Recent research on surface texture

Presented by Martin Greene
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# Surface texture and tyre tread depth

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Introduction

- Study undertaken for the Highways Agency:
  - Responsible for motorways and trunk roads in England
  - Focus on building, maintaining and operating safe roads
  - Objective to reduce adverse effects of strategic roads on the environment
Introduction

- Road surface texture and tyre tread depth can influence safety
  - Wet grip, especially at higher speeds
  - Spray

- But also contribute to environmental effects
  - Noise
  - Rolling resistance
  - Aggregate supply
  - Tyre manufacture
  - Disposal of used tyres
Introduction

- Project aimed at identifying an appropriate balance between surface texture on the road and tyre tread depth
  - In keeping with HA’s objectives for safety and the environment
Texture

Macrotexture or Texture Depth

Microtexture

- Microtexture provides the grip
- Texture depth helps to keep it at higher speeds
Measuring texture depth

- Two approaches

- Volumetric
  - Texture depth = Void volume / Surface area
  - Standard test uses glass spheres spread over a circular patch of the road surface
  - Localised measure of texture

- Laser measurements
  - Measure the profile of the surface
  - Continuous measurement
    - Sensor Measured Texture Depth (SMTD): root-mean-square measurement of texture (routine monitoring in the UK)
    - Mean Profile Depth (MPD): average depth below plane containing highest points in the surfacing
Recent research

- Tyre tread can act in a manner analogous to surface texture
- Current skid resistance measurements use a smooth tyre
  - Could current surface texture requirements be relaxed if the influence of tyre tread was taken into account?
  - Reduced tyre noise and rolling resistance
  - Better use of premium aggregates

However.........

- Research has also shown that:
  - Where water depths exceed 2mm, current minimum tread depth requirement may not be adequate
  - Motor industry tests have shown that for wet stopping distance a tread depth of 3mm gave 25% better performance than 1.6mm
Characterising tyre texture

- Need to relate tyre tread depth and pattern to a texture depth
- Applied the volumetric principle
  Texture depth = Void volume / Surface area
- Requires measurement of contact area and average tread depth
Characterising tyre tread

- Used the “Tekscan” system
  - Loaded wheel applied to a pressure sensor mat
  - Measures load distribution on the tyre
  - Provides data on the overall size of the contact patch and the area of loaded cells

- Tread depth measured with a digital depth gauge at several points around the tyre
Tekscan image
Test programme

Friction measurements

- Undertaken using HA’s Pavement Friction Tester (PFT).
- Locked wheel friction device
- Peak and average locked wheel values recorded
- All tests conducted at 100km/h
  - Influence of texture on friction greater at higher speeds
  - Representative of typical traffic speeds
Test programme

PFT measurement cycle
Test programme

Test tyres

- ASTM smooth tyre
- ASTM ribbed tyre
  - Simple circumferential groove tread pattern
- Range of production road tyres with different tread patterns
- Tested in as new condition and machined down to provide lower tread depths
- Tyre texture depths ranged from 0 to 3.2 mm (volumetric)
Test programme

Test surfaces

- Sections on TRL test track
  - Thin Surfacing (14mm aggregate)
  - Experimental thin surfacing with 6mm aggregate (MARS)
  - HRA
  - Grooved concrete (GC)
  - Brushed concrete (BC)

- Trial site on HA network
  - Proprietary thin surfacings
  - 6, 10 and 14mm aggregate sizes (T1 – T6)

- Surface textures ranged from 0.37 to 1.8mm (SMTD)
Test programme

Water application

- PFT self wetting system.
- Nominal water depths of 0.5 and 1mm.

- Spray bars located on some of the TRL test track sections.
# Drying tests

## Questions addressed

- How is skid resistance affected by water depth?
- How does skid resistance change as the surface dries out?
- Is the PFT self-wetting system representative of a “wet” road?

## Method

- Surface was saturated using the spray bars.
- PFT self-wetting system turned off.
- Initial test undertaken with spray bars still operating.
- Spray bars turned off.
- Repeat friction tests at intervals as surface dried.
Drying tests
Results (14mm Thin Surfacing)

ASTM smooth tyre

ASTM ribbed tyre

Friction vs Elapsed time (minutes)

- right peak
- left peak
- right lock
- left lock
- 0.5mm peak
- 1.0mm peak
- 0.5mm lock
- 1.0mm lock
Drying tests

Results

- In saturated conditions smooth tyre friction was noticeably lower than in self-wetting tests

- As the surface dried:
  - Locked wheel friction recovered
    - to levels comparable to the self-wet levels
  - Peak friction was slightly higher than the self-wet levels
Drying tests

Results

- Ribbed tyre cope better in flooded conditions
  - but did not show same increase in peak friction as the surfaces dried

- Results consistent with physical effects

- PFT self-wetting system provides conditions similar to those shortly after a period of heavy rain

- Friction levels reduced compared to dry friction for some time as the surface dries
## Self-wet tests

<table>
<thead>
<tr>
<th>Questions addressed</th>
<th>Method</th>
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<tr>
<td>How do tyre characteristics (tread pattern and depth) affect skid resistance?</td>
<td>PFT self-wetting system turned on</td>
</tr>
<tr>
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<td>Measurements at 0.5 and 1mm nominal water depth</td>
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<td>Standard test tyres and road tyres</td>
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<td>Range of surfaces</td>
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</tbody>
</table>
Self-wet tests

Locked-wheel friction for 1mm self-wet tests

![Graph showing friction vs. tyre texture depth](image-url)
Self-wet tests

Results

- Friction levels measured with the smooth test tyre broadly increase with increasing texture depth of the surfacings
  - (HRA > 14mm Thin Surfacing > 6mm Thin Surfacing > GC > BC)

- Similar trends for treded tyres but friction levels on 6mm Thin Surfacing are higher than HRA or 14mm Thin Surfacing

- Friction levels remain sensibly constant above about 2mm of tyre texture depth
Combining surface and tyre characteristics

- Surface texture and tyre texture were combined
  - Simple arithmetic sum

![Graph showing the relationship between friction and combined texture]

Legend:
- Thin Surfacing (14mm)
- HRA
- BC
- GC
- MARS (6mm)
Combining surface and tyre characteristics

- Additional data from trial site on HA network included and previous tests on TRL track
Self-wet tests

Results

- Rate of decrease in friction increases below a combined texture of about 1.5 – 2mm
- Friction levels measured on the surfaces incorporating 6mm aggregates provide high levels of friction in spite of the low combined texture levels
  - Combined texture is not the only indicator of high speed friction
## Assessment of results

<table>
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<th>Tyre properties</th>
<th>Combined texture (mm)</th>
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<tr>
<td></td>
<td>Road Surface texture (mm)</td>
</tr>
<tr>
<td></td>
<td>1.1</td>
</tr>
<tr>
<td>Tread depth (mm)</td>
<td></td>
</tr>
<tr>
<td>6 (new)</td>
<td>2.2</td>
</tr>
<tr>
<td>3 (recommended)</td>
<td>1.1</td>
</tr>
<tr>
<td>1.6 (legal min.)</td>
<td>0.6</td>
</tr>
</tbody>
</table>

- Combinations of low tread depth and low surface texture provide a combined texture below the level where a downturn in high speed skid resistance was observed.
Summary

- Surface texture and tyre texture appear to be interchangeable
  - Appears to be a level of combined texture above which high speed skid resistance does not increase markedly
  - Other properties appear to influence the high speed skid resistance performance of the tyre (tread pattern, material composition)

- Current UK requirements for texture on new surfaces and minimum tyre tread appear adequate
  - Low tread tyres on older pavements with low texture could increase risk

- Any reduction in required road surface texture would need to be offset by an increase in required tread depth (or “tyre texture”)

- Further research needed into skid resistance performance of thin surfacings with smaller sized aggregates (6mm)
Do You Have Any Questions?
Thank you

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