Causes of Rail Cant and Controlling Cant through Wheel/Rail Interface Management

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Why Study Cant?
Rail Vehicle Curving

Low rail
Conical wheels - rolling radius differential – high wheel rolls further than low wheel

High rail
Outline

• Description of Rail Cant
• Rail cant test
• Test Variables - Track Maintenance Conditions
• Test Results
• Conclusions & Next Steps
Description of Rail Cant

Cant is the amount of rail rotation referenced from standard tie plate position (typically 1:40 inward)

Two types of rail cant:
1. Static
2. Dynamic
Video 1: Almost no cant
Description of Rail Cant

Static Cant

• Tie plate cutting
Description of Rail Cant

Static Cant

• Tie plate cutting
• Uneven adzing

Photograph shows 1.5° of outward cant – the adzer took too big a bite out of the field side!
Description of Rail Cant

Static Cant
- Tie plate cutting
- Uneven adzing
- Worn tie plates

10/64” wear
Video 2: Cant due to worn tie plates
Description of Rail Cant

Static Cant

- Tie plate cutting
- Uneven adzing
- Worn tie plates
- Hot weather - impacts high rail
Description of Rail Cant

Static Cant

- Tie plate cutting
- Uneven adzing
- Worn tie plates
- Hot weather – impacts high rail
- Cold weather – impacts low rail
Description of Rail Cant

Dynamic Cant

- The amount of rail rotation caused by wheel loading
- Can vary from truck to truck
- Included in geometry car gage & cant measurements
Rail Cant Test

- Confirm geometry car results
- First measurement tool: fish gage
Rail Cant Test

- Wills, WV, Roanoke - Bluefield Line
- 7.8° curve
- TT Speed 25 mph
- Superelevation 4"
- 8\" x 18\" tie plates, cut spikes
- Gage 57-3/8"
- Rail cant 3° both high and low rails
Rail Cant Test

- Strain gages measure vertical and lateral forces
- String pots measure displacement
Track Maintenance Conditions

1. April 19, 2011: both rails with 3° cant, gage 57-3/8”
2. April 26: grinding cycle #1
5. June 21: TOR friction modifier turned on
6. August 23: grinding cycle #2
7. Sept 1: TOR turned off
8. October 1: grinding cycle #3
9. October 12: TOR turned on
Test Results - Lateral Forces

Loaded 286k Coal Trains, Lateral Forces, Lead Wheels

Loaded 286k Coal Trains, Lateral Forces, Trail Wheels
Track Maintenance
1) starting condition

- Tie plates 8” x 18” with spikes
- Gage under load 57-3/8”
- Cant 3° both high and low rails
Track Maintenance
1) starting condition

- Abundant gage-face lubrication
- No top-of-rail friction modifier (units were turned off)
2) grinding cycle 1

- Cycle 1 – 5 passes each on both high & low rails
- Grinding template was applied to a canted high rail, result was gage-side relief
Excessive gage-side grinding + insufficient field-side grinding = wheel contact band on the outside of the rail
Track Maintenance
3) Elastic fasteners on high rail

- Pandrols installed on high rail
- Gage 56-3/8” (tight)

- Wheel contact moved to field side
- Low rail: 8 x 18” plates & spikes
Video 3: Low rail, after elastic fasteners were installed on high rail
Scuff marks from wheel/rail friction saturation
3) Elastic fasteners on high rail

- 40 feet from first video
- Spikes were already raised 7/8"; we drove two of them down in advance of a train
Video 4: Low rail, after two spikes were driven down
Track Maintenance
4) Elastic fasteners on low rail

- Pandrols installed on low rail
- Gage widened to 56-3/4"
- Wheel contact on low rail now on field side
Track Maintenance
5) TOR units turned on

- Two nearby TOR units turned on
Video 5: Low rail, elastic fasteners now on both rails
Track Maintenance
6 & 8) Grinding Cycles 2 & 3

• Grinding cycle 2 - two passes high rail, five passes low rail

• Grinding cycle 3 - two passes high rail only
Track Maintenance
6 & 8) Grinding Cycles 2 & 3

Post-grind cycle 1

Post-grind cycle 2

Post-grind cycle 3
Track Maintenance
7 & 9) TOR turned off, then on

- TOR turned off
- TOR turned on
Test Results - Lateral Forces

Loaded 286k Coal Trains, Lateral Forces, Lead Wheels

Start test 04/19/2011
High rail Pandrols 06/06/2011
Low rail Pandrols 06/21/2011
Grinding 1 04/26/2011
Grinding 2 08/23/2011
Grinding 3 10/01/2011
TOR off
TOR on
TOR on

Loaded 286k Coal Trains, Lateral Forces, Trail Wheels

Test Results - Lateral Forces

Loaded 286k Coal Trains, Lateral Forces, Lead Wheels

Start test 04/19/2011
High rail Pandrols 06/06/2011
Low rail Pandrols 06/21/2011
Grinding 1 04/26/2011
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TOR off
TOR on
TOR on

Loaded 286k Coal Trains, Lateral Forces, Trail Wheels

Test Results - Lateral Forces
Test Results – L/V Ratio

Each data point represents the average truck-side L/V for an entire loaded coal train:
- blue = low rail
- pink = high rail
Test Results – Lateral Forces

- Each data point is a lead wheel from one of two loaded coal trains
- Blue train shows worst condition – Pandrols on high rail
- Red train shows optimum condition - post-grind cycle 3
Conclusions

1. Tight gage and field-side contact can generate very high lateral forces

2. Track maintenance tasks that restore a rail to its normal, upright position can have the unintended consequence of causing field-side contact

3. Managing the wheel/rail interface (gage, rail profiles, fasteners, TOR) can lower lateral forces
Conclusions

4. Cut spikes do not provide sufficient vertical restraint under adverse wheel/rail contact

5. Elastic fasteners appear able to out-muscle high lateral forces caused by adverse wheel/rail contact

6. The progression of cant to rail roll-over can be caught by a vigilant track inspector
1. What caused the dramatic force reduction at Wills?
   - Gage?
   - Elastic fasteners?
   - Rail profiles?
   - TOR?
2012 Research Objectives

2. Can wheel/rail contact be managed, and lateral forces kept low enough, such that elastic fasteners are not needed?

A second test site was established this year to answer these questions.
Questions?