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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
• 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

![Graph showing radial material loss over mileage](image)
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
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.
Wheel Handheld Unit – 2

- Handheld unit specification:
  - 1 mm = Lower Detection Limit (shallowest artifact)
  - 10 mm = Upper Detection Limit (deepest artifact)
  - +/- 0.5 mm = System Accuracy
• Surface breaking and near-surface damage
  – Cracking and cavities
• 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

Un-Cut Wheel - cavity/thermal damage not visible

Wheel after 1st Cut - cavity/thermal damage visible

Scan of un-cut 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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