The Value of Smoothness

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VDOT Research
VDOT’s Ride Spec

- Genesis ~ 1996
- Applies high-speed profilers & the IRI
- IRI “targets” for Interstate and Non-Interstate pavements
- Incentives for superior smoothness
- Disincentives for excessive roughness
- Applied to 0.01-mile pay lots (2001/2 – present)
Questions to Explore

• What (if any) impact does our ride spec have on achieved smoothness?
• Do we pay more for work that’s subject to the ride spec?
• What do we gain by using the ride spec? That is, what is the Value of Smoothness?
Historically, what impact has VDOT’s Ride Spec had on achieved ride quality?
Historical Smoothness Data

• In 1998, Data collected on 405 project-lanes across state
  – 315 not subject to ride spec ("non-spec")
  – 90 subject to ride spec ("spec")

• In 2005, forty-seven of original 405 records retested
  – 21 among “non-spec” projects
  – 26 among the “spec” projects

• “Spec” projects 8.8 in/mi smoother…over entire 7-year period
• McGhee (1999) ... “identified a consistent 6 to 8 in/mi decrease in IRI for projects constructed under the Special Provision…”
• Clark (2005) … “documented an IRI on the (VDOT) spec work of 8 in/mi smoother (lower IRI) than for non-spec activity.”
Does the Ride Spec have an impact on the unit price in the winning bids?
## Resurfacing Schedules (’01 – ’05)

<table>
<thead>
<tr>
<th>VDOT District</th>
<th>Contracts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bristol</td>
<td>55</td>
</tr>
<tr>
<td>Salem</td>
<td>63</td>
</tr>
<tr>
<td>Lynchburg</td>
<td>31</td>
</tr>
<tr>
<td>Richmond</td>
<td>74</td>
</tr>
<tr>
<td>Hampton Roads</td>
<td>24</td>
</tr>
<tr>
<td>Fredericksburg</td>
<td>26</td>
</tr>
<tr>
<td>Culpeper</td>
<td>25</td>
</tr>
<tr>
<td>Staunton</td>
<td>56</td>
</tr>
<tr>
<td>Northern Virginia</td>
<td>49</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>403</strong></td>
</tr>
</tbody>
</table>
## Quantities & Costs

<table>
<thead>
<tr>
<th>Mix</th>
<th>No. Contract “Appearances”</th>
<th>Total Quantity (tons)</th>
<th>Avg. Price (Wtd. $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM9.5 (3)</td>
<td>395</td>
<td>7,024,957</td>
<td>38.39</td>
</tr>
<tr>
<td>SM12.5 (2)</td>
<td>304</td>
<td>4,027,265</td>
<td>39.01</td>
</tr>
<tr>
<td>SMA9.5 (2)</td>
<td>9</td>
<td>99,173</td>
<td>59.81</td>
</tr>
<tr>
<td>SMA12.5(2)</td>
<td>41</td>
<td>559,098</td>
<td>63.91</td>
</tr>
<tr>
<td>SMA19 (2)</td>
<td>12</td>
<td>95,449</td>
<td>54.30</td>
</tr>
<tr>
<td>All Surfaces</td>
<td>761</td>
<td>11,805,942</td>
<td>40.12</td>
</tr>
</tbody>
</table>
...subject to Ride Spec?

<table>
<thead>
<tr>
<th>Mix</th>
<th>Contracts w/Spec</th>
<th>Quantity w/Spec</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
</tr>
<tr>
<td>SM-9.5 (3)</td>
<td>131</td>
<td>33.3</td>
</tr>
<tr>
<td>SM-12.5 (2)</td>
<td>111</td>
<td>36.5</td>
</tr>
<tr>
<td>SMA-9.5 (2)</td>
<td>5</td>
<td>55.6</td>
</tr>
<tr>
<td>SMA-12.5 (2)</td>
<td>29</td>
<td>90.6</td>
</tr>
<tr>
<td>SMA-19.0 (2)</td>
<td>7</td>
<td>58.3</td>
</tr>
<tr>
<td>All Surfaces</td>
<td>283</td>
<td>37.2</td>
</tr>
</tbody>
</table>
Statistical Analysis

- 761 Observations, 5-Superpave, 6-SMA
- Variables of the analysis:
  - Winning bid price ($/ton)
  - Mix type (using 11-dummy variables)
  - Total quantity in award (by mix)
  - Price of “regular unleaded gasoline”
  - Fraction of job subject to each: ride spec, MTV, time-of-day restrictions, additional structural layer, and planing/milling
Analysis Results

- **Ride spec impact not statistically significant**
  - point estimate was $1.03 per ton with 90% confidence band from -1.56 to $3.09/ton

- **Estimated quantity and gasoline prices** only statistically significant influences
  - “…price per ton…drops by some $0.10 for every thousand tons in bid…”
  - increases by $1.46 per ton for every 10-cent increase in price per gallon of gasoline
What do we gain through use of the Ride Spec?
Surface Life and Resurfacing

• “Turns back the clock” on IRI by about 7 years
• Deferring resurfacing by just 2-years:
  – Reduces present value of next overlay from 74.4% to 70.1% of current costs
  – Habitual use can reduce annual maintenance outlay to about 10/12 of what it otherwise would be (15% for applicable projects)
Road User Costs/Savings

• For continued 10-year resurfacing cycle, ride spec pavements are 12% smoother over lifetime

• Deferring additional 2-years (12-year cycle), ride spec pavements are 10% smoother

• WesTrack, FLDOT, and NCAT findings suggest 10% reduced IRI = 1.3 to 10% reduction in fuel consumption
  – Each 1% = > $5,617/million truck-miles
Cost/Benefit Example

- Consider 4-lane road (1-mile in length), ADT=10,000, 10% trucks
- Cost added by ride spec = $598 (based on $1.03/ton point estimate)
- Case 1 - Continue 10-Year Resurfacing Cycle
  - No maintenance cost savings
  - $425,076 lifetime fuel savings
- Case 2 - Extend Cycle to 12-years
  - $4,015 maintenance cost savings
  - $354,228 lifetime fuel savings
  - $149 travel time cost savings
Conclusions

- Ride Spec - No significant impact on HMA bid price
- Pavements accumulate ~1.23 in/mi of IRI roughness per year (Ride Spec or Not)
- Use of Ride Spec “turns back the clock” by as much as 7 years
- Two-year life increase ~ 15% reduced annual maintenance outlay
- 1% lower IRI = $5,617/million truck-miles
Recommendations

• Continue to promote, apply, and develop ride spec
• Pursue empirical link between measures of roughness and other pavement distresses (i.e., actual service life)
• Update the pay adjustment schedules for ride quality (using more scientific basis)
• Continue to monitor roughness progression on 1998 dataset
Promoting smoothness – doing our part to reduce fuel consumption and dependence on foreign oil!
More Info?

- www.vtrc.net
  - Go to “reports”
  - Search on “smoothness”
  - “Impact of a Smoothness Incentive/Disincentive on Hot-Mix Asphalt Maintenance-Resurfacing Costs” – McGhee & Gillespie
National Conference on Pavement Management
Norfolk, Virginia
May 7-10, 2007

Sheraton Norfolk Waterside Hotel

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Or visit our web site at
http://www.cpe.vt.edu/pavementmanagement07/