Evaluation of the International Friction Index Coefficients for Various Devices

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Overview

Objective

Background

Experimental program

Results

Conclusions
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  - Center for Sustainable Transportation Infrastructure, VTTI
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  - Virginia Transportation Research Council
- Mark Swanlund
  - Federal Highway Administration
Motivation

- Different research efforts have studied procedures to harmonize friction measurements
  - PIARC Experiment to Compare and Harmonize Texture and Skid Resistance Measurements
  - NASA Wallops Friction Workshops Program
  - HERMES Experiment
Objective

- To compare friction and macrotexture measurement results and determine if the previously adopted models are valid for the devices considered.
  - Measurements taken at the Virginia Smart Road in 2008 by the members of the Pavement Surface Properties Consortium.
Background: Pavement Surface Properties Consortium

- Research program focused on enhancing the level of service provided by the roadway transportation system through optimized pavement surface texture characteristics.
The Virginia Smart Road
The Virginia Smart Road Layout

- Ending Location
- Starting Location

- Railroad Bridge
- CRCP
- Cargill EP5
- Section D
- Section C
- Section B
- Section A

- JRCP
- Tined CRCP
- Cargill SafeLane™
- OGFC
- VDOT EP5LV
- SMA 9.5 D
- SM 9.5 D SUPERPAVE
- Ground JRCP
Pavement Surface Properties Consortium

Current Projects

1. Annual Equipment Rodeo
2. Seasonal Monitoring
3. Evaluation of New Measurement technologies
4. Evaluation of new “High-friction” pavement technologies
5. Griptester loan program
6. Stereo Vision Texture Measuring
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Experimental Program

- 24 sections
  - 12 x 2 directions
- 3 Speeds
- 5 repetitions @ each speed
- 2008 Devices:
  - 2 Locked-wheel trailers
  - DFTester
  - Griptester
  - 2 CTMeters
  - 1 laser profiler w/ macrotexture
  - Other …
Sample of Equipment Used
## Experimental Section Layout

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOOP</td>
<td>SMA 19.5</td>
</tr>
<tr>
<td>Section A</td>
<td>SM 12.5D</td>
</tr>
<tr>
<td>Section B</td>
<td>SM 9.5D</td>
</tr>
<tr>
<td>Section C</td>
<td>SM 9.5E</td>
</tr>
<tr>
<td>Section D</td>
<td>SM 9.5A</td>
</tr>
</tbody>
</table>

### WB (U)

- Test U-12
- Test U-11
- Test U-10
- Test U-9
- Test U-8

### EB (D)

- Test D-1
- Test D-2
- Test D-3
- Test D-4
- Test D-5

### Section E = SM 9.5D

### Section F = SM 9.5D

### Section G = SM 9.5D

### Section H = SM 9.5D

### Section I = SM 9.5A

### WB (I)

- Test U-7

### EB (NI)

- Test D-6

### Section J = SM 9.5D

### Section K = OGFC

### Section L = SMA 12.5+

### Concrete Section (CRCP)

### Special Surface

### WB (I)

- Test U-6
- Test U-5
- Test U-4
- Test U-3

### EB (NI)

- Test D-7
- Test D-8
- Test D-9
- Test D-10

### Concrete Section (CRCP)

### Special Surface

### Concrete Section (CRCP)

### Concrete Section (JPCP)

### Bridges: AA - Jennelle Road Bridge; BB - Railroad Bridge, CC - Smart Road Bridge

**Turn around**
Objective
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Conclusions

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Results: Comparison Using Original Coefficients

\[ y = 0.4972x + 0.1736 \]
\[ R^2 = 0.349 \]

\[ y = 0.5991x + 0.091 \]
\[ R^2 = 0.3707 \]

\[ y = 0.6727x + 0.0907 \]
\[ R^2 = 0.6728 \]

\[ y = 0.8287x + 0.0189 \]
\[ R^2 = 0.4757 \]
Revised Coefficients
Adding Macrotexture
## Comparison of F60 IFI Coefficients

<table>
<thead>
<tr>
<th>Friction Unit</th>
<th>Original Coefficients (1)</th>
<th>Revised Coefficients</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>LWS1</td>
<td>0.0446</td>
<td>0.925</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LWS2</td>
<td>0.0446</td>
<td>0.925</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GT</td>
<td>0.0821</td>
<td>0.9104</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LWR1</td>
<td>-0.0228</td>
<td>0.6068</td>
</tr>
</tbody>
</table>
“Experimental” Sp

\[ y = 91.0e^{-0.0147x} \]
\[ R^2 = 0.928 \]

\[ y = 0.87e^{-0.0034x} \]
\[ R^2 = 0.8554 \]
Speed Constant

```
\[
y = 19.973x + 37.147 \\
R^2 = 0.2096
\]
```

```
\[
y = 56.357x^{0.4881} \\
R^2 = 0.3156
\]
```

```
\[
y = 47.056x + 25.009 \\
R^2 = 0.3848
\]
```

```
\[
y = 70.677x^{0.7621} \\
R^2 = 0.5609
\]
```

```
\[
y = 121.64x + 258.7 \\
R^2 = 0.2611
\]
```

```
\[
y = 377.74x^{0.3802} \\
R^2 = 0.2247
\]
```

```
\[
y = 47.998x - 2.9332 \\
R^2 = 0.3342
\]
```

```
\[
y = 18.286x + 159.89 \\
R^2 = 0.0492
\]
```

```
\[
y = 135.7x^{0.211} \\
R^2 = 0.0823
\]
```
Comparison of Sp Models

<table>
<thead>
<tr>
<th>Devices</th>
<th>Lineal</th>
<th></th>
<th>Power</th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$a$</td>
<td>$b$</td>
<td>$R^2$</td>
<td>$a$</td>
<td>$b$</td>
</tr>
<tr>
<td>DFT Sp</td>
<td>122</td>
<td>259</td>
<td>0.2611</td>
<td>378</td>
<td>0.300</td>
</tr>
<tr>
<td>LWR1 Sp</td>
<td>18.3</td>
<td>160</td>
<td>0.0492</td>
<td>136</td>
<td>-0.211</td>
</tr>
<tr>
<td>LWS1 Sp</td>
<td>20.0</td>
<td>37.1</td>
<td>0.2096</td>
<td>56.4</td>
<td>0.469</td>
</tr>
<tr>
<td>LWS2 Sp</td>
<td>47.1</td>
<td>25.0</td>
<td>0.3848</td>
<td>70.7</td>
<td>0.767</td>
</tr>
<tr>
<td>GT</td>
<td>48.0</td>
<td>-2.95</td>
<td>0.3342</td>
<td>39.4</td>
<td>1.168</td>
</tr>
</tbody>
</table>
Conclusions

- The original PIARC coefficients did not produce harmonious results for the devices and surfaces tested

⇒ the original coefficients determined during the PIARC experiment may need to be adjusted for the devices evaluated before the IFI can be implemented in the participating agencies
The results also suggest that there is a better correlation of the speed gradient, $Sp$, with macrotexture using a power model than with the linear model used on the original IFI equations.

- Particularly for the measurements using smooth tires.
Conclusions (cont.)

- Preliminary revised coefficients for the participating devices are provided based on the results on the sections tested.

- However, it is recommended that these values are verified on other surfaces before implementation.