SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

S.R.M. Nagar, Kattankulathur - 603 203.

DEPARTMENT OF CIVIL ENGINEERING

Survey Lab

ACADEMIC YEAR 2021- 2022

(ODD Semester)

1903307 - SURVEYING LABORATORY

(REGULATION 2019)

LAB INSTRUCTION MANUAL

Specific Rules and Hazards Associated with this Lab Include

Capacity-Normal Occupancy during teaching labs is 18

- Students should enter the lab with proper uniform and ID card.
- Always keep work areas clean and tidy.
- Observe safety alerts in the laboratory.
- Always wear shoes that completely cover your feet. No sandals or opened toed shoes are allowed.
- Follow all written and verbal instructions carefully.
- Observe the safety alerts in the laboratory.
- Don't forget to bring Lab manual, Record, observation, calculator, graph sheet and other accessories when you come to lab.
- In the absence of Instructor no student shall be allowed to work in the laboratory.
- Don't use mobile phones during lab hours.
- Place tools and equipment in proper place after use.
- Turn off the power switches of weighing balance and equipments after used.
- Report to the staff if any injuries.
- Dont try to repair any faulty instruments.

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1903307 SURVEYING LABORATORY L T P C 0 0 4 2

OBJECTIVE :

- Acquire practical knowledge on handling survey instruments like Theodolite – to measure horizontal, vertical angles, calculation of area and elevation of ground surface.
- Acquire adequate knowledge to carryout Triangulation, understand the importance of Triangulation and their applications in surveying
- Tacheometery - to identify the elevation and horizontal distance between instrument and object
- Acquire practical knowledge on handling survey instruments like Total station including general field marking for various engineering projects
- At the end of the course the student will possess knowledge about Survey field techniques

LIST OF EXPERIMENTS:

CHAIN SURVEY

1. Study of chains and its accessories, Aligning, Ranging, Chaining and Marking Perpendicular offset
2. Setting out works – Foundation marking using tapes single Room and Double Room

TRAVERSING

1. Compass Traversing – Measuring Bearings & arriving included angles
2. Plane table Traversing

LEVELLING - STUDY OF LEVELS AND LEVELLING STAFF

1. Fly levelling using Dumpy level &Tilting level
2. Check levelling

THEODOLITE - STUDY OF THEODOLITE

1. Measurements of horizontal angles by reiteration and repetition and vertical angles
2. Determination of elevation of an object using single plane method when base is accessible/inaccessible
3. Determination of elevation of an object using double plane method

TACHEOMETRY – TANGENTIAL SYSTEM – STADIA SYSTEM

1. Determination of Tacheometric Constants
2. Heights and distances by stadia Tacheometry
3. Heights and distances by Tangential Tacheometry

TOTAL STATION

1. Study of Total Station, Measuring Horizontal and vertical angles
2. Traverse using Total station and Area of Traverse
3. Determination of distance and difference in elevation between two inaccessible points using Total station.

TOTAL: 60 PERIODS

OUTCOMES:

1. Students completing this course would have acquired practical knowledge on handling basic survey instruments including Theodolite, Tacheometry.
2. Have knowledge on handling survey instruments Total Station and GPS etc.,
3. Have adequate knowledge to carryout Triangulation
4. Have basic knowledge on astronomical surveying.
5. General field marking for various engineering projects and Location of site etc.

III SEMESTER

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CHAIN SURVEYING

Chain surveying is the type of surveying in which only linear measurements are taken in the field.This type of surveying is done for surveys of small extent to describe the boundaries of plot of land to locate the existing features on them.

It is the method of surveying in which the area is divided into network of triangles and the sides of the various triangles are measured directly in the field with a chain or a tape and no angular measurements are taken.

Chains are the measuring instrument used in surveying formed by the 100 links of 4mm galvanized mild steel wire. These links are joined by 3 circular or oval wire rings. These rings provide the flexibility to the chains.

Every aspect of the life requires some measuring units. Measurements are used to do the work precisely and accurately. Let it be from kitchen to office, everywhere measurements are used. So as in engineering calculation or measurements holds a very greater role in construction or surveying or any other aspect.

There are various units of measurements such as meters, centimeters, feets, inches, acre, yards and the list goes on. Same as units there are various instrument used in the measurements of any entity. One of the instruments used in measurement are chains.

Parts of Chains used in Surveying

The chain consists of many small parts used for handling or reading the measurements.

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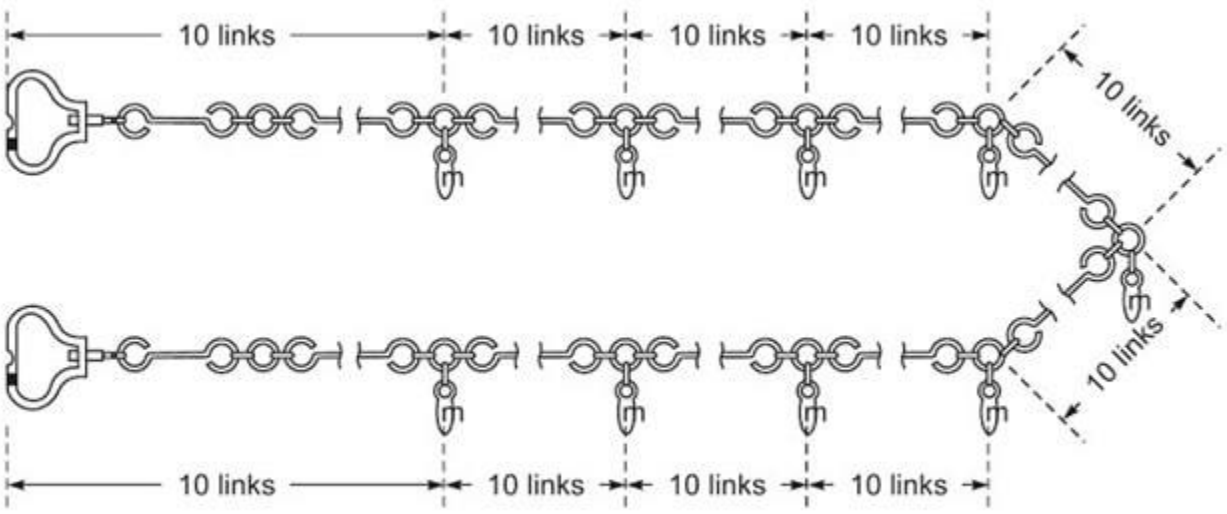
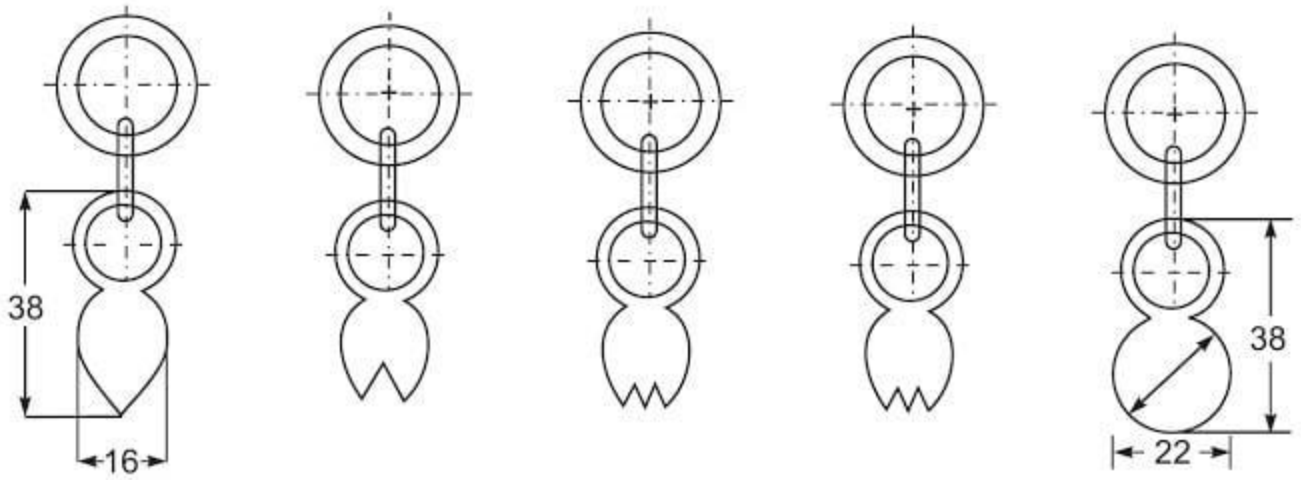
Parts of Chains used in Surveying

The chain consists of many small parts used for handling or reading the measurements.

- At the ends chain is provided with brass handle with swivel joint so that it can be easy to roll or unroll the chain without twisting and knots.
- At every 10^{th} link is provided with a tally of one teeth, 20^{th} link with a tally of two teeth and so on till 40^{th} link. This is provided for the easy reading of measurements.
- At the center of the chain is provided with a circular talley used for easy reading.



(a) 100 link chain



(b) Talleys

Types of Chains used in Surveying

Depending upon the length of the chain, these are divide into following types,

1. Metric chains
2. Steel band or Band chain
3. Gunter's chain or surveyor's chain
4. Engineer's chain
5. Revenue chain

A. Metric chains

Metric chains are the most commonly used chain in India. These types of chains comes in many lengths such as 5, 10, 20 and 30 meters. Most commonly used is 20m chain. Tallies are provided at every 2m of the chain for quick reading. Every link of this type of chain is 0.2m. The total length of the chain is marked on the brass handle at the ends.

B. Steel band or Band chain

These types of chain consist of a long narrow strip of steel of uniform width of 12 to 16 mm and thickness of 0.3 to 0.6 mm. this chain is divides by brass studs at every 20cm or instead of brass studs, band chain may have graduated engraving as centimeter.

For easy use and workability band chains are wound on steel crosses or metal reels from which they can be easily unrolled. These steel bands are available in 20m and 30m length and the width of about 12-16mm.

C. Gunter's chain or surveyor's chain

Gunter chain comes in standard 66ft. These chain consists of 100links, each link being 0.66ft or 7.92inches. The length 66ft is selected because it is convenient in land measurements.

10 square Gunter's chains = 1 Acre

10 Gunter chains = 1 Furlong

80 Gunter chains = 1 mile

D. Engineer's chain

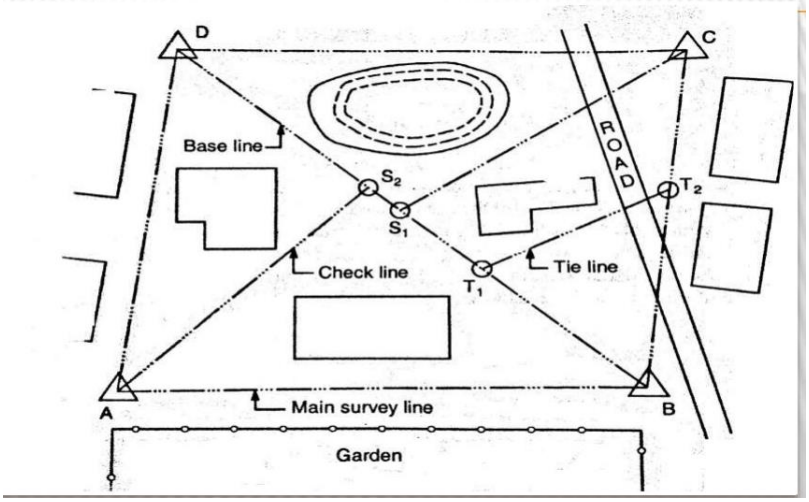
This chain comes in 100ft length. Its consist of 100 links each link being 1ft long. At every 10 links a brass ring or tags are provided for indication of 10 links. Readings are taken in feet and decimal.

E. Revenue Chain

The standard size of this type of chain is 33ft. The number of links are 16, each link being $2\frac{1}{16}$ ft. This chain is commonly used in cadastral survey.

PRINCIPLE OF CHAIN SURVEYING

- The principal of chain surveying is to divide the area into a number of triangles of suitable sides.
- As a triangles is the only simple plane of geometrical figure which can be plotted from the lengths of the three sides even if the angels are not known.
- A network of triangles (triangulation) is preferred to in chain surveying .
- If the area to be surveyed is triangular in shape and if the lengths and sequence of its three sides are recorded the plane of area can be easily drawn.

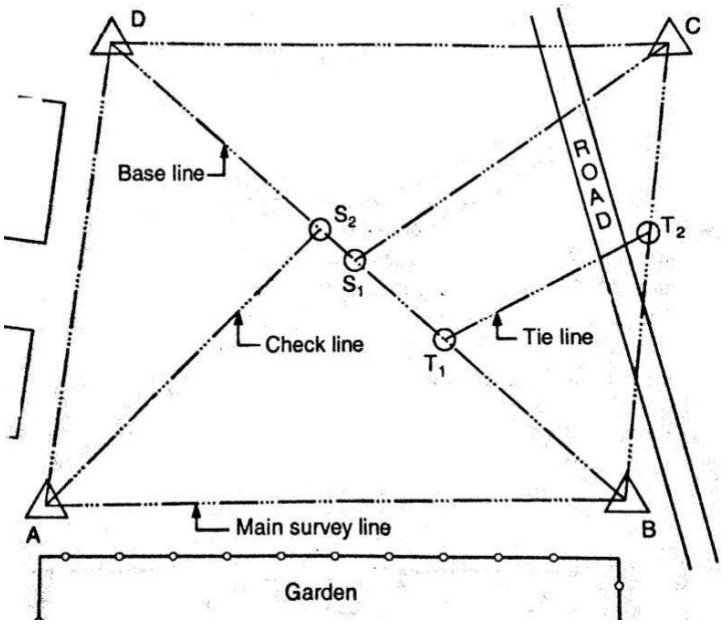


SURVEY STATIONS

Survey stations are the points at the beginning and at the end of the chain line. They may also occur at any convenient position on the chain line. Such stations may be :

(a) Main stations (b) Subsidiary stations (c) Tie stations

(a) Main stations : Stations taken along the boundary of an area as controlling points known as 'main stations'. The lines joining the main stations are called 'main survey lines'. The main survey lines should be cover the whole area to be surveyed. The main stations are denoted by ' ' with letters A,B,C,D, etc.

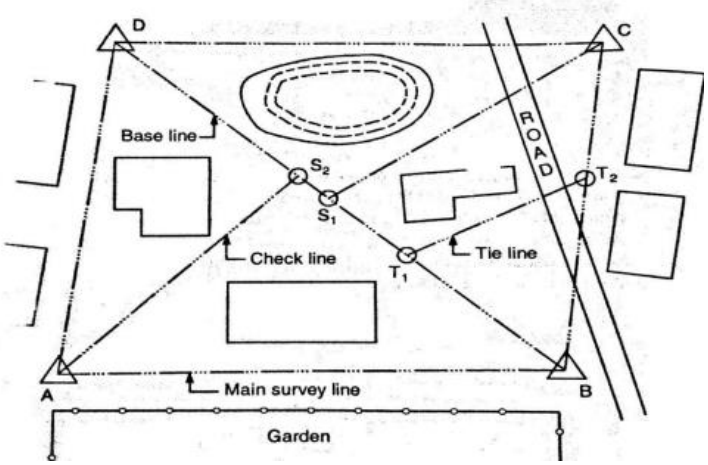


(B) Subsidiary stations : Stations which are on the main survey lines or any other survey lines are known as 'Subsidiary stations'. These stations are taken to run subsidiary lines

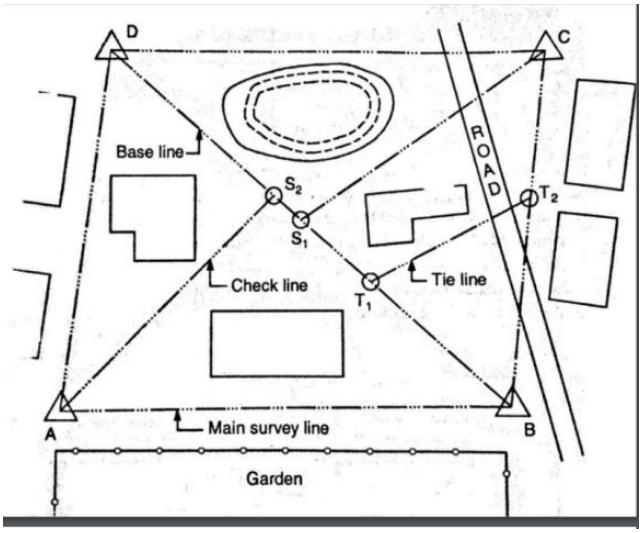
for dividing the area into triangles , for checking the accuracy of triangles and for locating interior details. these stations are denoted by ‘ ‘ with letters S1, S2, S3, etc.

(c) Tie stations : These are also subsidiary stations taken on the main survey lines. Lines joining the tie stations are known as ‘tie lines’. Tie lines are taken to locate interior details. The stations are denoted by ‘ ’ with letters T1 , T2 , T3 , etc.

(2) MAIN SURVEY LINES : The lines joining the main stations are called ‘main survey lines’ or chain lines in fig. AB,BC,CD and DA are the main survey lines.



(3) BASE LINE : The line on which the framework of the survey is built is known as the ‘base line’ . It is the most important line of the survey .Generally , the longest of the main survey line is considered as the base line. This line should be measured very carefully and accurately. In fig. BD is the base line



(4) CHECK LINE : The line joining the apex point of a triangle to some fixed points on its base is known as the 'check line'. It is taken to check the accuracy of the triangle . Sometimes this line is helps to locate interior details .In fig.CS1 , AS2 are the check lines.

(5) TIE – LINE : A line joining tie stations is termed as a tie line. It is run to take the interior details which are far away from the main lines and also to avoid long offsets. It can also serve as check line. In Fig. T1 T2 is the tie line.

PROCEDURE:

(1) Fix station A and B at some distance by fixing wooden peg to determine horizontal distance between them.

(2) Position of station A and B is fixed by measuring their position from at least three permanent objects and location sketch of station A and B are drawn.

(3) The follower holds one handle of the chain in contact with peg at station A.

(4) The leader takes the other handle of the chain, arrows and ranging rod & walks in the forward direction dragging chain with him.

(5) After the chain is stretched completely along the line the follower steps on one side of the line with the ranging rod touching the handle.

(6) The follower directs to leader to stand exactly in the line. The leader puts a scratch at the position & inserts an arrow. He then moves forward with the chain handle with the remaining arrows and ranging rod till the follower reaches the next arrow point.

STUDY OF CHAIN AND TAPE AND ACCESSORIES USED FOR CHAIN SURVEYING

DESCRIPTION OF THE INSTRUMENTS:-

A) Chain:-

1. The chains are made in lengths of 30 meters/20 meters.
2. The brass tallies are fixed at every 5m length.
3. Small brass rings are provided at every one meter length.
4. It is composed of 100 or 150 pieces of galvanized mild steel wire of 4mm in diameter called links.
5. The ends of each links are bent into a loop and connected together by means of 3 oval rings which give flexibility to the chain.
6. The length of each links is 20cm i.e. the distance between 2 consecutive middle rings.
7. The end of the chains is provided with brass handle for dragging the chain on the ground.
8. The chain length is measured from the outside of one handle to the other.
9. To hold the arrows in the position with the handle of the chain a groove is cut on the outside surface of the handle.

B) Ranging rods:-

1. They are usually of 2m or 3m in length.
2. They are in circular cross section and having alternate black, white and red bands of 20 cm length each to make them visible at a distance.
3. They are used for ranging the lines and for marking the positions of points on the ground.

C) Arrows:-

1. They are made of a steel wire of 4mm diameter for 40cm length.
2. They are pointed at one end for inserting into the ground and bent at the other end for facility of carrying.
3. They are used to mark the end of each chain during chaining.

D) Offset rods:-

1. These are used for measuring rough offsets.
2. They are round rods with pointed end on one side and provided with notch or a hook at the other to facilitate pulling the pushing the chain through obstructions.

E) Cross staff:-

1. It consists of a wooden block with two fine sow cuts at right angles to each other on the top.
2. It is used to set a perpendicular at a given point on the chain line.
3. The head is fixed to a top of an iron staff with pointed end to drive into the ground.

F) Optical square:-

1. This is also used to set a perpendicular with more accuracy.
2. This has 2 mirrors placed at an angle of 45 ° to each other.
3. By means of reflection we can see the ranging rods along the chain line and the offset point at right angles to the chain lines simultaneously.

Expt No. 1 Date: ----------

CHAIN SURVEYING

PLOTTING THE OUTLINE OF THE GIVEN BUILDING-CROSS STAFF SURVEY

Aim:-

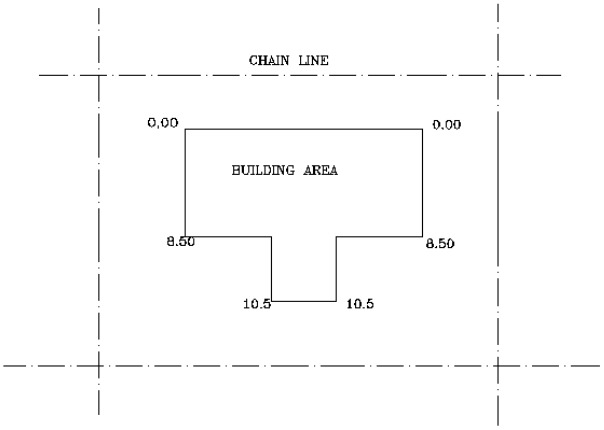
To plot the plan of an existing building by running a closed chain traverse and to find the area of the plot.

Instruments Required:-

Chain,Cross staff, optical square, ranging rods, arrow & tape.

Procedure:-

1. Range and chain the lines around the given building to form a rectangle in clockwise/anti clockwise direction.
2. Measure all the offset points (Perpendicular/ Oblique) from the chain line.
3. Plot the building in a drawing sheet with suitable scale.
4. Subtract the un-builtup area (open space) of the plot from the total area of the plot to find the builtup area of the building.



Result:-

The plan of the building is plotted as shown in figure.

Area of the plot (**a**) =……m^2

Area of the open space (**b**) = ……m^2

Area of the building = (**a**)-(**b**) = ……m^2

Expt No. 2 Date: ----------

DETERMINATION OF THE AREA OF CLOSED TRAVERSE

Aim:-

To find the area of the given boundary by perpendicular offset method.

Instruments Required:

Chain (30m), Ranging rods, arrows, Pegs, cross staff.

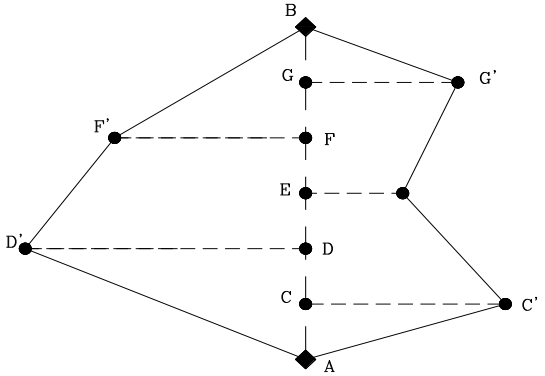
Formulae:-

Area of the triangle A= ½ bhsq.units.

Area of the trapezium A= ½ h (a+b) sq.units.

Procedure:-

1. The survey stations are fixed.
2. To range a line AB, the ranging rods are fixed at the end of the line.
3. The surveyors stand just behind the ranging rod A. The assistant holds a ranging rod at point C, approximately on the line AB.
4. Locate the perpendicular offset by using cross staff.
5. Move the cross staff towards left / right.
6. Now base line (AB) is visible and perpendicular line also visible.
7. Perpendicular line measurements are taken.
8. The operation is repeated until the end station of the line is reached.
9. To check the accuracy of the measurement, the line is measured in the reverse direction.
10. Split the area, by triangle and trapezoidal.
11. Calculate the area by using triangle and trapezoidal formula.



Result:-

The area of the field = ……

Expt No. 3 Date: ----------

SETTING OUT OF FOUNDATION MARKING USING TAPES SINGLE ROOM AND DOUBLE ROOM

Aim:

To determine the setting out the foundation for a building, b using center line method.

Instruments Required:

Theodolite, Pegs, Arrows, Measuring Tape or Chain, mason's square, ball of string, lime powder.

Planning and organization:

A small area is to be kept ready for setting out a simple rectangular building of size 6m x 3m. The site has to be cleaned off any vegetation and made level. or given plan.

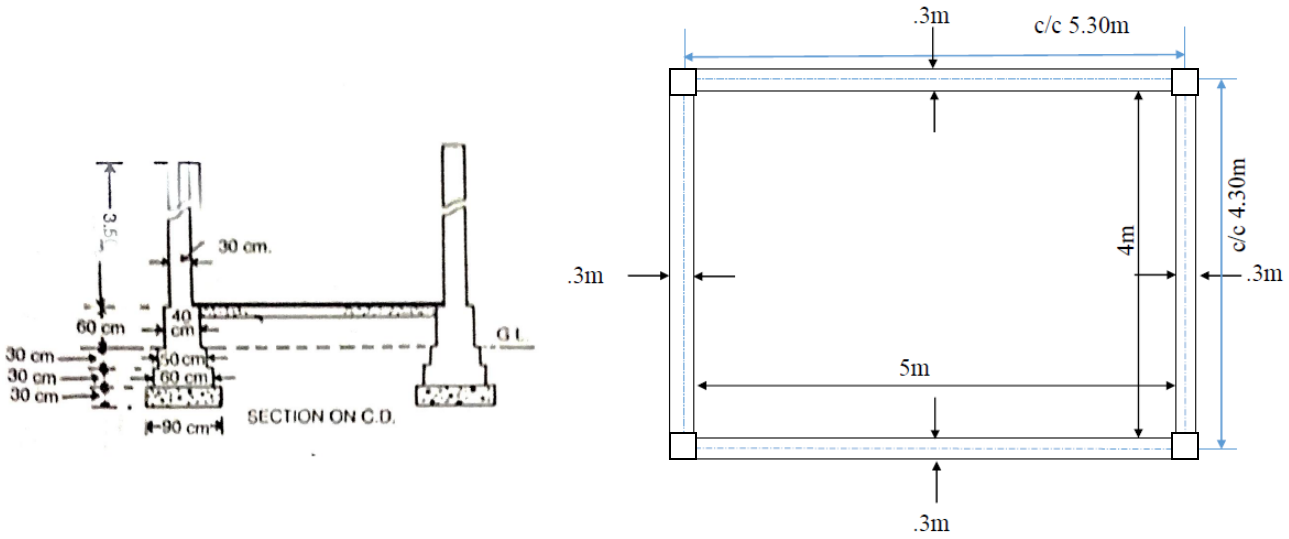
Given:

A hall 6m x 3m internal dimension has to be constructed. The wall is 230mm thick. The width of the foundation is 900mm. Set out the building, mark foundation trench.

Procedure:

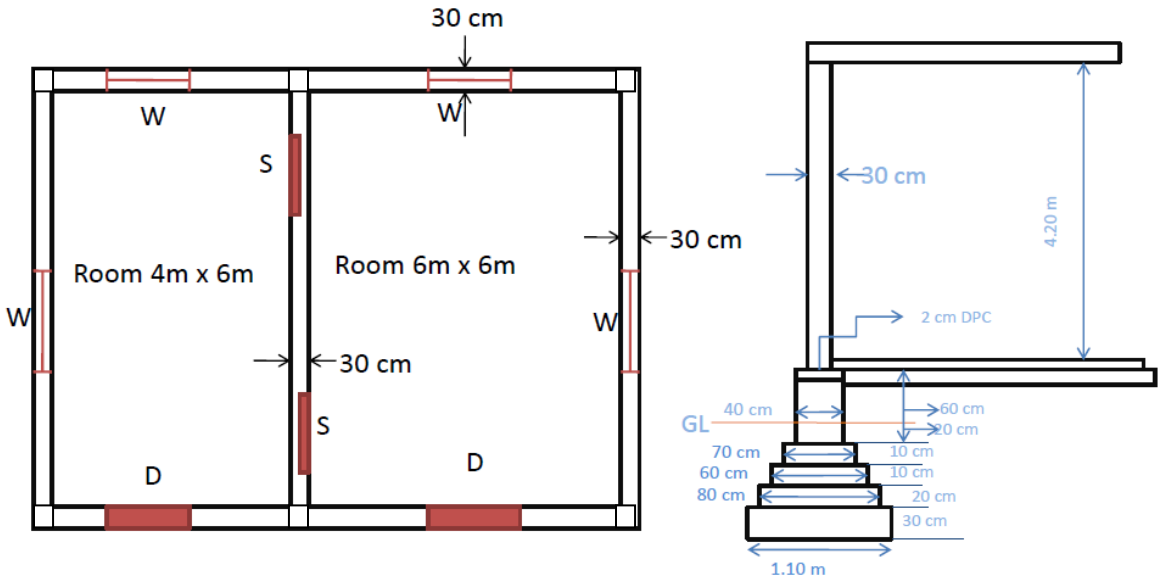
1. Study the plan of the building and note down the internal dimensions and also the width of the foundation.
2. Prepare the centre line sketch of the building.
3. Remove the any vegetation in the construction site.
4. Setting out a straight line slightly greater than the length of the front wall. The frontage is to be located with respected to other features is site plan such as road etc., this line will be the centre line of the front wall.
5. Now mark the two ends of the front wall.
6. Drive two pegs a little away from the ends marked and tied a string accurately.
7. At two ends, set out perpendicular strings using masons square.
8. Stretched strings of the sidewalls and ties\ with pegs a little beyond the required.
9. Repeat the same for other aside walls.
10. Now, stretched strings through the points C and D indicates the ends of the centers lines of the side wall give a rectangle bounded by strings. This rectangle indicates the centre line of the building.

11. Measuring the four sides of the rectangular and check its accuracy as per the centre line sketch prepared.
12. Check the angles of the corners.
13. Measure the diagonals and check for its accuracy.
14. If items 11,12,13 are satisfied the rectangle is marked.
15. Mark the width of foundation of wall on ground have the wide on either side of the centre line marked and apply lime powder to indicate outline of the foundation trench.



SINGLE ROOM

MARKING OF FOUNDATION



DOORS D 1.20 m x 2.10m
WINDOWS S- 1.00X1.50m
SHELVES S- 1.00m x 1.50m

DOUBLE ROOM

RESULT:

The foundation marking is done for the given layout.

COMPASS TRAVERSING

STUDY OF COMPASS SURVEYING

DESCRIPTION OF THE INSTRUMENTS

A. Prismatic Compass:-

1. A magnetic needle is attached to the circular ring made up of aluminum.
2. The needle is on the pivot to orient N and S ends.
3. The line of sight is defined by object vane and eye slit both attached to the compass bar.
4. The object vane consists of a vertical hair attached to a suitable frame while the eye slit consist of a vertical slit above the prism unit.
5. When the object is sighted, the sight vanes will rotate with respect to the NS end of the ring through an angle which the line makes with the magnetic meridian.
6. The reading increase in clockwise direction from 0˚ at south and to 90˚ at west end 180˚ at north end and 270˚ at east end.
7. Break- pin is placed at the base of the object vane to clamp the oscillation of the needle while taking reading.
8. To sight the objects, which are too high or too low, a hinged mirror is placed.
9. Dark glasses are used to sight bright objects.

Adjustments of prismatic compass:-

(A) Centering:-

a) It is the process of keeping the instrument exactly over the station.
b) It is done by dropping a pebble from the centre of the bottom of the instrument.

(B) Leveling:-

a) For which the tripod is provided with ball and socket arrangement to fix the compass on level.
b) Adjust the box in such a way that the graduated disc is swinging freely and appears to be level.

(C) Focusing the Prism:-

a) The prism attachment is sided up or down till the readings are seen to be sharp and clear.

B.Surveyors Compass:-

a) The object vane is similar to that of prismatic compass.
b) The eye vane consists of a simple metal vane with the fine slit without the prism.
c) The graduation ring is directly attached to the box and not with needle.
d) The object is to be sighted first with the object and eye vanes and reading is taken against the north end of the needle by looking vertically through the top glass.
e) The card is graduated in quandrantal system having 0˚ at N and S ends & 90˚ at west and east ends.

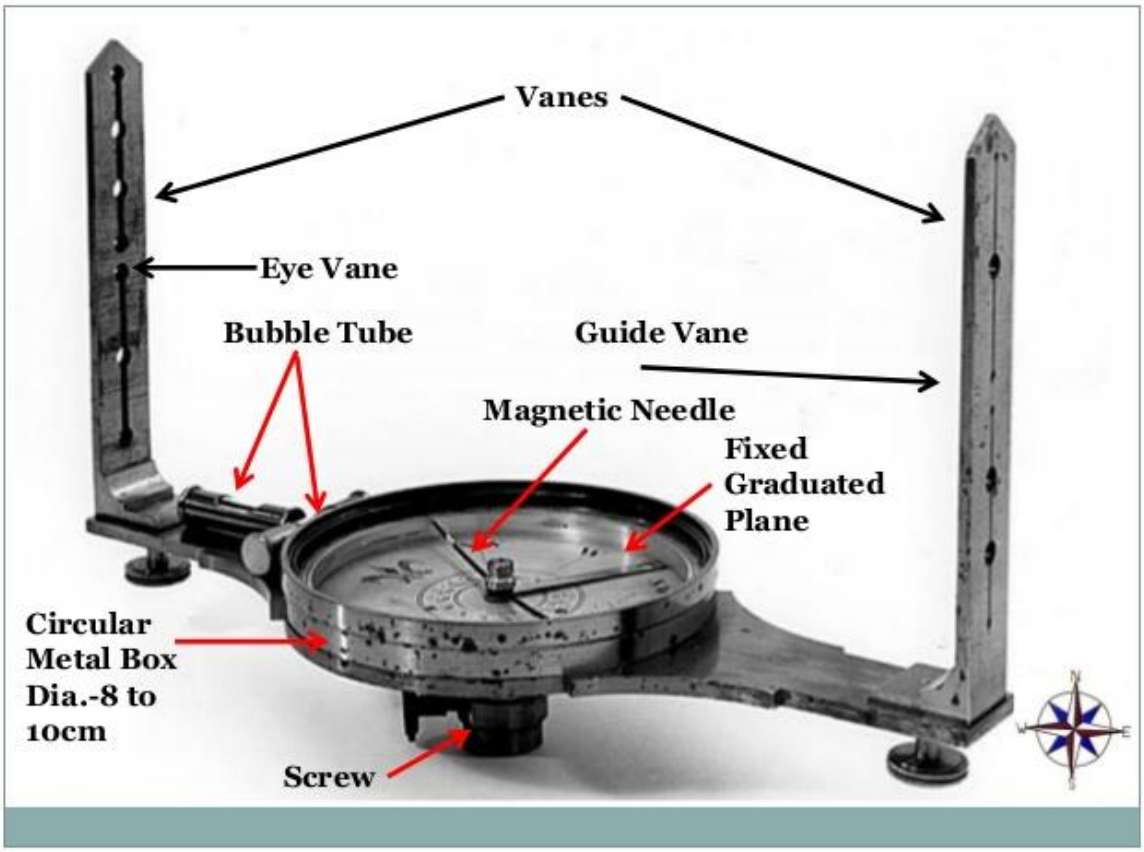


Fig 13: Parts of compass

COMPASS TRAVERSING – MEASURING BEARINGS & ARRIVING INCLUDED ANGLES

Aim: Measurement of bearings of sides of traverse with prismatic compass and computation of correct included angle.

Apparatus: Prismatic compass, ranging rod, chain, tape, peg Tripod stand

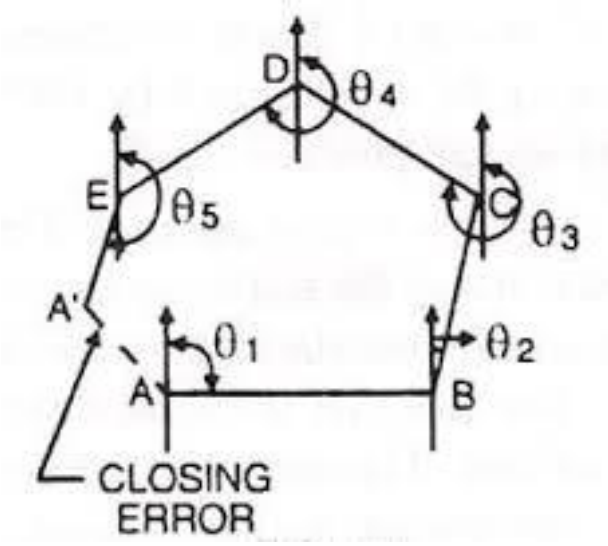
Procedure:

1) Four ranging rods are fixed at different points i.e. A, B, C, D etc. such that it should be mutually visible and may be measured easily.

2) Measure the distance between them. 1) At point A the prismatic compass is set on the tripod Stand, centering and leveling is then properly done. 2) The ranging rod at B is ranged through sighting slits and objective vane attached with horse hair and reading on prismatic compass is noted down.

3) It is fore bearing of line AB. Then the prismatic compass is fixed at B and ranging rod at C and A are sighted. And reading is taken as forbearing of BC and back bearing of AB.

4) Repeat the same procedure at the stations C, D etc.



Tabulation:

Inst. Station	Line	Observed bearing	bearing Local attraction	error	Correction	Corrected bearing	Included angle
A	**AB**						
B	**AD**						
	BC						
C	**BA**						
	CD						
D	**CB**						
	DA						
	DC						

Sample Calculation: Error = observed bearing –corrected bearing

Check:=(2n-4)x900

Result: The prismatic compass is studied and bearing of lines of traverse are Observed, the correction due to local attraction at affected station is done and corrected bearings are written in tabular form.

Expt No. 5 Date: ----------

TRAVERSING – PLANE TABLE

Aim:

To survey a small piece of land by closed traverse technique using plane table.

Equipment and Accessories:

Plane table and its accessories (tripod, alidate, trough compass, plumbing fork, spirit level, drawing sheet, cello- tape, pencil, eraser and dusting cloth), chain, tape, ranging rods, pegs, hammer and field-book.

Principle:

Traversing is that of survey in which a number of connected survey lines form a framework. The directions and lengths of the survey lines are measured with the help of an angle (or direction) measuring instrument and a tape respectively. If the framework formed by the lines closes at the starting station, that is, if they form a closed polygon, it is called closed traverse. In plane table traversing, at each successive station the table is set, a foresight is taken to the following station and its location is plotted by measuring the distance between the two stations as in the radiation method.

Procedure:

1) Select the traverse stations A,B,C,D and E on the ground.

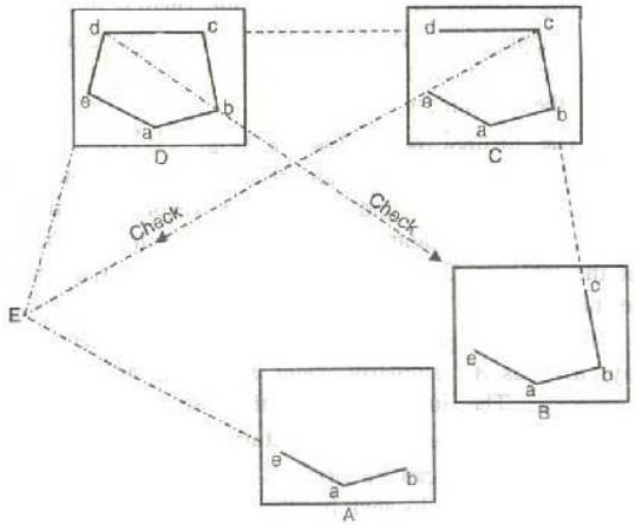
2) Set the table at A. Use plumbing fork and transfer A on to the sheet and name it ‘a’. On the top right corner of the sheet mark the direction of magnetic north with the help of trough compass.

3) With the alidade pivoted about a, sight it to B and draw the ray. Measure AB and scale of ab to a suitable scale. Similarly draw a ray towards E, measure AE and mark ‘e’.

4) Shift the table to B and set it. Orient the table accurately by back sighting A. Clamp the table.

5) Pivoting the alidade about b, sight to C. Measure BC and plot it on the drawn ray to the same scale. Similarly, the table can be set at other stations and the traverse is completed.

Note: While being at each station, take measurements by radiation to any details that are to be included in the plan.



Observations and Calculations: 1) Measure the distance DB and EC on the ground. 2) Scale the distance db and ec on the drawing sheet.

Result: Compare the ground distances DB and EC with corresponding plan distances db and ec.

LEVELLING

DESCRIPTION OF THE INSTRUMENTS: -

The level: -

The instrument which is used for measuring related elevations is known as a level and consists of the following parts.

1. A telescope to provide a line of sight.
2. A level tube to make the line sight horizontal.
3. A leveling head to bring the bubble of the level tube at the center of its run.
4. A tripod head to support the above three parts of the level.

Types of level: -

The dumpy level: -

1. This consists of a telescope rigidly fixed to its support.
2. It can neither be rotated about it longitudinal axis nor it can be removed from its support.

The wye level: -

1. The telescope is supported in Y supports and is not rigidly fixed to the supports.
2. The telescope can be removed from the supports reversed end to end and can be revolved about its longitudinal axis.

The reversible level: -

1. The telescope can be rotated about its longitudinal axis in the sockets and also can be withdrawn from its sockets and replaced end for end.

The tilting level: -

1. The telescope can be tilted within few degree in vertical plane by a tilting screw.
2. This designed for precise work.

Temporary adjustments of the dumpy level: -

a) Setting up the level: -

1. This includes fixing the instrument on the tripod and levelling the instrument approximately by leg adjustment.

2. To do this release the clamp hold the instrument in the right hand and fix it on a tripod by turning rounded the levelling head with left hand.

3. The tripod legs are adjusted so that the telescope is at a convenient height and is leveled approximately.

b) Levelling up: -

1. This is done with the help of three-foot screws and by using plate levels.
2. The object of levelling is to make its vertical axis truly vertical.
3. First loosen the clamp screw and turn the instrument until the longitudinal axis of the bobble tube is parallel to a joining any two levelling screws (say A and B).
4. Holding these two foot screws with the thumb and first finger of each hand turn them uniformly so that the thumbs move either towards each other on away from each other until the bubble comes to the center of the tube.
5. Rotate the upper plate through 90° until the axis of the plate level coincides a line joining the third foot screw C and the midpoint of the first two screws A and B.
6. Hold the third with the thumb and find finger of the right hand and turn it until the plate bubble is central.
7. Rotate the upper plate through 90° to its original position and repeat step 4 till the bubble is central.
8. Rotate again through 90 and repeat step 6.
9. Repeat steps 4 and 6 till bubble remains central in both the position.
10. Rotate the instrument through 180° and in this position the bubble should remain central if the instrument is in adjustment.

Elimination of parallax: -

1. Parallax is a condition arising when the image formed by the objective is not in the plane of the cross hairs.
2. To get accurate sighting those should be eliminated and this is done.
3. By focusing the eyepiece for distinct vision of the cross hairs and
4. By focusing the objective to bring the image of the object in the plane of cross hairs.

Focusing the eyepiece: -

1. Direct the telescope either towards the sky or hold a sheet of white paper in front of the objective.
2. Move the eyepiece in or out till the cross hairs appear distinct.

Focusing the objective: -

1. Direct the telescope towards the leveling staff.
2. Turn the focusing screw till the image appears clear and sharp.
3. The image formed must be in the plane of cross hairs.

DEFINATIONS

Important terms: -

The following are the important terms used during levelling.

1. Level surface: -

A level surface is any surface parallel to the mean spheroidal surface of the earth.

2. A level line: -

It is a line lying in a level surface and normal to the plumb line at all points.

3. A horizontal plane: -

A horizontal plane through a point is a plane tangential to the surface at that point.

4. A horizontal line: -

It is a line lying in the horizontal plane.

5. Vertical line: -

Vertical line any point is a line normal to the level surface through that point.

6. Vertical plane: -

A plane is a plane containing a vertical line.

7. Datum surface: -

It is any arbitrary assumed level surface form which vertical distances are measured.

8. Elevation: -

Elevation of a point is its vertical distance above or below the datum also known as reduced level (R.L)

9. Bench mark: -

It's fixed reference point of known elevation.

10. Line of collimation: -

It is the line joining the intersection of the cross hairs to the optical center of the object glass and its continuation also known as line of sight.

11. Axis of telescope: -

It is the line joining optical center of the object glass to the center of the eyepiece.

12. Vertical axis: -

It is the center line of the axis of rotation.

13. Back sight (B.S): -

It is a staff reading taken on a point of known elevation (i.e.) on Bench Mark or change point, and is the first reading taken after the level is set up and leveled.

14. Fore sight (F.S): -

It is a last staff reading on a point whose elevation is to be determined as on a change point.

15. Intermediate sight: -

It is any other intermediate staff reading taken on a point of unknown elevation from the same set of the level.

16. Change point: -

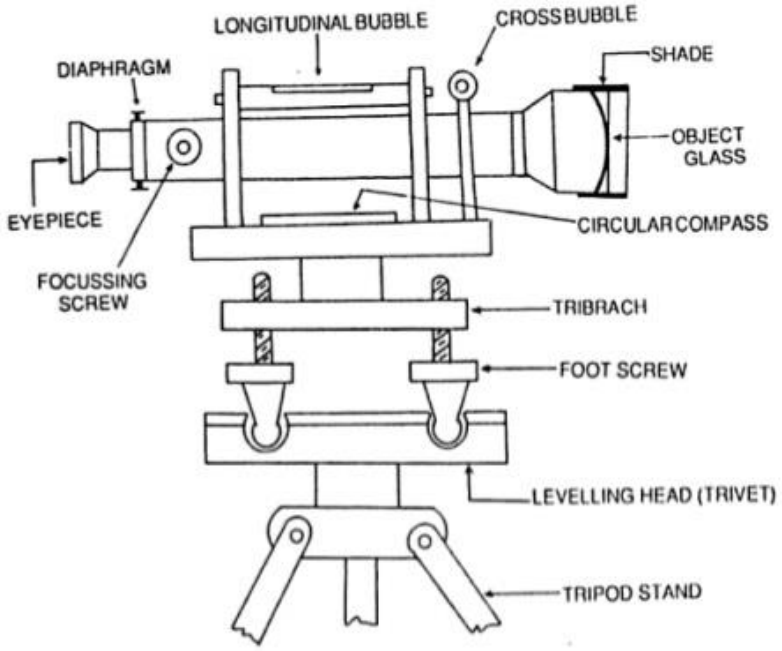
It is a point denoting the shifting of the instrument. It is a point on which the back and foresights are taken.

17. Station: -

It is a point whose elevation is to be determined or a point which is to be established at a given elevation.

18. Height of instrument: -

It is the elevation of the plane of collimation when the instrument is correctly levelled.


LONGITUDINAL BUBBLE
CROSS BUBBLE
SHADE
DIAPHRAGM
OBJECT GLASS
EYEPIECE
CIRCULAR COMPASS
FOCUSSING SCREW
TRIBRACH
FOOT SCREW
LEVELLING HEAD (TRIVET)
TRIPOD STAND

Dumpy level


49
37

Expt No. 6 Date: ----------

FLY LEVELLING

AIM: Fixing bench mark with respect to temporary bench mark with dumpy level by flylevelling

APPARATUS REQUIRED: Dumpy level, leveling staff, tripod stand, arrows, pegs.

INTRODUCTION:

Differential Leveling is Applied to determine the elevation of point which is some distant apart from B.M i.e., the unknown elevation of a point cannot be determined in a single set up of an instrument. Thus, in this method, instrument gets setup number of times to observe reading along a route in between observed points. For each set up, staff readings are taken back to a point of known elevation (first sight from the B.M and forward to a point of unknown elevation) final sight to the terminal station. This type of Leveling is also known as "fly-levelling".

Fly leveling: - It is a very approximate from of levelling in which distances are not measured and sights are taken as large as possible. In this method a line of levels is run to determine approximately reduced levels of the points carried out with more rapidly and less precision.

Dumpy level;

The dumpy level is a simple, compact and stable instrument. the telescope is rigidly fixed to its supports. hence it cannot be rotated about horizontal axis.

Tilting level: it is also known as I.O.P. level (Indian office pattern). in this level the telescope tilts about its horizontal axis hence it is called tilting level.

Check leveling: The main purpose of this type of leveling is to check the values of the reduced levels of the bench marks already fixed. In this method only back sight and foresight are taken. There is no need of intermediate sights. However great care has to be taken for selecting the change points and for taking reading on the change points because the accuracy of leveling depends upon these

PROCEDURE:

1) Instrument level is setup at convenient positions near first point (ay A).
2) Do all the initial adjustments.
3) Direct the telescope towards the First sight of B.M (point of known elevation) is taken and reading is entered in back Sight column. Enter the reading of the last visible point from the instrument stations as F.S and of all other points as I.S.
4) If distance is large instrument is shifted, the instrument becomes turning point (or) changing point. Don't change the position of the staff until the back staff reading is taken on the staff held at the last required point.

5) After setting up instrument at new position, performing temporary adjustment and Take back sight as turning point.
6) Thus turning point will have both back sight and fore sight readings.
7) Link wise the process is repeated till last point (B) is reached.
8) The above procedure is shown in fig. Readings are entered in a tabular form is given below and Reduced levels are calculate either by height of instrument method (or) rise and fall method.

Table 1.Level book note for Rise and Fall method

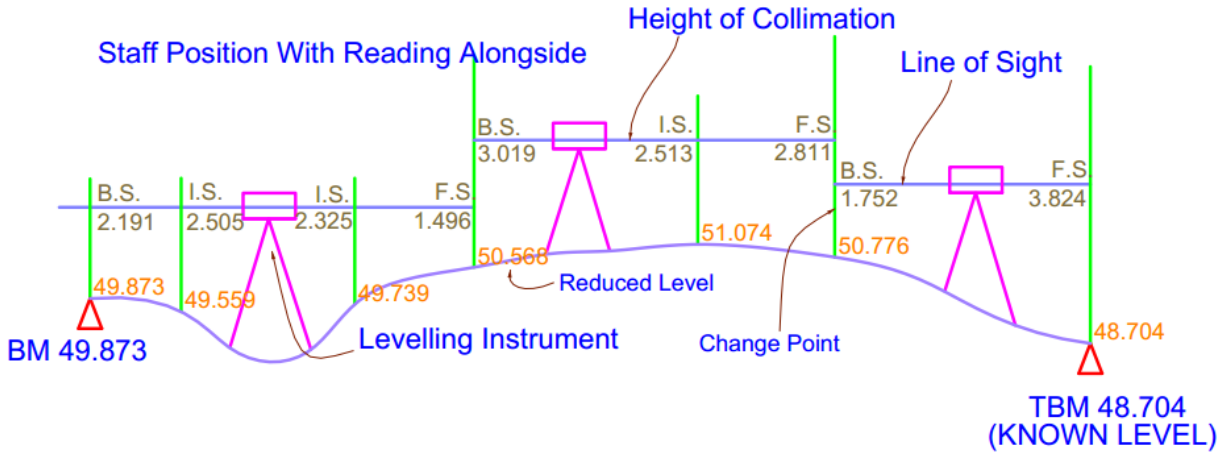
	Staff Reading		**Difference in Elevation**		**Elevation**	
Points	**B.S (m)**	**F.S.(m)**	**Rise (m)**	**Fall (m)**	**R.L (m)**	**Remark**
A					100.000	B.M.
S_1						T.P1
S_2						T.P2
S_n						T.Pn
B						

Arithmetic Check: Σ B.S - ΣF.S = ΣRISE – ΣFALL = Last RL - First R.L

Table 2.Level book note for Height of instrument method

	Staff Reading			**Height of Instrument (m)**	**R.L. (m)**	**Remarks**
Points	**B.S (m)**	**I.S (m)**	**F.S.(m)**			
A					100.000	B.M.
S_1						T.P1
S_2						T.P2
S_n						T.Pn
B						

Arithmetic Check: Σ B.S - ΣF.S = Last RL - First R.L



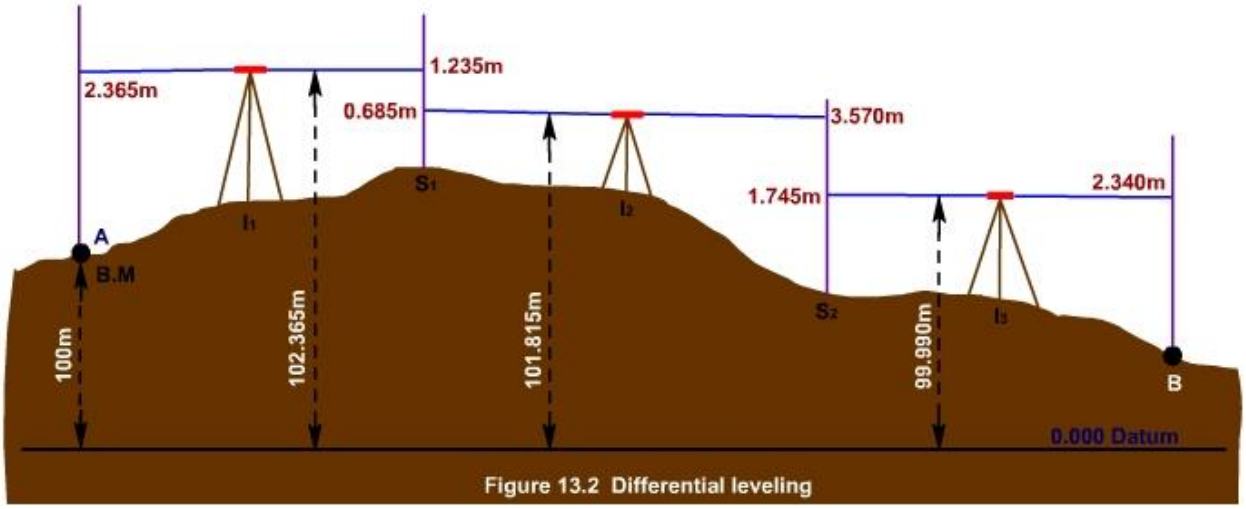


Figure 13.2 Differential leveling

RESULT:

Difference of elevation between two given point is _____ M. Elevation/R.L of point B = _____ M.

Expt No. 7 Date: ----------

CHECK LEVELLING

AIM:

To run the check level to find the difference of the given points and also to find the amount of closing error.

APPARATUS REQUIRED: Dumpy level, leveling staff, tripod stand, arrows, pegs.

PROCEDURE: -

1. Setup the instrument at P to cover the maximum points.
2. Do all the initial adjustments.
3. Direct the telescope towards the first point and enter the reading as B.S.
4. Enter the reading of the last visible point from the instrument stations as F.S. and ofall other points as I.S.
5. Shift the instrument to Q, set up and level it correctly.
6. Don't change the position until the fore staff reading is taken on the staff held at the last required point.
7. Do the same procedure in the reverse direction and close with the first point.

TABULATIONS:

	Staff Reading			Height of Instrument (m)	R.L. (m)	Remarks
Points	B.S (m)	I.S (m)	F.S.(m)			

RESULT: -

Closing error =

R.L for the given points = _____ M.

STUDY OF THEODOLITE

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

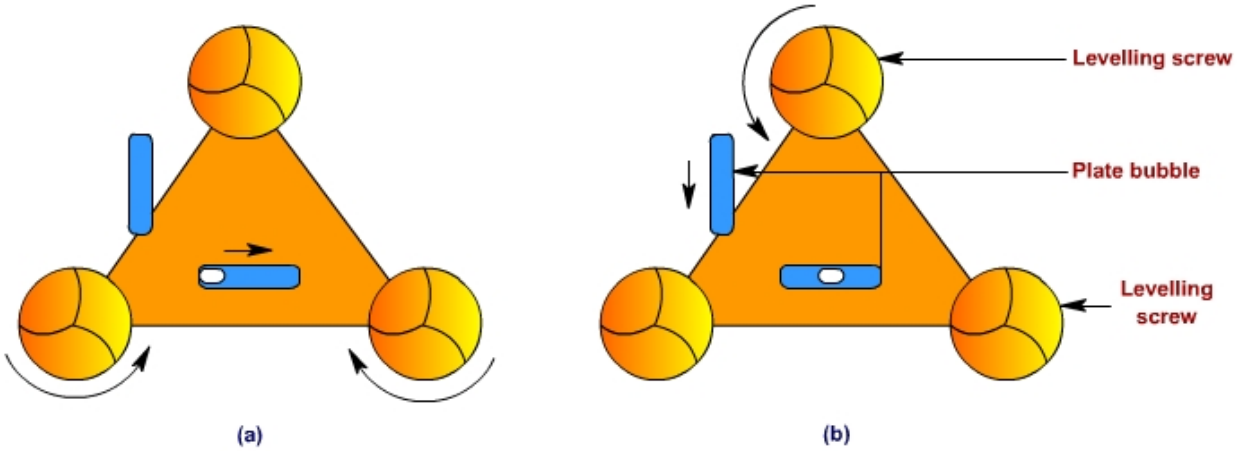
It is the operation by which the vertical axis of the theodolite represented by a plumb line is made to pass through the mark of instrument station on the ground.

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.

Expt No. 8 **MEASUREMENT OF HORIZONTAL ANGLES** Date: ----------

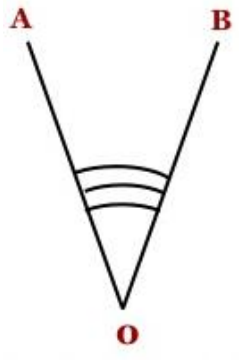
BY REPETITION METHOD

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 "A". Lower clamp is clamped and the point "A" 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 "B" is bisected.

5. Upper clamp is clamped and "B" is bisected exactly using tangent screws. Both the verniers are read. Mean of the readings provide an approximate included angle of AOB.

6. The reading of vernier A gives directly the angle AOB, and 180° is subtracted by the reading of vernier B. The mean value of two readings gives the angle AOB with one face.

7. Lower clamp is unclamped and the telescope is turned anticlockwise to sight A again. Lower clamp is clamped and A is bisected exactly using tangent screws.

8. Upper clamp is loosened and the telescope is turned clockwise and B is bisected. Upper clamp is clamped and B is bisected exactly using tangent screws. The vernier now read twice the value of angle AOB.

9. Last two steps (7&8) are repeated once again to get the thrice value of angle AOB.

10. Finally obtained reading is divided by 3 to get the mean value of angle AOB.

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.

Measurement of Horizontal Angle (Reiteration Method)																											
Instrument Station	**Sight to**	**Face:**									**Swing:**			**Face:**									**Swing:**				**Average Horizontal angle**		
		A			**B**			**Mean**			**Horizontal angle**			**A**			**B**			**Mean**			**Horizontal angle**					
		0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″

JLT:

The horizontal angle measured at O between A and B. i.eAOB

a) With face left:-

b) With face right:-

c) Average:-

=

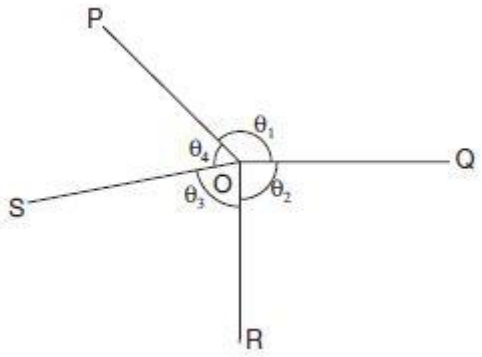
HORIZONTAL ANGLE BY REITERATION METHOD

AIM

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

APPARATUS USED

Theodolite,
Ranging rods,
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. 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.

Measurement of Horizontal Angle (Reiteration Method)																											
Instrument Station	**Sight to**	**Face: Swing:**												**Face: Swing:**												**Average Horizontal angle**		
		A			**B**			**Mean**			**Horizontal angle**			**A**			**B**			**Mean**			**Horizontal angle**					
		0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″

RESULT

The horizontal angle between the points

i) Face Left **ii) Face Right**

POQ = POQ =

QOR = QOR =

ROS = ROS =

SOP = SOP =

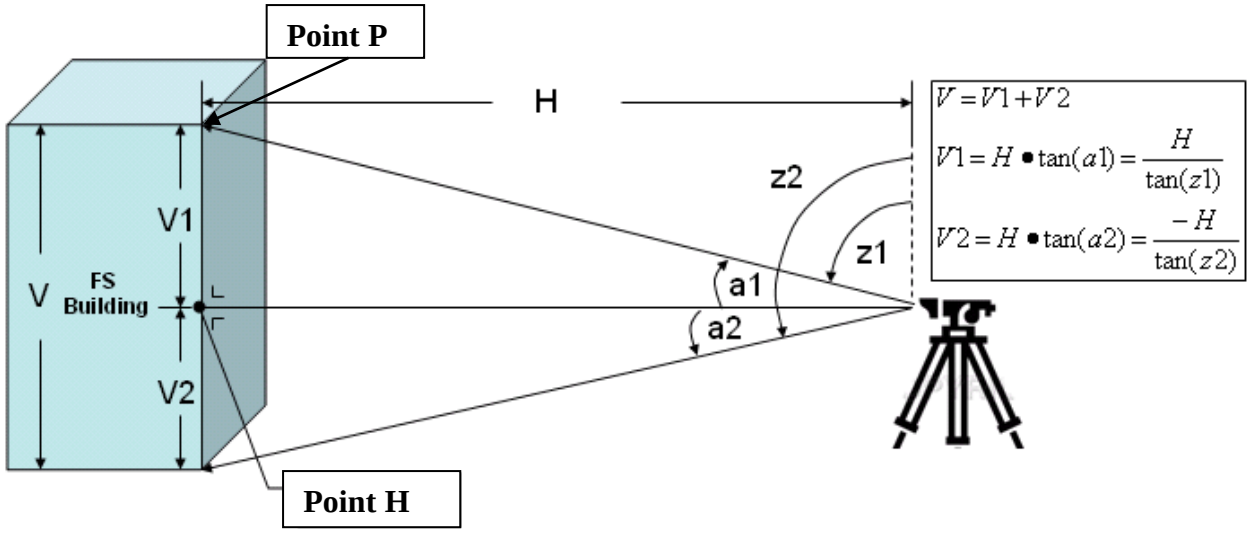
MEASUREMENT OFVERTICAL ANGLES

AIM

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

APPARATUS USED

Theodolite
Ranging rod
Peg or an Arrow.



PROCEDURE

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.

Measurement of Vertical Angle																												
Instrument Station	**Sight to**	**Face: Swing:**												**Face: Swing:**												**Average Vertical angle**		
		A			**B**			**Mean**			**Vertical angle**			**A**			**B**			**Mean**			**Vertical angle**					
		0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″

RESULT

1. The observed angle of Elevation is ----------

2. The observed angle of Depression is ----------

Expt No. 9 Date: ----------

TRIGONOMETRICAL LEVELLING
HEIGHTS AND DISTANCES: BASE ACCESSIBLE

AIM

To determine the reduced level and height of given object by trigonometric leveling, when the base is accessible.

INSTRUMENT REQUIRED

Theodolite with tripod
Ranging Rod
Arrows
Tape

FORMULA

Elevation height $h_2 = D \tan \alpha_1$

Depression height $h_3 = D \tan \alpha_2$

Total height $H = h_2 + h_3$

Height of instrument (HI) = RL of BM + h_1

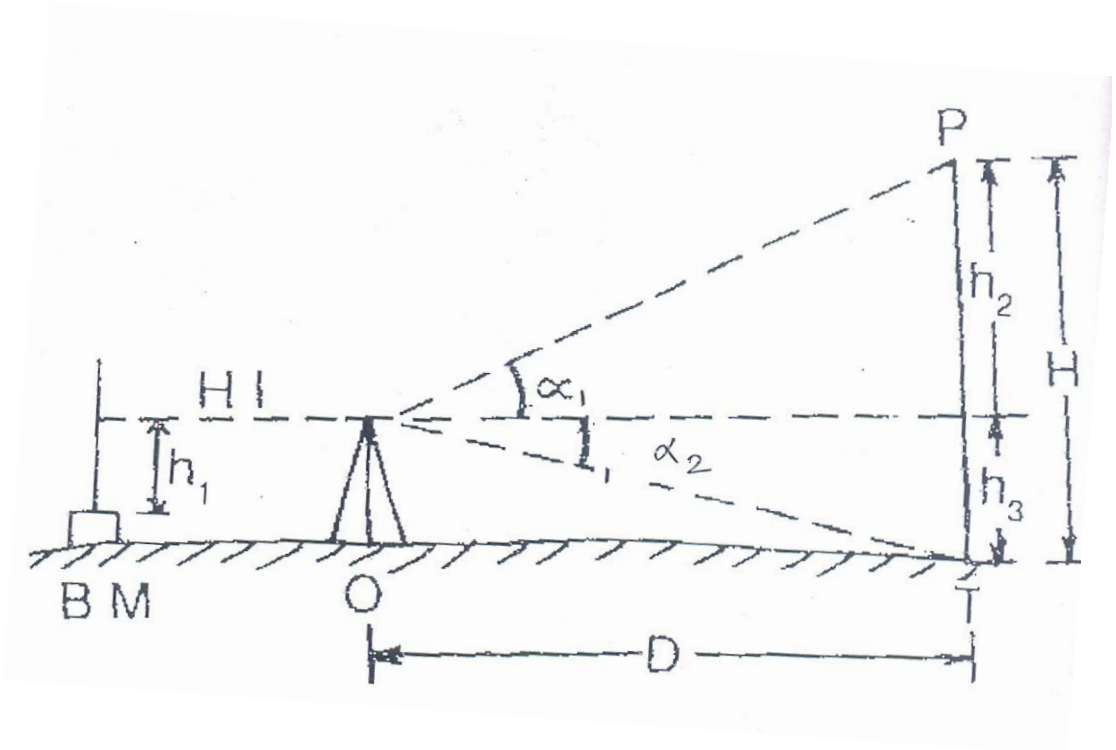
RL of the top of object = HI +h_2

Where,

h_1 – Staff reading on the BM

D – Distance between the object and instrument

$\alpha_1 \& \alpha_2$ – Top and bottom inclined angle of the object.



PROCEDURE

1. The instrument is set up at a convenient point from when the object is clearly visible.
2. Temporary adjustment are made and the line of sight is made horizontal. The staff is held vertically over the bench mark and staff reading corresponding to the middle hair is taken. Let it be h_1
3. The distance D is measured by chain or tape.
4. Now, the top and bottom of the object is bisected. Corresponding vertical angle of elevation α_1 and angle of depression α_2 is noted down.
5. By using suitable formula, the R.L of the top of object can be calculated.

Instrument Station	Object	Observation	Angle	Reading on vernier						Angle on vernier						Mean angle of vernier			Mean angle of observation			Distance
				C			D			C			D									
1	2	3	4	5			6			7			8			9			10			
				0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	
O	A	Face : Left Swing : Right	AOC																			
	B		BOC																			
O	A	Face : Right Swing : Right	AOC																			
	B		BOC																			

R.L. of B.M = _____ m.

RESULT:

1. The height of the given object is _____m.

2. The RL of the top of the object is _____m.

Expt No. 10 Date: ----------

TRIGONOMETRICAL LEVELLING
HEIGHTS AND DISTANCES: BASE INACCESSIBLE – SINGLE PLANE METHOD

AIM

To determine the RL of given object by single plane method.

INSTRUMENT REQUIRED

Theodolite with tripod
Pegs
Levelling staff
Arrows
Tape

FORMULA

$h_1 = D \tan \alpha_1$
$h_2 = (D+d) \tan \alpha_2$
R.L. of top of object = RL of BM + S_1+h_1
= RL of BM + S_2+h_2
$S = S_1 \sim S_2 = h_1 \sim h_2$ = Difference in level of instrument.

$D = (S \pm d \tan \alpha_2) / (\tan \alpha_1 – \tan \alpha_2)$

(Use + sign, when the instrument axis A is lower and – sign, when it is higher than at B)

PROCEDURE

1. The instrument is set up at a convenient point A and temporary adjustments are made.

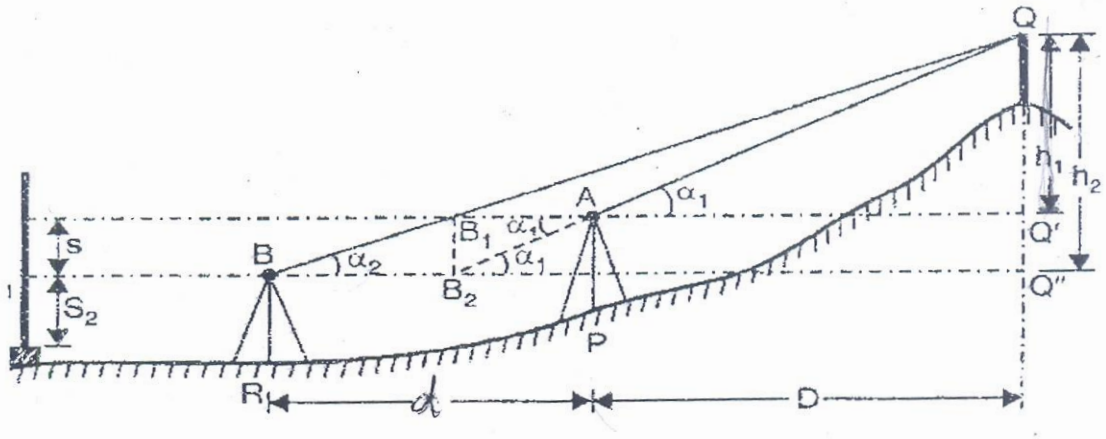
2. Keeping one line of sight horizontal, staff reading is taken over the bench mark (S_1)

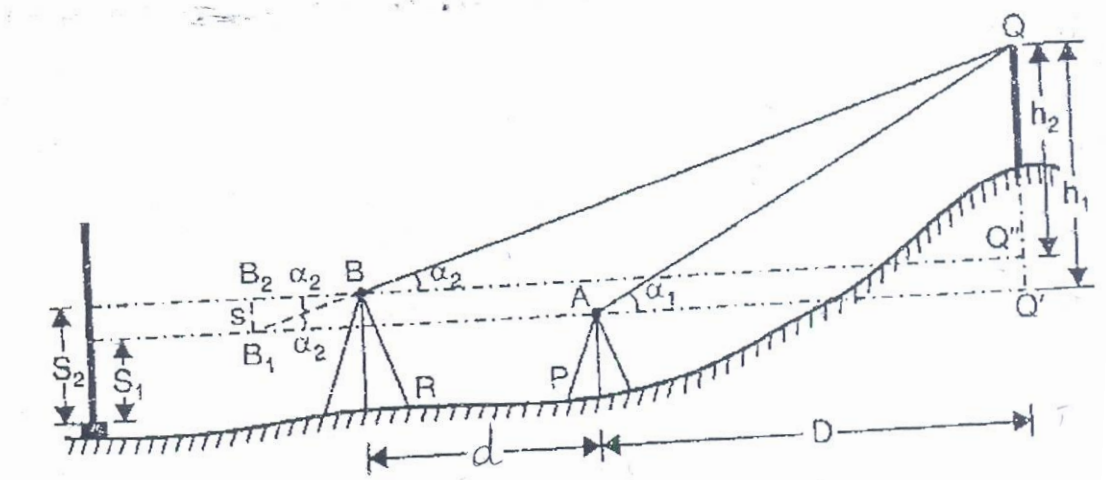
3. The telescope is inclined and the top of the object is bisected. Vertical angle is noted down (α_1)

4. The instrument is transited. So that the line of sight is reversed. The second instrument station B is marked on the ground. The distance AB is measured accurately.

5. The theodolite is shifted and set up at B at a distance d from A. The telescope is inclined and the top of the object is bisected. Vertical angle is noted down (α_2). A staff reading on the B.M is taken (S_2)

6. The R.L. of the object is calculated using above formula.


Q
h1
h2
A
α1
B1
α1
Q'
s
B
α2
B2
α1
Q''
S2
P
R
d
D


Q
h2
h1
Q''
B2 α2 B
α2
A
α1
Q'
s
S2
B1 α2
S1
R
P
d
D

2'Instrument Station	Object	Observation	Angle	Reading on vernier						Angle on vernier						Mean angle of vernier			Mean angle of observation			Staff reading
				C			D			C			D									
1	2	3	4	5			6			7			8			9			10			
				0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	
A	BM Q	Face : Left Swing : Right	α_1																			S_1=
	Q	Face : Right Swing : Right	α_1																			
B	BM Q	Face : Left Swing : Right	α_2																			S_2=
	Q	Face : Right Swing : Right	α_2																			

R.L. of B.M = _____ m.

RESULT:

The RL of the top of the object is _____m.

TRIGONOMETRICAL LEVELLING
HEIGHTS AND DISTANCES – DOUBLE PLANE METHOD

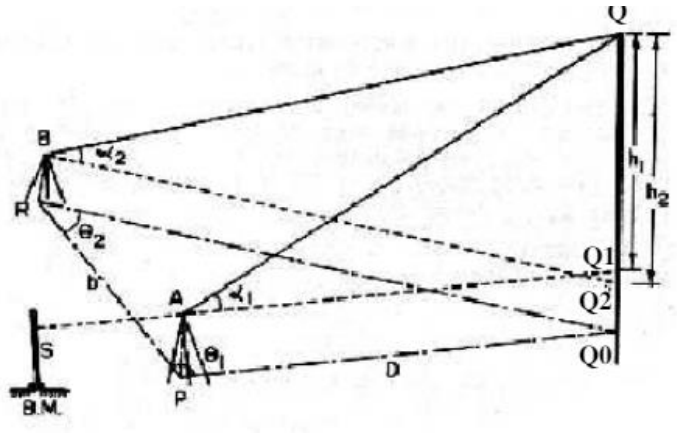
Aim:
To find the R.L. of the top of an object, when the base of the object s inaccessible and the instrument stations are not in the same vertical plane as the elevated object, adopt trigonometrical leveling (double plane method).

Equipment:
Transit Vernier theodolite, tripod stand, plumb bob, tape, leveling staff and pegs.

Procedure: Let P &R be the two instruments stations which are not in the same vertical plane as that of the elevated object 'Q' as shown in figure P&Q should be selected such that the triangle PQR is a well conditioned triangle.

It is required to find out the elevation of the top of an object 'Q'

1. Setup the instruments at P and level it accurately w.r.t the altitude bubble. Bisect the point Q and measure the angle of elevation 'α_1'.
2. Sight to point R ith reading on horizontal circle as zero and measure the horizontal angle RPQ_1 (θ_1) from P.
3. Take a back sight 'S' on the staff kept at A. (B.M.)
4. Shift the instrument to R and measure 'α_2' and 'θ_2' from R.
5. Measure the distance between two instrument stations R&P (equal to 'b')



Let
Q_1 = projection of Q on the horizontal line thought A,
Q_2 = projection of Q on the horizontal line thought B,
AQ_1 = horizontal line though A
BQ_1 = horizontal line though B
AQQ_1 is the vertical plane simultaneously,
BQQ_1 is the vertical plane simultaneously,
PRQ_3 is the horizontal plane
θ_1 = Horizontal angle measure at P
θ_2 = Horizontal angle measure at R
α_1 = Vertical angle measure at A.

Instrument Station	Object	Observation	Angle	Reading on vernier						Angle on vernier						Mean angle of vernier			Mean angle of observation			Distance
				C			D			C			D									
1	2	3	4	5			6			7			8			9			10			
				0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	
O	A B	Face : Left Swing : Right	AOC BOC																			
O	A B	Face : Right Swing : Right	AOC BOC																			

Angle $PQ_0R = 180 - \theta_1 - \theta_2$

R.L. of B.M = _____ m.

Instrument Station	Object	Observation	Angle	Reading on vernier						Angle on vernier						Mean angle of vernier			Mean angle of observation			Staff reading
				C			D			C			D									
1	2	3	4	5			6			7			8			9			10			
				0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	
A	BM Q	Face : Left Swing : Right	α_1																			S_1=
	Q	Face : Right Swing : Right	α_1																			
B	BM Q	Face : Left Swing : Right	α_2																			S_2=
	Q	Face : Right Swing : Right	α_2																			

R.L. of B.M = _____ m.

RESULT:

The RL of the top of the object is _____m.

Expt No. 12 Date: ----------

DETERMINATION OF TACHEOMETER CONSTANT

AIM

To determine the Tacheometer constants

INSTRUMENT REQUIRED

Tacheometer with tripod
Pegs
Levelling staff
Arrows
Tape

FORMULA

TacheometricequationD = Ks+C

Where,

K = Multiplying constant
C = Additive constant
S = staff intercept
D = distance of peg points

PROCEDURE

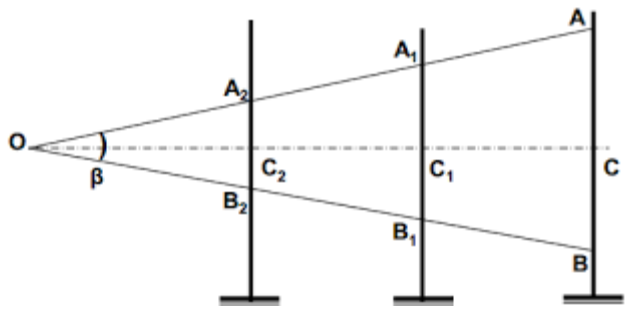
1. A line of fixed length is fixed on the ground and pegs are driven at some specified interval.

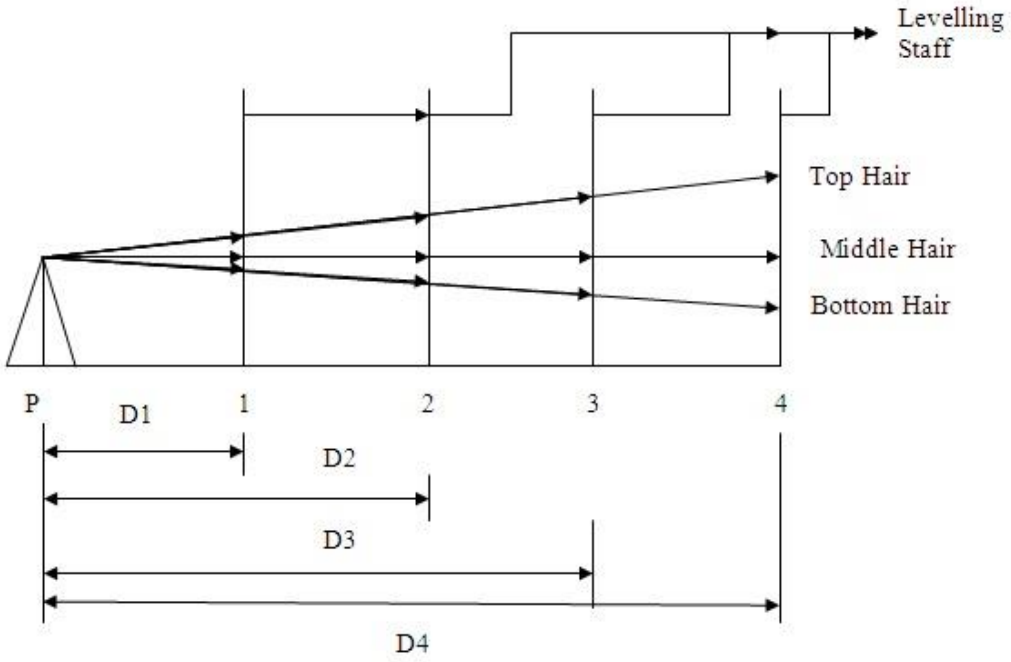
2. The instrument is set up at a convenient point from which all the pegs can be seen;

3. Temporary adjustments are made and the line of sight iskept horizontal.

4. Levelling staff is kept at peg fronts and staff intercept is noted down.

5. Knowing the staff intercept and distance, the tacheometric constants can be found bysolving the tacheometric equations.





Instrument at	Staff at	Staff hair reading		Staff intercept	Distance (m)
		Top	Bottom		

RESULT:

The constants of tachometer are

Multiplying constant K =

Additive Constant C =

Expt No. 13 Date: ----------

STADIA TACHEOMETER

STADIA HAIR METHOD – HORIZONTAL LINE OF SIGHT (Staff held vertical)

AIM

To determine the length of the traverse legs and to find the area enclosed by the traverse.

INSTRUMENT REQUIRED

Tacheometer with tripod

Levelling staff

FORMULA

Tacheometricequation: $D = Ks+C$

Where,

K = Multiplying constant
C = Additive constant
s = staff intercept
D = distance of peg points

$C^2 = a^2 + b^2 - 2ab\cos\theta$

Area = (1/2) ab sin C

PROCEDURE

1. The instrument is kept at O from which observation can be taken to all the given points and the temporary arrangements are made.
2. Levelling staff is kept at various points and after keeping the line of sight horizontal, staff intercepts are taken.
3. Horizontal angles subtended by these stations with the instrument are also observed.
4. With these set of readings, area & the lengths are computed.

Instrument Station	Sight to	Stadia horizontal readings		Horizontal angles
		Top	Bottom	
O	A			AOB =
	B			BOC =
	C			COD =
	D			DOE =
	E			EOA =

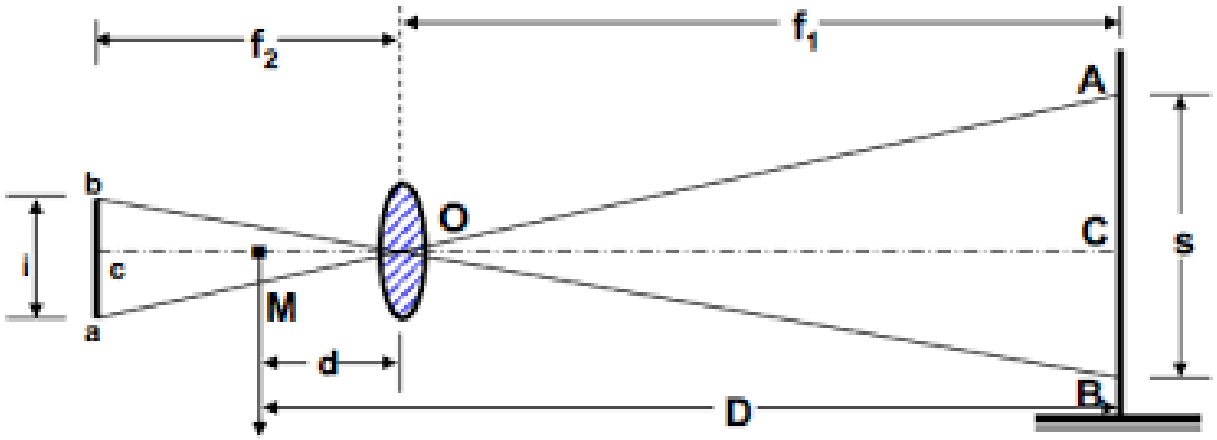


Figure: PRINCIPLE OF STADIA METHOD

Instrument Station	Station bisected	Observation	Angle	Reading on vernier						Angle on vernier						Mean angle of vernier			Mean angle of observation			Correction			Corrected angle		
				A			B			A			B														
1	2	3	4	5			6			7			8			9			10			11			12		
				0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″
O	A B C D E A	Face : Left Swing : Right	AOB																AOB =						AOB =		
			BOC																								
			COD																BOC =						BOC =		
			DOE																								
			EOA																COD =						COD =		
O	A B C D E A	Face : Right Swing : Right	AOB																								
			BOC																DOE =						DOE =		
			COD																								
			DOE																EOA =						EOA =		
			EOA																								

RESULT:

1. The length of traverse legs:

AB =

BC =

CD =

DE =

ED =

STADIA TACHEOMETER

STADIA HAIR METHOD – INCLINED LINE OF SIGHT (Staff held vertical)

AIM

To determine the reduced level of points A and B and also the gradient of the line joining A & B.

INSTRUMENT REQUIRED

Tacheometer with tripod
Levelling staff

FORMULA

1. Distance $D = Ks \cos 2\theta + C \cos\theta$

Where,

K = Multiplying constant
C = Additive constant
s = staff intercept
D = distance of peg points

2. $V = (Ks \sin 2\theta)/2 + C \sin \theta$

Where θ = vertical angle
V = height of middlehair above the line of sight.

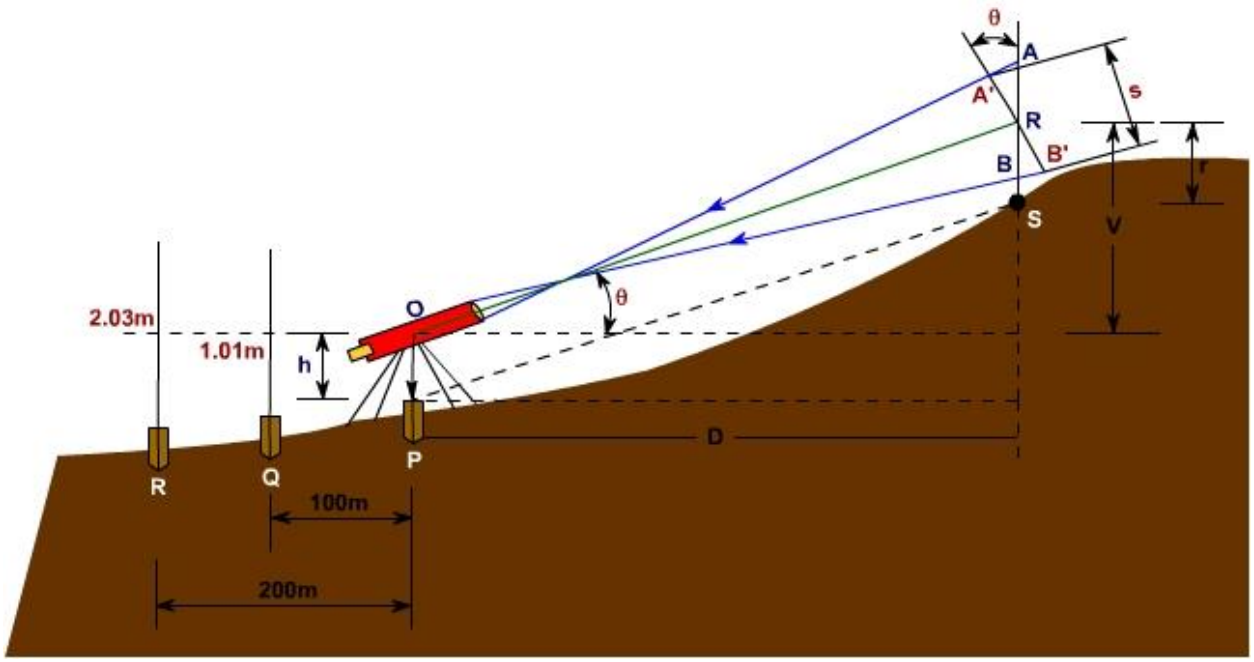
3. Gradient = (RL of A – RL of B)/ Distance

4. Elevation of staff station (RL of A or B) = Elevation of P + h+V-r

PROCEDURE

1. The instrument is set up at a convenient point (O) so that the points A and B are visible.
2. Staff and stadia hair readings are observed at A and B after leveling it accurately.
3. The vertical angles to A and B are also observed.
4. A staff reading is taken on the BM with a horizontal line of sight.
5. The horizontal angle subtended at O between A and B is also noted down.
6. The RL and the gradient are calculated by using the relevant formulas.

Instrument Station	Sight to	Stadia hair reading			Vertical angle	Horizontal angle
		Top	Middle	Bottom		
O	BM					
	A					
	B					



ELEVATED SIGHT : VERTICAL HOLDING

Instrument Station	Station bisected	Observation	Reading on vernier						Angle on vernier						Mean angle of vernier			Mean angle of observation		
			C			D			C			D								
1	2	3	4			5			6			7			8			9		
			0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″
O	A	Face : Left Swing : Right																		
		Face : Right Swing : Right																		
O	B	Face : Left Swing : Right																		
		Face : Right Swing : Right																		

RL of BM = _____ m

Instrument Station	Object	Observation	Reading on vernier						Angle on vernier						Mean angle of vernier			Mean angle of observati		
			A			B			A			B								
1	2	3	4			5			6			7			8			9		
O	A B	Face : Left Swing : Right	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″
	A B	Face : Right Swing : Right																		

RESULT:

1. The RL of A =

   RL of B =

2. Gradient =

Expt No. 14 Date: ----------

TANGNETIAL METHOD OF TACHEOMETRY

AIM

To determine the reduced level of the object by using tangential tacheometry.

INSTRUMENT REQUIRED

Tacheometer with tripod
Levelling staff

FORMULA

1. For Both angles of elevation

$D = S/(\tan \alpha_1 - \tan \alpha_2)$
$V = D \tan \alpha_2$
RL of Q = HI+ V-r

2. For both angles of depression

$D = S /(\tan \alpha_2 – \tan \alpha_1)$
$V = D \tan \alpha_2$
RL of Q = HI- V-r

3. For one angle of elevation and one depression

$D = S /(\tan \alpha_2 + \tan \alpha_1)$
$V = D \tan \alpha_2$
RL of Q = HI- V-r

PROCEDURE

1. The instrument is set up at station P and temporary adjustments are made.
2. A Staff reading is taken on the BM with a horizontal line of sight.
3. The telescope is transited. Upper tangent is sighted on the staff held at station Q and the angle of elevation α_1 is noted.
4. The telescope is depressed. The lower tangent is sighted on the same staff and the angle α_2 is noted.
5. The staff intercept between the two tangents is noted.
6. Using the relevant formula, the RL of the given point.

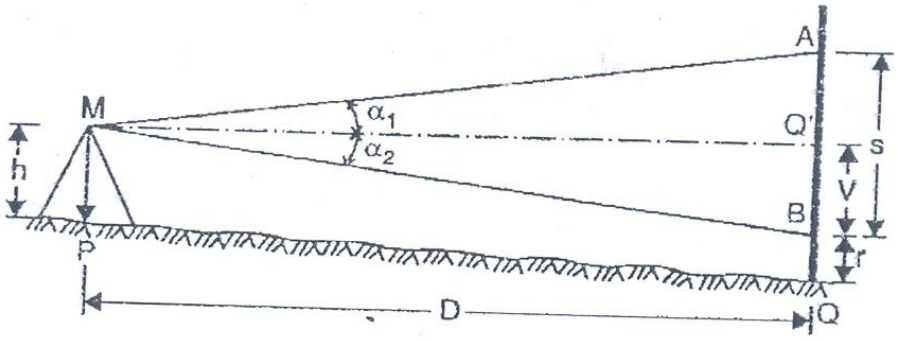


FIG. 22.22. ONE ANGLE OF ELEVATION AND THE

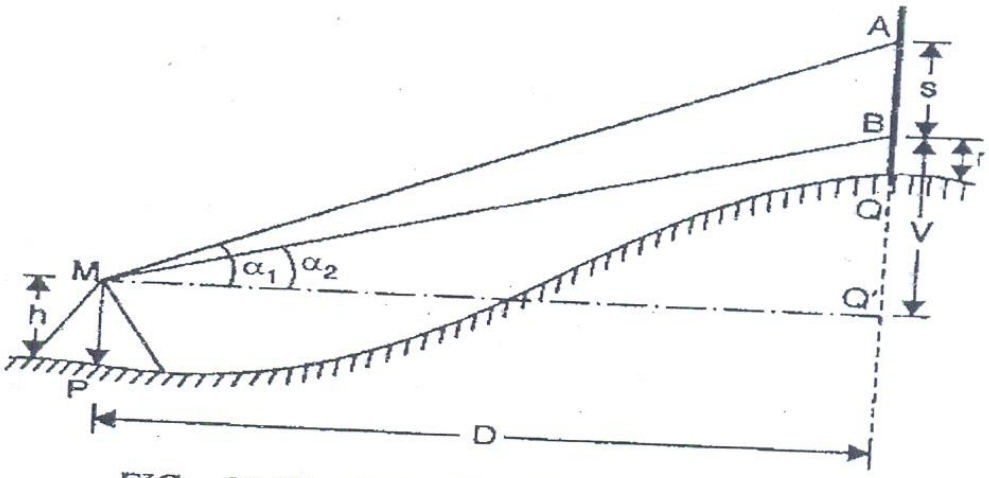


FIG. 22.20. TANGENTIAL METHOD : ANGLES OF ELEVATION

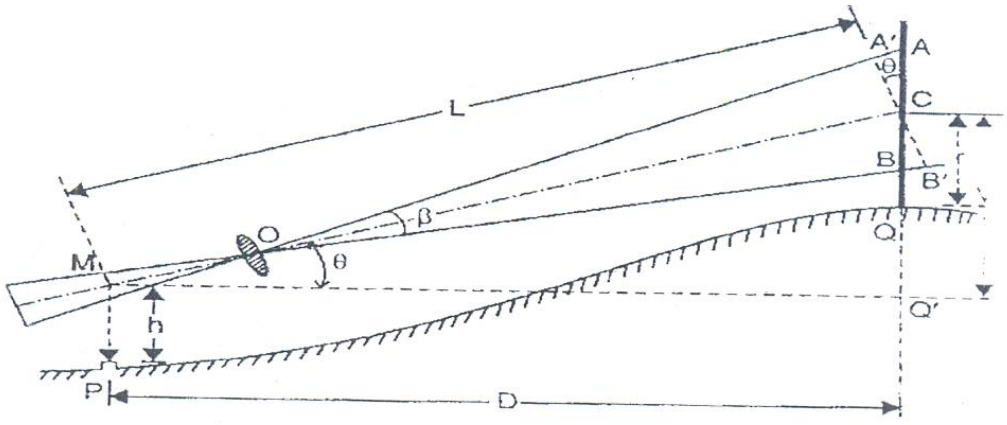


FIG. 22.5. ELEVATED SIGHT : VERTICAL HOLDING.

Instrument Station	Object	Observation	Reading on vernier						Angle on vernier						Mean angle of vernier			Mean angle of observation			Stadia readings	Stadia Intercept	Height of instrument
			C			D			C			D												
1	2	3	4			5			6			7			8			9			10	11	12
O	P Q	Face : Left Swing : Right	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	0	′	″	m	m	m
	P Q	Face : Right Swing : Right																					

RL of BM = _____ m

RESULT:

1. The RL of a given object = _____ m

2. Distance between the instrument station and staff station = _____m

TRAVERSE USING TOTAL STATION AND AREA OF TRAVERSE

AIM:

To form a closed traverse using total station.

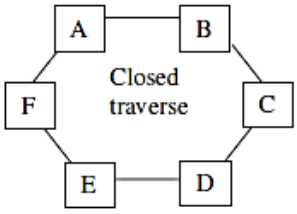
RESOURCES:

1 total station 1
2 Prism 1
3 Tripod 1
4 Pegs

PROCEDURE:

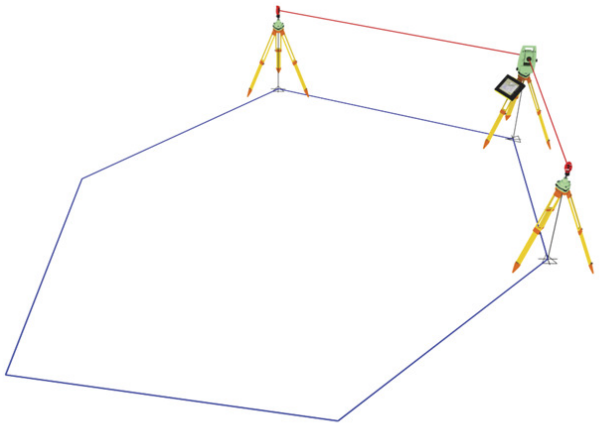
1. Fix the total station over a station and level it
2. press the power button to switch on the instrument.
3. select MODE B -------> S function-------->file management------>create(enter a name)-------->accept
4. then press ESC to go to the starting page
5. then set zero by double clicking on 0 set(F3)
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.

PN.....
E.....
N.....
IH.....
PC.....



8. Then press accept(Fs)
9. 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.
10. Then select MEAS and the display panel will show the point specification
11. Now select edit and re-enter the point number or name point code and enter the prism height that we have set.
12. 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.
13. Then turn the total station to second point and do the same procedure.
14. Repeat the steps to the rest of the stations and close the traverse
15. Now go to S function----> view/edit----graphical view.
16. It will show the graphical view of the traverse.

DIAGRAM:



CALCULATION :

Select S function---> calculation---> 2D surface---->All------> accept

RESULTS:

Select S function---> calculation---> 2D surface---->All------> accept

This will give the area of the closed traverse. Area of the closed traverse is calculated.

Expt No. 16 Date: ----------

DETERMINATION OF DISTANCE AND DIFFERENCE IN ELEVATION BETWEEN TWO INACCESSIBLE POINTS USING TOTAL STATION

AIM:

To find the height of a remote point using total station.

RESOURCES:

1 total station 1
2 Prism 1
3 Tripod 1
4 Pegs

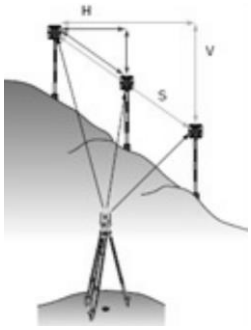
PROCEDURE:

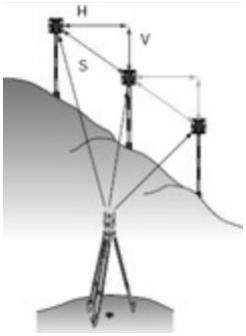
1. Fix the total station over a station and level it
2. press the power button to switch on the instrument.
3. select MODE B -------> S function-------->file management------>create(enter a name) ----->accept
4. Press ESC to go to the starting page
5. Then set zero by double clicking on 0 set(F3)
6. 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.

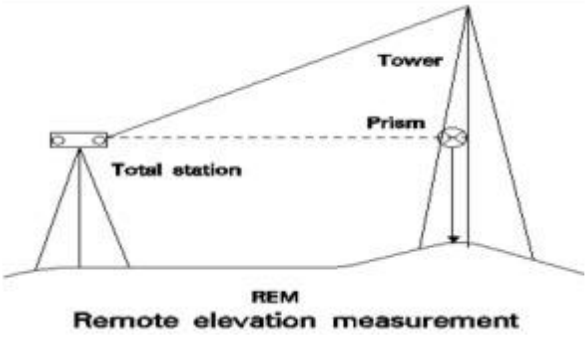
PN.....
E.....
N.....
IH.....
PC.....

8. Then press accept (Fs)
9. Setup a reflector vertically beneath the point, the height of which is to be determined.
10. Enter the reflector height, target to it, and measure the distance.
11. Target the high point.
12. The height difference H between the ground point and the high point is now calculated and displayed at the touch of a button

DIAGRAM:







CALCULATION:

Select S function---> calculation---> 2D surface---->All------> accept

RESULTS:

Select S function---> calculation---> 2D surface---->All------> accept

Height of a remote point using total station is obtained

VIVA QUESTIONS

CHAIN SURVEYING

What do you mean by plane surveying?
Plane surveying is defined as the division of surveying, in which all the survey works are carried based on the assumption that the surface of earth is a plane and the curvature of the earth is ignored.

What is meant by geodetic surveying?
The surveys, in which curvature of the earth is taken into account and higher degree of accuracy, required is called Geodetic surveying.

Describe the principles of Surveying
Following are the two fundamental principles of surveying. (a) Working from Whole to Part (b) Location of a Point

What are arrows?
Chain pins (or) Arrows are the steel wire of 4 mm diameter and its length may vary from 25 cm to 50 cm. One end of the arrow is bent into a loop of a circle of 50 cm diameter and the other end is made sharped point. Arrows are used to indicate (or to mark) the end of a chain line.

What is Plumb Bob?
Plumb bobs are used to test the verticality of ranging rods and levelling staves. It is also used to transfer the end points of the chain onto ground while measuring the distances in a hilly terrain.

What is the purpose of an Optical Square?
Optical Squares are also like cross-staves used for setting out the right angles in change-surveying. It consists of a circular metal box about 5 cm in diameter and the 1.25 cm deep. The periphery is formed by two cylinders, one capable of sliding over the other so that the eye and object openings can be closed to protect the mirrors from the dust.

What do you mean by reciprocal Ranging?
Reciprocal ranging is the method of indirect ranging, and it is adopted when the two end stations are not inter-visible due to raised grounds.

What do you understand by the term traversing?
Traverse is defined as the series of connected straight lines, each joining two stations on the ground. The endpoints are called traverse stations. The straight lines between the two consecutive stations are called traverse legs. There are two types of traverse 1. Closed Traverse 2. Open Traverse

Who are Leader and follower when a line is being chained?
For the chaining operations, two chainmen are required. The chainman at the forward end of the chain is called a leader. The chainman at the other end of the change is called a follower

In a chain how will you set out a right angle?
Cross-staff is the instrument used to locate the intersection point of a particular offset on a chain line
Optical Squares are also like cross-staves used for setting out the right angles in change surveying.

What are offsets? Name the types.
Offsets are defined as the lateral measurements, taken from the chain line, to locate the position of the boundaries, culverts, building, road markings, etc., An offset may be either left or right of the chain line. There are two types of offsets, which are (i) Perpendicular offset (ii) Oblique offset

Differentiate between check line and tie line.
The line which runs across the field to check the accuracy of the survey work is called check-line (or) proof line. A tie-line is a one which connects the two-tie stations. Sometimes, tie lines are used to check the accuracy of the field work and used to take the offset distances.

What are different sources of errors in chain surveying?
(a) Displacement of the arrows (b) Adding (or) Omitting the full chain length (c) Reading from the wrong end of the chain (d) Reading numbers wrongly (e) Reading wrong metre marks (f) Recording the reading in the field book wrongly etc.

What is it necessary to provide tallies in a chain?
Tallies are provided in a chain for the facility to counting some fractional length of the chain, when the full chain length is not required.

How will you set up a perpendicular with the help of only a chain and tape?
By forming triangle in the ratio 3:4:5 using the chain and tape.

COMPASS SURVEY

Distinguish between angle and bearing?
An angle is defined as the deviation of one straight line with respect to the other one. Bearing is defined as the angle (or) inclination of a survey line with respect to the north-southϖ direction

Define true meridian.
True meridian (or) Geographical meridian is defined as the line joining the geographical north and south poles. True meridian at various places are not parallel to each other.

What is magnetic meridian?
Magnetic Meridian is defined as the longitudinal axis, indicated by the freely suspended, properly balanced magnetic needle. It does not coincide with the true meridian except in certain places during the year.

Define Local Attraction
The deflection of the magnetic needle from its normal position due to attraction of magnetic materials such as magnetic rocks, iron ores, electrical cables etc., is called Local Attraction.

What are sources of local attractions?
Magnetic materials such as magnetic rocks, iron ores, electrical cables etc., are sources of local attractions

Define the term Dip.
The inclination of the magnetic needle with the horizontal plane is called Dip (or) Angle of Dip. The angle of dip at equator is 0 o and it increase when approaching the poles. It becomes 90 o at poles.

What is Magnetic declination?
Magnetic Declination is defined as the horizontal angle between the true north and magnetic north at a place, at the time of observation. The magnetic needle can either be deflecting, towards east (or) west of the true meridian.

How the surveyor's compass is graduated?
Surveyor's compass is graduated from 0^o to 90^o from North and South. At North and South 0^o to 90^o East and West 90^o is marked.

LEVELLING

Differentiate between a level line and horizontal line.
Level line is defined as the line lying on the level surface. At every point, the level surface and the level line are normal to the plumb line. The surface of still water (in a lake) represents the level surface and the level line. Horizontal line is defined as the line, lying on the horizontal surface. It is a straight line tangential to the level line.

Distinguish between line of Collimation and line of sight.
The imaginary straight line passing through the optical centre of the object and the point of intersection of the cross-hairs is called line of collimation. The imaginary straight line passing through the optical centre of the object, traversing the eye piece and entering the eye is called line of sight.

What is Dumpy Level?
This is the simplest type of the levelling instrument and it is compact and stable. It consists of a telescope, rigidly fixed to the supports. It can neither be rotated about its longitudinal axis nor can it be removed from its supports. A long bubble tube is attached to the top of the telescope.

Explain the use of Dumpy level and Tilting Levels.
In tilting level, the line of sight and the vertical axis need not be exactly perpendicular to each other, and hence tilting levels are used for quick leveling

What is fore sight?
Foresight is the last sight taken on a levelling staff held over an unknown elevation, before shifting the level.

What is back sight?
The first reading on the levelling staff, at a station of known elevation is called back sight. Back sight is used to obtain the height of the instrument.

Define Bench Mark.
Reference point of known elevation is called benchmark.

Write the types of bench mark.
G.T.S. Benchmark 2. Permanent Benchmark 3. Temporary Benchmark 4. Arbitrary Benchmark

What are G.T.S. Bench marks?
G.T.S. benchmarks are established by the GTS Department of India, with highest accuracy at an interval of about 100 km, all over the country. There elevations are referred to as M.S.L. datum.

What are the types of Staves?
Self-Reading staff (a) Solid Staff (b) Folding Staff (c) Telescopic Staff 2. Target staff

What is meant by change point in levelling?
Turning Point or Change point is defined as the instrument station, at which, the instrument is shifted from one point to another. It is the point, on which the back sight of the new station and foresight of the previous station are taken. Stable points and well-defined points are taken as the change (or) turning points.

What is meant by height of collimation?
The R.L. (or) elevation of the line of collimation, when the instrument is perfectly levelled, is called the Height of the Instrument

What is Reciprocal Levelling?
It is the method of levelling and it is used when the instrument is placed equidistant from the back staff and foreword staff stations, the difference in elevation of two stations, is equal to the difference of staff readings.

Define Contour.
Contour is defined as the imaginary line, joining the points of equal elevation (RLs). It is a line of intersection of a level surface with the ground. Generally, Contour lines are marked with their elevations from the datum. The map representing the contour lines is called Contour Map.

What do you mean by contour interval?
Contour interval is defined as the vertical distance between any two consecutive contours. It is a constant for a map.

Define the term Contour Gradient.
The imaginary line, throughout the surface of the earth having a constant inclination to the horizontal is called contour gradient.

What is horizontal equivalent? Why it is not a constant?
Horizontal equivalent is defined as the horizontal distance between the two consecutive contour lines. It is not a constant for a map. If the H.E. is small, it indicates the steeper slope. H.E. depends on the scope of the ground.

THEODOLITE

What is transit Theodolite?
Transit theodolite is defined as the theodolite, in which its telescope can be rotated horizontally through 180^{o} in the vertical plane.

List the qualities of a Theodolite telescope?
Internal focusing telescopes are best suited instead of external telescopes. The magnification factor of the internal focusing telescope should be from 15 to 30 times of theϖ diameter.

State the location and function of a plate bubble of a Theodolite.
Plate bubble is placed parallel to the trunnion axis at the upper plate (or vernier plate)

How do you eliminate parallax in Theodolite?
Parallax effect can be eliminated as follows. (a) Focussing the eye piece (b) Focussing the objective

What are the two methods of measuring the horizontal angle using a Theodolite?
Repetition Method Reiteration Method

What are the errors eliminated in measurements of horizontal angle by method of repetition?
Instrumental and Observational errors are eliminated in measurements of horizontal angle by method of repetition.

What you mean by temporary adjustments of a Theodolite?
The adjustments required to be made at every instrument station before taking observations are called temporary adjustments. The temporary adjustments of a theodolite consist of the following operations.ϖ 1. Setting and centering the theodolite 2. Levelling of the theodolite 3. Elimination of parallax

What is a spire test?
the horizontal axis (trunnion axis) is made perpendicular to the vertical axis. The objective of this adjustment is to ensure that the line of collimation revolves in a vertical plane, perpendicular to the vertical axis. This adjustment is carried out by Spire Test.

Explain face left and face right observations in Theodolite traversing?
When the vertical circle of the theodolite is on the left of the observer, the telescope position is called Face Left. When the vertical circle of the theodolite is on the right of the observer, then the telescope position isϖ called Face Right.

What kind of error can be eliminated by taking face left and face right observations?
Instrumental error can be eliminated by taking face left and face right observations Line of collimation not perpendicular to the trunnion axis⎫ Horizontal axis not perpendicular to vertical axis⎫ Vertical Index Errors⎫

TACHEOMETRY

Define Tacheometry
Tacheometry is a branch of angular surveying in which the horizontal and vertical distances (or) points are obtained by optional means as opposed to the ordinary slower process of measurements by chain (or) tape.

Define Analytic lens
Analytic lens is an additional lens placed between the diaphragm and the objective at a fixed distance from the objective. This lens will be fitted in ordinary transit theodolite. After fitting

this additional lens the telescope is called as external focusing analytic telescope. The purpose of fitting the analytic lens is to reduce the additive constant to zero.

Define the tangential method

In this method, the stadia hairs are not for taking readings. The readings being taken against the horizontal cross hair.

What is the principle of stadia method

The method is based on the principle that the ratio of the perpendicular to the base is constant to similar isosceles triangle.

Define the Azimuth

The azimuth of a heavenly body is the angle between the observer's meridian and the vertical circle passing through the body.

Define the hour angle

The hour angle of a heavenly body is the angle between the observer's meridian and the declination circle passing through the body. The hour angle is always measured westwards.