Geodesy 1B
Lecture 2
Precise Leveling

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- Important definitions
- Precise leveling
- Correction of P.L
- Applications of P.L
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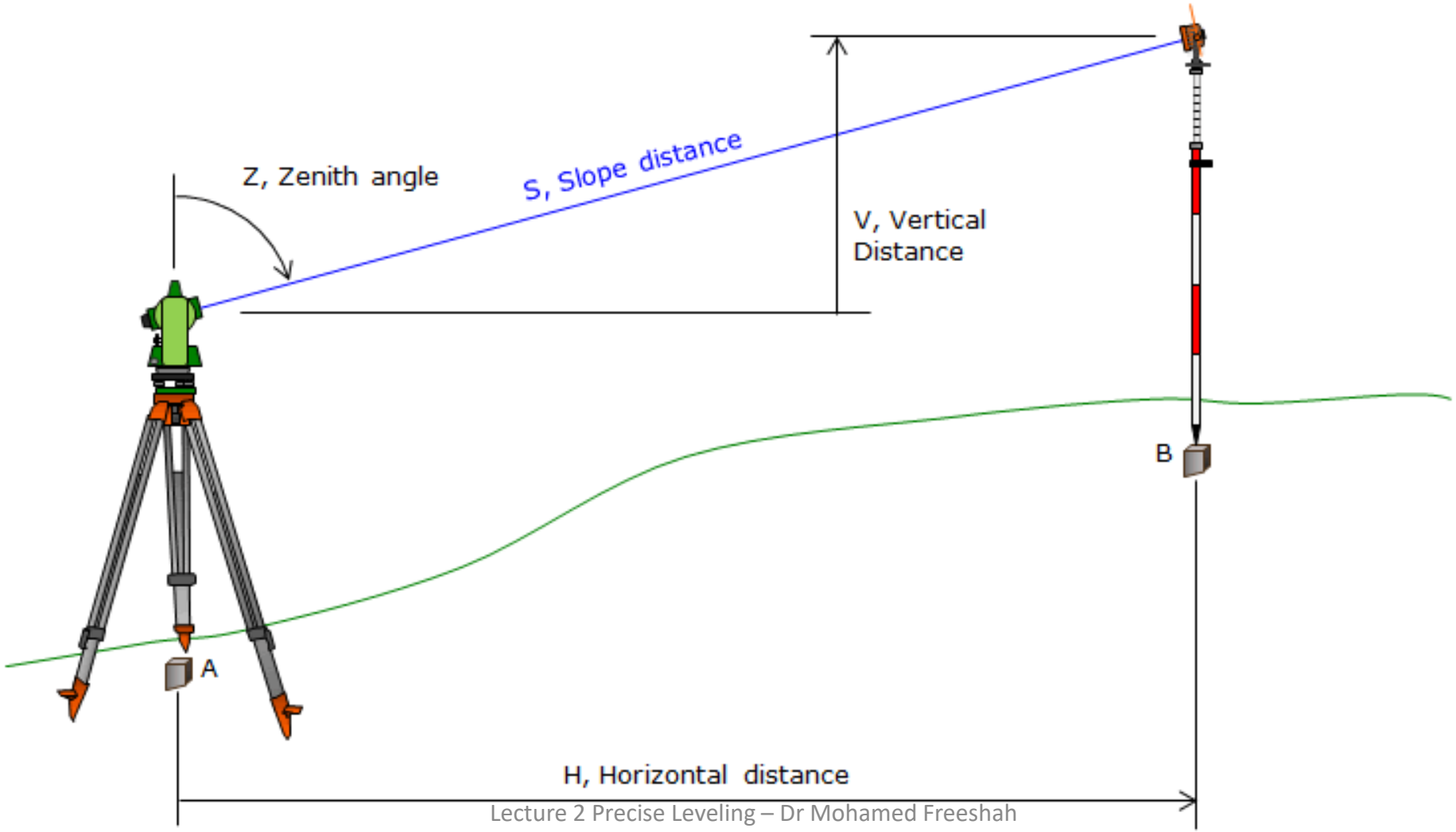
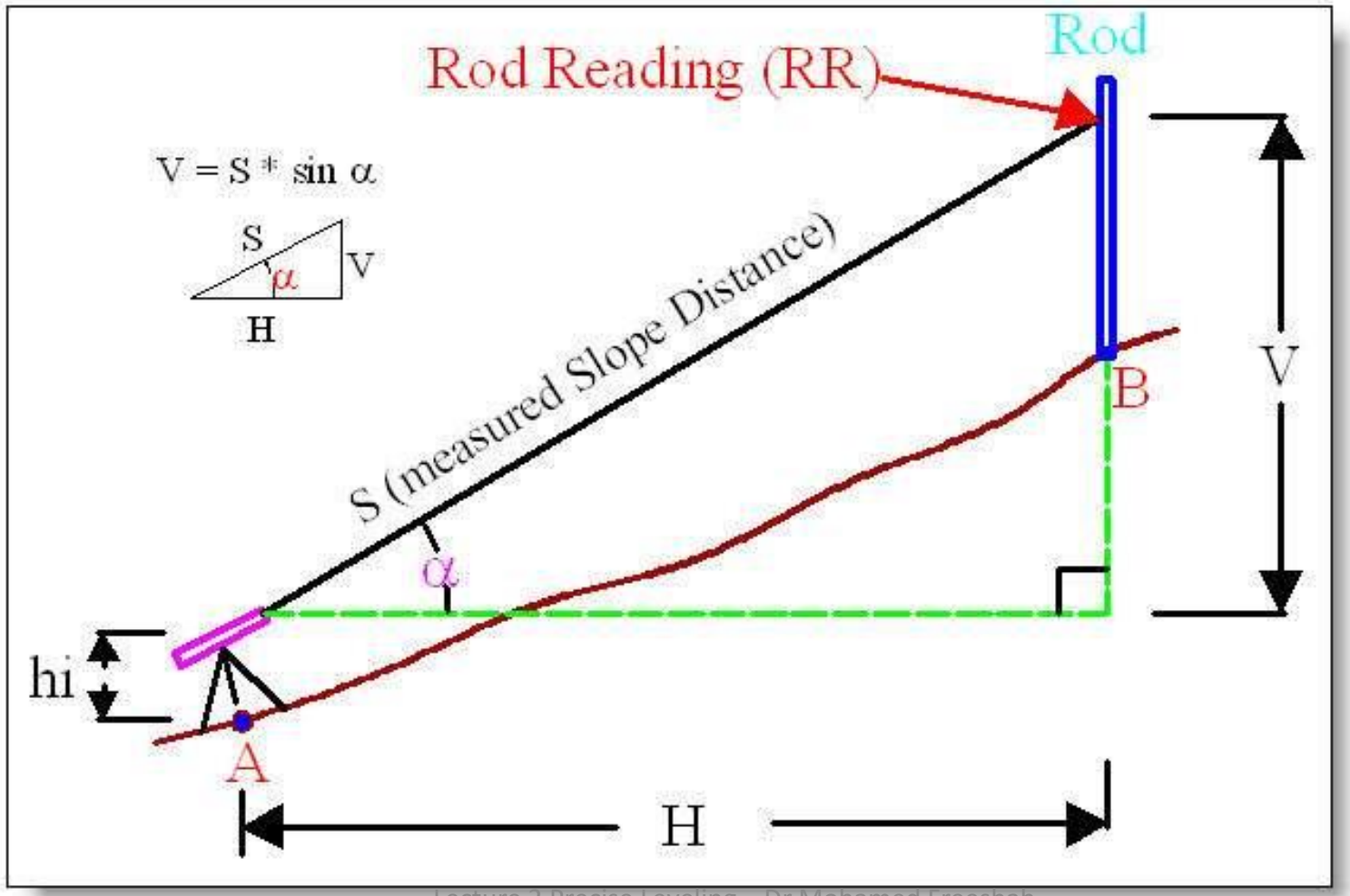
Trigonometric Levelling in small areas, Total Station mechanism



Trigonometric Levelling in small areas, Total Station mechanism



Important Definitions

1- LEVELLING

- *Levelling* is an operation in surveying performed to determine the difference in levels of two points. By this operation the height of a point from a *datum*, known as *elevation*.

2- LEVEL SURFACE

- A *level surface* is the **equipotential** surface of the earth's gravity field. It is a curved surface and every element of which is normal to the plumb line.

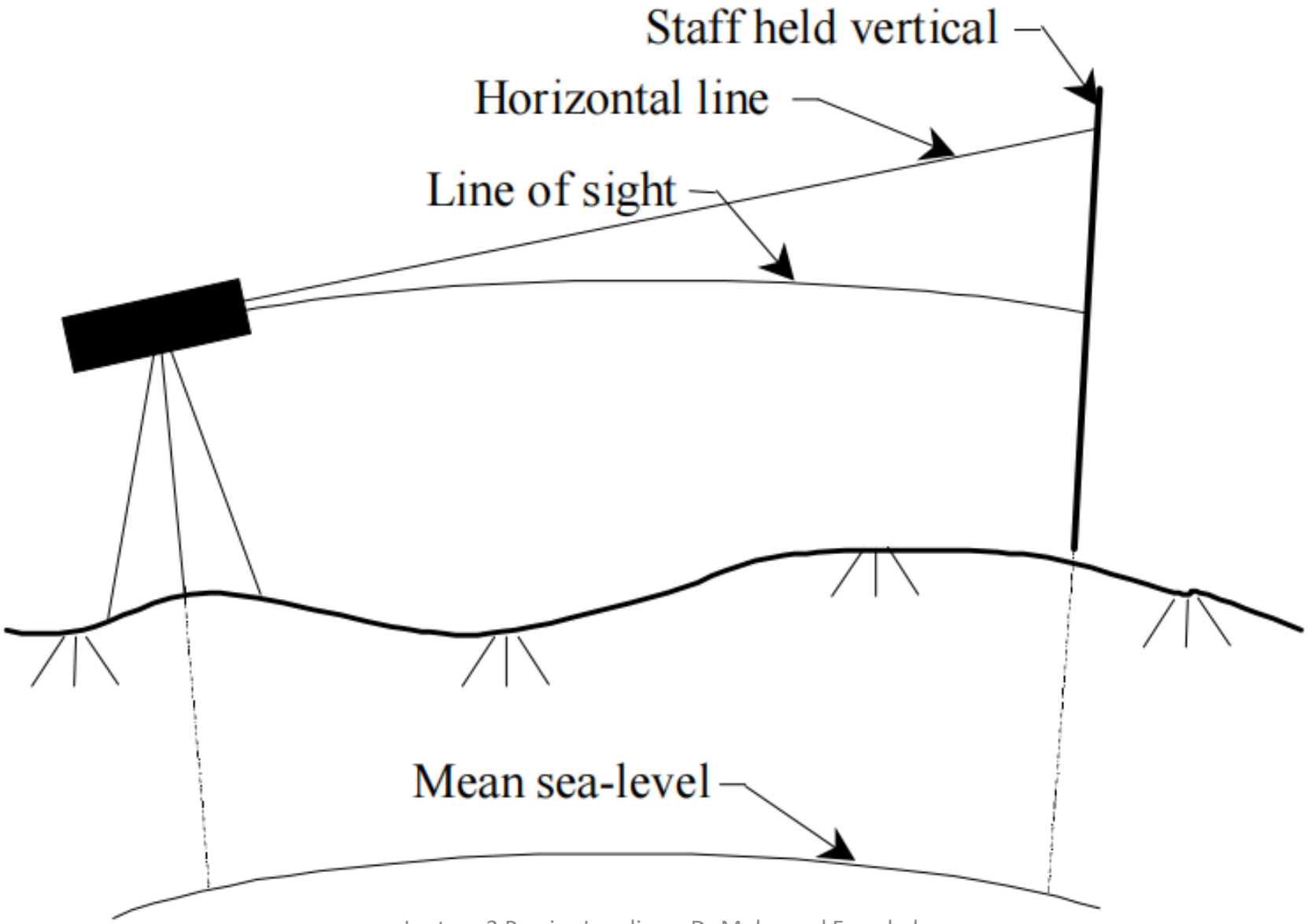
Important Definitions

3- DATUM

- A *datum* is a reference surface of constant potential, called as a level surface of the earth's gravity field, for measuring the elevations of the points. One of such surfaces is the **MSL** surface and is considered as a standard datum. Also **arbitrary** surface adopted as a datum.

4- LEVEL LINE

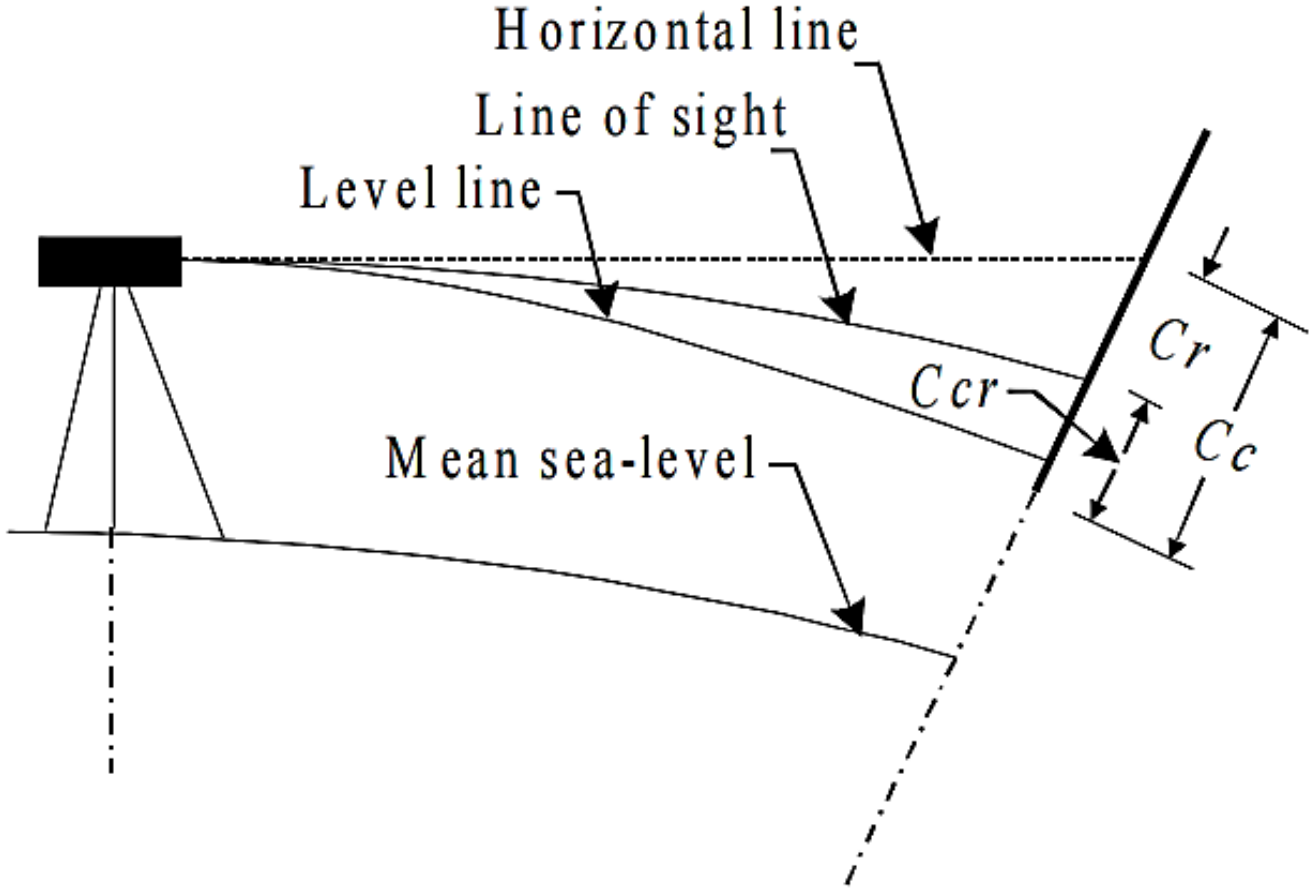
- A line lying in a level surface is a *level line.* It is thus a curved line.


Staff held vertical
Horizontal line
Line of sight
Mean sea-level

Precise Leveling

- This is the operation of levelling in which precise instruments are used. It is used for establishing bench marks for future public work.
- In principle, no difference between ordinary and precise leveling.
- In the former, distances between check points are short, elevations are satisfactory for routine purposes.
- Efforts to control all the sources of errors (balancing of B.S and F.S, equal length of sights…etc.)
- Read temperatures to correct graduations along the length of staff, also, coefficient of refraction. Shimmering (near foot of staff)
- Unequal expansion of instrument parts (keep it in shade)

Precise Leveling Corrections



Precise Leveling Corrections

- The corrections for the curvature of the level line *Cc* and refraction *Cr* are shown in
- The combined correction is given by

$$C_{cr} = -\frac{3}{7}\frac{d^2}{R} \qquad \ldots(3.1)$$

where

C_{cr} = the correction for the curvature and refraction,

d = the distance of the staff from the point of tangency, and

R = the mean earth's radius.

For the value of R = 6370 km and d in kilometre, the value of C_{cr} in metre is given as

$$C_{cr} = -0.067d^2 \qquad \ldots(3.2)$$

Loop Closure

- A *loop closure* or *misclosure* is the amount by which a level circuit fails to close. It is the difference
- of elevation of the measured or computed elevation and known or established elevation of the same
- point. Thus loop closure is given by

$$e = \text{computed value of R.L.} - \text{known value of R.L.}$$

- If the length of the loop or circuit is *L* and the distance of a station to which the correction
- *c* is computed, is *l*, then

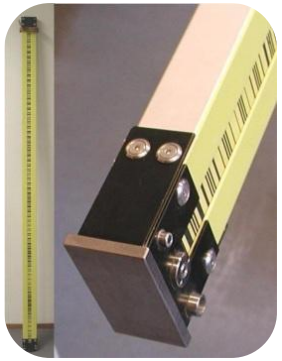
$$c = -e\frac{l}{L}$$

Precise level differ from ordinary level

- The leveling base is made broad and part of instrument is reduced in height. (stability)
- The bubble tube curvature is made large to increase sensitivity
- Magnification of telescope (aperture of telescope at least 4 cm)
- A parallel plate micrometer to read staff directly 0.001 m

Invar precision leveling staff

- Invar (an alloy of iron and nickel with a negligible coefficient of expansion, used in the making of clocks and scientific instruments.)
- It is used for precise leveling work. Generally, 3 m long. To mount staff accurately, detachable stays are provided.
- An invar band (5-10 mm thickness) is fitted to the wooden staff.



Has a circular bubble, Metal base
Prevent corrosion of staff base

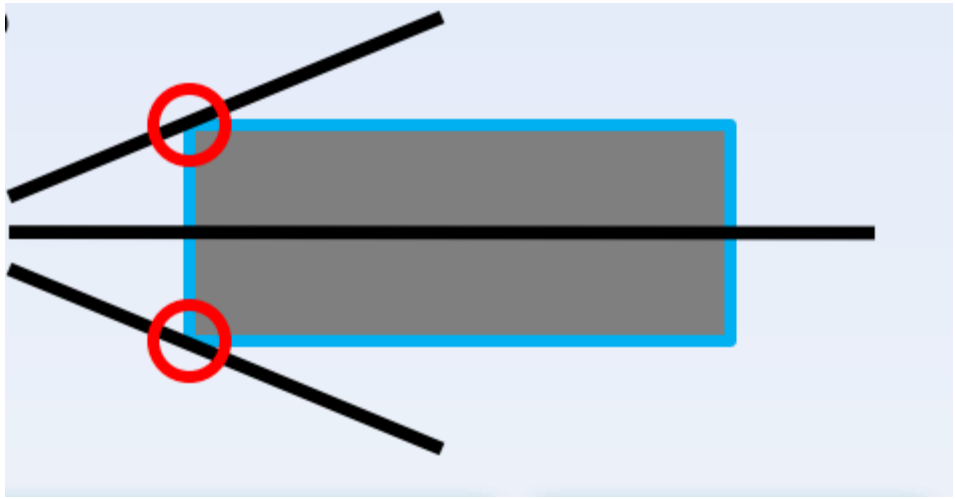
More accurate
Sometimes min. division 0.5cm (double that of ordinary staff)

Micrometer with certain divisions (50 or usually 100) dividing the min. division of the staff and increasing the final accuracy

Cross-hair in Precise Levelling

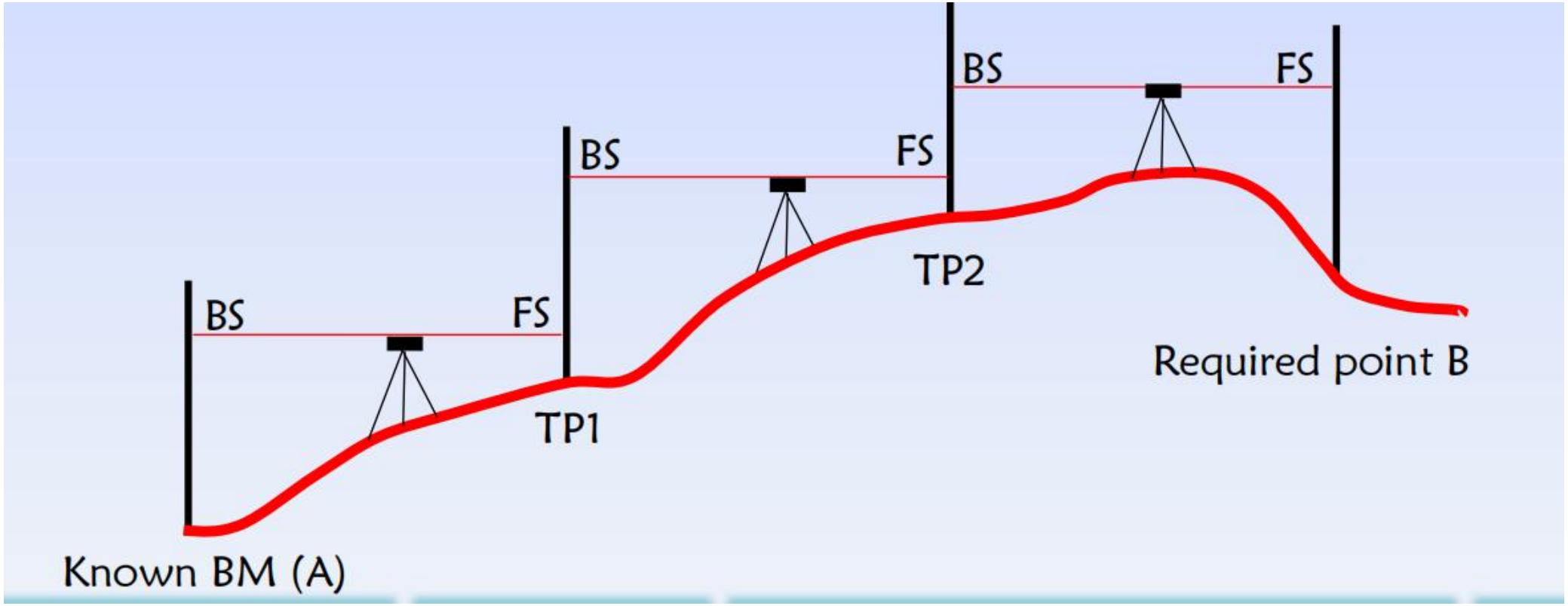
Wedge cross hair

- Focusing the division on the horizontal cross hair is replaced by focusing on the tangency of the wedge cross hair with the staff division
- **Micrometer readings are always added whatever**
- **focusing on upper or lower division**



Applications of precise leveling

1- Benchmark Transfer



Applications of precise leveling

2- Concrete Bridge's Loading Test

Fig 1: - Bridge Load Testing

- Determine the **deformation** of bridges due to ultimate cases of loading
- Check **elasticity** (returning to its original state) or **plasticity** (permanent deformation due to loading) of any bridge after removal of loading.

Applications of precise leveling

2- Concrete Bridge's Loading Test

- How to get Readings?

a) Before loading.

b) Just after loading.

c) 1 hour after loading.

d) 2 hours after loading.

e) Just after loading removal…and so on.

Applications of precise leveling

3- Crust Deformation

Check the movement of Earth's surface due to strong force such as Earthquakes

The level page for Precise leveling

Table 6.4 *Level book page 3*

Station	B.S.	H.I.	F.S.	R.L.	Temperature (°C)	Remarks
	1.530					
1	2.100					B.M.
	2.670					
Mean	2.100	128.425		126.325		
	1.260		1.200			
2	1.900		1.831			T.P.
	2.541		2.463			
Mean	1.900		1.831	126.594		
			1.382			
3		128.494	1.964			
			2.645			
		Mean	1.964	126.530		
	Σ B.S. – Σ F.S. = 4.000 – 3.795 = 0.205			Last R.L. – First R.L. = 126.530 – 126.325 = 0.205		

Standards of permissible errors in P.L

- 1^{st} order $\pm 4 (k)^{1/2}$ mm
- 2^{nd} order $\pm 8 (k)^{1/2}$ mm
- 3^{rd} order $\pm 12 (k)^{1/2}$ mm
- K is distance in km

Calculations of Curvature and Refraction corrections

- Look at white board