



# LECTURE # 6

**In this lecture you will learn about:**

Methods of Leveling:

- Height of Collimation Method
- Rise and Fall Method

**Course Name:**  
“Surveying I”

**Course Code:** CT-123

**Credit Hours:** 2

**Semester:** Summer 2020



# METHODS OF LEVELING

- Height of Collimation Method
- Rise and Fall Method



# HEIGHT OF COLLIMATION METHOD

It consist of finding the elevation of the plane of collimation ( H.I.) for every set up of the instrument, and then obtaining the reduced level of point with reference to the respective plane of collimation.



# HEIGHT OF COLLIMATION METHOD

- Elevation of plane of collimation for the first set of the level determined by adding back side to R.L. of B.M.
- The R.L. of intermediate point and first change point are then obtained by starching the staff reading taken on respective point (IS & FS) from the elation of the plane collimation. [H.I.]
- When the instrument is shifted to the second position a new plane collimation is set up. The elevation of this plane is obtained by adding B.S. taken on the C.P. From the second position of the level to the R.L. C.P. The R.L. of successive point and second C.P. are found by subtract these staff reading from the elevation of second plane of collimation  
Arithmetical check



# HEIGHT OF COLLIMATION METHOD

Sum of B.S. – sum of F.S. = last R.L. – First R.L.

- This method is simple and easy.
- Reduction of levels is easy.
- Visualization is not necessary regarding the nature of the ground.
- There is no check for intermediate sight readings
- This method is generally used where more number of readings can be taken with less number of change points for constructional work and profile leveling.



# RISE AND FALL METHOD

It consists of determining the difference of elevation between consecutive points by comparing each point after the first that immediately preceding it. The difference between there staff reading indicates a rise fall according to the staff reading at the point. The R.L is then found adding the rise to, or subtracting the fall from the reduced level of preceding point.

Arithmetic Check:

$$\text{Sum of B.S.} - \text{sum of F. S.} = \text{sum of rise} - \text{sum of fall} = \text{last R. L.} - \text{first R.L.}$$



# RISE AND FALL METHOD

- This method is complicated and is not easy to carry out.
- Reduction of levels takes more time.
- Visualization is necessary regarding the nature of the ground.
- Complete check is there for all readings.
- This method is preferable for check levelling where number of change points are more.



# BASIC DEFINITIONS

## **Bench Mark and Reference Datum**

In order to calculate the heights of points a datum is required, i.e. a reference level. This is usually the mean sea level. For this purpose, the use of Bench Marks is necessary, and these are classified as follows:

Bench Mark (BM) – a point with known height above mean sea level (or other reference datum). These are permanent points (e.g. unchanged by weather conditions) and are provided by the Department of Lands and Surveys.

## **Reduced Level**

The height of any target point is referred to as Reduced Level (RL), because it is reduced to a known datum.





# BASIC DEFINITIONS

## **Backsight (BS)**

First staff reading taken immediately after setting up the instrument.

## **Foresight (FS)**

Last staff reading taken before moving the instrument to another location.

## **Intermediate sight (IS)**

All readings taken between a BS and a FS.



# HEIGHT OF THE INSTRUMENT METHOD

## Problem # 1

The following readings were observed with a leveling instrument, the instrument was shifted after 5<sup>th</sup> and 11<sup>th</sup> reading.

**0.585, 1.010, 1.735, 3.295, 3.775(5<sup>th</sup>) 0.350, 1.300, 1.795,  
2.575, 3.375 3.895 (11<sup>th</sup>), 1.735, 0.635, 1.605**

Determine the RLs of various points if the reduced level (RL) of a point on which the first reading was taken is 136.440 gives the height of collimation method and applies the check.



# SOLUTION

Station	BS	IS	FS	HI	RL	Remarks
1, 2, 3.	0.585	1.0101.735		137.025	136.440	RL of I point
4.		3.295			136.015	
5.	0.350		3.775		135.290	
				133.600	133.730	CPI
6, 7, 8.		1.3001.795			132.300	CP II
9.		5			131.805	
10.	1.735	3.375	3.895	131.440	131.025	
					130.225	
					129.705	
11, 12.		0.635	1.605		130.805	
					129.835	
	Sum of BS = 2.670		Sum of FS = 9.275			

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# SOLUTION

$$\begin{aligned} \text{HI} &= \text{RL} + \text{BS} \\ &= 136.440 + 0.585 \\ &= 137.025 \end{aligned}$$

$$\text{RL} = \text{HI} - \text{IS}$$

## Check

$$\begin{aligned} (\text{Summation of BS}) - (\text{Summation of FS}) &= \text{Last RL} - \\ &\text{First RL} \end{aligned}$$

$$\begin{aligned} 2.670 - 9.275 &= 129.835 - 136.440 \\ -6.605 &= -6.605 \end{aligned}$$



# PROBLEM

The data from a survey, are shown below.

- Use either the Rise and Fall method or the Height of Plane of Collimation (HPC) method to reduce the data.
- Use arithmetic checks to support your answer.



# PROBLEM

STATION	POINT	BS	IS	FS	RISE	FALL	RL
1	TBM	0.771					+ 43.000
1, 2	A	0.802		1.552			
2	B		2.311				
2, 3	C	3.580		1.990			
3	D		1.220				
3	E		3.675				
3, 4	F	2.408		4.02			
4	G		0.339				
4	H			0.157			

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# SOLUTION

## RISE AND FALL METHOD:

STATION	POINT	BS	IS	FS	RISE	FALL	RL
1	TBM	0.771					+ 43.000
1, 2	A	0.802		1.552		(0.771-1.552) 0.781	(43.000-0.781) 42.219
2	B		2.311			(0.802-2.311) 1.509	(42.219-1.509) 40.710
2, 3	C	3.580		1.990	(2.311-1.990) 0.321		(40.710+0.321) 41.031
3	D		1.220		(3.580-1.220) 2.360		(41.031+2.360) 43.391
3	E		3.675			(1.220-3.675) 2.455	(43.391-2.455) 40.936
3, 4	F	2.408		4.02		(3.675-4.020) 0.345	(40.936-0.345) 40.591
4	G		0.339		(2.408-0.339) 2.069		(40.591+2.069) 42.660
4	H			0.157	(0.339-0.157) 0.182		(42.660+0.182) 42.842
---	---	= <u>7.561</u>	= <u>7.719</u>	---	= <u>4.932</u>	= <u>5.090</u>	---

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# SOLUTION

- **Arithmetic checks:**

1.  $LRI - FRI = 42.842 - 43.000 = - 0.158 \text{ m}$

2.  $\Sigma BS - \Sigma FS = 7.561 - 7.719 = - 0.158 \text{ m}$

3.  $\Sigma R - \Sigma F = 4.932 - 5.090 = - 0.158 \text{ m}$

**THEREFORE OK**





# SOLUTION

## HEIGHT OF PLANE OF COLLIMATION (HPC) OR HI METHOD:

STATION	POINT	BS	IS	FS	HI	RL
1	TBM	0.771			(43.000+0.771) 43.771	+ 43.000
1, 2	A	0.802		1.552	43.771	(43.771-1.552) 42.219
2	B		2.311		(42.219+0.802) 43.021	(43.021-2.311) 40.710
2, 3	C	3.580		1.990	43.021	(43.021-1.990) 41.031
3	D		1.220		(41.031+3.580) 44.611	(44.611-1.220) 43.391
3	E		3.675		44.611	(44.611-3.675) 40.936
3, 4	F	2.408		4.02	44.611	(44.611-4.020) 40.591
4	G		0.339		(40.591+2.408) 42.999	(42.999-0.339) 42.660
4	H			0.157	42.999	(42.999-0.157) 42.842
---	---	= <u>7.561</u>	---	= <u>7.719</u>	---	---

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# SOLUTION

## Arithmetic checks:

1.  $LRI - FRI = 42.842 - 43.000 = - 0.158 \text{ m}$

2.  $\Sigma BS - \Sigma FS = 7.561 - 7.719 = - 0.158 \text{ m}$

**THEREFORE OK**

*Thank You*