ENGINEERING DRIVER
SAFETY INTO PAVEMENT PRESERVATION
2015 TxDOT Short Course
Miguel Arellano, P.E.
Austin District Pavement Engineer
October 13, 2015
# Table of Contents

<table>
<thead>
<tr>
<th></th>
<th>Section</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Goals: Overall Reduction in Crashes and Fatalities</td>
<td>3-4</td>
</tr>
<tr>
<td>2</td>
<td>Risk Assessment and Planning</td>
<td>5-11</td>
</tr>
<tr>
<td>3</td>
<td>Assessing Narrow Pavement Widening Safety Performance</td>
<td>12-18</td>
</tr>
<tr>
<td>4</td>
<td>High-Friction Pavement Surface</td>
<td>17-23</td>
</tr>
<tr>
<td>5</td>
<td>Conclusions &amp; Future Work</td>
<td>24</td>
</tr>
</tbody>
</table>
Austin District Pavement Management Program

**Level 1: Objective**

Pavement Management Program (4/10-year Plan)

**Level 2: Goals**

- Enhance System Safety
- Preserve Pavement Infrastructure Condition
- Maintain Structural Capacity

**Level 3: Attributes**

- Truck ADT
- Fatigue Cracking
- Skid Values
- %Remaining Service Life
- Pavement Failures
- Maintenance Expenditure
- …etc.
Pavement Management Goals: Enhance System Safety

- **Goals:**
  - Reduction of overall crash types and severity
  - Reduction of overall fatality rates

- **Objectives:**
  - Develop new methods to identify and assess high-risk roadways
  - Identify roadway attributes potentially contributing to crash rates
  - Address high-risk roadways with appropriate preventative measures or improvements
  - Re-evaluate standards and policies
Roadway Safety Performance Index

Objective #1: Develop a method to identify high-risk locations for potential road safety improvements:

- Methodology must be:
  - Performance-based
  - Multiple roadway attributes
  - Proactive
  - Reliable
  - Effective

- Roadway Safety Performance Index (RSPI)
Roadway Safety Performance Index (RSPI)

Identified Data Sources

- CRIS
- Geo-HINI
- RHiNo
- PMIS
- Other sources

Oracle Database

Data Integration

Crash Prediction Models

Formulation of RSPIs

GIS-enhanced system:
- Store and manage related data
- Publish maps of RSPIs
- Functions: query, identify, export, etc.

Web-based inquiry

Highway Safety Analysis for the District
Roadway Safety Performance Index

- Two Regression Crash Prediction Models
- Over 20 geometric, pavement conditions, roadway, and traffic characteristics covariates
- Only Austin District data analyzed
- Does not consider variables pertaining to the operator such as health or impairment or the condition of the vehicle
Roadway Safety Performance Index

- $R_{Ind} SPI$ - reflects the individual risk of each exposure on a homogenous roadway segment or an intersection.

- $R_{Acu} SPI$ - describes the collective risk which influences the reliability of service on a roadway segment or an intersection and provides an overall safety performance.
Roadway Safety Performance Index

Top 10 most statistically significant covariates in crash risk (in no particular order):

- ADT (light vehicle & truck)
- Degree and length of horizontal curve
- **Lane width**
- Median type 3 (3=unprotected)
- Number of lanes
- Pavement type
- **Shoulder width**
- Skid number
- Speed limit
- Urban/rural

Widening or lane reconfiguration

Resurfacings with High-Friction Surface Courses
- Texas: 40,000 lane-miles with narrow two-lane FM/RM roads
- Crash rate: 108.4 per 100 million VMT in 2012
- Relative higher risk of run-off-the-road (ROR), and head-on (HO) crashes
Objectives:

- To investigate if narrow pavement widening projects can improve overall traffic safety or reduce the risks of certain types and/or severity levels of crashes
- To identify lane and shoulder widths and configurations and best practices to optimize reduction of risks of certain types and/or severity levels of crashes
Narrow Pavement Widening Projects

- Before and after study of 22 narrow widening projects in Austin rural areas from 2004 to 2011
  - Average length is 3.54 miles
  - Crash data from 2003 to 2012
  - For each project, a minimum of 12 months of crash data was available for the before/after periods

- Reference group: 1,585 roadway segments with similar characteristics as the 22 narrow widening projects
Narrow Pavement Widening Projects

Source: FHWA, Highway Safety Improvement Program (HSIP) Manual
Narrow Pavement Widening Projects

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>ROR</th>
<th>HO</th>
</tr>
</thead>
<tbody>
<tr>
<td># of crashes in after period</td>
<td>287</td>
<td>147</td>
<td>10</td>
</tr>
<tr>
<td>Expected crashes in after period without widening (STDV)</td>
<td>418.7 (22.1)</td>
<td>228.6 (15.6)</td>
<td>22.4 (4.4)</td>
</tr>
<tr>
<td>% reduction in crashes (STDV)</td>
<td>31.5 (5.4)</td>
<td>35.7 (6.8)</td>
<td>55.4 (15.4)</td>
</tr>
<tr>
<td>Index of effectiveness (STDV)</td>
<td>0.68 (0.05)</td>
<td>0.64 (0.07)</td>
<td>0.43 (0.15)</td>
</tr>
</tbody>
</table>

![Graph](image-url)
# Narrow Pavement Widening Projects

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>F+I</th>
<th>Injury</th>
<th>PDO</th>
</tr>
</thead>
<tbody>
<tr>
<td># of crashes in after period</td>
<td>287</td>
<td>127</td>
<td>120</td>
<td>146</td>
</tr>
<tr>
<td>Expected crashes in after period without widening (STDV)</td>
<td>418.7 (22.1)</td>
<td>180.2 (15.8)</td>
<td>173.2 (12.7)</td>
<td>213.6 (15.1)</td>
</tr>
<tr>
<td>% reduction in crashes (STDV)</td>
<td>31.5 (5.4)</td>
<td>29.5 (8.7)</td>
<td>30.7 (8.0)</td>
<td>31.7 (7.4)</td>
</tr>
<tr>
<td>Index of effectiveness (STDV)</td>
<td>0.68 (0.05)</td>
<td>0.70 (0.09)</td>
<td>0.69 (0.08)</td>
<td>0.68 (0.07)</td>
</tr>
</tbody>
</table>
Narrow Pavement Widening Projects

Findings:

- Narrow pavement widening projects reduced overall crash rates and the severity of the crashes for all crash types
  - 35.7% reduction in run-off-the-road crashes
  - 55.4% reduction in head-on crashes

- Integrated safety analysis will provide information and best practices such as lane widths, lanes configurations, shoulder widths, center striping widths, end treatments, and other practices to optimize the reduction in crash types and severity
High-Friction Surface Courses

Crash Rate vs. Skid Values

- Skid values have significant impact on crash rates.
- Sensitivity Study illustrates reduction in crash rates with increase in skid resistance (value)
- In FY 2007, started to implemented new High-Friction Surfaces Courses (Seal Coat, TOM, SMA or PFC)
- Goal was to reduce overall crash rate, especially wet surface crashes
High-Friction Surface Courses

Skid Scores

20% Increase in Overall District Skid Scores

Austin Skid Score
High-Friction Surface Courses

Wet Weather Crash History

![Graph showing wet weather crash history from 2003 to 2014. The graph displays the wet weather crash rate (Crashes per 100 million vehicle miles of travel) and the wet weather fatal crash rate (Crashes per 100 million vehicle miles of travel). The data is represented with bars and a line graph, indicating a trend of decreasing crash rates over the years.](image-url)
High-Friction Surface Courses

**WW Crash vs. Growth**

- Austin District is experiencing high growth rate and increasing traffic volumes
- Daily Vehicle Miles Growth Rate = 2.25% per year
- Wet Weather Fatalities Counts = -5.3% per year

![Graph showing WW Fatal Crash Count vs. Daily Vehicle Miles (million) from 2003 to 2014]
High-Friction Surface Courses

- High-friction surface course policy contributed to Wet Surface Crash Reduction Program:

<table>
<thead>
<tr>
<th>Year</th>
<th>Daily Vehicle Miles (millions)</th>
<th>WW_Crash_Rate</th>
<th>WW_Fatal_Crash_Rate</th>
<th>WW_Fatality_Rate</th>
<th>Annual Precipitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003-2008</td>
<td>28.6</td>
<td>21.3</td>
<td>0.18</td>
<td>0.21</td>
<td>32.3</td>
</tr>
<tr>
<td>2009-2014</td>
<td>31.9</td>
<td>15.7</td>
<td>0.10</td>
<td>0.11</td>
<td>33.0</td>
</tr>
<tr>
<td>% Change</td>
<td>11.6%</td>
<td>-26.6%</td>
<td>-45.5%</td>
<td>-48.0%</td>
<td>2.3%</td>
</tr>
</tbody>
</table>
Conclusions & Future Work

- RSPI in tandem with other pavement analysis is an effective tool to identify high-risk roadways and possible roadway attributes contributing to high crash rates
  - Abundant amount of unintegrated data
  - Continue to refine and calibrate algorithms with real-world data
- Currently reassessing our narrow widening practices
  - Creating a district standard for specific roadway situations
- High-friction surface has been hard-wired into the District Pavement Design SOP, as of March 2015
QUESTIONS?

For more information:
Mike Arellano, P.E.
Austin District Pavement Engineer
miguel.arellano@txdot.gov
(512) 585-3197