CIVIL ENGINEERING

SURVEY -I NOTE

4th SEMESTER

Levelling

* Define levelling
Levelling is a branch of Surveying, to determine the relative height of the different object on the Earth Surface is called as levelling.

use of levelling
* To find the elevation of given points with respect to a given or assumed datum
* To prepare the contour map
* To establish point at a given elevation or at different elevation with respect to a given
* To prepare longitudinal sectioning and cross sectioning of a project.

Bench mark :- Bench mark is a relatively permanent point of reference whose elevation with respect to some assumed datum is know as Bench mark.

Reduce level
The vertical distance of a point above or below the datum is know as the elevation or R.L of that point.
R.L of a point may be positive or negetive according to as the point is above or below the datum.

Different kinds of bench mark
A BM is the reference point of know elevation. it may be classified into following types.
1. G.T.S Bench mark
2. permanent Bench mark
3. Temporary Bench mark
4. Arbitary Bench mark

G.T.S Bench mark — The great trignometrical survey (G.T.S) bench mark are established by the Survey of India throughout the country. The level of this bench mark are established very accurately at large interval with respect to the mean Sea level at Bombay port.

② Permanent Bench mark :- These are established by different Government department like PWD, Railway, irrigation etc. The RL of these points are determine with reference to the G.T.S Bench mark. point on rock, culvert gate pillars etc

③ Temporary Bench mark :- These are established temporary whenever required. These are generally chosen to close the day's work and to start the next days. points on roof, walls basement, etc

④ Arbitrary Bench mark :- When the RL of some fixed points are assumed, they are termed arbitrary Bench-mark.

* Datum Surface

It is any surface, to which elevation are taken as a reference for the determination of elevation of various points. In India the datum adopted for the great trignometrical Survey (G.T.S) is the mean sea level at Bombay port.

* Line of collimation :- It is an imaginary line passing through the intersection of the cross hairs at the diaphragm and the optical centre of the object glass and its continuation

* Height of collimation :- The elevation of the line of collimation is known as height of collimation

* Type of levels Instruements

① Dumpy level
② Tilting level
③ Quick Setting level
④ Y - level
⑤ Reversible level
⑥ Automatic level
⑦ Lazer level

* Level surface :- curved surface perpendicular to direction of gravity
ex - Still water in a lake, pond

Horizontal plane :- Tangential to level surface and perpendicular to plumb bob line is known as Horizontal plane

Vertical plane :- It is normal to horizontal plane and shown by plumb bob

Mean sea level :-
Average height of sea for all the stages of tides considered for 19 years period.

* Method of levelling

*Barometric levelling :- RL difference b/w any two points can be measured by taking the diff. difference b/w them. Pressure can be measured with the help of barometer, hypsometer altimeter also.

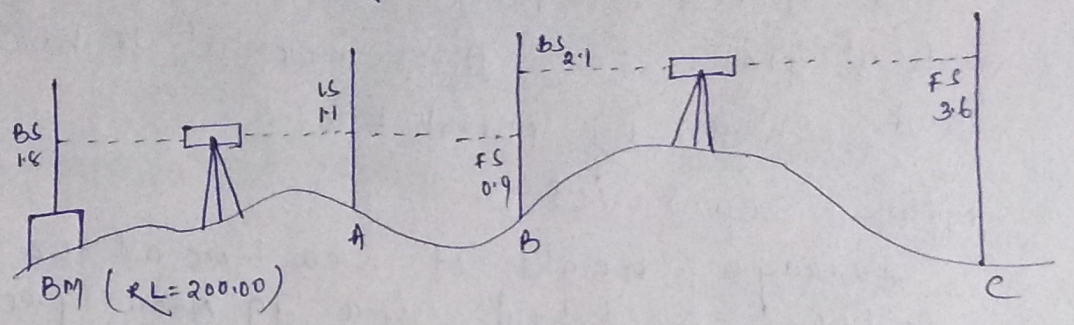
*Indirect levelling :- Height and distance of various points can be calculated by taking the Vertical angles

*Direct levelling :- Concept of telescope and Spirit level is coupled.

Types of levelling staff
(i) Self reading staff
(a) Solid - 3m
(b) folded - 4m
(c) Telescopic - 4m, 5m
(ii) Target levelling staff

Types of levelling

(i) Differential Levelling / fly levelling
ii) Profile levelling
iii) Longitudinal sectioning & cross-sectioning
iv) Precise Levelling
(v) Reciprocal levelling



Station :— location of levelling staff

Height of instrument :— It is the reduce level of lol

$$HI = RL + BS$$

Backsight (BS) :— It is the sight taken on a point of known elevation. It is called as a plus sight because HI can be calculated by adding BS to the known RL and it is the first reading taken on the levelling staff.

Force Sight (FS) :— It is the last reading taken on a point of Levelling staff.

Intermediate sight (IS) :— It is intermediate reading taken between force sight (FS) and back sight (BS) reading.

* Line of sight :— It is an imaginary line passing through the optical centre of object and intersection of cross-hairs.

Method of reduction of level

(1) HI method or collimation method

(2) Rise & fall method

HI method

It is not suitable for intermediate sight because there is no check for it.

Station	BS	IS	FS	HI	RL	Remarks
BM	1.8			201.8	200.00	RL of B
A		1.1			200.700	
B	2.1		0.9	203.00	200.900	C.P
C			3.6		199.400	

Check $\Sigma BS - \Sigma FS$ = Last RL − first RL

= 0.6

Rise & fall method — This method is superior than HI method as is one verified. Rise & fall method is used for small area, preparation of contours map

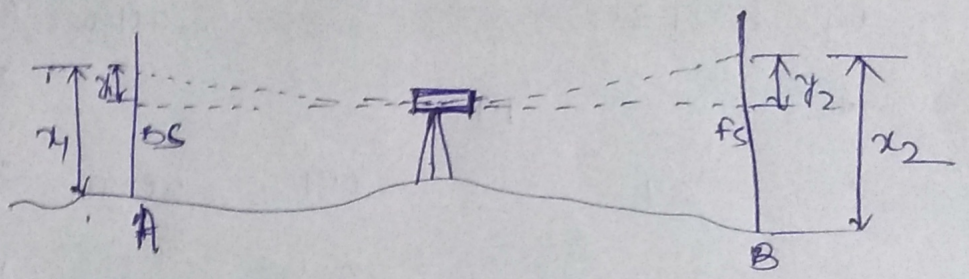
Station	BS	IS	fs	Rise	Fall	RL	Remarks
BM	1.8					200.00	
A		1.1		0.7		200.7	
B	2.1		0.9	0.2		200.9	C.P
C			3.6		1.5	199.4	

Check $\Sigma BS - \Sigma FS = \Sigma Rise - \Sigma Fall$ =

Last RL − first RL = 0.6

Balancing Backsight & Foresight

When it is required to evaluate the RL difference b/w any two points taking BS on point 1 and FS on point 2. It is necessary to make the distance equal from instrument to each of the station to eliminate the error due to Line of collimation and its adjustment error due to curvature and refraction.



Correct Staff reading on A = $x_1 - y_1$

Correct staff reading on B = $x_2 - y_2$

True difference in levels b/w point A & B

$= (x_1 - y_1) - (x_2 - y_2)$

$= x_1 - x_2$ if $y_1 = y_2$

$y_1 = y_2$

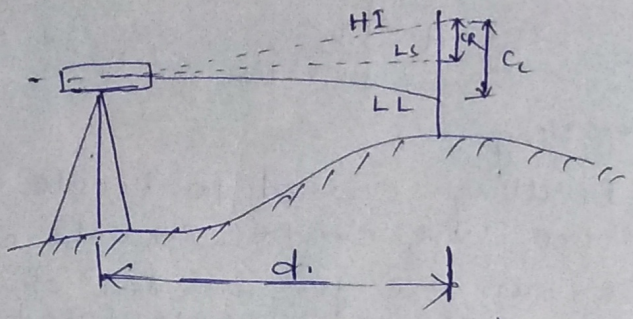
$D_1 \tan\alpha = D_2 \tan\alpha$

$\Rightarrow D_1 = D_2$

Instrument must be centrally located b/w station.

Correction for curvature

It is the difference b/w horizontal line and level line



The apparent reading is more and the object appears to be lower than it really is

Hence correction for curvature is (−)

$$C_c = \frac{d^2}{2R} \quad (-)$$

where $R = 6370$ Km

$C_c = -0.07857 d^2$

Correction for refraction

The LoS is deviated from horizontal line, hence the effect of refraction is to make the object appear higher than it really is C_R is positive

$$C_R = \frac{1}{7} C_c = \frac{d^2}{14R}$$

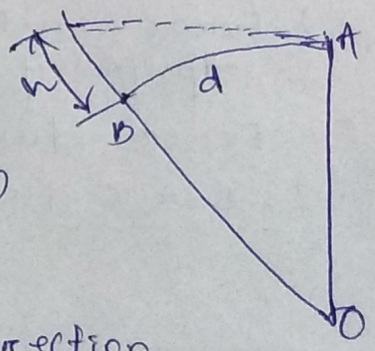
$C_R = 0.01122 d^2$ (when d in Km)

Combined correction $C = C_c + C_R$

$= -0.07857 d^2 + 0.01122 d^2$

$C = -0.06735 d^2$

① Distance to visible Horizon



P → point of observation

A − horizon

d − distance b/w P & A

w = Combined correction

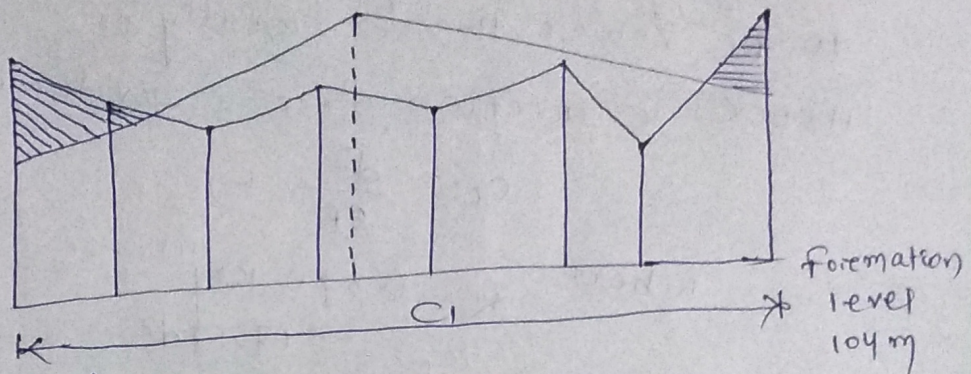
$= 0.06735 d^2$

$$\therefore d = \sqrt{\frac{h}{0.06785}} \quad (h \text{ in m})$$

Profile levelling

Profile levelling is used to locate the centre line of path. centre line can be straight or curved.

LS & CS can give you an idea of cross-section from which volume can be calculated.



LS : Internal 5m to 10m

CS : Internal 1m to 2m

Cutting

Filling

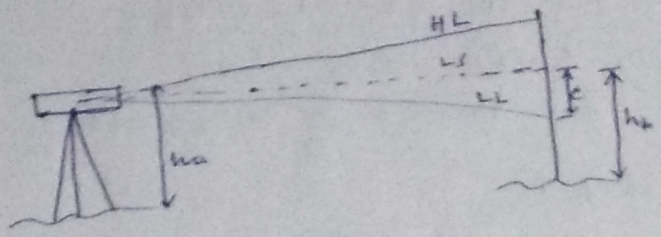
Reciprocal levelling

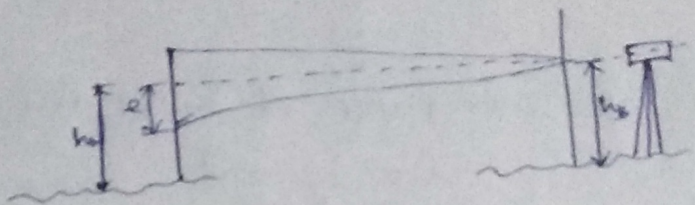
When it is necessary to carry the levelling across a river or ravine or any obstacle requiring long sight between two point so situated that no place for the level can be found from which the length of FS & BS will be each approximately equal, the special method, reciprocal levelling must be opted to obtain the accuracy and to eliminate the following errors :—

(i) Error in line of collimation and instrument adjustment

(ii) Error due to Curvature

(iii) Error due to refraction (partialy eliminate)





A → A : h_a B → A : h_a

A → B : h_b B → B : h_b

(i) True difference in level b/w A & B

$$\Delta = \frac{1}{2}\left[(h_a - h_b) + (h_a - h_b)\right]$$

It is average of difference of apparent reading both staff

(ii) RL of B = RL of A ± H

(iii) Total error $e = -\frac{1}{2}\left[(h_a - h_b) - (h_a - h_b)\right]$

$$e = e_{col} + e_{cur} + e_{ref}$$

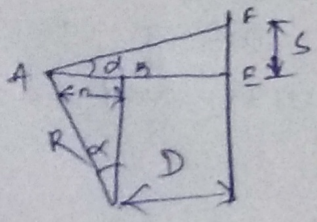
e_{col} → Collimation error

e_{cur} → Curvature error → $(= 0.0785 d^2$ d in Km)

e_{ref} → refraction error → $(= -0.01122 d^2$ d in Km)

Sensitivity of Bubble tube

It is an angular value of one division marked on the level tube. It is an amount the horizontal axis has to be tilted to cause the bubble to move from one graduation.



n → no of division disturb

S → diff in staff reading before and after disturb the level.

$S = CF - CE$ $\quad l = 2mm$

In ΔFAE

$$\tan\alpha = \frac{S}{D} \Rightarrow \alpha = \frac{S}{D}$$

Arc of AOB :-

$$nl = R\alpha$$

$$\therefore \alpha = \frac{nl}{R}$$

Radius of curvature of level tube $R = \frac{nlD}{S}$

$$\alpha = \frac{L}{R} \text{ rad}$$

$$= 206265 \frac{L}{R} \text{ sec}$$

$$\therefore \alpha = \frac{L}{R} = \frac{l}{\frac{nlD}{S}} = 206265 \frac{S}{nD} \text{ seconds}$$

unit second/2mm

Sensitivity depend on

(i) Increasing the radius of level tube
(ii) Increasing the drameter of the tube
(iii) Increasing the length of level tube
(iv) decreasing the roughness of wall
(v) decreasing the vicosity of liquid in level tube.

Contours

Imaginary line passing through points of same elevation

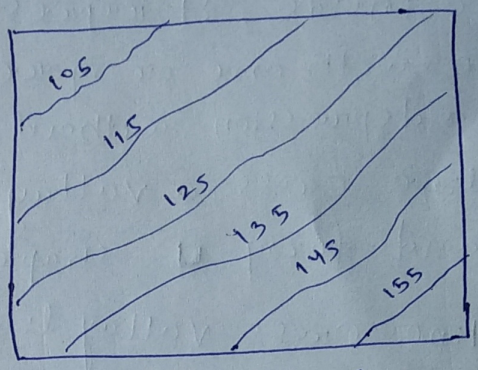
It is a line in which surface of ground intercepted by level surface.

Contour interval

It is the RL difference b/w two adjacent Contours

It is a constant for the given map

It is small for flat grounds and large for undulated ground.



Scale 1:20000
CG 1:1000

Horizontal equivalent

It is the horizontal distance b/w any two point on two consecutive contours

$$\text{Contour gradient (CG)} = \frac{\text{Contour interval}}{\text{Horizontal equivalent}}$$

Contour gradient

It is a line lying on the ground surface and maintaining a constant indination to the horizontal surface.

Characteristic of contours

* Two contour line of different elevation can cross each other in case of overhanging cliff
* Two contour line of different elevation can unite to form a line incase of vertical cliff.
* Contour line close together indicates steep slope and they are far apart represents a gentle slope

(iv) A closed contour line with one or more higher ones inside, it represent a hill. A closed contour line with one or more lower ones inside represent a depression without on out at right angle.

(v) Contour line cross a vallay line at right angle and form U - shape.

(vi) Contour line cross vallay line at right angle and form V - shape.

(vii) A contour line must close upon itself though not necessary within the limits of map.

Method of tracing contours

1. Direct method
   - (a) By Spot-level
   - (b) By radial line
2. Indirect method
   - (a) By Square
   - (b) By rectangular
   - (c) By grids
   - (d) Tacheometric method.

Direct method

Direct method is most accurate when used for small areas where high accuracy is required.

Indirect method

Indirect method is not accurate but used for large areas where less accuracy is required.

uses of contours

i) From contour map, section may be easily drawn in any direction

ii) Intervisibily from two ground point plotted on the map can be ascertained.

iii) It provided a suitable and economical site for any engg. project. A route of a given greade can be traced out on the map.

iv) Catchment area, capacity of reservoir quantity of earth work can be calculated from contour map.