THEODOLITE VERTICAL ANGLE CALIBRATION TECHNIQUES

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Your measure of excellence
Introduction

• Geodetic measuring instruments are mainly used in:
  a. civil engineering industry
  b. surveying industry

• Can be defined as measuring devices which are used to
  measure dimensions which may be in the form of one,
  two or three coordinates (1D, 2D, 3D)

• Three most commonly used instruments are:
  1. Theodolites
  2. Total Stations
  3. Dumpy Levels
Theodolite

- Theodolite
- angles in the vertical plane
- angles in the horizontal plane
Total Station

• Total Station:
  - angles in the horizontal plane
  - angles in the vertical plane
  - distances in both planes
  - X, Y, Z coordinates
Dumpy Level

- Dumpy level
  - horizontal level
Angles to be Calibrated

- Horizontal angles are used to determine bearings and directions in control surveys, for locating detail when mapping and for setting out all types of structures.

- Vertical angles are used when determining the heights of points and to calculate slope corrections.
Angle in Vertical Plane

Zenith

$Z_A$

$\alpha_A$

$\alpha_B$

A

B

T

0°

270°

90°

180°
Theodolite Errors

- Trunnion axis is not perpendicular to the vertical axis
- Line of sight is not perpendicular to the trunnion axis
- Vertical axis is not plumb
Method 1 - Results

<table>
<thead>
<tr>
<th>Position</th>
<th>Angle from Vertical ($\alpha$) (deg)</th>
<th>Theodolite Angle (deg)</th>
<th>Theoretical Angle (deg)</th>
<th>Deviation (arc sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position 1</td>
<td>0.03</td>
<td>60.00725</td>
<td>60.03284</td>
<td>-92.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>120.00072</td>
<td>120.02547</td>
<td>-89.1</td>
</tr>
<tr>
<td>Position 2</td>
<td>1.85</td>
<td>59.992</td>
<td>60.090</td>
<td>-352.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>120.001</td>
<td>120.240</td>
<td>-860.4</td>
</tr>
<tr>
<td>Position 3</td>
<td>4.00</td>
<td>60.018</td>
<td>60.030</td>
<td>-43.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>119.998</td>
<td>120.160</td>
<td>-583.2</td>
</tr>
</tbody>
</table>
Vertical Angle Calibration – Method 2
(based on a publication)
Vertical Angle Calibration – Method 3
Vertical Angle Calibration – Method 4

- Theodolite
- Collimator
- Clinometer
- Angle standard (Moore Index table)
- Secondary rotary table
Method 4 - Results

<table>
<thead>
<tr>
<th>Standard Angle (deg)</th>
<th>Average angle (deg)</th>
<th>Average angle (min)</th>
<th>Average angle (sec)</th>
<th>Deviation (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>90</td>
<td>0</td>
<td>6,1</td>
<td>6,1</td>
</tr>
<tr>
<td>60</td>
<td>59</td>
<td>59</td>
<td>57,2</td>
<td>-2,8</td>
</tr>
<tr>
<td>120</td>
<td>120</td>
<td>0</td>
<td>7,6</td>
<td>7,6</td>
</tr>
</tbody>
</table>

Calculated Uncertainty of Measurement = ± 4,3 arc sec
Conclusion

• Method 4 appears to be the most reliable but needs more research and development to improve the procedure before this method can be adopted as the standard for vertical angle calibration of theodolites/total stations.

• The next step will be to arrange and participate a laboratory inter-comparison with at least two local laboratories.
Thank you for attending this Presentation.

Any Questions?