Recent Innovations in Applied Friction Modifier Technology and Wheel/Rail System Safety

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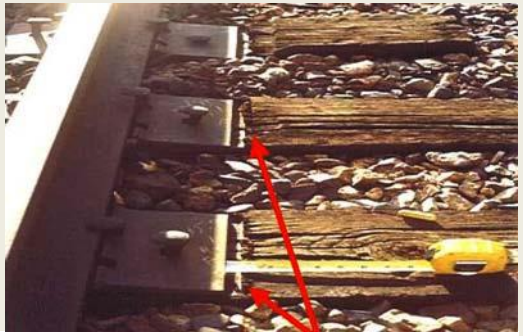
Overview

- High state of stress in the track infrastructure and RCF
- High Wheel/Rail Coefficient of Friction (CoF) as an underlying cause.
- Controlling the CoF to reduce the state of stress and RCF through use of Friction Modifier (FM) products
- New & Innovative approaches to apply FM products

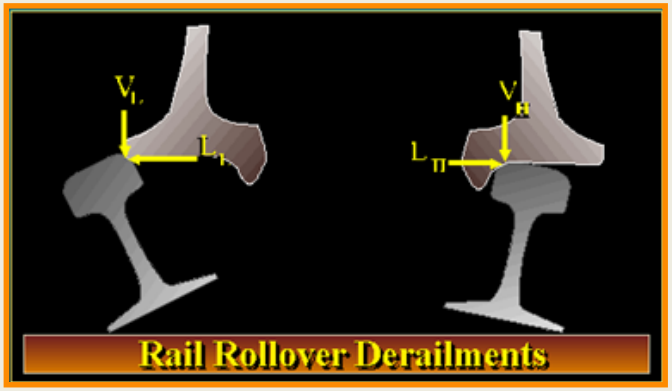
Impact of High Stresses (Lateral Forces) on Track Infrastructure in Curves

Loose Spikes

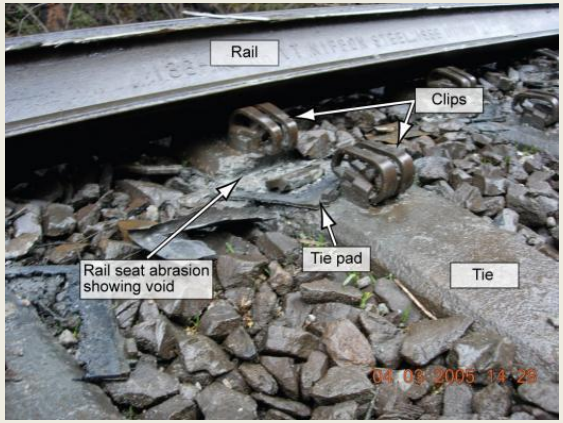


Tie Cutting

Broken Spikes

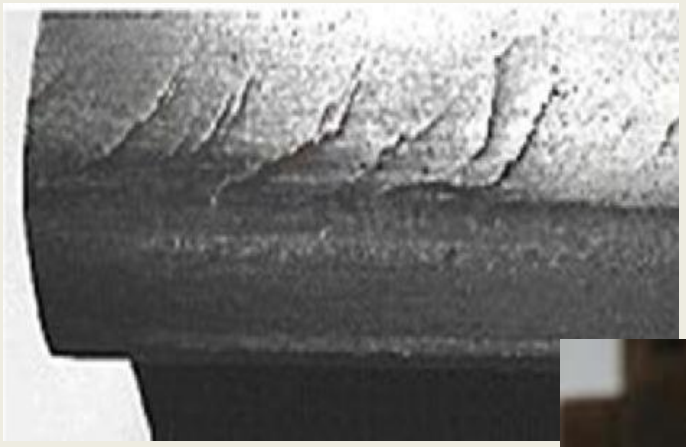


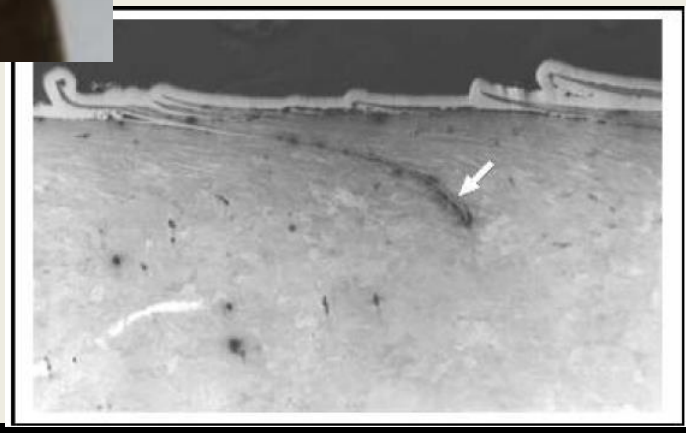
Broken Clips



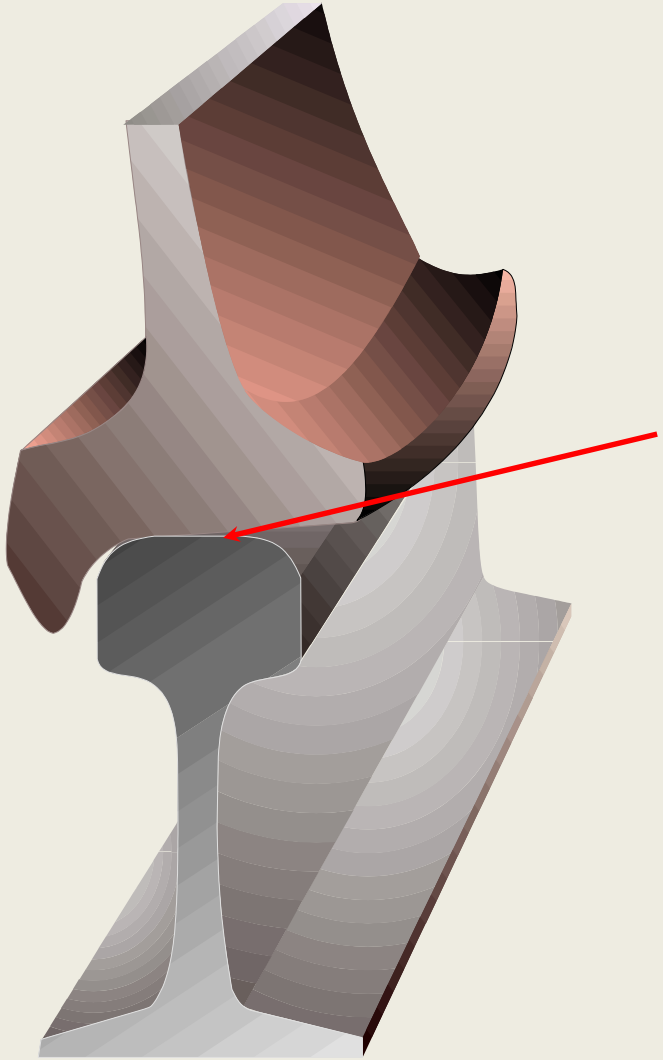
Rail Seat Abrasion

Impact of Rolling Contact Fatigue on Wheel & Rails





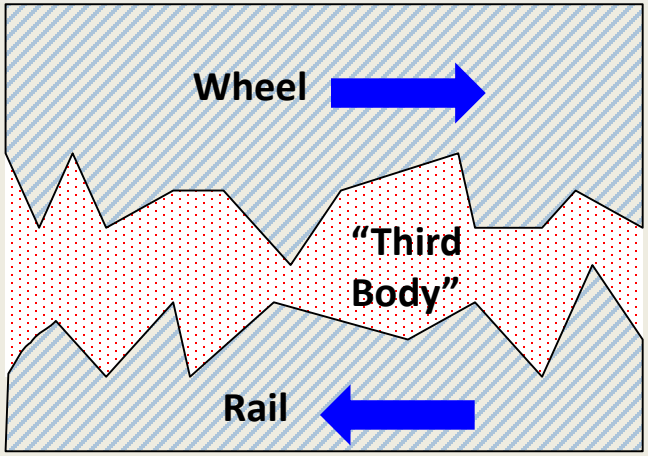
What do High Track Forces and RCF Have in Common? They are both impacted by W/R Friction Levels….

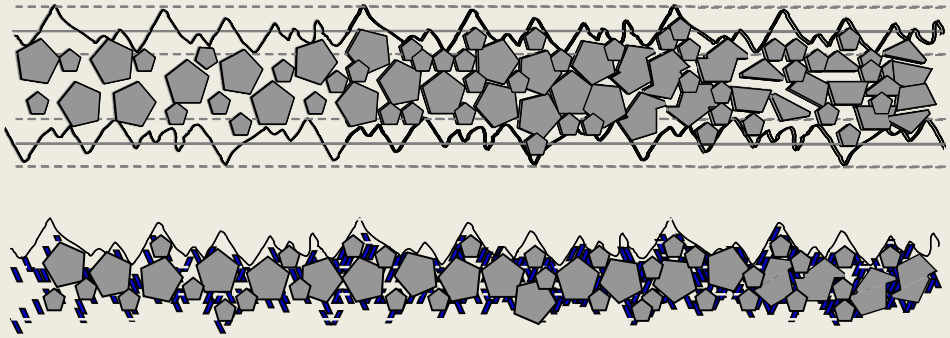


The Coefficient of Friction (CoF) between the Railhead and Wheel Tread Impacts:

- Derailment Potential in curves due to high stresses (Rail Rollover, Gauge Widening, Spike/Fastener Breakage)
  - ***Reducing the W/R CoF reduces lateral forces***
- RCF Development (wheels & rail)
  - **Reducing the W/R CoF reduces the onset of crack initiation**
- **Braking / Traction**
- Fuel Consumption (Train Resistance)
- Rail / Wheel Wear
- Corrugations
- Truck Hunting
- Squeal Noise

How the Wheel/Rail Friction is modified……

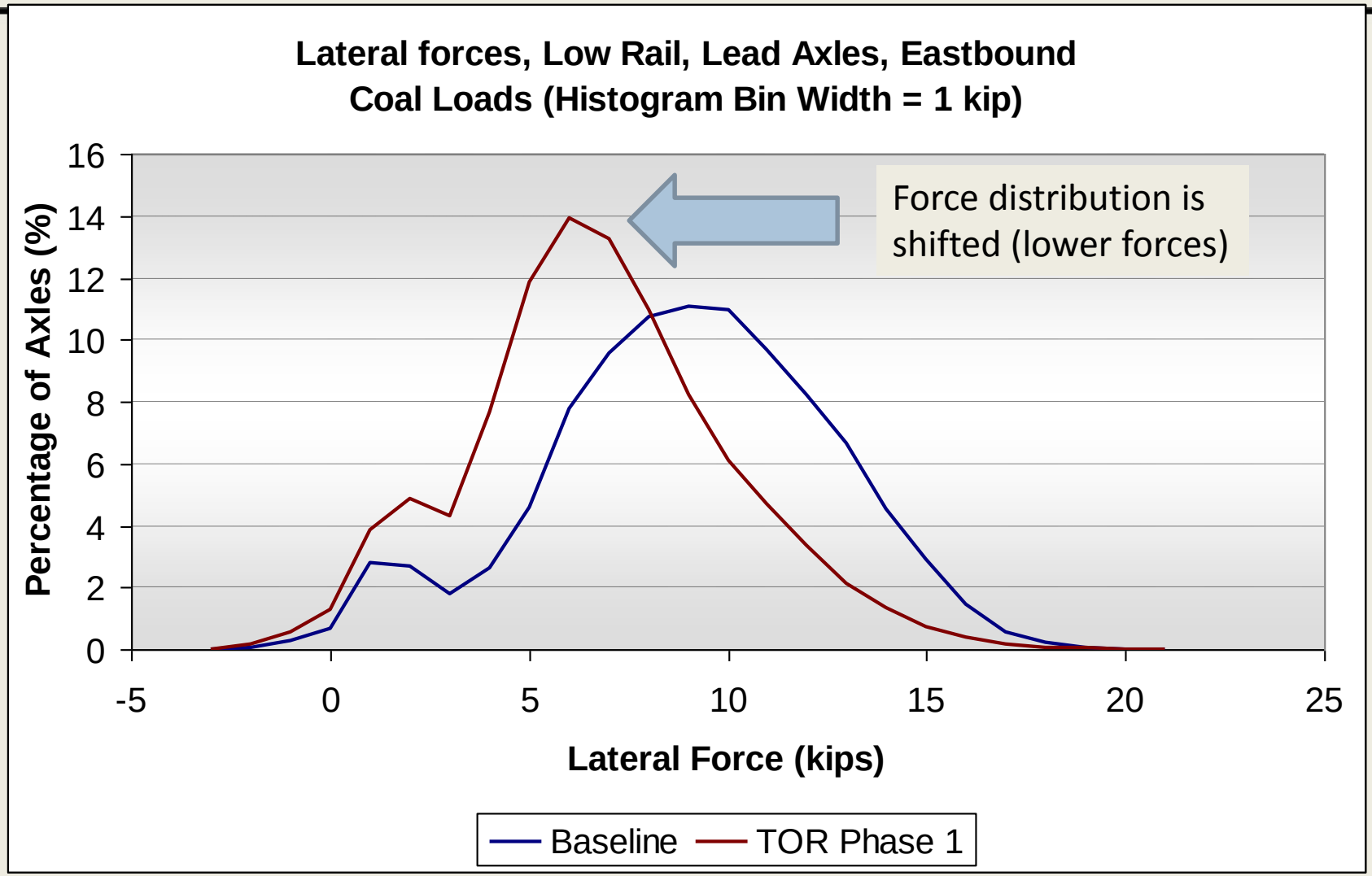




Modification of Iron Oxide Layer

- In curves, micro slip (displacement) occurs at the wheel/rail interface
- Displacement generates shear in the accommodative "third body" (interfacial layer which consists predominantly of iron oxides)
- Applied vertical force is translated to lateral force as a function of the absolute CoF Value
- **Rheology** of this layer determines the W/R CoF (Resistance to Shear)
- Changing the **rheology** of this layer will change the CoF

Benefits of FM Technology
Lateral Force Reduction



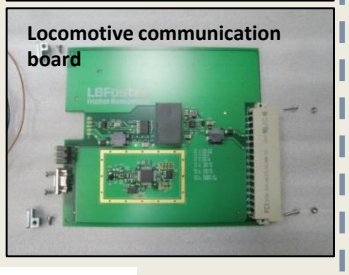
Typical Impact of FM Introduction on Lateral Forces

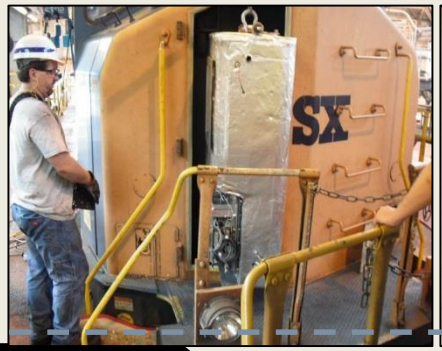
Benefits of FM Technology

Field Monitoring: Significant **simultaneous** reduction of **wear and RCF**

Recent Innovations:
Shifting towards onboard application

Current best practice is to apply liquid friction modifier from a trackside system





Why?

- More efficient use of capital
- More control of where to apply the friction modifier as well as how much
- **Minimizes required "on track" time (MOW)**
- Minimizes theft and vandalism of trackside equipment (in some regions)
- Provides the same benefits as friction modifiers applied from trackside systems.
- Benefits to following non equipped trains (100 % of trains need not be outfitted)

Innovations in the mobile applications field: Nozzle Technology

Nozzle design has been refined where it :

- *now lasts at least six months in continuous field operation before needing to be maintained (cleaned)*
- *can operate down to temperatures of -25 °C*
- *Is less susceptible to crosswinds (spray)*
- *can be changed out in 5-10 minutes*
- *has a built in auto purge feature*

Innovations in the mobile applications field:

Understanding the fundamentals of applying from a moving train

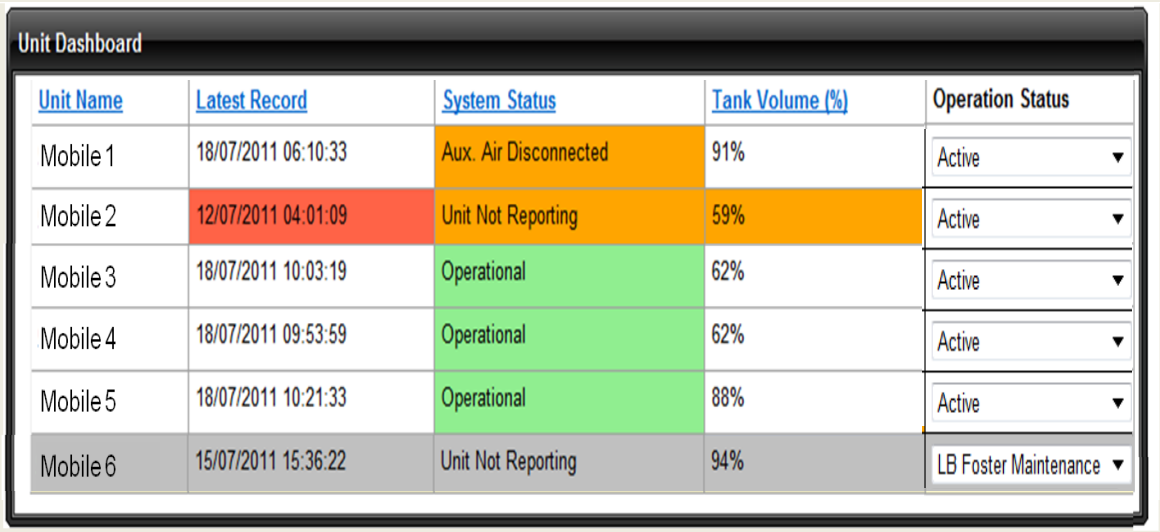
BYU
CAPSTONE

UBC

Where the Rubber Hits the Road.....

Innovations in the mobile applications field: "Smart Application System"

- Current mobile systems are preprogrammed (PLC) to apply (or not apply) the FM product in specific geographical locations (GPS control) as well as a function of train speed and track (tangent / curvature).
- Application strategy can be updated and sent remotely to each mobile unit via cellular modem.
  - *Provides a future platform where application strategy can be modified based on feedback from real time measurements (ie track side lateral force sites or other onboard measurement systems).*
- Same cellular modem also transmits real time telemetry to website in order to monitor performance/functionality of the mobile unit (RPM)



Unit Dashboard

Unit Name	Latest Record	System Status	Tank Volume (%)	Operation Status
Mobile 1	18/07/2011 06:10:33	Aux. Air Disconnected	91%	Active
Mobile 2	12/07/2011 04:01:09	Unit Not Reporting	59%	Active
Mobile 3	18/07/2011 10:03:19	Operational	62%	Active
Mobile 4	18/07/2011 09:53:59	Operational	62%	Active
Mobile 5	18/07/2011 10:21:33	Operational	88%	Active
Mobile 6	15/07/2011 15:36:22	Unit Not Reporting	94%	LB Foster Maintenance

Summary

- Application of FM technology remains a key tool for mitigating risk associated with high track forces and wheel/rail RCF development.

- Onboard FM application technology can offer a more efficient means of applying FM products to the wheel/rail interface in order to control friction.

- Onboard FM application technology is becoming more accepted in the industry. Significant strides made in improving the reliability of the technology under these harsh operating conditions. Units have been operating for 5+ years with high uptime.

TOR FM Benefits in the Literature

- "Implementation of Wayside Top of Rail Friction Control on North American Heavy Haul Freight Railways", *World Congress on Railway Research, 2006*
- "100% Effective Friction Management Strategy", *IHHA 2005*
- "The Effects of Top of Rail Friction Modifier on Wear and Rolling Contact Fatigue: Full Scale Rail-Wheel Test Rig Evaluation, Analysis and Modelling", *CM2006*
- "Top of Rail Friction Control: Reductions in Fuel and Greenhouse Gas Emissions" IHHA 2005
- "Freight Car-Based Top of Rail Friction Modifier Application System" IHHA 2005
- "Incorporation of Remote Monitoring Technology on a Train Mounted Top of Rail Friction Control Dispensing System Proceeding "IHHA 2007
- "Effects of Friction Control on Fuel Consumption using Train Energy Mode" TTCI Technology Digest 2007
- "A Review of Locomotive Fuel Savings with TOR-FM: Connecting theory and field results" ARM Wheel/Rail Seminar 2013

THANK YOU