

Online Surveying FE 208

Lecture 14

Leveling Errors

Learning Objectives for this Lecture

1. **Know the three types of leveling errors**
2. **Know the common mistakes for leveling**
3. **Know the keys to reducing leveling errors**

Leveling Errors

Three Types:

Instrument

Natural

Human

Instrument (Systematic) Errors

Line of sight not level

- Also called a collimation error
 - Can be canceled out if plus and minus sites are equal
 - This error can be determined through a field test and mathematically corrected

Incorrect rod length

- Rods can wear down- should be checked occasionally against a standardized tape

Loose Tripod Legs

- Leg bolts that are too loose or too tight can allow movement or cause strain that can affect the instrument head.
- Loose tripod shoes (feet) can cause unstable setups

Natural Errors (Random)

- Curvature of the earth

A level surface curves downward from a horizontal plane. This causes rod readings to increase (and elevations to decrease)

Making plus and minus sights the same length in differential leveling can cancel this error

- Refraction

Light rays coming from an object to the telescope are bent, and make the line of sight a curve that is concave to the earth's surface, and causes decreased rod readings (elevation decreases). This tends to be a random error when leveling is done over many days.

- A one-day job would result in systematic errors.
Again, balancing plus and minus sights can usually cancel the error
- Temperature
Mainly a concern for precise leveling.
Can impact the rod and the level instrument- shading these instruments (in box or cover when transporting) and keeping an umbrella over the level during use can help.

Heat waves from buildings or hot ground can also make the rod appear to wave. Taking shorter sights can help.

- Wind- can make precise leveling impossible.
- Instrument Settling between setups
These errors tend to be cumulative
Avoid spongy ground if you can. Take readings quickly, avoid walking around the instrument, alternate plus and minus sights.
 - Turning point settles
Similar to instrument settling. Use solid objects/stakes to set turning points.

Human Errors (Random Errors)

Bubble not centered. Instruments must be level, especially on long sights. If the level bubble changes level between plus and minus sights, re-level the instrument. Should check the level bubble before and after every sight.

Parallax.

Parallax is the apparent motion of an object caused by a movement in the position of the observer's eye. To demonstrate, place your index finger about a foot in front of your eyes and alternate closing one eye while the other eye watches the finger. In leveling, can result from poor focusing of the lens and results in bad rod readings. Careful focusing should eliminate. Focus so that the cross hairs appear clear and distinct.

Faulty rod readings

From poor weather, long sights, tall sights, parallax, bad rod work. Can be minimized by adjusting the sight distance.

Bad rod work

Not having a level rod. Use a plumb bob or rod level to make sure the rod is level. Wave the rod if in doubt- the lowest mark should indicate plumb. The instrument person can also tell you whether the rod appears plumb in the opposite axis (left to right).

COMMON MISTAKES IN LEVELING

Improper use of a long rod. Rod must always be extended so that the marks on the rod joints are exactly the same every time.

Moving the rod on a turning point that is used for the plus and minus sight. Make sure that the location is defined and the rod is in the same place for both sites. On hard surfaces the outline of the rod bottom can be chalked, may want to use a chaining pin to mark one of the rod corners in the forest.

Reading a rod to high. You might mix up 7.33 and 8.32. Note the foot marks above and below the horizontal cross hairs to prevent this mistake.

Recording notes. Have the notekeeper call out and get confirmation of the measurement from the instrument person before entering a measurement. Digital levels can automatically store this information and reduce blunders.

Leaning on the tripod while taking a measurement. It's human nature to use a hand to steady yourself when hunkered over an instrument. Locate the instrument at a comfortable height where you don't have to stoop and- keep your hands off!

Keys to reducing errors and avoiding mistakes

1. Check the bubble before and after every shot.
2. Use a rod level.
3. Keep the horizontal lengths of plus and minus sites equal.
4. Running lines fore and back.
5. Checking arithmetic in field books.
6. Turn the level gun 360 degrees after each initial setup