Department of

Civil Engineering

LAB MANUAL

Surveying-1 Lab

B.Tech– 3rd Semester

KCT College OF ENGG AND TECH.
VILLAGE FATEHGARH
DISTT.SANGRUR

Sr. No.	EXPERIMENT LIST FOR SURVEYING LAB (CE:215 E)	Remarks
1	TO PLOT A TRAVERSE OF A GIVEN AREA BY CHAIN SURVEYING & ALSO LOCATE OFFSETS	
2	TO PLOT A TRAVERSE OF A GIVEN AREA WITH THE HELP OF A COMPASS AND A CHAIN.	
3	TO WORK OUT RELATIVE ELEVATIONS OF VARIOUS POINTS ON THE GROUNDS BY PERFORMING PROFILE OR BY FLY LEVELING.	
4	TO PLOT A LONGITUDINAL SECTION AND CROSS SECTION OF GIVEN ALIGNMENT.	
5	TO DETERMINE THE DIFFERENCE IN ELEVATIONS OF TWO POINTS BY RECIPROCAL LEVELING.	
6	TO PLOT A CONTOUR MAP OF GIVEN AREA.	
7	TO DETERMINE THE POSITION OF STATION OCCUPIED BY PLANE TABLE USING THREE POINT PROBLEM.	
8	TO DETERMINE THE POSITION OF STATION OCCUPIED BY PLANE TABLE USING TWO POINT PROBLEM.	
9	USE OF A TANGENT CLINOMETER WITH PLANE TABLE.	

Experiment No. 1

Object: - To plot a traverse of a given area by chain surveying & also locate offsets

Theory: - A traverse of a given area can be plotted with the help of chain surveying.

Surveying: - The art in which the relative positions of distinctive features on above or beneath the surface of earth are determined by means of direct or indirect measurements of distances, directions and elevations is termed as surveying.

Principles of surveying: **-** The different methods of surveying are based upon the following two fundamental principles.

- Working from the whole to the part.
- Location of a point by measurements from two control points.

The Principle of chain surveying: - To provide a skeleton or framework consisting of a number of connected triangles.

Offsets: - In chain surveying, the positions of details i.e. boundaries, culverts, roads, river bends etc. are located w.r.t the chain line by measuring their distances right or left of the chain line. Such lateral measurements are called offsets.

Apparatus: - Metric chain, arrows, measuring tape, ranging rods and plumb bob.

Procedure: - All Survey stations are marked according to the area to be surveyed. Wooden pegs or nails of spikes are driven in the round. Ranging rods are fixed on the stations. The verticalness of the ranging rod is checked by using a plumb bob. The ranging is one between the end stations. A chain is stretched in true alignment keeping one end of the chain at the starting station. An arrow is fixed at the other end on the chain while it is kept lying on the ground. Offsets are taken at appropriate distance from the chain line using suitable land marks and measuring tape. Chainages and offsets are recorded in the field book. Process of chaining and offsetting is repeated until the end of the base line is reached. Entire area is surveyed by measuring other lines also

Precautions:

1) Check the verticalness of ranging rod with the help of a plumb bob

2) Ranging of rods should be proper i.e. all the ranging rods between two stations should be in one line with each other.

3) The chain should be properly examined to see if there is any error or defect in it and if so, preventive measures should be taken.

Results and discussion:-

Result of chain surveying is the plan or map of that area. Surveying is the first step for the execution of any project. The data collected from survey is used for the preparation of the plan or map of the area. Chain surveying is used in the projects like dams, roads and construction.

Experiment No. 2

Object: - To plot a traverse of a given area with the help of a Compass and a chain.

Theory: -Compass Surveying is that branch of surveying in which the directions of survey lines are determined by a compass and their length by chaining directly on the ground.

Bearing: The horizontal angle between the reference meridian and the survey line is called bearing. There are two types of compass used in the compass surveying:

I.**Surveyor's Compass**: This type of compass consists of a circular box of about 100mm diameter. (see fig. 1) It has a graduated ring attached to circular box. The magnetic needle moves freely on the pivot. The ends of the compass needle are made pointed for taking the reading correctly. There is a simple metal vane with the fine hole used as eye vane. The object vane carries a vertical hair attached to the suitable frame. The circular ring is graduated in quadrantal system. The object is to be sighted first with the object and eye vanes and the reading is then taken against the North end of the needle, by looking through the top glass vertically.

II.**The Prismatic Compass**: This type of compass consists of same arrangement as in case of surveyor's compass except that a triangular prism is fitted below the eye slit. The magnetic needle is attached to the circular ring. (see Fig. 2) Reading is taken in whole circle bearing system.

Apparatus: -Surveyor's compass or prismatic compass, chain (30m), arrows (5 in number), plumb bob, ranging rods and tripod stand.

Procedure: - Initially survey stations are fixed. Compass is kept on a tripod and is kept over one of the station (say station A). Some temporary adjustment such as centering, leveling and focusing are

performed on the compass. Centering is a process of marking the pivot exactly over the ground station mark. It is done by hanging plumb bob from the pivot and centering it over station. After performing the adjustment, bring the object vane in line with the eye vane

and then readings are taken against the North end of the needle or according to the compass available. Take fore bearings as well as back bearing. Measure the distance between two stations with the help of chain as done in chain surveying. Take all the readings of different stations and lines by repeating the same procedure.

Precautions:

1) There should not be any metallic material in the vicinity of the compass to prevent local attraction.
2) The chain should not be pulled more than the standard pull.
3) Adjustments of the compass i.e. centering, leveling and focusing of the prism should be done carefully.
4) Bubble should be in center before taking reading.

Result: Final traverse is to be plotted with bearings as well as lengths between the stations. Method of chain surveying is useful when the area to be surveyed is small, more or less leveled and has less obstruction in chain chaining. But when the area to be surveyed is large, then it is not possible to do the survey work by chain survey only. In such circumstances, angle measuring instruments are also used for measuring the angle between the chain lines at survey stations.

Experiment No. 3

Object: - To work out relative elevations of various points on the grounds by performing profile or by fly leveling.

Theory:-The art of determining the relative altitude on points on the surface of earth or beneath the surface of earth is called leveling. Levels used may be of many types.

1) Dumpy Level: The dumpy level consists of telescope rigidly fixed to its support. It can be neither rotated along its axis nor can it be removed from its supports.
2) Tilting Level: In this level small tilt can be given to help in quick leveling. This instrument is firstly leveled roughly and while taking the sight to a staff, the line of sight is made truly horizontal

by centering the bubble by means of fine pitched tilting screw which tilts the telescope w.r.t the vertical axis.

Apparatus: - Dumpy or tilting level, folding staff, tape, ranging rods, tripod stand and arrows.

Procedure: -Initially temporary adjustment such as setting up the level, leveling up and elimination of parallax is performed. Parallax can be removed either by focusing the eye piece or focusing the objective. Instrument is leveled with the help of foot screws. Direct the telescope towards the object (staff). Focus it carefully to obtain clear graduations. Take the readings of central horizontal hair of diaphragm where it appears to cut the staff ensuring that bubble is horizontal. By this method first Bench mark (B.M) is noted down. Bench mark is point with known elevation. Now staff is shifted to next point at a regular interval in case of profile leveling. In case of fly leveling staff can be fixed anywhere. Direct the telescope, focus the point, check the bubble and note down the reading. Repeat the above procedure till we reach the other end of line or required station. Back sight is the first ever sight taken ion the leveling staff held at known elevation for any setting on the instrument. The last sight taken on the leveling staff held at point on unknown elevation for any setting of the instrument is known as foresight. Any sight taken in between back sight and fore sight with any setting of instrument is known as intermediate sight. Note all the readings as BS, FS or IS w.r.t to setting of instruments.

Precaution

- In case of Dumpy level, it is to be fixed at a point from where it can take make maximum readings.
- Instrument should be leveled properly.
- Bubble should be in center before taking reading.
- Staff should be held vertically.

Applications: - Leveling has wide application in the field. It is used to measure the vertical distance between two points or to mark another point from datum point. Leveling is very much used in Road Canal, Dam and other construction works.

Results: - Result may be a profile level graph between two points or a difference in level between two points or elevation of known point.

Observation Table and Calculations:

Readings are to be noted down in field book in the table.

Station	B.S	I.S	F.S	Rise	Fall	R.L	Remarks

A							
B							
C							
Check							

Rise/Fall= F.S / I.S-B.S= F.S -.I.S

RL of a station= BM/RL of Previous station ± Rise/Fall

Arithmetic check

ΣB.S - ΣF.S = Σ Rise- Σ Fall = Last R.L - First R.L

If the above check is verified then the calculations are correct

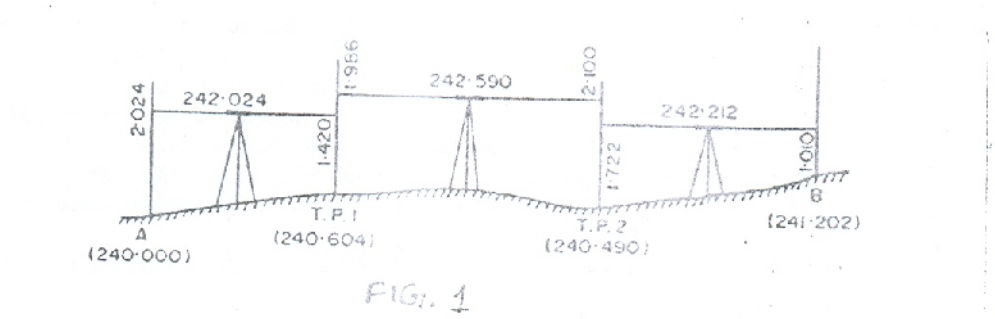


FIG. 1

Experiment No. 4

Object: To plot a longitudinal section and cross section of given alignment.

Apparatus: - Dumpy level, staff, Tape.

Theory: - Profile leveling is the process of determining the elevations of points at short measured intervals along a fixed line such as the center line of railway, highway, canal or sewer.

Cross sections are run at right angle to the longitudinal profile and on either side of it for the purpose of lateral outline of the ground surface.

Procedure:

1. Set up the level to one side of profile line.

2. Mark points A, B, C……. at every 20m along the profile line.
3. Mark the cross section points A1, A2….., B1,B2……,C1,C2….respectively on both sides at 5m interval.
4. Take back sight on the bench mark and along the profile line take FS\IS at A,B,C…. and also at cross section points A1, A2…., B1,B2….,C1,C2….

Precaution:

- In case of Dumpy level, it is to be fixed at a point from where it can take maximum readings.
- Instrument should be leveled properly.
- Bubble should be in center before taking reading.
- Staff should be held vertically.

Applications:

Profile leveling and cross sectioning can be used for providing the data for estimating quantities for cut and fill as well as or some other purposes.

Results: - Result may be a profile and cross section graph of an alignment.

Observation Table and Calculations:

Readings are to be noted down in field book in the table:

Table for longitudinal section (Profile)

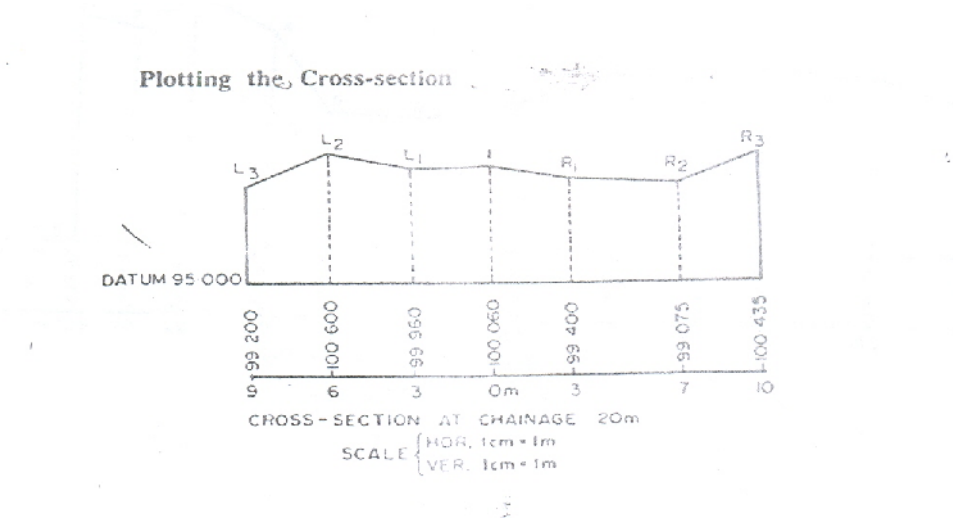
Station	B.S	I.S	F.S	Rise	Fall	R.L	Remarks
A							
B							
C							

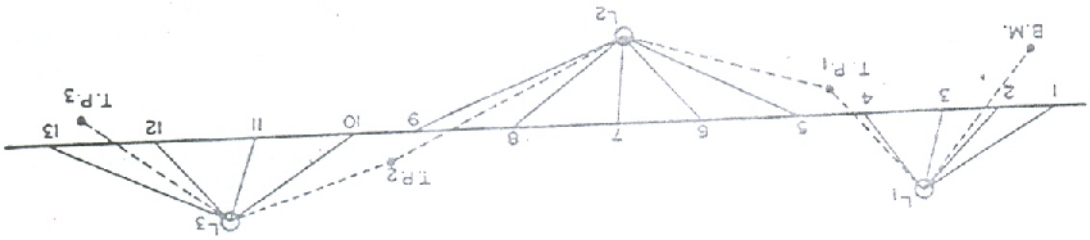
Table for cross section at A

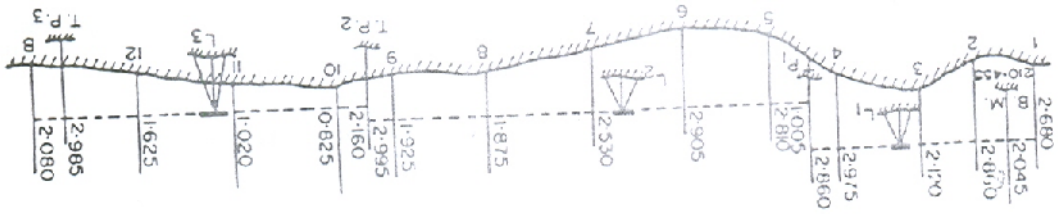
Station	B.S	I.S	F.S	Rise	Fall	R.L	Remarks
A1							
A2							
A3							

Rise/Fall = F.S / I.S. – B.S. = F.S. – I.S.

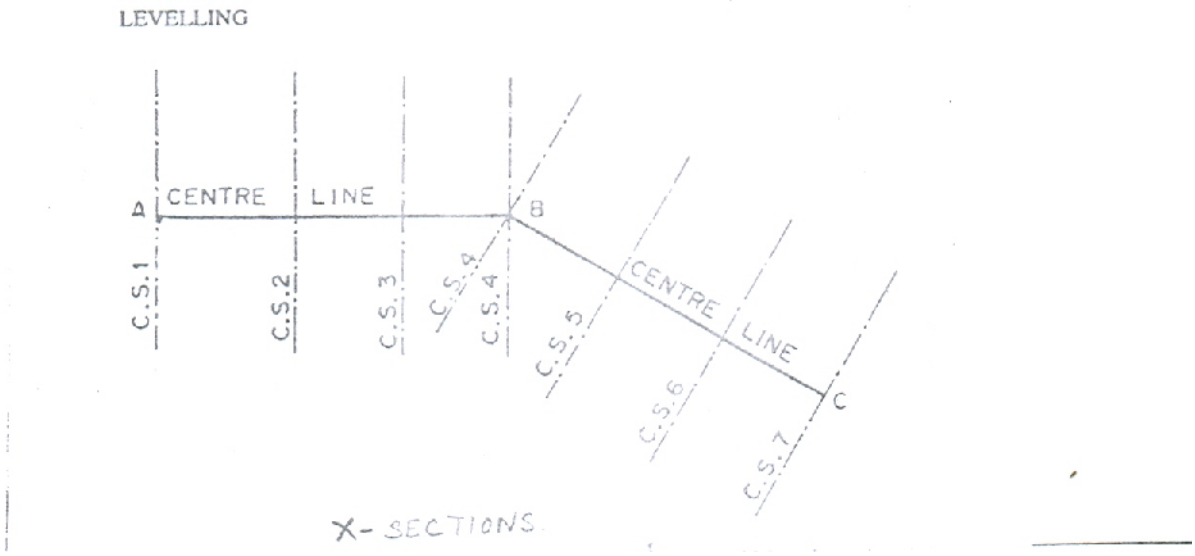
RL of a station = BM/RL of previous station ± Rise/ Fall







PROFILE LEVELLING.



Experiment No. 5

Object: To determine the difference in elevations of two points by Reciprocal Leveling.

Apparatus: Tilting Level, Staff etc.

Theory:-When it is necessary to carry leveling across a river, ravine or any obstacle requiring a long sight between two points so situated that no place for the level can be found from which the lengths of

foresight and backsight will be even approximately equal, special method i.e. reciprocal leveling must be used to obtain accuracy and to eliminate the following:

(1) error in instrument adjustment

(2) combined effect of earth's curvature and the refraction of the atmosphere, and

(3) variations in the average refraction

Procedure:-Let A and B be the two points and observations be made with a level, the line of sight of which is inclined upwards when the bubble is in the centre of its run. The level is set at a point near A and the staff readings are taken on A and B with the bubble in the centre of its run. Since B.M. 'A' is very near to instrument, no error due to curvature, refraction and collimation will be introduced in the staff readings at A but there will be an error 'e' in the staff reading on B. The level is then shifted to the other bank, on a point very near B.M. B, and the readings are taken on the staff held at B and A. Since B is very near, there will be no error due to the three factors in reading the staff, but the staff reading on A will have an error 'e'. Let h_a and h_b be the corresponding staff readings on A and B for the first set of the level and h_a' and h_b' be the readings for the second set

Precautions:

1. Instrument should be near the staff as possible

Temporary adjustment should be carried out such there is no movement of bubble for one complete rotation of the telescope.

Calculations:

From Fig.1, it is evident that for the first of the level, the correct staff readings will be

on A : h_a

on B : $h_b - e$

Therefore true difference in elevation = $H = h_a - (h_b - e)$

Similarly for the second set, the correct staff readings will be:

on A : $h_a' - e$

on B : h_b'

Therefore true difference in elevation = $H = (h_a' - e) - h_b'$

Taking the average of the two differences in elevations,

We get

$2H = [h_a - (h_b - e) + (h_a' - e) - h_b']$

$= (h_a - h_b) + (h_a' - h_b')$

Therefore $H = ½ [(h_a - h_b) + (h_a' + h_b')]$

The true difference in elevation, therefore, is equal to the mean of the two apparent differences in elevations, obtained by reciprocal observations.

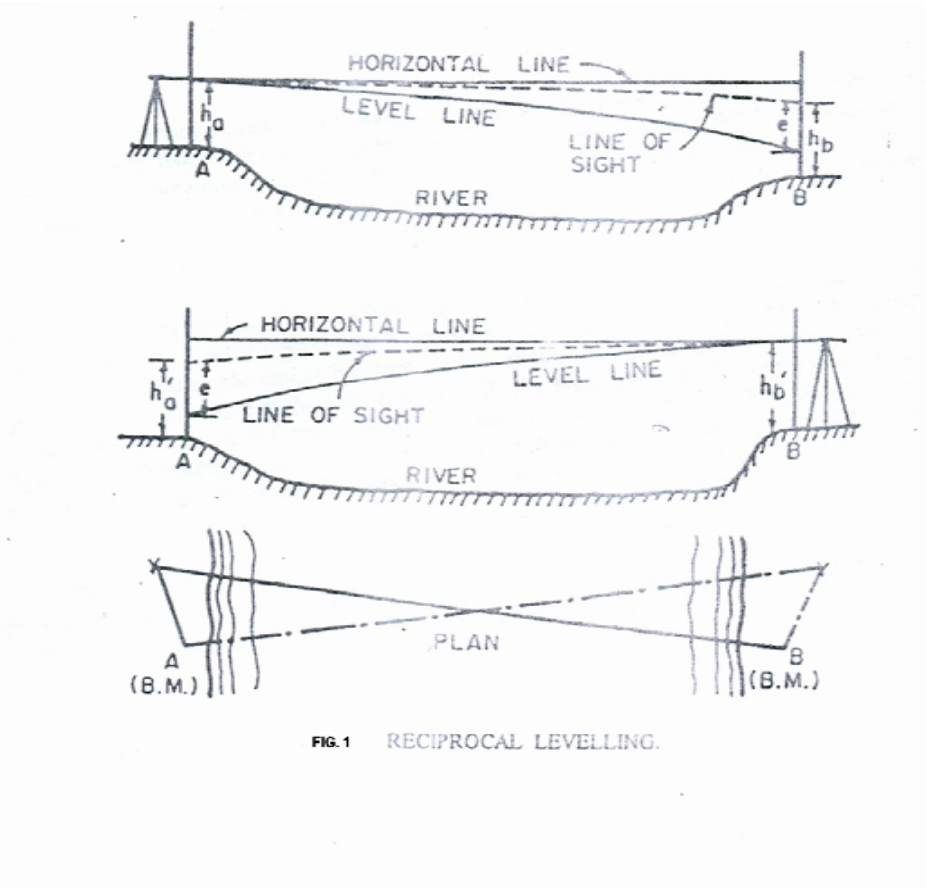


FIG. 1 RECIPROCAL LEVELLING.

Experiment No. 6

Object: To plot a contour map of given area.

Apparatus: Dumpy Level, Staff, and tape.

Theory: Contour is an imaginary line in the ground joining the points of equal elevations. Contour may be drawn by the direct and indirect method. Generally indirect methods have been used for contouring. In these methods some guide points are selected and surveyed. These guide points have been plotted on the map, which serves as basis for interpolation.

By square method: In this method the area to be surveyed is divided into a number of squares of size 5 to 20 meters depending upon the nature of contour and contour interval. The elevations are determined by staff and level and contours may be plotted by interpolation. Interpolation has been done by estimation assuming that the slope of ground between the points is uniform.

Procedure:

1. Mark a square area of size 20 m X 20 m (approximate) with the tape and divide it into squares of 1m X 1m and fix arrows at every corner of small squares.
2. Locate the position of end corners of big square on the sheet by plane tabling.
3. With the help of dumpy level and staff find the elevation of all the points marked previously.
4. Write the spot elevations of respective points on the sheet.
5. Using method of estimation draw contours at appropriate intervals.

Precautions:

- In case of dumpy level, it is to be fixed at a point from where it can take maximum readings.
- Instrument should be leveled properly.
- Bubble should be in centre before taking reading.
- Staff should be held vertical.
-
- **Applications:** Contour maps have many uses; some of them may be to find the capacity of a reservoir, to get the alignment of a road, to find the cut and fill volume etc.
- **Results:** Result may be a contour map of a given area.
- **Observation Table and Calculations:**
- Readings are to be noted down in field book in the table.

Station	B.S.	I.S.	F.S.	Rise	Fall	R.L.	Remarks
A							
B							
C							
Check							

-
- Rise/Fall = F.S. / I.S. – B.S. = F.S. – I.S.
- RL of a station = BM/RL of previous station ± Rise/Fall

Exp-7

Object: To determine the position of station occupied by plane table using three point problem.

Apparatus: Plane table, drawing sheet, pins, pencil, pegs, ranging rods, etc.

Theory: Location of the position, on the plan, of the station occupied by the plane table by means of observations to three well defined points whose positions have been previously plotted on the plan. In other words, it is required to orient the table at the station with respect to three visible points already located on the plan. Let P be the instrument station and A, B, C be the points which are located as a, b, c respectively on the plan. The table is said to be correctly oriented at P when the three resectors through a, b and c meet at a point and not in a triangle. The intersection of the three resectors in a point gives the location of the instrument station. Thus, in three point problem, orientation and resection are accomplished in the same operation. The following are some of the important methods available for the solution of the problem:-

a) Mechanical Method (Tracing Paper method)
b) Graphical Method
c) Lehmann's Method (Trial and Error method)

Procedure: - Let A, B, C be the known points and a, b, c be their plotted positions. Let P be the position of the instrument station to be located on the map.

1) Set the table on P. Orient the table approximately with eye so that ab is parallel to AB.
2) Fix a tracing paper on the sheet and mark on it 'P' as the approximate location of P with the help of plumbing fork.
3) Pivoting the alidade at 'P', sight A, B, C in turn and draw the corresponding lines P'a', P'b' and P'c' on the tracing paper. These lines will not pass through a, b and c as the orientation is approximate.
4) Loose the tracing paper and rotate it on the drawing paper in such a way that the lines P'a', P'b' and P'c' pass through a, b and c respectively. Transfer 'P' on to the sheet and represent it as P. Remove the tracing paper and join pa, pb and pc.
5) Keep the alidade on pa. The line of sight will not pass through A as the orientation, has not yet been corrected. To correct the orientation, loose the clamp and rotate the plane table so that the line of sight passes through A. Clamp the table. The table is thus oriented.
6) To test the orientation, keep the alidade along Pb. If the orientation is correct, the line of sight will pass through B. Similarly, the line of sight will pass through C when the alidade is kept on pc.

Precautions: -

- Fix the table in such a way that orientation does not change while working.
- Table should be properly balanced.

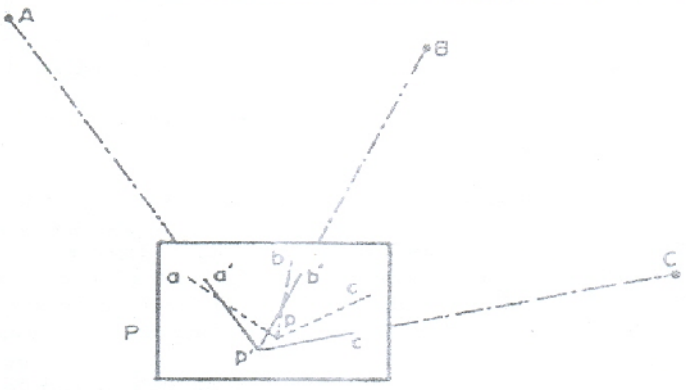
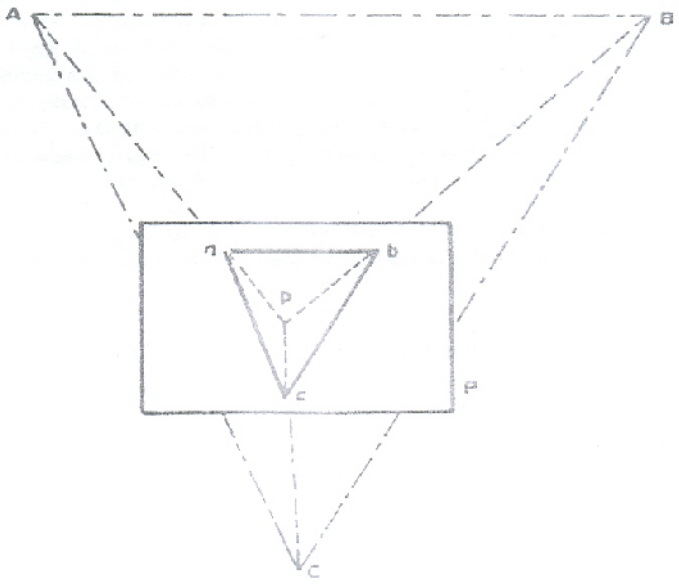


FIG. 1 TRACING PAPER METHOD

PLANE TABLE SURVEYING



- CONDITION OF CORRECT ORIENTATION

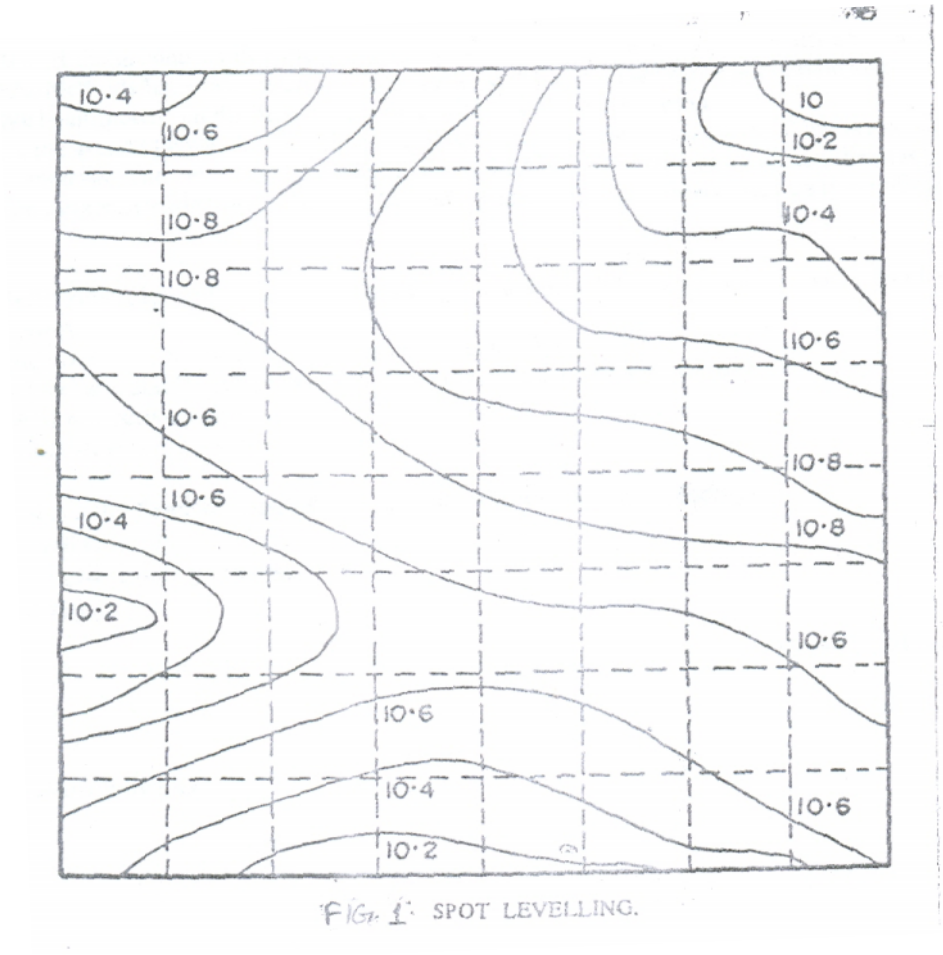


FIG. 1. SPOT LEVELLING.

Experiment No. 8

Object: - To determine the position of station occupied by plane table using two point problem.

Apparatus: - Plane table, drawing sheet, pins, pencil, pegs, ranging rods, etc.

Theory: - Location of the position on the plan of the station occupied by the plane table by means of observation to two well defined points whose positions have been previously plotted on the plan. Let us take two points A and B, the plotted positions of which are known, Let C be the point to be plotted. The whole problem is to orient the table at C.

Procedure: -

1) Choose an auxiliary point D near C, to assist the orientation at C. Set the table at D in such a way that ab is approximately parallel to AB (either by compass or by eye judgement). Clamp the table.
2) Keep the alidade at 'a' and sight A. Draw the resectors. Similarly, draw a resector from 'b' and sight B to intersect the previous at d. the position of d is thus got, the degree of accuracy of which depends upon the approximation that has been made in keeping ab parallel to AB. Transfer the point d on the ground and drive a peg.
3) Keep the alidade at d and sight C. Draw the ray. Mark a point c1 on the ray by estimation to represent the distance DC.
4) Shift the table to C, orient it (tentatively) by taking backsight to D and centre it with reference to c1. The orientation is, thus, the same as it was at D.
5) Keep the alidade pivoted at 'a' and sight at A. Draw the ray to intersect with the previously drawn ray from D in c. Thus, c is the point representing the station C, with reference to the approximate orientation made at D.
6) Pivoting the alidade about c, sight B. Draw the ray to intersect with the ray drawn from D to B in b'. Thus b' is the approximate representation of B with respect to the orientation made at D.
7) The angle between ab and ab' is the error in orientation and must be corrected for. In order that ab and ab' may coincide (or may become parallel) keep a pole P in line with ab' and at a great distance. Keeping the alidade along ab, rotate the table till P is bisected. Clamp the table. The table is thus correctly oriented.
8) After having oriented the table as above, draw a resectors from a to A and from b to B, the intersection of which will give the position C occupied by the table.

Result and discussion:

It is to be noted here that unless the point P is chosen infinitely distant, ab and ab' can not be made parallel. Since the distance of P from C is limited due to other considerations, two point problem does not give much accurate results. At the same time, more labour is involved because the table is also to be set on one more station to assist the orientation.

Result of this experiment is the location of position of station occupied by the Plane table on the previously plotted plan of the area under survey.

Precautions:-

1. Fix the table in such a way that orientation does nut change while working.
2. Table should be properly balanced.

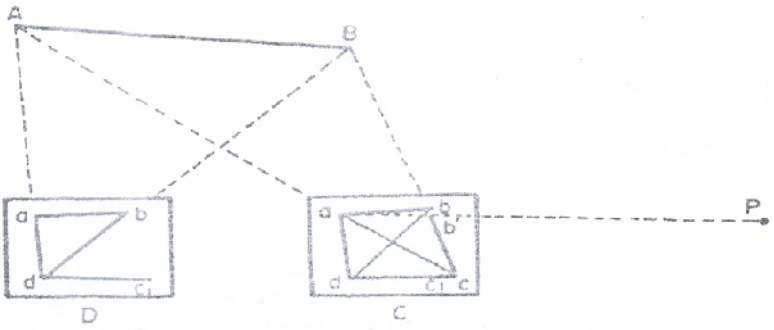


FIG.1 TWO POINT PROBLEM

Experiment No.9

Object: - Use of a tangent clinometer with plane table.

Apparatus: - Tangent clinometer, plane table, drawing sheet, drawing pins and ranging rod.

Theory: - Indian pattern clinometer is used for determining difference in elevation between points and is specially adapted to plane tabling. The clinometer is placed on the plane table which is leveled by estimation. The clinometer consists of the following:

(1) A base plate carrying a small bubble tube and a leveling screw. Thus the clinometer can be accurately leveled.

(2) The eye vane carrying a peep hole. The eye vane is hinged at its lower end to the base plate.

(3) The object vane having graduations in degrees at one side and tangent of the angles to the other side of the central opening. The object vane is also hinged at its lower end to the base plate. A slide provided with a small window and horizontal wire in its middle, can be moved up and down the object vane by a rack and pinion fitted with a milled head. The line of sight is defined by line joining the peep hole and the horizontal wire of the slide.

When the instrument is not in use, the vanes fold down over the base.

Procedure:-

(1) Set the plane table over the station and keep the Indian pattern clinometer on it.

(2) Level the clinometer with the help of the leveling screw.

(3) Looking through the peep hole, move the slide of the object vane till it bisects the signal at the other point to be sighted. It is preferable to use a signal of the same height as that of the peep hole above the level of the Plane table station.

(4) Note the reading. i.e tangent of the angle, against the wire. Thus the difference in elevation between the eye and the object= distance x tangent of vertical angle = d tan α.

The distance d between the plane table station and the object can be found from the plan. The reduced level of the object can thus be calculated if the reduced level of the plane table station is known.

Precaution: - When the instrument is not in use, the vanes fold down over the base.

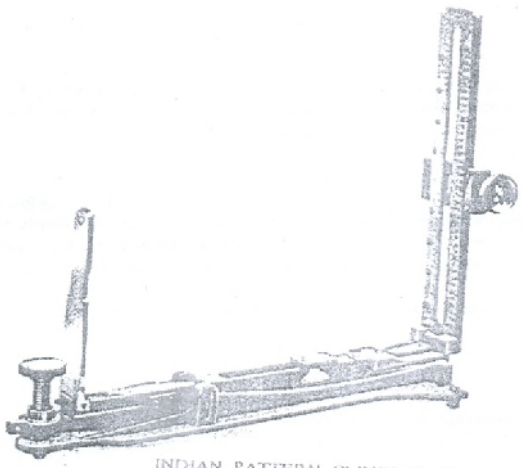
Observations: - d = ……

tan α = ……

Calculations:-

Difference in elevation between the eye and the object = d tan α

R.L of object = R.L of table station ± d tan α



INDIAN PATTERN CLINOMETER.

1. BASE PLATE
2. LEVELLING SCREW
3. BUBBLE TUBE
4. EYE VANE
5. OBJECT VANE
6. MILLED HEAD
7. RACK
8. SLIDE