First Nations Housing Conference
Building Elevation

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Topic:

- Building Elevations are established from a Benchmark somewhere and determined through differential leveling which is the process of measuring vertical distances from a known elevation point to determine elevations of unknown points.

Objectives:

- Introduce students to the basic technique of differential leveling and why it is important to the construction industry.

Question:

- What is the difference between level and plumb?

Key Facts:

- Easily and accurately transfers points of known elevation.
- During the building process everything carries through, so if you start level, plumb, and square and work at it, the finished product will be level, plumb, and square.

Construction phases where leveling is used

- Set the finished grade: Around any house project.
- Excavation: To determine the bottom of the excavation or bottom of footing.
- Foundation Footings: Set the top of the footing forms and misc. concrete pads.
- Foundation Walls: The top of the wall should be determined and transferred using a level; again, this carries through the house.
- Basement Concrete Slab: Cement finishers sometimes use levels to ensure the floor is flat, but not all the time.
- Miscellaneous: What else is installed level and plumb inside or outside a building?
- Types of leveling equipment used
    - Standing level, sometimes called a dumpy level or laser level
    - 6', 4', or 2' hand level, water level (piece of clear hose)
    - tape measure and 2 x 4 or surveyors rod

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Methods of measurement

Building Construction General:

1. All buildings must be located with reference to property lines.
    a. property lines are established (found)
    b. building is located according to the plan (by surveyors, carpenters)
    c. all corners are marked in the field (by surveyors, carpenters)
2. Large buildings will have horizontal control points established.
3. Temporary bench marks will be surveyed onto all major sites from the closest benchmark, usually three are established.

Single-Storey Construction:

1. Construction surveys for single-storey buildings may involve only survey layouts for the building footings.
2. The contractor can often locate the rest of the building components to the footings for both line and grade (most single-storey buildings).
3. A site grading survey will also be required in most circumstances.

Survey measurements can be acquired by using:

1. Direct techniques
    a. Pacing
        i. With a distance from a plan and one marker or property bar found, use your pace to locate the next property bar.
        ii. Also good for rough checking of construction layout points.
    b. Using a tape against the marks to be measured
        i. **Fiberglass tapes** used extensively for many types of measurement, should be periodically checked against a steel tape to check its accuracy. It should not be used for precision work.
        ii. Steel tapes (Invar tapes) are composed of 35 % nickel and 65% percent steel. This alloy has a very low coefficient of thermal expansion, making it useful in precise linear measurements.

   c. Odometer – used to measure from fence line to fence line helping to identify property lines, old roads, etc.

2. Indirect techniques would be measuring reflected light waves or microwaves used by Electronic Distance Measurement instruments (EDM).
   a. Such as the laser level to maintain footing elevation, top of foundation wall, or grading applications.
   b. Total stations used for heavy civil and building applications.

3. Calculated measurements such as Pythagorean Theorem and Trigonometry.
   a. Determine the diagonals for a footing or foundation wall.
   b. Height of a building, etc.

Elementary Surveying
How to Read a Leveling Rod

Leveling Rods

Leveling rods are manufactured from wood, metal, or fiberglass and are graduated in feet (Imperial Units) or metres (Metric Units). The foot rod can be read directly to 0.01 ft, whereas the metric rod can usually be read directly to only 0.01m (cm) with millimeters being estimated. When using the metric rod, it is customary to read the rod to the nearest 1/3 cm or 1/2 cm.

Most leveling surveys utilize two or three piece rods. The one piece rods are used for more precise leveling work. The sole of the rod is a metal plate that will withstand the constant wear and tear of leveling. The zero mark of any rod is at the bottom of the metal plate. Leveling rods are marked in a variety of patterns all of which readily respond to logical analysis. The surveyor should study a rod prior to using it to ensure that the graduations are thoroughly understood.

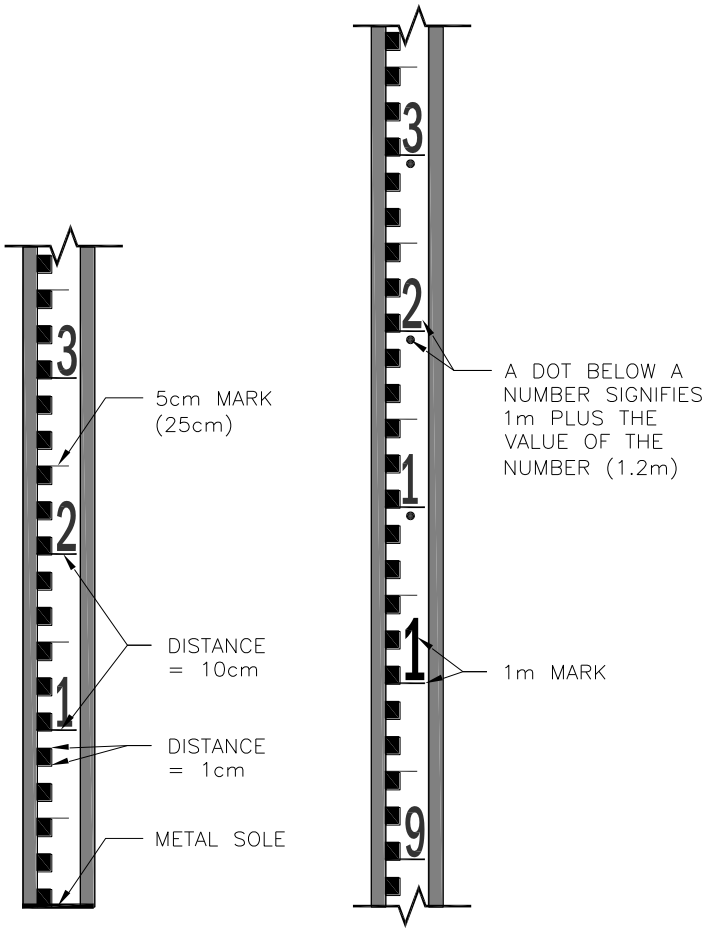


Figure 1

Elementary Surveying
How to Read a Leveling Rod

When taking a reading from an instrument on a leveling rod, the rod must be held in a plumb position (vertical). This can be achieved using a rod level. Another method to ensure an accurate reading is to gently rock or wave the leveling rod back and forth towards the instrument person (**Figure 7**). The correct rod reading will be the lowest "reading" observed when looking through the crosshairs of the leveling instrument.

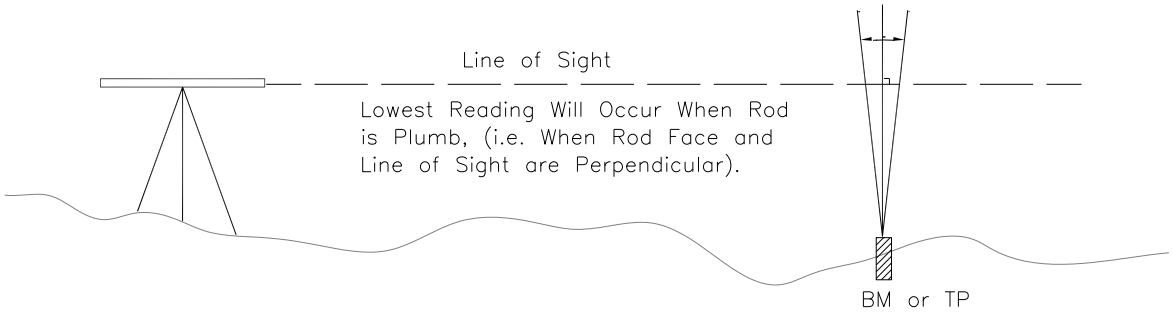


Figure 2 to Figure 6 are sample rod readings

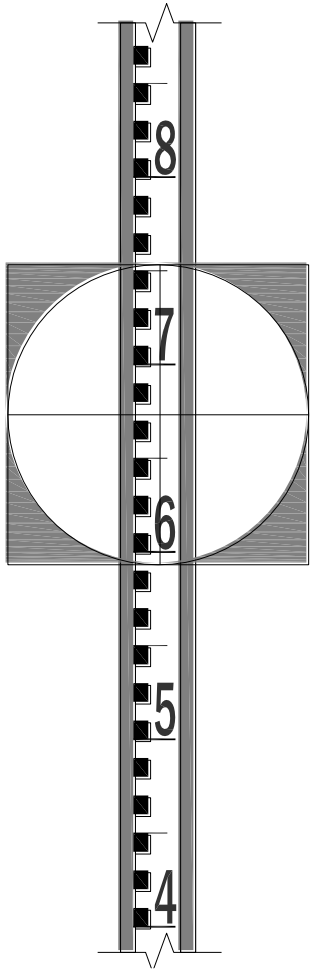


Figure 2
0.675m

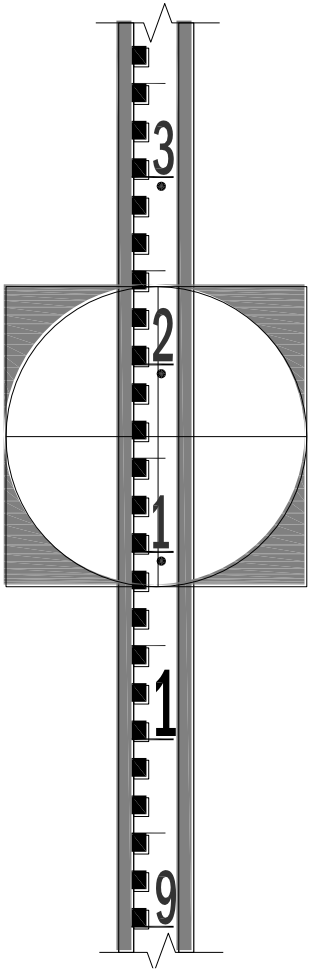


Figure 3
1.163m

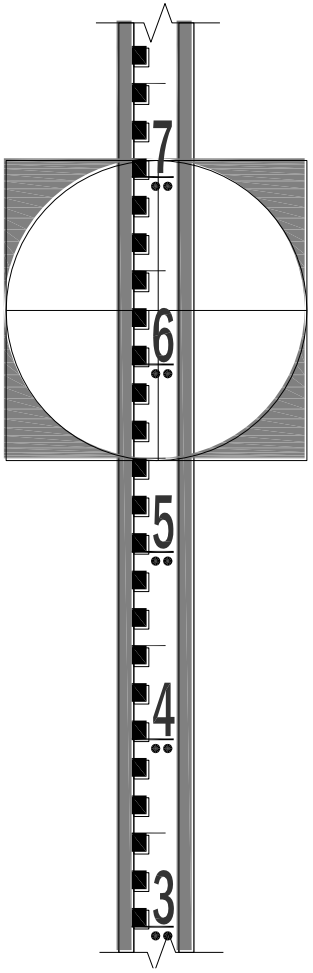


Figure 4
2.630m

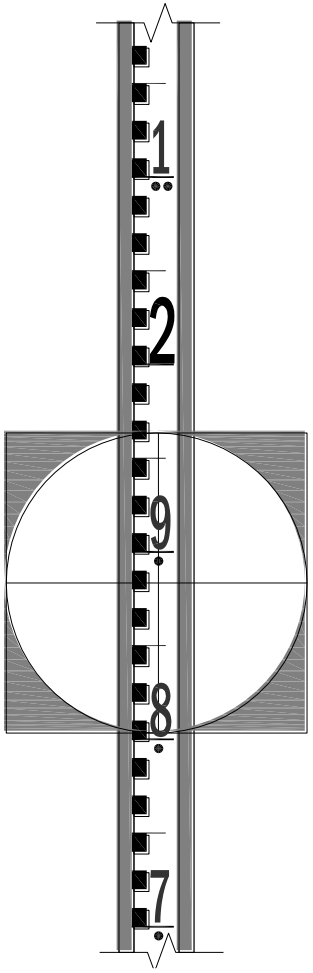


Figure 5
1.885m

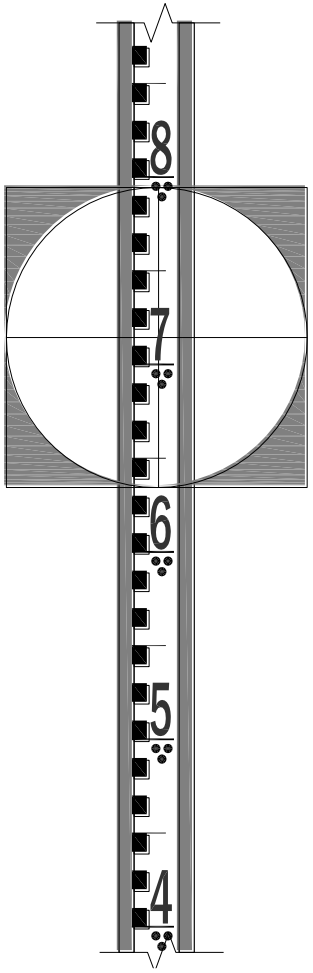
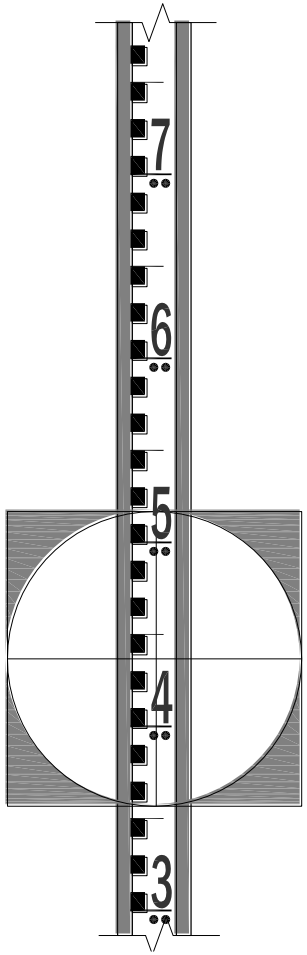


Figure 6
3.715m

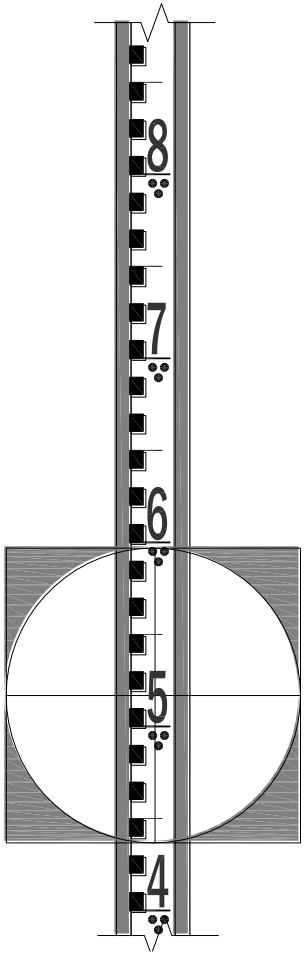
Elementary Surveying

Rod Reading Assignment

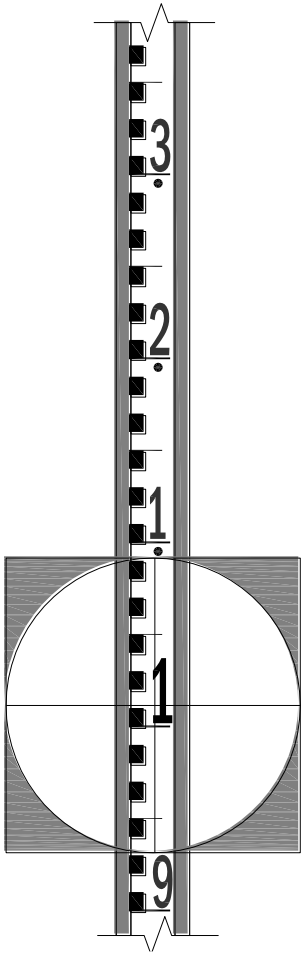
Give an accurate reading for each of the following rods. (To the nearest mm or 3 decimal places)(** Units)



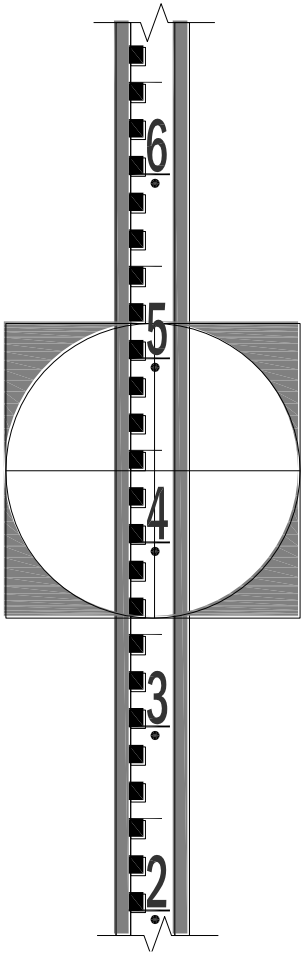
Rod #1 _____



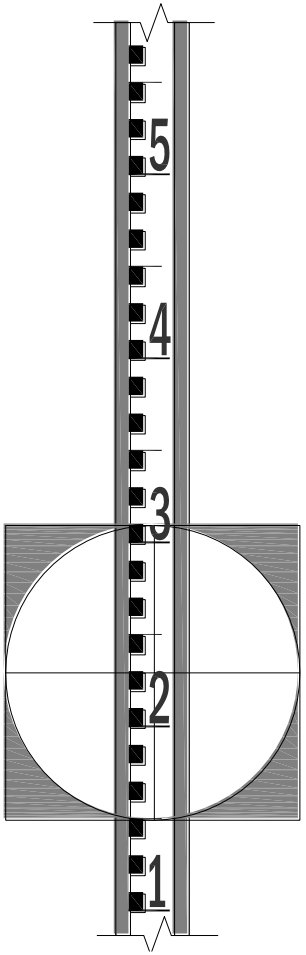
Rod #2 _____



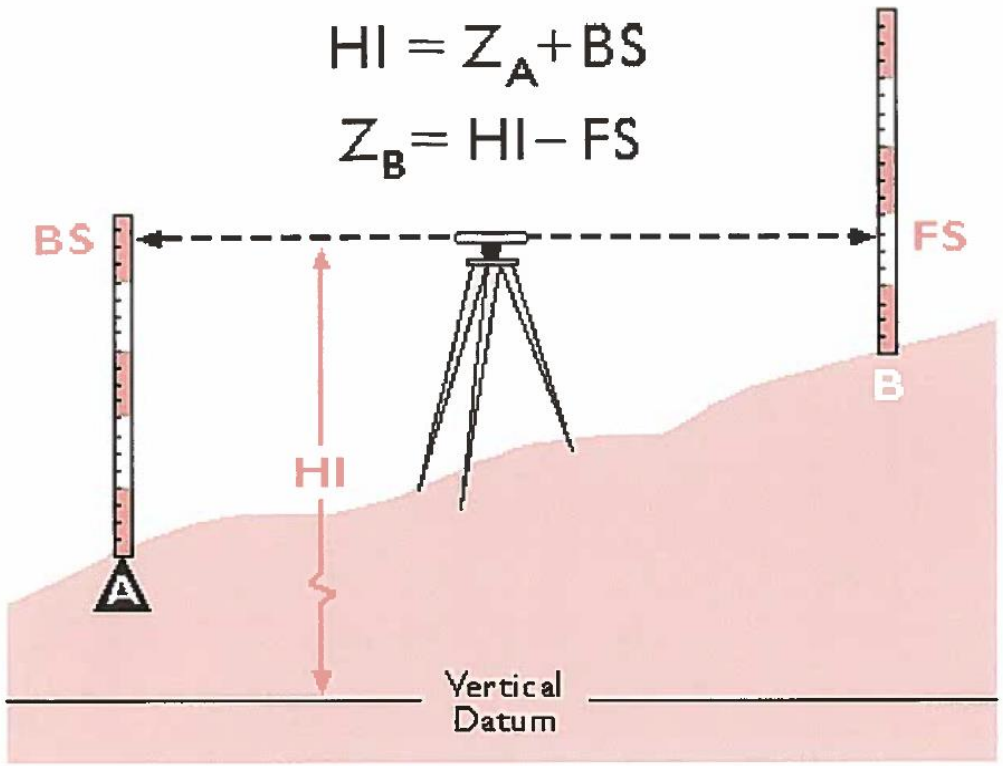
Rod # 3 _____



Rod # 4 _____



Rod # 5 _____



A) ZA = point of known elevation (bench mark whatever you decide)
ZB = elevation you are trying to determine
HI = height of instrument
BS = back sight (read the rod)
FS = foresight (read the rod)

Determine Elevation of Miscellaneous Points

Name_____/4

It is important for all trades to understand the basic principle of differential leveling in relation to a given benchmark or elevation. This exercise should demonstrate the ease with which elevations may be established on a small scale. Using the masking taped x marks found in the conference area and an elevation point (to be determined) calculate the difference in elevation between the points.
(Accuracy to within 3mm)

1. Point 1-X marked with masking tape _____+/-
2. Point 2-X marked with masking tape _____ +/-
3. Point 3-X marked with masking tape _____ +/-

Reduce the set of differential leveling notes, and complete the arithmetic check.(5)

Station		BS (ft)		HI(ft)		FS(ft)		Elevation (ft)
BM 25		5.41						95.33
TP 1		3.51				6.22		
TP 2		1.56				3.78		
TP 3		1.86				4.67		
TP 4		2.25				1.45		
TP5		4.5				5.23		
TP6		3.72				3.28		
BM 50						3.65		

BM 25 Elev + Sum BS - Sum FS = BM 50 Elev