FRICTION STUDY ON LTPP SECTIONS IN CONNECTICUT

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Who needs pavement friction?

I-84 in Manchester, Connecticut
Motivation

• To present a historical overview of pavement friction testing in CT.
• To report in the context of presenting a real-world State Highway Agency’s experience (ConnDOT’s)
• To present an academic perspective (UConn’s) of data collected using statistics.
History - May 1968
Bureau of Public Roads (FHWA)
Demonstration in Connecticut
In 1970, ConnDOT’s first pavement friction tester was this ‘one-of-a-kind’ unit from TestLab Corporation of Chicago.
K J Law Engineers Friction Testers

1978

1978

1989

1989
Dynatest Corp.
2005
High-Speed Laser Instrument Mounted to Dynatest Pavement Friction Tester

2005
2007 - Circular Texture Meter (CTMeter)
2008 - Transportation Pooled-Fund Study
TPF-5(141)

Study Partners:
- FHWA
- CT
- GA
- MS
- PA
- SC
- VA

Pavement Surface Properties Consortium: A Research Program
Contractor: Virginia Tech
Sponsoring Agency: Virginia DOT
2009 - GripTester™ Loan to ConnDOT
Pavement Characterization

Rt. 2 LTPP (SPS-9A) Sections

<table>
<thead>
<tr>
<th>COLCHESTER</th>
<th>MP 25.48</th>
<th></th>
<th>MP 27.56</th>
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<th>MP 29.64</th>
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<tbody>
<tr>
<td>WB 6</td>
<td>Alternative Superpave 20% RAP</td>
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<td>WB 5</td>
<td>Superpave 20% RAP</td>
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<tr>
<td></td>
<td>PG 64-22</td>
<td></td>
<td></td>
<td>PG 64-28</td>
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<td>(LTPP 090962)</td>
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<td>(LTPP 090961)</td>
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<table>
<thead>
<tr>
<th>Direction of Travel Eastbound</th>
<th>MP 25.48</th>
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<tr>
<td>EB 1</td>
<td>CT Class 1</td>
<td></td>
<td>EB 2</td>
<td>Superpave</td>
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<td></td>
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<td>(LTPP 090901)</td>
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<td>(LTPP 090902)</td>
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</table>
Equipment and Testing Protocols

ASTM E-274 locked-wheel tester

- V=40±1 mi/hr
- 100% slip
- SN\(_{40R}\) and SN\(_{40S}\) measured at start/end of ea. section
- 3 passes
- Macrotexture measured with high-speed laser
- Mean profile depth (MPD) and estimated texture depth (ETD) reported
Equipment and Testing Protocols

GripTester™ fixed-slip tester

- Borrowed from VTTI
- \( V=40\pm2 \) mi/hr
- \( \sim15\% \) slip
- GN reported
- 5 passes per section
Equipment and Testing Protocols

CTMeter

- ASTM E 2157 for measuring macrotexture.
- 5.6 inch radius circle.
- MPD measured every 50 ft.
- 8 measurements per section.
Analysis of the Results

• Methodology
  – Friction indicators: $100*\text{GN}$, $\text{SN}_{40R}$, $\text{SN}_{40S}$
  – Texture indicators: CTMeter MPD, High-speed Laser ETD, High-speed Laser MPD
  – Cross-correlation analysis of friction/texture measurements
  – Regression analysis of correlation between friction/texture and material properties
Grip Numbers (GN), Site 090901 (typical of EB Sections)

### Descriptive Statistics

<table>
<thead>
<tr>
<th>Pass</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
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<tr>
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<td>Pass 5</td>
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<td>.68</td>
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</table>

- **ConnDOT Class 1 Mix**
- **12.5-mm Nominal Max Size Aggregate**
Reason for Pass 5 Outliers?
Grip Numbers (GN), Site 090960
(typical of WB sections)

- Class 1
  ~20% RAP
- 12.5-mm Nominal Max Size Aggregate
Grip Numbers (GN), Pass 2

Perhaps lower values owe to changes in microtexture as a result of 20% RAP (black rock effect)?
GN Histogram for Site 090901
Normal Distribution (Typical of Others)
High-Speed Laser and CTMeter Measurement Locations

Typical LTPP Section

CTMeter Locations

High-Speed Laser Locations

1+00 2+00 3+00 4+00
High-Speed vs. Static Texture Measurements

![Graph showing the comparison between High-Speed MPD, High-Speed ETD, and CTMeter MPD for different sections. The graph includes descriptive statistics for each section, showing the mean and standard deviation.]

**Descriptive Statistics**

<table>
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<tr>
<th>Section</th>
<th>N</th>
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<td>High-Speed ETD</td>
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<td>.052</td>
<td>.0033</td>
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</table>
High-Speed ETD vs. Static MPD

\[ y = 1.0639x - 0.0141 \]

\[ R^2 = 0.93 \]
Analysis of the Results
Cross-Correlation

- No correlation between ribbed and smooth tire.
- Very low correlation between ribbed tire and texture ($R^2 = 0.3$).
Macrotexture vs. Smooth-Tire Friction Cross-Correlation

- Good correlation between smooth tire and texture ($R^2 = 0.8$)
- Validates how smooth-tire measurements correspond with pavement macrotexture.
Analysis of the Results

Cross-Correlation (GripTester vs. ASTM E-274)

- High correlation between ribbed tire and GN ($R^2 = 0.93$)
- No correlation between GN and smooth tire ($R^2 = 0.07$)
- Suggests Grip Numbers relate more to pavement microtexture, rather than macrotexture.
Conclusions

• A high correlation between $\text{FN}_{40R}$ and GN values was found ($R^2 = 0.93$).

• No correlation between $\text{FN}_{40S}$ and GN values was found ($R^2 = 0.07$).

• Indicates Grip Numbers relate better to microtexture than macrotexture even though a smooth tire is used.
Conclusions

- Good correlation between FN$_{40S}$ and texture was found ($R^2 = 0.8$).
- High-speed texture measurements corresponded very well with CTMeter measurements ($R^2 = 0.93$).
Acknowledgements

• The University of Connecticut

• FHWA

• Virginia DOT

• Virginia Tech
Questions?

Thank you!

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