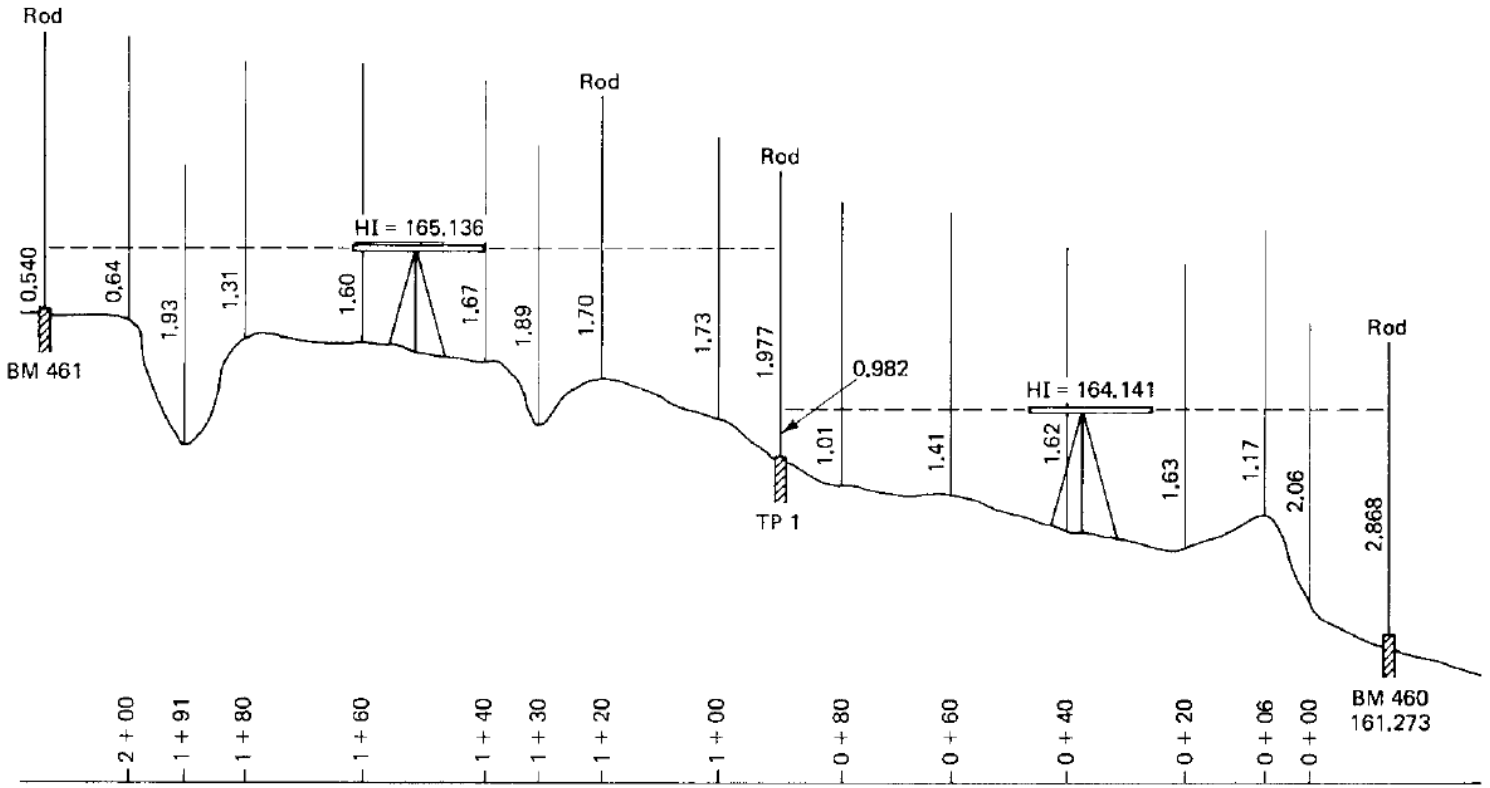
Profile and Cross-Section

- **Profile:**
- Profile levelling is done to know the nature of the ground surface the along the centre of the road at some regular intervals (Ex. 20 m, 30 m, etc.)
- If required, staff readings may also be taken at points of importance where the slope of the ground suddenly changes or at the intersection points.



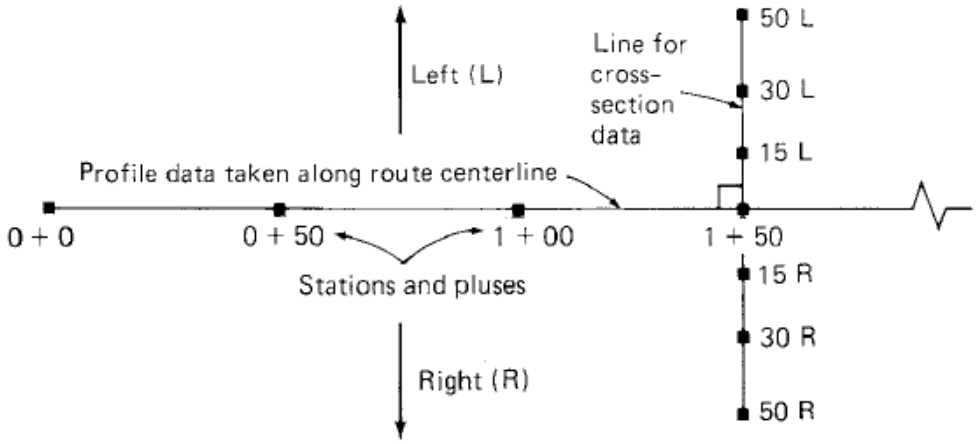
Cross-section:

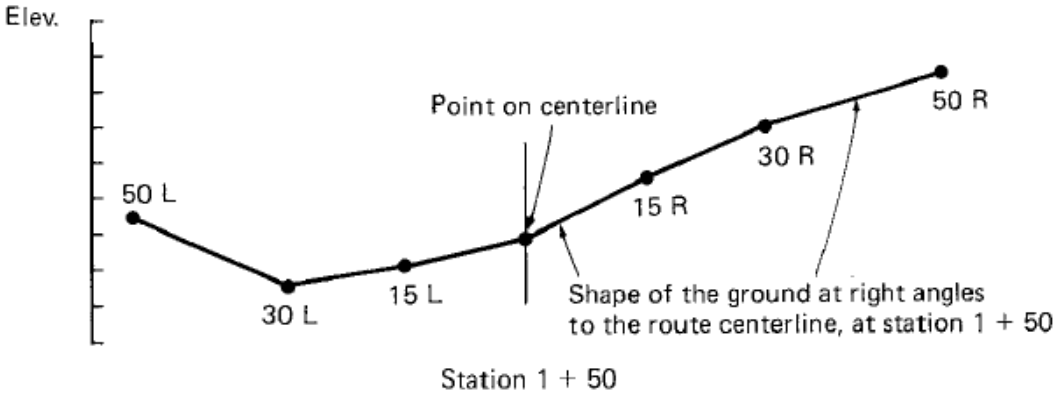
- It is the operation of levelling to determine the elevation of the points at right angles on either side of the center line of the proposed route.

  - The length of the cross-section is constant in in a particular project, and the length is dependent on the type of the project.

  - Cross-sections are used for:
    - Volume determination.
    - Construction project.

  - Points should be considered in taking levels along the cross-section in the same way as the profile itself.



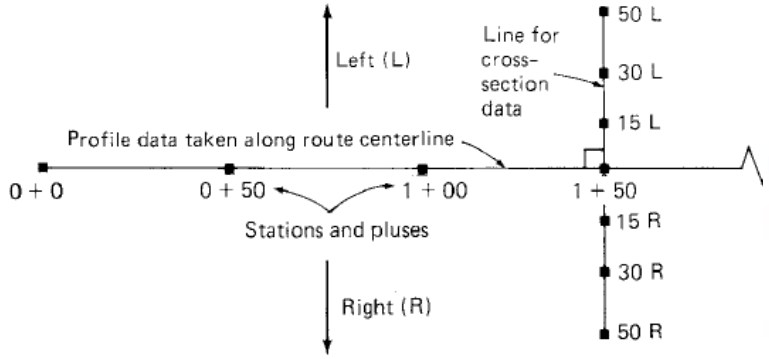


Stationing:

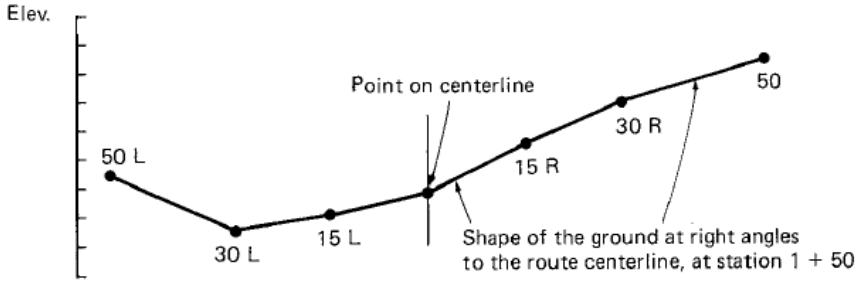
- Station: is any point on profile where the level is taken.
- Starting point is called zero station (zero St.)
- 0+00.00 or 0+000.00
- Any station along the profile is indicated by its distant from zero station
- 0+45.0 m 0+045.0 m
- 10+12.5 m 1+012.5 m
- 3+00.0 m 0+300.0 m
- End St. indicates the length of the profile
- End st. 156+25.13 m

Station along cross-section:

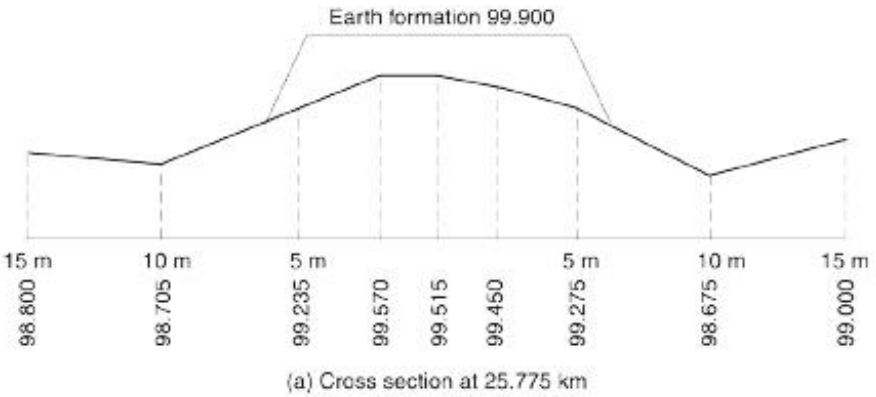
- The name of the cross-section is indicated by the name of the station where the cross-section is taken
- 0+00.00 0+35.00 5+00.00 End st. 125+25.23
- For location of points along cross-sections are indicated by their distant from the center line at that station with their respective location (left or right side of the profile)



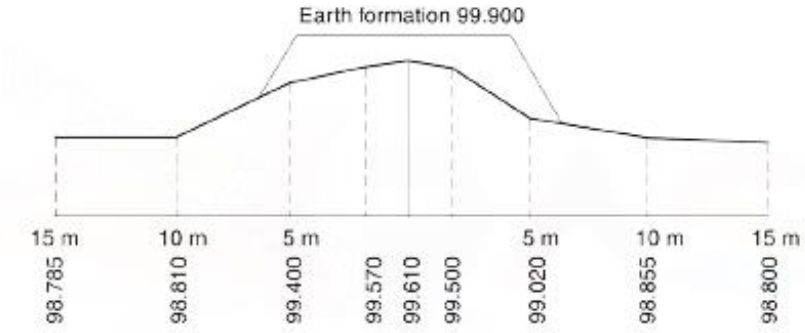
(a)



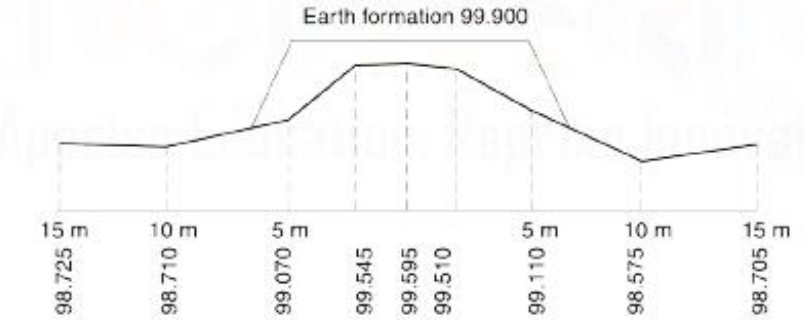
Station 1 + 50



(a) Cross section at 25.775 km



(b) Cross section at 25.750 km



(c) Cross section at 25.725 km

Field procedure for profile and Cross-section

- Start after located and the center line has been traversed.
- Locating the intersection points along the center line of the route according to the design for any project a full name of station is named.
- **Establishment of a net of Benchmarks**

1. Choose a BM nearby station zero, and reference it to an assumed datum (must be poured in concrete with an iron bar in the middle).
2. Location of BMs with respect to center line. (BMs are set beyond this limit to be kept safely 100 – 150m).
3. Distribution of BMs along the center line

1. BMs must be distributed at that particular distance from center line (ex, 100 – 150m) at intervals of 500m at either side, they must be poured in concrete.
2. Leveling between BMs, to establish the elevations of other BMs. [start from known elevation and close on the other or the same point of known elevation].
3. List of BM (official document)

BMs	Elevations (m)
BM1	500.00
BM2	502.00
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Plotting:

Plotting for profile and Cross-sections are made on millimetric papers (A4, A3, etc).

Procedure of plotting the profile

1. Selection of scale

Scale: is the ratio between distance on a map to the same (corresponding) distance on the ground.

$$scale = \frac{1cm\ on\ the\ map}{100m\ on\ the\ ground} = \frac{1cm}{(100 * 100)cm} = \frac{1}{10000}$$

In the profile, two types of scales are required;

Horizontal scale: to represent distances.
Vertical scale: to represent elevations.

Usually horizontal scale is exaggerated 5 times (5x) or ten times (10x) to obtain vertical scale.

- If horizontal scale is 1:1000, 1/1000, or $\frac{1}{1000}$
- Vertical scale (5x) = $\frac{1000}{5} = 200 = \frac{1}{200}$, 1:200
- Vertical scale (10x) = $\frac{1000}{10} = 100 = \frac{1}{100}$, 1:100

Why two scales required in profile?

Because the distances involved are too large with respect to the difference in elevation along the profile.

H.S	V.S
1:1000	1:200
1cm:10m	1cm:2m

On the map : on the ground

2. Draw distance and elevation axes in the way the origin lies at south, left of the sheet.
3. Draw two parallel lines to the distance axis at about 2 cm spacing.
4. These two spaces are for stations and elevations.
5. Make starting point about 2 cm away from elevation axis, so that will be station (0+00.00).
6. From the leveling book [data of profile (station, elevation), data of cross-section].

Station: indicates the distance from zero station.

For example, at station 0+20 → elevation = 441.00m
In this scale 1cm = 10 m
So, 20 m = 2 cm

For elevation axis

For maximum elevation = 444.5 $\rightarrow\uparrow\rightarrow$ 445.0

For minimum elevation = 435.1 $\rightarrow\downarrow\rightarrow$ 435.0

} $\Delta H = 10m$

1:200

1cm: 2m

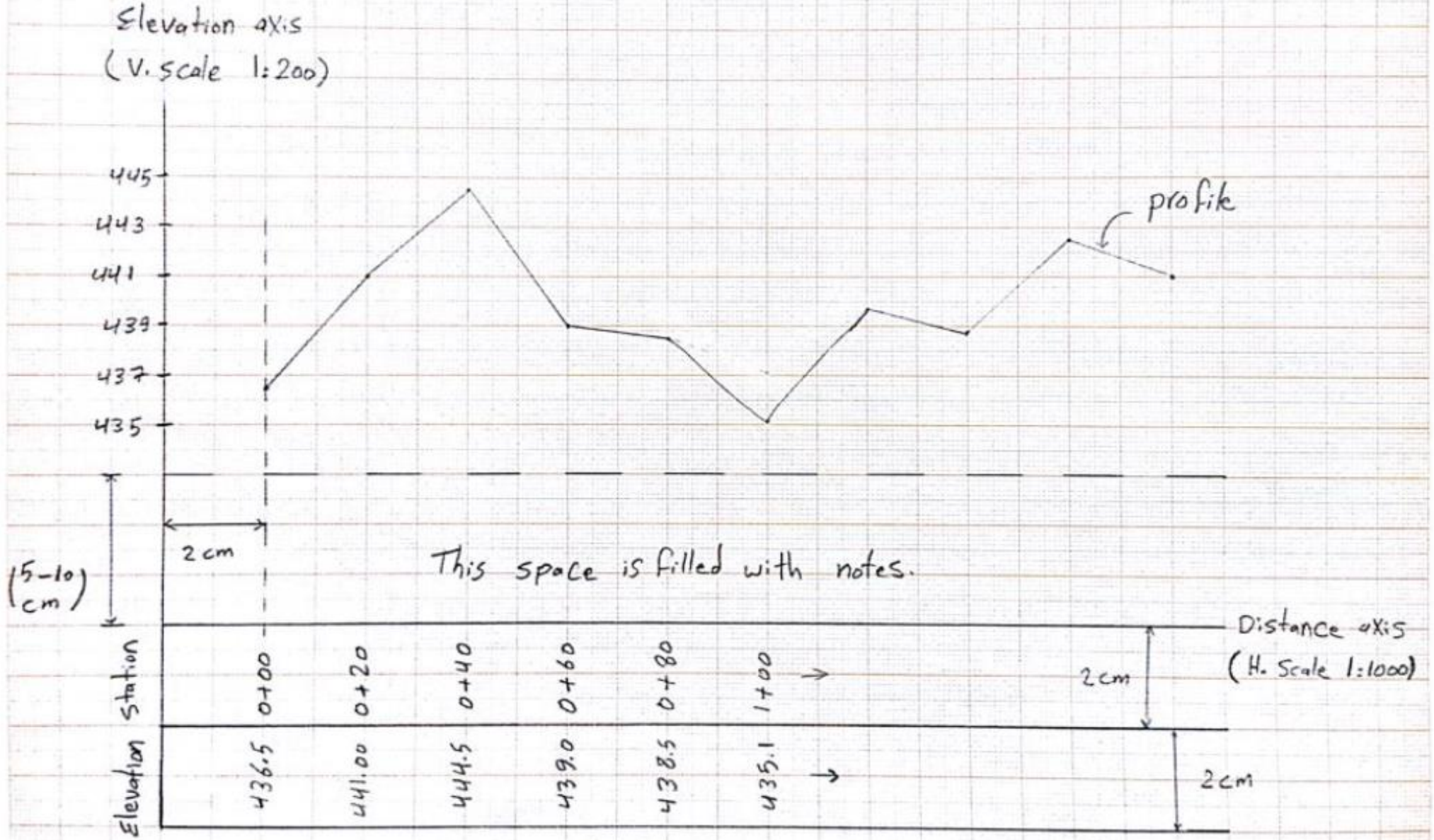
5mm: 1m

1mm: 20cm

7- after locating of all points along the profile, join these points by straight lines using a ruler.

Name of project :

From Station ..... to station .....



The Cross-section

Choice of the scale: one scale is required.

So, H. scale = V. scale.

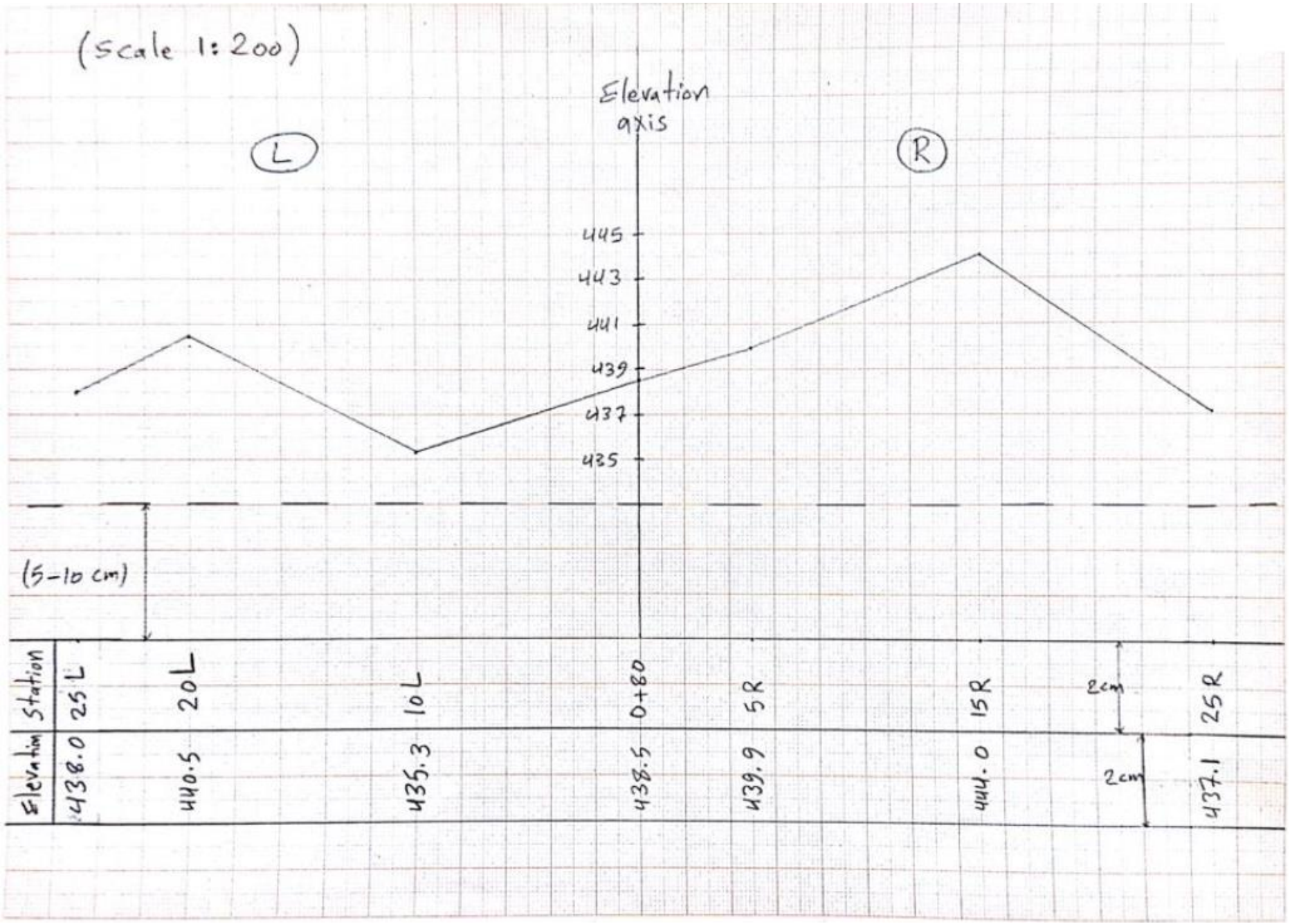
Data for cross-section (0+80)

Draw the axis as shown in the figure

Station (0+80) = 438.5

25 L: 438.0
20 L: 440.5
10 L: 435.3
5 R: 439.9
15 R: 444.0
25 R: 437.1

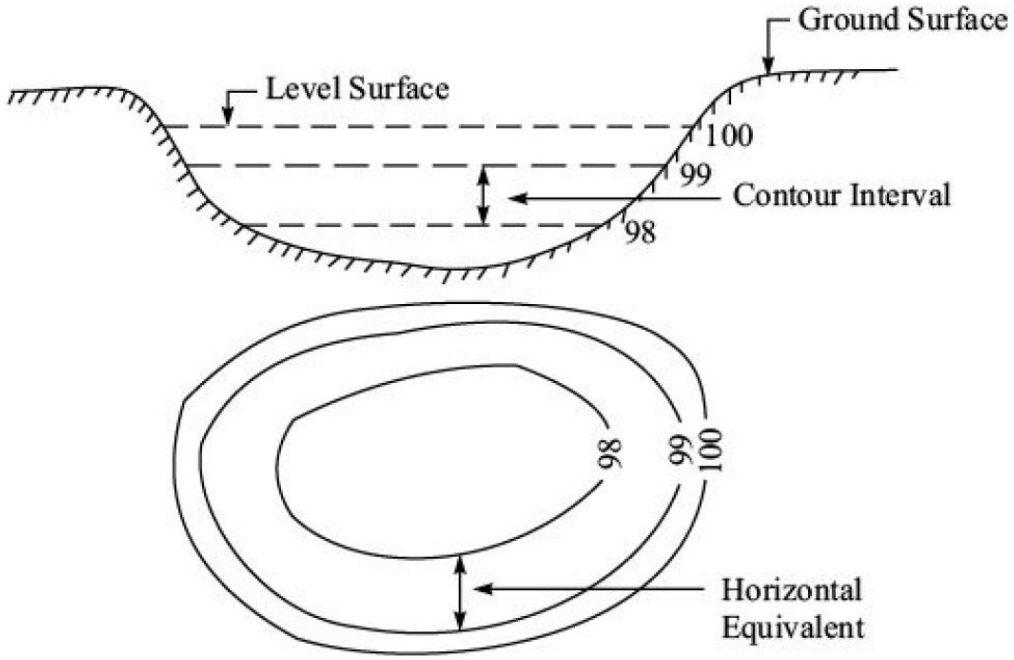
(Scale 1:200)


Elevation axis
L
R
445
443
441
439
437
435
(5-10 cm)
Station
25 L
20 L
10 L
0+80
5 R
15 R
25 R
Elevation
438.0
440.5
435.3
438.5
439.9
444.0
437.1
2cm
2cm

Contouring

A *contour line* is an imaginary line passing through points of equal elevation.

- For example, a contour of 100 m indicates that all the points on this line have an *elevation* of 100 m. Similarly, in a contour of 99 m, all points have an *elevation* of 99 m, and so on



- ***Contour Interval:***
- The vertical distance between any two consecutive contours is known as a contour interval.
- Major and minor
- Suppose a map includes contour lines of 100 m, 98 m, 96 m, and so on. The contour interval here is 2 m.
- This interval depends upon:
  - The nature of the ground (i.e. whether flat or steep):
    - For flat area is generally small, e.g. 0.25 m, 0.50 m, 0.75 m, etc.
    - For a steep slope in a hilly or valley area is generally greater, e.g. 5 m, 10 m, 15 m, etc.
  - The scale of the map, and

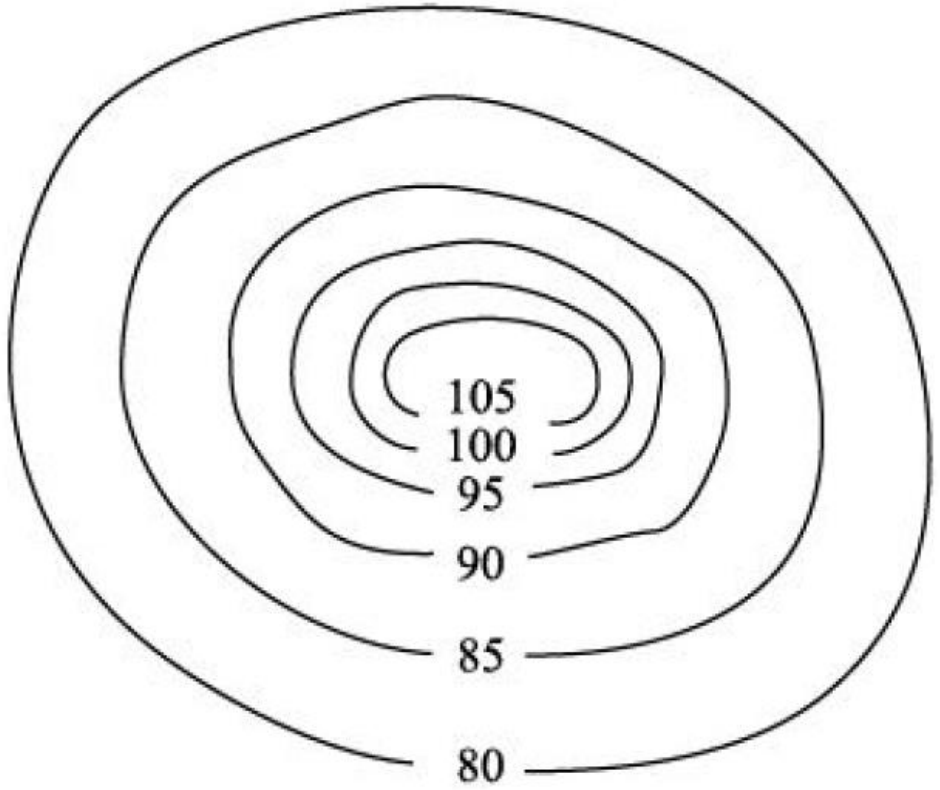
Ground surface	*Large scale (1 cm = 1 – 10 m)*	*Intermediate scale (1 cm = 10 – 100 m)*	*Small scale (1 cm = 100 m onwards)*
Flat	0.2 – 0.5 m	0.5 – 1.0 m	1.0 – 3.0 m
Rolling	0.5 – 1.0 m	0.5 – 1.5 m	2.0 – 5.0 m
Hilly	1.0 – 1.5 m	1.5 – 3.0 m	5.0 – 15 m

  - The purpose of the survey.

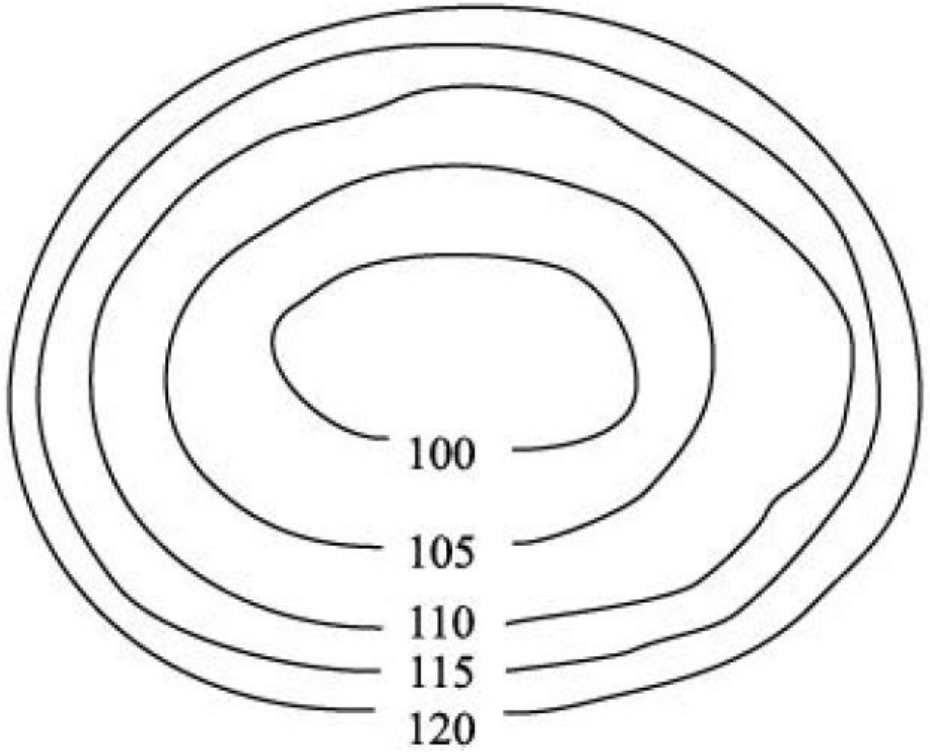
- ***Horizontal Equivalent:***
- The horizontal distance between any two consecutive contours is known as horizontal equivalent.
- It is not constant. It varies according to the steepness of the ground.
- For steep slopes, the contour lines run close together, and for flatter slopes they are widely spaced.
- ***Uses of Contour Map:***
- Understanding the nature of the ground surface.
- A suitable site or an economical alignment can be selected for any engineering project.
- The capacity of a reservoir or the area of a catchment can be approximately computed.
- A section of the ground surface can be drawn in any direction from the contour map.
- Quantities of earth work can be computed.

Characteristics of Contours

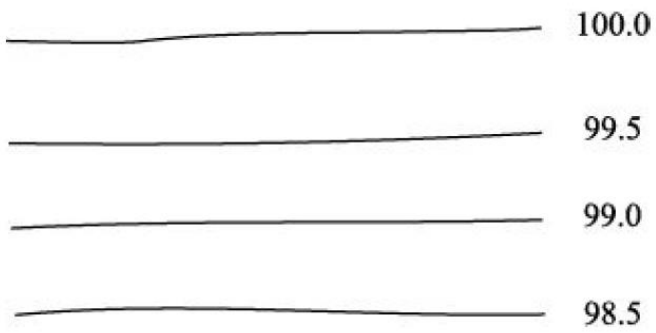
1. The contour lines are closer near the top of a hill or high ground and wide apart near the foot. This indicates a very steep slope towards the peak and a flatter slope towards the foot.



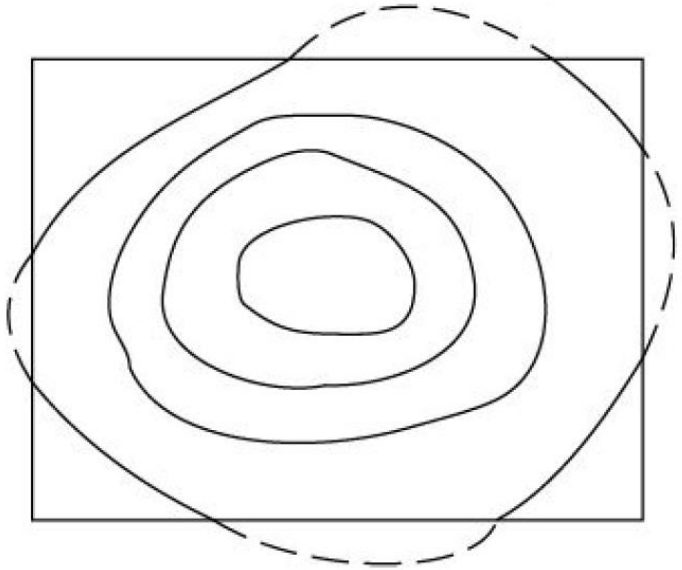
2. The contour lines are closer near the bank of a pond or depression and wide apart towards the centre. This indicates a steep slope near the bank and a flatter slope at the centre.



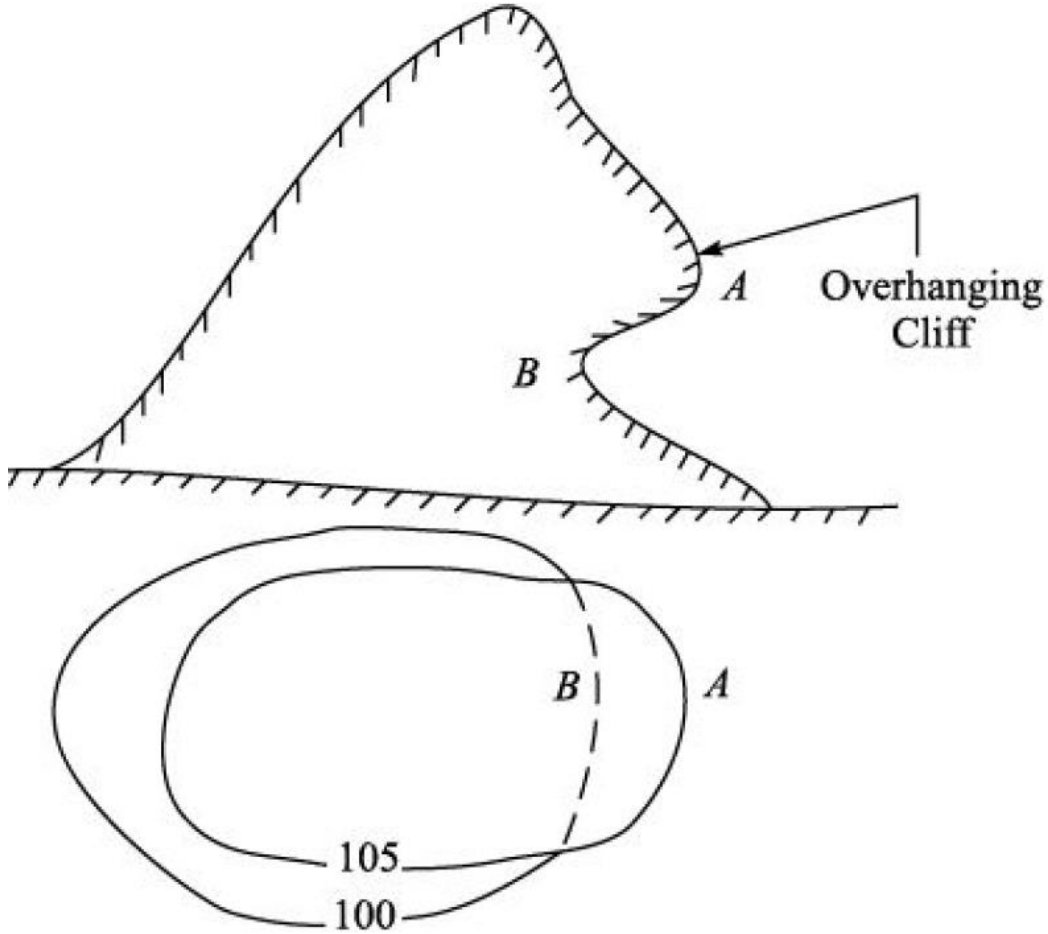
3. Uniformly spaced contour lines indicate a uniform slope.



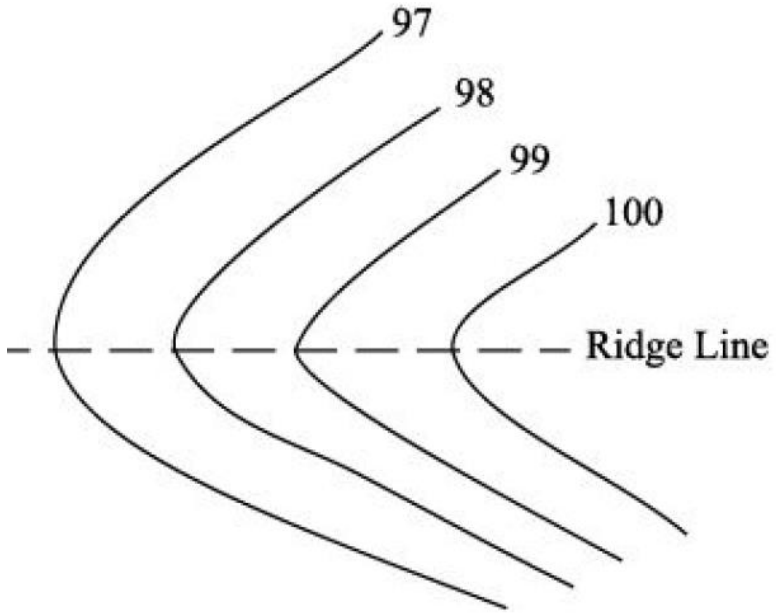
4. Contour lines always form a closed circuit. But these lines may be within or outside the limits of the map



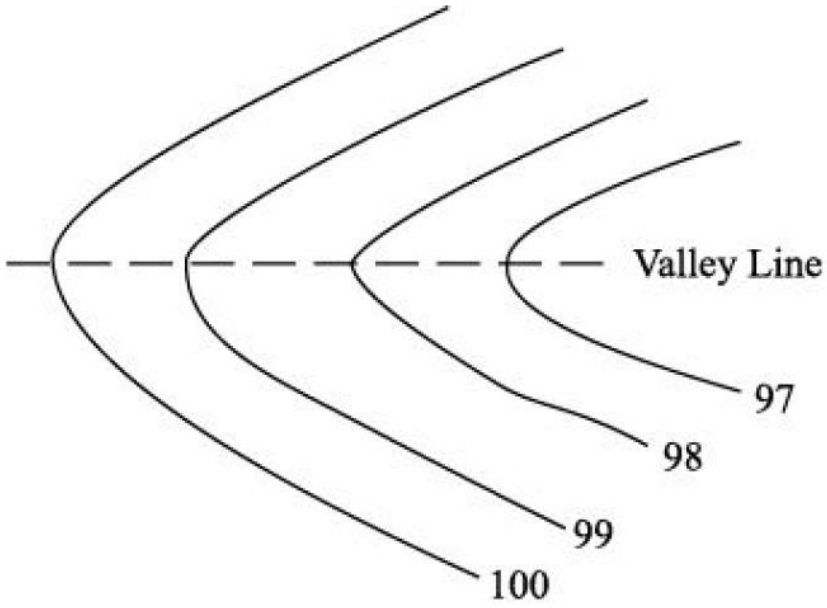
5. Contour lines cannot cross one another, except in the case of a overhanging cliff. But the overlapping portion must be shown by a dotted line.



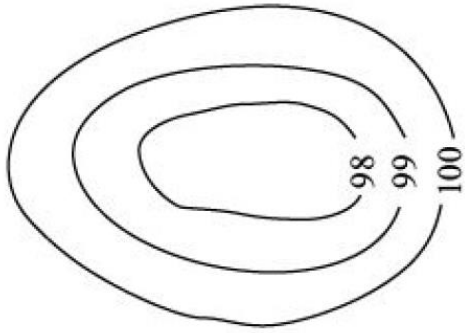
6. When the higher values are inside the loop, it indicates a *ridge line*. Contour lines cross ridge lines at right angles.

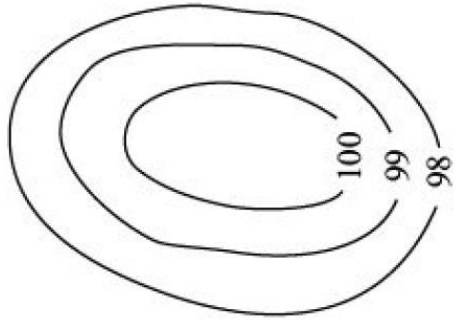


7. When the lower values are inside the loop, it indicates a *valley line*. Contour lines cross the valley line at right angles

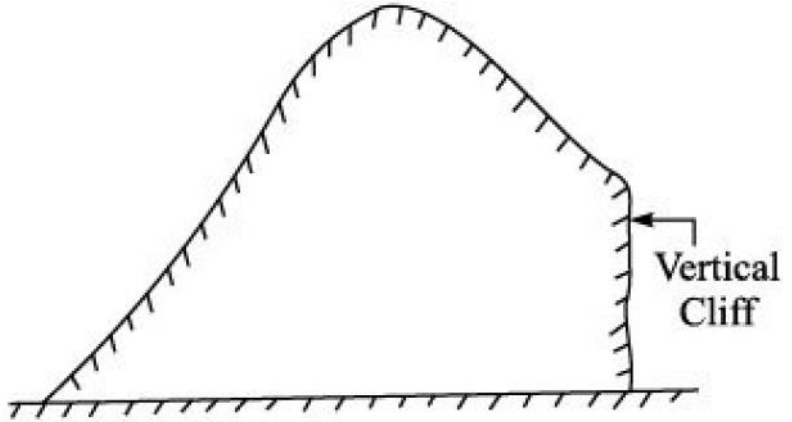


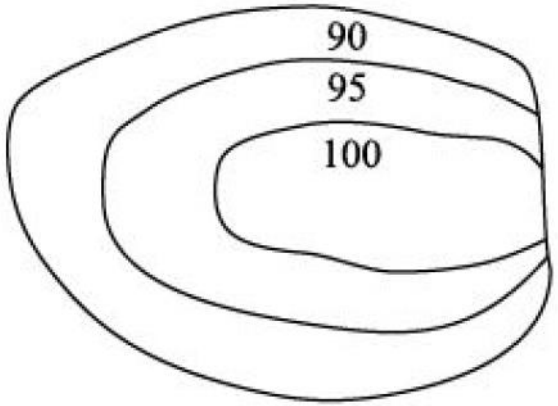
8. A series of closed contours always indicates a depression or summit. The lower values being inside the loop indicates a depression and the higher values being inside the loop indicates a summit





9. Contour lines meeting at a point indicate a vertical cliff





METHODS OF CONTOURING

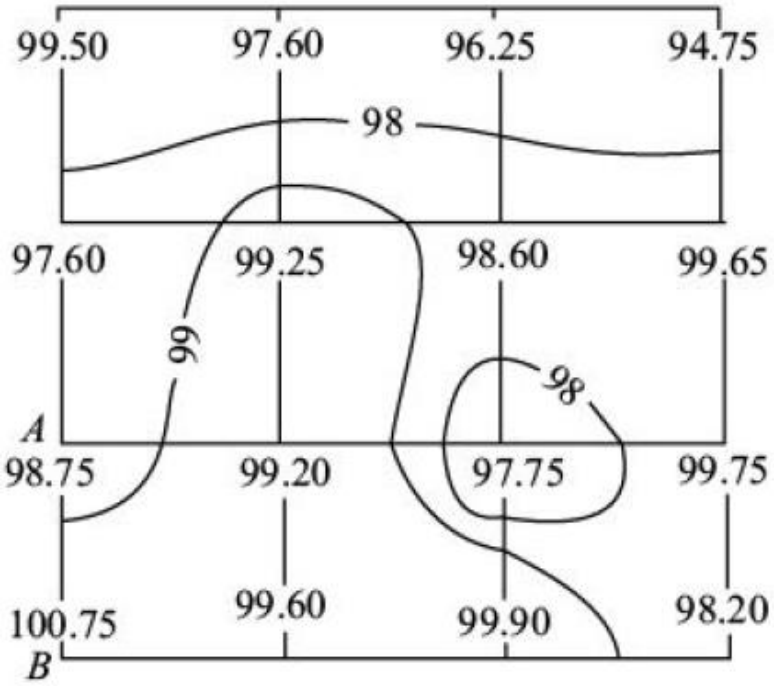
- Direct method
  - In field: In the field: the actual contour lines are located on the ground using levelling process.
  - Photogrammetry
- Indirect method:
- Random (using total station or GNSS)
- Grid (procedure):

1. Layout a grid using tape or (tape and theodolite)
2. The grid spacing will depend upon the nature of the area.
3. All the points of intersection throughout the grid should be marked using peg or paint spray.
4. Determination of elevation of intersection points (grid points) by using levelling process.
5. The contours are plotted using interpolation between levels.

Method of interpolation of contours

- The process of locating the contours proportionately between the plotted points is termed *interpolation*.
- Interpolation may be done by:

1. The graphical method
2. Arithmetical calculation:
   - Let *A* and *B* be two corners of the squares.
   - The RL of A is 98.75 m, and that of B 100.75 m.
   - The horizontal distance between *A* and *B* is 10 m
   - Vertical difference between *A* and *B* = 100.75 – 98.75 = 2m
   - Let a contour of 99.00 m be required.



- Difference of level between *A* and 99.00 m contour = 99.00 – 98.75 = 0.25 m

∴ Distance of 99.00 m contour line from $A = \frac{0.25}{2} \times 10 = 1.25$ m

- For example from the following square draw the contour lines if the VI = 0.5m and scale of the map is 1:100
- In this method (indirect method) we can plot the contour lines by interpolation between the lines and along the diagonal(s).
- **The procedure**

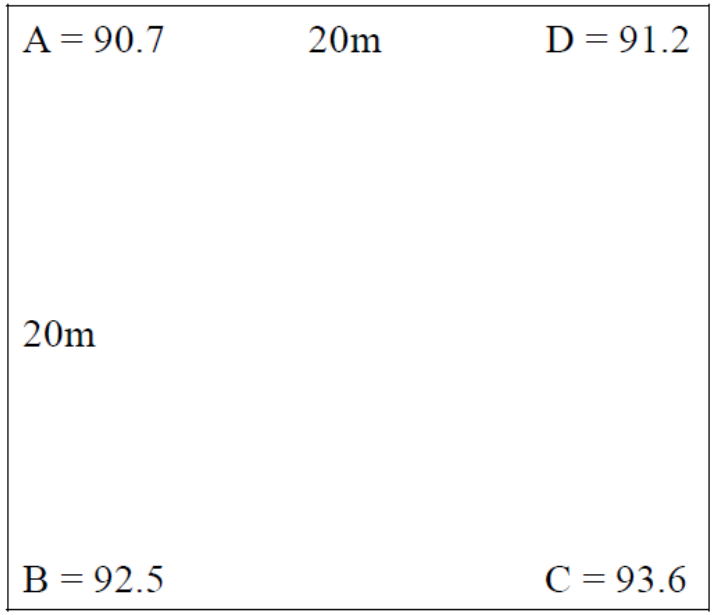
1.Determine maximum and minimum elevations. (maximum elevation = 93.6, minimum elevation = 90.7).

2.Determine the number of contour lines must be drown in this grid. Min Elev. = 90.7 → (91.0, 91.5, 92.0, 92.5, 93.0, and 93.5 → six contour lines must be drown).

3.To find the number of contour lines and find the first and end contour line; we can

[Min. Elev./VI = X (without digits), then (X * VI + VI) = first contour line],

[Max. Elev./VI = Y (without digits), then (Y * VI) = last contour line



- 4.Start with either 91.0 or 93.5 (starting with 91.0 contour line)
- 5.Locate the contour lines on the lines and diagonal(s) (AB, BC, CD, DA, AC or/and BD).
- Line AB
- Calculate ΔHAB → ΔH = 92.5 – 90.7 = 1.8m
- Calculate the difference in elevation between elevation of point (A) and first contour line (91.0); (91.0 – 09.7 = 0.3m)

H	V	
20cm	1.8	
X	0.3	→ x = 3.33cm

- Now measure 3.33cm from A to locate position of contour line 91.0m on the line AB
- Calculate number of contour lines on the line AB (91.0, 91.5, 92.0, 92.5) we have four contour lines on the line AB.

- Locate the contour lines of 91.5, 92.0, 92.5 by the same procedure on the line AB
- Calculate the contours on the lines of AD, BC, and CD by the same way of line AB.
- For line AC or/and BD
- Calculate ΔHAC → ΔH = 93.6 – 90.7 = 2.9m
- From point A difference the elevation of point A with the first contour line = 91.0 – 90.7 = 0.3m
- Length of AC=202+202=28.28m

H	V	
28.28	2.9	
X	0.3	→ X = 2.93cm

- From point C difference between the last contour line and point C

$$\Delta H = 93.6 - 93.5 = 0.1\text{m}$$

H	V	
28.28	2.9	
X	0.1	→ X = 0.97cm ≃ 10mm

- Then locate the contour lines of 91.5, 92.0, 92.5, 93.0 on the line AC by the same procedure.
- And for the line BD by the same procedure of line AC
- Connect the points that they have the same elevation by a smooth line to create contour lines.