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#### Optimisation of Wheelset Maintenance – Current Research Activities

Modern Railways 28<sup>th</sup> November 2014

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Inspiring tomorrow's professionals





### Background

- Wheelsets are expensive:
  - Manufacturing
  - Reprofiling
  - Inspections
  - Renewal
  - Environmental impact
  - Costs of trains out of service
- Strong demand to reduce the rate of wheel damage
  - Extend wheel reprofiling intervals
  - Better wheelset life
  - Lower costs





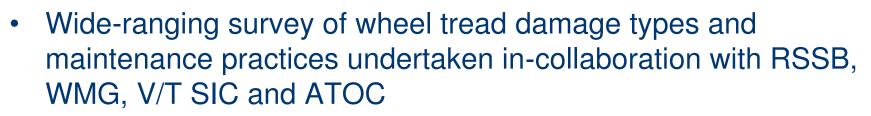


#### Wheelset Research



- Research projects relating to wheelset damage and maintenance practices include:
  - Influence of changes in material properties on observed damage
  - Optimisation of wheelset maintenance to reduce whole-system costs
  - Investigating the influence of route and vehicle design and maintenance policy on wheel tread damage
  - Assessment of alternative wheel profiles, considering both wholesystem costs and running safety
  - Categorisation of wheel damage mechanisms to improve identification and selection of appropriate mitigation
- This presentation provides an overview of some of these research areas

# Survey of Wheel Tread Damage

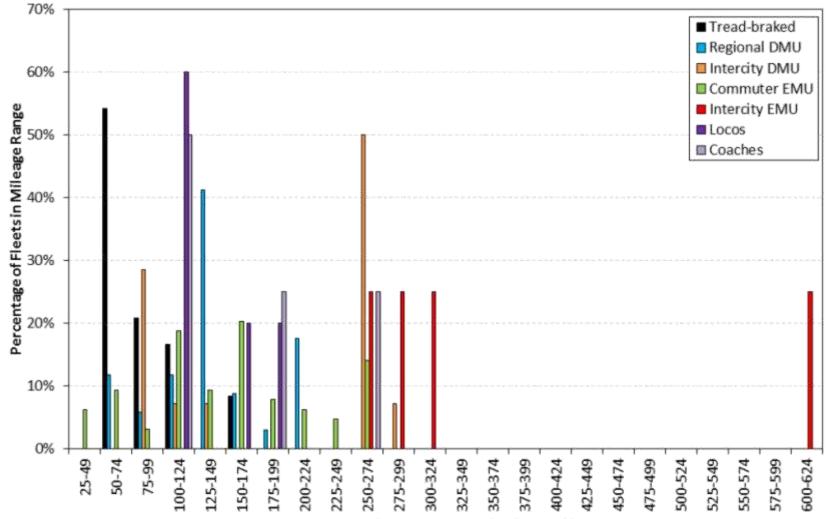


- Questionnaire review on passenger fleets
  - Wheel tread damage
  - Wheelset maintenance
  - Excellent response, >90% of all UK passenger vehicles
- Follow-up visits/calls to depots and wheel lathes
  - Detailed discussions and observations of damaged wheels
- Collate and analyse responses
  - Fed back to check data and identify any inconsistencies
- 'Workshops' held at maintenance depots
  - Presented results
  - Further discussions and feedback

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### **Reprofiling Intervals**





Average Mileage Between Wheel Reprofiling

# **Reprofiling Intervals**

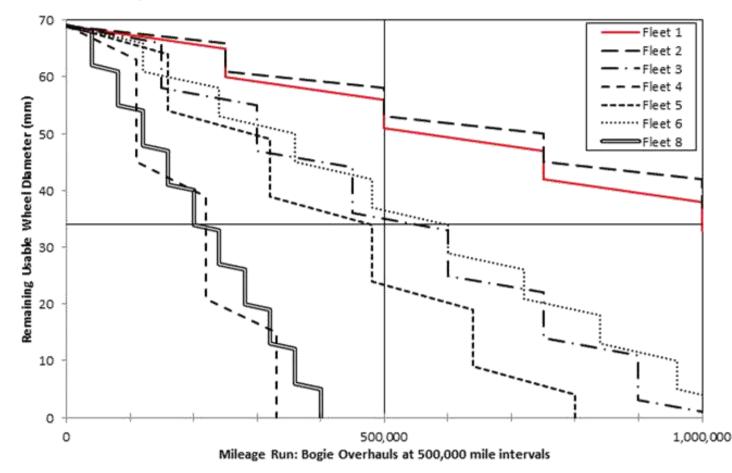


- Typical wheelset reprofiled 3 or 4 times
  - Depends on damage type and depth
  - Scheduled at a distance interval, or based on condition monitoring
  - Wheelset renewed at minimum diameter
  - Average reprofiling interval is a good indicator of wheel life
- Longest fleet-average interval ≈ 10× shortest
- Intercity trains generally better than commuter trains
  - Operating conditions (speed, curve distribution)
  - Wheel materials
- Older tread-braked trains are worst
- Potential for costs savings and improved fleet availability

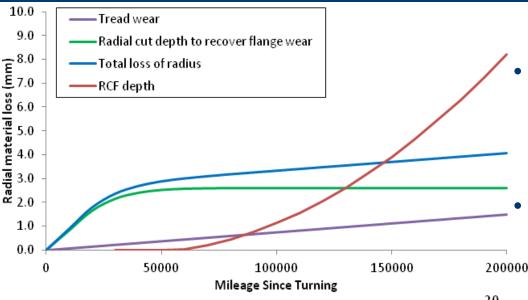
### Example EMU Wheel Life



Similar train architecture – various route characteristics and maintenance practices/constraints



### Interaction of Wear and Damage



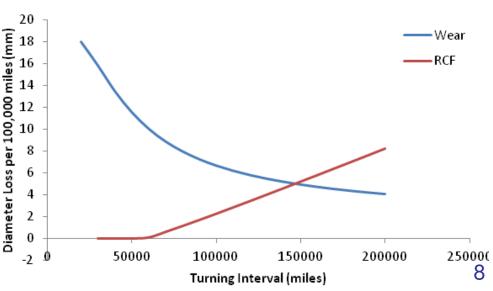
- Deeper cut required to remove RCF damage at higher mileages
- Optimum turning interval exists where material removal to restore profile shape is the same as required to remove RCF damage

 Following initial flange wear depth of cut on the lathe to restore the profile shape remains constant

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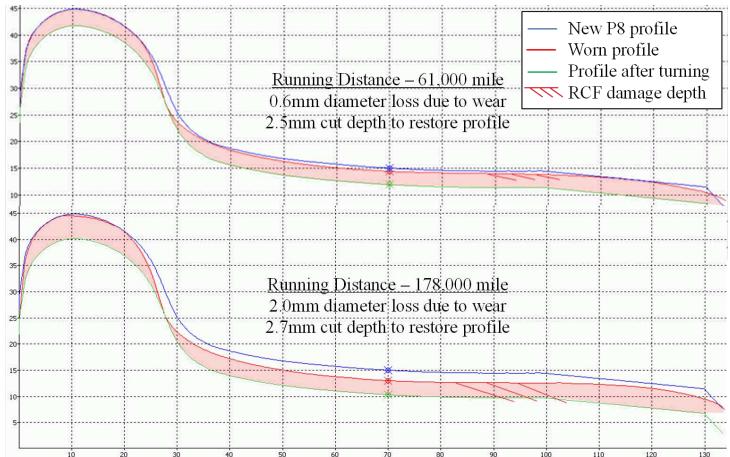
RCF cracks propagate more rapidly as the mileage increases



#### Cut Depth to Recover Flange Wear



• Example radial material loss during turning to recover profile shape

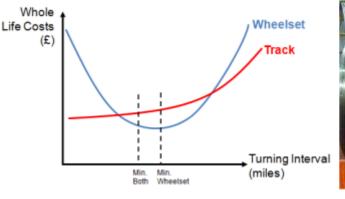


#### Wheelset Maintenance Costs



- Important to understand potential costs and savings from implementing measures to extend wheelset life
- Knowledge of the dominant damage mechanisms, constraints and costs are essential for identifying benefits and cost impact
- Tools such as RSSB/NR's *Wheelset Management Model* (*VTISM*) can help to support a business case







#### Categorisation of Damage



- RSSB research project T963 developed a Wheel Tread Damage Guide
- This guide provides:
  - Common basis for categorising wheel tread damage
  - Information on causes and mechanisms of wheel tread damage
  - Methods for managing wheel damage, maximising life and minimising costs
  - Industry case studies

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T963 Wheel Tread Damage Guide								
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#### Observations



- Route characteristics and maintenance practices have a large influence on wheelset life
  - In some cases more significant than the design parameters of the train
- Maintenance constraints resulting from design aspects are also important
  - e.g. bearing life, bogie overhaul periodicity and parity limits
- Maintainers who keep detailed wheel condition and maintenance records, managed and optimised their practices, achieved much better wheel life than those who did not

#### Observations



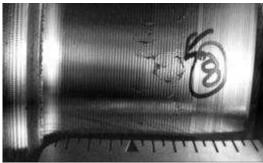
- Reprofiling may be scheduled on a regular-interval preventive basis, or using condition monitoring techniques:
  - Both methods can be effective
  - Mileage-based reprofiling tends to be carried out more frequently, but may remove less material on the lathe
- Obvious 'quick wins' could give good financial return:
  - Solving WSP problems to prevent flats
  - Provision of effective flange lubrication
  - Best practice at the wheel lathe to optimise cut depths
- With flats and flange wear solved, RCF is often the limiting damage mechanism:
  - Can be managed by preventive reprofiling at an optimised interval
  - Can be reduced by the use of an alternative wheel profile, suspension characteristic or premium wheel steel

#### **RCF Cracks in Wheels**



- Many factors influence RCF crack growth rates in wheels
  - Material properties, train type, operating/environmental conditions, position of wheelset on train
- Research being conducted to investigate changes in material properties and residual stresses during the life of a wheel
- Neutron diffraction used to measure distribution of strains and stresses in 3 entire railway wheels
- Initial results suggest that stresses are redistributed within the wheel rim during its life as material is removed and plastic flow occurs







#### Conclusions



- Benefits of managing and analysing wheel condition and maintenance records have been demonstrated
  - Bringing together maintainers of similar fleets helped to share best practice
  - It is expected that wheelset life can be improved on many fleets, with resultant cost savings
- A guidance document for optimising wheelset life has been developed
  - To assist maintainers in categorising and reducing wheel damage
  - Available to RSSB members though SPARK
  - Some maintainers have incorporated this into their maintenance documentation
- Feedback is requested to support future development