RAILWAY GEODESY: THE BENEFITS OF USING A MULTI-DISCIPLINE APPROACH FOR THE ASSESSMENT OF TRACK ALIGNMENT DURING CONSTRUCTION

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Classification of track surveying parameters

- absolute positioning
- relative positioning
- slew
- alignment
- gauge
- cant
- twist
- clearance
- distances
- driving
- dynamics

Measures of track alignment

- definition:
- straight line
- arc of circle
- clothoid

specifications:

\[ \delta h = b_i - b_j \]

\[ \delta \delta h = \{ |b_i| - |b_j| \} - \{ |b_j| - |b_i| \} \]

Tolerance specifications for track surveying parameters

<table>
<thead>
<tr>
<th>parameter</th>
<th>high speed trains</th>
<th>LRT &amp; tram</th>
</tr>
</thead>
<tbody>
<tr>
<td>slew</td>
<td>± 10 mm</td>
<td>± 20 - 30 mm</td>
</tr>
<tr>
<td>lift</td>
<td>± 10 mm</td>
<td>± 20 - 30 mm</td>
</tr>
<tr>
<td>track alignment</td>
<td>± 3 mm</td>
<td>± 4 mm / R&gt;300m</td>
</tr>
<tr>
<td>track gauge</td>
<td>-1 mm / +2 mm</td>
<td>-1 mm / +2 mm</td>
</tr>
<tr>
<td>cant</td>
<td>±2 mm</td>
<td>±3 - 4 mm</td>
</tr>
</tbody>
</table>

The Athens light rail project

- project details
  - 26 km of double track
  - planning & construction time 30 m
  - budget ~ 300 million euros

- critical design values
  - min radius of horizontal curve: 25 m
  - max longitudinal inclination: 6%
  - max superelevation: 150 mm

The Athens LRT project: construction stages

Phase A ➔ geodetic networks
- GPS & precise leveling control network
- 28 stations (~1 km / <10 mm)
- 68 repères (~0.4 km / <2 mm)

Phase B ➔ rail laying on site
- reference point establishment (35-50 m / ~0.4 mm)
- track laying & alignment GNP units
The Athens LRT project: construction stages

Phase C ⇒ pre-concreting geodetic QC
- rail marking & surveying
- track surveying parameter computation

Phase D ⇒ concreting on the site

Phase E ⇒ post-concreting geodetic QC

Phase F ⇒ run the line with a track surveying vehicle
- GSF units removal
- run the line with a trv
- track surveying parameter computation

The Athens LRT project: example data

- nominal alignment
- track length 120 m
- mixture of geometric elements
- small track radius

The Athens LRT project: track alignment results

nominal – geodetic survey data

nominal – track recording vehicle data

The Athens LRT project: track alignment statistics

maximum deviations of track alignment vs. track radius

distribution of track alignment deviations

Precise track surveying system

- absolute positioning
- GPS/RTK
- tracking tacheometer
- odometer
- relative positioning
- inclinometer
- gauge measuring system
- platform vehicle
- KRAB trolley
- accompanying sensors

Precise track surveying system – preliminary results

track alignment: tracking EDM data
- left rail
- right rail

track alignment, left rail: track recording vehicle – tracking EDM