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LEVELLING

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LEVELLING

- Levelling is the art of determining the elevation of given points above or below a datum line or establishing in given points of required height above or below the datum line. It evolves measurement in vertical plane.

Definition of basic terms used in levelling

- **Level surface**: Any surface parallel to the mean spheroid of the earth is called level surface and the line drawn on level surface is known as level line.

- **Horizontal surface**: Any surface tangential to level surface at a given point is called - Horizontal surface at point. Hence horizontal line is at right angles to plumb line.

- **Vertical surface**: It is the line connecting the point & centre of earth. Vertical & horizontal line is normal to each other.

- **Datum**: The point or the surface with respect to which levels of other points or planes are calculated is called Datum or surface.

- **Mean sea level (MSL):** Mean sea level is the average height of sea of all stages of tides. Any particular place is derived by averaging over a long period of 19 years. In India the mean s sea level used is that at Karachi (Pakistan). In all important survey this is taken as datum.

- **Reduced level**: Levels of various points are taken as heights above the datum surface are known as Reduced level.

- **Bench mark**: Bench mark is a relatively permanent point of reference whose Elevation w.r.t some assumed datum is known. There are four types of bench mark

- G.T.S (Great trigonometry survey)

- Permanent bench mark

- Arbitrary bench mark.

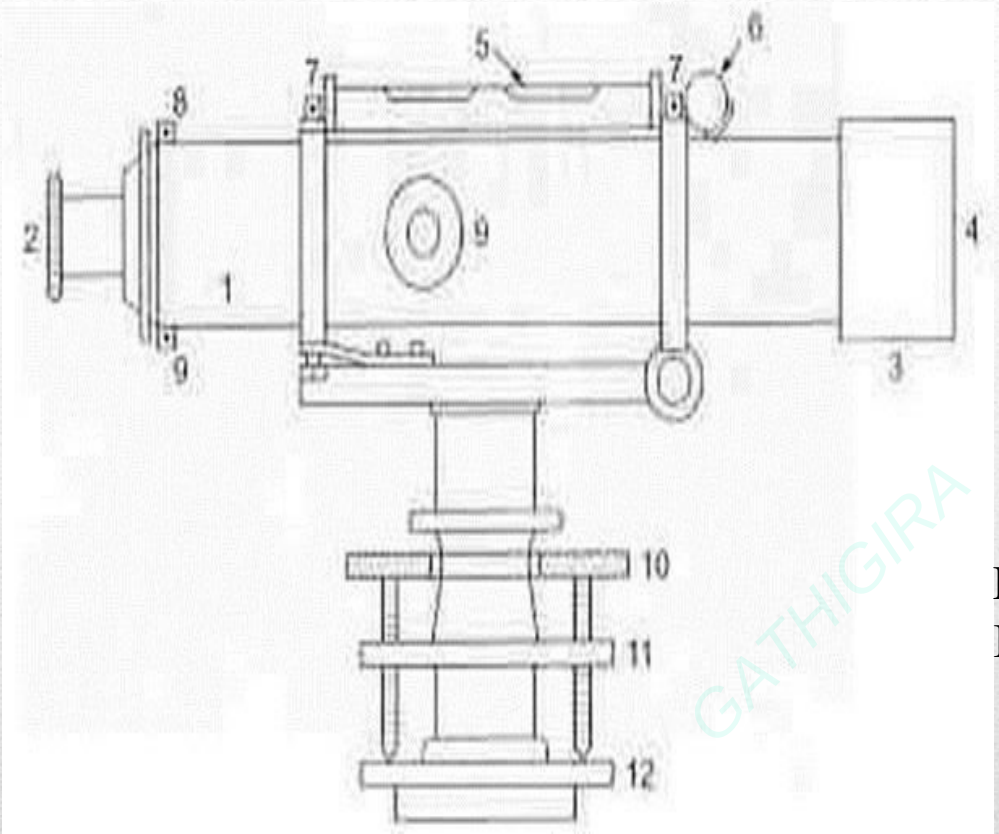
- Temporary bench mark.

LEVELLING INSTRUMENTS

- A level is an instrument giving horizontal line of sight & magnifying the reading far away from it. It consists of following 4 parts.
- Telescope to provide line of sight.
- Level tube to make the line of sight horizontal.
- The levelling head to bring the bubble in its centre of run.
- A tripod to support instrument

TYPES OF LEVELS

- Dumpy level
- wye level
- Cooke's Reversible level
- Tilting level
- Auto level
- Cushing's level



Telescope
Eye piece
Shade
Objective end
Longitudinal bubble
Focusing screw
Foot screws
Upper parallel plate
Diaphragm adjusting screws
Bubble tube adjusting screw
Transverse bubble tube
Foot plate.

WORKING PRINCIPLE OF AUTO & DUMPY LEVEL:

- The dumpy level originally designed by Gravatt consists of a telescope tube firmly secured in two collars fixed by adjusting screws to the stage carried by the vertical spindle.

- The modern form of dumpy level has the telescope tube & the vertical spindle cast as one piece & a long bubble tube is attached to the top of the telescope. This form is known as solid dumpy.

- Levelling head generally consists of two parallel plates with either three- foot screws or four foot screws. The upper plate is known as tribrach. Lower part is known as trivet which can be screwed on to a tripod.

The advantages of the dumpy level over the wye level:

- Simple construction with fewer movable parts
- Fewer adjustments to be made
- Longer life.

Levelling staff:

- A levelling staff is a straight rectangular rod having graduations. The foot of the staff representing 0 reading. During levelling staff is held vertical at the point and from level horizontal sight is taken.

- Levelling staff may be divided into 2 groups

  - Self reading
  - Target staff.

Fundamental axis of a level:

- **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.

Temporary staff adjustment of a level:

- Setting up
- Levelling up
- Focusing

- It is to set the tripod stand to a convenient height by bringing bubble to the centre of run through the movement of tripod legs radially.

Setting up:

Levelling up

- To make the vertical axis truly vertical the levelling is made with the help of foot screws.
  - Loosen the clamp and turn the instrument until bubble axis is parallel to line joining any two screws.
  - Turn the two screws inward or outward equally till bubble is centered.
  - Turn the telescope through 90 degrees so that it lies over the third screw.

Focusing:

- For quantitative measurements it is essential that the image should always be formed in the fixed plane in the telescope where the cross hairs are situated
- The operation of forming or bringing the clear image of the object in the pane of cross hairs is known as focusing

- Complete focusing involves two steps
- Focusing the eye piece
- Focusing the objective

- Telescope in which the focusing is done by the external movement of either objective or eye piece is known as External focusing telescope.
- Telescope in which the focusing is done by the internally with a negative less is known as internal focusing telescope
- Sensitiveness of a bubble tube: When the difference in elevation between any two points is determined from a single set up by back sighting on one point and fore sighting on the other. The error is due to non-parallelism. When the bubble is not in the centre of run and sensitivity is lost, due to the error of curvature and refraction which is eliminated if lengths of 2 sides are made equal.

TERMS USED IN LEVELLING

- Station: Station is the point where levelling staff is held & not the point where level is kept.
- Height of instrument: For any set up of the level the height of instrument is the elevation of the plane of sight respect to assumed datum. This also known as plane of collimation.
- Back sight: It is sight taken on a level staff held at a point of known elevation with an intension of determining plane of collimation or sight.
- Intermediate sight (I.S): Sight taken on after taking back sights before taking last sight from an instrument station is known as intermediate sight. The sight is also known as
- +ve sight (add)

- Fore sight (F.S): This is the last reading taken from instrument just before shifting the instrument. This is also ve sight.
- Change point (C.P): This is a point on which both fore sight & back sight are taken.
- Reduced level: Reduced level of a point is the level of the point with respect to assumed datum.

TYPES OF LEVELLING

- Simple levelling
- Differential levelling
- Fly levelling
- Profile levelling
- Cross-sectioning
- Reciprocal levelling

- **Simple levelling:** It is the difference in levels of two near by points. It is obtained by simple levelling
- **Differential levelling:** When the distance between two points is very large it may not be possible to take the readings from single setting of instruments. Each shifting facilitated by taking CP.
- **Fly levelling:** It is to carry out levelling with respect to temporary bench mark in convenient direction taking number of CP

- **Crossectioning:** In many engineering projects to calculate earth work involved not only LS is involved but CS of ground is taken in regular intervals.

- **Reciprocal levelling:** When it is not possible to balance FS and BS due to non-parallelism of line of collimation and axis of bubble tube and also due curvature and refraction this is used.

- **H= [(ha- hb) + (h'a- h'b)]/2**

PROFILE LEVELLING

- This type of levelling is known as longitudinal section.

- The reduced levels of various points at regular intervals are found along a line or a set of lines. Then the engineers draw the sectional view of the ground to get the profile. This type of levelling is commonly employed in deciding railways, highways, canal, sewage line routes.

- After getting reduced level of various points along the line, profile of the ground is plotted on a drawing sheet. Normally vertical scale is much larger than the horizontal scale to clearly view the profile. Then when the engineers decide the formation level of the proposed project
- The decision is mainly based on balancing, cutting & filling so that the transport of earth is minimum. However, the proposed gradient of formation level should not be more than as permitted. After deciding the formation level & the gradient the difference between two consecutive points is known. If RL of first point is known RL of other points are calculated.

Differential levelling

- is the method of direct levelling 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 Levelling is also known as FLY LEVELLING.

STEPS TO TAKE OBSERVATION

- Instrument level is setup at convenient positions near first point (say A).
- Temporary adjustments should be done, (setting up, levelling up, elimination of a par-allot) are Performed.
- First sight of B.M (point of known elevation) is taken and reading is entered in back Sight column.
- If distance is large instrument is shifted, the instrument becomes turning point (or) changing point.

- After setting up instrument at new position, performing temporary adjustment and Take back sight as turning point.
- Thus, turning point will have both back sight and fore sight readings.
- Link wise the process is repeated till last point (say B) is reached.
- Readings are entered in a tabular form is given Below and Reduced levels are calculated either by height of instrument method (or) rise and fall method.

STATION POINT	BACK SIGHT	INTERMIDEATE SIGHT	FORESIGHT	HEIGHT OF INSTRUMENT	REDUCED LEVEL	REMARKS

ARITHMETIC CHECK: -ΣB.S-ΣF.S=ΣRISE-ΣFALL=LAST RL -FIRST R.L

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REF

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- SURVEY HANDBOOK
- SURVEYING MADE EASY NOTES
- SURVEYING BANNISTER
- MY NOTES

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