# Profile Leveling

Engineers need accurate information about the topography along the proposed routes before they can correctly design linear facilities such as highways, railroads, transmission lines, aqueducts, canals, sewers, and water mains.

Profile leveling, which yields elevations at definite points along a reference line, provides the needed data. The subsections that follow discuss topics pertinent to profile leveling and include staking and stationing the reference line, field procedures for profile leveling, and drawing and using the profile.

## 7.1 Staking and Station the Reference Line

Depending on any project, the reference line may be a single straight segment, as in the case of a short sewer line; a series of connected straight segments which change direction at angle points, as with transmission lines; or straight segments joined by curves, which occur with highways and railroads. The required alignment for any proposed facility will normally have been selected as the result of a preliminary design, which is usually based on a study of existing maps and aerial photos.

The reference alignment will most often be the proposed construction centerline, although frequently offset reference lines are used.

To stake the proposed reference line, the following steps should be carried out:

1. The key points such as the starting and ending points and angle points will be set first.
2. Then intermediate stakes will be placed on a line, usually at 100-ft intervals if the English system of units is used, but sometimes at closer spacing. If the metric system is used, stakes are usually placed at 10-m, 20-m, 30-m, or 40-m spacing, depending on conditions.
3. Distances for staking can be taped or measured using the electronic distance measuring (EDM) component of a total station instrument operating in its tracking mode.

**The starting point**: is usually called (zero station (**0 + 00**)) and designated with some arbitrary value.

For example in the **English system** of units, 10+00 or 100+00, although 0+00 can be used.

If the beginning point was 10+00, a stake of (100 ft) along the line from it would be designated 11+00, 12+00, or a stake of (200 ft) along the line 12+00, 14+00, etc.

**The Full Station:** is a term applied to each of these points set at 100m or its increments (100m, 200m, 300m). This is the usual increment staked in rural areas.

**The Plus Station:** is a point located between two full stations.

**For example**, 95.50 m beyond station 18 + 00, will be designated as 18 + 95.50. For station 18 + 95.50, the plus is 95.50.

If the metric system is used, full stations are 100 m apart. The starting point of a reference line might be arbitrarily designated as 1 + 00 or 10 + 00, but again 0 + 00 could be used.

**In rural areas:** intermediate points are normally set at 30-m or 40-m increments along the line and are again designated by their pluses.

If the beginning point was **1+000** and stakes were being set at 40-m intervals, then 1+040, 1+080, 1+120, etc. would be set.

If the beginning point was **1+00** and stakes were being set at 30-m intervals, then 1+30, 1+60, 1+90, etc. would be set.

**For example:**

- In the English system, stations 17+84.9 and 24+18.3 or (1784.9 – 2418.3) are 633.4 ft apart,
- In the metric, system stations 1+120 and 2+040 or (2040 – 1120) are 920 m apart.

## 7.2 Profile types:

The profile is classified into two types as follows:

1. **Longitudinal profile (Longitudinal section).**

Implementing a longitudinal section on the Earth's surface located along a particular line.

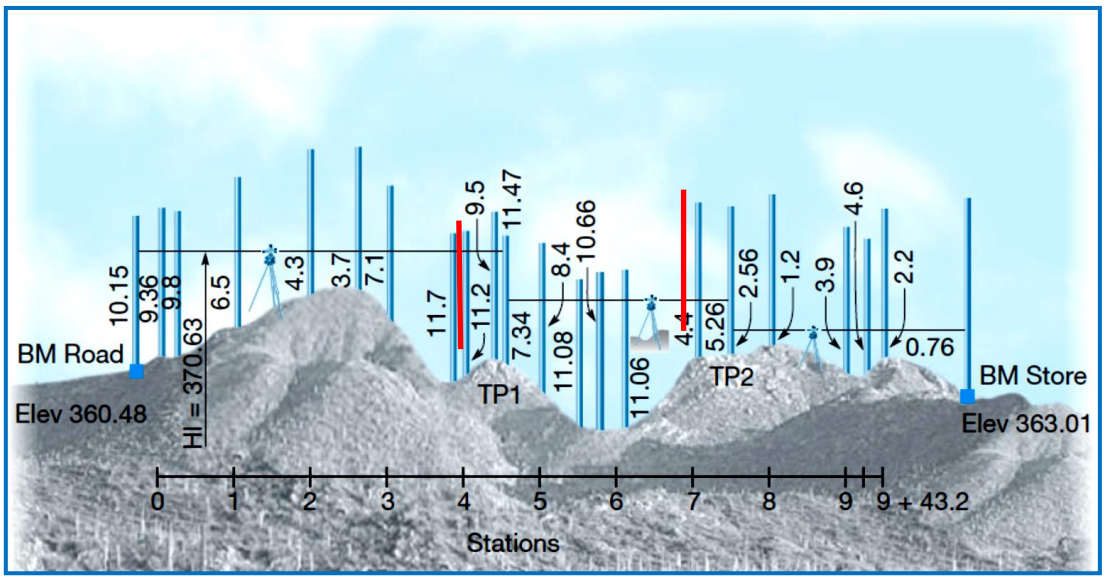
2. **Cross profile (Cross-section).**

Cross profile is carried out in a long line perpendicular to the central line of a project. The length of cross-sections is very short compared with longitudinal sections. Cross-sections are useful to determine the volume of earthwork.

## Example 7.1:

The following **table** shows the field measurements for the longitudinal profile along the central line for an engineering project. Calculate the elevations of stations along with the profile.

| Level Setup | Station | Rod Reading (ft) | Known Elevation (ft) |
|---|---|---|---|
| 1 | BM1 | 10.15 | 360.48 |
| | 0+00 | 9.36 | |
| | 0+20 | 9.8 | |
| | 1+00 | 6.5 | |
| | 2+00 | 4.3 | |
| | 2+60 | 3.7 | |
| | 3+00 | 7.1 | |
| | 3+90 | 11.7 | |
| | 4+00 | 11.2 | |
| | 4+55 | 9.5 | |
| | TP1 | 11.47 | |
| 2 | TP1 | 7.34 | |
| | 5+00 | 8.4 | |
| | 5+54 | 11.08 | |
| | 5+74 | 10.66 | |
| | 5+94 | 10.06 | |
| | 6+00 | 10.5 | |
| | 7+00 | 4.4 | |
| | TP2 | 5.26 | |
| 3 | TP2 | 2.56 | |
| | 8+00 | 1.2 | |
| | 9+00 | 3.9 | |
| | 9+25.2 | 3.4 | |
| | 9+25.3 | 4.6 | |
| | 9+43.2 | 2.2 | |
| | BM2 | 3.801 | 363.04 |



## Example 7.2:

| Level Setup | Station | Rod Reading (m) | Known Elev. (m) |
|---|---|---|---|
| 1 | BM1 | 1.272 | 100.562 |
| | 0+00 | 1.585 | |
| | 1+00 | 1.402 | |
| | 2+00 | 1.189 | |
| | 2+65 | 1.158 | |
| | 3+00 | 1.494 | |
| | 4+00 | 2.804 | |
| | TP1 | 2.847 | |
| 2 | TP1 | 0.367 | |
| | 4+25.5 | 1.341 | |
| | 4+55.8 | 3.081 | |
| | 4+85 | 1.615 | |
| | 5+00 | 1.524 | |
| | 5+61.5 | 1.189 | |
| | 6+00 | 1.372 | |
| | 6+19.3 | 1.646 | |
| | 7+00 | 0.671 | |
| | TP2 | 0.329 | |
| 3 | TP2 | 1.117 | |
| | 7+32.5 | 0.335 | |
| | 8+00 | 2.560 | |
| | BM2 | 3.801 | 96.347 |

**Example 7.3:**

The following readings were taken by the leveling instrument on the ground for points that are each one away 20 meters from the other and on one straight line. if you know that the level of the third point is 30 meters, and the leveling instrument was moved after the second and fourth readings. It is needing to connect the first and last point with a channel that has a depth of 1 meter lower than the first point and rises with a fixed slope of (1/200) towards the last point. Calculate the depth of backfill and excavation for each point.

| Point | B.S. | H.I. | I.F.S. | F.S. | Elevation |
|---|---|---|---|---|---|
| A | 1.792 | | | | |
| B | 1.336 | | | 2.5 | |
| C | 2.379 | | | 1.401 | 30 |
| D | | | 2.212 | | |
| E | | | 3.102 | | |
| F | | | | 1.898 | |