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Use of Magnetic Flux Techniques to Detect Wheel Tread Damage

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Overview

- Background
- Wheel tread damage
- SCM development
- Theory of SCM
- Wheel handheld unit
- Damage types
- Summary
- Acknowledgements
Background

- Wheelset account for a large proportion of a fleet's whole-life costs
- Wheelsets are routinely maintained to ensure safe operation and prolong life
- This includes measurements to inspect:
  - Roundness
  - Profile shape
  - Rim thickness
  - Visual inspection of surface damage
Wheel Tread Damage

- Surface damage is difficult to classify through visual inspections
  - Not possible to establish depth of damage
- Wheelsets are re-profiling to remove any identified damage
- Crucial balance exists:
  - Removing enough material to eliminate the damage
  - Minimising cut depth to preserve the rim thickness
- Taking multiple smaller cuts increases time at wheel lathe
Cut Depths

- Example radial material loss during turning
SCM Development

- MRX’s Surface Crack Measurement (SCM) technology has been in use on rails for 8+ years
- Technology has been adapted to measure surface damage on wheels using a hand held device
- Funding awarded through the RSSB/Future Railway ‘Rail Operator Challenge Competition’ to validate and further develop the product in collaboration with:
  - Bombardier Transportation
  - Institute of Rail Research, University of Huddersfield
  - Arriva Trains
Theory of SCM – 1

- Magnetic Particle Inspection (MPI) and SCM are similar
- They involve magnetizing the specimen surface
- This introduces lines of magnetic flux into the specimen
Theory of SCM – 2

- In a defect free specimen, these lines travel undisturbed through the specimen.
- If a defect is present, the flux cannot travel as easily through it.
- This causes some flux to leak at the position of the defect.
Wheel Handheld Unit – 1

- Wheel SCM uses 16 magnetic field sensors to measure and record the leaking flux
- Reports the depth of the deepest artifact in the scan
  - Amount of material to remove from the wheel to eliminate the damage
• Handheld unit specification:
  - 1mm = Lower Detection Limit (shallowest artifact)
  - 10mm = Upper Detection Limit (deepest artifact)
  - +/-0.5mm = System Accuracy
Damage Types – 1

- Surface breaking and near-surface damage
  - Cracking and cavities
Damage Types – 2

- Surface breaking and near-surface damage
  - Rolling contact fatigue (RCF) cracking
Damage Types – 3

- Surface breaking and near-surface damage
  - Rolling contact fatigue (RCF) cracking
  - Thermal cracking and cavities
Non-visible Damage – 1

- HHU reveals damage not visible on uncut wheel

Max. Measured Depth ~ 4.2mm
Non-visible Damage – 2

• HHU reveals damage not visible on uncut wheel

Max. Measured Depth ~ 7.3mm
Damage Free Wheel

• Confirms when wheel is damage free
Summary

- SCM technology has been adapted to evaluate surface and sub-surface defects in wheels
- Potential uses include:
  - *Replacing visual inspection during routine maintenance exams*  
    - Repeatable, not reliant on judgement  
    - Reveals damage that is not obvious/visible on uncut tread  
  - *Optimisation of cut depths at wheel lathe*  
    - Reduce risk of overcutting and also saves time removing defects  
  - *Trending to understand RCF development and growth rates*  
    - Improved planning of maintenance  
    - Highlight problem wheels/vehicles  
  - *Supporting specific case studies*  
    - New profiles, steels etc. (monitor performance)
Next Steps

• Further wheel lathe trials to confirm damage depth readings and access constraints etc.
• Further developments of prototype HHU
• Assessment of scrap wheels:
  – Samples to be examined optically to determine deformation depth, crack length and crack depth
  – Micro-hardness testing
  – Correlation HHU readings with measured damage
• Business case detailing the benefits of the data for trending and maintenance planning
Acknowledgments

- The results and findings presented were developed as part of the RSSB/Future Railway managed ‘Rail Operator Challenge Competition’

- For further information visit us at the blue-sky village exhibition or contact:
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