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TRANSPORTATION ENGINEERING – I

DEPARTMENT OF CIVIL ENGINEERING

FACULTY OF ENGINEERING & TECHNOLOGY

SURVEYING UNIT-1 LECTURE - 5

Topics to be covered:

- Profile Leveling
- Reduction of Level

Profile Leveling

Profile leveling is a method of surveying that has been carried out along the central line of a track of land on which a linear engineering work is to be constructed/ laid. The operations involved in determining the elevation of ground surface at small spatial interval along a line is called profile leveling.

Stations

The line along which the profile is to be run is to be marked on the ground before taking any observation. Stakes are usually set at some regular interval which depends on the topography, accuracy required, nature of work, scale of plotting etc. It is usually taken to be 10 meter. The beginning station of profile leveling is termed as 0+00. Points at multiples of 100m from this point are termed as full stations. Intermediate points are designated as pluses.

PROFILE LEVELING

Procedure

In carrying out profile leveling, a level is placed at a convenient location (say I1) not necessarily along the line of observation. The instrument is to be positioned in such a way that first backsight can be taken clearly on a B.M. Then, observations are taken at regular intervals (say at 1, 2, 3, 4) along the central line and foresight to a properly selected turning point (say TP1). The instrument is then re-positioned to some other convenient location (say I2). After proper adjustment of the instrument, observations are started from TP1 and then at regular intervals (say at 5, 6 etc) terminating at another turning point, say TP2 . Staff readings are also taken at salient points where marked changes in slope occur, such as that at X.

The distance as well as direction of lines are also measured.

PROFILE LEVELING

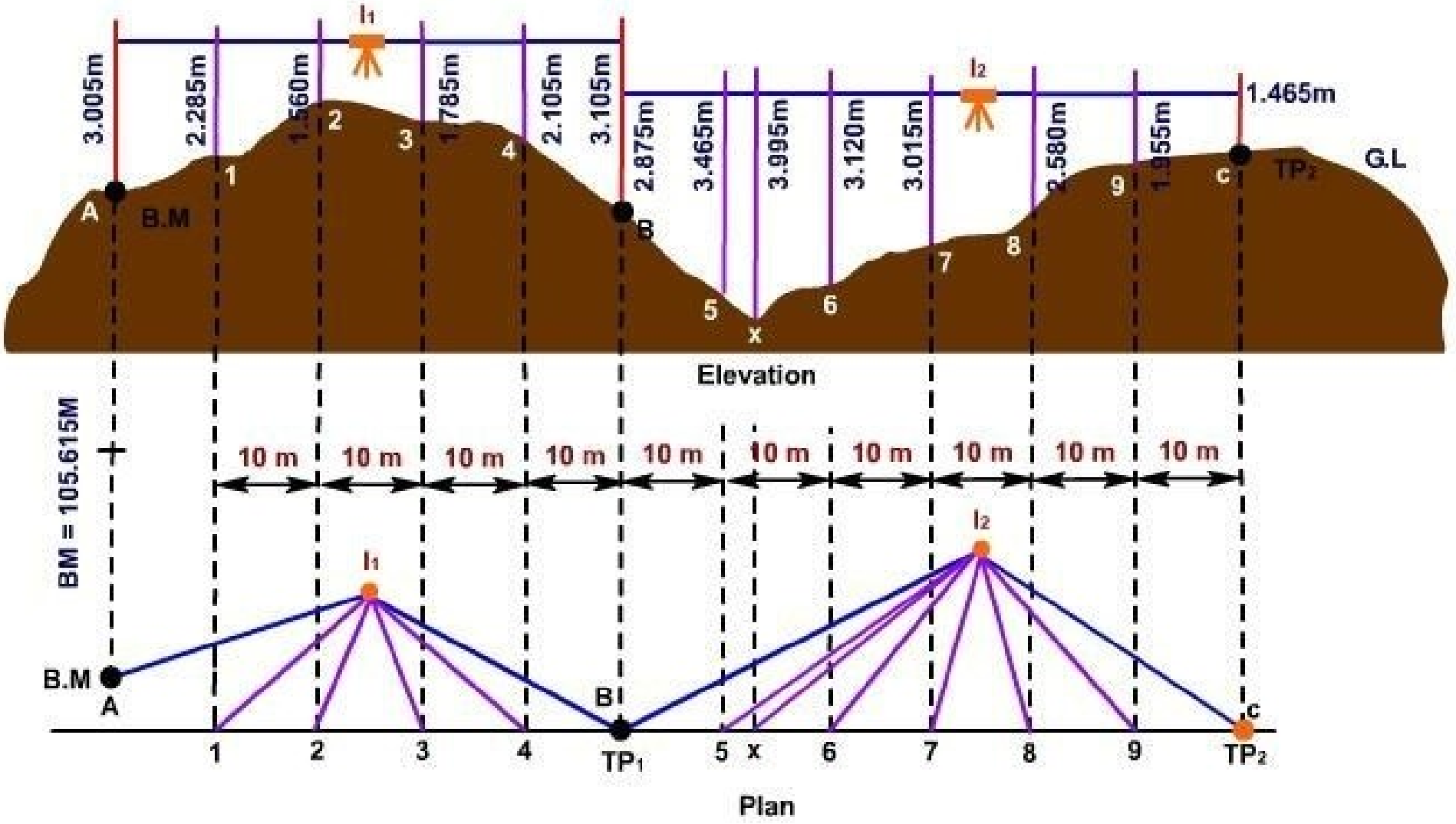

Figure 14.1 Profile Levelling

PROFILE LEVELING

Field book for Reduction of Level

Field book for Reduction of Level

Pegs	Distance(m)	Direction	Staff Reading (m)			Difference in Elevation (m)		H.I (m)	R.L(m)	Remarks
			B.S	I.S	F.S	Rise	Fall			
A			3.005					108.620	105.615	B.M.
1	0+00			2.285		0.720			106.335	
2	0+10			1.560		0.725			107.060	
3	0+20			1.785			0.225		106.835	
4	0+30			2.105			0.320		106.515	
B	0+40		2.875		3.105		1.000	108.390	105.515	T.P.$_1$
5	0+50			3.465			0.590		104.925	
X	0+53.35			3.955			0.490		104.435	
6	0+60			3.120		0.835			105.270	
7	0+70			3.015		0.105			105.375	
8	0+80			2.580		0.435			105.810	
9	0+90			1.955		0.625			106.435	
C	1+00				1.465	0.490			106.925	T.P.$_2$
		□□	5.880		4.570	3.935	2.625			

REDUCTION OF LEVEL

There are two methods of working out the reduced levels of the point from the staff readings taken in the field:

1. Height of Instrument or Collimation Method.
2. Rise and Fall Method.

1. Collimation Method:

It consists in finding the elevation of the plane of collimation i.e. (H.I.) for every setting of the instrument and then obtaining the reduced levels of the points with reference to the respective plan of collimation

To start with, the H.L is calculated by adding the back sight of the R.L. of the starting point. The reduced levels of the intermediate point and the first change point are then obtained by subtracting the respective readings from the H.I. When the instrument is shifted, a new plane of collimation is set up and the height of which is calculated by adding back sight reading to the R.L. of the first change point.

The reduced levels of the successive points and the second change point arc found out by subtracting their staff readings from this new H.I. The process is repeated until all the R.Ls are worked out, and then the arithmetical check is applied.

Arithmetical Check:

The difference between the sum of the back sights and the sum of the fore sights should be equal to the difference of the first and the last R.Ls i.e. Σ B.S. – Σ F.S. = Last R.L. - First R.L. This check verifies the calculation of R.Ls. of the planes of collimation and of the change points only. There is no check on the reduction of R.Ls. of the intermediate points.

This method may more clearly be understood by the following example of longitudinal levelling from flag – staff lower base to downstream parapet of culvert no. 8 . (Fig. 7.16).

REDUCTION OF LEVEL

Check Levelling:

It is conducted for the purpose of checking a series of levels, which have previously been fixed. At the end of each day's work a line of levels starting from the point and returning to the starting point of that day is run with the object of checking the work done on that day.
Since the circuit is completed i.e., the levelling work ends at the starting point, therefore, for the work to be correct the difference between the sum of all the back sights and that of all therefore sights on that day should be zero.

Precise Levelling:
It is special method of levelling used for establishing bench marks with high precision at widely distant points, it is conducted by some govt., agency such as Great Trignometrical Survey of India department for establishing G.T.S. bench marks.

REDUCTION OF LEVEL

Precautions while Levelling:

(i) The adjustment of the level are carefully tested.
(ii) (ii) The parallax should be entirely eliminated by correct focussing.
(iii) The staff should be exactly vertical. It may be plumbed with the staff-level or plumb-bob.
(iv) The bubble should be exactly in the centre of its run at the time of taking readings.
(v) Lengths of sights are limiting to about 100 m.
(vi) The back sight and fore sight distances should be exactly equal. Stadia readings may be taken for this purpose.
(vii) Ground for level and staff should be stable. To avoid error due to settlement of tripod and staff, the back sights and the following fore sights should be taken in quick successions and the order of taking readings is interchanged at alternate set up i.e. at first setting, the back sight is observed first and then the fore sight while at the 2nd setting, the foresight is taken first and then the back sight and so on.
(viii) Levelling work should be suspended in rainy and windy days and also at noon in hot summer days. If work is necessarily to be done under such conditions, level should be protected from the sun or wind by a screen or umbrella.
(ix) Check levelling should be performed by a different surveyor on different days with different change points. And if the closing error exceeds the permissible value, the work should be repeated.

REDUCTION OF LEVEL

Reciprocal Levelling:

It is a method of levelling adopted to determine the difference of levels between two points when it is, not possible to set up the level midway between them as in the case of a river, a deep valley etc.

This method also eliminates:
(i) The error due to curvature and refraction, and
(ii) The error due to line of collimation not being parallel to the bubble line which may otherwise occur due to non —equality of back and fore sight distances.
The operation involves two sets of observations giving two incorrect differences of levels, the mean of which is the true difference. Let A and B be two points [Fig- 7.3 (a) and (b)] on opposite banks of a wide river.

Then to find the true difference of level between A and B, proceed as follows:
(i) Set up and level the instrument very near to A or over A [fig. 7.31. (a)].
(ii) Read the staff held at A and B and let the staff readings be (a_1) and (b_1) respectively.
(iii) Transfer the instrument to B and set it up and level very near to B or over B [fig. 7.31 (b)].
(iv) Observe the readings on the staff held at A and B and denote them as (a_2) and (b_2) respectively.

REDUCTION OF LEVEL

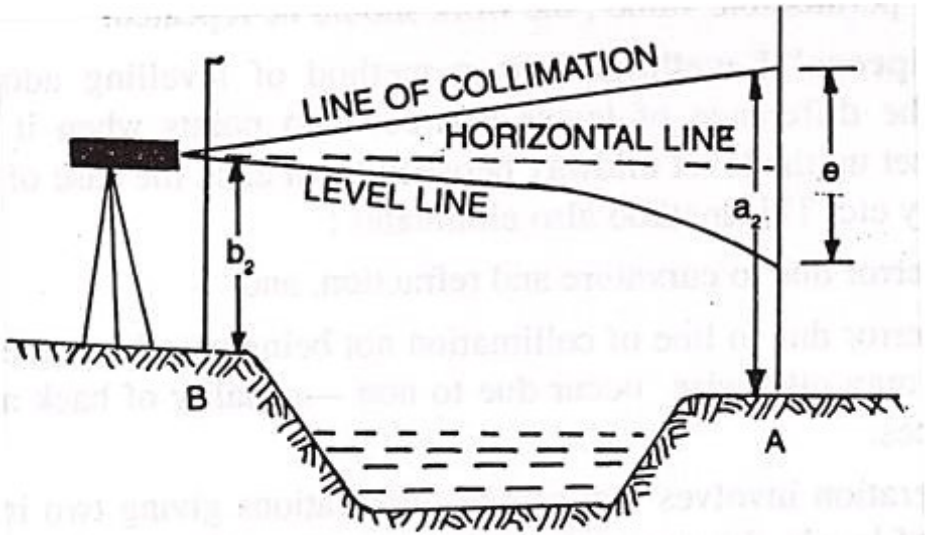

Fig. 7.31. (b)

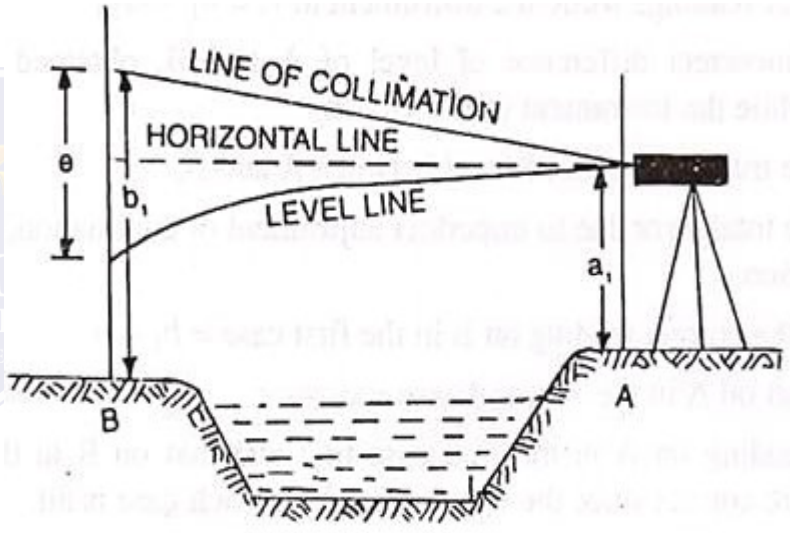

Fig. 7.31. (a)

REDUCTION OF LEVEL

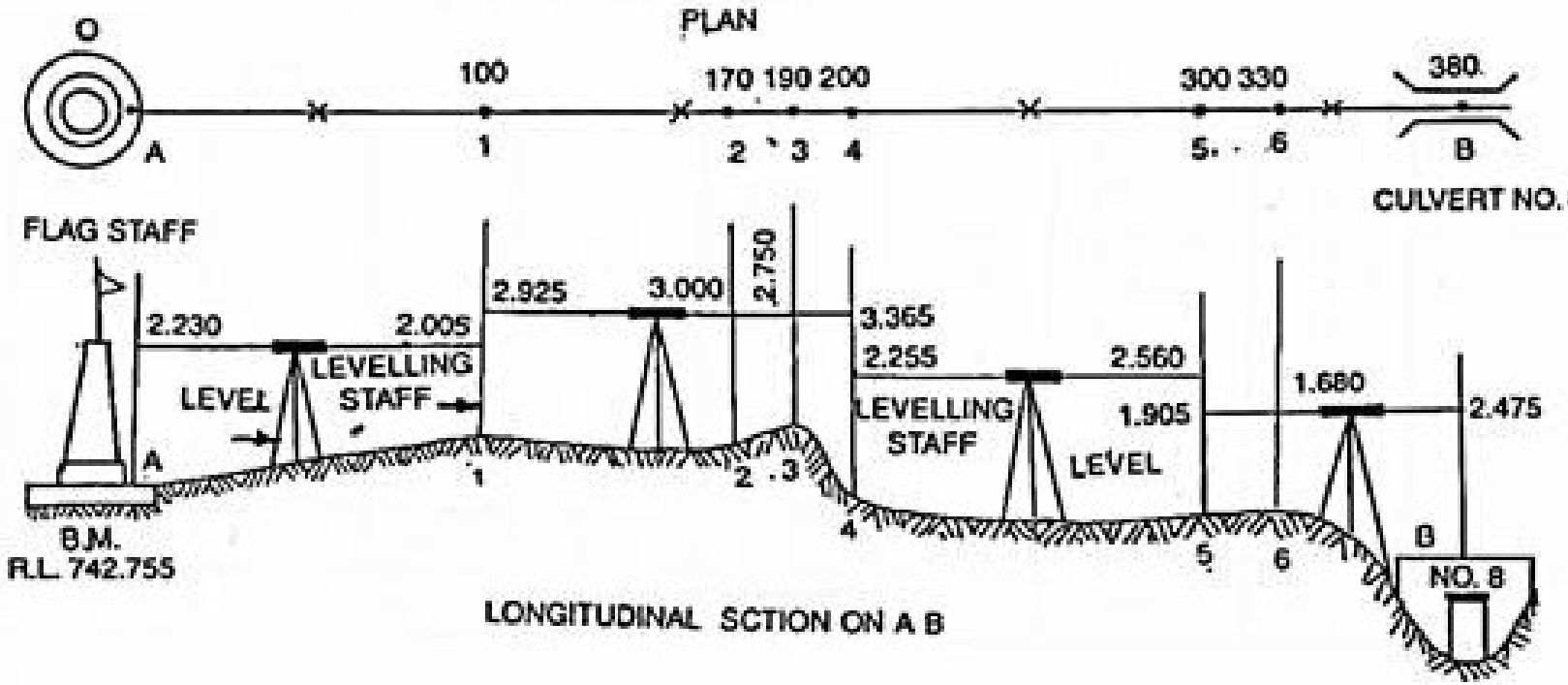

Fig. 7.16

Note:Cross marks in dicate the positions of level and dot marks those of stations points

REDUCTION OF LEVEL

Entries are shown in Table 7.1.

Table 7.1 : Refer to Fig 8.16
Level-Book Page by Collimation Method

Series of levels from flag-staff lower base of down stream parapet of culvert no.8 for Longitudinal Levelling.

Level No. 452 Dated :- 30.11.77.

Station	Distance in meters	Magnetic Bearings		Readings			Height of instrument (H.I.)	R.Ls.	Remarks.
		Fore	Back	B.S.	I.S.	F.S.			
A	0	250° 15'		2.230			744.985	742.755	Flag – Staff
1	100			2.925		2.005	745.905	742.980	C.P.
2	170				3.000		do	742.905	
3	190				2.750		do	743.155	
4	200			2.255		3.365	744.795	742.540	C.P.
5	300			1.905		2.560	744.140	742.235	C.P.
6	330				1.680		do	742.460	
B	380		70° 15'			2.475	do	741.665	Culvert no. 8
		Total = 9.315			10.405				

Arithmetical check:- $\Sigma B.S. - \Sigma F.S = \text{Last R.L.} - \text{First R.L}$

$= 9.315 - 10.405 = 741.665 - 742.755$

$= -1.090 = -1.090$

2. Rise and Fall Method:

In this method, the difference between consecutive points is calculated by comparing each point after the first with that immediately preceding it. The difference of their staff reading indicates rise or fall according as any staff reading is smaller or greater than that at the preceding point. The R.L. of each point is then found by adding rise or subtracting fall to or from the R.L. of the preceding point.

Remember:

If a staff reading (fore reading) is greater than that at the preceding point, then there is fall and if smaller then there is a rise.

Arithmetical Check:

In this method, there are three checks on the accuracy of reduction of levels. The difference between the sum of the back sights and the sum of the fore sights is equal to the difference between the sum of the rises and that of the falls is equal to the difference between the first and the last R.Ls.

Σ B S. – Σ F.S. = Σ Rise – Σ fall = Last R.L. – Ist R.L.

This method is made clear by finding R.Ls. of the points in Fig. 7.16 in Table 7.2.

REDUCTION OF LEVEL

Table 7.2 : Refer to Fig. 7.16

Level – Book –Page by Rise and Fall Method

Series of levels from flag – staff lower base to down stream parapet of culvert no. 8 for Longitudinal Levelling

Level No. 452 Dated :– 30.11.77

Station	Distance in metres	Magnetic Bearings		Readings			Rise (+)	Fall (–)	R.L.	Remarks.
		Fore	Back	B.S.	I.S.	F.S.				
A	0	250° 51′	2.230						742.755	Flag Staff
1	100			2.925		2.005	0.225		742.980	C.P.
2	170				3.000			0.075	742.905	
3	190				2.750		0.250		743.155	
4	200			2.255	3.365			0.615	742.540	C.P.
5	300			1.905	2.560			0.305	742.235	C.P.
6	330				1.680		0.225		742.460	
B	380		70– 15!			2.475		0.795	741.665	Culvert no. 8
				Total = 9.315		10.405	0.700	1.790		

Arithmetic Check :

$\Sigma B.S - \Sigma F.S. = \Sigma \text{ Rise} - \Sigma \text{ Fall} = \text{Last R.L.} - \text{First R.L.}$

$= 9.315 - 10.405 = 0.700 - 1.790 = 741.665 - 742.755$

$= -1.090 \qquad = -1.090 \qquad = -1.090$

REDUCTION OF LEVEL

Comparison of the Collimation and Rise and Fall Methods of Reduction of Levels:

Collimation Method:

1. In the case of more intermediate readings, there is considerable saving of labour and time as it involves only a few calculations.
2. There is no check on the R.Ls of intermediate stations.
3. There are two checks for arithmetical accuracy i.e. the difference between the sum of back sights of fore sights should be equal to the difference of the Ist and last R.Ls.
4. It is generally used for longitudinal and cross levelling operations and for giving levels of roads and canals and similar constructional works.

Rise and Fall Method

1. It is a laborious method as staff reading of each point on the ground, after the first is compared with that preceding it, and the difference of level entered as a rise or fall.
2. There is a complete check on the reduction of R.Ls. of intermediate stations.
3. There are three checks for arithmetical accuracy. The difference between the sum of the back sights and the sum of the fore sights should be equal to that between the sum of the sum of rises and the sum of the falls as well as that between the Ist. and the last R.Ls.
4. It is generally used for earth work calculations and other precise levelling operations.


“Thank you”