

**SECOND SEMESTER DIPLOMA EXAMINATION IN CIVIL
ENGINEERING — MARCH, 2016**

SURVEYING - I

[Time : 3 hours

(Maximum marks : 100)

PART — A

(Maximum marks : 10)

Marks

- I Answer the following questions in one or two sentences. Each question carries 2 marks.
1. Define the term surveying.
 2. Distinguish magnetic dip and declination.
 3. List the various types of bench marks.
 4. Define the term line of collimation.
 5. List any two uses of contour map.

(5×2=10)

PART — B

(Maximum marks : 30)

- II Answer *any five* of the following questions. Each question carries 6 marks.
1. Distinguish the terms:
 - (a) Base line
 - (b) Check line
 - (c) Tie line
 2. With the aid of a neat sketch, explain the method of radiation in plane table surveying.
 3. Explain briefly about local attraction.
 4. List the important axes of dumpy level and the relationship between them.
 5. Determine the elevation of the given points with respect to the given bench mark by height of collimation method. The staff readings are 1.850, 1.650, 1.020, 2.850 and 3.010. The first reading was taken on a bench mark of reduced level 58.550m. Apply arithmetic check.
 6. Differentiate the terms :
 - (a) Contour
 - (b) Contour interval
 - (c) Horizontal equivalent.
 7. List the characteristics of contour lines.

(5×6=30)

(Maximum marks : 60)
 (Answer one full question from each unit. Each full question carries 15 marks.)

UNIT — I

- III (a) List the accessories used in plane table surveying and their uses.
 (b) List the factors to be considered while selecting the survey stations.

OR

- IV (a) Describe with the aid of a neat sketch the intersection method of plane table surveying.
 (b) Explain the method of setting out right angle from a survey line using cross staff.

UNIT — II

- V (a) Calculate the included angles from the given whole circle bearings.

Line	Whole circle bearing
AB	218° 00'
BC	155° 30'
CD	75° 30'
DE	350° 00'
EF	320° 00'
FG	281° 00'
GH	160° 00'

- (b) Define the term meridian and describe the different types of meridians.

OR

- VI (a) The fore bearings and back bearings of a closed traverse are given below. Check the bearings for local attraction and find the corrected bearings.

Line	Fore bearing	Back bearing
AB	78° 30'	259° 30'
BC	350° 00'	171° 30'
CD	282° 30'	102° 30'
DE	242° 00'	60° 30'
EA	124° 00'	303° 00'

- (b) Differentiate between
 (i) WCB & RB
 (ii) True Bearing & Magnetic bearing

UNIT — III

- VII (a) The following staff readings were observed successively with a level, the instrument having been moved after the second, fifth and eighth readings. The first staff reading was taken with the staff held on a bench mark of reduced level +50.000. Enter the readings in the level field book form and find the reduced levels of all the points by Rise and Fall method and apply the check. Readings : 0.875, 1.520, 0.685, 2.675, 2.215, 1.895, 3.285, 3.330, 3.585 and 2.775. 9
- (b) List and explain the functions of the parts of a dumpy level. 6

OR

- VIII (a) An observer standing on the deck of a ship just sees a light house. The top of the light house is 52m above the sea level and the height of the observer's eye is 7m above the sea level. Find the distance to the observer from the light house. 9
- (b) List the steps involved in temporary adjustments of a dumpy level and state the necessity. 6

UNIT — IV

- IX (a) Explain longitudinal sectioning and cross sectioning. 9
- (b) Explain different methods of contouring. 6

OR

- X (a) The area within the contour line at the site of reservoir and the face of the proposed dam are as follows :

Contour	Area (m ²)
101	1100
102	13200
103	96000
104	151000
105	853000
106	968000
107	1376000

- Taking 101 as the bottom level of the reservoir and 107 as the top level, calculate the capacity of the reservoir using Prismoidal rule. 9
- (b) What do you mean by permanent adjustment of a dumpy level and its necessity. 6

ANSWER KEY

TED(15)-2011

(Revision-2015)

SECOND SEMESTER DIPLOMA EXAMINATION IN CIVIL ENGINEERING

MARCH,2016

SRVEYING-I

(Maximum mark-100)

PART-A

I

1. Surveying is the art of determining relative positions of points on, above or beneath the surface of the by means of direct or indirect measurements of distance, direction and elevation.

2. Declination

It is the horizontal angle between true meridian and magnetic meridian

Magnetic dip

Earth's magnetic line makes angle with the surface of earth, this is called angle of dip.

3. TYPES OF BENCH MARK

- GTS benchmark
- Permanent benchmark
- Arbitrary benchmark
- Temporary benchmark

4. Line of collimation is a line which passes through the optical centre of the objective and the intersection of the cross hairs

5. Tracing contour gradient and location of route.

Measurement of drainage areas.

PART-B

II

1. (a) Base line

It is the line passing through the center of the area and the longest one. The biggest of the main survey line is called base line and the various station are plotted with reference to this.

(b) Check line/proof line

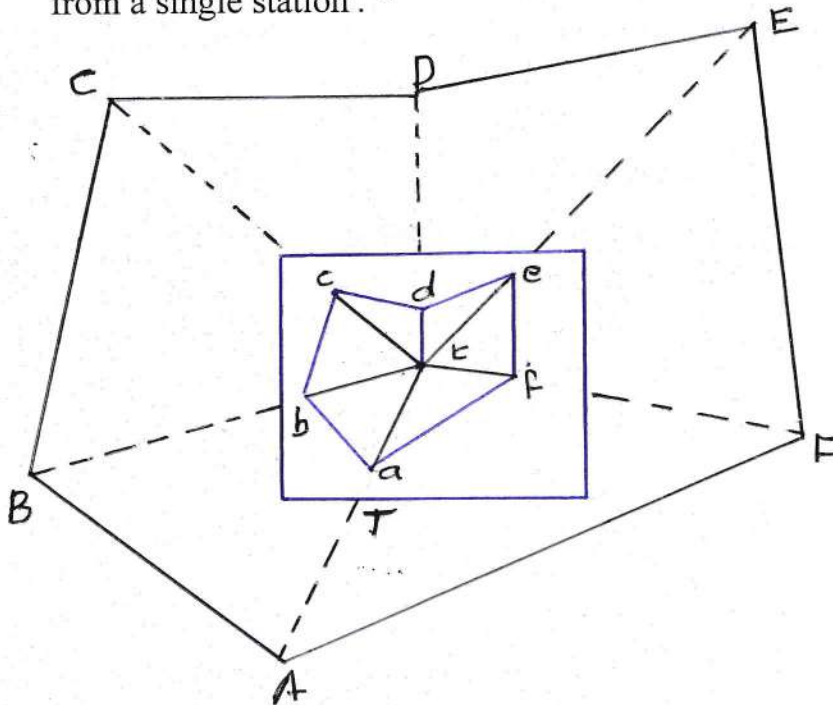
It is the line which is used to check the accuracy of the work. The length of the check line measured in the field must agree with its length on the plan.

(c) Tie line

It is a line which joins subsidiary or tie stations, which is provided to locate interior details like buildings, ponds etc. which are far away from main survey line.

2. RADIATION METHOD

This method is suitable for survey of small areas which can be commenced from a single station.



Procedure

- a) Set the table at 'O' and level it. Transfer the point on to the sheet by using U frame. Thus getting the point 'o' on the sheet tighten the table.
- b) Keep the alidade touching the point 'o' and sight to A. draw the ray along the fiducial edge of the alidade similarly sight different points B,C,D,E and draw the corresponding rays.
- c) Measure OA, OB,OC,OD.OE in the field. Their distance are plotted to suitable scale along the corresponding rays. Thus getting a,b,c,d,e on the sheet.

3..LOCAL ATTRACTION

The deviation of magnetic needle due to the presence of magnetic object in the near place of work is called local attraction.

The magnetic needle does not point to the magnetic north under the influence of external forces. The attractive forces may be steel structures,rail, electric pole ,iron ore etc. the observer should take care to see that he does not possess keys, iron buttons etc. The chain, arrows should be kept away while taking bearing.

To detect the presence of local attraction, it is necessary to observe the bearing of each line from both ends. If the difference between fore bearing and back bearing is 180° . There is no local attraction

4

- Vertical axis: It is the centre line of axis of notation of the level.
- Axis of level – tube: It is an imaginary line tangential to the longitudinal curve of the tube at its middle point. It is horizontal when the bubble is central.
- Axis of telescope: It is the line joining the optical centre of the object glass & the centre of eye piece.
- Line of collimation or line of sight: It is the line joining the intersection of cross hairs & optical centre of the object glass.
 - ✓ Axis of the level tube is perpendicular to the Vertical axis

- ✓ Horizontal cross hair should lie in a plane perpendicular to the Vertical axis, so that it will lie in a Horizontal plane when the instrument is properly leveled.
- ✓ The Line of sight is parallel to the axis of the level tube.

5

stn	B.S	I.S	F.S	H.C	R.L	remark
A	1.85			60.400	58.550	B.M
B		1.650			58.750	
C		1.020			59.380	
D		2.850			57.55	
		3.010			57.39	

Check

$$\sum B.S - \sum F.S = \text{Last R.L} - \text{First R.L}$$

$$1.85 - 3.010 = 57.39 - 58.55$$

$$-1.16 = -1.16$$

6.(a) Contour

It is an imaginary line joining the points of same elevation or reduced level on the ground

(b) Contour interval

The vertical distance between two consecutive contours are called contour interval. It remains constant throughout the survey.

(c) Horizontal equivalent

The horizontal distance between two contours is called horizontal equivalent. It depends

7. Characteristics of contour

- ✓ Two contour lines of different elevations cannot cross each other.
- ✓ Contour lines of different elevations can intersect only in the case of overhanging cliff or cave.
- ✓ Contour lines close together indicate steep slope:-
 - Contour lines are far apart – Gentle slope
 - Contour lines are equally spaced – Uniform slope
 - A series of straight, parallel and equally spaced contour lines – Plane surface.
- ✓ A closed contour line with one or more higher ones inside represent a hill
- ✓ A closed contour line with one or more lower ones inside it indicates a depression without an outlet.
- ✓ The same contour appears on either side of a ridge or valley.
- ✓ Two contour lines having the same elevation cannot unite and continue as one line.
- ✓ A single contour cannot split into two contours.
- ✓ Contour lines of different elevations can unite to form one line only in the case of a vertical cliff.
- ✓ Contour lines cross a watershed or ridge line at right angles. They form U shape round
- ✓ Contour lines cross a valley line at right angles. They form sharp curves V shape.

PART-C

UNIT-I

III

(a) ACCESSORIES USED IN PLANE TABLE SURVEYING

✓ Plane table with tripod

- It consists of a small drawing board of size 40cmX30cm, 75cmX60cm mounted on a tripod. In such a way that the board can be rotated about the vertical axis and can be clamped in position. Drawing paper is fixed on this table.

✓ Plumbing fork (u frame with plumb bob)

- It is a U shaped metal frame having arms of equal length with a plumb bob at the lower arm it is used for centering the table over the station point.

✓ Alidade

It is used to sight objects and draw the lines. It is of two types.

a) Plane alidade

It consists of metal or wooden rule with two vanes at the ends. One of the vanes consists of an arrow slit and it is known as sight vane. The other vane carries horse hair and it is known as object vane. One edge of the alidade is beveled for working. This edge is known as fiducial edge and it is also graduated to facilitate the plotting of distance to a scale. It is not used in hilly area.

b) Telescopic alidade

It is used when it is to take inclined sight. Telescope is used to sight the object and it is supported on a rule. It is useful for slopping ground.

✓ Trough compass

- It is used for marking the north on the sheet. It consists of a magnetic needle fixed on a pivot. It is enclosed in a box.

✓ Spirit level

It is used to level the table. The table is leveled by placing the spirit level on the board in two positions at right angle and getting the bubble central in both the positions.

(b) Factors should be considered in deciding the survey stations

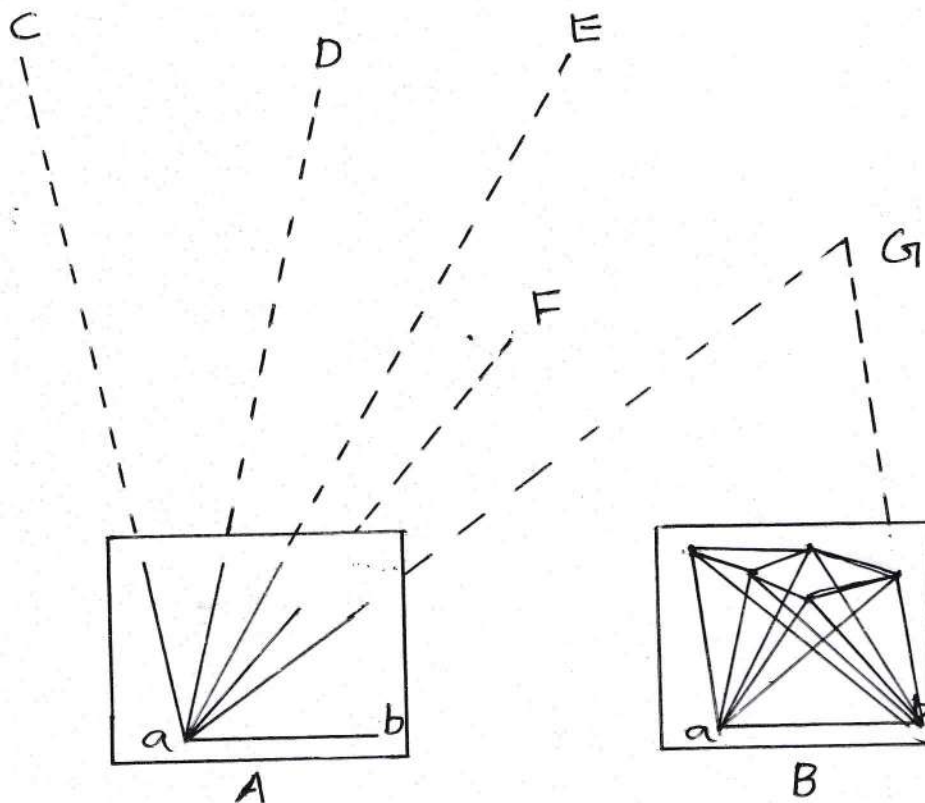
- ✓ Survey stations must be mutually intervisible
- ✓ Number of survey lines should be kept minimum.
- ✓ The main lines should form well conditioned triangle
- ✓ As far as possible the main survey lines should not pass through obstacles
- ✓ The lines must run through level ground as possible
- ✓ Each triangle must be provided with sufficient check lines
- ✓ The frame work must have one or two base lines. If one base line is used, it must pass the middle of the area. If two base lines are used, they must intersect in the form of letter X

OR

IV

(a) INTERSECTION METHOD

This method is used for locating the distant and inaccessible point. Two instrument stations are selected in this method. The line joining these two stations is called base line



Procedure:

- ✓ Set the table at A, level it and transferred the point A on to the sheet as 'a' and clamp the table
- ✓ Mark the north direction on the sheet with the help of trough compass.
- ✓ Keep the alidade touching 'a', sight the station B. measure AB and plot it to get 'b'. The base line ab is drawn.
- ✓ Then place the alidade touching 'a' and sight the station P, Q. then draw corresponding rays
- ✓ Shift the table at 'B' and set it. orient the table by back sighting towards 'A'
- ✓ Pivoting the alidade about 'b' and sight the station P, Q. draw the corresponding rays along the edge of the alidade to intersect with the previously drawn rays at station A. thus we get points p, q on the sheet

(b). The cross staff is set up at a point on the line from which the right angle is to run, and is then turned until one line of sight passes through the ranging pole at the end of the survey line. the line of sight through the other two vanes will be a line at right angle to the survey line and a ranging rod may be established in that direction.

UNIT-II

V

(a) $\angle B = \text{bearing of BC} - \text{bearing of BA}$

$$= 155^{\circ}30' - 38^{\circ} = 117^{\circ}30'$$

$\angle C = \text{bearing of CB} - \text{bearing of CD}$

$$= 335^{\circ}30' - 75^{\circ}30' = 260^{\circ} (\text{exterior})$$

$$360^{\circ} - 260^{\circ} = 100^{\circ} (\text{interior})$$

$\angle D = \text{bearing of DE} - \text{bearing of DC}$

$$= 350^{\circ} - 255^{\circ}30' = 94^{\circ}30'$$

$\angle E = \text{bearing of ED} - \text{bearing of EF}$

$$=170^{\circ}-32^{\circ}=138^{\circ}$$

<F=bearing of FG-bearing of FE

$$=281^{\circ}-212^{\circ}=69^{\circ}$$

(b) **MERIDIAN** :meridian is a direction

✓ True meridian

- It is the line joining true north and south on the earth surface

✓ Magnetic meridian

- It is the direction shown by a magnetic needle when it is suspended freely is known as magnetic meridian.

✓ Arbitrary meridian

- It is the direction towards a permanent object like building or top of a building

OR

VI

(a) Find out the difference between fore bearing and back bearings

Select line AB

$$259^{\circ}30' - 78^{\circ}30' = 181^{\circ} \text{(local attraction affected)}$$

Select line BC

$$350^{\circ} - 171^{\circ}30' = 178^{\circ}30' \text{(local attraction affected)}$$

Select line CD

$$282^{\circ}30' - 102^{\circ}30' = 180^{\circ} \text{(local attraction not affected)}$$

Select line DE

$$242^{\circ} - 60^{\circ}30' = 181^{\circ}30' \text{(local attraction affected)}$$

Select line EA

$$303^\circ - 124^\circ = 179^\circ \text{ (local attraction affected)}$$

Since the Stations C and D are free from local attraction fore bearing of line DE is correct

$$\text{Back bearing of line DE} = 242^\circ - 180^\circ = 62^\circ$$

$$\begin{aligned} \text{Correction at E} &= \text{corrected back bearing} - \text{measured back bearing} \\ &= 62^\circ - 60^\circ 30' = +1^\circ 30' \end{aligned}$$

Apply the correction at E in fore bearing of line EA

$$\text{Corrected fore bearing of line EA} = 124^\circ + 1^\circ 30' = 125^\circ 30'$$

$$\text{Back bearing of line EA} = 125^\circ 30' + 180^\circ = 305^\circ 30'$$

$$\text{Correction at A} = 305^\circ 30' - 303^\circ = +2^\circ 30'$$

$$\text{Corrected F.B of line AB} = 78^\circ 30' + 2^\circ 30' = 81^\circ$$

$$\text{Corrected B.B of line AB} = 81^\circ + 180^\circ = 261^\circ$$

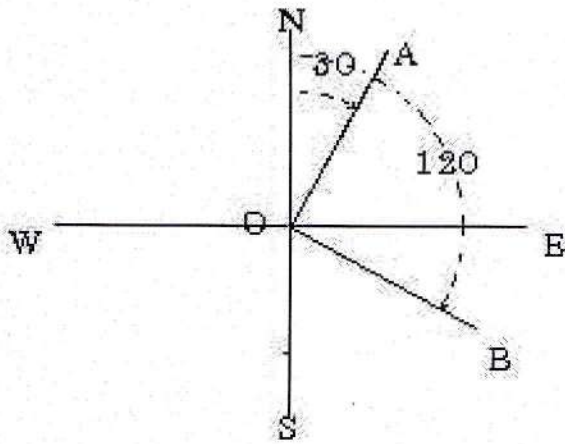
$$\text{Correction at B} = 261^\circ - 259^\circ 30' = +1^\circ 30'$$

$$\text{Corrected F.B of line BC} = 350^\circ + 1^\circ 30' = 351^\circ 30'$$

$$\text{Corrected B.B of line BC} = 351^\circ 30' - 180^\circ = 171^\circ 30'$$

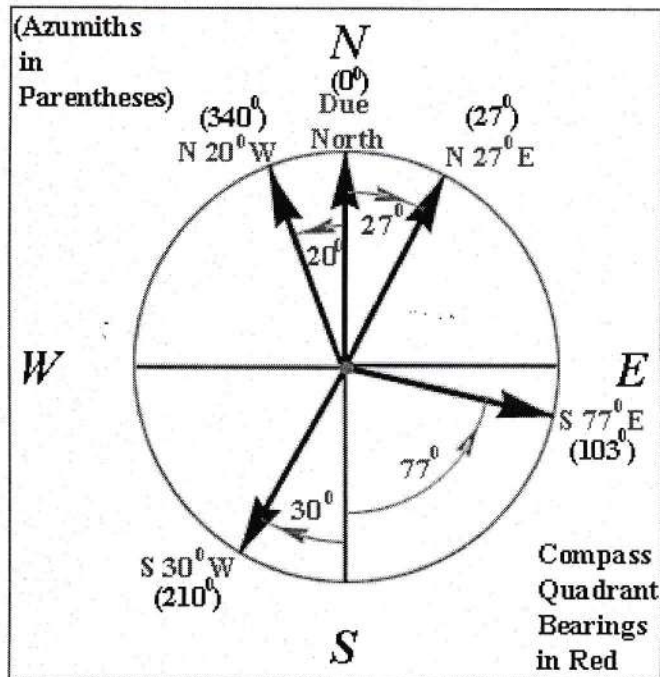
(b) (i) Whole circle bearing (WCB)

Whole circle bearing of a line is measured clockwise direction from north towards the line . it is obtained from prismatic compass. Value of a bearing varies from 0 to 360°



Quadrantal bearing (Q.B)

Bearing of a line measured clock wise or anticlockwise from north and south toward east or west is known as quadrantal bearing. It is obtained from surveyors compass. Value of bearing varies from 0 to 90°. It is also known as reduced bearing



(ii) True bearing

It is the horizontal angle between true meridian and the line

Magnetic bearing

It is the horizontal angle between magnetic meridian and the line

UNIT-III

VII

(a)

stn	B.S	I.S	F.S	Rise	Fall	R.L	Remark
1	0.875					50.00	
2	0.685		1.520		0.645	49.355	
3		2.675			1.99	47.365	
4	1.895		2.215	0.46		47.825	
5		3.285			1.39	46.435	
6	3.585		3.330		0.045	46.39	
7			2.775	0.81		47.2	

Check

$$\sum B.S - \sum F.S = \sum \text{rise} - \sum \text{fall} = \text{Last R.L} - \text{First R.L}$$

$$(0.875 + 0.685 + 1.895 + 3.585) - (1.520 + 2.215 + 3.330 + 2.775) = (0.46 + 0.81) - (0.645 + 1.99 + 1.39 + 0.045) = 47.2 - 50$$

$$= -2.8$$

(b) A levelling instrument essential consist of the following

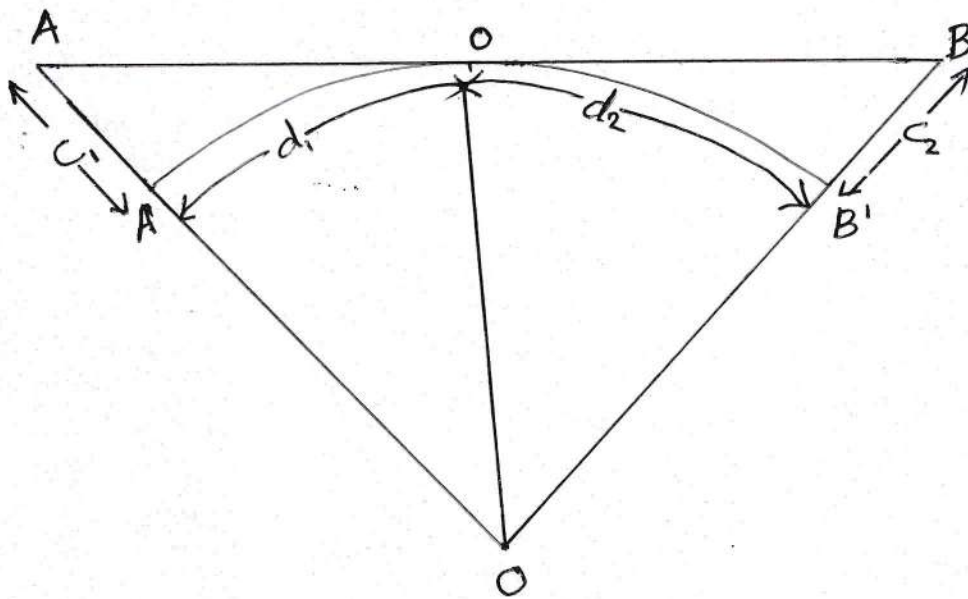
- A levelling head with three foot screws which enables to bring the bubble center
- . A telescope that provides line of sight to bisect the distant object
- . A bubble tube to make line of sight horizontal

- A tripod for supporting the levelling instrument The telescope of levelling instrument consist of the following
 - A body of the telescope with focusing arrangement
 - Object lens or objective: A combination of double convex lens at the front face and a concave lens at the back face is used. The image formed by the above compound lens is an inverted image
 - Eye piece: The main purpose of eyepiece is to effect the magnification of cross hair of the diaphragm, and the image is formed by the object lens
 - Diaphragm: It consists of very fine cross hairs bounded in a braising fitted inside the body of the telescope .The cross hairs are made of line platinum wires or line attached on glass plate
 - . The line of sight: The line of sight is maintained perpendicular to the direction of gravity through a system of prisms called a compensator. This compensator maintains a horizontal line of sight when the instrument is approximately leveled.

OR

VIII

(a)



Let A be the position of the top of the light house and B be the position of the observer's eye. Let AB be the tangential to water surface at O

$$d_1 = 3.8553\sqrt{C_1} = 3.8553\sqrt{52} = 27.8 \text{ km}$$

$$d_2 = 3.8553\sqrt{7} = 10.2 \text{ km}$$

$$\text{distance between A and B} = d_1 + d_2 = 34.429$$

(b) TEMPORARY ADJUSTMENTS OF DUMPY LEVEL

Temporary adjustments are to be made at each setup of the instrument. The following are the temporary adjustments to be made.

- Setting up of the level
- Leveling up
- Elimination of parallax.

Setting up of the level

- a) Release the clamp screw of the instrument
- b) Hold the instrument in the right hand and fix it on the tripod by turning round only the lower part with the left hand.
- c) Screw the instrument firmly.
- d) Bring all the foot screws to the center of its run.
- e) Spread the tripod legs well apart.
- f) Fix any two legs firmly into the ground by pressing them with the hand.
- g) Move the third leg to the right or left until the main bubble is approximately in the center.
- h) Then move the third leg in or out until the bubbles of the cross-level is approximately in the center.
- i) Fix the third leg firmly when the bubbles are approximately in the centers of their run.

Levelling up

- **Thee screw head**

 - a) Place the telescope parallel to a pair of foot screws.

- b) Bring the bubble to the center of its run by turning the foot screws equally either both inwards and both outwards.
- c) Turn the telescope through 90° so that it lies over the third foot screw.
- d) Turn this third foot screw so that the bubble corners to the center of its run.
- e) Bring the telescope back to the original position without reversing the eye-piece and object glass.
- f) Repeat the above operations until the bubble remains in the center of its run in both the positions.
- g) Turn the telescope through 180° and check whether the bubble remains central.

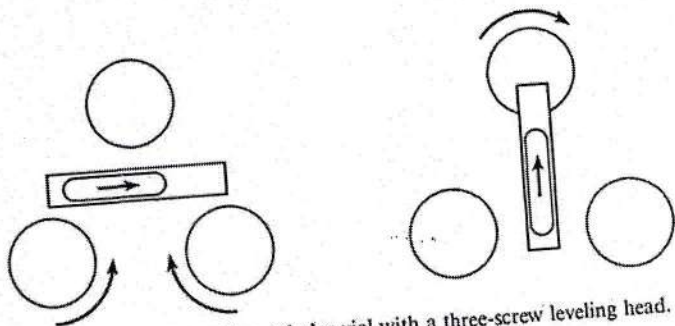
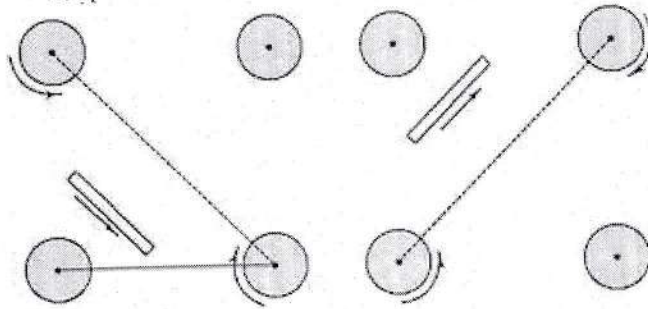


Fig. 9-22. Leveling with a tubular vial with a three-screw leveling head.

• **Four screw head**

- a) turn the upper plate until the longitudinal axis of the plate level is roughly parallel to the diagonal screws.
- b) bring the bubble centre
- c) turn the upper part until the spirit level axis is parallel to the other two diagonal screws.
- d) centre the bubble
- e) repeat the procedure.
- f) turn through 180 degree to check



Elimination of parallax:

It can be done by focusing the eye piece and objective.

- Remove the lid from the object glass.
- Hold a sheet of white paper in front of the object glass.
- Move the eyepiece in or out until the cross hairs are distinctly visible.
- Direct the telescope towards the staff.
- Turn the focusing screw until a clear and sharp image is formed in the plane of the cross hairs.

UNIT-IV

IX

(a) PROFILE LEVELLING OR LONGITUDINAL LEVELLING

It is the process of determining the elevation of points at the short interval along a fixed line such as center line of a railway, road, canal etc. In this method the object of leveling operation is to determine the undulation of the ground surface along a center line of a road, railway, canal or pipe line.

Profile leveling procedure

- First of all a chain was stretched through the center of rode points marked at a specified interval of x m.
- One point was marked on either sides of the points on center line. The levelling instrument was setup from which all points are visible
- A back sight was taken on the bench mark after levelled the instrument
- The height of collimation was calculated .
- Then sights were taken and considered as intermediate sight and reduced level was calculated.
- Change points are also set up if required.

Plotting the profile

The horizontal distances are plotted along the horizontal axis to some convenient scale and distances are also marked. The elevations are plotted along the vertical axis. Each ground point is thus plotted by the two co ordinate. The various points so obtained are joined by straight lines.

Purpose of profile leveling

- It is used to fix the centre line of a railway, highway, canal, or sewer
- It is used to fixing the grades of land
- It is used to estimating the cost of project
- It is used to determine the quantity of earth work

CROSS SECTIONING

It is the process of taking level on each side of a mainline at right angles to the main line. The process of taking levels perpendicular to the direction of longitudinal leveling is known as cross sectional leveling.

Purpose

They provide the data for estimating quantities of earth work and other purposes.

Procedure

Centre line of the ground is marked by using chain. The cross sections are run at right angles to the center line. The cross staff or the optical square the distance are measured left and right from the centre line. The length of cross section depends upon the nature of work. The dumpy level is set up suitable place and staff readings are taken on left or right side of the centre line. And calculate the reduced levels of each Stations of the Cross section.

Plotting cross sections

Cross sections are plotted almost in the same manner as the longitudinal sections except that in this case both the scales are kept equal.

The points along the longitudinal section are plotted at the centre of the horizontal axis. The points to the left of the centre point are plotted to the left and those to the right are plotted to the right. The points are so obtained are joined by straight lines.

(b) Two method

- Direct method
- Indirect method
- ✓ **Direct method**

In the direct method of contouring, the reduced levels of various selected points on contour lines are obtained and their positions are located. The contours are then drawn by joining these points. It is a very accurate method but it is slow and tedious and is used for small areas and where great accuracy is required. The field work is twofold,

Vertical control

Horizontal control

Vertical control

The points on the contours are traced either with the help of a level and staff or with the help of a hand level. The level is set at a suitable point and leveled. The staff is kept on the BM and the height of instrument is determined. And also determined the reduced level of each station. The instrument man asks staff man to move up and down in the area till the required staff reading is found.

Horizontal control

The system to be adopted depends mainly on the type and extends of areas. For small area, chain surveying may be used and points may be located by offsets from the survey lines. In a work of larger nature, a traverse may be used. The traverse may be theodolite or a compass or a plane table traverse.

A surveyor establishes the horizontal control of that point using instruments. After that instrument man directs staff man to another point where the same staff reading can be found. It is followed by establishing, horizontal control. Thus several points

are established on a contour line on one or two contour lines and suitably noted down. Plane table survey is ideally suited for this work.

✓ **Indirect Methods**

In this method, some suitable guide points are selected and surveyed. The guide points need not necessarily be on the contour. After locating the points on the plan, reduced levels are marked and contour lines are interpolated between the selected points.

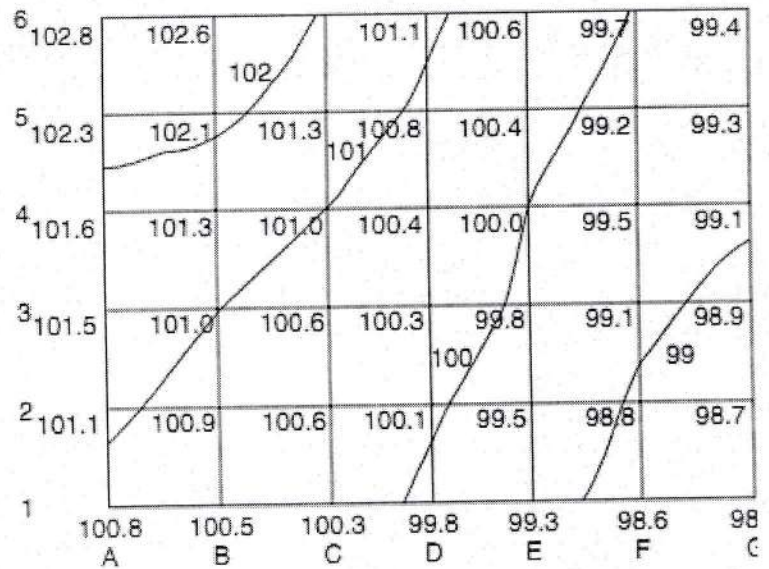
Three types,

- ✓ Method of squares,
- ✓ Method of cross-section, or
- ✓ Radial line method.

Method of Squares:

In this method is used when the area to be surveyed is small and the ground is not very much undulating. The area is divided into a number of squares and all grid points are marked.

Commonly used size of square varies from 5m x 5m to 20m x 20m. Levels of all grid points are established by leveling. Then grid square is plotted on the drawing sheet. Reduced levels of grid points marked and contour lines are drawn by interpolation. Sometimes rectangles are also use in place of square. This leveling is known as spot leveling.



Method of cross section:-

In this method, cross sections are run transverse to the centre line of a road, railway or canal etc. This method is most suitable for railways route surveys. The cross

sectional points are taken at regular interval. By leveling the reduced levels of all those points are established. The points are marked on the drawing sheet their reduced levels are marked and contour lines interpolated.

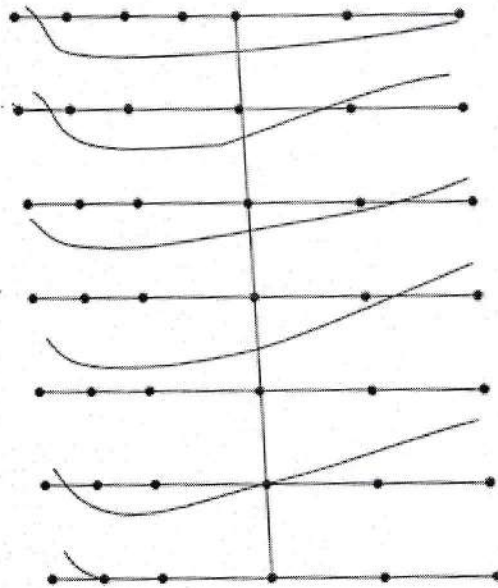
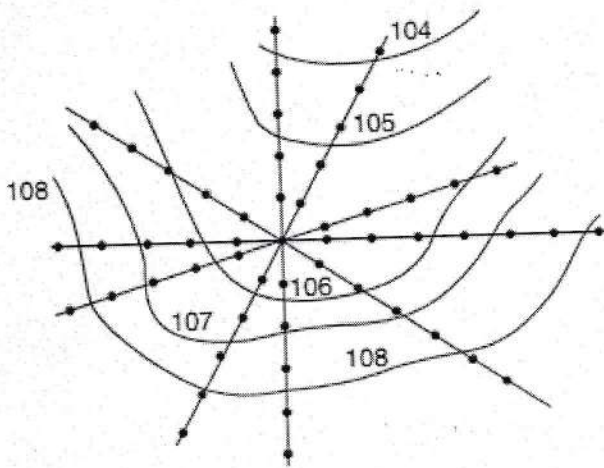


Figure shows a typical planning of this work. The spacing of cross section depends upon the nature of the ground, scale of the map and the contour interval required. It varies from 20 m to 100m. Closer intervals are required if ground level varies abruptly. The cross sectional line need not be always is at angles to the main line.

By Tacheometric method or radial line method

In the case of hilly terrain, tacheometric method is used. Tacheometer is a theodolite fitted with stadia diaphragm so that staff readings against all the three hair may be taken.

In this method several radial line are taken from a point in the area. The direction of each line is noted. On these lines at selected distances points are marked and levels determined. The elevation of each point is calculated by tacheometric formulas and entered. and contours can be interpolated as usual.



OR

$$(a) \text{ Volume} = h/3[(A_1 + A_7) + 4(A_2 + A_4 + A_6) + 2(A_3 + A_5)]$$

$$h = \text{contour interval} = 1\text{m}$$

$$= h/3[(1100 + 1376000) + 4(13200 + 151000 + 968000) + 2(96000 + 853000)]$$

$$= 2601300\text{m}^3$$

(b) Permanent adjustment of Dumpy Level The permanent adjustment of a level is tested by finding the relative position of fundamental lines. If any fundamental relation is found to be disturbed in a dumpy level, the cross-hairs and level tube are adjusted so that the fundamental relations get satisfied. The reference line for the adjustments in dumpy level is the vertical line which remains fixed in direction, as it depends upon the direction of gravity.

- . Axis of the level tube is perpendicular to the Vertical axis
- . Horizontal cross hair should lie in a plane perpendicular to the Vertical axis, so that it will lie in a Horizontal plane when the instrument is properly leveled.
- . The Line of sight is parallel to the axis of the level tube.