800 about trunnion axis. Since it is reversed in this operation, it is also called as known as plunging or reversing.

7. **Swinging the telescope:** It is the process of turning the telescope in the horizontal plane. If the telescope is rotated in the clock wise direction, known as right swing. If the telescope is rotated in the anti-clock wise direction, known as left swing.

8. **Face Left Observations:** If the face of the vertical circle is to the left of the observer, the observation of the angle is known as face left observations.

9. **Face Right Observations:** If the face of the vertical circle is to the right of the observer, the observation of the angle is known as face right observations.

10. **Telescope Normal:** A telescope is said to be normal or direct when the face of the vertical circle is to the left and the "bubble up".

11. **Telescope Inverted:** A telescope is said to be inverted or reversed when the face of the vertical circle is to the right and the "bubble down".

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

PARTS OF THEODOLITE:

A transit theodolite consist of the following essential parts as follows:

Telescope: A telescope is a focusing instrument which has object piece at one end and eye piece at the other end. It rotates about horizontal axis in vertical plane. The graduations are up to an accuracyof 20'.

Vertical Circle: Vertical circle is fitted to telescope and moves simultaneously with telescope. It hasgraduation in each quadrant numbered from 0 to 90degrees.

Index Frame: It is also called as t-frame or vernier frame. It consists two arms vertical andhorizontal. Vertical arm helps to lock the telescope at desired level and horizontal arm is useful to take the measurements of vertical angles.

The Standards: The standards are the frames which supports telescope and allow it to rotate about vertical axis. Generally, these are in letter A-shape. So, standards are also called as A-frame.

The Upper Plate: This is also called as vernier plate. The top surface of upper plate gives support to the standards. It also consists an upper clamping screw with respect to tangents screw which helps tofixing it to the lower plate.

When the upper clamping screw is tightened both upper and lower plates are attached and moved together with some relative motion because of upper tangent screw. The upper plate also consists two verniers with magnifiers which are arranged diagonally. It is attached tow inner spindle.

The Lower Plate: This is also called as scale plate. Because it contains a scale on which 0 to 360 readings are graduated. It is attached to the outer spindle and consists lower clamping screw. If lowerclamp screw is loosened and upper clamp screw is tightened, both plates can rotate together.

Similarly, if lower clamping screw is tightened and upper clamp is loosened then, only upper plate is movable and lower plate is fixed with tribratch plate.

The leveling head: The leveling head contains two parallel triangular plates called as tribratch plates. The upper one is known as upper tribratch plate and is used to level the upper plate and telescope with the help of leveling screws provided at its three ends. The lower one is called as lowertribratch plate and is attached to the tripod stand.

The Shifting Head: Shifting head also contains two parallel plates which are moved one over the other with in small area. Shifting head lies below the lower plate. It is useful to centering the whole instrument over the station.

Plate Levels: Plate levels are carried by the upper plate which are right angles to each other with one of them is parallel to trunnion axis. These plate levels help the telescope to settle in exact vertical position.

Tripod: Tripod is nothing but a stand on which theodolite is mounted. It should place in such a way that theodolite should be in exact leveled position. The tripod has legs with steel shoes at their ends. These hold the ground strongly without any movement when placed.

Tripod has an external screw which helps to attach the theodolite by tribratch plate in fixed position.

Plumb Bob: Plumb bob is tool having a cone shaped weight attached to a long thread. The weight ishanged using thread from the center of tripod stand and centering of theodolite is done.

Magnetic Compass: Simpler theodolites may contain circular compass box in the center of upper plate. When we select north as reference meridian it will be useful.

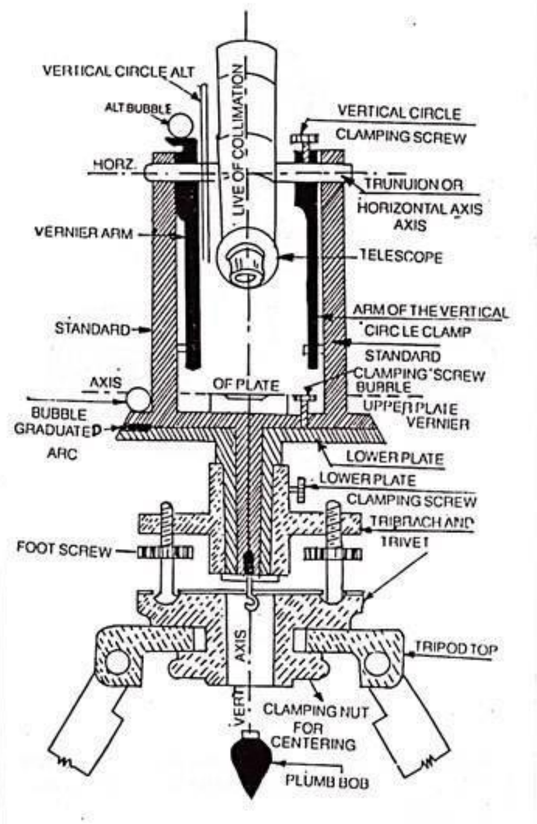


Fig. 9.1. (a) : Transit Vernier Theodolite (Sectional Elevation)

FUNDAMENTAL AXES OF THEODOLITE:

The fundamental axes of theodolite instrument are:

1. The vertical axis.
2. The horizontal axis.
3. The line of collimation or the line of sight.
4. Axis of the altitude level tube.

5. Axis of the plat level.

The following are the relation between the fundamental axes are as follows:

1. Axis of the plate level must be perpendicular to the vertical axis.
2. Horizontal axis must be perpendicular to the vertical axis.
3. Line of collimation must be perpendicular to the horizontal axis.
4. Axis of the altitude level must be parallel to the line of collimation.
5. Vertical circle vernier must be zero when the line of collimation is horizontal.

USES OF THE THEODOLITES:

The following are the uses of the theodolites:

1. To measure the horizontal and vertical angles.
2. To measure the deflection angles and magnetic bearings.
3. For astronomical observations.
4. To run a straight line between two points.
5. For foundation layout of the buildings, boundaries, etc.
6. To fix the alignment of rail, road, electric poles, telephone poles, etc.
7. Extending a line in the field.
8. Taking observations for the measurements of areas and volumes.
9. Theodolite traversing.
10. Setting out the roads, railways curves, grade lines.
11. Finding the difference of elevations of inaccessible points.
12. Finding the vertical height of the object.

TEMPORARY ADJUSTMENTS OF TRANSIT THEODOLITE:

It is defined as the adjustments which are made at every instrument stations and preparatory to taking observations with the instruments. The following are the temporary adjustments of the theodolite:

1. Setting over the station.
2. Levelling up
3. Elimination of Parallax.

1. **Setting over the station:** The operation of setting up includes:

a. Centering of the instrument over the station mark by a plumb bob or by the optical plummet and
b. Approximate levelling with the help of tripod legs. Some instruments are provided with shifting the head with the help of which accurate centering can be done easily. By moving the leg radially, the plum bob is shifted in the direction of the leg while by moving the leg circumferentially or sideways considerable change in the inclination is effected without disturbing the plum bob. The second movement is therefore, effective in the approximate levelling of the instrument. The approximate levelling is done either with the reference to a small circular bubble provided on tribrach or is done by eye judgement.

2. **Levelling up:** After having centering and approximately levelled the instrument, accurate levelling is done with the help of foot screws and with reference to the plate levels. The purpose of the levelling is to make the vertical axis truly vertical. The manner of levelling the instrument by the plate levels depend upon whether there are three levelling screws or four levelling screws.

3. **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 impossible. It can be eliminated by the following steps:

a. **Focusing the eye -piece:** To focus the eye-piece for the distinct vision of the cross hairs, point the telescope towards the sky and move eye piece in or out till the cross hairs are seen sharp and distinct. In some, telescopes graduations are provided at the eye piece end so that one can always remember the particular graduation position to suit his eyes. This may save much of time.

b. **Focusing the objective:** The telescope is now directed towards the object to be sighted and the focusing screw is turned till the image appears clear and sharp. The image so formed is in the plane of cross- hairs.

EXERCISE-03 (A)

MEASUREMENT OF HORIZONTAL ANGLESS BY REPETITION METHOD USING THEODOLITE

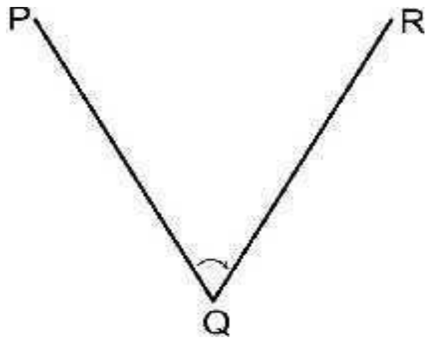
AIM:

To measure the horizontal angles using Theodolite by method of repetition

INSTRUMENTS REQUIRED:

Theodolite, Ranging rod, pegs etc.

DIAGRAM:



PROCEDURE:

Set the theodolite over the station Q and make temporary adjustments.

1. With the help of upper clamp and tangent screw, set 0^0 reading on vernier A, note the reading of vernier B.
2. Release the lower clamp and direct the telescope towards the point P. clamp the lower clamp and bisect point P accurately by the lower tangent screw.
3. Release the upper clamp and turn the instrument clockwise about the inner axis towards R. Clamp the upper clamp and bisect R accurately with the upper tangent screw. Note the reading of vernier A and B to get one value of angle PQR.
4. Release the lower clamp and turn the telescope clockwise to sight "P" again. Clamping the lower one, bisect P accurately by using the lower tangent screw. It should be noted that the cornier reading is not changed in this operation since the upper plate is clamped.
5. Release the upper clamp, turn the telescope clockwise and sight R. bisect R accurately by upper tangent screw.

6. Repeat the steps to a desired number of trails (usually 3).
7. The average angle in one particular face will be equal to final reading divided by number of trails.
8. Repeat steps (1) to (7) for another face and get the average angle for that face.

TABULAR COLUMN:

Inst. at	Sight to	Face left						Mean			Angle			Face right						Mean			Angle			Remarks
		Vernier 'A'			Vernier 'B'									Vernier 'A'			Vernier 'B'									
		°	'	"	°	'	"	°	'	"	°	'	"	°	'	"	°	'	"	°	'	"	°	'	"	

<u>**RESULT:**</u>

The horizontal angle PQR by repetition method is______________-

EXERCISE-03 (B)

MEASUREMENT OF VERTICAL ANGLES BY THEODOLITE

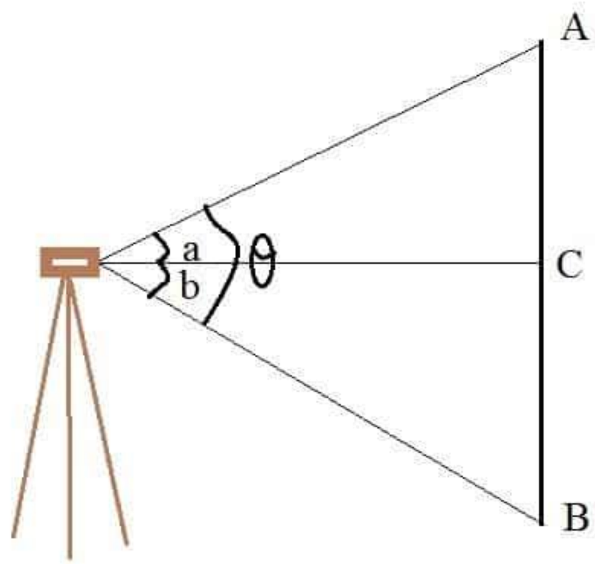
AIM:

To measure the vertical angles using Theodolite.

INSTRUMENTS REQUIRED:

Theodolite, ranging rod, pegs etc.

DIAGRAM:



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” .
4. The line of sight is made horizontal by setting both the vernier C and D on the vertical circle at 0°00’00”.
5. 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.

6. The vernier A is then initially set at 90°00’00” and the same vertical angle is observed by repeating the above procedure.
7. 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” .
8. 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.
9. The vernier A is then initially set at 270°00’00” and the same vertical angle is observed by repeating the above procedure.
10. The observations are recorded in the field book.
11. 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.
12. 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.

TABULAR COLUMN:

Measurement of vertical angle

Inst. at	Sighted to	Face left											Face Right											Average Vertical angle		
		C			D		Mean			Vertical angles			C			D		Mean			Vertical angles					
		°	'	"	'	"	°	'	"	°	'	"	°	'	"	'	"	°	'	"	°	'	"	°	'	"

RESULT:

The vertical angle between the given station and the horizontal instrument axis about the instrument station as the vertex is determined .

EXERCISE-04

SETTING OUT SIMPLE CIRCULAR CURVE – RANKINE'S METHOD

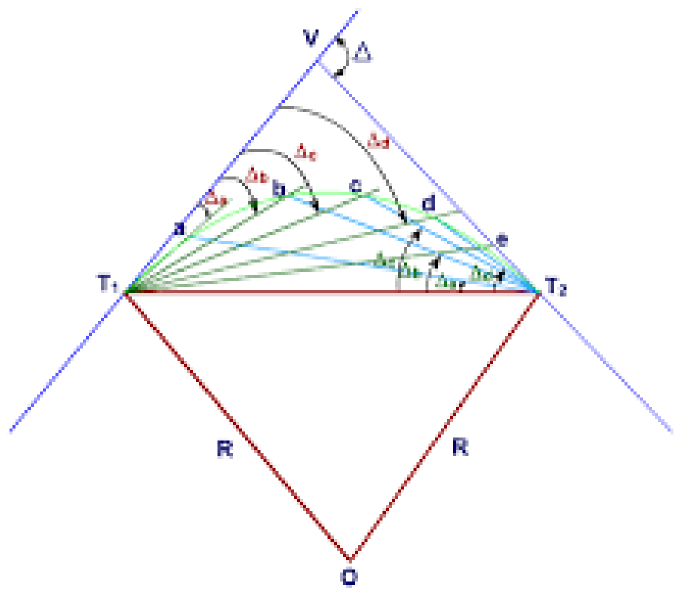
AIM:

To set out the simple curve by Rankine's method of Deflection angles by using Single theodolite method.

INSTRUMENTS REQUIRED:

Theodolite, Ranging rods, Chain, Arrows

DIAGRAM:



PROCEDURE:

1. Prepare a table of deflection angles for the first subchord, normal chord and last subchord.
2. Set up a theodolite over T1. Direct the telescope to bisect the point of intersection (V), with both plates clamped to zero.
3. Release the vernier plate and set angle D1 on the Vernier. The line of sight is thus directed along chord T1A
4. Point the zero end of the tape at T1 and an arrow held at a distance C1 along it and swing the tape around T1 till the arrow is bisected by the cross hairs to fix point A.
5. Set the deflection angle D2 = D1 + d2.

where,

$$d2 = 1718.9 \times \frac{C2}{R} \text{ min.}$$, so the line of sight is along T1V.

6. With zero end of the tape pinned at A and an arrow held at distance AB=C2 along it and swing the tape around A till the arrow is bisected by the cross hairs thus fixing the point B.
7. Repeat steps 5 and 6 till the last point T2 is reached.

check:

The last point so located must coincide with the point of tangency (T2) fixed independently by measurements from the point of intersection.

RESULT:

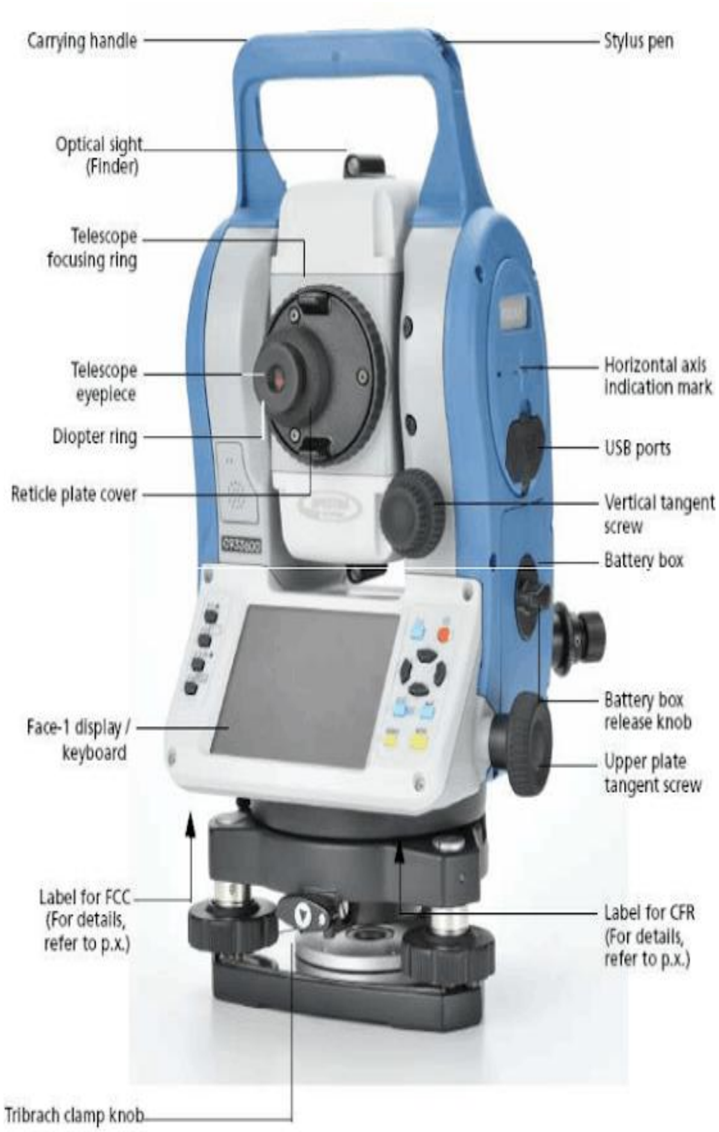
The given simple curve is thus setout.

EXERCISE-5

TOTAL STATION:
SETTING UP OF TOTAL STATION. FEATURES AND COMPONENTS OF TOTAL STATION

TOTAL STATION:

It is an electronic or optical instrument used to measure horizontal and vertical angles as well as the sloping distance of the object to the instrument and an onboard computer to collect data and perform triangulation calculations. It is an electronic transit theodolite integrated with electronic distance measurement (EDM), microprocessor, electronic data collector, and storage system. It is also known as total station theodolite.



PARTS OF THE TOTAL STATION

- Handle
- Handle securing screw
- Data input/output terminal (Remove handle to view)
- Instrument height mark
- Battery cover
- Operation panel
- Tribrach clamp (SET300*S*/500*S*/600*S*: Shifting clamp)
- Base plate
- Leveling foot screw
- The circular level adjusting screws
- Circular Level
- Display
- Objective lens
- Tubular compass slot
- Optical plummet focusing ring
- Optical plummet reticle cover
- Optical plummet eyepiece
- Horizontal clamp
- A horizontal fine-motion screw
- Data input /output connector (Besides the operation panel on SET600/600*S)*
- External power source connector (Not included on SET600/600S)
- Plate level
- Plate level adjusting screw
- Vertical clamp
- A vertical fine-motion screw
- Telescope eyepiece
- Telescope focusing ring
- Peep sight
- Instrument center mark

COMPONENTS OF TOTAL STATION

The keyboard is an essential part of the total station in the microprocessor section which contains switching keys, command keys, lighting keys, power keys, and so on. In the database, data collects and stores information. Reflectors are using beams to take the estimations. It is a constructed reflecting crystal that has the shape of squares. The Windows system is installed in the total station. Electronic displays are responsible for showing the different values. Around 4000 points can be stored in an electronic book. This electronic book data can be transferred to a personal computer. The control panel just adjusts all types of buttons. It can be modified by our own preferences. It is moisture-proof with different color switches. Rechargeable nickel–cadmium batteries have been used that can power up 2 to 10 hours. Some total station has two control panels and a power saver.

ADVANTAGES OF USING TOTAL STATIONS

1. You can quickly set up the instrument on the tripod with the help of laser plummet. It can be used as a multidisciplinary instrument.
2. Working capability is high as well as time is to be saved.
3. There are no recording or writing errors.
4. It gives more accurate measurements than any other device.
5. Natural language can be supported.
6. We get graphical views of lands and plot as well as computerized old maps.
7. Computation onboard area is used to calculate the area.
8. Integrated Database is used which can be transferred to a Personal computer.
9. Multiple surveys can be made by one set-up location.

DISADVANTAGES OF TOTAL STATION

1. Buying cost is higher.
2. While the operating errors may be unseen.
3. Highly skilled operators required.
4. Low battery life.
5. Leveling instruments can cause problems with elevation.

FEATURES OF TOTAL STATION

(a) Angle Measurement :

An electronic theodolite of a total station is used to measure angles. All the features of electronic theodolites are same as total station. A total station can record angles with a resolution between 1″ and

20″. All the instruments incorporate either single-axis or dual-axis compensator, the latter being expensive.

(b) Distance Measurement :

Generally a total station measures a slope distance and the microprocessor uses the vertical angle recorded by the theodolite along the line of sight to calculate the horizontal distance. In addition, the height between the trunnion axis and prism center is also calculated and displayed. All the total stations use co-axial optics in which the EDM transmitter and receiver are combined with the theodolite telescope. These 3 modes are generally available for distance measurement.

#Standard or Coarse Mode: It has a resolution of 1 mm and measurement time of 1-2 seconds.

#Precise or Fine Mode: It has a resolution of 1″ but a measurement time of 8 – 4 seconds. This is more accurate than the standard mode, since the instrument refines the arithmetic mean value by making repeated measurements.

#Tracking or Fast Mode: The distance measurement is repeated automatically at interval of less than 1″. Normally this mode has a resolution of 10 mm.

(c) Control Panel :

The total station is activated through its control panel. It consists of keyboard and multiple line liquid crystal display (LCD). The LCD is moisture-proof, can be illuminated and some LCD's incorporate contrast controls to accommodate different viewing angles. Some of the total stations have two control panels, one of each face the electronic theodolite to make them easier to use. The keyboard enables the user to select different measurement and implement modes, enables instrument parameters to be changed and allows special software functions to be used. Some keyboards incorporate multi-function keys to carry out specific tasks, whereas others use keys to activate and display menu systems. Angle and distances are usually recorded electronically in a digital form as data. If a code is entered from the keyboard to define the feature being observed the data can be processed much more quickly by downloading it into appropriate software. On numeric keyboards, codes are represented by numbers, whereas keyboards with feature codes are also available.

(d) Power Supply: Rechargeable nickel- cadmium batteries are used for power supply. The usage time is 2-10 h. Some total stations have an auto power save feature which switches the instrument off or into some standby mode after it has not been used for a specified time.

SETTING UP A TOTAL STATION

The process for setting up the device is fairly simple. Just follow these ten steps and you will be ready for your total station survey:

1. **Gather Your Equipment:** First, you will need to have your equipment ready. In addition to the device, this should include a tripod, tribrach, controller, cables, survey stake or nail and a mallet.
2. **Establish and Mark a Point of Reference:** Establish a point of reference for your project. This often needs to be measured using conventional means. Mark this point with a stake or nail.
3. **Set Up the Tripod at the Reference Point:** Open the tripod and set it over the point of reference. Try to position the center of the tripod roughly over the stake.
4. **Attach the Tribrach and Course Level:** Attach the tribrach to the tripod and course level to the tripod.
5. **Adjust as Necessary:** Using these initial, course instrument, get the tripod as close as possible to be totally level and directly over the point of reference.
6. **Place the Total Station on the Tripod:** Attach the device to the tripod being careful not to move it off-center.
7. **Connect Cables:** Connect the battery pack and controller to the total station using the appropriate cables.
8. **Power On and Start Controller:** Turn the device on and open the fine-level functionality using the controller.
9. **Make Fine Adjustments:** Adjust the device using the fine level to get to directly over the survey marker on the stake. Also, ensure that it is perfectly level.

EXERCISE-06

COORDINATE MEASUREMENT WITH TOTAL STATION

AIM:

Coordinate measurement with Total station

INSTRUMENTS REQUIRED:

Total Station with tripod, Prism

Coordinate Measurement using Total Station :

For measuring the coordinates of an unknown point, the instrument should know the coordinates of the point on which it is setup and the instrument should also know our reference coordinate directions (i-e which direction corresponds to Northing/Easting). This is achieved by the process of orientation. There are several methods of orienting a Total Station, here we will use the backsight coordinate method.

Orientation:

1) After setting up the instrument on a known station turn the instrument on and go into coordinate measurement mode.

2) Select Occ. Orientation (Occupied Station Orientation) and enter the Northing (No), Easting (Eo) and Elevation (Zo) of the occupied point. Also enter a name for the station point and the height of instrument above the station (HI or INS.HT).

3) Select the Backsight Coordinate (NEZ) option and enter the coordinates of known point on which we are going to take the backsight and press OK.

4) Sight the known point through the telescope and put it in the crosshairs accurately and press “YES”. Note: We can target the point on the ground or a prism above the point. It doesn’t make a difference because this operation is not dependant on Elevation.

5) The total station is now oriented.

Coordinate Measurement of unknown point:

1) Once oriented select the OBSERVATION option.

2) Place a prism on the unknown point keeping the staff of the prism as vertically erect as possible.

3) Check the height of Prism/Reflector and enter the value in total station (HR or R.HT)

4) Target the prism and press the MEAS (measure) function key.

5) The total station will display coordinates of the unknown point and will allow us to enter a name for this point.

6) You can note down the coordinates or record them in the total station.

EXERCISE-07

MEASUREMENT OF DISTANCE, SLOPE, VERTICAL DISTANCE, HORIZONTAL AND VERTICAL ANGLES USING TOTAL STATION

AIM:

Total Station with tripod, Prism To measure the distance, slope, horizontal and vertical angle using total station

INSTRUMENTS REQUIRED:

Total Station with tripod, Prism

PROCEDURE:

Horizontal Angle and Distance Measurement

1. Set the total station on the firm ground and carryout all the temporary adjustments.
2. Point the total station to the point that marks the left hand side of the angle. Lock the motion and set zero on the instrument.
3. Free the motion and aim the total station to the point that marks the right hand side of the angle (second corner of the building, write the measured angle in your field notes
4. Turn the total station back to the left pointing again to the first point and write the measured angle in your field notes (if you use the repetition mode, then this reading should be double your measured angle in step 3), Note down the distance.
5. Repeat this process for two times.

Vertical Angle Measurement

1. Set the total station on the firm ground and carryout all the temporary adjustments.
2. Point the total station telescope towards the top of the point that marks. Note down the angle.

Slope Measurement:

1) Place the instrument on a point along the straight line, the slope of which is to be determined, and position a reflector pole at a second point along that line.
2) Enter the instrument height i and the target height t (prism). The vertical angle reading in gon or degrees can be set to % so that the slope can be read off directly in %
3) Target the center of the prism and measure the distance. The slope is shown on the display in %.

EXERCISE-08

LONGITUDINAL SECTIONING AND CROSS SECTIONING USING TOTAL STATION

AIM:

To plot the longitudinal and cross section profile of the survey line using total station

INSTRUMENTS REQUIRED:

Total Station with tripod, Prism

PROCEDURE:

Profile Levelling:

1. Set the total station on the firm ground and carryout all the temporary adjustments.
2. Establishing a base line: A straight line is marked along the path of the feature being surveyed. This line serves as the reference for all subsequent measurements.
3. Taking elevation measurements: At regular intervals along the base line, surveyors measure the elevation of the ground surface using a total station. These measurements are recorded to create a profile of the land.
4. Plotting the profile: The collected elevation data is plotted on graph paper or entered into specialized software to create a longitudinal section. The resulting graph shows the variations in ground level along the surveyed line.

Cross -Section Levelling

1. Establishing cross-section lines: Surveyors mark perpendicular lines to the alignment being surveyed at regular intervals. These lines are known as cross-section lines or station lines.
2. Taking measurements: Along each cross-section line, surveyors measure the ground level at predetermined intervals using total stations. Additional measurements may be taken for features such as buildings, utilities, or natural elements.
3. Taking measurements: Along each cross-section line, surveyors measure the ground level at predetermined intervals using leveling instruments or total stations. Additional measurements may be taken for features such as buildings, utilities, or natural elements.

RESULT:

The profile of the survey line is plotted.

EXERCISE-09

CONTOURING AND PLOTTING WITH TOTAL STATION

AIM:

To plot the contour using data from total station

INSTRUMENTS REQUIRED:

Total Station with tripod, Prism

PROCEDURE:

1. Fix the total station over a station and level it
2. Press the power button to switch on the instrument.
3. Select MODE B -------> S function------->file management------>create(enter a name)-------->accept
4. Then press ESC to go to the starting page
5. Then set zero by double clicking on 0 set(F3)
6. Then go to S function ------> measure-----> rectangular co-ordinate---->station --->press enter.
7. Here enter the point number or name, instrument height and prism code.
8. Then press accept(Fs)
9. Adopt Cross section method for establishing the major grid around the study area.
10. Project suitably spaced cross sections on either side of the centre line of the area.
11. Choose several points at reasonable distances on either sides.
12. keep the reflecting prism on the first point and turn the total station to the prism,focus it and bisect it exactly using a horizontal and vertical clamps.
13. Then select MEAS and the display panel will show the point specification

Now select edit and re-enter the point number or name point code and enter the prism height that we have set.

15. Then press MEAS/SAVE (F3) so that the measurement to the first point will automatically be saved and the display panel will show the second point.
16. Then turn the total station to second point and do the same procedure.
17. Repeat the steps to the rest of the stations and get all point details.
18. Plot cross section lines to scale and enter spot levels.

19. The points on the chosen contours are interpolated assuming uniform slope between adjacent points and join them by a smooth line.

RESULT:

The contour of given land is drawn in the sheet.

EXERCISE-10

SETTING OUT CENTRAL LINE OF A SMALL RESIDENTIAL BUILDING

AIM:

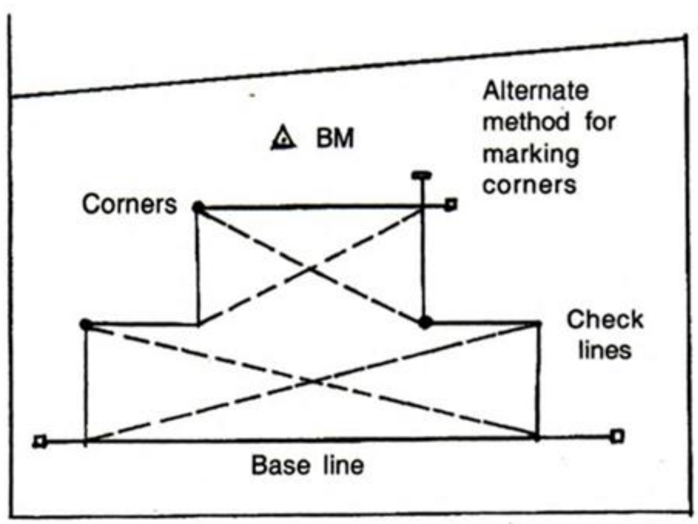
To plot the contour using data from total station

INSTRUMENTS REQUIRED:

Total Station with tripod, Prism

PROCEDURE:

Step 1: Establish a benchmark from which all levels for the various parts of the building can be established and which will not be disturbed during the building operations. This can be done by driving down a 50 mm x 50 mm angle 2 m long or a steel rod of suitable diameter and 2 m length in a previously dug hole so as to project about 10 cm from the ground level and then concreting the base to a suitable depth below the ground level to form a pedestal around it.



Setting out centre lines and checking out corners.

Step 2: The second step is to mark a baseline from which all dimensions can be measured. The centre line of the longest outer wall of the building is usually taken as the baseline. This is marked with respect to the boundary.

Step 3: The third step is to start from the baseline and mark the corner points of the centre line of walls of a building by means of 50 mm x 50 mm wooden posts driven firmly to the ground projecting 25 to 50 mm above the ground. A nail or saw cut is placed on the peg to indicate the exact centre point. Setting dimensions are measured with steel tapes and ranging roads between corner posts. It is essential that the 90-degree angles at corners are calculated using a builder's square or the 3: 4: 5 principle or a theodolite. Check whether all the dimensions of the diagonals tally.

Step 4: Using the corner points, transfer the centre line to the ground with dry lime by stretching lines between the pegs.

RESULT:

The center line for a small residential building is set out using Total Station

Exercise-12

Demonstration of Equipment’s used for chain, compass and plane table surveying

Chain Surveying: Chain surveying is a method of surveying that uses a chain or tape to measure linear distances between survey stations, dividing an area into triangles and relying on linear measurements rather than angular measurements.

- **Chain/Tape:** The primary instrument for measuring horizontal distances.
- **Arrows:** Used to mark the ends of the chain during measurement.
- **Pegs:** Used to mark survey points.
- **Ranging Rods:** Tall, slender rods used for sighting and aligning points.
- **Plumb Bob:** Used to mark points directly above or below a point on the ground.

Compass Surveying: Compass surveying is a surveying method that uses a magnetic compass to determine the directions of survey lines and a chain or tape to measure their lengths, often employed in large, undulating areas or those with many details where chain surveying is difficult.

- **Prismatic Compass:** Used to measure horizontal angles and magnetic bearings.
- **Tape:** Used for measuring distances between points.
- **Ranging Rods:** Used for sighting and aligning points.
- **Tripod:** To hold the compass.
- **Arrows:** Used to mark survey points.

Plane Table Surveying: Plane table surveying is a graphical surveying method where field observations and plotting are done simultaneously using a plane table, a flat, leveled board mounted on a tripod, to create maps or plans directly in the field.

- **Plane Table:** A drawing board mounted on a tripod, where the map is drawn and observations are made.
- **Alidade:** A straight-edge ruler with a sighting device (like a telescope) used for sighting points.
- **Spirit Level:** Used to ensure the plane table is level.
- **Trough Compass:** Used to orient the plane table and map.
- **U-Frame or Plumbing Fork:** Used to plumb the alidade.
- **Tripod:** To hold the plane table