Survey I

Lecture 6

Out lines

- Sources of errors in levelling
- Instrumental Errors.
- Earth curvature and refraction.
- Personal errors and on site mistakes.

Sources of errors in levelling.

The followings are the most common errors in the leveling process.

1- Instrumental errors.
2- Earth curvature and refraction.
3- Personal errors and on site mistakes.

Instrumental errors.

A- Collimation error: This can be a serious error in levelling if the sight lengths from one instrument position are not equal, since the collimation error is proportional to the difference in these. So, in all types of levelling sight lengths should be kept equal, particularly back sights and fore sights and before using any level it is advisable to carry out a two-peg test to ensure the collimation error is within acceptable limits.

B- Compensator not working: For an automatic or digital level, the compensator is checked by moving a foot screw slightly off level, by tapping the telescope gently or by pushing the compensator check lever to ensure that a reading remains constant. If any of the checks fail, then the compensator is not working properly and needs to be repaired.

Instrumental errors.

C- Imperfect adjustment of the Instrument: The only essential relation is that the line of sight should be parallel to the axis of the level tube. Any inclination between these lines causes a systematic error; the effect of imperfect adjustment of the instrument is minimized by adjusting the instrument and by balancing back sight and foresight distances.

D- Parallax: This condition is present when either or both of the following occur:

i- The objective lens is not focused on the object.

ii- The observer's eye is not focused on the plane of the cross hairs.

E- Defects of the staff: The base of the staff should be checked to see if it has become worn – if this is the case then the staff has a zero error. This does not affect height differences if the same staff is used for all the levelling, but introduces errors if two staffs are being used for the same series of levels. When using multi-section staff, it is important to ensure that it is properly extended by examining the graduations on the other side of each section as it is extended. If any of the sections become loose the staff should be returned for repair.

Earth curvature and refraction.

A- Earth Curvature.

Due to the curvature of the Earth, the line of sight at the instrument will deviate from a horizontal line as one moves away from the level.

$(R+e_C)^2=R^2+D^2$

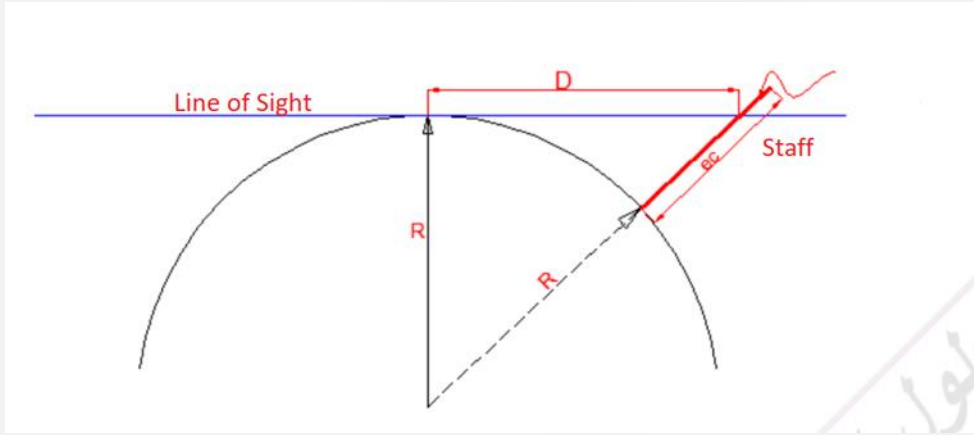
$R^2+^2Re_C+e_C^2= R^2+D^2$

$2R.\ e_C = D^2$

$e_C= D^2/2R$

Where: R = 6370 km

$$\therefore e_c = \frac{D^2}{2\times 6370}\times 1000 \quad \rightarrow \quad \therefore e_c = 0.0785\,D^2$$



$e_C= 0.0785\ D^2$

e_C = Earth curvature correction (m) (-)

D = Distance from instrument to the staff (km)

Earth curvature and refraction.

Example: -

Find the effect of earth curvature on staff reading taken on 283 m away from the instrument, if the staff reading was 2.794m

Solution: -

$$\therefore e_c = \frac{D^2}{2 \times 6370} \times 1000 \quad \rightarrow \quad \therefore e_c = 0.0785\, D^2$$

$e_c = 0.0875 \text{ x } (283/1000)^2 = 0.006$

corrected staff reading = 2.794-0.006 = 2.788 m

Earth curvature and refraction.

B- Atmospheric refraction.

Refraction (r) is affected by atmospheric pressure, temperature, and geographic location but, as noted earlier, it is usually considered to be about one-seventh of the curvature error

$e_r = 1/7\ e_c$

$e_r = 0.14\ e_c$

Total Earth curvature and refraction = $- 0.0785\ D^2 + 0.14(0.0785\ D^2) = - 0.0673 D^2$

3-Personal errors and on site mistakes

Some of the mistakes commonly made in leveling are:

1. Confusion of numbers in reading the rod, for example, reading and recording 4.92 when it should be 3.92.
2. Recording back sights in foresight column and vice versa.
3. Faulty additions and subtractions; adding foresights and subtracting back sights.

As a check, the difference between the sum of the backsights and the sum of the foresights should be computed for each page or between bench marks.

4. Rod not held on same point for both foresight and backsight. This is not likely to occur if the turning points are marked or otherwise clearly defined.

How to Reduce the Chance of Errors Occurring?

- Levelling should always start and finish at bench marks so that misclosures can be detected.
- When only one bench mark is available, levelling lines must be run in loops starting and finishing at the same bench mark.
- Where possible, all sights lengths should be below 50 m.
- The staff must be held vertically by suitable use of a circular bubble or by rocking the staff and noting the minimum reading.
- BS and FS lengths should be kept equal for each instrument position.

References

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End of Lecture 6

Next Lecture :Profile leveling.