SAMPLES OF SINGULAR DETAILED TEXTURE AND SKID RESISTANCE ANALYSIS

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Introduction

- **Singular studies/works**
  - Require specific techniques

- **Type of measurement**
  - Network level
    - High speed equipment used when possible
  - Project level
    - Specific equipment
Equipment characteristics

- **Texture**
  - Laser profiler mounted on vehicle
    - Either on profiling or skid resistance equipment
  - Static equipment to measure local characteristics
    - Sand patch
    - Circular Texture Meter (CTMeter)

- **Skid resistance**
  - High speed skid measurement units
    - SCRIM, Griptester, ...
  - Static equipment to measure local characteristics
    - British pendulum
    - Dynamic Friction Tester (DFTester)
Specific singular works

- **M-30 Road (Madrid)**
  - Analysis of low skid road sections by static devices
    - Influence of speed
    - Influence of texture

- **Tram bus lane**
  - Compare the skid resistance of different pavement surfaces in order to build a guided tram bus lane
The characteristics of the equipment used (I)

- **DFTester**
  - ASTM E1911 Standard
  - Friction coefficient at speeds on the range: 100 km/h to 0 km/h
    - Allows to check differences on the skid resistance of different pavement surfaces at different speeds
  - Test procedure
    - Spinning wheel (platform) up to 100 km/h speed
    - Drop of the platform with the rubber sliders
    - Measurement of the skid resistance continuously until the stop of the spinning wheel

- **Samples:**

![Graph showing friction vs speed](image)

Portorož, Slovenia
The characteristics of the equipment used (II)

- **CTMeter**
  - ASTM E2157 Standard
  - Texture (MPD/RMS) at different directions
  - Laser profiler spins
  - Circular track

- **Common**
  - Small footprint
    - Usable on tight locations
  - Slow procedure
    - Unusable at network level

Portorož, Slovenia
M-30 Road (Madrid)

- **Standard road testing with high speed device - Grip tester**
  - Results by means of:
    - Grip number
    - Converted to SCRIM coefficient

- **Detail testing to evaluate some poor skid resistance sections**
  - Skid resistance
    - DFTester
    - British pendulum
  - Texture
    - CTMeter (ASTM E21567)
    - Sand patch (ASTM E965)
Standard road testing results

- The results provided four kinds of pavement sections

<table>
<thead>
<tr>
<th></th>
<th>Grip Number</th>
<th>SCRIM Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test section 1 (Good skid resistance)</td>
<td>0.66</td>
<td>0.56</td>
</tr>
<tr>
<td>Test section 2 (Good skid resistance)</td>
<td>0.69</td>
<td>0.59</td>
</tr>
<tr>
<td>Test section 3 (Poor skid resistance)</td>
<td>0.52</td>
<td>0.44</td>
</tr>
<tr>
<td>Test section 4 (Poor skid resistance)</td>
<td>0.55</td>
<td>0.47</td>
</tr>
</tbody>
</table>
Specific testing - Skid resistance & Texture

- **Skid resistance**
  - Average results

<table>
<thead>
<tr>
<th></th>
<th>British Pendulum</th>
<th>DFTester (20 km/h) $\mu_{20}$</th>
<th>DFTester (40 km/h) $\mu_{40}$</th>
<th>DFTester (60 km/h) $\mu_{60}$</th>
<th>DFTester (80 km/h) $\mu_{80}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test section 1 (Good skid resistance)</td>
<td>0.63</td>
<td>0.65</td>
<td>0.57</td>
<td>0.52</td>
<td>0.50</td>
</tr>
<tr>
<td>Test section 2 (Good skid resistance)</td>
<td>0.61</td>
<td>0.64</td>
<td>0.52</td>
<td>0.45</td>
<td>0.44</td>
</tr>
<tr>
<td>Test section 3 (Poor skid resistance)</td>
<td>0.57</td>
<td>0.54</td>
<td>0.46</td>
<td>0.42</td>
<td>0.41</td>
</tr>
<tr>
<td>Test section 4 (Poor skid resistance)</td>
<td>0.57</td>
<td>0.52</td>
<td>0.46</td>
<td>0.43</td>
<td>0.43</td>
</tr>
</tbody>
</table>

- **The results for skid resistance confirmed what was seen on grip tester (standard) results**
  - Sect. 1 and 2 ok
  - Sect. 3 and 4 low

- **Check that section 2 has quite large variations of skid resistance at different speeds**
  - It was not seen by high speed device (grip tester)
  - It was not seen by low speed device (pendulum)
Texture results

Texture
- Measured with
  - CTMeter
  - Sand patch

From the analysis of the textures
- Seems like section 2 has lower texture values than sections 1, 3 and 4

<table>
<thead>
<tr>
<th>Test section</th>
<th>MTD (ASTM E965)</th>
<th>MPD (ASTM2157)</th>
<th>RMS (ASTM2157)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Good skid resistance)</td>
<td>1.44</td>
<td>1.48</td>
<td>1.16</td>
</tr>
<tr>
<td>2 (Good skid resistance)</td>
<td>1.23</td>
<td>1.15</td>
<td>0.97</td>
</tr>
<tr>
<td>3 (Poor skid resistance)</td>
<td>1.36</td>
<td>1.38</td>
<td>1.12</td>
</tr>
<tr>
<td>4 (Poor skid resistance)</td>
<td>1.29</td>
<td>1.40</td>
<td>1.16</td>
</tr>
</tbody>
</table>
Variations of skid resistance because of speed variation can once again provide erroneous information

- From high speed results section 1 and 2 seem to be similar but verifying their characteristics at different speeds showed that the pavement sections were working differently
- Same skid coefficient at 20 km/h... and quite different at 80 km/h
Tram bus lane

Objective
- Help in the decision on how should be built the slabs that conform a guided tram bus lane
- Evaluation of skid and texture characteristics of the pavement

Tasks
- Measure the slabs that are currently working on a similar setup on Essen (Germany)
- Measure the different test slabs that are being manufactured
- Compare the results of the measurements to decide how should the final slabs manufactured
Cross section of the reference tram bus “rails”

- **Singular structure**
  - Road made as a “rail track”
Why use singular equipment (I)

- **Tight location (Reference site)**
  - Impossible to drive through the guided tram bus lane with a "conventional" equipment as SCRIM and/or Griptester
Why use singular equipment (II)

- **Laboratory (Test slabs)**
  - Impossible to measure the skid resistance of the test slabs with a “conventional” equipment as SCRIM and/or Griptester
  - Need of an static device
Testing procedure on the reference tram bus rails

- Test a collection of points to verify the skid resistance properties of the reference track
  - Test points: Over 50 tests
Results on the reference tram bus rails

- Results homogeneous at different speed levels
  - 20 to 80 km/h
- Average skid coefficient results at the different speeds within the range:
  - 0.60 to 0.64
Procedure for testing the slabs

- **Track construction procedure**
  - The track manufactured on a factory
  - Then installed on the final location

- **Before building the new track**
  - Decide characteristics of the manufacturing procedure
  - Objective: Guarantee the skid resistance needs of the track

- **Manufactured test slabs characteristics:**
  - Regular slabs
  - Slabs treated with acid
  - Slabs modified with setting retardant

Those characteristics may have effect to the skid resistance of the resulting pavement
Results for test slabs

- Three groups of slabs based on their skid resistance
  - Medium
  - Low
  - Very low
Details of the results

- Medium friction slab sample
- Low friction slab sample
- Very low friction slab sample

- Difference $\mu_{80} - \mu_{20} = 0.063$
- Difference $\mu_{80} - \mu_{20} = 0.128$
- Very low speed friction results (from 0 to 10 km/h) ok
- Problem if skid resistance verified ONLY at low speeds
Skid resistance (British Pendulum)

- Problem of low speed results
- British pendulum values between 20 and 60
- DFTester provides values between 0.0 and 0.20 (Results at 20km/h)

- This issue is not significant if there are not variations of skid resistance in the pavement material because of the speed variations
  
  - DFTester results slope can be important
Compared results

- Reference tram bus rail track compared to test slab results

- Reference slabs
  - Good skid resistance

- Test slabs
  - Slabs modified with setting retardant provide good skid resistance
  - Other test slab may compromise the skid resistance of the resulting track/pavement
Overall conclusions

- **This kind of studies is not useful at network level**
  - Low performance

- **Static devices**
  - Like the pendulum can provide “confusing” results on some cases

- **High speed devices provide valuable information**
  - But that information can not always be applicable at speeds different to those at which the test has been done

- **Special projects may need special studies**
Thank you!

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