Selection of Candidate Sites for in-depth Evaluation

Technical Memorandum 0-5566-3

Conducted for Texas Department of Transportation
P.O. Box 5080
Austin, Texas 78763

April 2009

Center for Transportation Infrastructure Systems
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El Paso, TX 79968
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Selection of Candidate Sites for in-depth Evaluation

by

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Research Project 0-5566

Strategies to Improve and Preserve Flexible Pavement at Intersections

Conducted for
Texas Department of Transportation

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Center for Transportation Infrastructure Systems
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INTRODUCTION

A vast majority of the TxDOT highway system consists of secondary roads that are constructed with this pavement structures and thin hot mix asphalt surfaces or two-course surface treatment. This network of low-volume roads has served the public well, and for the most part, performs satisfactorily with periodic maintenance. One of the weakest links in this network is the performance of the pavement at intersections.

This project would seek to understand the mechanisms of intersection pavement failures and determine the best practices to minimize the failures at existing intersection pavements. The outcome of this project should help to reduce the frequency of maintenance needed at rural intersections. This project would also determine how the mechanisms causing the surface failures at intersections can be mitigated through design and construction modifications.

A flowchart of tasks associated with this project is summarized in Figure 1. The flowchart outlines the highlights of the nine tasks proposed and the anticipated outcome of each task. This technical memorandum represents the work progress of Task 3 highlighted in the figure. Also incorporated in this technical memorandum, is the schedule of research activities (see Figure 2). The schedule highlights the original work schedule and the work completed “work progress” of Task 3. As noted in the figure, this task started late waiting until the results of the preliminary survey were completed to identify potential districts that showed interest in this study. We were also attempting to visit Lubbock as the first district to have a practice run on interviewing the expertise in the District. Due to the busy schedule during the construction season there was a delay in scheduling the meetings with the Lubbock District. However, there was an intersection in Laredo on FM1472 that came up for forensics and we were invited to participate in the meeting since it related to this project. That is one site that we will be using on this project. We have also scheduled another meeting with the Laredo District for a more in depth interview of personnel and to locate additional sites. In addition, we have scheduled interviews with seven additional districts. We expect that this allows us to locate sites and to document their typical problems and their effective and ineffective remedies to solve their problems. Table 1 provides a summary of the schedule for the district visits and the contact person assisting us from the districts. We will also share the matrices of the remedies accumulated in Task 1 to get their impression about the feasibility of implementing them in their district. A sample of the interview question is included in Appendix A.

Based on the feedback we will determine if there is a need to expand the visit to other districts. We have also started to lay out the framework for the expert system as it relates to Tasks 5, 6, and 7. The results from these visits will be included in future progress reports.
1. Information Search
   • A comprehensive Literature Review

2. Understanding and Documenting Extent of Problems and Solutions in Texas
   • Surveying Districts
   • Reviewing Forensic Reports
   • Interviewing District Personnel and site visits
   • Interviewing CST Personnel

3. Selection of Candidate Sites for In-Depth Evaluation
   • An in depth statistical and trend analysis of results from Task 2 to categorize typical problems

4. Thorough Forensic Study of Candidate Sites
   • Structural and Functional evaluation of sites
   • Testing and Sampling
   • Laboratory tests of Pavement Materials
   • Recommending solutions
   • Conducting thorough structural design of the existing and recommended Solutions
   • Life Cycle Cost Analysis of Solutions

5. Preliminary Guideline Based on Results from Tasks 2 through 4
   • Develop a Comprehensive Decision tree
     - to guide TXDOT personnel through the process of field and Laboratory evaluation of intersections
     - to select the most appropriate rehabilitation solutions

6. Develop Final Design and Construction Guideline
   • Incorporate the outcome of Task 5, the remaining outcome of field work and feedback from PMC in a final guideline

7. Develop an Expert System
   • Incorporate the outcome of Task 5 and 6 in an expert system shell to readily guide TXDOT personnel in determining the best solution

8. Recommend changes to TXDOT Policies
   • Based on the outcome of all tasks, recommend changes to the TXDOT 2004 Specifications
   • A technical memorandum at the end of each task
   • A final report documenting all work performed, method used, and results achieved.
   • A Project Summary Report (PSR)

9. Submit Reports

Figure 1 – Summary of Tasks as an Overview of Research Approach
<table>
<thead>
<tr>
<th>Research Activity</th>
<th>Estimated % of Total Project Budget</th>
<th>FY 2009</th>
<th>FY 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Task 1</strong></td>
<td>Information Search</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td><strong>Task 2</strong></td>
<td>Understanding and Documenting Extent of Problems and Solutions in Texas</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td><strong>Task 3</strong></td>
<td>Selection of Candidate Sites for In-depth Evaluation</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td><strong>Task 4</strong></td>
<td>Thorough Forensic Study of Candidate Sites</td>
<td>28%</td>
<td></td>
</tr>
<tr>
<td><strong>Task 5</strong></td>
<td>Preliminary Guideline Based on Results from Task 2 through 4</td>
<td>11%</td>
<td></td>
</tr>
<tr>
<td><strong>Task 6</strong></td>
<td>Develop Final Design and Construction Guideline</td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td><strong>Task 7</strong></td>
<td>Develop an Expert System</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td><strong>Task 8</strong></td>
<td>Recommend Changes to TxDOT Policies</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td><strong>Task 9</strong></td>
<td>Submit Reports</td>
<td>4%</td>
<td></td>
</tr>
</tbody>
</table>

Note: A Tech Memo will be submitted to the PD & RTI at the end of each non-deliverable task.

Figure 2 - Schedule of Research Activities
<table>
<thead>
<tr>
<th>District</th>
<th>Date</th>
<th>Contact Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austin</td>
<td>April 13\textsuperscript{th}, 2009</td>
<td>Mike Arillano</td>
</tr>
<tr>
<td>Bryan</td>
<td>April 14\textsuperscript{th}, 2009</td>
<td>Catherine Hejl</td>
</tr>
<tr>
<td>Houston</td>
<td>April 15\textsuperscript{th}, 2009</td>
<td>Mike Alford</td>
</tr>
<tr>
<td>Atlanta</td>
<td>April 20\textsuperscript{th}, 2009</td>
<td>Miles Garrison</td>
</tr>
<tr>
<td>Paris</td>
<td>April 22\textsuperscript{nd}, 2009</td>
<td>Mykol Woodruff</td>
</tr>
<tr>
<td>Lubbock</td>
<td>April 27\textsuperscript{th}, 2009</td>
<td>Tracy Crumby</td>
</tr>
<tr>
<td>Abilene</td>
<td>April 28\textsuperscript{th}, 2009</td>
<td>Brian Crawford</td>
</tr>
<tr>
<td>Laredo</td>
<td>April 29\textsuperscript{th}, 2009</td>
<td>Jo Ann Garcia</td>
</tr>
</tbody>
</table>
Purpose of Interview: Many rural intersections originally constructed with thin untreated flexible base and hot mix or a two-course surface treatment experience severe distress. This research project seeks to understand the mechanisms of intersection pavement failures and determine the best practices to minimize the failures at existing pavement intersections.

The outcome of this project should help to reduce the frequency of maintenance needed at rural intersections. This project would also determine how the mechanisms causing the surface failures at intersections can be mitigated through design and construction modifications.

The information gathered from this research will be used to develop an expert system. An Expert System is a tool used to guide in the design process and provide an easy means for disseminating the knowledge and expertise of specific guidelines and practices to pavement managers and designers across the state. This tool was selected based on the following (among other reasons):

- More than one solution to a problem,
- Expert experiences can be available to everyone, and
- More design consistency across the districts

The following are questions that we thought are appropriate for this interview. Tracy Crumby, the project PD, is helping to coordinate this interview process. This interview will be in a group format to allow for discussion and consensus. The idea is to interview a group from each district that represents the expertise of that district. These questions are provided to you in advance as a means of preparation for the interview so that you are aware of the type of question that will be asked. Thank you in advance for your participation and support of this project.
A. Distress Identification

1. What is low volume traffic in your perception (how many ESALS)?
2. What percent of roads is considered rural in your District/area?
3. Do you have a count on the number of intersection in the District/area?
4. Are intersection treated differently than the remaining part of the road?
   a. Distress identification to repair
   b. Is the condition of the road better 150 ft away from the intersection?
5. What are typical or common distress types found at intersections in your District/area?
   a. Description of each distress type
   b. Level or severity of a distress
   c. What are the most probable causes of each type of distress
   d. Which layer(s) of pavement structure are most probably contributing to distress
   e. Do you give any consideration to the drainage at intersections?
   f. What preliminary information do you gather for determining the best remediation strategies?
      i. The type and volume of traffic
      ii. The location of stop signs
      iii. The depth, extent and shape of the rutted section
      iv. The speed limit of the roads leading to the intersection
      v. The best estimate of the pavement layers’ thickness and type

B. Remediation Strategies

1. What are typical remediation strategies (Maintenance, Rehabilitation, Reconstruction) you consider
   a. Description of each remediation process and unit cost associated with each process
   b. Probable feasibility of each remediation strategy to solve each type of distress identified
   c. Effectiveness: short-term (a band aid), intermediate (1 to 3 years), long term (3 to 7 years)
   d. What additional information do you gather for properly designing and constructing each remediation strategy?
      i. coring and sampling
      ii. performing nondestructive testing with FWD and/or GPR
      iii. conducting laboratory tests
      iv. performing structural design for the new intersection
      v. performing life-cycle cost analysis

2. How do you select materials for each remediation and layer
   a. hot mix asphalt
   b. type of base and/or treatment (use less than 2% additive) or stabilization (more than 2% additive) if necessary
      i. When do you use base without treatment of stabilization
ii. When and how do you decide on treatment or stabilization
   1. What type of additive to use for a given base
   2. How to decide on additive concentration

c. When and how to improve subgrade
   i. When to use subgrade without treatment of stabilization
   ii. When and how to decide on treatment or stabilization
      1. What type of additive to use for a given subgrade
      2. How to decide on additive concentration

d. How do you go about selecting the appropriate drainage system?

C. Construction Practices

1. What are the construction practices for each remediation method
   a. Site preparation
   b. Construction practices
   c. Time and scheduling of repairs at intersections.

What type of quality control to implement for each remediation method ( 

D. Decision Making

1. How is the decision making process in your district or area office in terms of selecting candidates for maintenance and rehabilitation?
   a. How much or what information is gathered to select the maintenance or rehabilitation method?
   b. Is life cycle cost analysis used in the decision/selection process
   c. What is more important in your decision making, cost or expected life?

2. What is the available budget range for maintenance and rehabilitation for rural road intersections?

E. Remediation Strategies for Common Distress Indicators

Table 1 shows the results from the national and international literature search and the preliminary condition survey that was sent to all districts. Based on your experience Please fill out Table 2 (as a group).
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Distress</th>
<th>Maintenance</th>
<th>Rehabilitation</th>
<th>PCC</th>
<th>Deep Repairs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Microsurfacing</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Fog Seal</td>
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<td></td>
<td></td>
<td>Crack Seal</td>
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<td></td>
<td></td>
<td>Sand Seal</td>
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<td></td>
<td></td>
<td>Slurry Seal</td>
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<td></td>
<td></td>
<td>Ultra Thin Wearing</td>
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<td></td>
<td>Coarse Chip Seals</td>
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<tr>
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<td></td>
<td>Chip Seals</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Surface Treatment</td>
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<td></td>
<td></td>
<td>Hot in Place Recycling</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>Cold in Place Recycling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>HMA &amp; RAP Overlay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hot Mix Overlay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>HMA &amp; Recycled Asphalt Shingles (RAS) Overlay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ultra-Thin Whitetopping</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Full Depth Reclamation</td>
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<td></td>
<td></td>
<td>Roller Compacted Concrete (Base)</td>
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<tr>
<td></td>
<td></td>
<td>Stabilization</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Moisture Control</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- ● Appropriate
- ○ May Be Appropriate
- ∘ Not Appropriate
- ✗ Not a Candidate
- * No TxDOT specifications

Table 1 - Remediation Strategies for Common Distress Indicators
Flexible Pavement Treatment Selection Matrix
<table>
<thead>
<tr>
<th>Distress</th>
<th>Maintenance</th>
<th>Rehabilitation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Microsurfacing</td>
<td>HMA Surfacing</td>
</tr>
<tr>
<td></td>
<td>Fog Seal</td>
<td>Hot in Place Recycling</td>
</tr>
<tr>
<td></td>
<td>Crack Seal</td>
<td>Hot Mix Overlay</td>
</tr>
<tr>
<td></td>
<td>Sand Seal *</td>
<td>HMA &amp; Recycled Asphalt Shingles (RAS) Overlay</td>
</tr>
<tr>
<td></td>
<td>Slurry Seal *</td>
<td>Ultra Thin Wearing Coarse</td>
</tr>
<tr>
<td></td>
<td>Chip Seals</td>
<td>Surface Treatment</td>
</tr>
<tr>
<td>Surface</td>
<td>&lt; 3/8 in</td>
<td>Hot in Place Recycling</td>
</tr>
<tr>
<td>Rutting</td>
<td>3/8 - 1 in</td>
<td>HMA &amp; RAP Overlay</td>
</tr>
<tr>
<td></td>
<td>&gt; 1 in</td>
<td>PCC Overlay (Thick)</td>
</tr>
<tr>
<td>Instability</td>
<td>Low</td>
<td>Moisture Intrusion</td>
</tr>
<tr>
<td>Rutting</td>
<td>Moderate</td>
<td>Moisture Intrusion</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Moisture Intrusion</td>
</tr>
<tr>
<td>Shoving</td>
<td>Low</td>
<td>Moisture Intrusion</td>
</tr>
<tr>
<td>Fatigue</td>
<td>Moderate</td>
<td>Moisture Intrusion</td>
</tr>
<tr>
<td>Cracking</td>
<td>High</td>
<td>Moisture Intrusion</td>
</tr>
<tr>
<td>Base</td>
<td>Low</td>
<td>Moisture Intrusion</td>
</tr>
<tr>
<td>Structural Rutting</td>
<td>Moderate</td>
<td>Moisture Intrusion</td>
</tr>
<tr>
<td>Subgrade</td>
<td>Moisture Intrusion</td>
<td>Moisture Intrusion</td>
</tr>
</tbody>
</table>
Site Related Issues:
As part of Task 2 of the proposal: Understanding and documenting extent of problems and solutions in Texas.

Historical data (in terms of construction and maintenance records and as built pavement structure, the typical truck traffic and best estimate of the ADT)

Document the extent of the damage and/or the effectiveness of the remedies.

If feasible, perform some rudimentary site evaluation by performing simple tests (e.g., DCP) to obtain some indication of the structure integrity of the section.

Other information such as:

- the speed limits
- the location of the stop signs,
- the slopes at the intersections,
- the geometry of the intersections,
- the drainage conditions

This information will be placed in a database for further trend analysis to determine the common attributes that may contribute to the excessive permanent deformation of the site.