Effects of Wheel-Rail Profile Design and Maintenance on Wheel-Rail System Performance

Vehicle / Track Systems Research

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October 6, 2015
Maximize Life of Wheel and Rail

♦ Challenges addressed by SRI 1A
  ● Wear and fatigue
  ● Fuel costs — rolling resistance

End products: Optimized profiles, grinding, rep Roofing
Maximize Safety
Prevent Derailments

♦ Challenges addressed by SRI 1A

- Wheel climb derailments
  ▲ At switch-point protector
  ▲ At worn yard switch points
- Rail rollover derailments due to reverse rail cant

End Product: Recommendations to prevent wheel-rail interface related derailments
## SRI 1A Current Work

<table>
<thead>
<tr>
<th>Specific Topic</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Derailment of locomotive wheel chamfer at switch point protector</td>
<td>Investigation completed, resolution underway</td>
</tr>
<tr>
<td>Wheel climb at worn yard switch points</td>
<td>Investigation completed</td>
</tr>
<tr>
<td>Reverse rail cant</td>
<td>Rail roll tests complete</td>
</tr>
<tr>
<td>SRI 1A wheel profile</td>
<td>Analysis of revenue service test underway</td>
</tr>
<tr>
<td>Survey of current rail grinding practices</td>
<td>Survey completed</td>
</tr>
</tbody>
</table>
Wheel Chamfer / Switch Point Protector

♦ Increased risk of wheel climb at worn switch point protector with large locomotive wheel chamfer

♦ Chamfer issues
  ● Wheel width
  ● Cutter head position
  ● Chamfer size, shape

♦ Protector issues
  ● Worn ramp for climb
  ● Flare angle
  ● Initial hardness

Locomotive wheel with large undesirable chamfer ~ 0.8 inch

Wear plane to lift wheel

Flare angle
Wheel Chamfer / Switch Point Protector (SPP)

♦ Wheel cutter heads designed for narrow wheels: 5.563, 5.625 inch
♦ Lateral alignment of wheel and cutter head

![Graph showing wheel width distribution](Image)

- These wheels will produce large chamfers when trued

- Material flow at sharp corner from “biting” into the SPP
Wheel Chamfer / Switch Point Protector

♦ Short term recommendation
  ● Additional training regarding optimal locomotive wheel cutter head lateral positioning and its importance

♦ Longer term
  ● TTCI working with AAR committees to reduce variation in permissible locomotive wheel widths
    ▲ Less variation in wheel width = smaller chamfers
  ● Discuss switch point protectors with AREMA
Rail Reverse Cant

♦ Rail profile issues when ground with reverse cant
♦ Rail roll measurement tests
  ● Track geometry car versus actual cants under traffic
  ● Tested 3 sites with a variety of fastening systems
    ▲ Wood ties/curve blocks
    ▲ Wood ties/cut spike
    ▲ Wood ties/elastic fasteners

Displacement transducers at head and base of rail
Rail Reverse Cant

♦ Low Rail — wood ties/curve blocks
  ● Track geometry car reported 3.4 degrees
  ● Max. test value = 5.3 degrees (-0.4 deg. static + 5.7 deg. dynamic)

Increasing speed through test zone

Rail base lateral movement produced some “spikes” in calculated rail roll
High Rail — wood ties/cut spikes

- Track geometry car reported 3 degrees
- Max. test value = 4.1 degrees (2.0 deg. static + 2.1 deg. dynamic)
Rail Reverse Cant

♦ High Rail — wood ties/elastic fasteners
  ● Track geometry car reported 3.3 degrees
  ● Max. test value = 3.4 degrees (1.5 deg. static + 1.9 deg. dynamic)
Rail Reverse Cant

♦ Summary from three test sites
  ● Tie condition, tie plate cutting, rail seat wear, spike lift
  ● Reasonable agreement between maximum measured rail roll and value reported by track geometry car (typically averaged over some distance)
  ● Rail profiles showed some indication of repetitive wear and grinding in a canted position

High rail profiles as measured

Set upright (1:40 cant)

Field side

High rail profiles from test sites have similar shapes

Gage side

Field side relief advisable if a 1:40 cant is re-established

Gage side
SRI-1A Wheel Profile Implementation

- SRI-1A Wheel profile = improved steering in curves
  - Fuel economy
  - Rail wear
  - Rail rolling contact fatigue
  - Wheel rolling contact fatigue

SRI-1A  AAR-1B WF
SRI-1A starts with a high rail conformal profile

AAR-1B must wear to a high rail conformal profile

- Undesirable severe 2-point contact, poor steering
SRI-1A Wheel Profile Implementation

♦ Typical wear patterns
  ● SRI-1A little flange wear
  ● AAR-1B heavy early flange wear
  ● Both profiles wear to a common similar shape
SRI-1A Wheel Profile Implementation

♦ Revenue service implementation test

● First round
  ▲ One 5-pack intermodal car, ten 110-ton coal cars
  ▲ Found reduced wheel wear and reduced asymmetric wheel flange wear
  ▲ Found reduced wheel-rail forces early in wheel life

● Second round
  ▲ 75 grain hoppers with SRI-1A (75 comparison cars)
  ▲ 25 grain hoppers with SRI-1A (25 comparison cars)
  ▲ Receiving data from wayside detectors

● Looking to increase implementation
  ▲ 1,000 car sets of SRI-1A wheel profile approved by Arbitration Committee
## Summary and Next Steps

<table>
<thead>
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<th>Next Step</th>
</tr>
</thead>
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<tr>
<td>Derailment of locomotive wheel chamfer at switch point protector</td>
<td>Wheel chamfer size &amp; shape, protector geometry are critical</td>
<td>Follow up with AAR committees and AREMA for changes</td>
</tr>
<tr>
<td>Wheel climb at worn yard switch points</td>
<td>Mechanical devices advisable for worst case switches</td>
<td>N/A</td>
</tr>
<tr>
<td>Reverse rail cant</td>
<td>Max. cant under train ≥ cant under TG car</td>
<td>Publish results</td>
</tr>
<tr>
<td>SRI 1A wheel profile</td>
<td>SRI 1A reduces curving forces and early wear</td>
<td>Progress towards full implementation</td>
</tr>
<tr>
<td>Survey of current rail grinding practices</td>
<td>Template age, preventative grinding</td>
<td>Publish results</td>
</tr>
</tbody>
</table>