USE OF LEVELLING FOR ROADS - EXAMPLE

A level survey has been carried during a road construction. The data recorded is shown in the table below, with all readings in metres. The chainage (CH) of the points is also given (distance from beginning).

a) Reduce the data using either the Rise and Fall or the Height of Plane of Collimation (HPC) method. Use simple arithmetic checks to support your answer.

b) Plot the longitudinal soil profile (height against distance) and indicate where excavation or fill is needed if the proposed finished level of the road starts from +24.500m at X1, and rises with a slope of 2% from X1 to X6.

Solution

a) Both reduction methods are presented, the calculated numbers are handwritten.

<table>
<thead>
<tr>
<th>Station</th>
<th>Point</th>
<th>BS</th>
<th>IS</th>
<th>FS</th>
<th>RISE</th>
<th>FALL</th>
<th>RL</th>
<th>CH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>X1</td>
<td>1.250</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+25.000</td>
<td>0.00</td>
</tr>
<tr>
<td>1</td>
<td>X2</td>
<td>1.050</td>
<td>0.200</td>
<td></td>
<td></td>
<td></td>
<td>+25.200</td>
<td>5.00</td>
</tr>
<tr>
<td>1, 2</td>
<td>X3</td>
<td>1.435</td>
<td>0.885</td>
<td>0.165</td>
<td></td>
<td></td>
<td>+25.365</td>
<td>10.00</td>
</tr>
<tr>
<td>2</td>
<td>X4</td>
<td>1.520</td>
<td>0.085</td>
<td>0.105</td>
<td>0.085</td>
<td>+25.280</td>
<td>15.00</td>
<td></td>
</tr>
<tr>
<td>2, 3</td>
<td>X5</td>
<td>0.650</td>
<td>1.625</td>
<td>0.105</td>
<td>0.105</td>
<td>+25.175</td>
<td>20.00</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>X6</td>
<td>1.835</td>
<td></td>
<td></td>
<td>1.185</td>
<td>+23.990</td>
<td>25.00</td>
<td></td>
</tr>
</tbody>
</table>

Arithmetic checks

\[ \Sigma (BS) - \Sigma (FS) = 3.335 - 4.345 = -1.010m \]
\[ \Sigma (RISES) - \Sigma (FALLS) = 0.365 - 1.375 = -1.010m \ => OK \]
\[ \text{LAST (RL)} - \text{FIRST (RL)} = +23.990 - 25.000 = -1.010m \ => OK. \]
b) the ground level profile is plotted on graph paper as Chainage vs. RL (i.e. distance on horizontal axis and height on vertical axis). This is shown below at each point and a line joining the points is drawn to show the existing ground profile.

For road profile, slope is constant from X1 to X6 at 2%
Difference in length is \( dx = 25 \text{m} \), so we can find the difference in height using the given slope.

\[
\text{slope} = \frac{dy}{dx} = 2\% \quad \Rightarrow \quad dy = 0.02 \times 25 = 0.500 \text{m}
\]

This is added to the road level at X1 to find the road level at X6 \( \Rightarrow \) road level at X6 is 24.500 + 0.500 = +25.000m. A straight line is drawn to show the road surface profile, since it has a constant slope.

The area above the road surface and below ground profile is indicated as excavation or cut (i.e. needs to be removed for the road construction), and the area below the road surface and above ground level is indicated as fill (earth fill needs to be brought in area since road level is higher).

\[\text{(note: graph paper will be provided for the final exam)}\]

Ideally in practice there is an effort to have cut area equal to fill area for cost savings, but this is not always possible due to variations in soil conditions (excavated soil may not be suitable for earthfill).