

Lecture 3.2  
August 14, 2007

# CE200 SURVEYING

## LEVELING

### Vertical Distances

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### VERTICAL POSITION FIXING - LEVELING

(determining the elevation of points)

Consider two points A and B, and consider that the elevation of A (HA) is known and the elevation of B (HB) is required. What can we do to find HB when we know HA?

### SOME TERMINOLOGY

- **Differential leveling** is the process used to determine a difference in elevation between two points.
- A **Level** is an instrument with a telescope that can be leveled with a spirit bubble.
- The optical line of sight forms a horizontal plane, which is at the same elevation as the telescope crosshair.
- By reading a graduated rod held vertically on a point of known elevation (Bench Mark) a difference in elevation can be measured and a height of instrument (H.I.) calculated by adding the rod reading to the elevation of the bench mark.
- Once the height of instrument is established, rod readings can be taken on subsequent points and their elevations calculated by simply subtracting the readings from the height of instrument.

### SOME TERMINOLOGY

- The first reading from any instrument position is termed **backsight**.
- Readings which are neither the first nor the last from the instrument station are termed **intermediates**.
- The last reading from an instrument position is termed a **foresight**.

- Measuring rod with cm (or mm) divisions on it = staff
- Telescope with a bubble tube and tripod = level instrument

### Level Book

Site: Ataturk Kuru Instrument: L 52  
Date: 05/10/05 Observer: Ali  
Weather: Sunny Booker: Selen

Point	BS	IS	FS	Elevation	Distance	Remarks
A	2,95		100,50			
C		2,76		100,69		
D		2,61		100,84		
E		1,43		102,02		
B			1,14	102,31		
	2,95		1,14			
	1,81		1,81			

### optical telescope

1. Rotate eyepiece to give a sharp, clear image of the cross hairs
2. Rotate focusing screw to give a sharp, clear image of the object being observed.

The aim of focusing is to remove (eliminate) **PARALLAX**

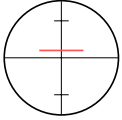
### Parallax

When focussing any optical instrument it is vitally important that we **eliminate Parallax**.

Move the eye up and down (or from left to right) over the eyepiece of the telescope.

If the cross hairs move relative to the object being observed then Parallax exists and the focussing is not satisfactory.

#### Elimination of Parallax



Focus the crosshairs (using the Eyepiece)  
Focus the object (using the Focussing screw)

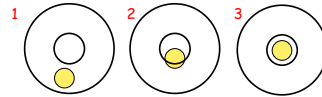
Move eye up and down over the eyepiece

Images appear to move

Parallax exists and must be removed by better focussing

Parallax has been removed. Therefore focussing is good

### Pond Bubble

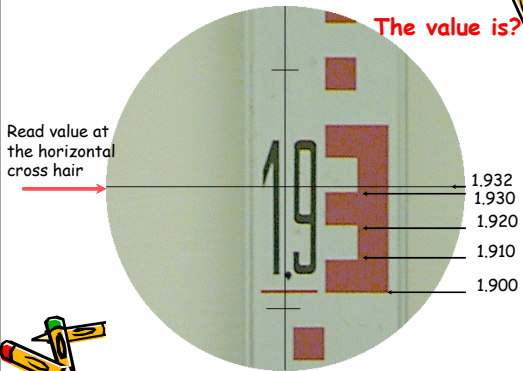


When pond bubble is centred the instrument's standing axis is approximately vertical.

The compensators in the instrument take over and adjust the optical Line of Collimation so that it is horizontal (hopefully)

When the instrument is rotated the compensators ensure that a **horizontal plane of collimation** is swept out (hopefully)

### Reading an E-type levelling staff



### Errors and how to eliminate them

**Refraction** - varies with line of sight, and time

BS = FS  
sight to the same staff first  
don't take reading lower than 0.5m

**Sighting errors**

minimise line of sights  
compare readings on left and right hand side of the staff

**Instrument errors**

adjustment of the circular bubble  
compensator errors  
eliminated by always setting the instrument up facing the same staff

**Staff errors**

graduation error  
staff non verticality  
temperature corrections  
sinking or rising of the staff and instrument

### IN THE FIELD USING THE LEVEL

- ❖ Perform a collimation test as well as before starting and on completion of the job.
- ❖ Allow the instrument to settle for 30 seconds before observing.
- ❖ Allow the instrument to adjust to the ambient temperature for 10 minutes prior to starting work.
- ❖ Point the instrument to the same staff when leveling the instrument.
- ❖ Observe the same staff first.
- ❖ Check automatic levels for their compensator sticking.
- ❖ Use an umbrella to shade the instrument from direct sun.
- ❖ Turn the instrument very slowly from backsight to foresight and vice versa.
- ❖ Make observations as quickly as possible.

### IN THE FIELD USING THE STAFF

- Check the staff bubble regularly.
- Ensure change points are stable.
- Use special change plates.
- Check the bottom of the staff is clean.
- Avoid sighting in wind or when visibility is poor.
- Don't lean on the staff or put any weight on it.

## BOOKING

- ❑ Never use intermediate sights for important stations as these are not checked.
- ❑ Use Rise and Fall method.
- ❑ Reduce observations as you go.
- ❑ Perform standard checks on calculations at the end of a page.



## WARNING

At **every** instrument set up - always **start** with a **BS** to a point of known height.

At **every** instrument set up - always **finish** with a **FS**.

Either the instrument moves or the staff moves.  
**NEVER BOTH**

**ALWAYS CLOSE** leveling to a point of known height.



## Using a level instrument

- Set the tripod
- Take out the instrument from its case
- Put the instrument on the table of the tripod and fix it using tightening screw.
- Center circular level (leveling the instrument roughly) with using three foot screws.
- Aim the telescope to the staff (bring the image of the staff in the objective) using clamping screw.
- Focus the staff using the focus screw.
- Sharpen the image of cross hairs using focusing ring on the eye piece.
- Bring the vertical cross hair exactly on the staff using tangent screw.
- Center the bubble of spirit level using knob for coincidence setting.
- Read the staff in mm precision.
- Check the bubble.



## FIELDWORK 3 PHASE 2

- ✓ You will begin phase 2 of fieldwork 3 after finishing phase 1 (horizontal position fixing, preparing a plan)
- ✓ We will show you as main groups in the field how to use a level instrument which is **very expensive**.
- ✓ We will show you a point in the field, and give its elevation.
- ✓ The leader may arrange the order of main groups in learning how to use a level instrument.
- ✓ It is your responsibility to keep your instruments.



## Attention

- You as a subgroup must show us your reference and contour points in the field before you begin leveling operation.
- We do not have enough leveling instruments so you will work in turn.
- You may arrange the turns of subgroups by yourself.
- 0.5 m. < Working range at leveling < 20 m.
- Acceptable errors:
  - For Check Points → max. 3 cm.
  - For Field Loop → max. 1 cm.



You must bring us **raw data** at every step !!!

- ✓ You will take measurements
- ✓ Calculate the height of points by level book
- ✓ Draw a plan with contour lines
- ✓ Report of phase II

