
# Recent research on surface texture

Presented by Martin Greene
Senior Researcher – 20/10/11

# Surface texture and tyre tread depth

# 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

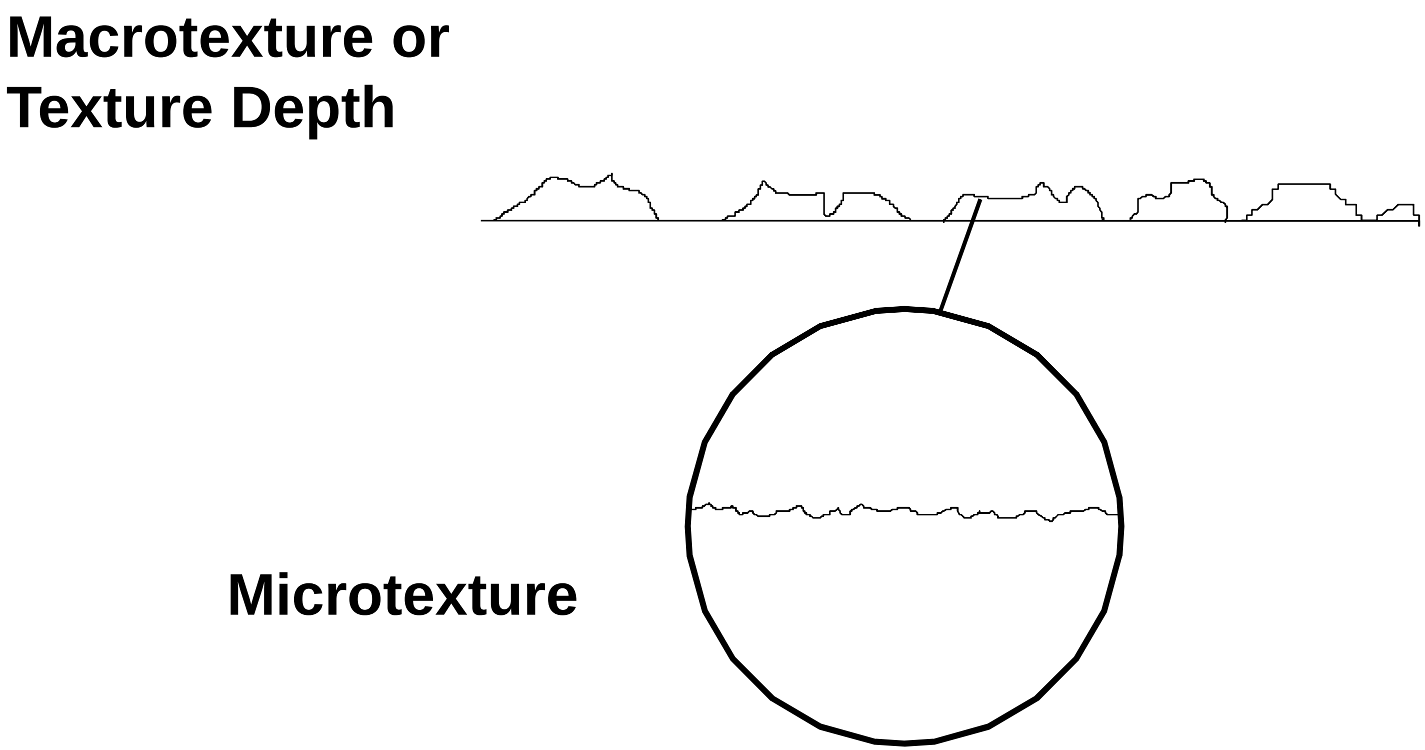
# Introduction

- 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




- 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

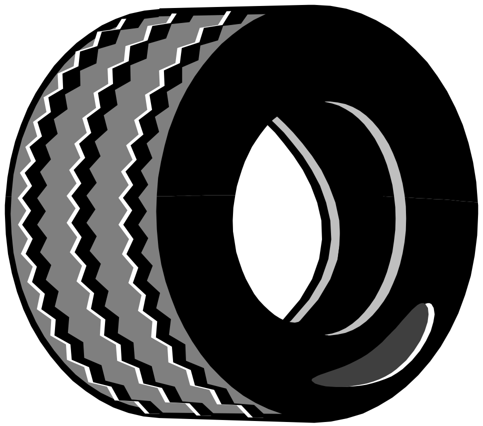
# Recent research

- 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

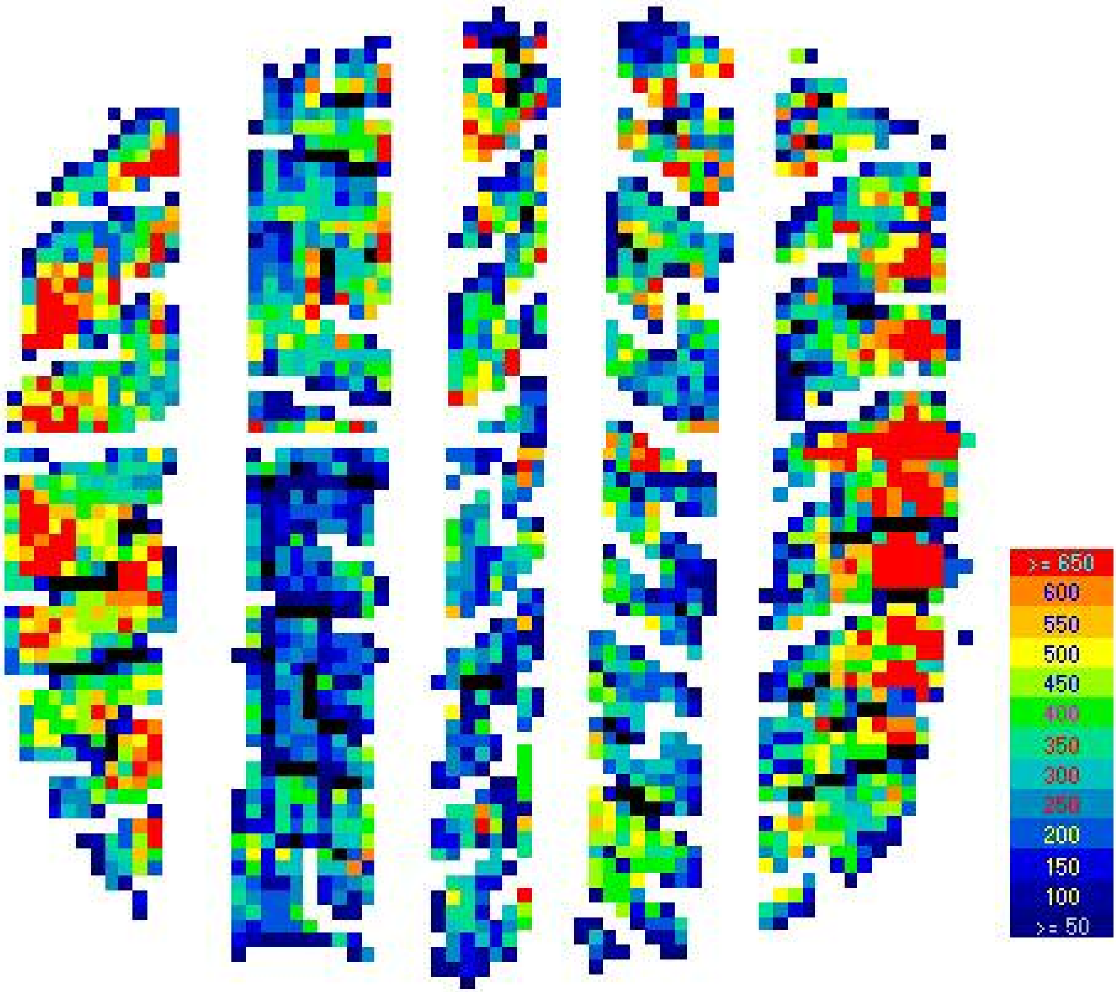
  Texture depth = Void volume / Surface area
- Requires measurement of contact area and average tread depth



# 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



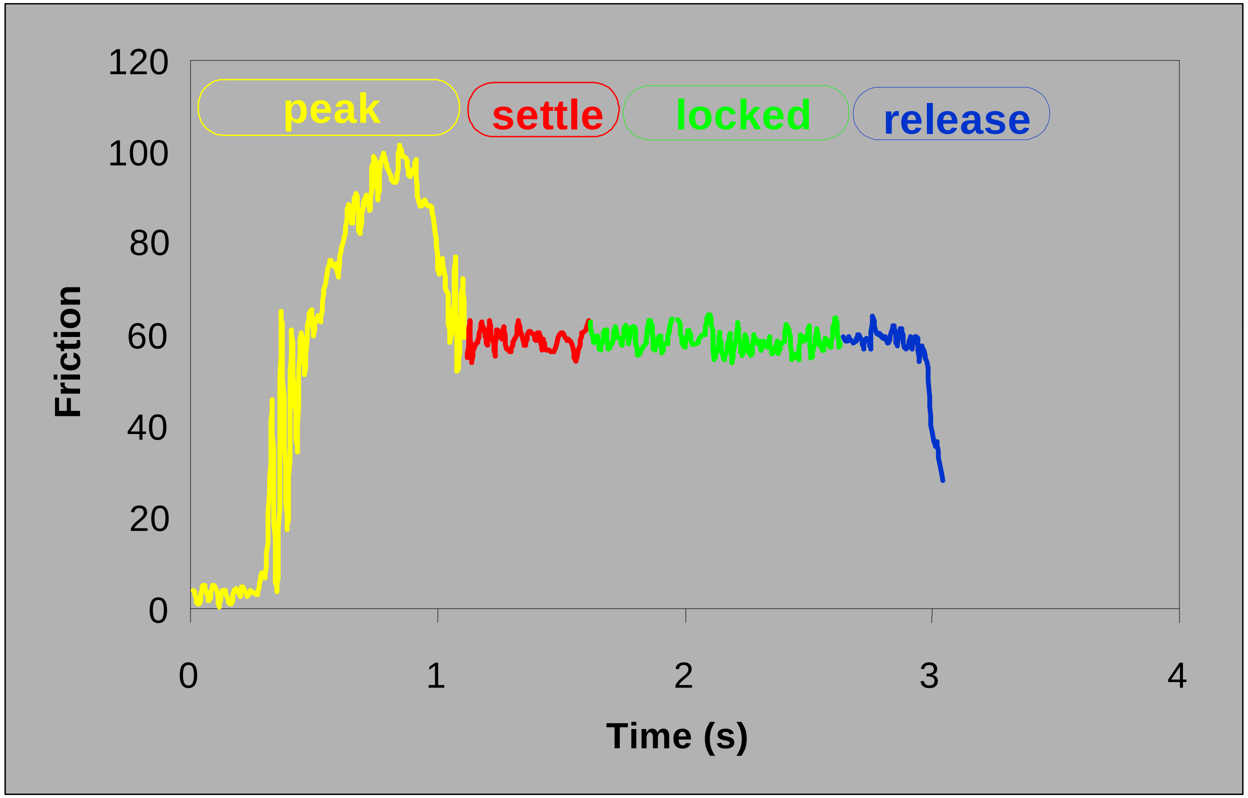
# Test programme

## 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?

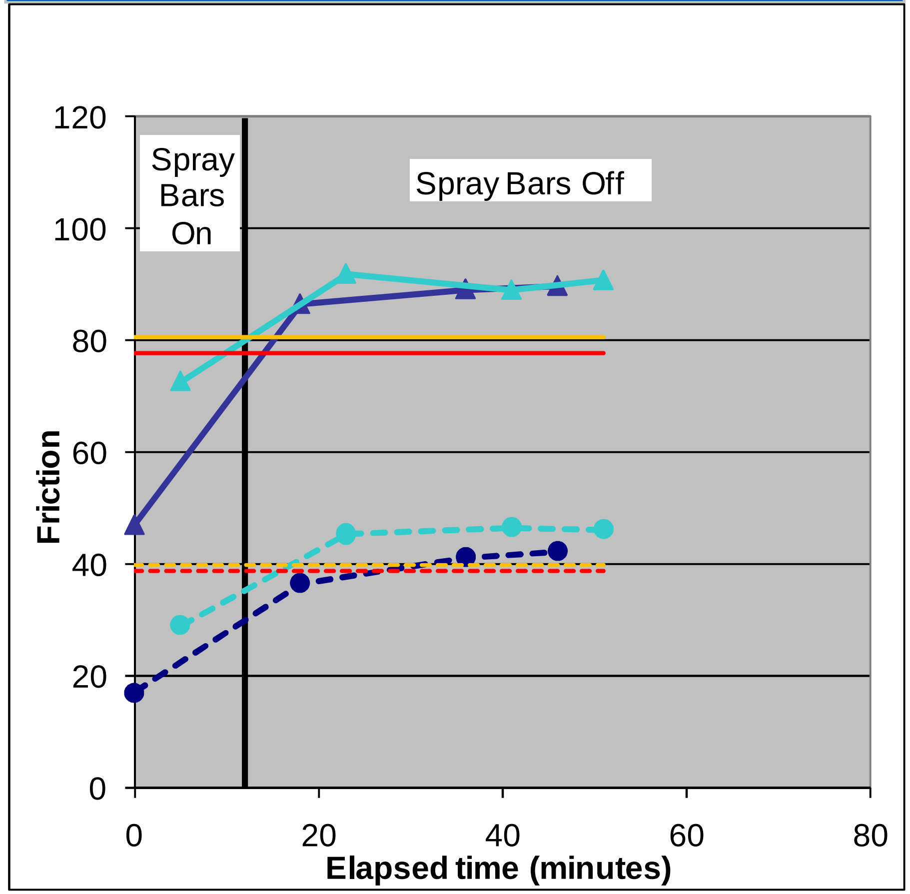
**Method**

- 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.

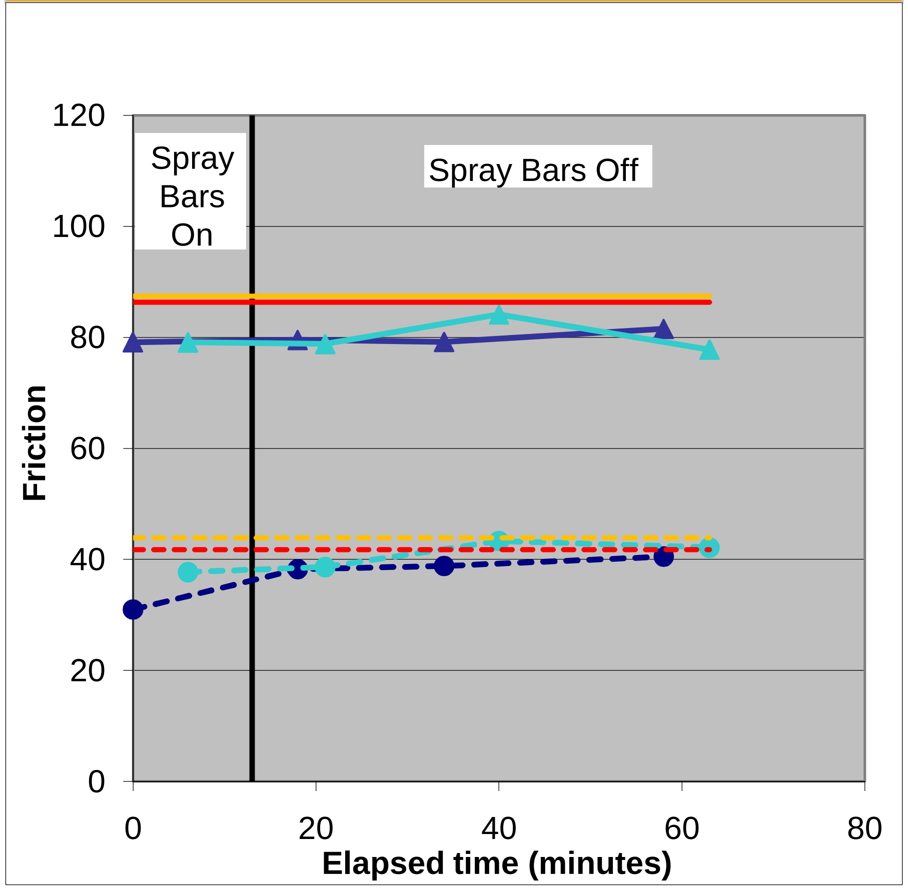
# Drying tests

Results (14mm Thin Surfacing)

**ASTM smooth tyre**




**ASTM ribbed tyre**




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 coped 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

## Questions addressed

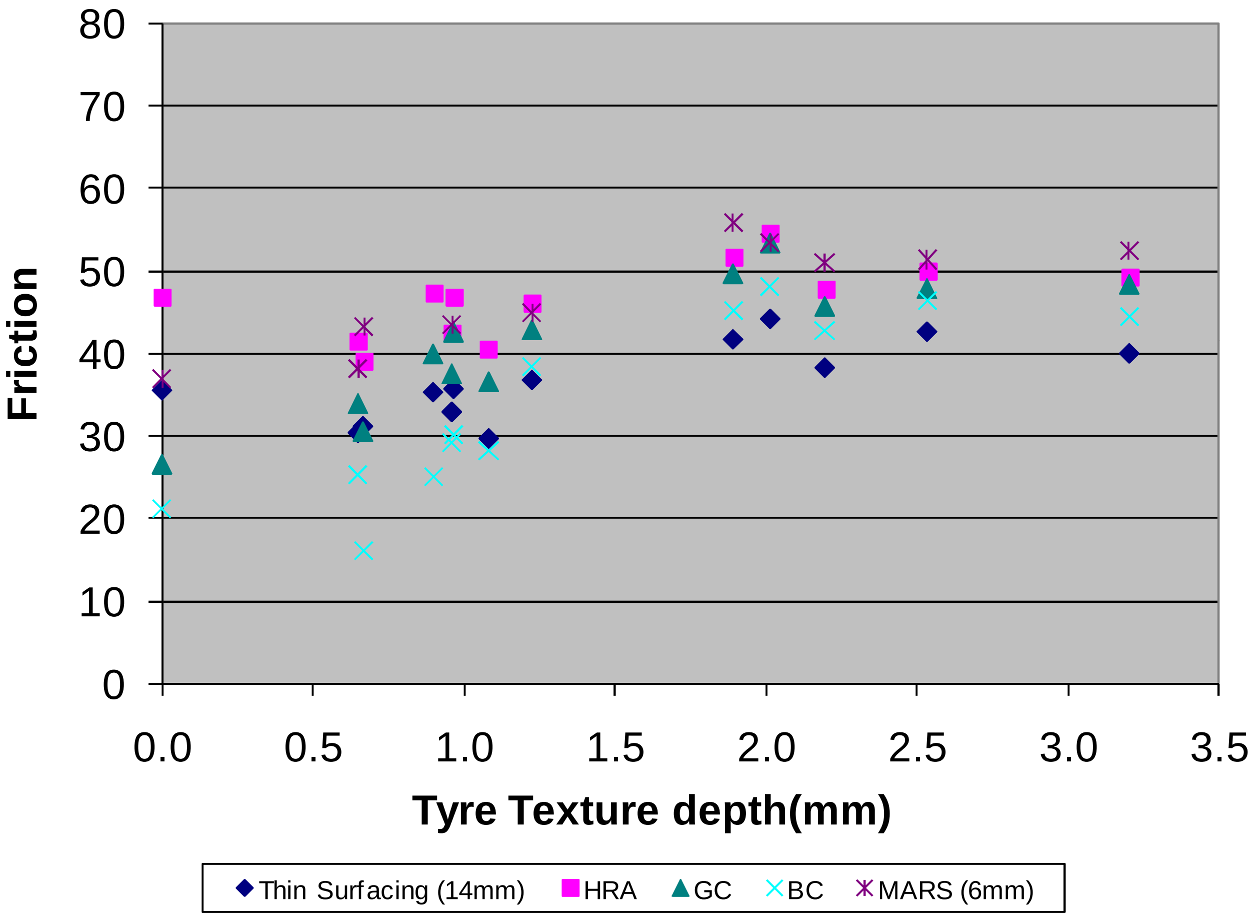
- How do tyre characteristics (tread pattern and depth) affect skid resistance?

## Method

- PFT self-wetting system turned on
- Measurements at 0.5 and 1mm nominal water depth
- Standard test tyres and road tyres
- Range of surfaces

## Self-wet tests

Locked-wheel friction for 1mm self-wet tests



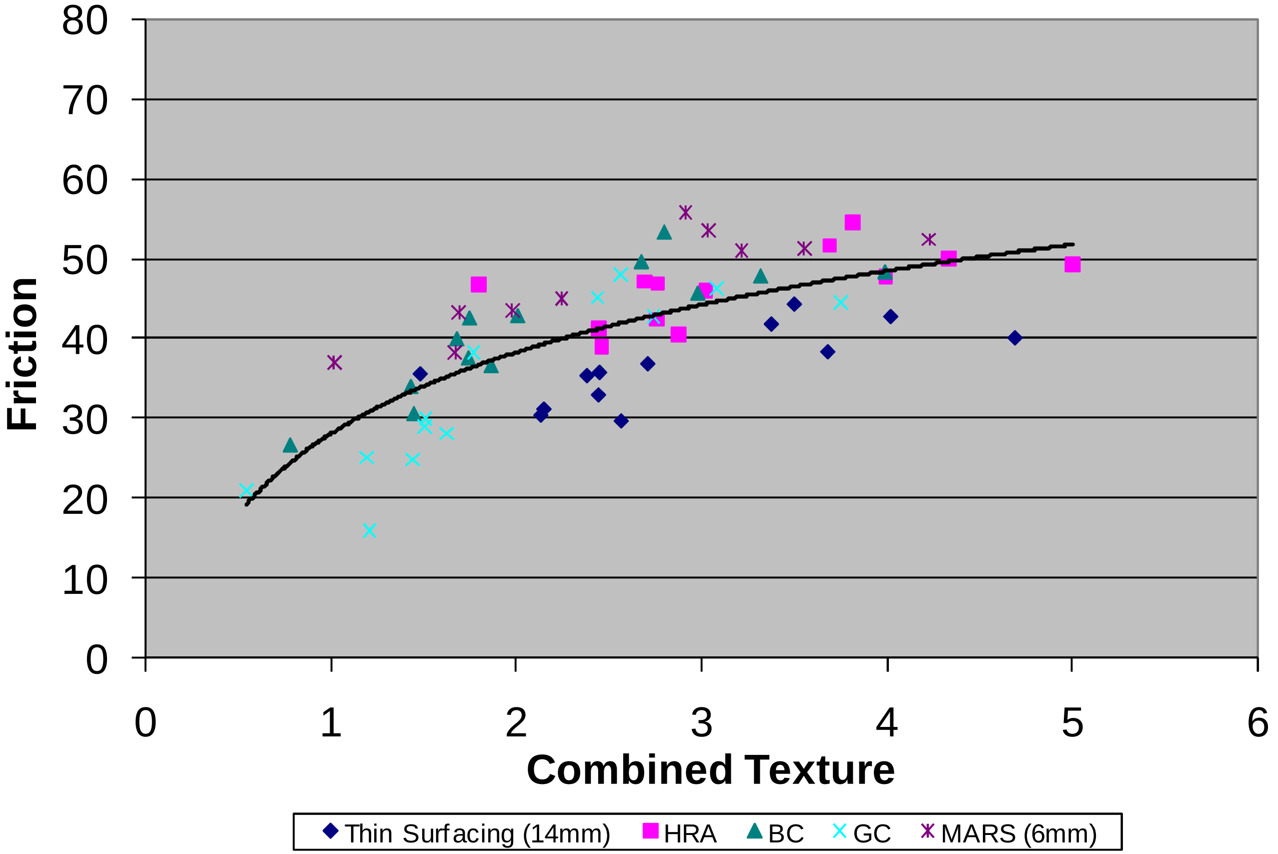
# Self-wet tests

## 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 treaded 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

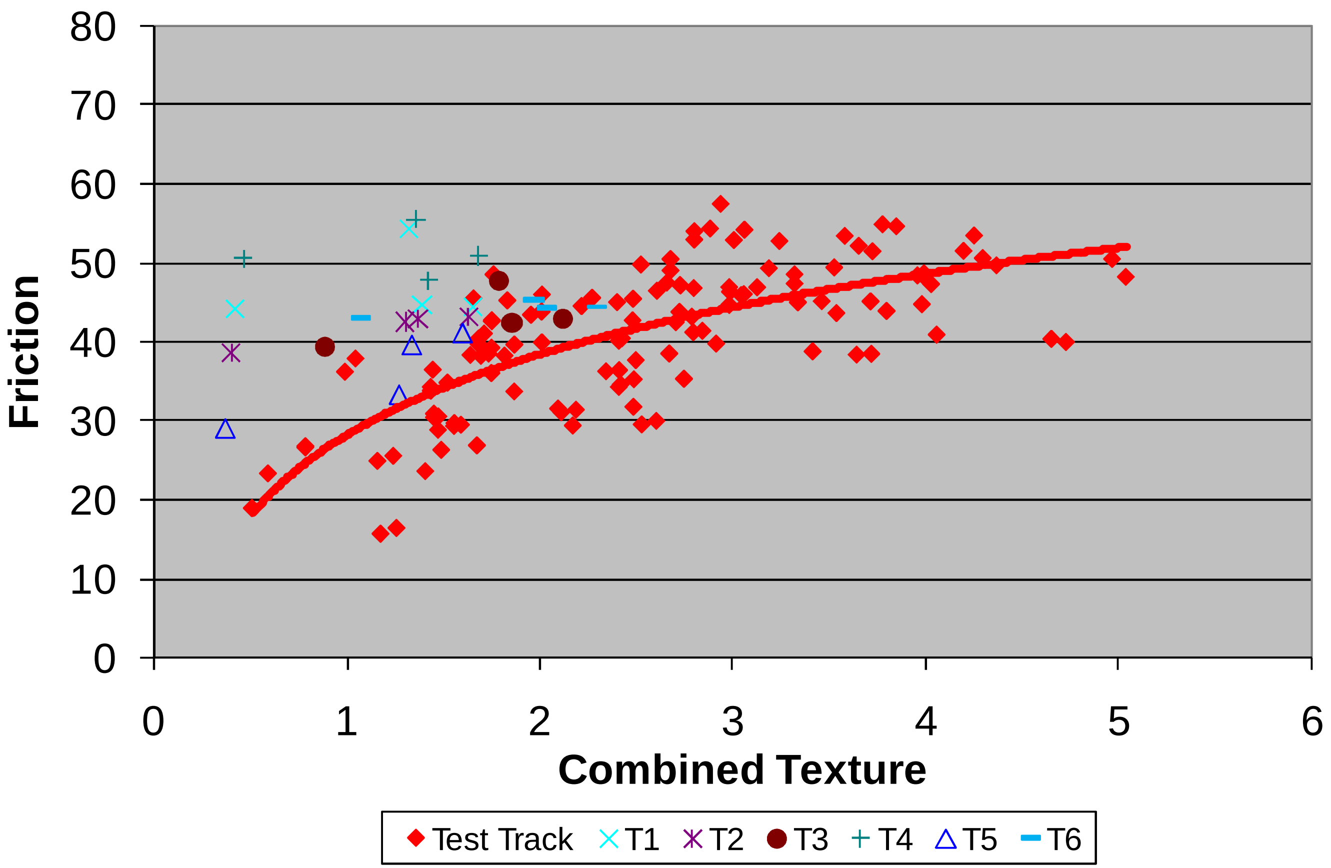
# Combining surface and tyre characteristics

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



# 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

| Tyre properties | | Combined texture (mm) | | |
|---|---|---|---|---|
| | | Road Surface texture (mm) | | |
| Tread depth (mm) | Approx. tyre texture depth (mm) | 1.1 | 0.8 | 0.4 |
| 6 (new) | 2.2 | 3.3 | 3.0 | 2.6 |
| 3 (recommended) | 1.1 | 2.2 | 1.9 | 1.5 |
| 1.6 (legal min.) | 0.6 | 1.7 | 1.4 | 1.4 |

- 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

Presented by Martin Greene
Senior Researcher – 20/10/11
Tel: +44 (0)1344 770278
Email: mgreene@trl.co.uk