Track geometry degradation in Swedish heavy haul railroad

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Introduction

- Higher axle loads and faster trains
- Faster degradation of assets
- Higher maintenance costs
- Cost-effective maintenance strategy
• To develop a methodology to optimize track geometry maintenance by using historical geometry data. The methodology is based on reliability and cost analysis and supports the maintenance decision-making process to identify cost-effective maintenance thresholds.
Case Study Background

- Section of iron ore line in north of Sweden
- Harsh climate conditions: snow and extreme temperatures.
Trafikverket track geometry assessment

- Two fault limits are defined for isolated points:
  - “B-fault” limit: it identifies the limit for the execution of preventive maintenance.
  - “C-fault” limit: it is a safety-related limit and identifies the maximum allowable deviation from the design position.
Track geometry quality

- The most important condition indice is Q-value.
- Q-value: indicates the quality of track geometry.

\[ Q = 150 - 100 \left[ \frac{\sigma_H}{\sigma_{H\text{ lim.}}} + 2 \frac{\sigma_S}{\sigma_{S\text{ lim.}}} \right] / 3 \]

- $\sigma_S$: STDV of the cant error (C) and the average lateral position error of the high rail ($S_{\text{High}}$).
- $\sigma_H$: STDV of the average vertical error for left and right rails.
- $\sigma_{H\text{ lim.}}$: The comfort limit for the $\sigma_H$ value.
- $\sigma_{S\text{ lim.}}$: The comfort limit for the $\sigma_S$ value.
Track geometry degradation analysis

- Total number of detected longitudinal level C-faults on each 1000m track segment between 2004 and 2010
- Collected from inspection database (STRIX)
Track geometry degradation analysis

- Tamping
- July 2004
- June 2006
- July 2005
- August 2006
- July 2008
- August 2007

Location

C-faults

Location

C-faults
Swampy environment on the south side
Drier environment on the north side
Track geometry degradation analysis

- The effect of poor drainage
Track geometry degradation analysis

- Accumulated number of C-faults between 2004 and 2010
- Total number of C-faults along the track
- Collected from inspection database (STRIX)
Track geometry degradation analysis

- Average Temperature
- Minimum Temperature
- Maximum Temperature

- Longitudinal Level
- Twist 3 m

Total number of failures from 2004 to 2010

<table>
<thead>
<tr>
<th>Months</th>
<th>Total number of failures</th>
</tr>
</thead>
<tbody>
<tr>
<td>April-May</td>
<td>25</td>
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<tr>
<td>June-July</td>
<td>35</td>
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<td>August-September</td>
<td>15</td>
</tr>
<tr>
<td>October</td>
<td>10</td>
</tr>
</tbody>
</table>
Evaluation track geometry maintenance

- Probability density function of tamping execution
- Between 2007 and 2009
- 200 m tangent segments

UIC: Best Practice Guide for Optimum Track Geometry Durability
Evaluation track geometry maintenance

- Degradation rates of longitudinal level for 200m tangent segments (mm/MGT)
- Between 2007 and 2009
Evaluation track geometry maintenance

- Tamping efficiency on 200m tangent segments
- Between 2007 and 2009

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![Graph showing tamping intervention and standard deviation longitudinal level]
Evaluation track geometry maintenance

- The contractor’s performance between 2004 and 2010
- Q-value of entire track

a) The contractor’s performance on the “case study line”.

b) The contractor’s performance on a reference line in central Sweden.
On-going research

- Geometrical degradation of turnouts
Thank you!