Laboratory Manual

LAND SURVEY PRACTICE-I

Subject Code- Pr 1

DEPARTMENT
OF
CIVIL ENGINEERING

GOVERNMENT POLYTECHNIC, BARGARH

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PTGF IN CIVIL ENGINEERING

PREFACE

For any Civil Engineering project like building a house, constructing a dam, laying out a road, setting up of an industry etc., the first requirement is to have a plan/map of the area. To have a plan/map of any area, it is required to collect information and data about the terrain as well as the objects present in the area by taking necessary measurements using different types of instruments. Data thus collected are being subsequently used to prepare the plan/map of the area. The domain of engineering which involves the collection of field data and subsequently preparation of plan/map of the area is termed as 'Surveying'. Surveying is defined as the science of making measurements of the earth specifically the surface of the earth. This is being carried out by finding the spatial location (relative/absolute) of points on or near the surface of the earth. Different methods and instruments are being used to facilitate the work of surveying.

Surveying is primarily utilised to fix the national and state boundaries, chart coastlines, navigable streams and lakes, establishing control points, execute hydrographic and oceanographic charting and mapping, prepare topographic map of land surface of the earth, prepare plan or map of the area surveyed, collect field data, analyse and to calculate the field parameters for setting out operation of actual engineering works. Moreover, during execution, project of any magnitude is constructed along the lines and points established by surveying.

Thus, surveying is a basic requirement for all Civil Engineering projects.

The main objective of this study is to help students in gaining the practical experience by exposing them to various techniques of field surveying.

At this juncture, the present course on Surveying Lab - I plays a vital roll for enhancing the knowledge of an aspiring civil engineer. This lab course comprises of experiments which are intended to make the students to understand and gain familiarity with surveying techniques. The study consists of Linear Mesurements,

Chaining and Chain Surveying, Angular Measurement and Compass Surveying, Plane Table Surveying, Theodolite Traversing, Levelling and Contouring.

At the end of this course, a student should be able to

- Undertake linear measurement activities using chains in absence or presence of obstacles
- Conduct compass surveying and record data in necessary format
- Setup plane table and conduct survey using different methods
- Use of theodolite and plot the traverse and contour maps
- Use of dumpy level

MANDATORY INSTRUCTIONS

1. Students should report to the labs concerned as per the timetable.

2. Record should be updated from time to time and the previous experiment must be signed by the faculty in charge concerned before attending the lab.

3. Students who turn up late to the labs will in no case be permitted to perform the experiment scheduled for the day.

4. After completion of the experiment, certification of the staff in-charge concerned in the observation book is necessary.

5. Students should bring a notebook of about 100 pages and should enter the readings/observations/results into the notebook while performing the experiment.

6. The record of observations along with the detailed experimental procedure of the experiment performed in the immediate previous session should be submitted and certified by the staff member in-charge.

7. Not more than FIVE students in a group are permitted to perform the experiment on a set up.

8. The group-wise division made in the beginning should be adhered to, and no mix up of student among different groups will be permitted later.

9. The components required pertaining to the experiment should be collected from Lab- in-charge after duly filling in the requisition form.

10. When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.

11. Any damage of the equipment or burnout of components will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for the semester/year.

12. Students should be present in the labs for the total scheduled duration.

13. Students are expected to prepare thoroughly to perform the experiment before coming to Laboratory.

14. Procedure sheets/data sheets provided to the students groups should be maintained neatly and are to be returned after the experiment.

CONTENTS

EXPERIMENT NO-1

AIM OF THE EXPERIMENT:-

Testing and adjusting of metric chain.

APPARATUS REQUIRED:-

1. Test gauge
2. 30 metre metric chain
3. 20 metre metric chain

THEORY:-

1. Due to continuous use of chain may be elongated or shortened .So a chain should be tested and adjusted.

2. If full adjustment is not possible, the amount of shortening and elongation should not be clear.

3. For testing a chain a test gauge is established level platform with the help of a standard steel tape.

4. The steel tape is standardize 20^0 c under a tension of 80kg.

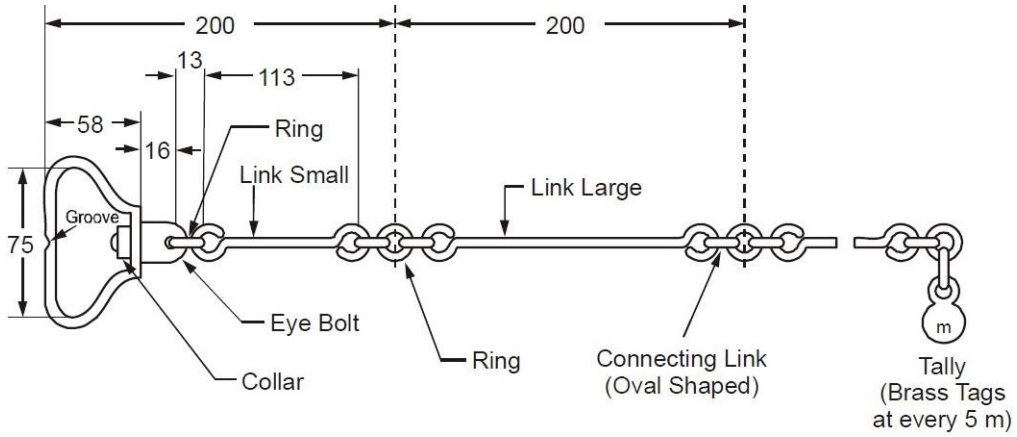
5. The test gauge consist of two pegs having nails at the top and fixed on the level platform at the required distance apart.

6. The incorrect chain is fully stretched by pulling the test gauges.

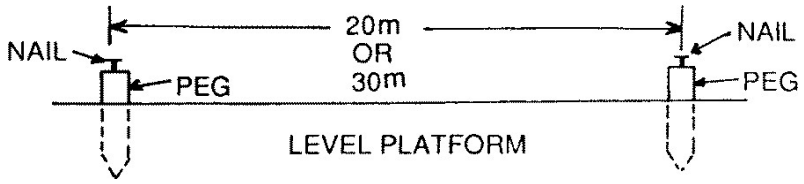
7. If the length of the chain does not tally with standard length then a attempt should be made to rectify the error. Finally the amount of elongated and shorted should be noted.

8. The allowable error is about 2mm or metre length of the chain should be within the followed permissible limit.

(a) 20 mtr chain +/- 5 mm
(b) 30 mtr chain +/- 8 mm



Details of Metric Chain



PROCEDURE:-

ADJUSTMENT OF CHAIN :-

Chains are adjusted in the following ways.

(a) when the chain is too long:

(i) Closing the joined of ring.
(ii) Hammering the elongated ring.
(iii) Remove some ring.

(iv) Replacing old ring to new ring.

(b) When the chain is too short:

(i) Straightening of the ring.
(ii) Opening the joints of rings.
(iii) Replacing the larger ring.
(iv) Insert new ring if necessary.

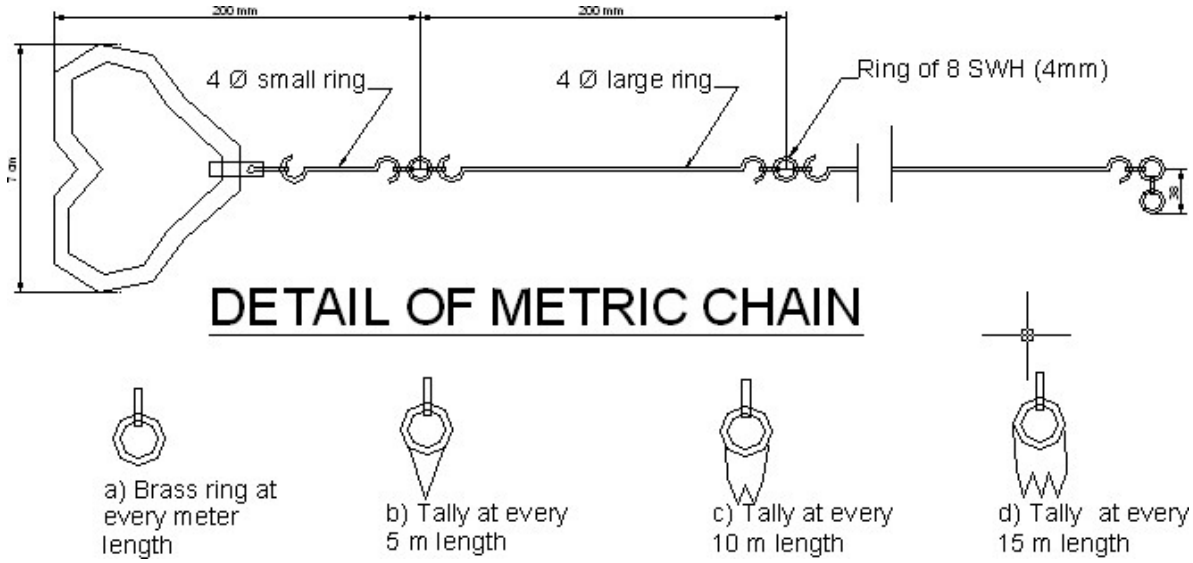
CONCLUSION:-

The 20m/30m chain was found to be_____cm long or_____cm short.

EXPERIMENT NO-2

AIM OF THE EXPERIMENT : Measurement of distance by Ranging and Chaining

APPARATUS REQUIRED : Chain, Arrows, Tapes, Ranging Rods, Offset Rods, Cross staff or optical square, Plumb bob, wooden mallet, pegs.



THEORY : By the various methods of determining distance the most accurate and common method is the method of measuring distance with a chain or tape is called Chaining. For work of ordinary precision a chain is used. But where great accuracy is required a steel tape is invariably used.

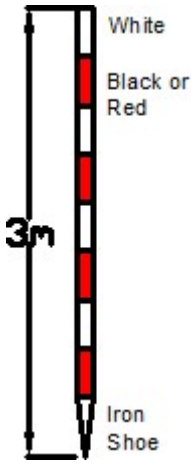
The term chaining was originally applied to measure Distance with a chain. The term chaining is used to denote measuring distance with either chain or tape, In the process of chaining, The survey party consists of a leader (the surveyor at the forward end of the chain) a follower (the surveyor at the rare end of the chain and an assistant to establish intermediate points) .

The accuracy to which measurement can be made with chain and tape varies with the methods used and precautions exercised. The precision of chaining. For ordinary work, ranges from 1/1000 to 1/30,000 and precise measurement such as Baseline may be of the order of 1000000.

The chain is composed of 100 or150 pieces of galvanized mild steel were 4mm in diameter called links. The end of each link is bent into a loop and connected together by means of three oval rings which afford flexibility To the chain and make it less liable to become kinked. The ends of chain are provided with brass handles for dragging the chain on the ground, each with a swivel Joints so that the chain can be turned round without twisting. The length of the A link is the distance between the centres of the two consecutive middle rings. The end links include the handles metallic rings indicators of distinctive points of the Chain to facilitate quick reading of fractions of chain in surveying measurements.

RANGING RODS:

The ranging rods are used for marking the positions of Stations conspicuously and for ranging the lines. Io order to make these visible at a distance, they are painted alternately black and white, or red and white or red White and black successively.The adjustment of the chain should as far as possible be affected symmetrically on either side of the middle so as that the position of central tag remains unaltered. In measuring the length of survey line also called as chain line. It is necessary that the chain should be laid out on the ground in a straight line between the end stations.



PROCEDURE:

Two men are required for chaining operation; The chain man at the forward end of chain is called the leader while the other man at the rear end is known as the follower.

Duties of leader &follower

Leader:-
1) To put the chain forward
2) To fix arrows at the end of chain
3) To follow the instruction of the followers.

Follower:-
1) To direct the leader to the line with the ranging rod.
2) To carry the rear end of the chain.
3) To pick up the arrows inserted by the leader.

Chaining

1) The follower holds the zero handle of the chain against the peg &directs the leader to be in line of the ranging rod.
2) The leader usually with to arrows drags the chain alone the line.
3) Using code of signals the follower directs the leader as required to the exactly in the line.
4) The leader then fixes the arrows at the end of chain the process is repeated.

Ranging

1) Place ranging rods or poles vertically behind each point
2) Stand about 2m behind the ranging rod at the beginning of the line.
3) Direct the person to move the rod to right or left until the three ranging rods appear exactly in the straight line.
4) Sight only the lower portion of rod in order to avoid error in non-vertically.
5) After ascertaining that three rods are in a straight line, ask the person to fix up the rod.

RESULT : By Chaining and ranging the total distance is found to be_____

EXPERIMENT NO 3
SURVEY OF AN AREA BY CHAIN SURVEY (CLOSED TRAVERSE)

AIM OF THE EXPERIMENT:

To survey an open field by chain survey in order to calculate the area of the open field.

APPARATUS REQUIRED:

Chain, Tape, Ranging Rods, Arrows, Cross Staff.

Procedure for surveying the given open field (Closed Traverse):

Note: This procedure is general procedure only. This procedure varies with the experiment given to students. Therefore students are required to write the procedure according to the experiment given to them.

Example 1:

1. ABCDEF is the required closed traverse open field to be surveyed for calculating the area as shown in Fig 1.
2. From the station A the length of all the opposite corners such as AC, AD and AE are measured with a chain and the longest distance is considered for laying off the main chain line. In this case AD is the longest and a chain line running from A to D is laid.
3. Offsets to corner points B, C, E and F are now laid from the chain line AD either by tape or cross-staff and their foot of offsets are G, I, J, H respectively.
4. All the offset lengths GB, HF, IC and JE are measured either by chain or tape depending on the length of offsets.
5. The distances between all the points AG, GH, HI, IJ and JD are also measured along the chain line.
6. Area Calculations: (Note: Areas of all triangles and trapeziums are calculated and added together to calculate the total area of open field (Closed Traverse) as described in class).

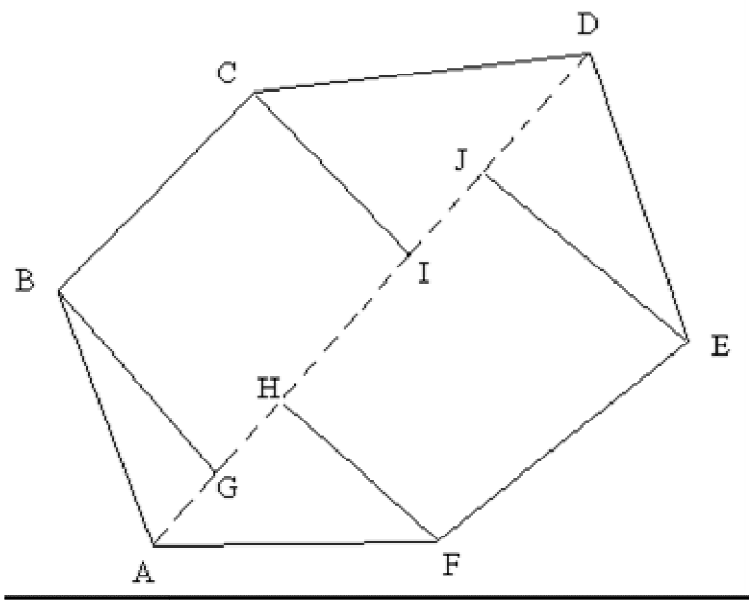


Figure 1: Survey of an Open Field (Closed Traverse)

Example 2:

1. Let ABCDE be the given field whose area is to be measured, fix the pegs at A, B, C, D & E.

2. Divide area into three triangles ADE, ABD and BCD by joining AD and BD.

3. Measure the lengths AB, BC, CD, DE, EA, AD and BD.

4. Calculate the area of the triangles.

5. The sum of the areas of the three triangles is the area of the given field.

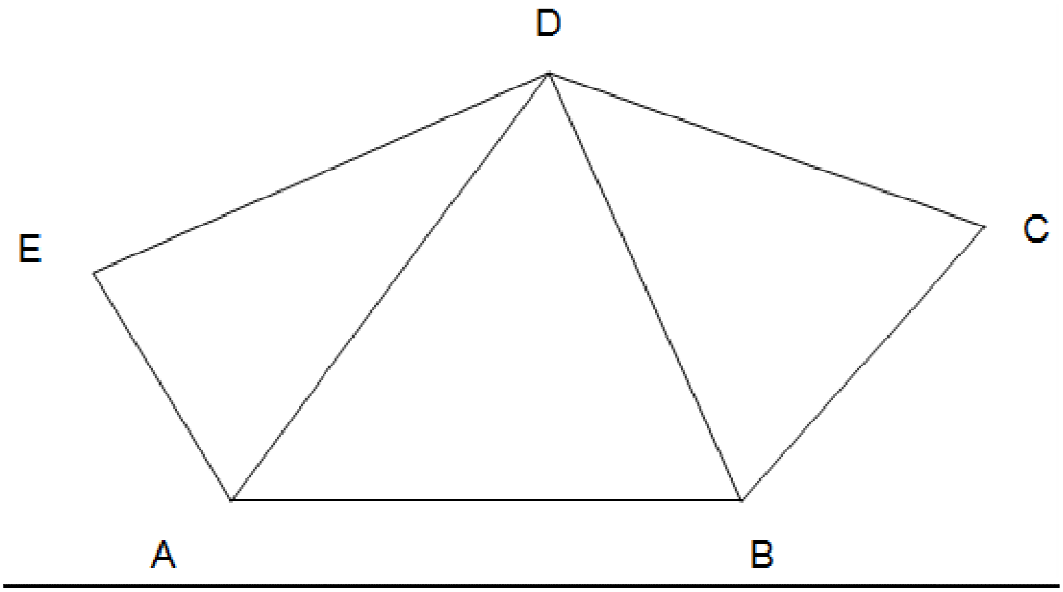
FORMULA:

Area of the triangle $\Delta = \sqrt{s\,(s-a)\,(s-b)\,(s-c)}$

Where $S = (a + b + c) / 2$

a, b, c, are the sides of the triangle.

SKETCH:



RESULT:

The area of the given field = Square meter.

EXPERIMENT NO-4

AIM OF THE EXPERIMENT:-

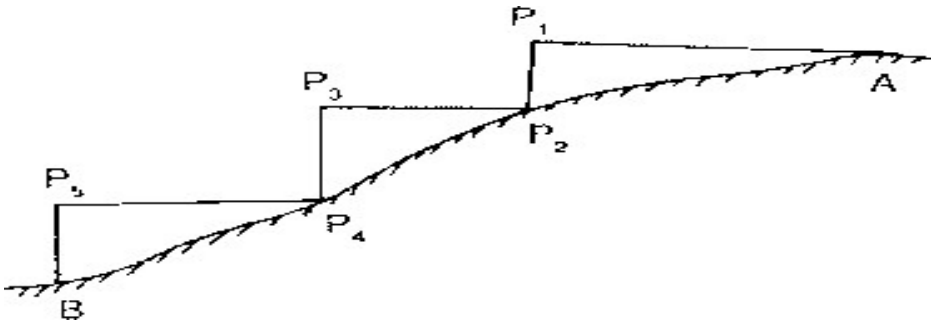
To measure the distance between two point by chaining across a slope ground using stepping method.

APPARATUS REQUIRED:-

1. Chain
2. Tape
3. Ranging rod
4. Peg
5. Plumb bob
6. Mallet

THEORY:-

The sloping ground is divided in to a number of horizontal and vertical strips, like steps. So, this method is known as stepping method. The length of the horizontal portions are measured and added to get the total horizontal distance between the points. The steps may not be uniform, and would depend on the nature of the ground.



PROCEDURE:-

- Suppose the horizontal distance between points A and B is to be measured.
- The line AB is first ranged properly.
- Then, the follower holds the zero end of the tape at A.

- The leader selects a suitable length AP1 so that P_1 is at chest height and AP_1 is just horizontal.
- The horizontal is maintained by eye estimation, by tri-square or by wooden set-square.
- The point P_2 is marked on the ground by plumb-bob so that P_1 is just over P_2.
- The horizontal length AP_1 is noted then the follower moves to the position P_2 and holds the zero end of the tape at that point.
- Again the leader selects a suitable length P_2P_3 in such a way that P_2P_3 is horizontal and P_3P_4 vertical.
- Then the horizontal lengths P_2P_3 and P_4P_5 are measured.
- So the total horizontal length, $AB = AP_1 + P_2P_3 + P_4P_5$

TABULATION:-

SL.NO	POINTS	STEPS LENGTH	TOTAL LENGTH

CONCLUSION:-

The total distance is found to be_____

EXPERIMENT NO -5
CHAINING ACROSS OBSTACLES

AIM OF THE EXPERIMENT:-

To survey an area by chain survey across obstacles and to calculate the obstructed lengths by using different methods.

APPARATUS REQUIRED:-

Chain, Tape, Ranging Rods, Arrows, Cross Staff.

Obstacles to Chaining:

During measurements, it is impossible to set out all the chain lines in a straightforward method because of a variety of obstacles to chaining and ranging in the field.

1) Obstacles to measurement:

The obstacles which do not obstruct the ranging (view) like ponds, rivers are known as Obstacles to Measurement.

2) Obstacles to alignment:

The obstacles which we cannot see across, i.e. both the chaining and ranging are obstructed, e.g. houses, stacks, etc. are known as Obstacles to Alignment.

Procedures to find out Obstructed Length:

1) **Obstacles to measurement:**

A) First Method:

Let ABCD be a chain line obstructed by a pond (Fig 1). Let BC be the obstructed length. Two offsets BE and CF of equal lengths are made at B and C and chaining is done along EF to measure the distance EF.

Now the required obstructed length BC is equal to the measured distance EF.
Therefore, BC = EF

B) Second Method:

Let AB be the obstructed length across the river (Fig 2). AC is laid off, of any convenient length, perpendicular to the required distance AB.
Now a perpendicular is laid off from C such that it meets the extended line of AB at D.
Triangles ABC and ADC are similar triangles.
From the principle of similar triangles,
AB / AC = AC / AD
Therefore, obstructed length AB = AC^2 / AD

C) Third Method:

Let AB be a chain line obstructed by a river (Fig 3). A point I is assumed anywhere in line with the required distance AB. A point H is taken in such a way that HJ = HI and HK = HB.
Now a point L is established in line AH and at the same time in the line JK produced.
Triangles KHL and ABH are similar triangles and their corresponding sides are equal to each other as the points K, B and I, J are equidistant either side from H.

Therefore, the obstructed length AB = KL

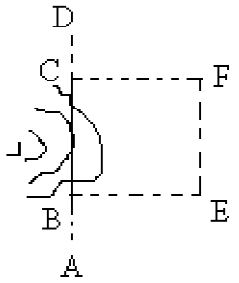


Fig 1

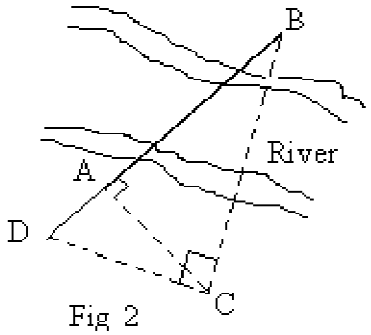


Fig 2

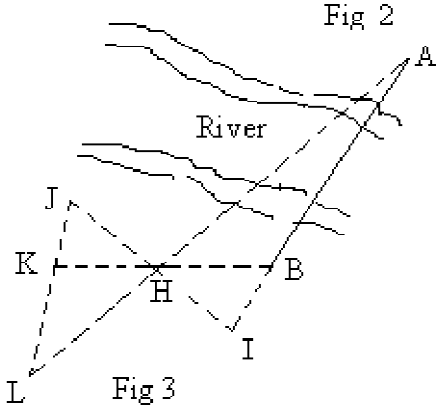


Fig 3

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2) Obstacles to alignment:

A) First Method:

Let DE be the obstructed length across the building (Fig 4). A point C is assumed arbitrarily. E and C are joined such that EC = CB. Now D and C are also joined such that DC = CA.
Triangles CDE and CBA are similar triangles and their corresponding sides are equal to each other as points BE and AD are equidistant either side from C.
Therefore, obstructed length DE = BA

B) Second Method:

Let DE be the obstructed length across the building (Fig 5). A point F is established at equal distances from D and E at any convenient distance. Points H and G are established such that FH = FG.
Triangles FDE and FHG are similar triangles.
From the principle of similar triangles,
DE / DF = HG / HF

Therefore, obstructed length DE = (HG X DF) / HF

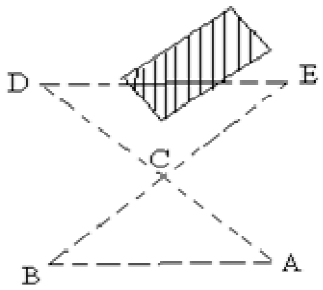


Fig 4

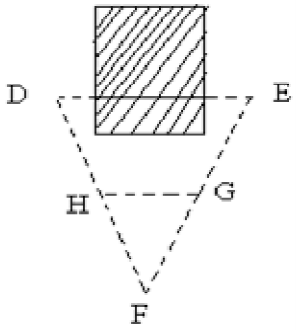


Fig 5

Calculations:

Note: All calculations of all methods to find obstructed lengths should be shown here.

Results:

1) Obstacles to measurement:

Obstructed length from First Method = m

Obstructed length from Second Method = m

Obstructed length from Third Method = m

2) Obstacles to alignment:

Obstructed length from First Method = m

Obstructed length from Second Method = m

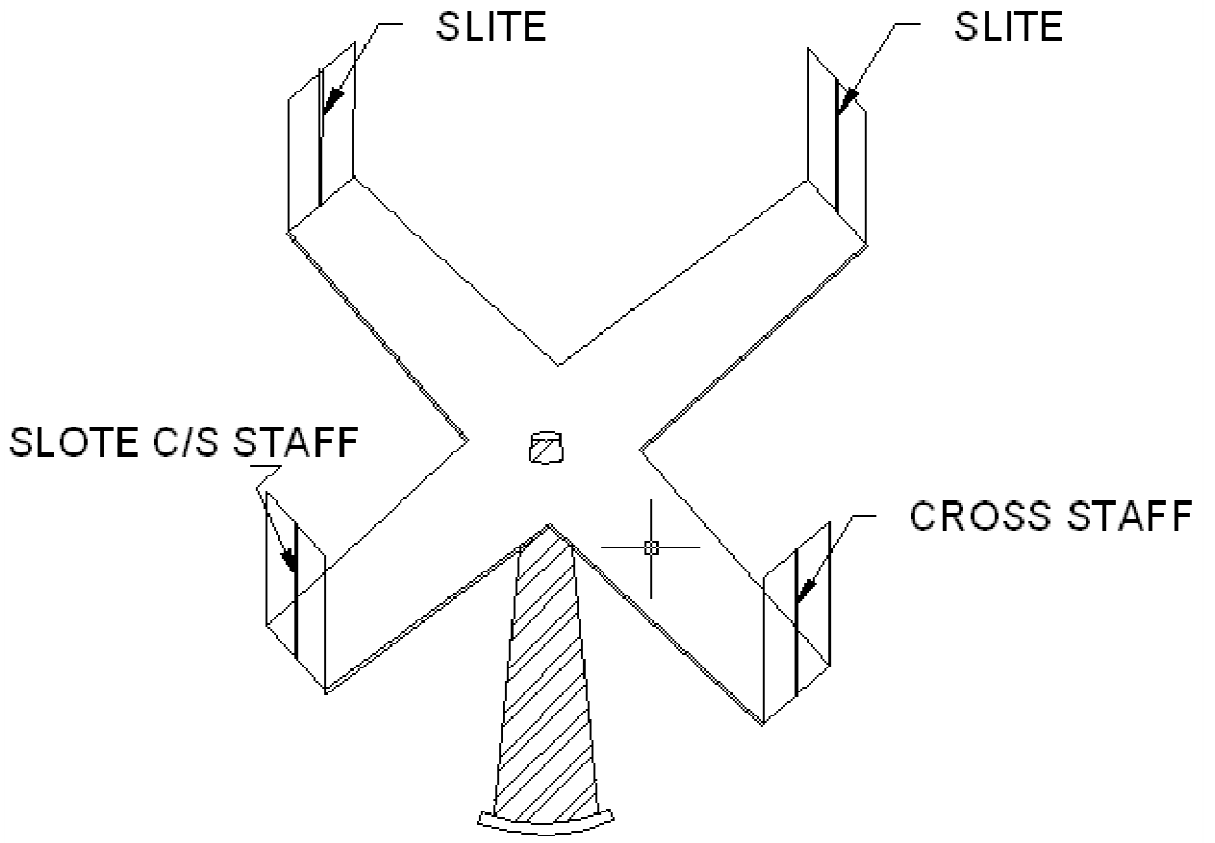
Instructions to students:

Students are required to draw all the diagrams of all methods to scale with all dimensions on the left pages of lab record

EXPERIMENT NO-6

AIM OF THE EXPERIMENT: Locating various object by chain & cross staff survey

APPARATUS REQUIRED: Chain, Ranging rod, Arrows, Cross-staff, Metallic Survey (Tape)



Cross staff

THEORY:

Cross-Staff is the simplest instrument used for setting out perpendicular i.e taking offsets from a chain line. it is easier and quicker method ,but not very accurate .if great accuracy is desired ,the work should be carried out by the theodolite.
Open cross staff:- The simplest Type consists two parts 1) the head 2) the leg .the head is made of wooden block octagonal or round in shape about 15cm side or diameter an 4cm deep . on it are scribed two lines at right angles to another .At the end of these two lines are fixed two points of metallic strip having slits made in them .These slits two lines of sight which are at right angles to one another .The head is fixed on a wooden staff or pole about 3cm in diameter and 1.2 to 1.5m length .The pole is provided conical metal shoe so that it can be driven into the ground.

PROCEDURE –

1) To find the foot of the perpendicular from the object the cross staff is held approximately in position and one pair of slits is directed in the direction of the rangingvrod fixed at the forward and the chain line . The observer then looks through the other pair of slits and sees whether the particular object is bisected or not. if not the cross staff is moved to and from till the necessary bisection is obtained. Before noting down the chainage of the foot of the perpendicular care must be taken to see that one pair of slit is the direction of chain or not. While shifting the position of the cross-staff it may get twisted and hence precaution is necessary.

2) To set a perpendicular to the chain line at a given point one pair of slits is oriented in the direction of chain line by looking at the ranging rod fixed at the forward and by looking through the other pair of slits ranging rod is fixed in the direction of the line of sight provided by this pair.

RESULT: Various perpendicular to the chain line object are created using cross-staff survey.

EXPERIMENT NO-7

AIM OF THE EXPERIMENT: Measurement of bearings of sides of traverse with prismatic compass and computation of correct included angle.

APPARATUS REQUIRED: Prismatic compass, ranging rod, chain, tape, peg Tripod stand , Plumb bob

THEORY:.

The important parts of compass are:-

1) A box with graduated circle.
2) A magnetic needle
3) A line of sight

When the line of sight is pointed to point, the magnetic needle of compass points towards north (Magnetic meridian). The angle which this line of sight makes with the magnetic meridian is read on graduated circle.it is known as magnetic bearing of the line.

There are two types of compasses:-

1) Prismatic compass
2) Surveyor's compass.

Prismatic Compass:-

Prismatic compass is very valuable instrument. It is usually used for rough survey for measuring bearing and survey lines. The least count of prismatic compass is 30 min. It consists of circular box of 10cm-12 cm dia. of non magnetic material. pivot is fixed at the centre of box and is made up of hard steel with a Sharp pivot. Graduated aluminum is attached to the needle. It is graduated in clockwise direction from 0^o to 360^o.The figures are written in inverted. Zero Is written at south end and 180 at north end and 270 at the east. Diametrically opposite are fixed to the box. The sighting vane consists of a hinged metal frame in the centre of which is stretched a vertical Horse hair fine silk thread of which is stretched a vertical hair. It presses against a lifting pin which lift the needle of the pivot and holds it against the glass lid. Thus preventing the wear of the pivot point to damp the oscillations of the needle when about to take reading and to bring to rest quickly, a light spring is brought lifted inside the box. The face of the prism can be folded out the edge of the box when North end is used .Sometime the sighting vanes is provided with a hinge mirror which can be placed upward or downwards

on the frame and can be also slided along it is required. The mirror can be made inclined at any angle so that objects which are too high or too low can be sighted directly by reflecting.

BEARING OF LINES: A bearing of a line is a horizontal angle made by the survey line with some
reference direction or meridian. Meridian may be
1) A true meridian
2) A magnetic meridian
3) An arbitrary or assumed meridian

TRUE MERIDIAN: The true geographical meridian passing through a point is a line of intersection of earth's surface by a plane containing north south pole and given point.They are not parallel to each other at different places.

MAGNETIC MERIDIAN:-The direction indicate by a free suspended and a properly balanced magnetic needle free from all other attractive forces. The direction of magnetic meridian can be established with the help of Magnetic compass.

ARBITRARY MERIDIAN: Any direction is assumed to be the Reference meridian to carry out small survey.

Whole Circle Bearing: In whole circle bearing system, the bearing of a line is always measured clockwise from the north point of the reference meridian towards the line right round the circle. The angle thus measured between the reference meridian and the line is called Whole circle bearing of the line. Angles measured will have value between 0 to 360 degrees.

Conversion of W.C.B. in R.B

Case	W CB between	R . B .	QUADRANT
1	0^{o} TO90^{o}	WCB	N-E
2	90^{o} TO -180^{o}	180-WCB	S-E
3	180^{o} TO -270^{o}	WCB-180^{o}	S-W
4	270^{o} TO 360^{o}	3 60-WCB	N-W

REDUCED BEARING (R.B): In this system of bearing of a line is measured clockwise or anticlockwise from north or south direction whichever is nearer to the line towards east or west. The concept of reduced bearing facilitates computations in traverse surveying.

Conversion of R.B in W.C.B.

Case	R .B in quadrant	Rule of W.C.B.	W .C.B between
1	N-E	WCB=R.B	0_0 TO90^o
2	S-E	WCB =180-R.B	90^oTO -180^o
3	S-W	WCB =R.B+180	180^o TO -270^o
4	N-W	WCB =360-R.B	270^o TO 360^o

ADJUSTMENT OF THE PRISMATIC COMPASS

The compass may be held in hand but for better results it should be fitted at the top of tripod having ball and socket arrangement. The adjustment of a compass is done in the following three steps.

1) Centering: - The compass fitted over the tripod Is lifted bodily and placed approximately on the station peg by spreading the leg of a tripod equally, The centre of the compass is checked by dropping a small piece of stone from the centre of the bottom of the compass so that it falls on the top of the station peg. A plumb bob may be used to judge the centering either bt attaching it with a hook providing at the bottom or otherwise by holding it by hand.

2) Levelling:-After the compass is centred, it is leveled by means of ball and soket arrangement so that the graduated circle may swing freely.It can be checked roughly by placing a round pencil on the top of the compass, when the pencil does not move,that is roughly the horizontal position.

3) Focusing the prism: - The prism attached is moved up and down so that grauation on the graduated circle should become sharp and clear.

LOCAL ATTRACTION:

Sometimes .the magnetic needle does not point towards magnetic North or South. The reason being that the needle may be under the influence of external attractive forces which are produced due to magnetic substances Thus the deflection of the needle from its original position, due to the presence of some magnetic substances is known as local attraction. To detect local attraction at a particular place, fore and back bearing of each line are taken. Then difference comes out to be 180° there is no local attraction at either station. On the other hand of the difference is other than 180°,the bearing may be rechecked to find out the discrepancy may not be due to the presence of iron substance near to the compass. If the difference still remains the local attraction exists at on or both the stations.

ELIMINATION OF LOCAL ATTRACTION:-

1st method: - In this method, the bearing of the other lines are corrected and calculated on the basis of the a line which has the difference between its fore bearing and back bearing equal to 180°.
The magnetic of the error is formed due to local attraction by drawing a sketch of observed and correct bearing of the line at each station. The error will be negative when the observed bearing is less than the corrected one and the correction will be positive and vice versa.
If however, there is no such line in which the difference of fore bearing and back bearing is equal to 180°, the correction should be made from the mean value of the bearing of that line in which the difference between the fore and the back bearing is the least.
If the bearings are observed in quadrantal system, the correction should be applied in proper direction by drawing a neat sketch roughly.

2nd Method: - This method is more general as the bearing at a station locally affected may be incorrect but include angles calculated from these bearing will be correct since the amount of the error will be the same for all the bearing observed from that station. Thus starting from the unaffected line and using these included angles the correct bearing of all other lines can be calculated.
Note: -
The sum of the internal included angles must be equal to (2n-4) right angles where n=number of sides of a closed traverse.

PROCEDURE:

1) Four ranging rods are fixed at different points i.e. A, B, C, D, E 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.

OBSERVATION TABLE

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

SAMPLE CALCULATION:- Error = observed bearing –corrected bearing

Check =(2n-4)x90^{o}

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.

EXPERIMENT NO:8
RADIATION METHOD, INTERSECTION METHODS BY PLANE TABLE SURVEY

AIM OF THE EXPERIMENT:

To plot a given area by Radiation and Intersection methods of Plane Table Survey

APPARATUS REQUIRED:

Tape , Ranging Rods , Arrows , Plane Table with Tripod and its accessories , Two Drawing Sheets , Drawing Clips , Pencil, Eraser and Pins

THEORY:

Plane table surveying: The system of surveying in which field observation and plotting work i.e. both are done simultaneously is called plane table surveying.

The plane Table:- The drawing board made of well seasoned wood such as teak or pine which is used for the purpose of plotting is called plane table.It is available in sizes 500x400x15mm,600x5000x15mm and 750x600x20mm.The top surface of board is perfectly plane and to the underneath it is fitted with a leveling head or ball and socket arrangement. The table is mounted on a tripod by means of a central screw with a wing nut or in such a manner so that the board can be revoled, leveled and clamped in any position.

Alidade: The tool or instrument which consist of metal (usually of brass) or wooden (well seasoned) rule 40cm to 60cm long, 3cmto5cm wide and fitted with two vanes at the ends is called an alidade.
The beveled graduated edge is known as the fiducial edge. Such an alidade is known as plain alidade.

Trough Compass:
The compass which is used to mark the direction of the magnetic meridian on the plane table is called trough compass. It consist of a long narrow rectangular non magnetic metallic box 8cm to 15cm long,3cm to 5cm wide and 2cm to 3cm high on the covered with a glass cover. It the centre of the box is provided a magnetic needle with a agate stone mounted on the sharp steel pivot. At the end the through compass graduated scales are with zero degree at the centre and up to 5°

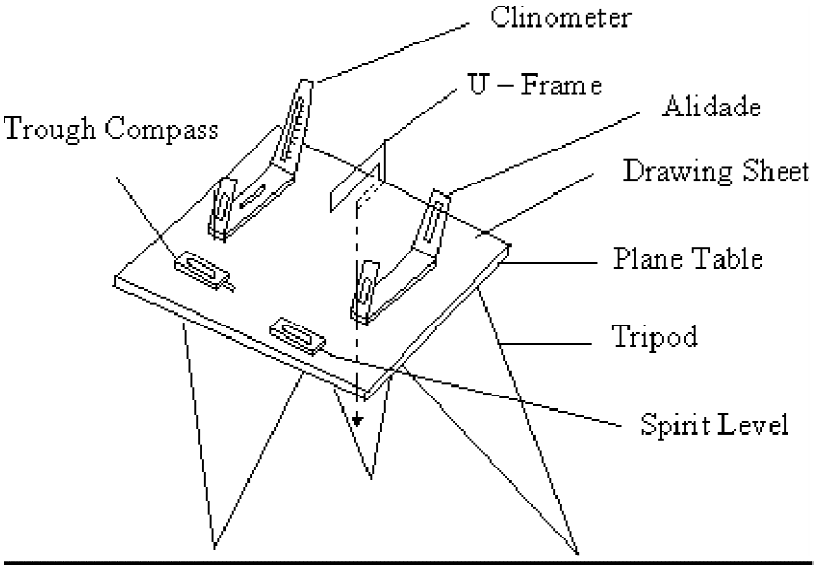
on either side of the zero line.A counter weight is also used for North end of the needle to represent North and is also used for balancing the dip of the needle.

Sprit Level:- A small sprit level circular or rectangular is required for seeing if the table is properly level. The level must have flat base so that it can be placed on the table.

Plumbing fork or U-frame :- The plumbing fork to which is attached a plumb bob ,used for centering the plane table over the station occupied by the plane table. it is also meant for transforming the ground point on to sheet so that both the points should be in the same vertical line

It consists of two light metal arms as shown in fig. approximately of equal lengths. A hook for suspending a plumb bob is provided at the lower arm immediately below the end point of the upper arm. The upper arm is placed on the plane table while the lower arm with a plumb bob is moved below the table for centering over the ground station mark,thus in the exact position the pointed end of the upper arm will give the corresponding position on the paper.

Radiation Method:-When from a single set of plane table on instrument station different details are located on the sheet, the method is known as radiation method In this method the rays are drawn from the instrument station to the point to be located, then the distances are measured from the instruments station to the point and the position of the each point is plotted on the sheet using a suitable scale. The method is most suited for surveying small areas which can be controlled by single setting. It can also be used in combination with other method. This method can be applied for locating distant points if the distances are obtained tacheometrically with the help of the telescope alidade.


Clinometer
U – Frame
Alidade
Trough Compass
Drawing Sheet
Plane Table
Tripod
Spirit Level

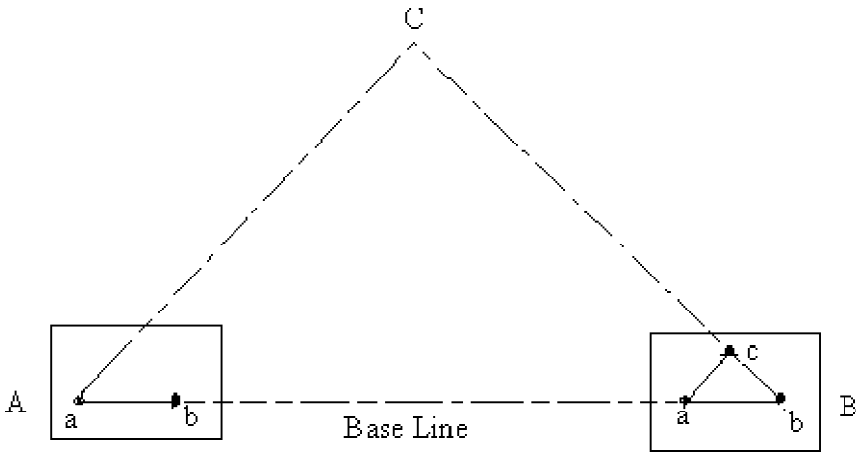

C
A
a
b
Base Line
c
a
b
B

Fig 3

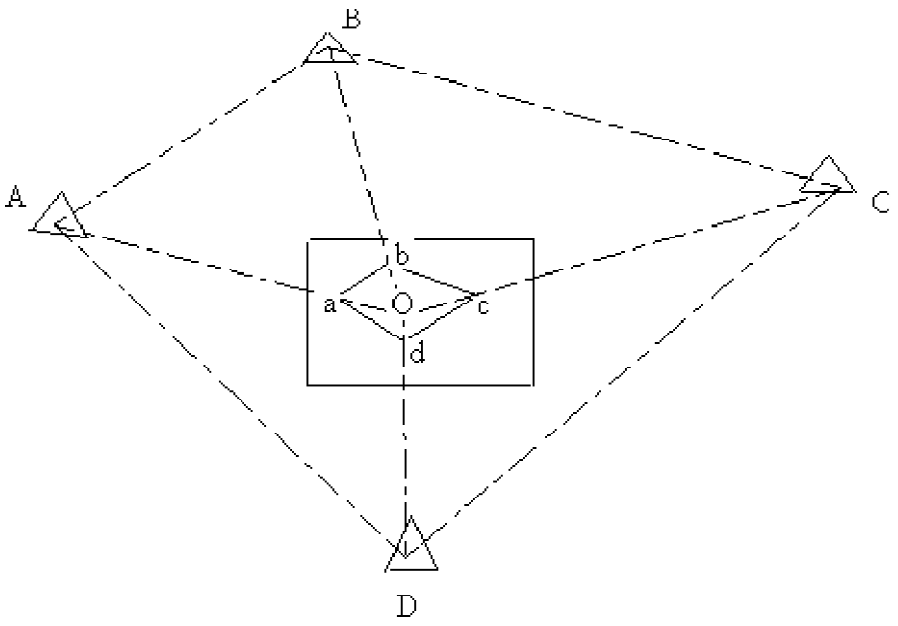


Fig 2

Intersection method:-

When the location of an object is obtained on the sheet of paper by the intersection of the rays drawn after sighting at the object from two plane table stations (previously plotted), it is called intersection method.

The method is suitable when the distance between the point and the instrument station is either too large or cannot be measured accurately due to some field conditions as in case of mountainous country. It is also employed for filling up details, locating distant and inaccessible object, locating the broken boundaries as in the case of rivers etc. The method can also be used for checking of plotted points.

The line joining the two instrument stations is known as the base line. No linear measurement other than the base line is made.

PROCEDURE:

Radiation Method:

In this method the instrument is setup at a station and rays are drawn to various stations which are to be plotted. The distances are cut to a suitable scale after actual measurements.

A station O is selected such that all other stations A, B, C and D are accessible and visible from O (Fig 2). N – S direction is plotted. The plane table is setup at O. The alidade is placed at „o" and rays are drawn from „o" to the stations A, B, C, D and the distances oa, ob, oc and od are cut to the chosen scale. Joint a, b, c and d.

Intersection Method:

In this method two stations are so selected that all the other stations to be plotted are visible from these. The line joining these two stations is called Base Line. The length of this line is measured very accurately. Rays are drawn from these stations to the stations to be plotted. The intersection of the rays from the two stations gives the position of the station to be plotted on the drawing sheet. Let A and B be the two accessible stations (Fig 3), such that A and B can be suitably plotted. C is the station to be plotted by intersection. The plane table is placed at A. N – S direction is plotted. The ground station A is transferred as „a" onto the drawing sheet. With the alidade centered at „a", station B is sighted. A ray aB is drawn and is cut as „ab" to a suitable scale. With the alidade at „a", C is also sighted and a ray aC is drawn. The table is now shifted to B and is setup. The alidade is placed at „b" and C is sighted. A ray bC is drawn. The intersection of the two rays gives the position of C as „c" on the plane table.

CALCULATIONS:

RESULT:

Given area is plotted on paper by Radiation and Intersection methods of PlaneTable Survey.

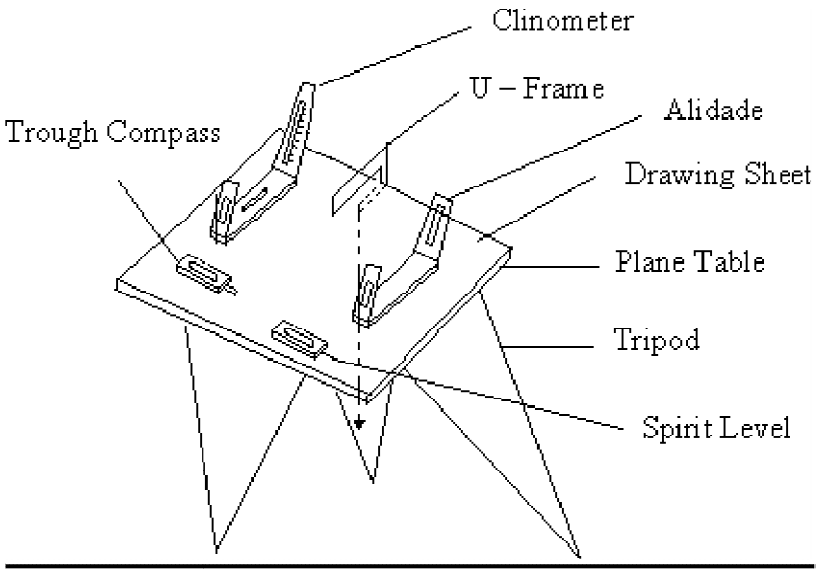
EXPERIMENT NO:9
TWO POINT PROBLEMS IN PLANE TABLE SURVEY

AIM OF THE EXPERIMENT:

To find the required stations by using two point problem.

APPARATUS REQUIRED:

Tape , Ranging Rods , Arrows , Plane Table with Tripod and its accessories , Two Drawing Sheets , Drawing Clips , Pencil, Eraser and Pins



THEORY

In the two-point problem, two points are sighted from other point corresponding to the points given in plane table sheet

PROCEDURE FOR TWO POINT PROBLEM:

A. Let two points A and B be the plotted positions on the plane.

B. C is the station over which the table is to be set up and c is its position on the plane which is required to be located.

C. The solution of the problem requires two instrument stations.

D. The station is obtained as follows.
1) Choose a suitable auxiliary point D, so that the angle CAD and CBD aren‟t too acute for good intersection at A and B.

2) Setup the table at D and level it .Orient the table by compass or by judging ab to be parallel to AB and clamp it.

3) With the alidade touching a, sight A, and draw a ray through a. Similarly, with the alidade against b, sight B and draw a ray through through at d1,which approximately represents the station D and the orientation is approximately.

4) With the alidade centered on d1 ,sight C and draw a ray d1c1 through d1,estimating the position of c1.
5) Remove the table and set it up at C with c1over c and level it.Orient the table parallel to its position at D ,by back sighting on D .To do this ,place the alidade along c and d ,rotate the table until D is bisected, clamp the table .

6) With the alidade against a, sight A and draw a ray through a, Intersect the line c1d1in C1 .With the alidade through C1, sight B and draw a ray through C1..This ray will pass through b, provide the initial orientation of the table at D was correct. But since the orientation at D and also at C, also constituent was only approximate, the ray C 1 B will not pass through b. Mark the point of intersection b1 of C 1 B ,and d1b .The point b1 thus represents B. Hence points ad1c1b1 represents ADCB. But since ab is the true representation of AB ,the error in the initial orientation is equal to the angle b1ab between the lines ab and ab1.To eliminate the error ,the table must be rotate through this angle. To do this,

7) Place the alidade along ab1, and fix a ranging rod P at a great distance from the table in the line ab1 produced.

8) Place the alidade along ab and turn the table until the ranging rod P is bisected. Clamp the table ,ab is now parallel to AB and the orientation of the table is correct.

9) To find the true position of C, center the alidade on a and sight A .Draw a ray through a. Similarly with alidade touching b, sight B, and draw a ray through b. The intersection of these two rays gives the true position (c) on the plan of the station (c) occupied.

RESULT:

The required instrument station C is occupied by using two point problems.

EXPERIMENT NO -10

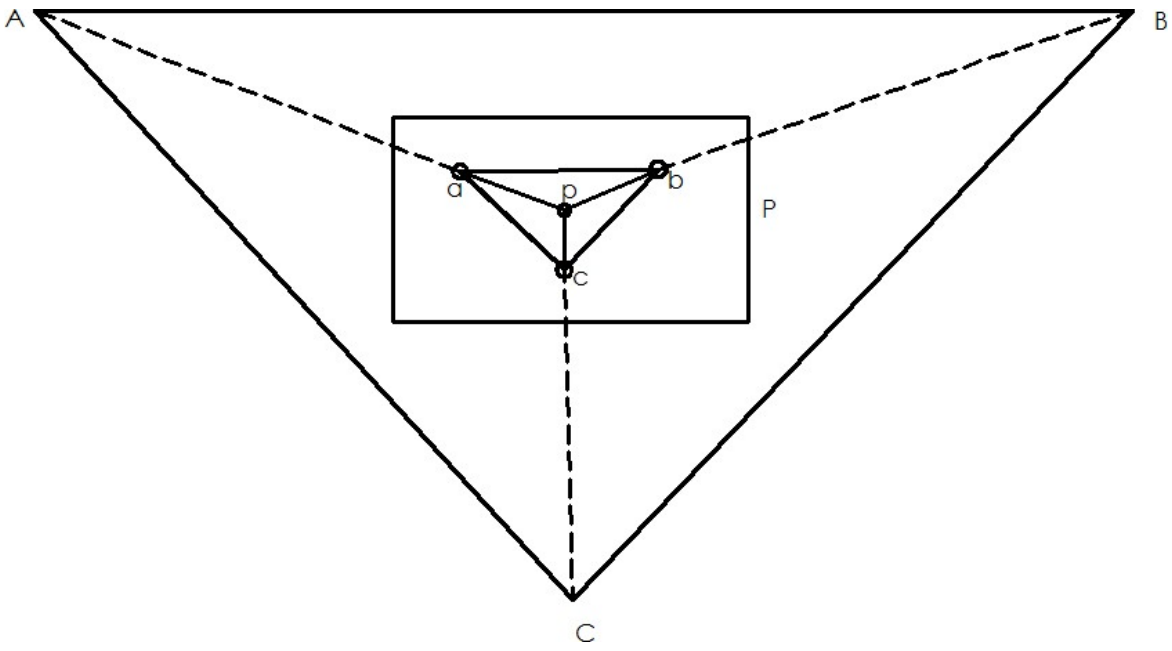
AIM OF THE EXPERIMENT: Three point problem in plane table surveying.

APPARATUS REQUIRED: Plane table alidade, plumbing fork, plumb bob, Ranging rod, drawing sheet etc.

THEORY :

It is finding the location of the station occupied by a plane table on the sheet, by means of sighting to three well-defined points of known location on the sheet The principle of this method lies in the fact that if the plane table is correctly oriented, the three resectors through a ,b,& c, shown in fig. meet at a point p which is the location of the plane-table station on the sheet, provided the points A,B,C& P do not lie on the circumference of a circle. By solving three- point problem, thus, the orientation & resection are accomplished simultaneously.
The solution of three-point problem is further illustrated graphically in fig. the stations A, B, & C are of known position & p is of unknown position. If the angle a is observed between PB, & PA, the position of P is indeterminate, because P can be anywhere on the circle circumscribing the triangle PAB. Additional information is needed to make the problem determinate. If the angle B, which is the angle subtended by AC at P, is also observed then the solution is unique since P, A &C lie on the circle that circumscribe triangle PAC, & P is one of the two intersection points of the circles & A is the other intersection point. This solution becomes indeterminate of A, B, C, & P fall on the circumference of one circle.
If the two circles tend to merge into one circle, the problem will be less stable & finally becomes indeterminate again when the two circles coincide. Points should be selected in the field so as to avoid this situation.
There is number of solutions of three-point problem but the following methods applicable to the plane table discussed.

a. mechanical method (tracing paper method)
b. graphical method
c. trial & error method (Lehmann's method)



PROCEDURE:-

The three point problem consists in locating on the plan the position of the instrument station on the ground by means of observation to three well defined points whose positions have been already plotted on the plan. Suppose A, B, &C are the three points which have been plotted as a, b, & c on the plan & the t able is set up at T from which A, B, & C are visible. It is required to plot on the plan the position t of the instrument station T.

The problem may be solved by (1) Mechanically (2) Graphically (Bessel's method) & (3) by trial & error method

Bessel's method: - This method is simplest & most commonly used.

i. After setting & leveling the table, the alidade is placed along the line ca

& the board turned until A is sighted being towards A. the table is then clamped. With the alidade centered on C, B is sighted & a ray CB is drawn along the edge of the alidade.

ii. When the alidade placed along ac, the board is turned until the line of sight bisects c, c being towards C & then clamped. With the alidade touching a, B is sighted & a ray aB is drawn through a; intersecting the ray previously drawn through in the point d.

iii. With the alidade along bd, the table is turned until B is bisected & then clamped. The table is now oriented & t must lie on db & also on Aa & Cc. with the alidade centered on a, A is bisected & a lay is drawn through a, intersecting the ray bd in t, which represent the instrument station T.

To check the orientation, the alidade is pivoted on c &C is bisected. The ray Cc should now pass through t, if the work is correct.

RESULT: The location of the station on given point is found on sheet.

EXPERIMENT NO:11
TRAVERSING BY PLANE TABLE SURVEY

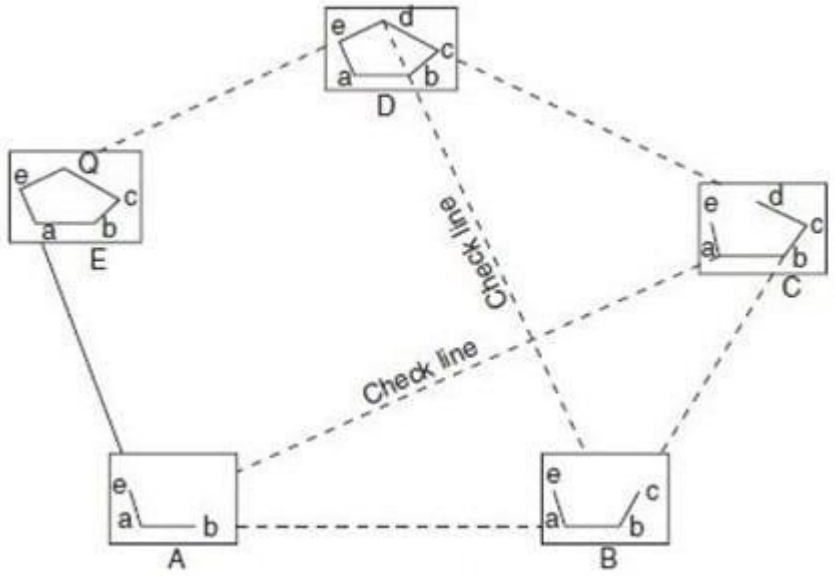
AIM OF THE EXPERIMENT:

Traversing method for running survey lines of a closed or open traverse

APPARATUS REQUIRED: Plane table alidade, plumbing fork, plumb bob, Ranging rod, drawing sheet etc.

THEORY

Traversing is the connection of series of straight lines. In case of **traversing**, **plane table** is located at one point for suppose A as shown below. From that point sight towards B and measure the distance AB. Then shift the **plane table** to point B and sight towards A and measure BA.



PROCEDURE:

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

2) Set the table on starting station „a" and perform temporary adjustments.

3) Mark the magnetic meridian.

4) Locate A on the sheet as „a".

5) Pivot on „a" bisect the next station B and draw a ray

6) Measure the distance AB and locate „b" on the sheet with a suitable scale.

7) Shift the table to next station B, set the table over B, and do temporary adjustments.

8) Place the alidade along „ba" and bisect A for doing orientation of plane table.

9) Pivot on b bisect c draw a ray

10) Measure the distance BC and locate „c" on the sheet with the suitable scale.

11) Report the same procedure at every successive station until the traverse is completed.

CALCULATIONS:

1) Area of a triangle = ½ * base *height

2) Area of a square = side * side

3) Area of a rectangle = length * breadth

4) Area of a trapezium = ½ * (a + b) * h

A, b are the parallel sides. h is the distance between parallel sides.

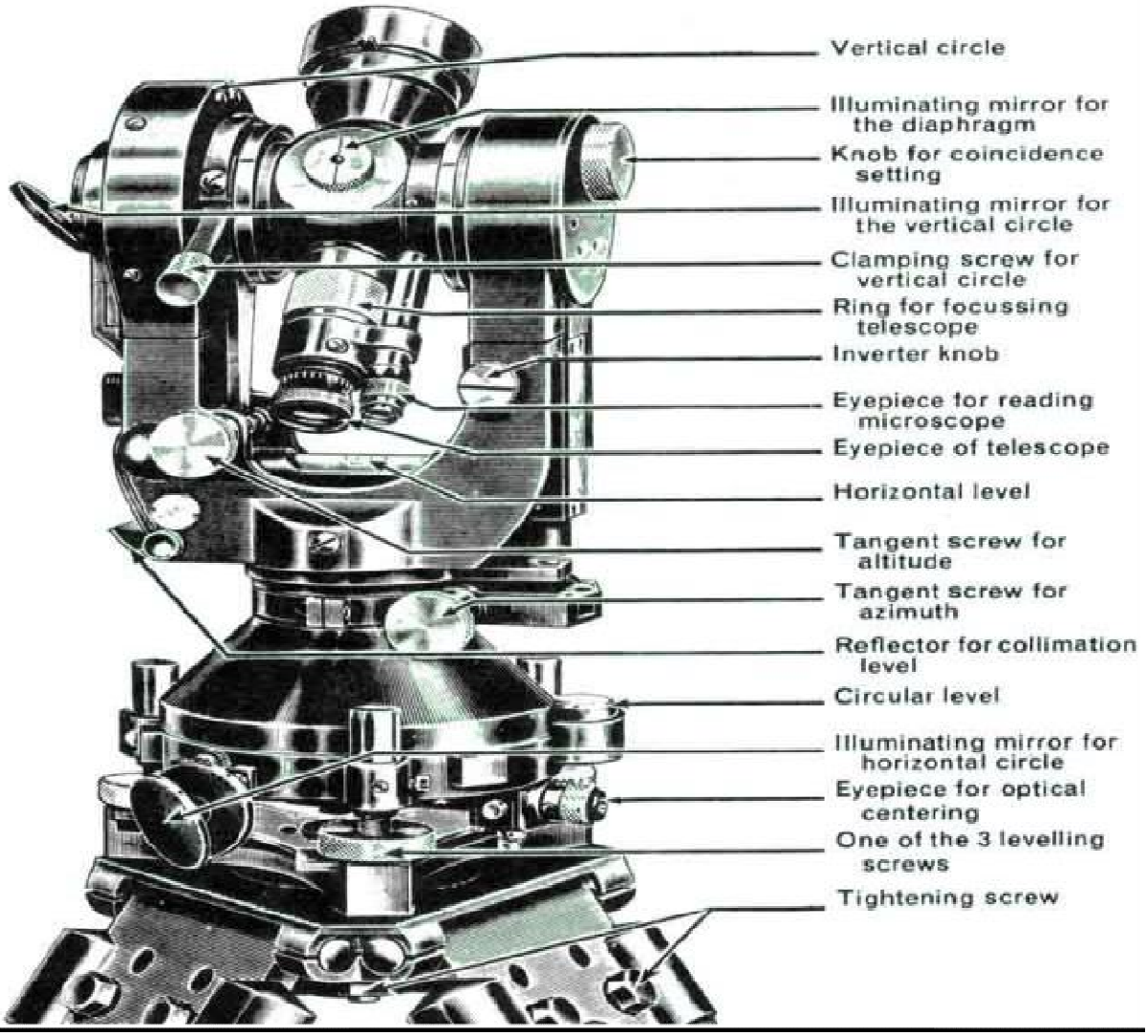
RESULT:

Traversing method for running survey lines of a closed or open traverse is done.

EXPERIMENT NO-12

AIM OF THE EXPERIMENT : Measurement of horizontal angles theodolite by method of repetition

APPARATUS REQUIRED:- Theodolite , Ranging rod, pegs etc.



TRANSIT THEODOLITE

THEORY :

Theodolite :

The theodolite is the most intricate and accurate instrument used for measurement of horizontal and vertical angles. It consists of telescope by means of which distant objects can be sighted. The telescope has two distinct motions on in the horizontal plane and the Other in the vertical plane. The former being measured on a graduated Horizontal vertical circle of two vernier.

Theodolite are primarily classified as
1) Transit theodolite
2) Non-transit theodolite
A theodolite is called transit theodolite when its telescope can be resolved through a complete revolution about its horizontal axis. In a vertical plane. The transit type is largely used.

Various parts of transit theodolite

1) Telescope: It is an integral part and is mounted on the spindle known as horizontal axis or turn on axis. Telescope is either internal or external focusing type.

2) The leveling head: It may consists of circular plates called as upper and lower Parallel plates. The lower parallel plate has a central aperture through which a plumb bob may be suspended. The upper parallel plate or tribranch is supported by means of four or three leveling screws by which the instrument may be leveled.

3) To lower plate or screw plate: It carries horizontal circle at its leveled screw. It carries a lower clamp screw and tangent screw with the help of which it can be fixed accurately in any desired position.

4) The upper plate or vernier plate:- It is attached to inner axis and carries two vernier and at two extremities diametrically opposite.

5) Compass: The compass box may be either of circular form or of a rough type. The former is mounted on the vernier plate between the standards while the

latter is attached to the underside of the scale or lower plate or screwed to one of the standards. Modern theodolite is fitted with a compass of the tubular type and it is screwed to one of the standards.

6) Vertical circle: The vertical circle is rigidly attached to the telescope and moves with it. It is silvered and it is usually divided into four quadrants.

7) Index bar or T-frame: The index bar is T shaped and centered on horizontal axis of the telescope in front of the vertical axis. It carries two vernier of the extremities of its horizontal arms or limbs called the index arm. The vertical leg called the clip or clipping screws at its lower extremity. The index arm and the clipping arm are together known as T-frame.

8) Plumb bob: To centre the instrument exactly over a station mark, a plumb bob is suspended from the hook fitted to the bottom of the central vertical axis. Repetition method of measuring Horizontal angles

When it is required to measure horizontal angles with great accuracy as in the case of traverse, the method of repetition may be adopted. In this method the same angle is added several times by keeping the vernier to remain clamped each time at the end of each measurement instead of setting it back to zero when sighting at the previous station. The corrected horizontal angle is then obtained by dividing the final reading by the number of repetitions. Usually six reading, three with face left and three with face right, are taken The average horizontal angle is then calculated.

PROCEDURE:-

1) Let LOM is the horizontal angle to be measured as shown in fig. O is the station point fixed on the ground by a peg. Set up the theodolite over the peg ‘o’ and level it accurately.

2) Set the horizontal graduated circle vernier A to read zero or 360° by upper clamp screw and slow motion screw. Clamp the telescope to bisect the bottom shoe of the flag fixed at point ‘L’ and tighten the lower clamp. Exactly intersect the centre of the bottom shoe by means of lower slow motion screw. Check that the face of the theodolite should be left and the telescope in normal position.

3) Check the reading of the vernier A to see that no slip has occurred .Also see that the plate levels are in the centre of their run. Read the vernier B also.

4) Release the upper clamp screw and turn the theodolite clockwise. Biset the flag bottom shoe fixed at point M by a telescope. Tighten the upper clamp screw and bisect the shoe exactly by means of upper slow motion screw.

5) Note the reading on both the vernier to get the approximate value of the angle LOM.

6) Release the lower clamp screw and rotate the theodolite anticlockwise ai azimuth. Bisect again the bottom shoe of the flag at 'L' and tighten the lower clamp screw. By means of slow motion screw bisect exactly the centre of the shoe.

7) Release now the upper clamp screw and rotate the theodolite clockwise. Bisect the bottom shoe of the flag fixed at M and tighten the upper clamp screw. By means of slow motion screw bisect exactly the centre of the shoe. The vernier readings will bw now twice the of the angles.

8) Repeat the process until the angle is repeated the required number of times (usually 3). Add 360° for every complete revaluation to the final reading and divided the total angle by number of repetitions to get the value of angle LOM.

9) Change the face of the theodolite the telescope will now be inverted. Rrpeat the whole process exactly in the above manner and obtain value of angle LOM.

10) The average horizontal angle is then obtained by taking the average of the two angles obtained with face left and face right.

11) Usually three repetitions face left and three with face right should be taken and the mean angle should be calculated.

Observation Table:- Repetition method of measuring horizontal angle

SN	INSTRUMENT STATION	SHIFTED TO	FACE LEFT READINGS			
		Venier A 0,I,II	Venier B 0,I,II	Total angle	No of Repetition	Mean horizontal angle 0,I,II
		L				
		M				
		L				
		M				
		L				
		M				

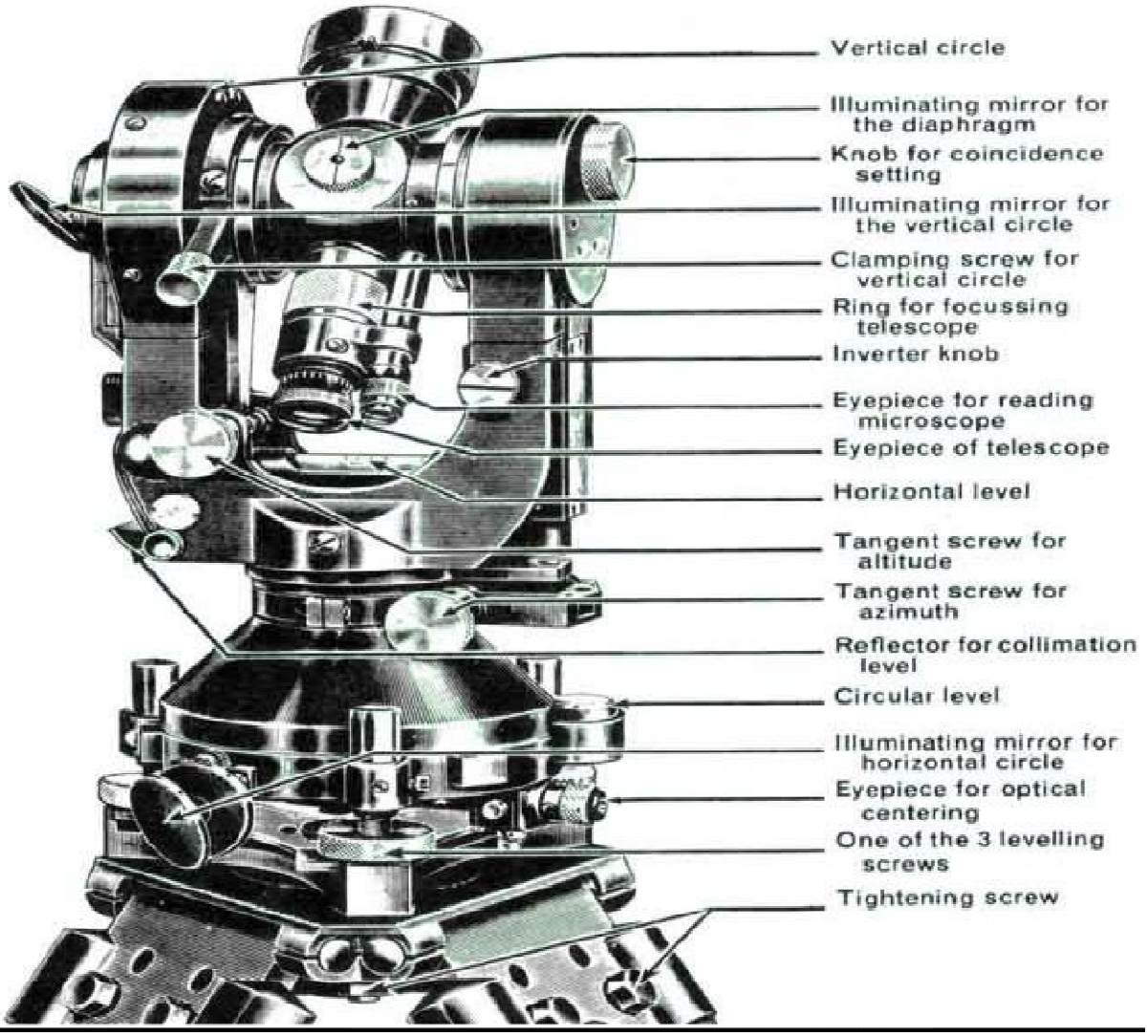
SN	INSTRUMENT STATION	SHIFTED TO	FACE RIGHT READINGS				
		Venier A 0,I,II	Venier B 0,I,II	Total angle 0,I,II	No of Repatition	Mean horizontal angle 0,I,II	Average horizontal angle 0,I,II
		L			3		
		M					
		L					
		M					
		L					
		M					

RESULT: Average horizontal angle is found to be ----------

EXPERIMENT NO-13

AIM OF THE EXPERIMENT : Measurement of horizontal angles theodolite by method of reiteration

APPARATUS REQUIRED:- Theodolite , Ranging rod, pegs etc.



TRANSIT THEODOLITE

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Theodolite are primarily classified as
1) Transit theodolite
2) Non-transit theodolite
A theodolite is called transit theodolite when its telescope can be resolved through a complete revolution about its horizontal axis. In a vertical plane. The transit type is largely used.

Various parts of transit theodolite

1) Telescope: It is an integral part and is mounted on the spindle known as horizontal axis or turn on axis. Telescope is either internal or external focusing type.

2) The leveling head: It may consists of circular plates called as upper and lower Parallel plates. The lower parallel plate has a central aperture through which a plumb bob may be suspended. The upper parallel plate or tribranch is supported by means of four or three leveling screws by which the instrument may be leveled.

3) To lower plate or screw plate: It carries horizontal circle at its leveled screw. It carries a lower clamp screw and tangent screw with the help of which it can be fixed accurately in any desired position.

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5) Compass: The compass box may be either of circular form or of a rough type. The former is mounted on the vernier plate between the standards while the latter is attached to the underside of the scale or lower plate or screwed to one of

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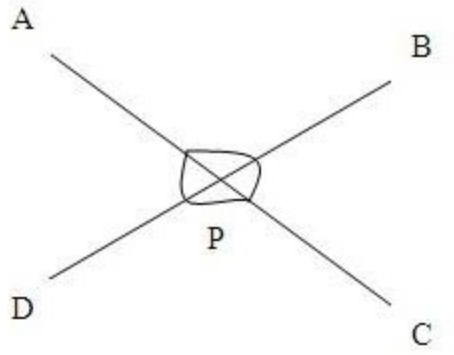
Repetition method of measuring Horizontal angles

When it is required to measure horizontal angles with great accuracy as in the case of traverse, the method of repetition may be adopted. In this method the same angle is added several times by keeping the vernier to remain clamped each time at the end of each measurement instead of setting it back to zero when sighting at the previous station. The corrected horizontal angle is then obtained by dividing the final reading by the number of repetitions. Usually six reading, three with face left and three with face right, are taken The average horizontal angle is then calculated.



PROCEDURE:

1. The theodolite is mounted on the tripod stand.
2. The theodolite is centered over an arbitrarily selected station P from where the given stations can be sighted without any obstruction and the instrument is levelled using the foot screws and the plate bubble is brought to the centre of the run.
3. The theodolite is set on the face right mode on the vernier A and the horizontal circle is initially set at 0°00’00” and the station A is sighted .
4. The upper clamp screw is unclamped and the theodolite is swung to the right and the station B,C,D and A are sighted in sequence and the central vertical cross hair is made to bisect these stations and the horizontal angles on both the vernier A and B are observed and recorded. The observations are closed on the first station A.
5. The theodolite is then set on the face left mode and the vernier A on the horizontal circle is initially set at 180°00’00” and the station A is sighted.
6. The upper clamp screw is unclamped and the theodolite is swung to the left and the stations D,C,B and A are sighted in sequence and the central vertical cross hair is made to bisect these stations and the horizontal angles on both the vernier A and B are observed and recorded. The observations are closed on the first station A.
7. The observations are recorded in the field book.
8. The mean values of the horizontal angles on vernier A and B are computed for every sighting and the horizontal included angles are determined as the difference in successive mean values.
9. The average of the two sets of horizontal included angles observed one set each for the two initial settings of vernier A is determined as the result.

TABULATION

10.

Inst at	Sighted to	Horizontal Circle Reading								Included Angle			Average Included Angle			Remarks
		Vernier A			Vernier A		Mean									
		°	‘	“	‘	“	°	‘	“	°	‘	“	°	‘	“	
FACE RIGHT																
P	A															
	B															
	C															
	D															
	A															
FACE LEFT																
P	A															
	D															
	C															
	B															
	A															

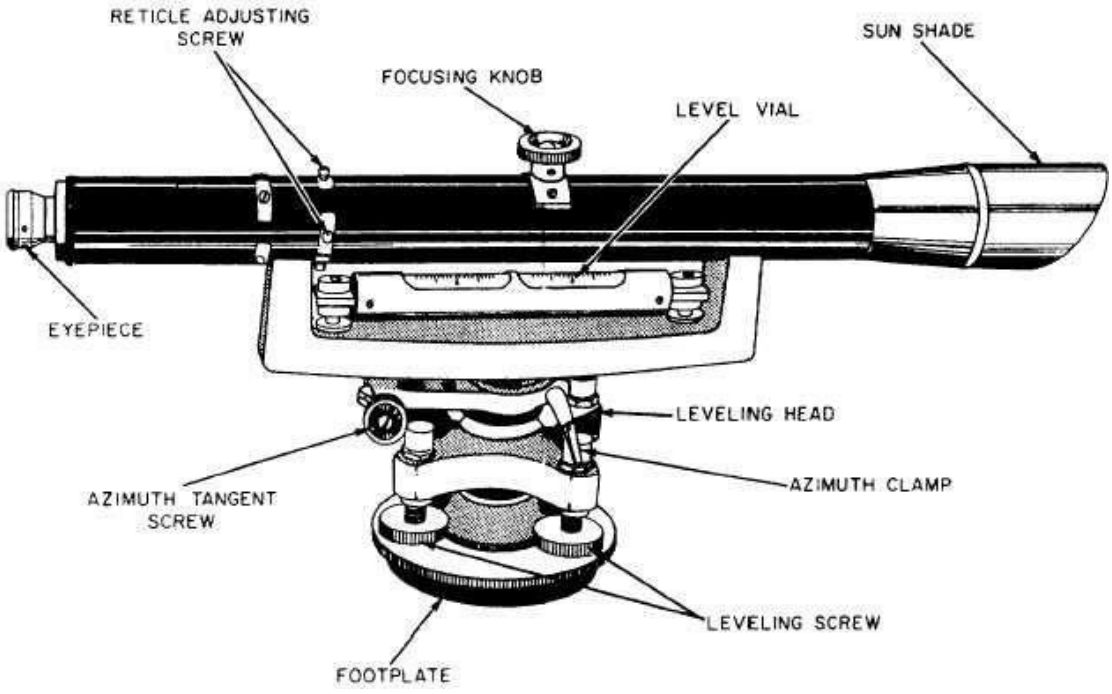
RESULT: The horizontal angles between the given stations about the instrument station as the vertex are determined by the method of reiteration

i. Angle APB =
ii. Angle BPC =
iii. Angle CPD =
iv. Angle DPA =

EXPERIMENT NO-14

AIM OF THE EXPERIMENT: Determination of elevation of various points with dumpy level by collimation plane method and rise & fall method.

APPARATUS REQUIRED: Dumpy level, leveling staff



DUMPY LEVEL

THEORY:

Levelling: The art of determining and representing the relative height or elevation of different object/points on the surface of earth is called leveling. It deals with measurement in vertical plane.

By leveling operation, the relative position of two points is known whether the points are near or far off. Similarly, the point at different elevation with respect to a given datum can be established by leveling.

LEVELLING INSTRUMENTS:- The instrument which are directly used for leveling operation are:-
Level, Levelling staff
Level: - An instrument which is used for observing staff reading on leveling staff kept over different points after creating a line of sight is called a level.
The difference in elevation between the point then can worked out. A level essentially
consists of the following points:

1) Levelling Heads
2) Limb plate
3) Telescope

Telescope consists of two tubes, one slide into the other and fitted with lens and diaphragm having cross hairs. It creates a line of sight by which the reading on the staff is taken.
The essential parts of a telescope are
1) body 2) object glass 3)Eye-piece 4) Diaphragm 5) Ray shade 6) The rack and pinion arrangement 7) Focusing screw 8) Diaphragm screw.

4) Bubble tube
5) Tripod stand

Dumpy level:
The dumpy level is simple, compact and stable instrument. The telescope is rigidly fixed to its supports. Hence it cannot be rotated about its Longitudinal axis or cannot be removed from its support. The name dumpy is because of its compact and stable construction. The axis of telescope is perpendicular to the vertical axis of the level. The level tube is permanently placed so that its axis lies in the same vertical plane of the telescope but it is adjustable by means of captain head not at one end.
The ray shade is provided to protect the object glass. A clamp and slow motion

screw are provided in modern level to control the movement of spindle, about the vertical axis. The telescope has magnifying power of about thirty diameters. The level tube is graduated to 2mm divisions and it has normally a sensitiveness of 20
seconds of are per graduation. The telescope may be internally focusing or external focusing type.

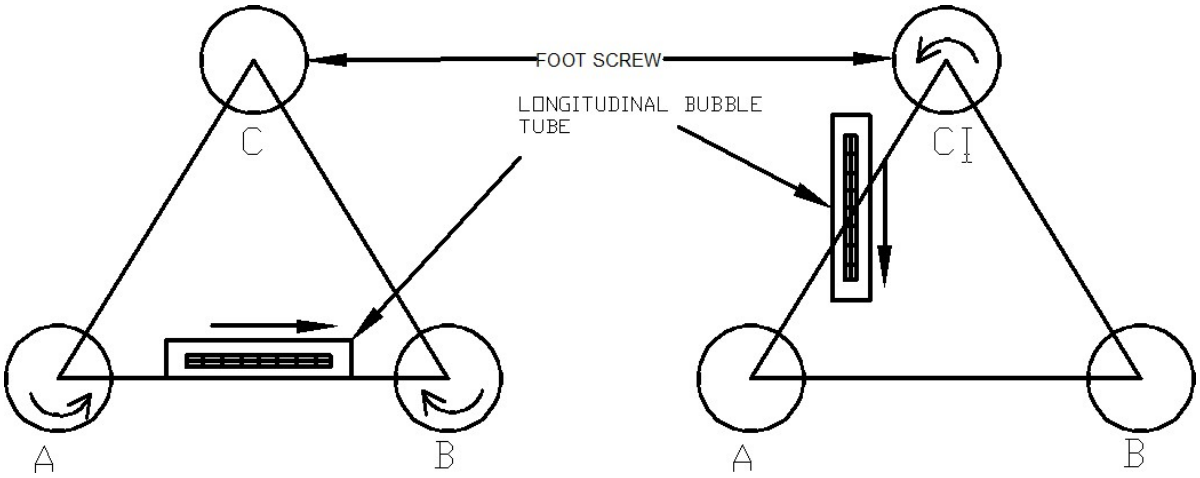
Adjustment of the level

The level needs two type of adjustment
1) Temporary adjustment and
2) Permanent adjustment
Temporary adjustments of dumpy level
These adjustments are performed at each set-up the level before taking any observation.

A) **Setting up the level:-** this includes

1) Fixing the instrument in the tripod:- The tripod legs are well spread on the ground with tripod head nearly level and at convenient height. Fix up the level on the tripod.
2) Leg adjustment:- Bring all the foot screws of the level in the centre of their run .Fix any two legs firmly into the ground by pressing them with hand and move the third leg to leg to right or left until the main bubble is roughly in the centre. Finally the legs is fixed after centering approximately both bubbles. This operation will save the time required for leveling.

B) Levelling: - Levelling is done with the help of foot screws and bubbles. The purpose of levelling is to make the vertical axis truly vertical. The method of leveling the instrument depends upon whether there are three foot screws or four foot screws. In all modern instruments three foot screws are provided and this method only is described.



1) Place the telescope parallel to pair of foot screws.
2) Hold these two foot screw between the thumb and first finger of each hand and turn them uniformly so that the thumbs move either toward each other until the bubble is in centre.
3) Turn the telescope through 90°so that it lies over the third foot screw.
4) Turn this foot screw only until the bubble is centred.
5) Bring the tescope back to its original position without reversing the eye piece and object glass ends.
6) Again bring the bubble to the centre of its run and repeat these operation until the bubble remains in the centre of its run in both position which are at right angle to each other.
7) Now rotate the instrument through 180°,the bubble should remain in centre provided the instrument is in adjustment: if not ,it needs permanent adjustment.

c) Focusing the eye piece:- To focus the eye piece, hold a white paper in front of the object glass ,and move the eye piece in or out till the cross hairs are distinctly seen. Care should be taken that the eye piece is not wholly taken out ,some times graduation are provided at the eye piece and that one can always remember theparticular graduation position to suit his eyes,This will save much time of focssing theeye piece.

(d) Focusing the object glass: - Direct the telescope to the leveling staff and on looking through the telescope, turn the focusing screw until the image appears clears and sharp. The image is thus formed inside the plane of cross hairs, Parallax,if any is removed by exact focusing. It may be noted that parallax is completely eliminated when there is no change in staff reading after moving the eye up and down.

Reduced Levels

The system of working out the reduced level of the points from staff reading taken in the field is called as reduced level (R.L) of a points is the elevation of the point with reference to the same datum.

There are two systems of reduced levels

1) The plane of collimation system (H.I. method)

2) The Rise and fall system

1) The plane of collimation system (H.I. method)

In this system, the R.L. of plane of collimation (H.I) is found out for every set-up of the level and then the reduced levels of the points are worked out with the respective plane of collimation as described below.

1) Determine the R.L. of plane of collimation for the first set up of the level by adding B.S. to the R.L. of B.M. i.e(R.L of plane of collimation= R.L. of B.M.+B.S.)

2) Obtained the R.L. of the intermediate points and first change point by subtracting the staff readings (I.S. and F.S. from the R.L. of plane of collimation (H.I). (R.L. of a point=R.L of plane of collimation H.I.-I.S or F.S)

3) When the instrument is shifted and set up at new position a new plane of collimation is determined by addition of B.S. to the R.L of change point. Thus the levels from two set-ups of the instruments can be correlated by means of B.S. and F.S. taken on C.P.

4) Find out the R.L.s of the successive points and the second C.P. by subtracting their staff readings from this plane of collimation R.L.

5) Repeat the procedure until all the R.Ls are worked out.

Station	Reading			R.L. of plane collimation (H.I)	Reduced Level	Remarks
	BS	IS	FS			

Arithmetical check: The difference between the sum of the back sights and the sum of the fore sights should be equal to the difference between the last and first reduced levels.
i.e ∑**B.S -** ∑ **F.S.= LAST R.L –FIRST R.L**

2) The Rise and fall system

In this system, there is no need to determine R.L. of plane of collimation .The difference of level between consecutive points are obtained as described below.

1) Determine the difference in staff readings between the consecutive point comparing each point after the first with that immediately proceeding it.

2) Obtained the rise or fall from the difference of their staff reading accordingly to the staff reading at the point is smaller or greater than that of proceeding point.
3) Find out the reduced level of each point by adding the rise to or subtracting fall from the R.L. of a proceeding point.

Station	Reading			RISE	FALL	Reduced Level	Remarks
	BS	IS	FS				

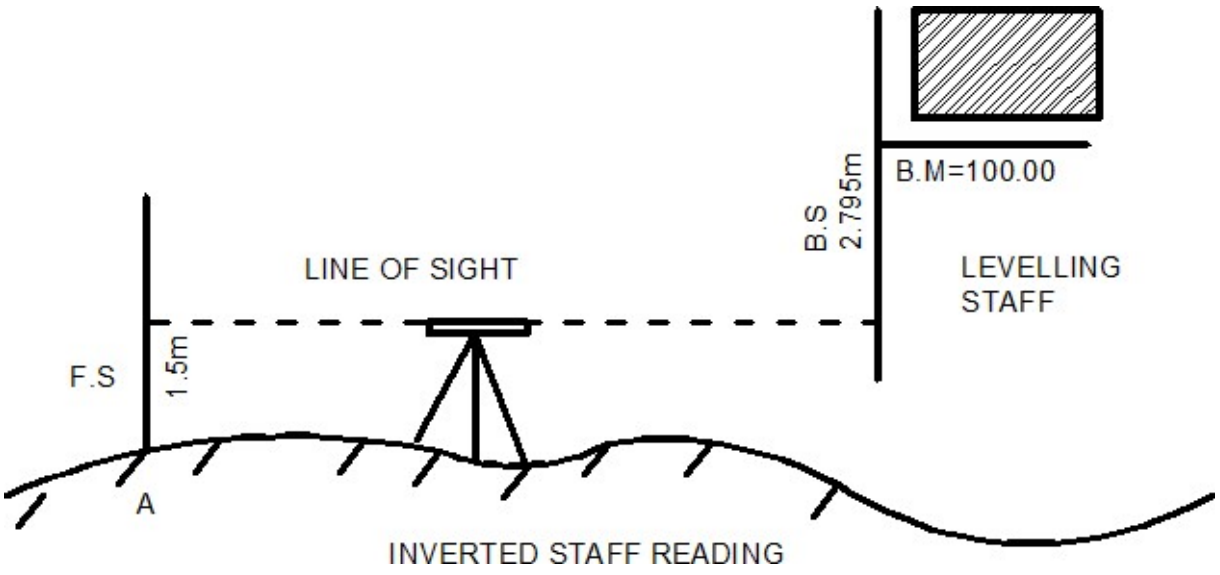
Arithmetic check:-
The difference between the sum of back sight and the sum of

Fore sight= difference between the sum of rise and the sum of fall = the difference between the last R.L. and the first R.L.

∑B.S-∑F.S =∑RISE -∑FALL =LAST RL- FIRST RL

Inverted staff reading

When the B.M of staff station is above the line of collimation (or line of sight) the staff is held inverted on the point and reading is taken .This reading being negative is entered in the level field book with minus sign, or to avoid confusion, 'Staff inverted' should be written in the remarks column against the entry of the reading.



The results are tabulated as below:

BS	IS	FS	HI	RL	REMARKS
-2.795		1.500	97.215	100.000 95.715	B.M.Staff inverted Point A

When the reading on the inverted staff is a foresight or intermediate sight .it should also be recorded in field book with minus sign

The R.L. of such points may be worked at as:

R.L.of the point (where the inverted staff is held)=R.L. of H.I +F.S. or I.S.reading

RESULT:

The various reduced levels are calculated by rise and fall method and by using height or plane Of collimation method and are shown in observation table.

Experiment No:15

FLY LEVELLING (DIFFERENTIAL LEVELLING)

AIM OF THE EXPERIMENT:

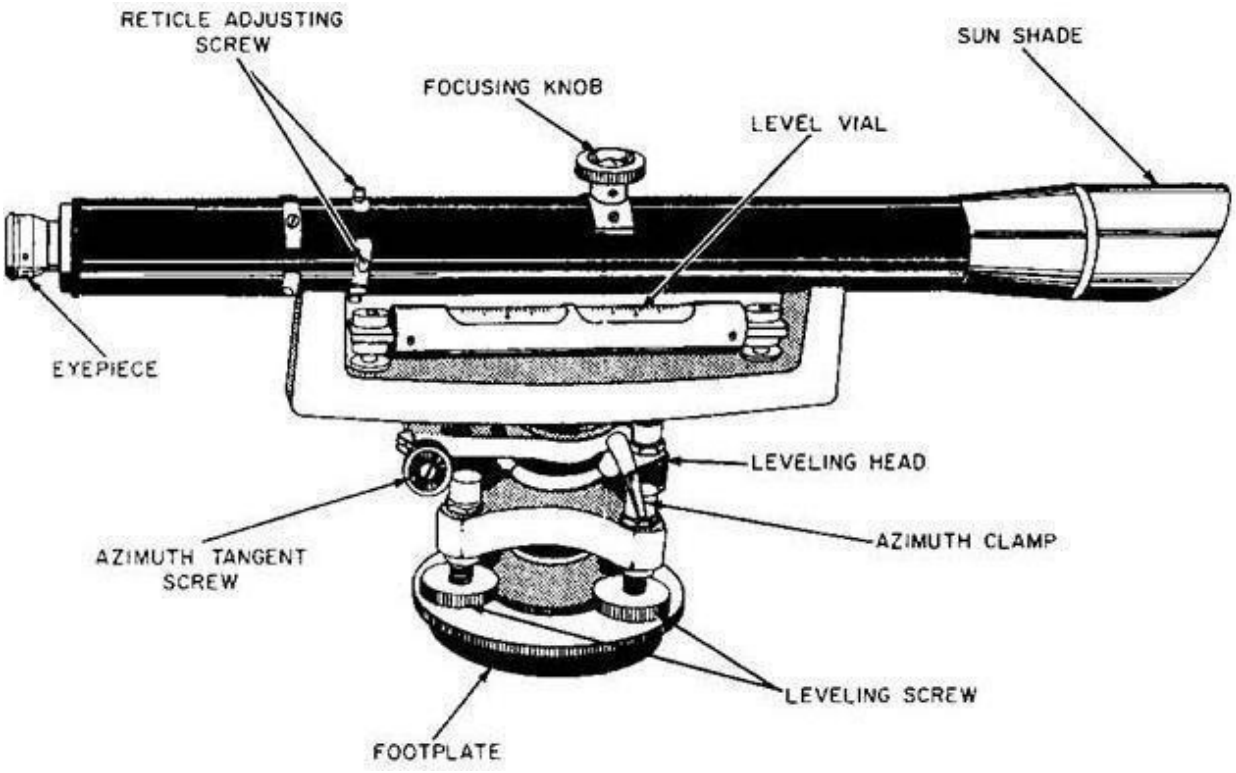
To ascertain the difference of elevation between any two points.

APPARATUS REQUIRED:

Dumpy level , Ranging Rod, Arrow, Levelling staff, Tripod

THEORY:

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.



PROCEDURE:

1. Differential leveling is the method of direct leveling the object of which is To determine Difference in elevations of two points regardless of horizontal position of point with respect to each Other, when points are apart it may be necessary to setup the instrument several times. This type of Leveling is also known as "FLY-LEVELLING".

2. Instrument level is setup at convenient positions near first point (say A).

3. Temporary adjustments should be done, (setting up, leveling up, elimination of a par- allot) are Performed.

4. First sight of B.M (point of known elevation) is taken and reading is entered in back Sight column.

5. If distance is large instrument is shifted, the instrument becomes turning point (or) changing point.

6. After setting up instrument at new position, performing temporary adjustment and Take back sight as turning point.

7. Thus turning point will have both back sight and fore sight readings.

8. Link wise the process is repeated till last point (say B) is reached.

9. 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.

CALCULATIONS:

SIMPLE LEVELING

Station no	BS	IS	FS	HI	RL	REMARKS

ARITHMETIC CHECK:-

Σ B.S - ΣF.S=ΣRISE - ΣFALL=LAST RL - FIRST R.L

DIFFERENTIAL LEVELING

Station no	BS	IS	FS	HI	RL	REMARKS

ARITHMETICAL CHECK:-

ΣB.S – ΣF.S =Last R.L-First R.L

RESULT:

Difference Between points = m.

EXPERIMENT NO-16
DIFFERENTIAL OR FLY LEVELLING – REDUCE LEVELS BY RISE AND FALL METHOD

AIM OF THE EXPERIMENT:

To find the difference in elevation and to calculate the reduced level of various points by Rise and Fall method.

APPARATUS REQUIRED:

Dumpy level, Leveling staff.

THEORY:

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.

PROCEDURE:

The field procedure and booking of staff reading is done in the same way as explained in the height of instrument method (each reading is entered on a different line in the appropriate column, except at a change point, where a FS and BS occupy the same line). However the data booking is performed as shown in the Table below.

TABULATION

Station no	BS	IS	FS	Rise	Fall	RL	REMARKS

CALCULATIONS:

1. The difference in elevation between any two successive points (say A and B) can be calculated as:

Elevation difference between A and B = first reading at A – second reading at B

Checks:

The following checks on the booking and arithmetic calculations are performed:

A) Number of BS readings = Number of FS readings

B) ΣBS - ΣFS = Σ Rise – Σ Fall = RL of last point – RL of first point

EXPERIMENT NO-17

AIM OF THE EXPERIMENT: C
APPARATUS REQUIRED: Dumpy level, leveling staff, ranging rod, tape etc.

THEORY:

Profile leveling: The process of determining elevations at points at short measured intervals along a fixed line is called Longitudinal or profile leveling.

Cross sectioning: It is a method of leveling to know the nature of Ground on either side of the centerline of the proposed route. Levels are taken at right angles to the proposed Direction of the road end at suitable distances and leveling is carried out along this cross Section.

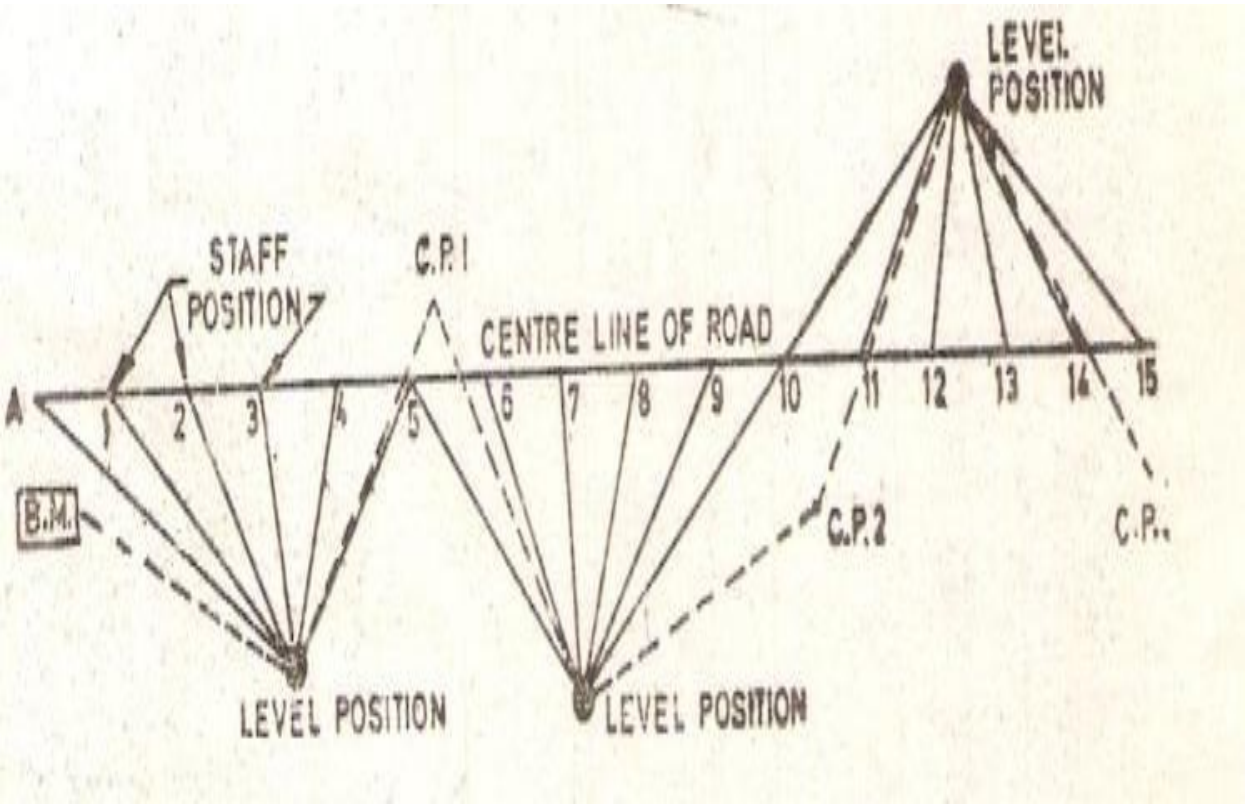
During location and construction of highways, Rail tracks sewers and canals strakes or other marks are placed at various aligned points and the undulation of the ground surface along a predetermined line is adjoined. The line of section may be a single straight lines changing directions.

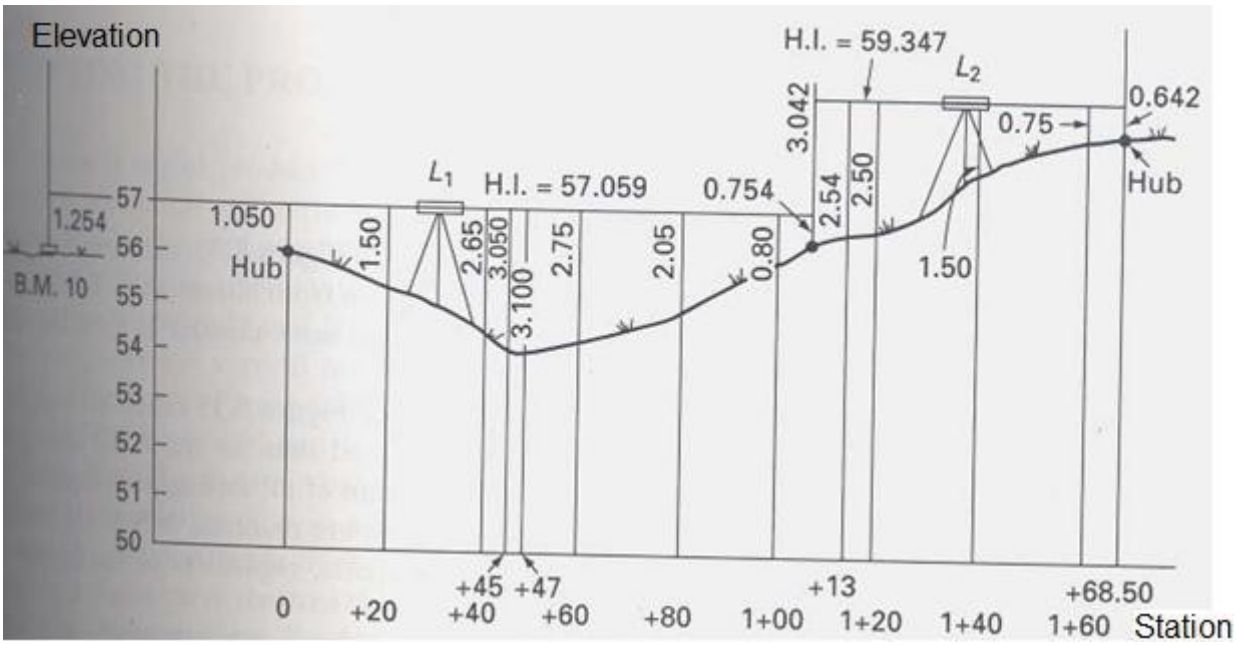
Levels are taken at right angles to the proposed Direction of the road end at suitable distances and leveling is carried out along this cross section. Cross section are the sections run at right Angles to the centerline and on the either side of it for the purpose They are taken at each 10,m station on the centerline. The length of Cross section depends upon the nature of the work if cross sections are Short they are set square out by edge. If long they are set out by the Optical square, box sextant or theodolite.
They are serially numbered from the beginning of the Centerline and are taken simultaneously with the longitudinal section they may be taken at the hand level, level, abney level or theodolite

PROCEDURE:

Let ABC be the line of section set out on the ground and marked with pegs driven at equal interval (say 20m to 30m) as in the figure. The level is set up generally on one side of the profile to avoid too short sight on the points near the instrument and care is taken to set up the level approximately midway between two change points. The leveling is strated from the bench mark of known value. From each set up staff reading are taken on pegs already fixed at the desired interval and also at

significant points where abrout changes of slope etc. occur. All these readings are recorded as intermediate slight against the respective chainages along the line in the level book. Other data of the level book is also filled up before starting the work. When the length of sight is beyond the power of the telescope (usually it is 100m) ,the foresight on the change point is taken. The level is then is then shifted and setup in an advanced position and a back sight is taken on the change point. The change point may or may not lie in the line of section. Chaining and reading are then continued as before,till the whole line of section is completed.
The work is to be checked in the progress of leveling by taking reading on other bench marks, on the way or on bench marks fixed by differential leveling.
The fore and back bearing of the section line should betaken and recorded. Next sketches of the bench mark, change points, and other feature such as nallah, a road, canal, etc. crossing the section line be drawn and fully described in the remarks column of the level-book.The procedure and corresponding reading and values are represented on the page of a level-book for a part of road project.





LEVEL BOOK

When ever leveling operation is carried out the staff reading taken in the field are entered in the note book called a Level-Book. Each page of it has the following columns which help in booking of reading and reduction of levels.

Page of Level-Book

Page of Level-Book										
Name of work survey for:-									Page no	
Levelling from_____To_____										
Instrument No----------				Conducted by:-						
Station	Distance In meters	Bearings		Staff Reading			Height of Instrument		RL	Remarks
		fore	back	BS	IS	FS	Rise	Fall		

EXPERIMENT NO-18

AIM OF THE EXPERIMENT : Counter plan of given area (On full size drawing sheet)

APPARATUS REQUIRED: Dumpy level, prismatic compass, chain 20m, 30m, metallic Tape, ranging road Leveling staff, pegs line.

THEORY:

CONTOURING: The elevation and depression the undulations of the surface of the ground are shown as map by interaction of level surface with by means of contour line. a contour may be defined as the line of intersection of a level surface with the surface of the ground.

Characteristics of Counter Lines

The following are the Characteristics of the contours/ contour lines.

1) All points on the same contour line will have the same elevation.

2) Contour lines close together represent steep ground, while uniform slope is indicated when they are uniformly spaced. A series of straight, parallel and equally spaced contours show a plane or flat surface.

3) Contour lines of different elevation cannot merge or cross one another on the map, expect in the case of an overhanging cliff. A vertical cliff is indicated when several contours coincide

4) A contour line must close upon itself either within or without the limits of the map.

5) Series of closed contour lines on the map either represent a hill or a depression according as the higher or lower values are inside them

6) A contour will not stop in the middle of the plan. It will either close or go out of the plan.

7) Ridge or water shad and valley lines are the lines joining the top most or the bottom most points of hill and valley respectively, cross the contours at right

angles. A ridge line is shown when the higher values are inside the loop, while in the case of a valley line, the lower values are inside the loop
8) Contour lines are not drawn across the water in the stream or river because the water level in the it is not constant; but contours are drawn along the bed of a river or a stream.
Uses of contour map
1) For preparing contour map in order to select the most economical or a suitable site.
2) For getting the importance about ground whether it is undulating or Mountainous

3) To locate the alignment of canal so that it should follow a ridge line, thus canal construction will be economical and will command maximum irrigated area.

4) To make the alignment for the road, railway so that the quantity of earthwork both in cutting and filling should be minimum.

5) To find out the capacity of the reservoir or a volume of earthwork especially in the Mountainous region.

6) For preparing contour map in order to select the most economical or suitable site.

7) As its definition itself indicates the line joining the points of same elevation that Means it naturally prefers the condition of nature of ground itself.

8) It is also used for irrigation purpose as from it capacity of reservoir is shown.

LOCATING CONTOURS:

By cross-section method:

This method is commonly used in rough survey, cross sections are run traverse to the contour line of road, and railway as canal and the point of change of slope (representations) are located. The cross-section line may be inclined at any angle to the centerline if necessary. The spacing of the cross sections depends upon the characteristics of the ground.

By interpolation of contour is meant the process of spacing the contour

proportioning between the plotted ground points. Contour may be interpolated by

1) Estimation
2) Arithmetical calculations
3) Graphical method .in all these methods

It is assumed that the slope of the ground between any two random points is uniform.

RESULT: The contour of given land is drawn in the sheet.