The use of Digital Levels in dynamic data acquisition and generation of profiles is well established. Less common though is application in earthworks. This article provides guidelines in dynamic measurements of cross-section, areas and volumes in road construction.

## Principles

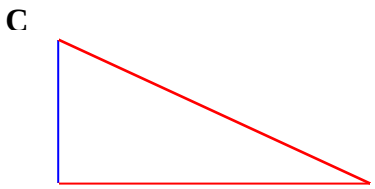


*fig. i*

Consider the diagram i, illustrating a right-angled triangle. If the distances **AB** and **AC** are known, then **BC** is determined from Pythagoras's theorem. This may be extended to the model in level profile survey. In diagram ii, **Inst** is the instrument position, **BS** the back sight point while $IS_L$ and $IS_R$ are intermediate points. If **BS** and **Inst** lie along the center line, then right angled triangles are defined and the measured distances to **BS** and **IS** from **Inst** allow reduction of distances along the cross-section.

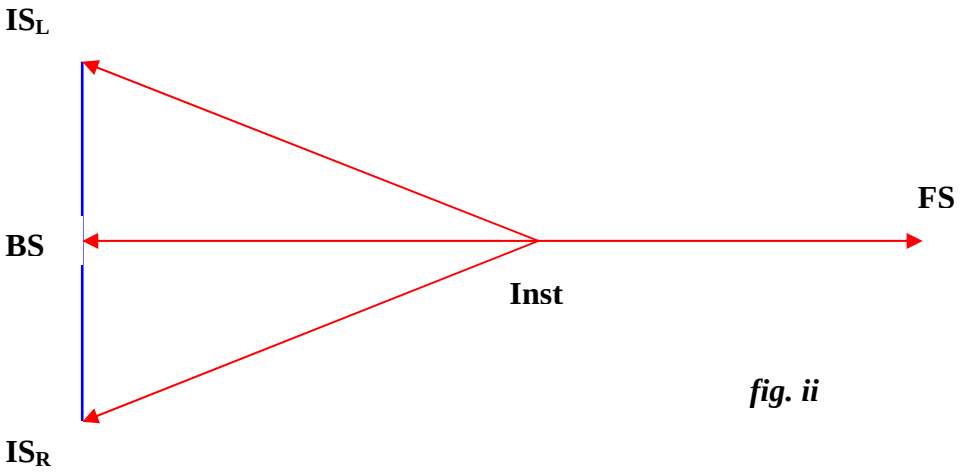


*fig. ii*

## Coding

Point Coding is essential in order to associate the reduced distances with right or left of the centerline. SMS supports alphanumeric characters for station names. Up to five characters are allowed but the first must be a character and defaults to P in point numbering. So point 1234 becomes P1234 in the field book. To achieve coding, a

simple point numbering formula is adopted: 1xxx or 2xxx where the integer 1 and 2 represents right and left sides respectively. This definition of side should be in the direction of chainage, but may vary with users. Each level point has a unique point number identification in the database; hence with this coding formula up to 1000 intermediate points are supported in the profile. With an average of 10 points per section and 10 sections in per km, this coding can cover up to 10 km. However, data should be processed at intervals, avoiding errors that accumulate in long level runs.

The coding principle also applies to instruments that allow alpha numeric numbering of stations. Thus the option provides point numbers such as A1xxx or B2xxx, and more than ten-fold increase in range of numbers available in the profiles. Similarly, where the instrument provides options for digital circle reading, SMS provides options for data acquisition away from the centerline.

## Methodology

In summary, the survey process may be enumerated as follows:

- Commence level run along the centerline.
- Select salient points along the profile.
- Set up on the centerline and between staff points, BS and FS.
  - Back sight to point BS, on centerline and cross-section.
  - Pick points along the cross-section as intermediates, only.
  - Name point's right/left of centerline as 1xxx/2xxx, respectively.
  - Fore sight to point FS, on next section and center line.
  - Move to the next instrument station.
  - Repeat until survey is complete.
- Process and compute the survey.
- Select a profile and load the spreadsheet.
- Apply design specifications
- Preview each section and observations.
- Review the earthwork information.

## Conclusion

Usually earthwork information is generated mostly from terrain models acquired in topographic and aerial surveys. However these may involve interpolation and are suitable for large extents of territory. In contrast digital levels provide precise level information over the area of survey. And in addition to precise profiles, users can now measure areas and volumes to the same standard of accuracy.