CE 103: Surveying

Lecture 3: Leveling

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Outline

- ❑Purpose and use of levelling
- ❑Datum, elevation, mean sea level
- ❑Bench mark and reduced level
- ❑Height of instrument
- ❑Rise and Fall method

4.1 Levelling

Levelling is a surveying operation carried out to determine the elevations of points or to find the differences in elevations of points.

4.2 Purpose and use of levelling

There are 2 main objectives/purposes-

- Find the elevations of given points with respect to a given or assumed reference surface (datum)
- Establish points at a given elevation or at different elevations with respect to a given or assumed datum.

The uses of levelling include-

- To design railways, railroads, canals, sewers, water supply systems etc. having grade lines that best conform existing topography.
- To lay out construction projects according to planned elevations.
- To calculate volume of earthworks and other materials.

4.3 Definitions

Level surface and Level line: A level surface is defined as a curved surface at which each point is perpendicular to the direction of gravity at that point. The surface of a still water is a truly level surface. A line lying in a level surface is called level line.

Elevation: The elevation of a point on or near the surface of the earth is its vertical distance above or below an arbitrarily assumed level surface.

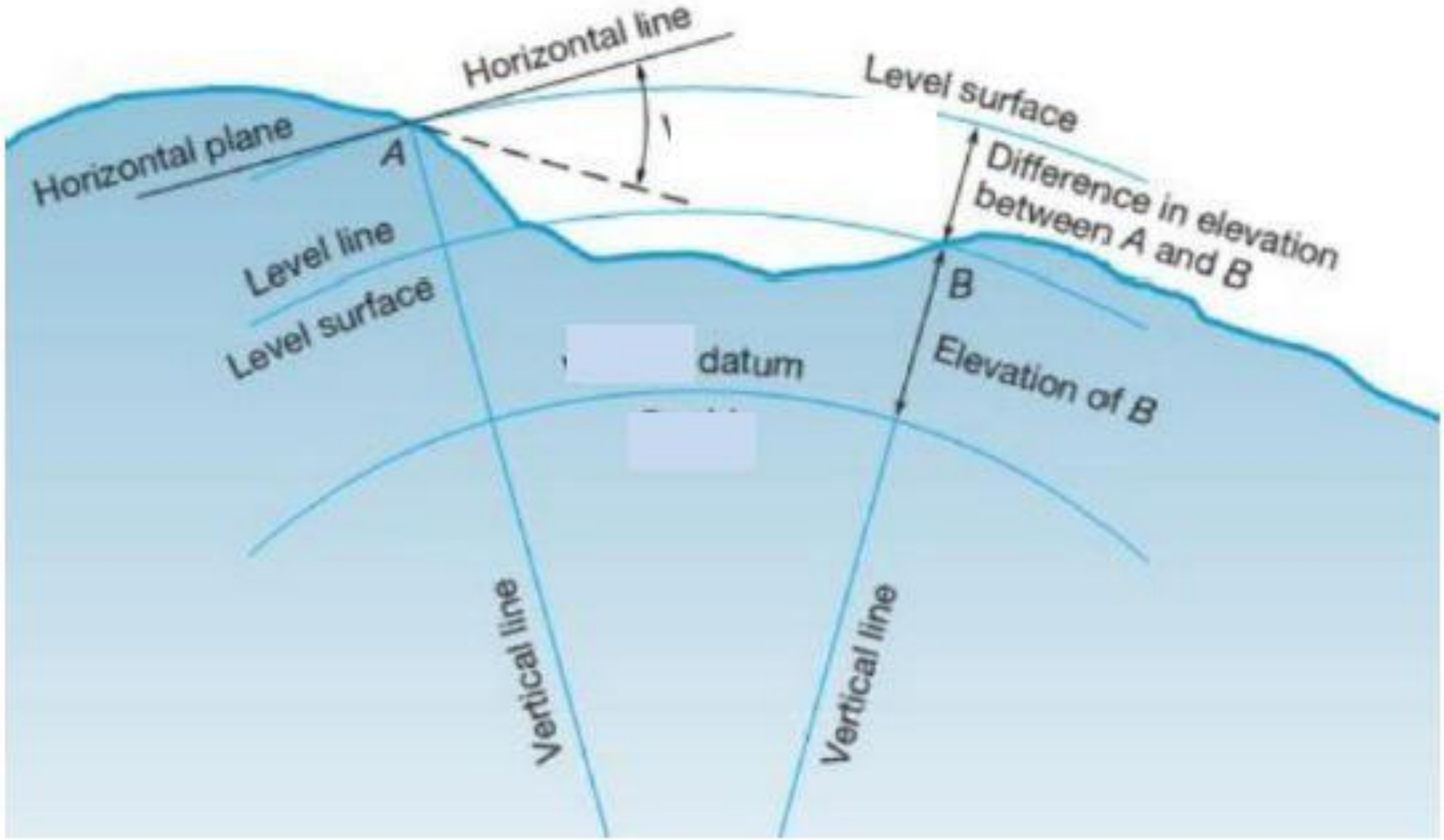
Datum: Datum is any surface to which elevations are referred.

Mean Sea Level: Mean sea level is the average height of the sea for all stages of tides. MSL affords a convenient datum world over, and elevations are commonly given as so much above or below sea level.

Bench Mark: Bench mark is a relatively permanent point of reference whose elevation with respect to some assumed datum is known.

Reduced Level: Reduced level in surveying refers to equating elevations of survey points with reference to a common assumed datum. It is a vertical distance between survey point and adopted datum plane.

Line of collimation: It is the line joining the intersection of the cross hair and the optical center of the objective lens.


Horizontal line
Horizontal plane
A
Level surface
Difference in elevation
between A and B
Level line
Level surface
B
datum
Elevation of B
Vertical line
Vertical line

1. Height of instrument method

Problem 1:

Station	B.S.	I.S.	F.S.	R.L. (m)	Remarks
A	0.865			560.500	Bench Mark
B	1.025		2.105		T.P.
C		1.580			
D	2.230		1.865		T.P.
E	2.355		2.835		T.P.
F			1.760		

Station	B.S.	I.S.	F.S.	H.I.	R.L. (m)	Remarks
A	0.865			561.365	560.500	Bench Mark
B	1.025		2.105	560.285	559.260	T.P.
C		1.580			558.705	
D	2.230		1.865	560.65	558.42	T.P.
E	2.355		2.835	560.17	557.815	T.P.
F			1.760		558.41	

(1) Height of instrument method

A → HI 561.365 from

560.5 + 0.865 = 561.365

[H.I. = R.L. + B.S.]

B → FS − BS = 2.105 − 1.025 = 1.08

HI = 561.365 − 1.08 = 560.285

RL = HI′ − FS = 561.365 − 2.105

= 559.26

C → RL = HI′ − IS = 560.285 − 1.58

= 558.705

D → FS − BS = 1.865 − 2.23 = − 0.365

HI = HI′ + 0.365 = 560.285 + 0.365

= 560.65

RL = HI − BS = 560.65 − 2.23

= 558.42

E → FS − BS = 2.835 − 2.355 = 0.48

HI = HI′ − 0.48 = 560.65 − 0.48

= 560.17

RL = HI − BS = 560.17 − 2.355 = 557.815

F → RL = HI′ − FS = 560.17 − 1.76 = 558.41

Check:

$\sum$ B.S. - $\sum$ F.S. = Last R.L. - First R.L.

Here, $\sum$ B.S.= 6.475 $\sum$ F.S. = 2.090

Last R.L. = 558.41

First R.L. = 560.5

2. Rise and Fall Method

Station	B.S.	I.S.	F.S.	R.L. (m)	Remarks
A	0.865			560.500	Bench Mark
B	1.025		2.105		T.P.
C		1.580			
D	2.230		1.865		T.P.
E	2.355		2.835		T.P.
F			1.760		

Station	B.S.	I.S.	F.S.	Rise	Fall	R.L. (m)	Remarks
A	0.865					560.500	Bench Mark
B	1.025		2.105		1.240	559.260	T.P.
C		1.580			0.555	558.705	
D	2.230		1.865		0.285	558.42	T.P.
E	2.355		2.835		0.605	557.815	T.P.
F			1.760	0.595		558.41	

~~Fall = 2.105 − 1.025 = 1.24~~

(2) Rise and Fall method

B ⟶ F.S. − B.S.′ = Fall

Fall = 2.105 − 0.865 = **1.24**

RL = RL′ − Fall = 560.5 − 1.24

= **559.26**

C ⟶ ~~BS′ − IS = +~~ IS − BS′

Fall = 1.58 − 1.025 = **0.555**

RL = RL′ − Fall = 559.26 − 0.555

= **558.705**

D → Fall = FS - IS = 1·865 − 1·58

= 0·285

RL = RL′ − Fall = 558·705 − 0·285

= 558·42

E → Fall = FS - BS′ = 2·835 − 2·23

= 0·605

RL = RL′ - Fall = 558·42 − 0·605 = 557·815

F ⟶ Rise = BS′ − FS = 2·355 − 1·76

= 0·595

RL = RL′ + Rise = 557·815 + 0·595

= 558·41

Check:

$\sum$ B.S. - $\sum$ F.S. = Last R.L. - First R.L. = $\sum$ Rise. - $\sum$ Fall.

Here, $\sum$ Rise = 0.595

$\sum$ Fall = 2.090