Influence of thin water film on skid resistance

Y. Beautru / V. Cerezo / M.-T. Do / M. Kane
Driving on wet roads

- Risk perception

high

few mm

low

< 1 mm
Driving on wet roads

- Speed adaptation

<table>
<thead>
<tr>
<th>Situation</th>
<th>Risk perceived</th>
<th>Speed adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flooded</td>
<td>Yes</td>
<td>V ↘</td>
</tr>
<tr>
<td>Wet</td>
<td>No</td>
<td>V ≈ V dry</td>
</tr>
<tr>
<td>Damp</td>
<td>No</td>
<td>V ≈ V dry</td>
</tr>
<tr>
<td>Rain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy</td>
<td>Yes</td>
<td>V ↘</td>
</tr>
<tr>
<td>Light</td>
<td>No</td>
<td>V ≈ V dry</td>
</tr>
<tr>
<td>After rain</td>
<td>No</td>
<td>V ≈ V dry</td>
</tr>
</tbody>
</table>

Source: French APTP project
Previous researches

1950
speed
road surface (macrotexture)
tire tread (pattern, depth)

1970

1990
road surface (microtexture)
tire (rubber)

…

Norfolk, Virginia / September 19-22, 2012
7th symposium on pavement surface characteristics
Overview

- Friction-water depth variation
- Critical water depth definition
- Effect of road surface microtexture (FP7)
Experiments

- Laboratory specimens

Real pavement surfaces

very thin asphalt concrete

semi-coarse asphalt concrete

aggregate mosaic slab

Changing microtexture by sandblasting
Experiments

- Ifsttar test tracks
## Experiments

### Test surfaces

<table>
<thead>
<tr>
<th>Type of pavement</th>
<th>Size of aggregates (min/max)</th>
<th>Acronym</th>
<th>Photography</th>
<th>SFC</th>
<th>MPD (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Thin Asphalt Concrete</td>
<td>0/6</td>
<td>VTAC 0/6</td>
<td><img src="VTAC_0-6.png" alt="Image" /></td>
<td>0.56</td>
<td>1.00</td>
</tr>
<tr>
<td>Very Thin Asphalt Concrete</td>
<td>0/10</td>
<td>VTAC 0/10</td>
<td><img src="VTAC_0-10.png" alt="Image" /></td>
<td>0.71</td>
<td>1.30</td>
</tr>
<tr>
<td>Porous Asphalt Concrete</td>
<td>0/6</td>
<td>PAC 0/6</td>
<td><img src="PAC_0-6.png" alt="Image" /></td>
<td>0.65</td>
<td>2.90</td>
</tr>
<tr>
<td>Surface Dressing</td>
<td>0.8/1.5</td>
<td>SD 0.8/1.5</td>
<td><img src="SD_0-8_1-5.png" alt="Image" /></td>
<td>0.90</td>
<td>0.45</td>
</tr>
<tr>
<td>Semi-coarse Asphalt Concrete (old)</td>
<td>0/10</td>
<td>SCAC 0/10</td>
<td><img src="SCAC_0-10.png" alt="Image" /></td>
<td>0.73</td>
<td>0.66</td>
</tr>
<tr>
<td>Semi-coarse Asphalt Concrete (new)</td>
<td>0/10</td>
<td>SCAC 0/10</td>
<td><img src="SCAC_0-10.png" alt="Image" /></td>
<td>0.59</td>
<td>0.82</td>
</tr>
</tbody>
</table>
Experiments

- Friction measuring machines

Dynamic Friction Tester

Adhera
Experiments

- Friction coefficients

<table>
<thead>
<tr>
<th>Dynamic Friction Tester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friction coefficient</td>
</tr>
<tr>
<td>Test speed (km/h)</td>
</tr>
</tbody>
</table>

- Adhera

\[ \text{LFC} = \frac{F_H}{F_V} = \mu \]

- Braking curve
- 20, 40 and 60 km/h
- ASTM E1911 (2009)

- Blocked wheel
- 40, 60 and 90 km/h
- EN TS 15901-4 (2009)
Experiments

- How obtaining reproducible very thin waterfilm?

Surface wetting protocol in laboratory

⇒ WD < 0.1 mm
Results

- Friction-water depth variation (laboratory)
Results

- Laboratory vs in-situ
Results

- Microtexture effect

Smooth aggregates vs sandbasted aggregates

![Graph showing friction coefficient vs water depth with and without sandbasted aggregates.](attachment:image.png)
Results

- Microtexture effect
Results

- Critical water depth

\[ \Leftrightarrow \text{Limit between the boundary and mixed lubrication} \]
Results

- Microtexture effect on critical water depth
Conclusions

• Effect of very thin water film on friction coefficient both in laboratory and on real test site
  ➔ Strubeck curve shape with boundary, mixed and hydrodynamic lubrication regimes
  ➔ Definition of a critical waterdepth

• Effect of microtexture on critical waterdepth

• Next step: modeling friction with texture descriptors and predicting viscoplaning phenomenon
This study was carried in the context of the project: Enhanced Driver Safety due to Improved Skid Resistance (SKIDSAFE) financed by the European Union 7th Framework Program, Theme: Safety and Security by Design.

http://www.skidsafe.org/
Thank you for attention...

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