Evaluation of Centerline Rumble Strip Impacts on Short-Term Pavement Performance

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Overview

- Introduction
- Potential Pavement Quality Concerns
- Prior Research
- Study Design
- Results
- Maintenance/Design Strategies
Introduction: Michigan Rumble Strip Program

- Statewide installation program covering 5700 miles of high-speed, rural non-freeways
- 3-year installation period (2008-2010)
- Short-term evaluation examined safety impacts, along with other concerns:
  - Bicyclists
  - Noise
  - Pavement quality
Introduction: Potential Pavement Quality Concerns

- Rumble strips are generally milled into existing pavement surface.
- Milling process may cause several detrimental conditions:
  - effective pavement surface thickness is reduced in the milled areas
  - milled areas may allow moisture to infiltrate the pavement surface
  - milled indentation may allow for water to pool and freeze
- Little published research exists pertaining to pavement deterioration associated with rumble strips.
Prior Research

- 2001 - Colorado DOT evaluated distresses in rumble strips; after 5 years, no detrimental impact found
- 2004 – National survey showed 62.5% of states found no adverse effects; 8.3% experienced some problems (remainder unsure)
- 2008 – Minnesota study found that grinding in rumble strips could be problematic on HMA pavement surfaces
Field Evaluation of Pavement Condition

- Visual reviews of pavement imagery data from biennial survey
- Random sample of segments along high-speed (55 mph), two-lane rural highways throughout Michigan
Pavement Deterioration

- All pavements deteriorate over time, with rate of deterioration affected by:
  - Traffic load
  - Temperature
  - Moisture
  - Pavement age
Summary Data from Study Sections

<table>
<thead>
<tr>
<th>Factor</th>
<th>Classification</th>
<th>Rumble Strip Sections</th>
<th>Control Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Miles</td>
<td>Percent</td>
<td>Miles</td>
</tr>
<tr>
<td>Region</td>
<td>Upper Peninsula</td>
<td>131</td>
<td>47.6%</td>
</tr>
<tr>
<td></td>
<td>Northern Lower Peninsula</td>
<td>85</td>
<td>30.9%</td>
</tr>
<tr>
<td></td>
<td>Southern Lower Peninsula</td>
<td>59</td>
<td>21.5%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>275</td>
<td>100.0%</td>
</tr>
<tr>
<td>AADT</td>
<td>Under 4,000</td>
<td>165</td>
<td>60.0%</td>
</tr>
<tr>
<td></td>
<td>Over 4,000</td>
<td>110</td>
<td>40.0%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>275</td>
<td>100.0%</td>
</tr>
<tr>
<td>Pavement</td>
<td>2 yrs old</td>
<td>28</td>
<td>10.2%</td>
</tr>
<tr>
<td>Age</td>
<td>3 yrs old</td>
<td>43</td>
<td>15.6%</td>
</tr>
<tr>
<td></td>
<td>4 to 5 yrs old</td>
<td>105</td>
<td>38.2%</td>
</tr>
<tr>
<td></td>
<td>6+ yrs old</td>
<td>99</td>
<td>36.0%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>275</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
Pavement Distress Quantification

- Pavement distress quantified using metrics such as:
  - Quantity (i.e., frequency)
  - Extent (i.e., length)
  - Severity (i.e., width/size)
Crack Propagation Examination

- Changes in number of cracks intersecting centerline compared before and after rumble strip installation.
- Rate of crack propagation compared between segments where rumble strips were installed and comparable control segments.
Marginal Rates of Crack Propagation (i.e., increases) Over Two-Year Period

<table>
<thead>
<tr>
<th>Factor</th>
<th>Factor Level/Group</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rumble Strip Presence</td>
<td>Control Section (w/o Rumble Strips)</td>
<td>3.92</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td>Rumble Strip Section</td>
<td>4.11</td>
<td>0.26</td>
</tr>
<tr>
<td>AADT</td>
<td>Less than 4,000</td>
<td>3.63</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>More than 4,000*</td>
<td>4.41</td>
<td>0.31</td>
</tr>
<tr>
<td>Geographic Region</td>
<td>Upper Peninsula</td>
<td>3.60</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>Northern Lower Peninsula</td>
<td>3.75</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>Southern Lower Peninsula*</td>
<td>4.71</td>
<td>0.38</td>
</tr>
<tr>
<td>Pavement Age (Second Year)</td>
<td>2 yrs old*</td>
<td>4.87</td>
<td>0.54</td>
</tr>
<tr>
<td></td>
<td>3 yrs old*</td>
<td>4.96</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td>4 to 5 yrs old</td>
<td>3.37</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>6+ yrs old</td>
<td>2.88</td>
<td>0.33</td>
</tr>
</tbody>
</table>

*indicates propagation rates that are significantly higher at 95-percent confidence
Results

- Rumble strips did not significantly impact rate of crack propagation when controlling for other relevant factors.
- Road segments with more than 4,000 vehicles per day showed 21.5 percent higher distress rate compared to lower volume segments.
- Southernmost region of Michigan experienced higher rates of crack propagation than northern parts of the state (Weather? Traffic composition? Construction/Maintenance Practices?)
Maintenance

- Cutting into an asphalt joint could expedite deterioration
  - MDOT adopted joint density specification to ensure soundness of centerline pavement

- Chip seal
  - Rumble strips maintain functionality w/single chip seal
  - Double chip seal reduced effectiveness
  - MDOT updated Special Provisions, for double chip seal only top layer crosses the rumble strips

- Microsurfacing treatments found to nullify rumble strips
  - MDOT updated Special Provision, rumble strips should be filled in prior to surface treatment
Maintenance

- Crack treatments for longitudinal joints
- Various types of sealants (e.g., fog seal) and rejuvenators.
Recent Design Modifications
Conclusions

- Rumble strips likely to have some adverse impacts on pavement condition
- Design and maintenance strategies can mitigate the degree of these impacts
- Installation on local systems is strongly justified from an economic standpoint
Thank You!

Questions and comments?

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