Fastening System Design Priorities
Union Pacific Railroad

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Union Pacific Concrete Tie Facts

- Over 4,000 miles of concrete tie railroad
- Concrete tie installations have been done in the multi-faceted approach:
  - Heavy Haul (> 100 MGT Annual)
  - High Curvature and Heavy Grade Areas (Curves > 7 degrees, Grades > 2%)
  - Metropolitan Areas (Houston, Dallas, Chicago etc.)
- Many successful installations dating back to the late 1980’s and 1990’s
- Mix between different fastening systems:
  - E-clip (1980’s and 1990’s)
  - Surelok (1990’s)
  - Fastclip (1990’s)
  - Safelok I (McKay) (1990’s to mid 2000’s)
  - Safelok III (2005 to Present)
    - Largest Percentage
  - Vossloh W15 and W30 (2009 to Present)
Handling Increased Axle Loads

• Heavy Axle Loads
  – Annual increases in tons per car
  – Heavier and denser trains to create capacity
  – Railroads generated 93% more ton-miles of freight in 2008 than in 1980

• Impact of Increased Axle Loads
  – Increased capacity
  – Increased operating efficiencies
  – Reduced track component life cycles
  – Increased maintenance requirements

• Stronger Tie Designs
• Improved Fastening Systems
• Improved Rail Chemistries
• Better Maintenance Practices
• Lubrication
What is the Ultimate Goal for Union Pacific?

• Ultimate Goal is a concrete fastening system that lasts the life of the rail
  – Eliminates the need for intermediate interventions
  – Increases safety and reduces the burden on inspection and maintenance forces
  – Improves the economic model for concrete ties

• Wood ties – Fastening system often lasts the life of the rail, however the ties themselves generally do not......

• Longer term goal is to continue improving the life of the entire system
  – Rail
  – Ties
  – Fastening System
Impact of High Forces on Fastening System

- Tangent track segments weather high loading fairly well with Pads taking the brunt of the loading
- Curves (Specifically > 3 degrees) see the highest system wear and drive base gage exceptions
Pad and Insulator Replacement Operations
Insulator Improvements

• Insulator performance continues to improve but still needs work
• Design revisions focused on increasing insulator foot print on rail base and increased material thickness
• Continued research needs to focus on system tolerances
• New system developments are beneficial but existing system support is critical
Epoxy Rail Seat Treatments

- UPRR treats both newly produced ties and field repaired ties with epoxy to help reduce rail wear
- Favored epoxy is a UV activated epoxy produced by Encore
- Photo shows a 2001 5 degree curve test location reviewed in 2013. Original epoxy from 2001 still in place

First epoxy used to repair seat abrasion on UP
Marshall Texas in May of 2001
UPRR Research and Development

- UPRR owned MTS Machine being utilized to perform AREMA chapter 30 severe service load testing
- Put into service in 2013
- Cycles being increased to upwards of 10 million to further life cycle analysis
- Comparison is being performed on different fastening systems, insulator materials, clip designs and tie designs.
Pad Wear Analysis – 3D Scanner Imaging
Tie Spacing Studies

- Changes to tie spacing can impact fastening system performance
- UPRR has test zones in various track conditions with spacing from 19” to 23”
- Insulator performance and track stability are being monitored
Impact of Top of Rail Lubrication on Fastening System Performance

- Union Pacific has done extensive testing on the impact of top of rail lubrication on track loading conditions.
- Top of rail locations are selected based on tonnage, curvature and historical rail wear.
- Top of rail lubrication has been shown to cut lateral loading conditions in curves by as much as 40%.
- Evaluation continues being done on overall fastening system benefit.
Top of Rail Lubrication – Lateral Load Reduction (Moffat Tunnel Subdivision Test)
2013 La Grande Subdivision Tie and Fastening System Test

- In 2012 UPRR approached several concrete tie manufacturers and fastening system suppliers and solicited ideas for the latest state of the art tie design
- Concepts tested include:
  - Full width of the tie insulators (bearing area is critical)
  - Improved insulator and pad materials
  - Raised concrete shoulders (spread out the loading pattern)
  - Improved concrete material designs (many of these are already being utilized)
  - Epoxy rail seat treatments
- The goal was to install these ties in high degree of curvature and grade
- La Grande Subdivision (Oregon Blue Mountains) was selected
UPRR La Grande Subdivision

- Single Main Track
- Oregon Blue Mountains
- 19 trains per day
- 55 MGT Annual
- High degree curves with some > 10 degree
- Critical route on the PNW corridor
Original Ties Being Removed

- Installed in the 1980’s, Almost 30 years of service
- Curves are > 7 degrees with many grades > 2%
- Produced at CXT Spokane, concrete still in outstanding shape
- Fastening system failures have led to shoulders and rail seats that cannot be repaired
Pandrol FE System
Vossloh W40 System
La Grande Test Monitoring Going Forward

• UPRR will monitor insulator and pad performance by removing components semi-annually and performing laser imaging to look at wear patterns

• Twice annual geometry car runs and once annual GRMS runs will be utilized to determine long term gage restraint

• Rail wear will be monitored by field sampling and laser imaging to determine fastening system impact on rail performance

• Lubrication condition will be monitored using vehicle based tribometers and field inspections

• Curve movement will be monitored by reviewing surveying data and curve stakes
SSL Tie Testing
La Grande Subdivision
UPRR Installation Locations – SSL Ties

- **South Morrill Subdivision (Mega-Site)**
  - Three test Locations
    - Bridge Approaches MP 80.5
      » Installed 15 SSL ties on east and west approach
      » Installed April 2011
    - Bridge Approach MP 18.45
      » Installed 15 SSL ties on west approach
      » Standard ties on east approach
      » Installed April 2011
    - Insulated Joint Location MP 45.16
      » Installed 30 SSL ties underneath insulated joints
      » Installed August 2011

- **La Grande Subdivision (Curve Test)**
  - 7 Degree 14 Minute 37 Second RH Curve
    - Installed June 2012
    - 253 SSL ties installed out of face