Assessment of surface ravelling using traffic speed survey techniques

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Presentation outline

○ Fretting on the Highways Agency network
○ Traffic-speed surveys on the Highways Agency network
○ Developing and testing algorithms to identify fretting
○ Conclusions
Fretting on the Highways Agency Network

What is fretting?
Fretting on the Highways Agency Network

**Why does fretting matter?**

- **Category 1 defects**
  - Good
  - Optimum intervention period.
  - Some unplanned small works interventions are likely as the pavement deteriorates
  - Poor

Time

Category 1 defects

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Fretting on the Highways Agency Network

Surveys carried out manually

- Using Coarse Visual Inspections
- Difficult to identify fretting
- Difficult to quantify
- Difficult to trend
- Quality and repeatability issues
Traffic-speed condition surveys

- Traffic-speed condition surveys
  - TRACS / HARRIS

- Data
  - Transverse profile
  - Longitudinal profile
  - Texture profile
  - Cracking

- Locationally referenced using GPS

- Covers
  - The Motorway and Trunk Road network
  - Lane 1 every 6 months
  - Lane 2 annually
  - Slip roads over 2 years

- Over 45,000km each year
Traditional measures of texture profile

- 1mm spacing available in nearside and offside wheeltrack
- Single 32/64 kHz lasers
- Methods have already been proposed to measure fretting using data from single texture lasers
Measuring fretting using texture profile

- The “Stoneway” method (Van Ooijen et al., 2004 (DWW, Netherlands)) for fretting
  - Developed for porous asphalt
- Has been implemented in the UK for measuring fretting in the nearside wheeltrack
  - Was “tuned” for Hot Rolled Asphalt
  - Is successful only where fretting is present in the wheeltrack
  - Does not identify fretting on other surfaces
- In this research we:
  - Extended this approach to provide full lane coverage
  - Considered if this could be developed for multiple surfaces
  - Developed alternative methods
  - Tested on a range of sites
Measuring fretting over the full lane width

- Traffic-speed surveys are becoming more sophisticated
- **HARRIS1**
  - Can provide transverse profile data at 6mm longitudinal spacing
  - At traffic-speed
  - Using 25 profile lasers mounted spaced (transversely) at 150mm
- Each laser effectively measures a coarse ‘texture profile’
- Other systems are “upgradeable” to deliver this
Multiple-line pseudo-texture profile

- Provided using 25 16kHz lasers
- Can we use this to improve the detection of fretting?
Expanding the current algorithms

- **Can apply the current methods to the multiple line data**
  - Requires adoption for the different properties of the data
  - Lead to the Enhanced Fretting Algorithm

- **For each of 25 lines longitudinally:**
  - Filter measured profile - leave only data which is representative of the pavement surface texture, not shape
  - Divide into 200mm segments
  - Establish a baseline for each 200mm segment – in this case the ‘MPD’ (mean profile depth) is used
  - Compare each filtered profile point against baseline – if it meets certain criteria then the presence of fretting is reported
  - Requires development of key parameters
Expanding the current algorithms

- **Algorithm criteria are:**
  - $D$ – a parameter relating to the “depth” of missing “stones”
  - $L$ – a parameter relating to the “length” of missing “stones”

- **Apply to particular surface types**

- **Needed a reference data set to decide these and to test the performance**

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**Graph:***

- **Filtered profile** vs **Baseline texture level**
- Measurement points: $L_0, L_1, L_2$
- Chainage markers: 48.13, 48.24, 48.35

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Obtaining reference data – site surveys

- For development and testing
- Extensive reference surveys
  - Pavement manually assessed using 0.7m x 5m elements
  - Each given a “rating” of 0-3

Fretting visual surveys
Obtaining reference data – image assessment

- When required, we were able to refer to the HARRIS1 downward facing videos to examine the pavement surface in detail.
- Not always easy.
Expanding the current algorithms

- Target was to obtain the best combination of parameters to
  - Identify lengths with high levels of fretting
  - With low false positives

- Reference data
- Algorithm, with various values of D and L

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Testing the enhanced algorithm

- Amalgamate data over 10m lengths for large scale testing

Reference data | Algorithm data
Testing the enhanced algorithm

- **Algorithm is capable of broadly identifying poor lengths**
  - Reasonable comparability between reference and machine data
  - Is able to identify severe fretting on HRA
  - Improved performance over single texture laser method
Enhanced algorithm - strengths and weaknesses

**Strengths**
- High resolution transverse profile data can be used to identify fretting over the full pavement width
- The method identifies sound and poor surface condition – on HRA surfaces
- Can be implemented without expensive equipment changes

**Weaknesses**
- A large (and increasing) proportion of the Highways Agency network is not HRA, but Thin Surfacings
  - Separate parameters are required for assessing Thin Surfacings
- We would require
  - A high performance automated surface type measure
  - Or good inventory data
  - Or a surface independent measure

**Conclusion:**
- Develop a surface independent measure
Developing a surface independent measure

**Aims**
- Develop method suitable for use on all surface types
- Improve performance over the enhanced algorithm, if possible

**Approach**
- Based on assumption that deterioration will appear as unevenness of texture
- Characterise texture values over long lengths (100m)
  - Global data - B
- Characterise texture values over short length (10m)
  - Local data - A
- Compare the local and global datasets
Characterising the unevenness of texture

Pseudotexture data at 6mm intervals

Bandpass filter: 2.5 – 100mm

RMS measure

Distribution of texture values: A

Distribution of texture values: B

A - B

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Non-fretted location

Portorož, Slovenia
Fretted location

Portorož, Slovenia
Fretted location
Comparing…..

Fretted

Un-fretted

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Characterisation

- **Need parameters to characterise the differences between the distributions**
  - **Correlation parameter** – the correlation of the local and global distributions
  - **Texture ratio** – characterises the widths of the local and global distributions by considering the tails
  - **Local difference** – assesses the variability of the local texture across the survey width

- **Combine these to produce a final parameter**
  - To reduce response of the correlation parameter to false positives
Characterisation

- Tested on 100km of HRA and TS
- Very promising results
Conclusions

- Traffic-speed methods have potential to replace manual techniques for the measurement of fretting
- More information on surface condition can be obtained using pseudo-texture data, provided by traditional transverse profile measurement systems
- It is challenging to develop fully automated techniques covering all surface types
- In an attempt to do so, we have proposed a system that assesses local texture variability
- This does not strictly detect fretting, but the reported values are indicative of possible fretting
- Ongoing work:
  - Wider testing
  - Establish final threshold levels
  - Enhance the method by combining with image processing techniques