**OBJECT AND USE OF LEVELLING**

**Object:** The aim of levelling is to determine the relative heights of different objects on or below the surface of the earth and to determine the undulation of the ground surface.

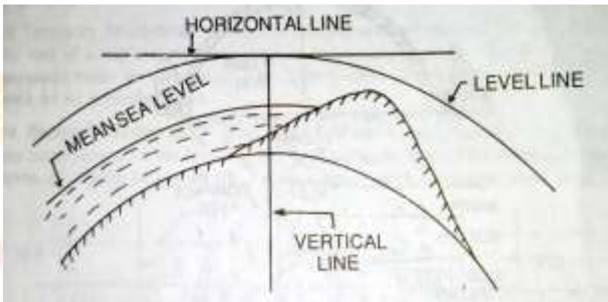
Levelling is done for the following purposes:

1. To prepare a contour map for fixing sites for reservoirs, dams, barrages, etc., and to fix the alignment of roads, railways, irrigation canals, and so on.
2. To determine the altitudes of different important points on a hill or to know the reduced levels of different points on or below the surface of the earth.
3. To prepare a longitudinal section and cross-sections of a project (roads, railways, irrigation canals, etc) in order to determine the volume of earth work.
4. To prepare a layout map for water supply, sanitary and drainage schemes.

**DEFINITIONS**

1. Levelling The art of determining the relative heights of different points on or below the surface of the earth is known as levelling. Thus, levelling deals with measurements in the vertical plane,

2. Level line Any line lying on a level surface is called a level line. This line is normal to the plumb line (direction of gravity) at all points

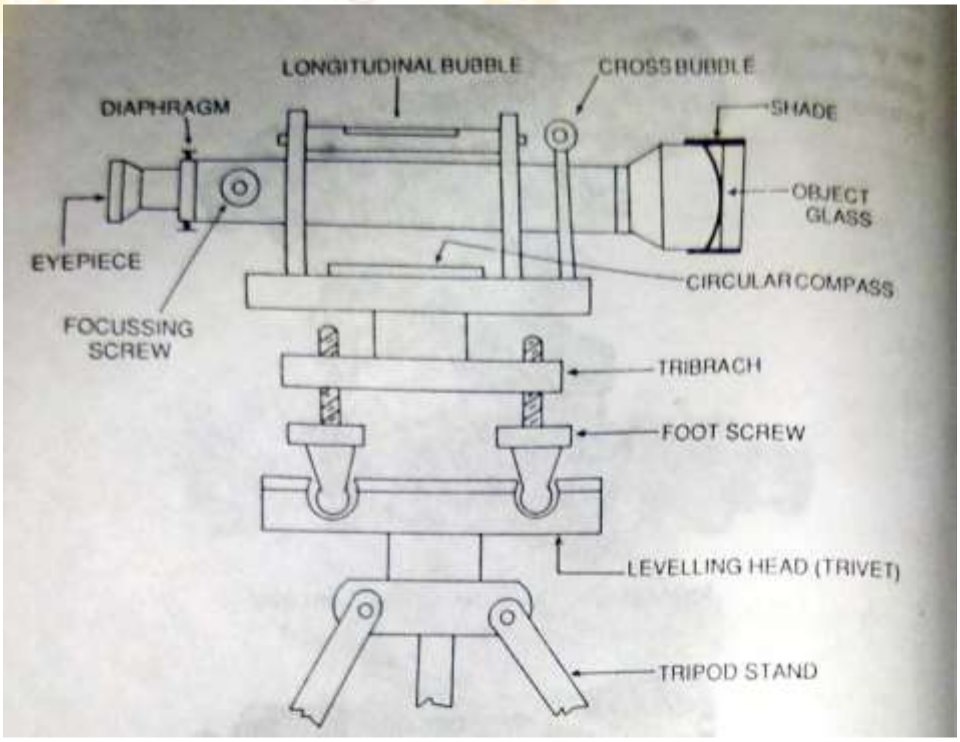



3. Horizontal plane Any plane tangential to the level surface at any point is known as the horizontal plane. It is perpendicular to the plumb line which indicates the direction of gravity.

4. Horizontal line Any line lying on the horizontal plane is said to be a horizontal lire. It is a straight line tangential to the level line

5. Vertical line The direction indicated by a plumb line (the direction of gravity) is known as the vertical line. This line is perpendicular to the horizontal line.

**The dumpy** level It cannot be removed from its supports nor can it be rotated about its longitudinal axis. The instrument is stable and retains its permanent adjustment for a long time. This instrument is commonly used.




1. **Tripod stand** The tripod stand consists of three legs which may be solid or framed. The legs are made of light and hard wood. The lower ends of the legs are fitted with steel shoes.

2. **Levelling head** The levelling head consists of two parallel triangular plates having three grooves to support the foot screws.

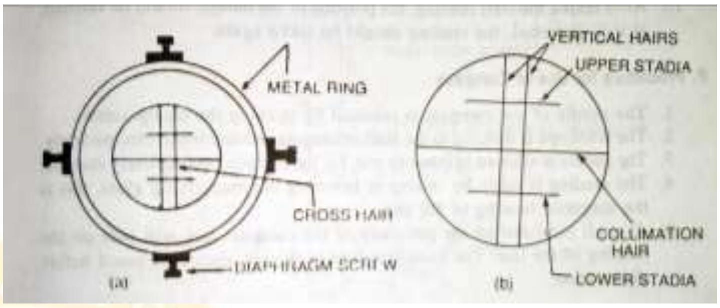
3. **Foot screws** Three foot screws are provided between the trivet and tribrach. By turning the foot screws the tribrach can be raised or lowered to bring the bubble to the centre of its run.

4. **Telescope** The telescope consists of two metal tubes, one moving within the other. It also consists of an object glass and an eye-piece on opposite ends. A diaphragm is fixed with the telescope just in front of the eye-piece. The diaphragm carries cross-hairs. The telescope is focussed by means of the focussing screw and may have either external focussing, or internal focussing

5. **Bubble tubes** Two bob the tubes, one called the longitudinal bubble wave and other the cross-bubble tube, are placed at right angles to each other These tubes contain spirit bubble. The bubble brought to the centre with the help of foot screw. The bubble tubes are fixed on top of the telescope

6. **Compass** A compass is provided just below the telescope for taking the magnetic bearing of a line when required The compass is graduated in such a way that a pointer, which is fixed to the body or compass, indicates a reading or the north line. when the telescope is directed along.

**Diaphragm** The diaphragm is a brass ring fitted inside the telescope, just in front of the eye piece. It can be adjusted by four screws. The ring carries the cross-hairs, which get magnified when viewed through the eye-piece. The cross-hairs may be marked in the following ways




1. With spider webs stretched across the ring

2. By very fine scratch marks made in a glass fitted with the ring, or

3. By means of platinum wires or silk threads stretched across the ring (Fig. 5.8(a).

The cross-hair consists of the following lines:

1. Two vertical hairs meant for maintaining the verticality of the staff,
2. Middle horizontal hair representing the line of collimation,
3. Upper stadia hair and lower stadia hair, both horizontal and short in length.

**The rise-and-fall system** In this system, the difference of level between two consecutive points is determined by comparing ench forward staff reading with the staff reading at the immediately preceding point.

If the forward staff reading is smaller than the immediately preceding staff reading, a rise is said to have occurred. The rise is added to the RL of the preceding point to get the RL of the forward point.

If the forward staff reading is greater than the immediately preceding staff reading, it means there has been a fall. The fall is subtracted from the RL of preceding point to get the RL of the forward point.

Point A (with respect to BM) = 0.75 -1.25 = -0.50

Point B (with respect to A) = 1.25 -2.75 = - 1.50

Point C (with respect to B) = 2.75 -1.50 = + 1.25

Point D (with respect to C) = 1.50 - 1.75 = -0.25

RL of BM = 100.00

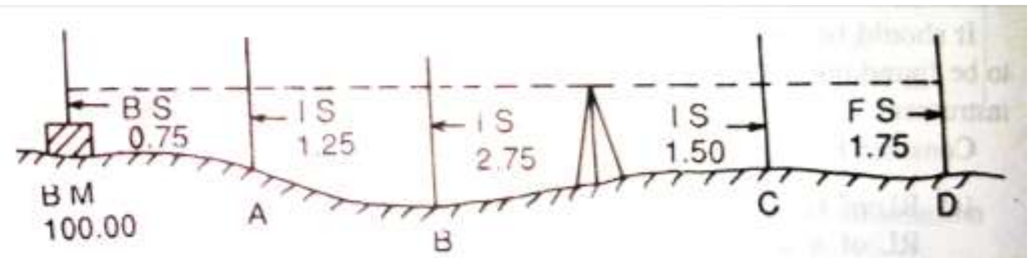
RL of A = 10000050 = 99.50

RL of B = 9950150 = 98.00 1059925

RL of C = 98.00 + 1.25 = 99.25

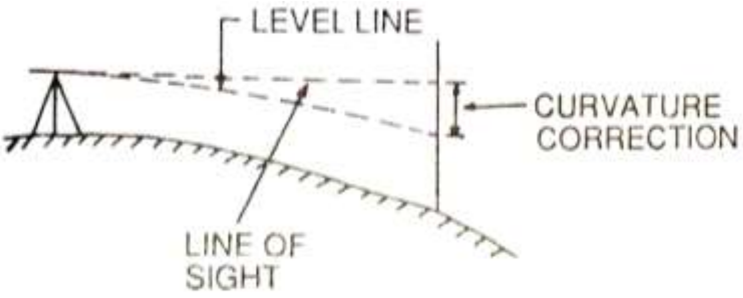
RL of D = 9925025 = 99.00

Arithmetical check: ∑BS - ∑FS = ∑Rise- ∑Fall = last RL- 1st RL



**CORRECTIONS TO BE APPLIED**

**1. Curvature correction** For long sights, the curvature of the earth affects staff readings. The line of sight is horizontal, but the level line is curved and parallel to the mean spheroidal surface of the earth (Fig. 5.18).




The vertical distance between the line of sight and the level line at a particular place is called the curvature correction. Due to curvature, objects appear lower than they really are.

Curvature correction is always subtractive (ie negative) The formula for curvature correction is derived as follows

Let

AB = D = horizontal distance in kilometres

BD = $C_C$ = curvature correction

DC = AC = R = radius of earth

DD' = diameter, considered as 12,742 km

From right-angled triangle ABC

$BC^2 = AC^2 + AB^2$

$(R + C_C)^2 = R^2 + D^2$

$R + 2RC_C + C_C^2 = R^2 + D^2$

$C_C X 2R = D^2$

Curvature correction $C_C = D^2 / 2R$

($C_C^2$ is neglected as it is very small in comparison to the diameter of the earth)

$C_C = D^2 \times 1{,}000 / 12{,}742 = 0.078S\ D^2$ m (negative)

Hence,

True staff reading = observed staff reading - curvature correction

**2. Refraction correction** Rays of light are refracted when they pass through layer of air of varying density. So, when long sights are taken, the line of sight refracted towards the surface of the earth in a curved path. The radius of a curve is seven times that of the earth under normal atmospheric conditions to the effect of refraction, objects appear higher than they really are. But the erie of curvature varies with atmospheric conditions,

However, on an average, the refraction correction is taken as one-seventa the curvature correction

Refraction correction, $C_r = (1/7) \times (D^2/2R)$

$C_r = (1/7) \times 0{,}0785\ D^2 = 0.0112\ D^2$ m (Positive)

Refraction correction is always additive (i.e. positive).

True staff reading= observed staff reading + refraction correction

3. **Combined correction** The combined effect of curvature and refraction is as follows:

Combined correction= curvature correction + refraction correction

$= -0.0785\ D^2 + 0.0112\ D^2$

$= -0.0673\ D^2$ m

So, combined correction is always subtractive dhe negative)

True staff reading = observed staff reading - combined correction