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UGC RECOGNISED UNIVERSITY

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MINING ENGINEERING

BTECH

LAB MANUAL

MINE SURVEYING II

LIST OF EXPERIMENTS

Sl. No.	Name of the Experiment	Page No.
1.	To determine the height of a tower by Trigonometric Leveling when Base of the object is accessible.	3
2.	To determine the height of a tower by Trigonometric Leveling when Base of the object is inaccessible.	5
3.	To draw a contour map	7
4.	To plot a small area using measurements taken from a Total Station.	10

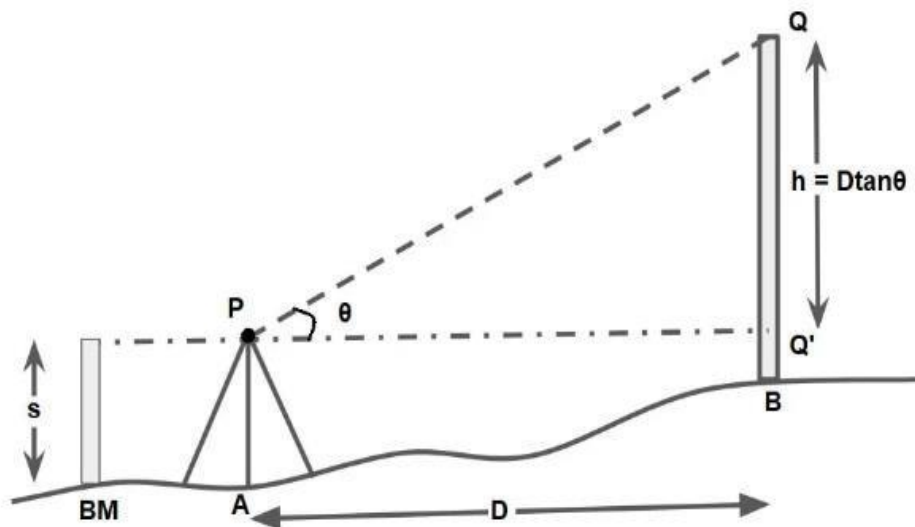
EXPERIMENT NO. 1

Objective: To determine the height of a tower by Trigonometric Leveling when Base of the object is accessible.

Instrument:

1. Theodolite
2. Staff
3. Measuring Tape
4. Arrow/ peg
5. Ranging rod

Let the base B of the any structure (like: tower, chimney, etc) is accessible, and the horizontal distance D between the instrument station A and the base B can be measured using a tape. Let Q be the top of structure whose elevation is to be calculated.



$$\text{R.L of the top of the structure } Q = \text{R.L. of B.M} + s + D \tan \theta.$$

Set up the theodolite over A. Take a backsight on the B.M. and determine the height of instrument(s).

R.L. of the line of collimation = R.L. of B.M. + s

If the line of collimation intersects the structure at Q, the distance PQ' is same as the horizontal distance D.

Sight the top of the chimney, and measure the angle of elevation θ .

In the triangle PQQ'.

$$QQ' = D \tan \theta$$

$$h = D \tan \theta$$

$$\text{R.L. of the top of the structure} = \text{R.L. of B.M.} + s + D \tan \theta.$$

Calculation: Calculations must be based on the readings taken during the survey work on the field

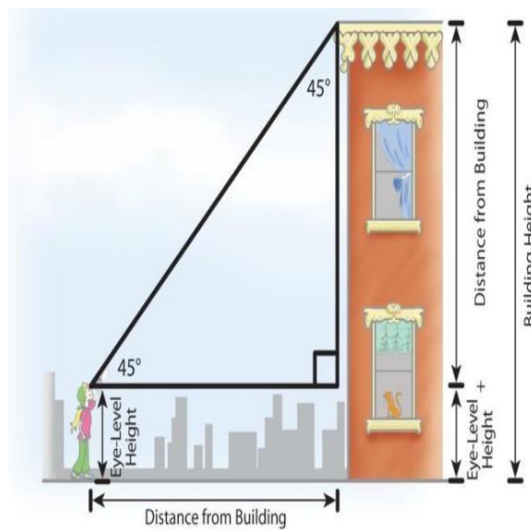
EXPERIMENT NO. 2

Objective: To determine the height of a tower by Trigonometric Leveling when Base of the object is inaccessible.

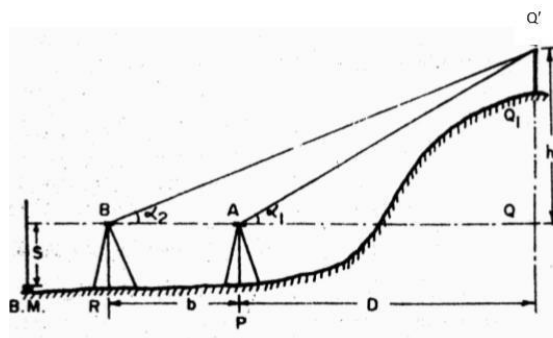
Instrument:

1. Theodolite
2. Staff
3. Measuring Tape
4. Arrow/ peg
5. Ranging rod

Base of the object inaccessible: Instrument stations in the same vertical plane as the elevated object



If the horizontal distance between the instrument and the object can be measured due to obstacles etc., two Instrument stations are used so that they are in the same vertical plane as the elevated object.



Procedure:

1. Set up the theodolite at P and level it accurately with respect to the altitude bubble.
2. Direct the telescope towards Q and bisect it accurately. Clamp both the plates. Read the vertical angle (α).

3.3 Transit the telescope so that the line of sight is reversed. Mark the second instrument station R on the ground. Measure the distance RP accurately. Repeat steps (2) and (3) for both face observations. The mean values should be adopted.

4. With the vertical Vernier set to zero reading, and the altitude bubble in the centre of its run, take the reading on the staff kept at the nearby B.M.

5. Shift the instrument to R and set up the theodolite there. Measure the vertical angle α_2 to Q with both face observations.

6. With the vertical Vernier set to zero reading, and the altitude bubble in the centre of its run, take the reading on the staff kept at the nearby B.M.

In order to calculate the R.L of Q, there can be three cases:

- (a) When the instrument axes at A and B are at the same level.
- (b) When they are at different levels but the difference is small, and
- (c) When they are at very different levels.

Here Instrument axes at the same level is considered in this work

Let $h = QQ'$

α_1 = Angle of elevation from A to Q

α_2 = Angle of elevation from B to Q'

S = staff reading on B.M., taken from both A and B, the reading being the same in both the cases.

b = horizontal distance between the instrument stations.

D = horizontal distance between P and Q

From triangle AQQ', $h = D \tan \alpha_1$ (1)

From triangle BQQ', $h = (b + D) \tan \alpha_2$ (2)

Equating (9.1) and (9.2) $\Rightarrow D \tan \alpha_1 = (b + D) \tan \alpha_2$

$\Rightarrow D = b \tan \alpha_2 / (\tan \alpha_1 - \tan \alpha_2)$ (3)

$\therefore h = D \tan \alpha_1 = b \tan \alpha_1 \tan \alpha_2 / (\tan \alpha_1 - \tan \alpha_2)$ (4)

R.L. of Q = R.L. of B.M. + S + h

Significance: Through this fieldwork, students will learn about indirect method of height measurement and when they should apply this method. This method is particularly useful when a structure is too tall to be measured using direct instruments (rope, tape, chain, etc.) or it is not possible to ascend to the top of the structure (e.g. if it is on the apex of a mountain, or is separated by a difficult-to-traverse terrain).

EXPERIMENT NO. 3

Objective: To draw a contour map

Methodology: Square or Grid System

Instruments:

1. Level
2. Leveling Staff
3. Arrows
4. Tape

Definitions:

(a) **Contours:** Contours are imaginary lines joining points of equal altitudes upon the earth's surface with reference to a fixed datum.

(b) **Contouring:** The process by which a contour map is prepared is known as contouring.

(c) **Contour map/topographic map:** The map showing the altitudes of all these points is called contour map or topographic map.

(d) **Contour Interval:** The difference in elevation between successive contour lines.

(e) **Contour Spacing:** The horizontal gap between successive contour lines.

Procedure:

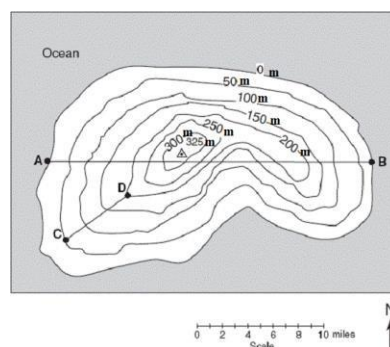
(a) Select any suitable place for setting up the instrument. Place the instrument and try to adjust it. Adjustment procedure should be consist of the followings,

- (i) Setting up the level (ii) Leveling up (iii) Elimination of parallax

(b) Mark an area of 100 m²; i.e., length 10 m and width 10m.

(c) Take staff reading at every station at an interval of 2.5 m. (e.g. 2.5 m × 2.5 m grid). The grid points are determined using tape, and marked using arrows.

(d) Take the elevation of top left corner as 7.00 m (A-1) which may be considered as bench mark.



Typical Contour Diagram

Significance:

Contouring helps in studying the general character of the tract of the country without visiting the ground. With the knowledge of characteristics of contours, it is easy to visualize whether country is flat, undulating or mountainous. Contouring can assist in deciding the sites for engineering works such as reservoirs, canals, roads and railways etc. on the basis of the economy. Contouring is used to determine the catchment area of the drainage basin and hence capacity of the proposed reservoir. It is useful in computing the earth work required for filling or cutting along the linear alignment of the projects such as canals, roads, etc. In addition the height of earth retaining structures (e.g. retaining walls) can be easily estimated. Contouring is also used to find out the inter-visibility of the points and to trace out a contour gradient for road alignments. Besides, we can draw longitudinal and cross-sections to ascertain nature of the ground. Through this fieldwork students will learn about procedures of collecting data for contour maps, using level and tape. Students will also learn about the procedures to draw contour maps.

Data Sheet:

Station	Distance (m)	Staff Reading at station			H. I.	Difference		Reduced Level (m)	Remarks
		Back (m)	Inter (m)	Fore (m)		Rise (m)	Fall (m)		
A1									B.M.
A2									
A3									
A4									
A5									
B1									
B2									
B3									
B4									
B5									
C1									
C2									
C3									
C4									
C5									
D1									
D2									
D3									
D4									
D5									
E1									
E2									
E3									
E4									
E5									

Contour Map:

EXPERIMENT NO. 4

Objective: To plot a small area using measurements taken from a Total Station.

Theory:

Total station is a surveying equipment combination of Electromagnetic Distance Measuring Instrument and electronic theodolite. It is also integrated with microprocessor, electronic data collector and storage system. The instrument can be used to measure horizontal and vertical angles as well as sloping distance of object to the instrument.

Total stations with different accuracy, in angle measurement and different range of measurements are available in the market. Figure 1 shows one such instrument manufactured by SOKKIA Co. Ltd. Tokyo, Japan.

Important Operations of Total Station:

1. **Distance Measurement:** Electronic distance measuring (EDM) instrument is a major part of total station. Its range varies from 2.8 km to 4.2 km. The accuracy of measurement varies from 5 mm to 10 mm per km measurement. They are used with automatic target recognizer. The distance measured is always sloping distance from instrument to the object.
2. **Angle Measurements:** The electronic theodolite part of total station is used for measuring vertical and horizontal angle. For measurement of horizontal angles any convenient direction may be taken as reference direction. For vertical angle measurement vertical upward (zenith) direction is taken as reference direction. The accuracy of angle measurement varies from 2 to 6 seconds.
3. **Data Processing:** The instrument is provided with an inbuilt microprocessor. The microprocessor averages multiple observations. With the help of slope distance and vertical and horizontal angles measured, when height of axis of instrument and targets are supplied, the microprocessor computes the horizontal distance and X, Y, Z coordinates. The processor is capable of applying temperature and pressure corrections to the measurements, if atmospheric temperature and pressures are supplied.

Significance:

Through this fieldwork, students will learn the operation of and data usage from total station to plot a surveyed area. Total Station is used in Mine Survey, Cadastral Survey, Engineering Survey, Large Scale Survey, Road / Rail / Canal Survey, etc. It is particularly useful in Remote Distance Measurement (RDM) and Missing Line Measurement (MLM).

Instruments:

1. Total Station
2. Tripods
3. Batteries and Chargers
4. Data and Power cables
5. Prisms
6. Prism Poles

7. Tribraches

Procedure:

1. The total station instrument is mounted on a tripod and is levelled by operating levelling screws. Within a small range instrument is capable of adjusting itself to the level position. Then vertical and horizontal reference directions are indexed using onboard keys.
2. It is possible to set required units for distance, temperature and pressure (FPS or SI). Surveyor can select measurement mode like fine, coarse, single or repeated.
3. When target is sighted, horizontal and vertical angles as well as sloping distances are measured and by pressing appropriate keys they are recorded along with point number. Heights of instrument and targets can be keyed in after measuring them with tapes. Then processor computes various information about the point and displays on screen.
4. This information is also stored in the electronic notebook. At the end of the day or whenever electronic note book is full, the information stored is downloaded to computers.
5. The point data downloaded to the computer can be used for further processing. There are software like auto civil and auto plotter clubbed with AutoCAD which can be used for plotting contours at any specified interval and for plotting cross-section along any. Specified line.

Advantages of Using Total Stations

The following are some of the **major advantages of using total station** over the conventional surveying instruments:

1. Field work is carried out very fast.
2. Accuracy of measurement is high.
3. Manual errors involved in reading and recording are eliminated.
4. Calculation of coordinates is very fast and accurate. Even corrections for temperature and pressure are automatically made.
5. Computers can be employed for map making and plotting contour and cross-sections. Contour intervals and scales can be changed in no time.

However, surveyor should check the working condition of the instruments before using. For these standard points may be located near survey office and before taking out instrument for field work, its working is checked by observing those standard points from the specified instrument station.

