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The Effect Of Top Of Rail Friction Control on a European Passenger System: The Heathrow Express Experience

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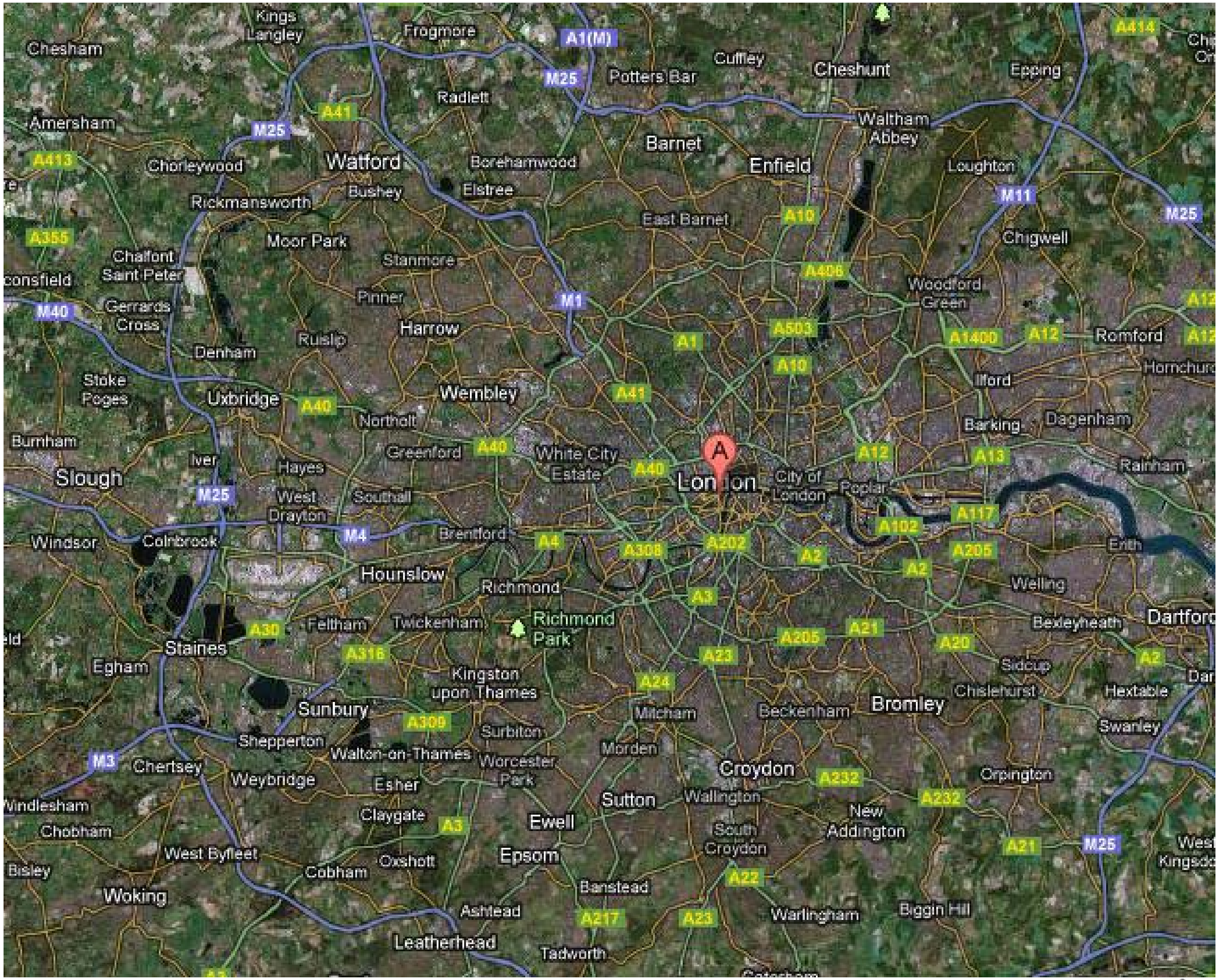
Outline

- Heathrow Express: background and issues
- TOR Friction Control
- Test goals, area, trial methodology
- Results
- Conclusions



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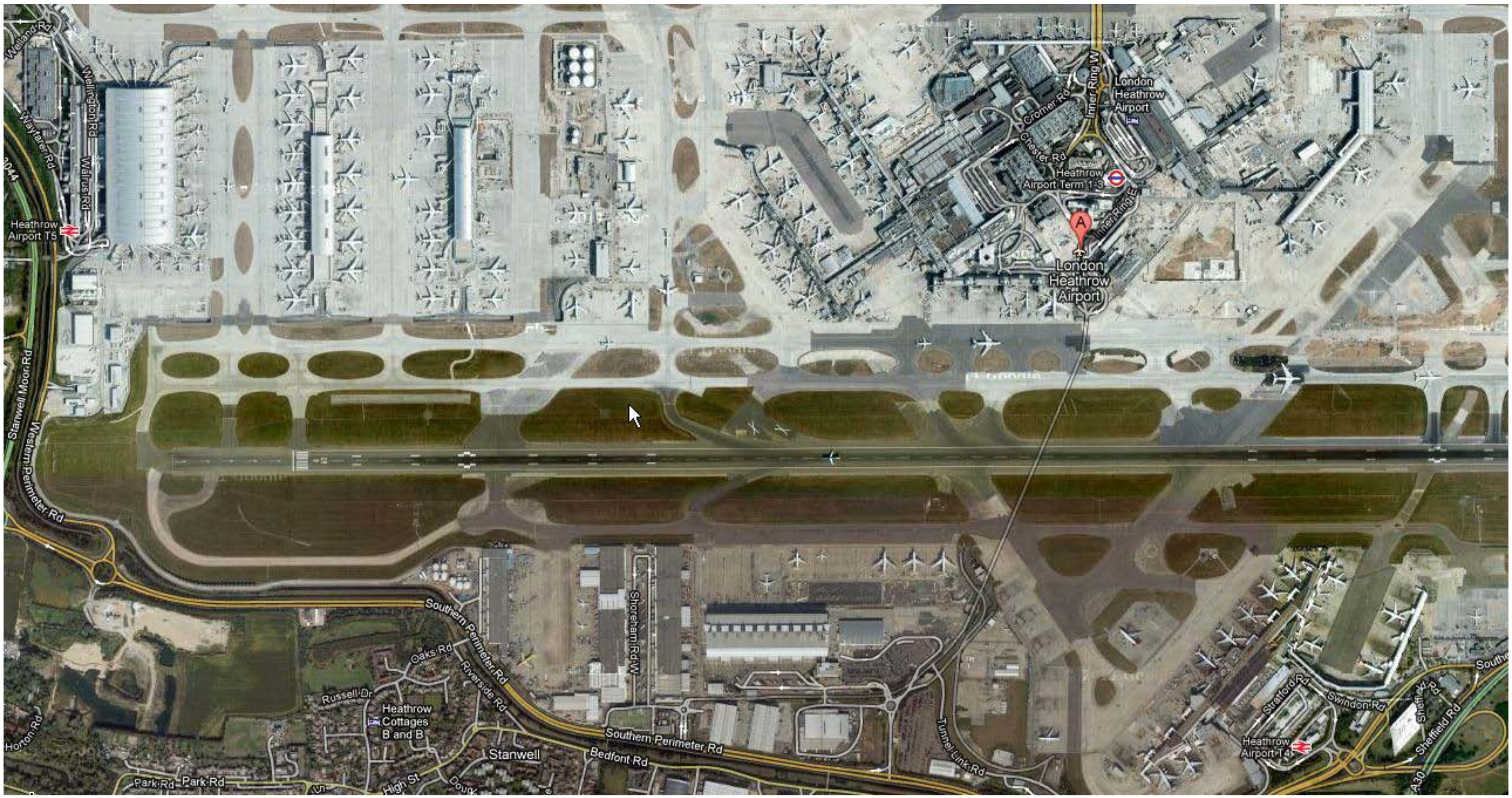

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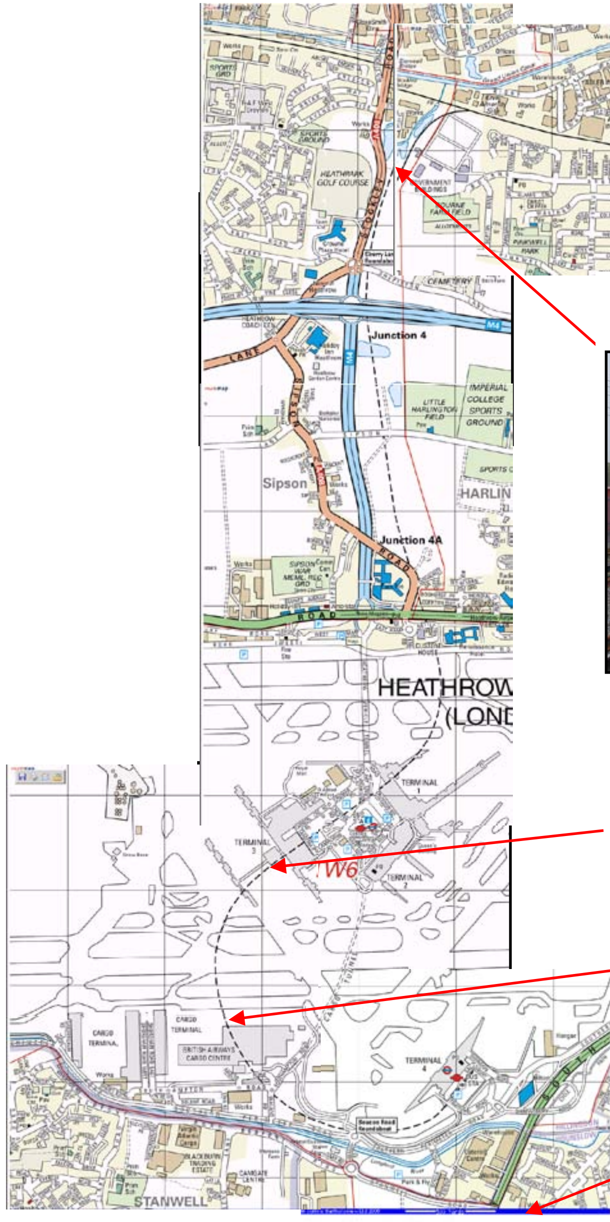

London Paddington 16.2km

Tunnel portal

Start of Single line track

Scale

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Class 332 train at Paddington

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Class 360: Heathrow Connect

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Wheel / Rail Issues at HEX

- Excessive clip breakage
- Corrugation growth
- Differential wheel wear – differential wheel diameter
- RCF

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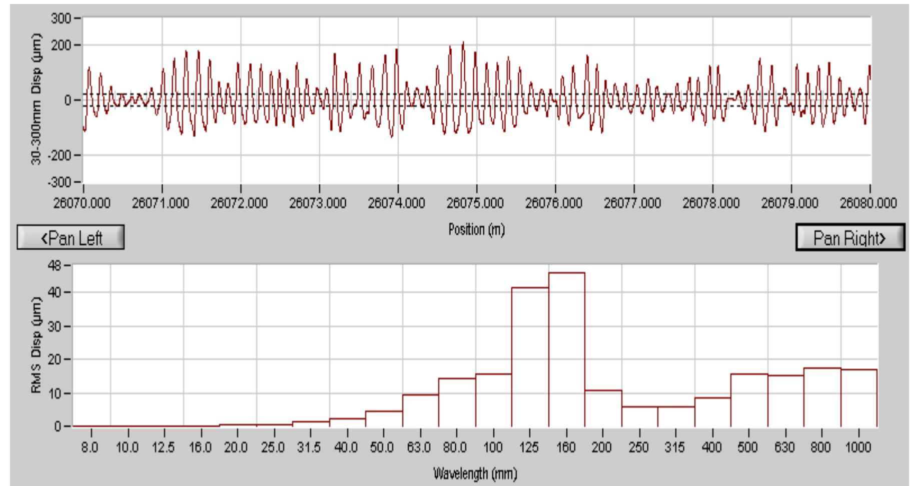
The problem: Low Rail Corrugation



- Median wavelengths 125 to 160 mm
- Peak to valley depth up to 0.8mm
- Due to P2 resonance of the unsprung mass on the track stiffness.

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The problem: Excessive Clip breakage

- Stiff and non resilient track structure.
- Concrete sleepers on studded rubber pads with concrete slab track.
- Up to 50 clip breakages per **week** between CTA and T4

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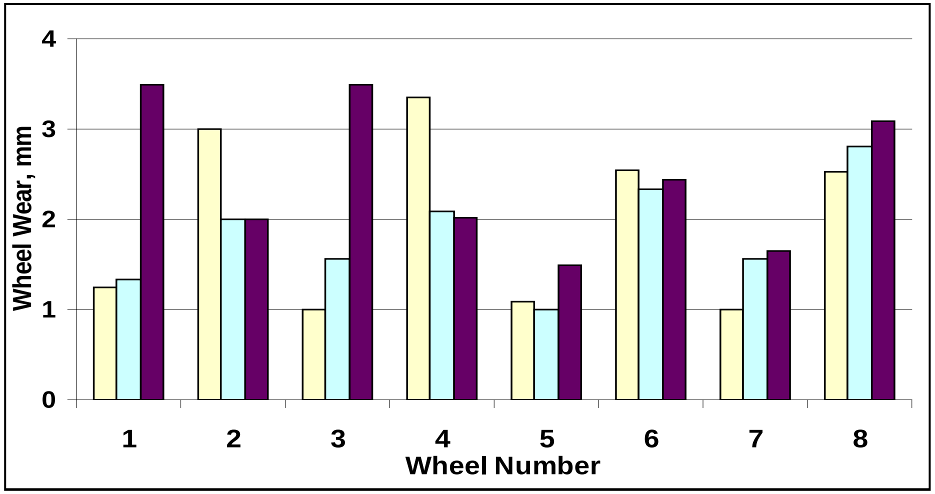
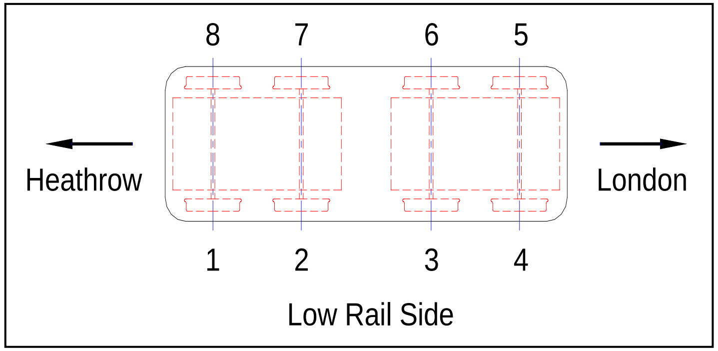
The problem: Differential wheel diameter

- Up to 3 mm differential wheel diameter (side to side)
- Results from differential wear – trains cannot be turned, curves predominantly in one direction
- Differential wheel diameter identified as a major cause of RCF
- UK P8 wheel profile (conicity 1:20)





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Why Top of Rail Friction Control?

- Friction on top of low rail: related to lateral forces
- Effect on corrugation growth in curves:
  - Reduce wear component of corrugation by controllably reducing friction
  - Reduce roll-slip oscillation contribution to wavelength fixing mechanism
- Dry thin film friction modifier provides intermediate coefficient of friction safe for braking – dead stop at end of Terminal 4 – validated with braking trial
- Wayside application suitable for dealing with site specific issues on HEX

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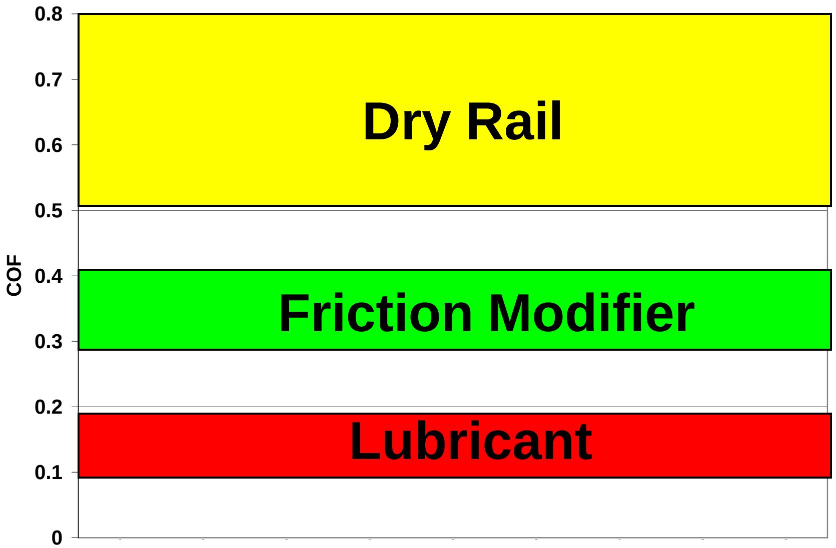
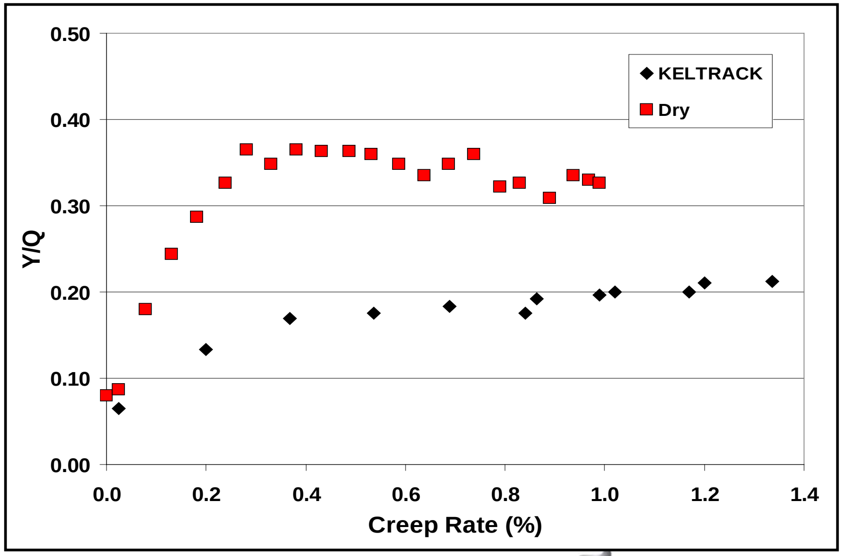
Friction Modifier Characteristics

KELTRACK® Trackside Transit

Controlled intermediate coefficient of friction based on material properties

Positive friction





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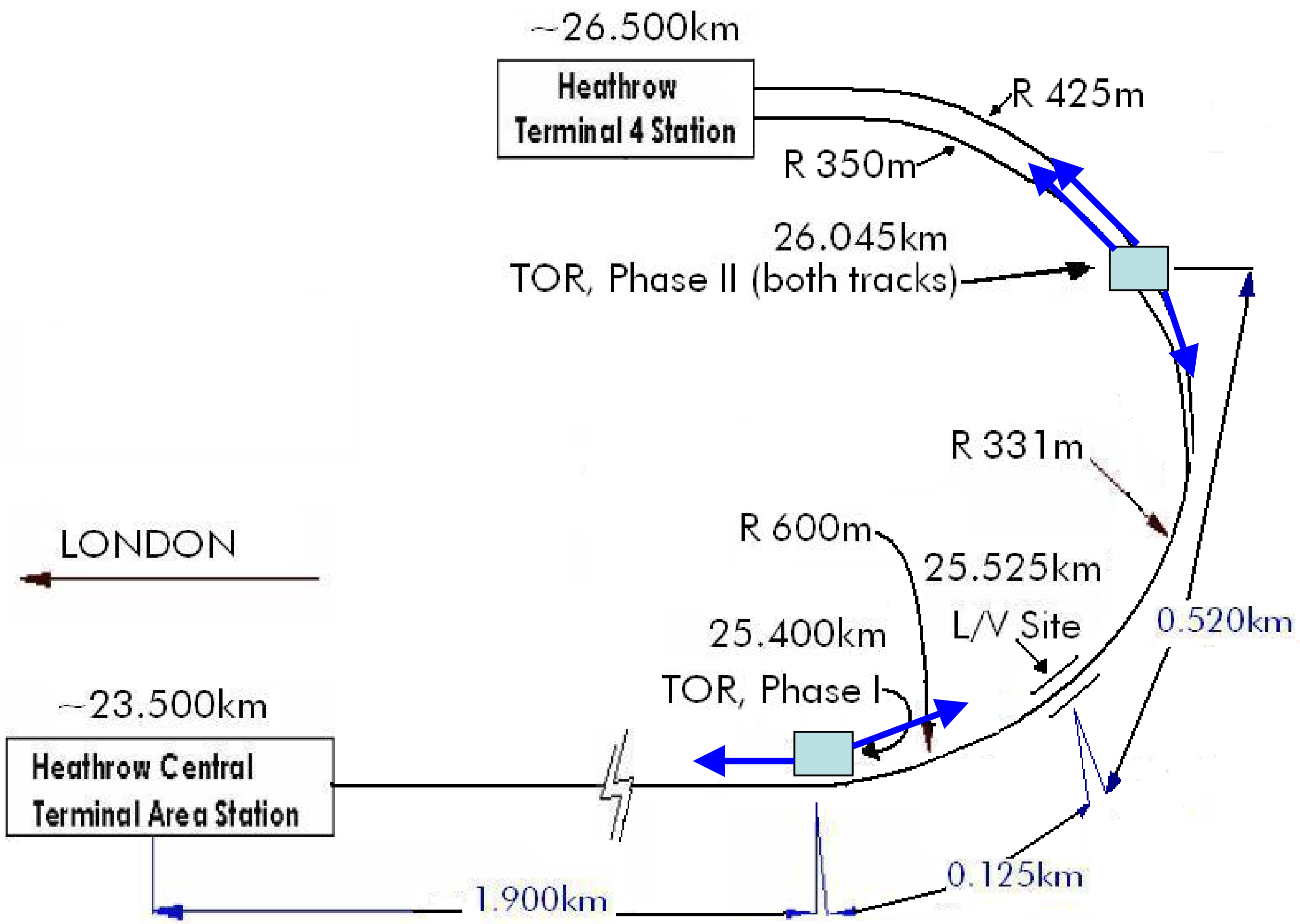
Trial Outline



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HEX Trial Success criteria

- Reduced clip breakage
- Reduced rates of corrugation growth and ultimate amplitude development
- Positive or nil effect on train wheels (tread wear)
- Reduced rail head transverse profile degradation
- Positive or nil effect on RCF.

Trial Methodology

- Lateral force measurement campaigns
- Intensive clip monitoring in trial area
- Corrugation monitoring by CAT
- Wheel wear / differential wheel diameter – analysis of routine maintenance records

Chronology of Key trial events

- August 2006 – baseline grinding
- December 2006: Install Phase I PIV, low rail application
- January 2007: Grinding
- January to June 2007 – equipment / application optimization
- January 2008: grinding
- March 2008: Change in service: from 8/9 car Class 332 trains to 5 car Class 360 trains (opening of Terminal 5)
- July 2008: Install Phase II PIV wayside applicator
- Sept – Nov 2008: Equipment upgrades

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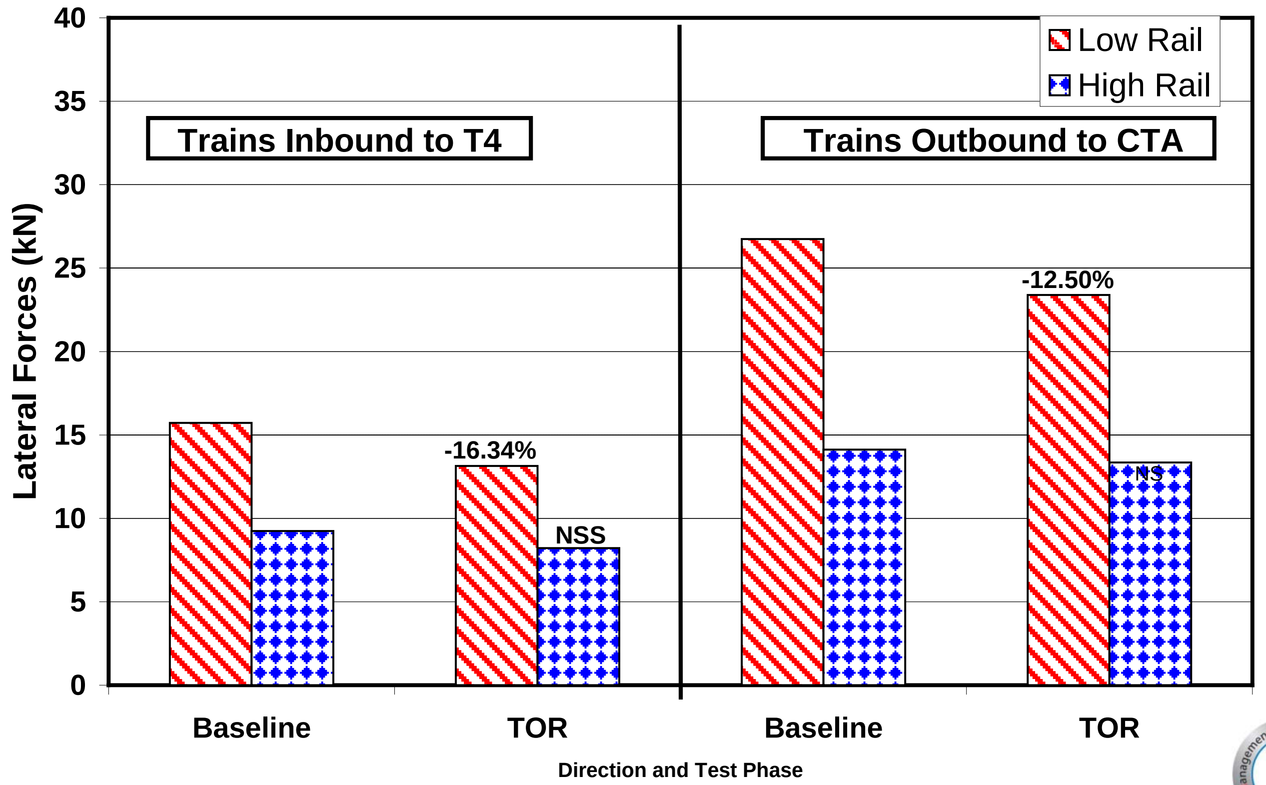
Phase I, ***average*** leading axle lateral forces:

- Outbound trains causing more damage
- Modest force reduction on low rail



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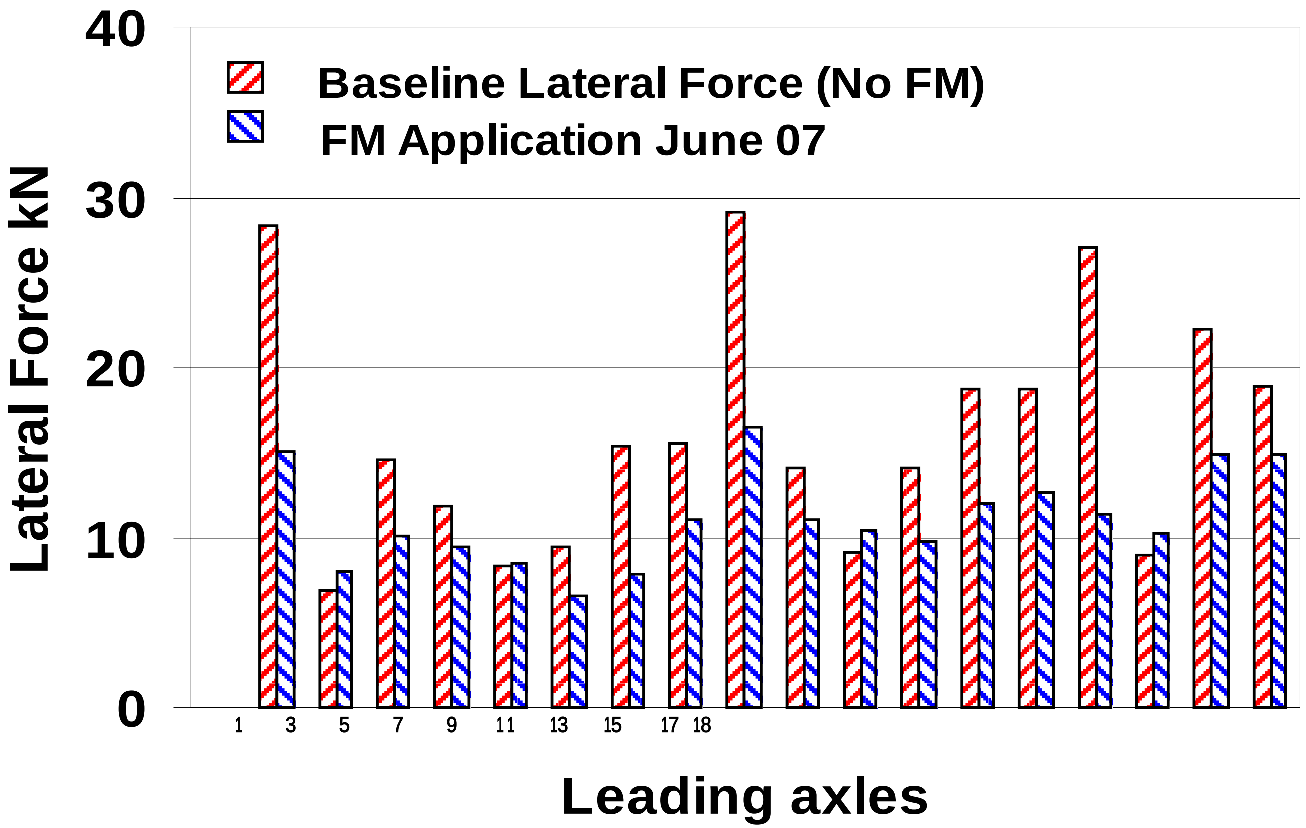
Phase I lateral forces

Largest reduction on the highest force axles



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Service Change: Comparison of Class 360 vs. Class 332.

Class 360 show higher inbound Low Rail forces (baseline data)

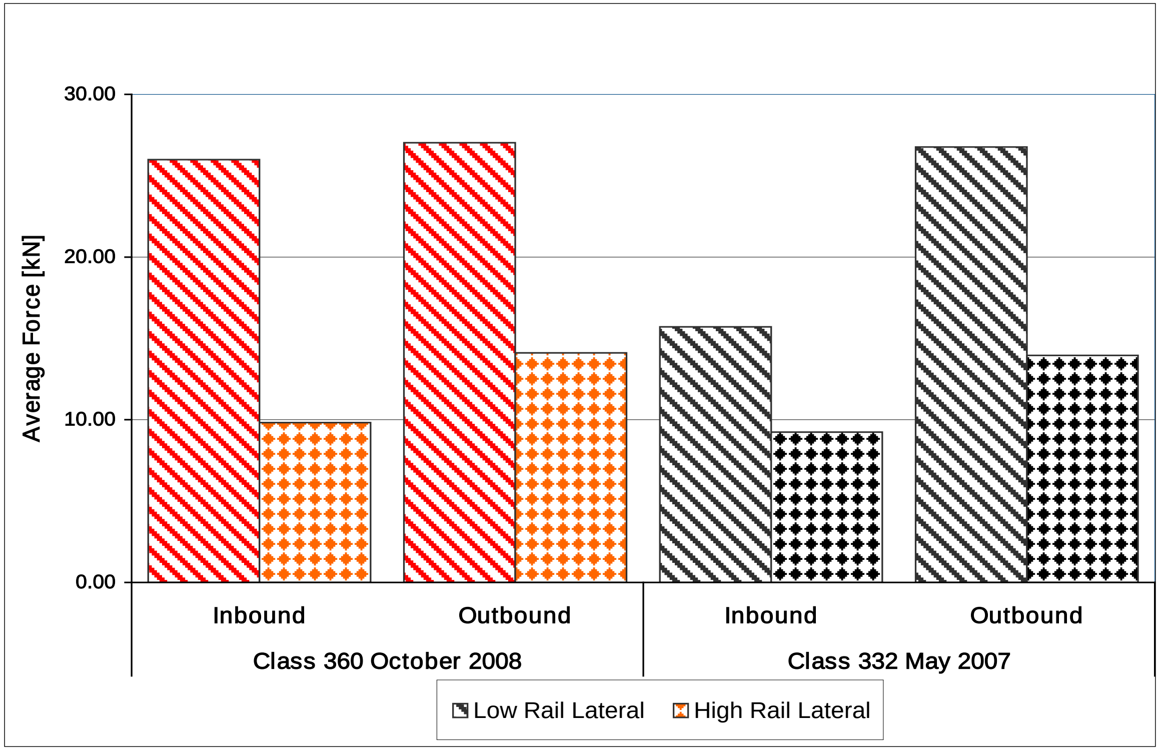

Fig 6 Leading Axle Average Lateral forces for Class 332 and Class 360, no FM

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Phase II lateral forces – large reductions from baseline

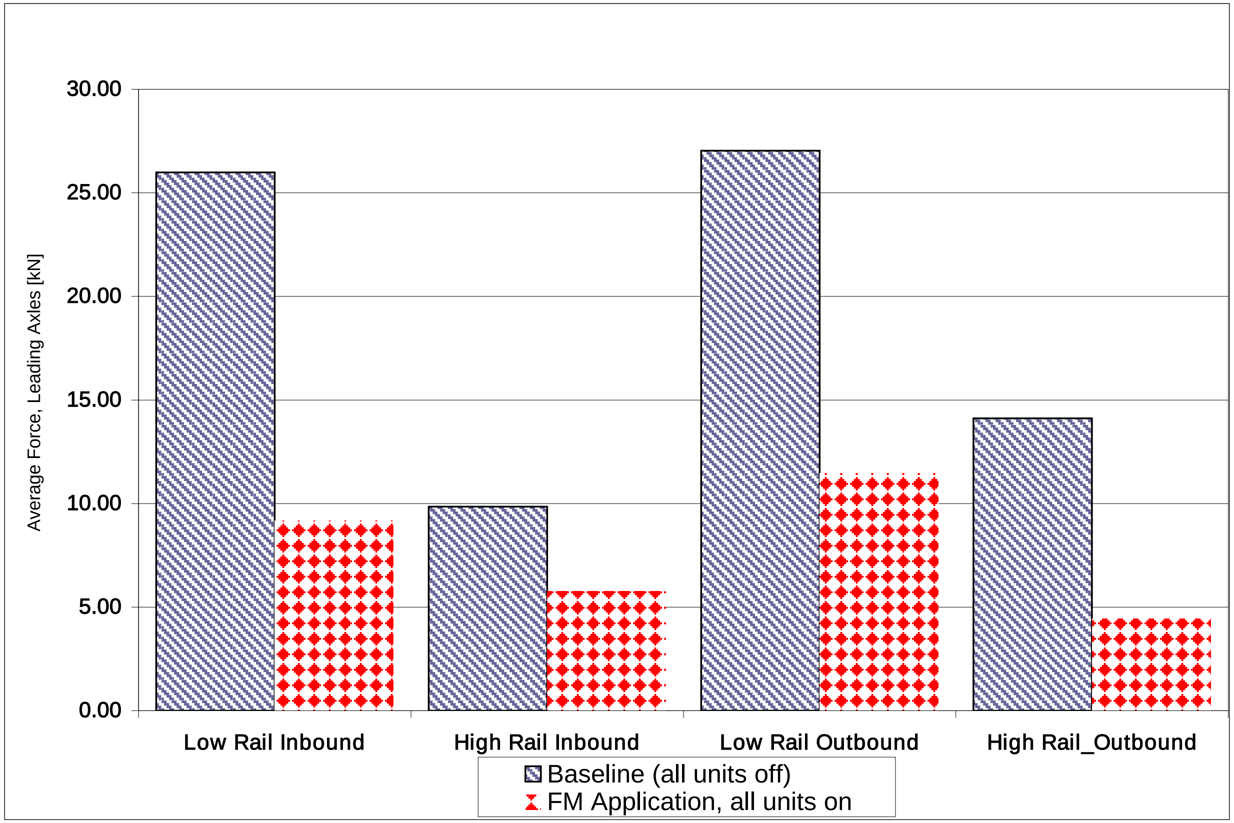

Fig7 Average leading axle lateral forces, with and without FM (Phase I and Phase II units operating), Class 360 vehicles

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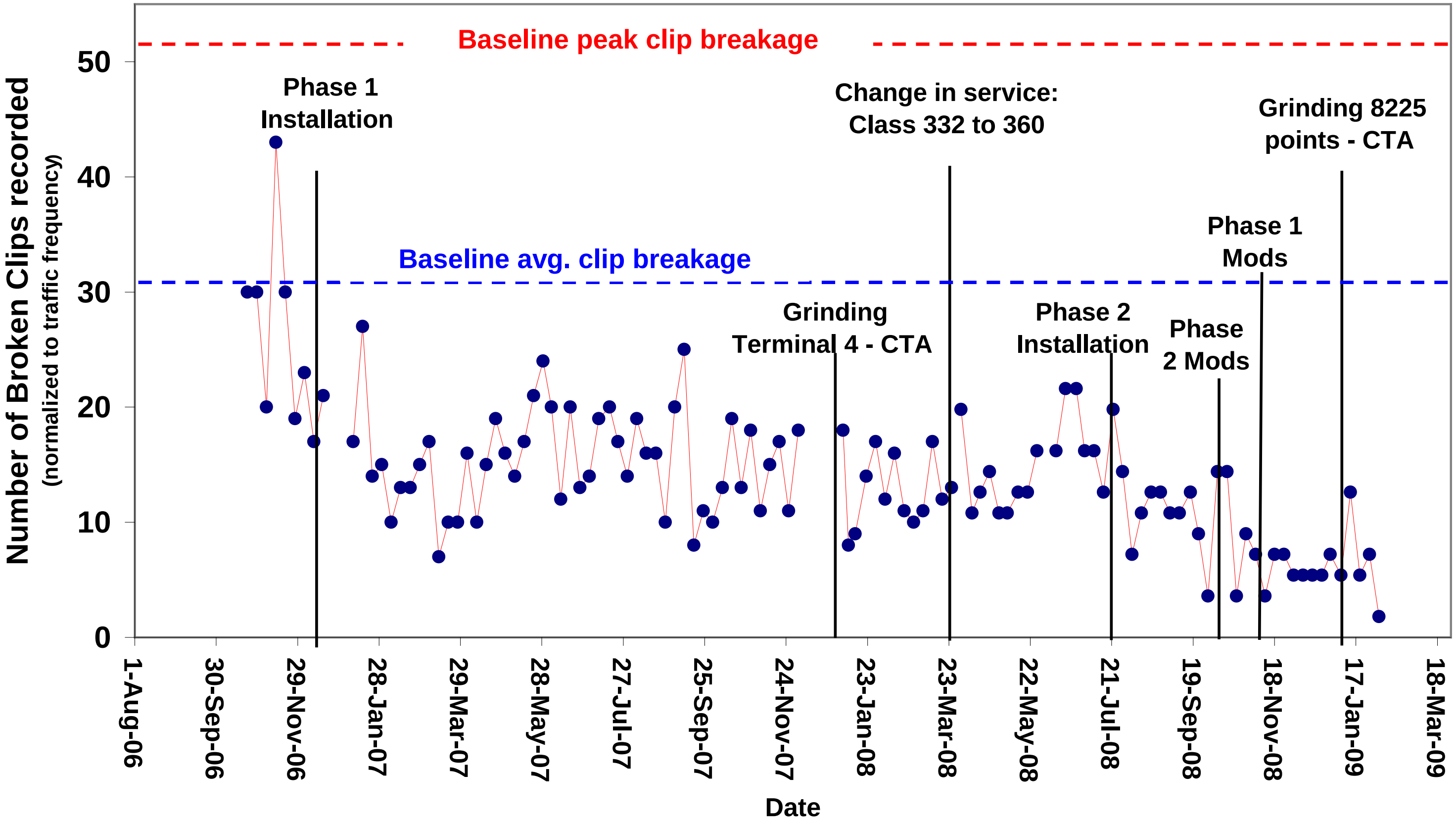
So what about clip breakage?



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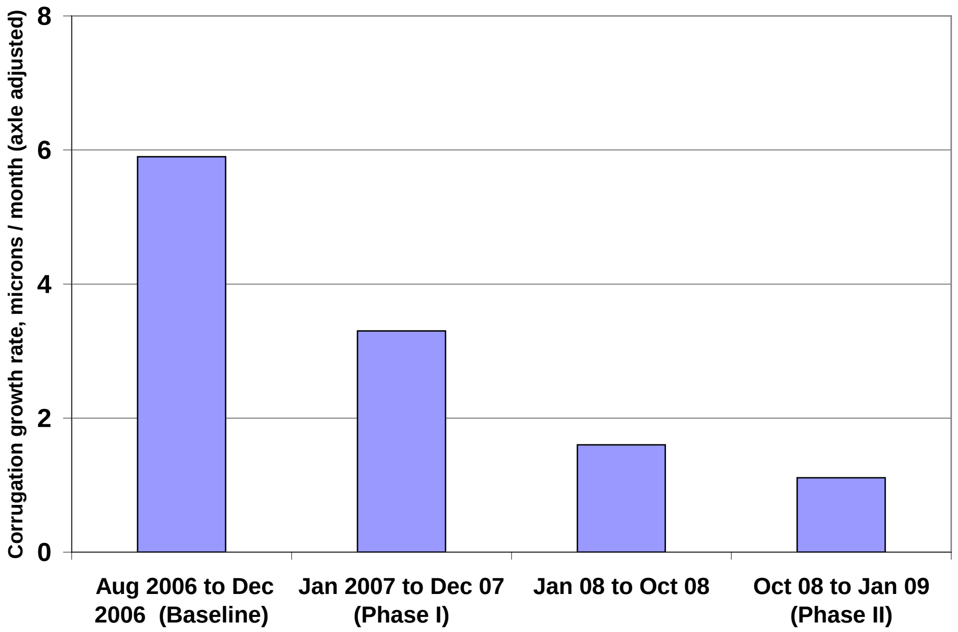
Corrugation

Corrugation growth rate (microns / month, axle adjusted



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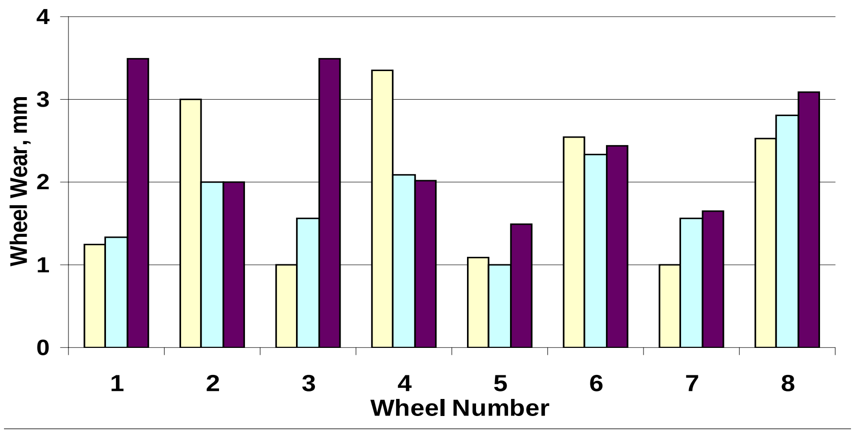
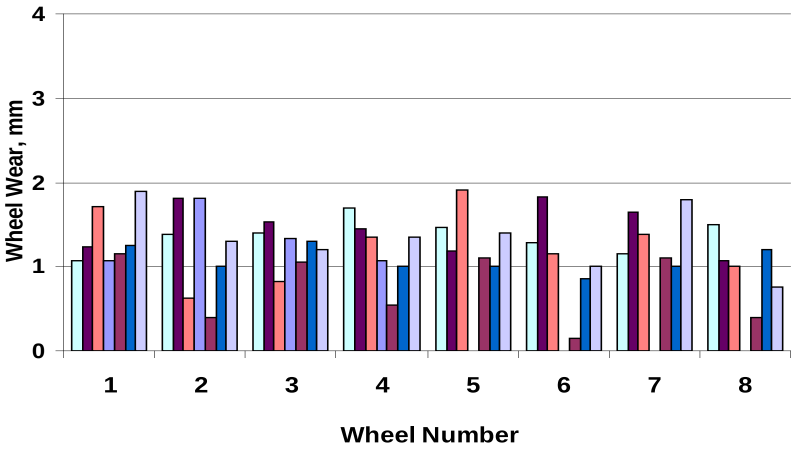
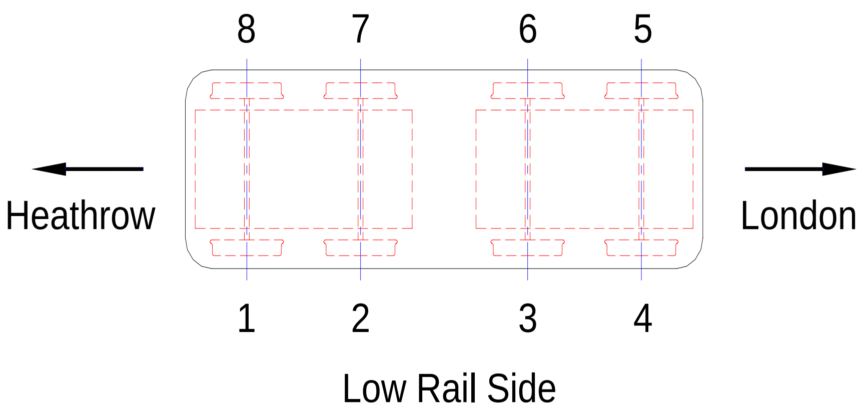
Tread wear effects



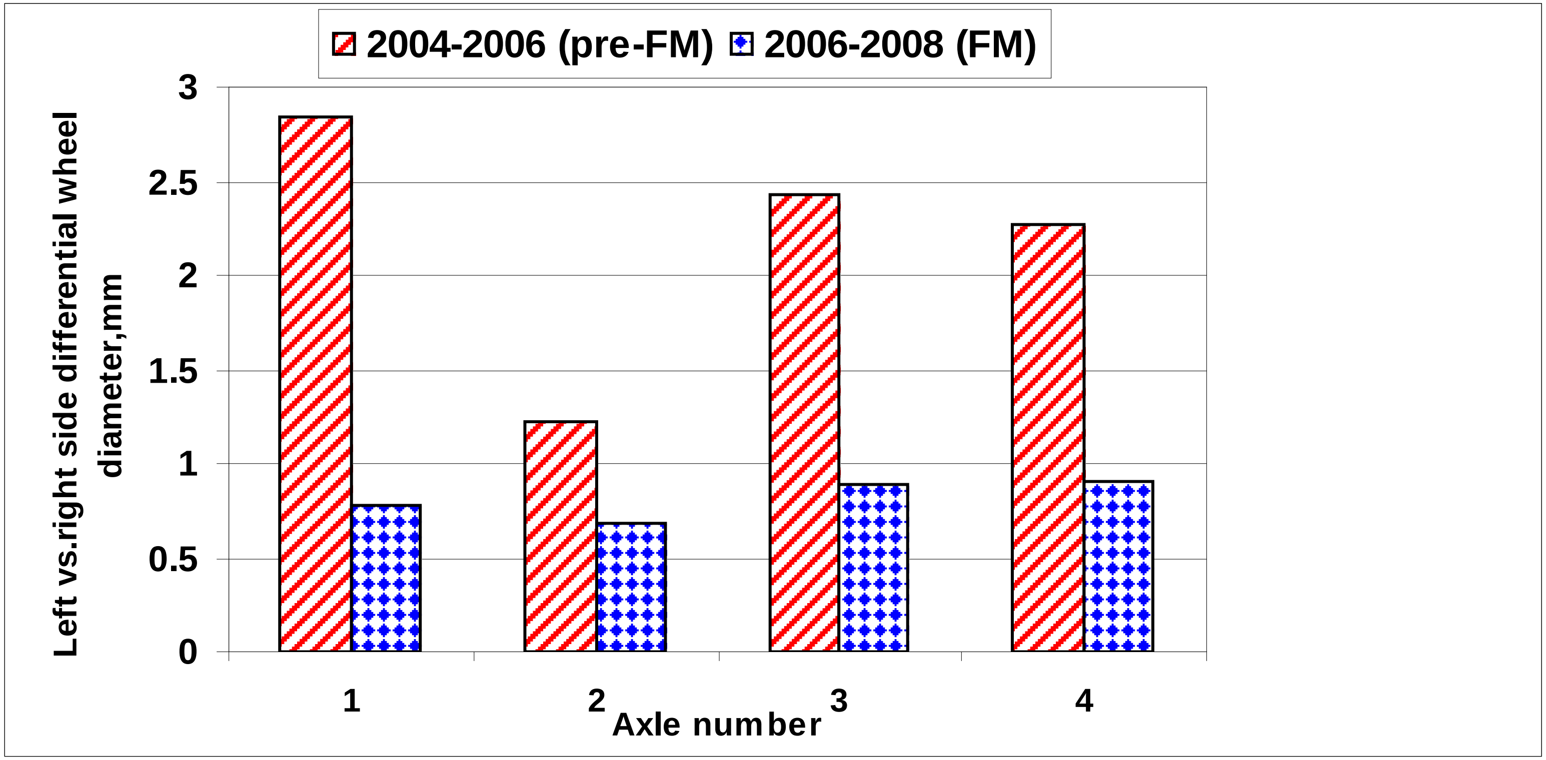
Wheel tread wear after 370000 km, baseline (pre FM) (2004 to 2006), motor and pantograph cars



Tread Wear after 370000 km, FM application (2006 to 2008), motor and pantograph cars.



Side to side differential wheel diameter



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Summary and Conclusions

- No issues with braking or signaling
- Lateral force reduction, particularly on most damaging axles
- Corresponding reduction in clip breakage, due to reduction in lateral rail deflection causing clip fatigue.
- Large reduction in corrugation growth rate – extended grinding intervals. Grinding when it occurs removes less metal
- Reduced wheel wear – easier maintenance
- Less differential wheel diameter: less resulting rail RCF and less metal removed in reprofiling

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Epilogue (2012)

- Rail condition remains much improved (low corrugation growth rate)]
- No return of clip breakages
- TOR-FM also installed on Terminal 5 line
- TOR-FM installed at portal entrance for RCF mitigation – continuing to monitor