Activity 3.4.1A Differential Leveling

Introduction

How can someone determine exactly where she is on Earth? How can a property owner determine exactly where his property ends and his neighbors' begin? How can a builder be sure that he is constructing the floor of a building above the floor plane? Land surveying refers to the science of determining the relative positions of points on the Earth's surface.

There are many types of land surveys. A *property survey* establishes property lines. A *topographic survey* is used to gather data to prepare maps that show the location of natural and man-made features and the contours and elevations of the ground. A site survey (also called a plot survey or a lot survey) often refers to the combination of a property survey and a topographic survey for a single property. When prepared by a licensed surveyor, the survey is a legal document that is filed with the deed to the property, generally at the local courthouse.

A *construction survey* locates points and elevations that can be used to establish correct locations and elevations for civil engineering and architectural projects and is often called an engineering survey. For instance, a construction survey might stakeout a line and grade for a foundation, fence, or road.

A surveyor uses several types of surveying instruments to perform a survey. These instruments utilize either optical or laser technology. Some surveying activities are based on Global Positioning System (GPS) technology. GPS works very well for topographic mapping, wetland delineation, and such. Many property and construction surveys are performed using optical or laser equipment.

Optical instruments rely on line-of-sight observations to determine position. The user looks through a telescope on the instrument to spot a target or leveling rod held by an assistant.

A level is one type of optical instrument. The telescope of a level is fixed in a horizontal plane and can be used to accurately measure changes in elevations (vertical difference) and estimate horizontal distances (stadia calculations). An automatic level, or auto level, includes an internal compensator which automatically levels the instrument and is common on building sites because it is easy to set up and use.

In this activity you will use a surveying technique called differential leveling to establish the elevation of a horizontal plane of sight in order to determine the elevation of various features in your classroom.

Equipment

- Pencil
- Level or autolevel
- Leveling rod

- 100 ft measuring tape
- Surveyor's field notebook

Procedure

Set up the surveying instrument and determine the elevations of the specific features indicated by your instructor.

1. Level the instrument on the tripod description.
2. Use a plumb bob or an optical plumb to accurately establish the point over which you are set up.
3. Establish the location and elevation of a bench mark or point of reference (POR). Your instructor will provide you with POR information. **Record the POR elevation in the field notes.**
4. Place the leveling rod on the POR and sight through the telescope to the leveling rod. **Record the rod reading (backsight, BS) in the field book**. This backsight rod reading is the vertical difference between the POR elevation and the line-of-sight of the instrument.
5. Calculate the height of instrument (HI). **Record the HI in the field book**.

   HI = Elevation + BS
6. **Record the upper and lower stadia readings**.
7. Estimate the distance to the POR using the stadia readings.
8. Measure the horizontal distance to the POR using the tape to check your estimate.
9. Move the leveling rod to a point of interest indicated by your instructor.
10. Sight through the telescope to the leveling rod. **Record the rod reading (foresight, FS)**. The foresight rod reading is the vertical difference between the height of instrument and the elevation of the point of interest.
11. Calculate the elevation of the point of interest. **Record the elevation in the field notes.**

    ELEVATION = HI - FS
12. **Record the upper and lower stadia readings.**
13. Estimate the distance to the point of interest using the stadia readings.
14. **Record the horizontal angle from the POR to the desired location**. Be sure to indicate a right or left angle.
15. Repeat the preceding steps as necessary to find the elevation, estimated distance to, and angle to each of the required classroom features.

Remember there is never too much information. It costs much more in time and money to return to the site to retrieve additional data than it does to spend an extra 30 minutes the first time at the site collecting data.

Conclusion

1. Why would a plane survey be unacceptable in order to lay out a pipeline from Alaska to

the continental U.S.?

2. In this activity we found the vertical position (elevation) of the points of interest. What information would be gained from a survey that provides vertical position? When would the determination of horizontal position be important in a construction project?

3. Give some examples of the need for **highly** accurate location (vertical and/or horizontal) information during the design or construction of a civil engineering project.