

1. Report No. FHWA/TX-06/0-4498-3		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle DEVELOPMENT OF WARRANTY-BASED SPECIFICATIONS FOR CONSTRUCTION				5. Report Date October 2005 Resubmitted: January 2006	
				6. Performing Organization Code	
7. Author(s) Stuart Anderson, Byron Blaschke, David Trejo, Cuneyt Erbatur				8. Performing Organization Report No. Report 0-4498-3	
9. Performing Organization Name and Address Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135				10. Work Unit No. (TRAVIS)	
				11. Contract or Grant No. Project 0-4498	
12. Sponsoring Agency Name and Address Texas Department of Transportation Research and Technology Implementation Office P. O. Box 5080 Austin, Texas 78763-5080				13. Type of Report and Period Covered Technical Report: August 2002 - August 2005	
				14. Sponsoring Agency Code	
15. Supplementary Notes Project performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration. Project Title: Warranty Based Specifications for Construction URL: <a href="http://tti.tamu.edu/documents/0-4498-3.pdf">http://tti.tamu.edu/documents/0-4498-3.pdf</a>					
16. Abstract The Texas Department of Transportation (TxDOT) has continued to be proactive in finding innovative practices in programming and administering projects, including the construction contracting area. Warranty specifications show potential for reducing the life-cycle cost of facilities while ensuring the quality of constructed facilities.  This report documents the research effort and findings for TxDOT Project 0-4498, "Warranty Based Specifications for Construction." The overall approach to this research leverages off of the guidelines documented in National Cooperative Highway Research Program (NCHRP) Report 451. The researchers modified these guidelines for consistency with TxDOT design, contracting, and maintenance systems.					
17. Key Words Warranty, Specifications, Construction, Pavements, Asphalt			18. Distribution Statement No restrictions. This document is available to the public through NTIS: National Technical Information Service Springfield, Virginia 22161 <a href="http://www.ntis.gov">http://www.ntis.gov</a>		
19. Security Classif.(of this report) Unclassified		20. Security Classif.(of this page) Unclassified		21. No. of Pages 122	22. Price



# **DEVELOPMENT OF WARRANTY-BASED SPECIFICATIONS FOR CONSTRUCTION**

by

Stuart Anderson  
Program Manager  
Texas Transportation Institute

Byron Blaschke  
Research Engineer  
Texas Transportation Institute

David Trejo  
Assistant Research Engineer  
Texas Transportation Institute

and

Cuneyt Erbatur  
Graduate Research Assistant  
Texas Transportation Institute

Report 0-4498-3

Project 0-4498

Project Title: Warranty Based Specifications for Construction

Performed in cooperation with the  
Texas Department of Transportation and  
The Federal Highway Administration

October 2005

Resubmitted: January 2006

TEXAS TRANSPORTATION INSTITUTE  
The Texas A&M University System  
College Station, Texas 77843-3135



## **DISCLAIMER**

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Federal Highway Administration (FHWA) or the Texas Department of Transportation (TxDOT). This report does not constitute a standard, specification, or regulation. The engineer in charge was Stuart D. Anderson, P.E., (TEXAS, #89556).

## **ACKNOWLEDGMENTS**

This project was conducted in cooperation with TxDOT and FHWA. The authors thank the members of TxDOT's Project Monitoring Committee. Special thanks go to Jim Hunt, David Head, and Gregory Cleveland for all their help in making this project a success.

# TABLE OF CONTENTS

	Page
<b>List of Tables</b> .....	<b>viii</b>
<b>Chapter 1 INTRODUCTION</b> .....	<b>1</b>
BACKGROUND .....	1
SCOPE .....	2
ORIGINAL WORK PLAN .....	3
REVISED WORK PLAN .....	4
<b>Chapter 2 REVIEW STATE OF PRACTICE</b> .....	<b>7</b>
LITERATURE REVIEW .....	7
Past Research .....	7
Key State Experiences .....	17
Other Warranty Related Activities .....	28
SURVEY QUESTIONNAIRE .....	33
City Questionnaire .....	46
<b>Chapter 3 TXDOT WARRANTY SPECIFICATIONS</b> .....	<b>49</b>
METHODOLOGY .....	49
DEVELOPMENT OF DRAFT WARRANTY SPECIFICATIONS .....	50
WARRANTY SPECIFICATION STRUCTURE .....	52
INDUSTRY INTERACTION FORUM .....	53
Background Information Presented .....	54
Industry Perspective .....	56
Rationale for the Need of Warranties .....	58
Control of the Work .....	60
Use of Retainage to Secure the Warranty .....	61
Small Contractors .....	61
Why Not Portland Cement Concrete Warranty? .....	62
Applicability of Warranty-Based Specifications for Surface Treatments .....	62
Liability .....	62
ELEMENTS OF WARRANTY SPECIFICATIONS .....	63
Warranty Bonds and Length of Warranty .....	64
Maintenance Responsibility .....	64
Conflict Resolution Team .....	65
Warranty Indicators and Threshold Values .....	65
PILOT PROJECT EFFORT .....	73
<b>Chapter 4 TXDOT WARRANTY IMPLEMENTATION PLAN</b> .....	<b>77</b>
DEVELOPMENT OF WARRANTY IMPLEMENTATION PLAN .....	77
GUIDELINE STRUCTURE AND FORMAT .....	78
<b>Chapter 5 SUMMARY</b> .....	<b>79</b>
<b>References</b> .....	<b>83</b>
<b>Appendix A:</b> .....	<b>85</b>
<b>Appendix B:</b> .....	<b>105</b>

## LIST OF TABLES

	<b>Page</b>
Table 1. Uses of Warranty Provisions (5).....	9
Table 2. Advantages and Disadvantages of Warranty Contracting (3).....	11
Table 3. Issues to Consider When Drafting a Warranty Specification (3).....	13
Table 4. State Highway Agencies Targeted for Survey.....	34
Table 5. Number of Warranted Projects.....	35
Table 6. Common Criteria Involved in Warranty Projects.....	35
Table 7. Major Barriers to Implement Warranties.....	36
Table 8. Use of Warranties for Other End Products in the Future.....	36
Table 9. Warranty Period for Different Products (Years).....	37
Table 10. Summary of Bonding Requirements.....	38
Table 11. Maintenance Responsibility.....	40
Table 12. Conflict Resolution Team Functions.....	40
Table 13. Conflict Resolution Team Types.....	41
Table 14. Hot Mix Asphalt Concrete Performance Indicators.....	42
Table 15. Pavement Performance Indicators, Threshold Ranges, and Guide to Remedial Action for Hot Mix Asphalt Concrete.....	43
Table 16. Surface Treatment Performance Indicators.....	44
Table 17. Pavement Performance Indicators, Threshold Ranges, and Guide to Remedial Action for Surface Treatments.....	44
Table 18. Microsurfacing Performance Indicators.....	45
Table 19. Pavement Performance Indicators, Threshold Ranges, and Guide to Remedial Action for Microsurfacing.....	45
Table 20. Texas City Questionnaire Results.....	46
Table 21. Comparison of TxDOT PMIS and Asphalt Concrete Warranty Indicators (WIs) Used by Other States.....	68
Table 22. Comparison of TxDOT PMIS and Surface Treatments WIs Used by Other States.....	69
Table 23. Comparison of TxDOT PMIS and Microsurfacing WIs Used by Other States.....	69
Table 24. HMAC Warranty Indicators and Threshold Values.....	72
Table 25. Surface Treatment Warranty Indicators and Threshold Values.....	72
Table 26. Microsurfacing Warranty Indicators and Threshold Values.....	72
Table 27. Pavement Warranty Indicators, Threshold Values, and Possible Remedial Actions for Warranted HMAC Project in El Paso.....	74
Table 28. Pavement Warranty Indicators, Threshold Values, and Possible Remedial Actions for Warranted Surface Treatments Project in Odessa.....	75



# CHAPTER 1

## INTRODUCTION

### BACKGROUND

State highway agencies (SHAs) are looking at innovative contracting practices in programming and administering projects to improve their construction contracting practices. The Texas Department of Transportation (TxDOT) is being proactive and investigating alternative contracting practices. Warranty contracting is one alternative that many states use successfully.

Hancher defines a warranty “as a guarantee of the integrity of a product and of the contractor’s responsibility for the repair or replacement of deficiencies. A warranty is an absolute liability on the part of the Warrantor (Contractor), and the contract is void unless it is strictly and literally performed” (1).

Warranty specifications have the potential to reduce the life-cycle cost of facilities while ensuring the quality of constructed facilities. Further, the use of warranty specifications may reduce the level of inspection required during construction. TxDOT is investigating if warranty contracting can be successfully used in Texas.

Construction warranties can be placed in two categories: performance warranties, and materials and workmanship warranties. This research focuses on the latter. The distinction between performance warranties and materials and workmanship warranties was identified in *Asphalt Pavement Warranties Technology and Practice in Europe* (2). According to this document for performance warranties, “the contractor assumes full responsibility for pavement performance during the warranty period. In effect, the contractor guarantees that the pavement will perform at a desired quality level. The contractor assumes some level of responsibility, depending upon the specific project, for the structural pavement or mix decisions” (2).

In the case of materials and workmanship warranties, “the contractor is responsible for correcting defects in work elements within the contractor’s control during the warranty period. This includes distresses resulting from defective materials and/or workmanship during construction. The owner is responsible for the pavement structural design. The contractor assumes no responsibility for pavement design or those distresses that result from the design.

Some responsibility is shifted from owner to the contractor for materials selection and workmanship” (2).

The goal of TxDOT Project 0-4498 was to develop a warranty contracting implementation plan. The researchers based the TxDOT plan on the guidelines for warranty contracting previously developed under Project 10-49 for the *National Cooperative Highway Research Program* (NCHRP) Report 451 (3). These existing guidelines were modified to fit within the TxDOT design, contracting, and maintenance systems. The researchers developed warranty specifications for hot-mix asphalt concrete (HMAC), surface treatments, and microsurfacing. TxDOT’s objectives for investigating warranties and potentially implementing a warranty program were:

- Reduce TxDOT manpower requirements for inspection, testing, and maintenance.
- Reduce project life-cycle costs.
- Improve quality of materials and construction.

## **SCOPE**

This report documents the research effort and findings for TxDOT Project 0-4498, “Warranty Based Specifications for Construction.” The overall approach to this research leverages off of the guidelines documented in *NCHRP Report 451* (3). These guidelines were developed based on the practices of those state highway agencies most active in warranty contracting. Thus, the guidelines follow a logical, structured, and practical approach to implementing warranties. The researchers modified these guidelines to fit into TxDOT processes for specification development, contracting, and maintenance.

A TxDOT Project Advisory Team was formed to maximize TxDOT involvement during the research project. This Advisory Team provided input and expertise in areas such as materials selection, pavement performance, contracting, and maintenance requirements. Furthermore, the Advisory Team provided valuable input during the development of warranty specifications.

Previous experience of other state highway agencies that have effectively implemented warranties suggests that an important component of successfully implementing warranty contracting is working closely with those in the industry that this contracting method impacts. To facilitate this collaborative effort an Industry Interaction Forum was conducted. The Industry

Interaction Forum effort and the results or lessons learned from this forum are presented later on in this report.

Another important aspect of implementing warranties was to identify champions that would be willing to be actively involved in the development process. The effort in this area was focused at the TxDOT district level due to the need for pilot projects as identified in the original work plan. The following chapters of this report discuss in detail the pilot project effort.

## **ORIGINAL WORK PLAN**

The original work plan for this project was comprised of seven tasks that focus on the successful development and implementation of warranty contracting for TxDOT. The seven tasks, as summarized below, correspond to the phases of the implementation process described in *NCHRP Report 451*:

Task 1 – Conceptual Planning

Task 2 – Program Planning

Task 3 – Bidding/Contract Award

Task 4 – Construction

Task 5 – Maintenance and Evaluation

Task 6 – TxDOT Warranty Program

Task 7 – Project Reports

The main focus of Task 1, *Conceptual Planning*, was to:

- Form a TxDOT Advisory Team.
- Confirm TxDOT objectives for the warranty program.
- Review best practices in warranty contracting.

The goal of Task 2, *Program Planning*, was to develop the environment for successful implementation of warranty contracting. The sub-tasks needed to achieve the goal were to:

- Confirm the end products to be warranted
- Establish cooperation with industry.
- Select pilot projects to test the warranty specifications.
- Develop draft warranty specifications.

According to the original work plan the draft warranty specifications developed were going to be tested on pilot projects selected by TxDOT. The researchers planned to carry out this

effort during Task 3, *Bidding/Contract Award*; Task 4, *Construction*; and Task 5, *Maintenance and Evaluation*.

The goal of Task 6, *TxDOT Warranty Program*, was to:

- Provide a plan for evaluating pilot projects and for continuing the warranty program, if successful; and
- Develop a comprehensive warranty implementation (WI) plan designed specifically for TxDOT.

The goal of Task 7, *Project Reports*, was to prepare a research report and a project summary report.

## **REVISED WORK PLAN**

The original work plan required identification of pilot projects within the first three to four months of the project. The warranty specifications would then be developed for specific pilot projects. TxDOT opted to develop complete draft warranty specifications before identifying pilot projects; therefore, the researchers revised the work plan. Furthermore, the research team deemed it necessary to include two additional tasks and incorporate one original task into these new tasks to finalize the draft specifications for testing on pilot projects. As a result, the task structure was changed as follows:

Task 1 – Conceptual Planning

Task 2 – Program Planning

Task 3 – Warranty Indicators and Threshold Values

Task 4 – Modify Draft Warranty Specifications

Task 5 – Bidding/Contract Award

Task 6 – Construction

Task 7 – TxDOT Warranty Program

Task 8 – Project Reports

As part of Task 1, *Conceptual Planning*, an Advisory Team was formed. The team consisted of the following individuals: David Head, Jim Hunt, Gregory Cleveland, Andrew Wimsatt, Mark McDaniel, Duane Schwarz, Mike Lehmann, Ralph Browne, Richard Williammee, and Steve Smith.

To identify best practices in warranty contracting the researchers conducted a literature review and a survey of state highway agencies that were identified as using warranties. The literature review focused on the period from about mid-1998 through 2002. The literature review results were divided into three groups: Past Research, Key State Experiences, and Other Warranty Related Activities.

The states selected for the survey were those included in the Federal Highway Administration (FHWA) briefing document, *Use of Warranties in Federal-Aid Highway Program* (2003 edition) (4). The researchers contacted 18 states. The states surveyed consisted of California, Colorado, Florida, Illinois, Indiana, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, New Mexico, North Carolina, Ohio, Oregon, South Carolina, Utah, Washington, and Wisconsin. Furthermore, several Texas municipalities including Austin, Dallas, Houston, San Antonio, and El Paso were contacted to obtain information about their use of warranties. The focus of the survey questionnaire was on the recent experiences of the state highway agencies with warranties. Sample warranty specifications were gathered for three end products: hot-mix asphalt concrete, surface treatments, and microsurfacing.

As part of Task 2, *Program Planning*, end products to be warranted were selected as hot-mix asphalt concrete, surface treatments, and microsurfacing. The researchers developed draft warranty specifications for each of these end products at this step.

In order to establish cooperation with industry, an Industry Interaction Forum was held in Austin, Texas. The forum included representatives from the Associated General Contractors of America (AGC), contractors, surety industry, Texas Transportation Institute (TTI), and TxDOT.

TxDOT identified two pilot projects: an asphalt concrete project in the El Paso district, and a surface treatment project in the Odessa district.

The goal of Task 3, *Warranty Indicators and Threshold Values*, was to identify warranty indicators and determine appropriate threshold values for the identified warranty indicators. A workshop-type approach using brainstorming techniques and experts was used to select warranty indicators and threshold values. The panel of experts was comprised of the project director, project advisors, TTI research team members, and a concrete supplier. The panel established warranty indicators and threshold values for hot-mix asphalt concrete, surface treatments, and microsurfacing.

As part of Task 4, *Modify Draft Warranty Specifications*, the issues identified in the Industry Interaction Forum were resolved and incorporated into the draft warranty specifications. Furthermore, the compatibility of the draft warranty specifications with the approved 2004 Standard Specifications was ensured, and warranty specifications were finalized for use on pilot projects identified in El Paso and Odessa.

Task 5, *Bidding/Contract Award*, and Task 6, *Construction*, were not accomplished. According to the proposed work plan, the researchers were to provide assistance under this task. This assistance would include incorporating the warranty specifications into the contract documents of the pilot projects. The researchers proposed helping to develop information for conducting a pre-bid conference to emphasize the differences between bidding traditional projects and warranty projects. As proposed in the work plan the researchers were to assist TxDOT during the construction phase by monitoring and documenting contractor methodology, steps, and other processes specifically employed by the contractor for the warranty project. This effort could have answered a critical question of interest: whether or not a warranty motivates the contractor to perform better and ultimately construct a higher quality product.

The goal of Task 7, *TxDOT Warranty Program*, was to provide a plan for evaluating pilot projects and for continuing the warranty program, if successful, and also develop a comprehensive warranty implementation plan designed specifically for TxDOT. As part of this task a draft warranty implementation plan was developed. The purpose of the implementation plan was to provide TxDOT with the information necessary to successfully implement warranties.

As part of Task 8, *Project Reports*, this report and a Project Summary Report were developed.

## **CHAPTER 2**

### **REVIEW STATE OF PRACTICE**

The objective of reviewing the most recent practices in warranty contracting was to ensure that any lessons learned during warranty implementation by other states were understood and could be used to assist TxDOT during the implementation of warranties. These lessons were incorporated into the warranty implementation plan developed through this research project. To review recent practices in warranty contracting, a literature review and a survey of state highway agencies identified as using warranties was conducted. This chapter discusses the literature review and the results obtained by the survey questionnaire.

#### **LITERATURE REVIEW**

This section addresses the state of practice through a literature review that focuses on key publications related to pavement warranties. The review is divided into three categories:

- Past Research,
- Key State Experiences, and
- Other Warranty Related Activities.

#### **Past Research**

Past research review is comprised of American Association of State Highway and Transportation Officials (AASHTO) “Primer on Contracting for the 21<sup>st</sup> Century” (5), NCHRP Report 451 (3), NCHRP Project 20-7 Task 109 (6), and “State-of-Practice of Warranty Contracting in the United States” (7).

#### *AASHTO Primer on Contracting for the Twenty-first Century*

The 2001 version of the Primer is an updated version of the 1997 “Primer on Contracting 2000,” which was prepared by the Contract Administration Task Force of the AASHTO Subcommittee on Construction and published by AASHTO.

This document lists various contracting and contract administration techniques that various contracting agencies currently use in their transportation programs. One of these contracting methods incorporated is warranty contracting. The Primer provides a description of warranty contracting, limited information regarding the use of the warranty provisions, a list of

contracting agencies that have some experience with the technique, and a contact person for additional information.

As indicated in the Primer, warranties have been successfully used in the highway industry to protect investments from early failure. Prior to 1991, FHWA had a longstanding policy that restricted the use of warranties on federal-aid projects to electrical and mechanical equipment. The rationale for the restriction was that such contract requirements may indirectly result in SHAs using Federal-aid funds to cover maintenance costs. By law, FHWA funds may not be used for maintenance. The following bulleted items summarize the information presented in the Primer:

- The 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) permitted states to use local procedures for the design and construction of Federal-aid projects located off the national highway system. For such projects, warranty clauses may be used in accordance with state procedures.
- On August 25, 1995, FHWA published an Interim Final Rule (IFR) for warranties for projects on the national highway system. The IFR states that warranty provisions will be for a specific construction product or feature. Routine maintenance items are still not eligible. The IFR also prohibits warranties for items not within the control of contractors.
- Sharing Best Practices – FHWA provided financial assistance to Utah State University, Local Technology Assistance Program, to conduct a study on the best practices for certain innovative contracting techniques. Utah State established a web page to collect information from the states and share best practices regarding warranties and other areas of innovative contracting (<http://www.ic.usu.edu>).
- Prior to the rulemaking noted above, eight states participated in the evaluation of warranties under Special Experimental Project 14 (SEP-14). As of 2001, FHWA reported approximately 25 states have evaluated some form of warranty provision on a Federal-aid highway project. Table shows a summary of this use, which is taken from the Primer.
- Several SHAs have statutes or administrative policies, which require the use of warranties where appropriate. Michigan Enrolled Senate Bill 303 of 1997 included the following provision for development of warranties on state trunk line



construction projects: “Of the amounts appropriated for state trunk line projects, the department shall, where possible, secure warranties of not less than 5-year full replacement guarantee for Contracted Construction Work.”

- In 1999, the Ohio Legislature passed House Bill 163 that requires Ohio Department of Transportation (ODOT) to utilize construction warranties on at least one-fifth of its capital construction projects. At least one-tenth of all pavement projects must include a warranty. For new pavements, the warranty must be at least seven years. For resurfacing and rehabilitation projects, a minimum five-year warranty is required. For all other products, a warranty of at least two years is required.

**Table 1. Uses of Warranty Provisions (5).**

Product	Range of Warranties (Years)	States
Asphaltic Concrete / Rubberized Asphalt	3-20	AL, CA, CO, FL, IL, IN, ME, MI, MO, MS, OH, NM, UT, WI
Asphaltic Crack Treatment	2	MI
Portland Cement Concrete Pavement	5-10	IL, KY, ME, MI, MS, UT, WI
Bridge Components	5-10	WA, ME, NM
Bridge Painting	2-10	IN, MA, MD, ME, MI, NH
Chip Sealing	1-2	CA, MI
ITS Components / Buildings	2-3	VA, NC
Landscaping, Irrigation	1	WY
Microsurfacing	2	CO, MI, NV, OH
Pavement Marking	2-6	FL, MT, OR, PA, UT, WV
Sign Sheeting	7-12	WV
Roofing	10	HI

*NCHRP Report 451 - Guidelines for Warranty, Multi-Parameter, and Best Values Contracting*

*NCHRP Report 451 (3)* was the published end result of NCHRP Project 10-49, which was conducted by Anderson and Russell. The report contains comprehensive guidelines for implementing non-traditional contracting methods for highway construction projects, including guidelines for warranty, multi-parameter, and best value contracting. The process for implementing warranty contracting is illustrated in the form of a flowchart, including a discussion for each step shown. In addition to this process, the report also contains a model

warranty specification for asphalt pavement, a case study for warranted asphalt pavement, and performance indicators for warranties used by other states for various end products.

Current practice regarding the warranty contracting method was studied using survey questionnaires and interviews with SHAs. Data from these sources were compiled into a table of advantages and disadvantages for the warranty method. [Table 2](#) lists nine critical issues related to the use of alternate contracting methods (Column 1). Columns 2 and 3 indicate whether the critical issue represents an advantage or disadvantage with respect to the warranty method. Column 4 offers a brief explanation of this associated advantage or disadvantage, and Column 5 discusses the possible impact on the contracting community associated with the critical issue.

A warranty process model was developed and refined based upon data collected from SHAs, as well as from studying individual specifications, programs, and projects. The format selected to represent the guidelines was a graphical flowchart. The flowchart was subdivided into the following phases: Conceptual Planning, Program Planning, Bidding, Contract Award, Construction, Maintenance and Evaluation of Performance, Evaluation of the Pilot Project, and Evaluation of the Organizational Program. Each phase contained detailed steps an SHA can follow to develop and implement a warranty contracting program.

[Table 3](#) provides a list of key items that should be addressed when preparing the warranty specifications. This table identifies issues that are commonly found in current warranty specifications and are considered critical to developing a successful warranty specification.

**Table 2. Advantages and Disadvantages of Warranty Contracting (3).**

Critical Issue	Advantage	Disadvantage	Explanation	Impact
Compatibility with Low Bid System	✓		The warranty method is compatible with the low-bid system.	If an “A-B” system as described in the accompanying model specifications is used, contractors will need to develop a method and rationale for developing the ‘B’ parameter to use in their bids.
Impact on Open Competition		✓	The number of bidders on warranty projects may decrease compared to traditional methods-based specification projects.	Some contractors, particularly small contractors, may be hesitant to bid warranties. This trend may reverse itself once contractors better understand warranties and the risks associated with them. Contractors located considerable distances from the site may also be discouraged from bidding, due to the possibility of being required to return for maintenance activities.
Reduction of Agency Human Resources	✓		Warranties reduce the number of SHA inspection and testing personnel required on a project. Since the contractor is responsible for quality control, the agency need not perform the quality assurance function.	A contractor’s inspection and testing personnel requirements may decrease due to elimination of a SHA-mandated minimum quality control program. The contractor may run as many or as few quality control tests as deemed necessary.
Reduction in Project (bid) Cost	✓	✓	At this point definitive conclusions are not possible, but there is some indication that warranty contracts may cost less per ton of hot-mix than standard contracts. This is based on preliminary data from a small number of asphalt pavement projects.	At this point definitive conclusions are not possible, but there is some indication that contractors may increase items such as “mobilization” in their bids to offset the increased risk they believe they are taking in bidding on a warranty project, as well as the increased cost they may factor into their bids for possible remedial work.
Improvement in Quality of Constructed Project	✓		Warranty contracting appears to increase the quality of the completed project. Since the contractor runs the risk of returning to repair or replace work that fails to meet product threshold levels, there is a greater incentive to construct a high quality product from the beginning, rather than merely meet the minimum levels set by a specification requirement.	Contractors may have to estimate some percentage in their bid for future remedial actions. However, if the product performance meets or exceeds the threshold levels set by the SHA in the specifications, the contractor will not have to spend that money, and therefore profit may increase.

**Table 2. Advantages and Disadvantages of Warranty Contracting (Continued).**

Critical Issue	Advantage	Disadvantage	Explanation	Impact
Reduction of Project Completion Time	-	-	Warranty contracting may increase project completion time. Contractors will be reluctant to complete their work until all other factors that may affect performance of their product have been addressed. For example, a paving contractor may not want to pave over a flaw in the sub-base, as this may cause the roughness of the finished pavement to increase. Innovative construction methods, however, may help reduce project completion time.	Contractors may need to take into account and document all factors that may affect the final performance of their final product.
Shifting of Risk from Agency to Contractor	✓		The agency shifts some of the post-construction performance risk of the warranted product to the contractor.	The contractor assumes more post-construction risk than under a traditional methods-based specification.
Ease of Implementation with Respect to Resources, Data, Systems, and Expertise		✓	The establishment of a warranty contracting program requires resources to be invested up-front for training. Additional expertise is also required to write and implement the warranty specifications. A large amount of data is also required. In particular, the establishment of threshold levels for distress indicators for some products such as pavements requires a large amount of research, or a well-kept product management system from which to extract data.	The contractor will also need to spend some time and resources in training personnel and becoming familiar with the warranty method. In addition, the contractor may need to conduct some research in developing quality control methods often required for warranty projects.
Contractor Innovation	✓		Contractors are not restrained by traditional SHA methods-based specifications. Thus, they have the latitude to use alternative or innovative construction methods and techniques that would otherwise not be allowed under traditional specifications. In the long run, innovation by contractors may increase product quality and decrease life cycle cost. Also, manufacturers promoting new products may benefit from a warranty requirement as SHAs will be more likely to allow the use and evaluation of new products if a reasonable warranty is provided.	A contractor may use a cost-saving innovative construction method under a warranty specification, but not under a traditional methods-based specification. This may be beneficial to small contractors with innovative ideas who are unable to incorporate these ideas within the traditional specification.

**Table 3. Issues to Consider When Drafting a Warranty Specification (3).**

<b>Item</b>	<b>Explanation</b>
Description	<ul style="list-style-type: none"> <li>• Describe what the specification covers and work required.</li> </ul>
Length of Warranty	<ul style="list-style-type: none"> <li>• Establish length of the warranty. Can be fixed or varying using “A minus B” system described in the model specifications below.</li> </ul>
Bonding Requirements	<ul style="list-style-type: none"> <li>• Establish the penal value of warranty bonds or retainage system. The penal value should be enough to cover the cost of remediating a worst case failure scenario.</li> <li>• Establish acceptable bond rating using A.M. Best rating system.</li> <li>• Determine combinations of acceptable bonds (e.g., one full-length bond or a combination of bonds).</li> <li>• Determine steps to be taken if surety company falls below acceptable rating.</li> <li>• Determine penalties if contractor fails to renew warranty bond.</li> </ul>
Maintenance	<ul style="list-style-type: none"> <li>• Establish who is responsible for maintenance activities.</li> <li>• Establish how contractor-performed maintenance activities will be approved.</li> </ul>
Conflict Resolution	<ul style="list-style-type: none"> <li>• Establish Conflict Resolution Team (CRT).</li> <li>• Determine composition of the CRT.</li> <li>• Determine when CRT will be used.</li> <li>• Determine length of conflict resolution process.</li> </ul>
Contractor Responsibilities	<ul style="list-style-type: none"> <li>• Securing of a warranty bond for the entire period of the warranty.</li> <li>• Guarantee of the end product for the entire period of the warranty.</li> <li>• Selection of materials and construction methods.</li> <li>• Remedial action if any threshold levels are met or exceeded.</li> <li>• Establishment and submission of a Quality Control Plan and data.</li> <li>• Elective/preventative actions deemed necessary by the contractor.</li> <li>• Maintenance of third party liability insurance.</li> </ul>
Department Responsibilities	<ul style="list-style-type: none"> <li>• Approve liability insurance and bond providers.</li> <li>• Determination of end product inspection method.</li> <li>• Annual inspection of end product.</li> <li>• Compilation and timely submission of an annual written report to contractor documenting performance of end product.</li> <li>• Notification of contractor regarding any required remedial actions.</li> <li>• Approval of materials and construction methods and techniques used to perform remedial actions.</li> <li>• Approval of any elective/preventative action performed by the contractor.</li> <li>• Specification of special requirements such as Quality Control Plans.</li> <li>• Definition of what constitutes an emergency condition.</li> <li>• Determination of responsibilities and time frames for responses to emergency conditions.</li> <li>• Determination of the existence of emergency conditions and remedy if necessary.</li> <li>• Establishment of acceptable contractor response time in an emergency situation.</li> <li>• Definition and performance of Routine Maintenance (e.g., snow removal, sign maintenance, mowing grass) during the warranty period.</li> </ul>
Performance Indicators	<ul style="list-style-type: none"> <li>• Establishment of performance indicators and threshold levels.</li> <li>• Definition of conditions under which specified threshold values are not valid.</li> </ul>
Requirements for Corrective Action	<ul style="list-style-type: none"> <li>• Approval of remedial action.</li> <li>• Establishment of remedy period.</li> <li>• Establishment of activity types that void requirements for remedial action by the contractor (e.g., destructive testing procedures by the SHA or utility relocation).</li> </ul>
Basis of Payment	<ul style="list-style-type: none"> <li>• Establishment of measurement method for warranted end product (i.e., by the foot, meter, ton, square foot).</li> </ul>

*NCHRP Project 20-7, Task 109*

At its August 1998 meeting, the AASHTO Highway Subcommittee on Construction identified the need for technical provisions for innovative contracting methods. These provisions were developed in conjunction with NCHRP Project 10-49, under NCHRP Project 20-7, Task 109, Technical Provisions for Innovative Contracting (6). The objective of this task was to prepare draft technical provisions for the following contracting methods:

- warranties,
- cost-plus-time (A+B) bidding,
- incentives/disincentives,
- lane rental, and
- night-time construction.

These provisions were developed in sufficient detail and in a format that the AASHTO Highway Subcommittee on Construction could modify for incorporation into the Guide Specifications for Highway Construction (1998 edition).

The process for developing each of the five technical provisions involved a review of existing specifications, state highway agency practice, and the literature. Next, critical issues that would substantially impact the development of the technical provisions were identified and a preliminary draft of each technical provision was prepared. A special Task Force of the AASHTO Highway Subcommittee on Construction reviewed the preliminary draft of each technical provision. A revised draft technical provision was developed incorporating modifications suggested by the AASHTO Task Force.

The following key elements guided the development of the technical provisions:

- The technical provisions should be easily integrated into the AASHTO Guide Specifications for Highway Construction.
- The format of the technical provisions should be consistent with the AASHTO Guide Specifications.
- Necessary modifications of the AASHTO Guide Specifications should be identified and developed.
- Best business practices should be incorporated into the technical provisions, while maintaining a generic approach.

In the area of warranties, a generic technical provision was developed. A hot-mix asphalt concrete technical provision was also developed to provide an illustration of how the generic technical provision would be applied in practice.

### *State-of-Practice of Warranty Contracting in the United States*

“State-of-Practice of Warranty Contracting in the United States” (7) documents the most current use of warranty contracting in the U.S. In order to document state of practice of warranty contracting, SHAs, contractors, and surety companies that are involved with warranties were surveyed. Personal interviews were also conducted with selected parties. Based on the surveys and the interviews conducted, the impact of implementing warranties was analyzed. The results of the questionnaire survey are based on 13 SHA, 16 contractor, and 6 surety company responses. Eight SHAs, 9 contractors, and 5 surety companies were further interviewed. The SHAs that have used warranty contracting and responded to the questionnaire consisted of Michigan, Ohio, Florida, South Carolina, California, Wisconsin, Minnesota, West Virginia, Colorado, Mississippi, Indiana, Oregon, and Pennsylvania.

This paper addresses several of the big issues in warranty contracting, such as:

- increase in bid price,
- effect on life-cycle costs,
- anticipated improvements in quality,
- risks and difficulties in bonding, and
- impact on project duration.

The criteria determined for documenting the state of practice included cost, quality, duration, bonding, and contract components of highway projects. The questionnaire included seven sections: general information, cost issues, quality issues, construction duration issues, bonding issues, contract issues, and unclassified issues.

The general information section includes information about the usage of warranty contracting by the SHAs, the experiences of the interviewed SHAs, warranty period requirements for different types of projects, and the effect of warranties on the number of bidders. It is indicated in the paper that 69 percent of the SHAs have annual sales of warranties less than 5 percent of their total annual budget. Twenty-three percent indicated 10 to 20 percent, and 8 percent of the SHAs specified more than 30 percent. The majority of the states

(84 percent) indicated that they did not experience a change in the number of bidders on warranty projects compared to non-warranty projects. Only West Virginia reported a decrease in the average number of bidders from more than 30 bidders to just a few on warranty projects.

The cost issues section includes information about average bid prices based on warranty provisions, expected savings in maintenance costs, and expected savings in project life-cycle cost. Ten SHAs provided information about the bid price change due to warranty provisions. According to the paper, two states indicated no effect, two states indicated that the increase was less than 5 percent, four states reported a 5 to 10 percent increase in bid prices, one state stated a 10 to 20 percent increase, and one state indicated that the increase in bid price was 20 to 50 percent. Eight out of nine SHAs reported that the expected savings in maintenance costs was less than 10 percent. Only West Virginia expected to save more than 50 percent in maintenance costs. Only 8 percent of the SHAs indicated that they expected a substantial savings in the project life-cycle cost of warranty projects compared to non-warranty projects. Twenty-three percent indicated that they expected a little savings while another 23 percent reported that they expected no impact on life-cycle costs. The remaining 46 percent expected a little increase in project life-cycle cost due to warranty provisions.

The quality issues section includes the information obtained on the impact of warranties on quality, site inspection, and record keeping. The majority of the SHAs reported an improvement in project quality with 46 percent indicating slightly improved project quality and 23 percent indicating great improvement. The remaining 31 percent of the SHAs reported that the impact of warranty provisions on project quality was uncertain at the time the survey was conducted. Sixty-two percent of the contractors indicated that they try to maintain higher quality due to the warranty provisions, whereas the rest of the contractors surveyed (38 percent) reported that they did not experience any changes because of the warranty provisions. The survey also indicated that the contractors chose to be more conservative and focus on quality rather than employing innovative methods during construction. This finding is interesting because one of the major objectives of warranty contracting is to increase contractor innovation, not to cause the contractor to be more conservative.

Most of the SHAs (77 percent) reported that the need for site inspection was decreased due to the warranty provisions, while 15 percent indicated no change, and 8 percent reported that the agency had to conduct more inspections. Sixty-nine percent of the contractors indicated that



there was no change in site inspection on warranty projects, whereas 25 percent reported that the need for inspection by the contractor was increased due to warranty provisions. Fifty-four percent of the SHAs indicated that because of the warranty provisions they had to perform less record keeping, while 31 percent reported no change, and 15 percent indicated more record keeping. An overwhelming majority (94 percent) of the contractors reported that the warranty provisions resulted in increased record keeping because of a potential future dispute over a warranty requirement.

About 61 percent of the SHAs indicated that warranties do not save construction time, while the other 39 percent stated otherwise. Fifty percent of the contractors stated that because of uncertain conditions and emphasis on quality, warranty provisions may cause delays during construction, while the other 50 percent indicated that there would be no difference in construction duration due to warranty provisions.

All six of the surety companies surveyed indicated that the surety companies were not interested in providing a bond to small firms for a period of three to seven years. Surety companies also reported that there is a lack of appropriate risk assessment methods for the long-term obligations associated with warranty provisions. According to the paper, this was the main reason the surety companies prefer larger contractors to smaller ones.

The paper indicates that most SHAs require a warranty bond when the contract is signed; however, the surety companies state that they would prefer to issue the warranty bond after project completion.

About 41 percent of the SHAs indicated that there was no observable effect on contract disputes and litigation due to warranty provisions, while 25 percent reported that disputes may increase slightly, and 17 percent stated that disputes may increase greatly. The remaining 17 percent reported that disputes may decrease slightly.

### **Key State Experiences**

The key state experiences reviewed contain those included in the following reports:

- Wisconsin DOT's "Asphaltic Pavement Warranties Five-Year Progress Report" (8),
- Colorado DOT's "Materials and Workmanship Warranties for Hot Bituminous Pavements" (9),
- Indiana DOT's "Benefits of Warranties to Indiana" (10),

- Ohio DOT’s “Implementation of Warranted Items on Construction Projects” (11), and
- Michigan DOT’s “Status Report on Road Warranties” (12).

*Wisconsin DOT – Asphalt Pavement Warranties – Five Year Progress Report*

This report provides an overview of Wisconsin Department of Transportation’s (WisDOT) experience during the implementation of asphalt pavement warranties. WisDOT began building asphaltic concrete pavements with a warranty specification in 1995. By the end of 2000, WisDOT built 24 asphalt warranty pavement projects. The report discusses the progress of WisDOT’s warranty program.

Initially, WisDOT was operating under a very comprehensive quality control/quality assurance (QC/QA) program, which was the beginning of the shift in post-construction performance responsibility from WisDOT to the contractor. In early 1994, the development of an asphaltic pavement warranty specification began as a cooperative effort among WisDOT, the Wisconsin Asphalt Pavement Association, and the Wisconsin Division Office of FHWA. The first warranty projects were built in 1995.

As part of the warranty the contractor is responsible for the asphaltic mixtures (including mix design, materials, quality control, and construction) and any required warranty for a period of five years following the opening of the pavement to traffic. Some of WisDOT’s goals through the use of warranty specifications were to:

- enhance pavement quality,
- shift product responsibility to the contractor, and
- foster contractor freedom to be innovative and creative, while maintaining WisDOT standards.

As indicated in the report, the intent of this effort was to relieve WisDOT of construction inspection and quality assurance testing and, instead, to concentrate its effort on evaluating the final product. The contractor was, however, to comply with some constraints specified by WisDOT, such as location of projects, schedule for completion, thickness of pavement, and type of base. The contractor was held responsible for acceptable pavement performance for the warranty period, but not for factors/conditions which were beyond the contractor’s control.

The original specifications were drafted in the fall of 1994 and have been modified annually. The report provides a copy of the 2000 Warranty Specifications. The specification contains threshold values for visible distress indicators, which are based on statistical analyses of pavement performance data. If a threshold is met or exceeded during the warranty period, the contractor is responsible for conducting a remedial action.

The performance data for 18 projects constructed from 1995 to 1999 have been summarized in the appendix of the report. As part of the evaluation of the warranted pavements, distress information is collected annually on each warranted project and is collectively incorporated into the pavement distress index (PDI) which ranges from zero (perfect condition) to 100 (worst possible condition). Ride quality information is also collected and expressed as International Roughness Index (IRI) in metric units (m/km). In addition, distress values for transverse cracking and longitudinal cracking are noted for each section of the project. At the time the report was developed threshold values had never been exceeded on any project.

The benefits derived by the Wisconsin DOT through the use of warranties were shown with the pavement performance comparison between warranted and non-warranted projects. However, the cost effectiveness of warranty contracts over standard contracts was difficult to assess at the time the report was developed because sufficient performance data to indicate long term trends were not available. As stated in the report, cost effectiveness of warranty contracts over standard contracts needs to include all “other costs” experienced by WisDOT and the contractor during the warranty period in order to make a valid comparison. A list of cost factors required in standard contracts and warranted contracts has been provided in order to make a valid comparison. Based on these factors, the cost analysis carried out by WisDOT was broken into two separate categories, 1995 to 1999, and 2000 to 2001, in order to account for escalation in asphalt prices after 2000. Warranted projects cost less per ton in both categories as compared to standard projects.

In order to calculate the life-cycle costs of the pavements, the performance data collected were applied to deterioration models and the estimated longevity of warranty pavements was determined. The methodology has been clearly described in the report. Once the average life-cycle cost for warranted pavements is determined in present worth value, a comparison can be made with the life cycle cost of standard asphaltic pavements. Using this methodology it was determined that even at an initial up-front cost of up to 7 percent greater, warranted pavements

are still more cost effective than standard pavements. Some of the possible reasons are the careful selection of warranty projects by WisDOT, good materials and construction practices used by the contractors, and elimination of the QC/QA procedures and state inspection.

This report highlights the Wisconsin asphalt industry's perspective and concerns. The issues are mainly related to pavement performance prediction, acceptance of warranty contracts, suitability of warranty contracts for all projects, and extension of the warranty period. The industry also provided its views on innovative practices that the warranty process needs to standardize. These practices mainly include using mix designs that require better materials, closer tolerance in monitoring during the quality control process, risk sharing with the subcontractors and suppliers, allowing contractor innovation, and contractor quality assurance of all systems.

WisDOT believes that warranty contracting is a positive direction for both contractors and themselves. The contractors have been more conscientious when performing their work and have been giving more attention to the quality of workmanship and materials. Under their own initiative contractors use the best practice, methods, and procedures. The DOT staff required on warranty projects has been minimal and a delivery cost savings is usually experienced. In addition, the warranty concept has proven to be an innovative means for contract administration.

For future warranty projects, industry and WisDOT are considering the possibility of narrowing the performance criteria for the same five-year period or allowing the same performance criteria but with an increase in the warranty period. This would tend to assure an even better quality and longer-lasting pavement. An incentive provision was also proposed that could reward the contractor for an exceptionally good pavement. WisDOT recommends factoring in the warranty concept earlier into the design process and considers this concept an acceptable, not experimental way of delivering projects. The possibility of bidding all projects with a warranty, that is pursuing a full warranty implementation program, is being investigated by WisDOT.

#### *Colorado DOT – Materials and Workmanship Warranties for Hot Bituminous Pavements*

This report includes the Colorado Department of Transportation's (CDOT) evaluation of six warranty projects. At the time the report was developed, five of these projects were constructed and one of them was under construction. For three of these projects the warranty

period was expired. The end product warranted was hot bituminous pavement (HBP) with a three-year warranty. Each warranty project was compared to a similar non-warranted project. The cost items used in the comparison included costs for the initial HBP, maintenance, pavement evaluation team, weigh-in-motion (WIM) station, and construction engineering. An analysis was also conducted on the competition, performance, and use of experimental features. In addition, the report covers the lessons learned and recommendations to improve the current warranty specification.

The Colorado DOT's warranty specification allows the contractor to use innovative practices. CDOT believes that the contractor is more motivated to follow good construction practices when the contractor is responsible for the warranted pavement's performance to the extent that the contractor can control it. In other words, contractors are only held responsible for distresses that may occur due to defective materials and/or workmanship.

According to the report, there were limited data available from the six warranty projects. There was no appreciable difference in competition or performance of the warranty projects when compared to the control projects.

Control projects were selected to perform the cost-benefit analysis. The control projects used the traditional CDOT specifications (non-warranty) and were similar to the warranty projects in terms of year of construction, overlay thickness, rehabilitation strategy, traffic, and original pavement condition.

The Cost Benefit Evaluation Committee (CBEC) gathered data for their report. It became clear that more data would be needed than what was readily available from the standard plans and cost estimate documents. In order to include as much pertinent information as possible and minimize the gaps in the data the CBEC conducted the evaluation and decided to survey individuals familiar with the project.

The CBEC conducted two formal surveys. The first survey was about project specific information. The purpose of this survey was to query CDOT and contractor project personnel to ensure that any information that they had available could be considered in the evaluation. The second survey was about the contractors' initial cost data. The purpose of this survey was to determine the cost that the successful contractors used to value the warranty at the time of bidding. As the CBEC tried to determine the cost implications of including a warranty in a project specification, one technique used was to ask the contractors directly.

The survey suggested that the contractor's quality control plan (QCP) was in place for all of the projects. These plans differed greatly. Also, CDOT's audit or surveillance process of the plan was not uniform from project to project. Some projects' QCPs were audited in greater detail whereas others had less scrutiny. The report suggests that some additional language should be developed in the specification to define the quality control plan and, in particular, how to address differences in the level of auditing from one project to another.

During construction, contractors indicated that all five projects had an equal or greater level of attention to quality than normal projects. CDOT indicated that all five projects had an equal or greater level of attention to testing and quality control than normal projects, and three of the five projects had an equal or greater level of attention to constructability.

Most of the contractors (primarily the major ones) had internal quality control (QC) operations that were very good. This is a result of the QC/QA initiative that started about 10 years ago. When a contractor with a fully developed QC operation constructed a warranty project, there was not much change in that contractor's quality control practices for testing and constructability. However, since these were the first warranty projects, there was very likely some level of additional attention to detail in all of the projects. The report suggests that the warranty task force should reconvene to evaluate the areas of concern that developed after the construction of these five projects.

To estimate the overall additional cost of warranties CDOT analyzed four cost items. These items included the initial bids, maintenance costs, cost of the pavement evaluation team, and cost of WIM station. Considering the variability in the data and the limited number of projects, the cost of the three-year warranty was considered negligible.

The contractor performed maintenance on two of the projects. Maintenance was part of the warranty work; therefore, it was performed at no direct cost for CDOT. For the control projects, the average cost of maintenance per project was \$2500 per year.

According to the report, each time the Pavement Evaluation Team (PET) reviewed a pavement, the total of all costs was approximately \$5400. It is assumed that this evaluation would occur once per warranty project, so the cost was estimated at \$5400 per project.

WIM stations were installed on the warranty projects for monitoring the traffic loads. The report indicates that the initial cost of a WIM station was approximately \$50,000. The annual maintenance cost for the WIM station was approximately \$10,000 or \$30,000 over the

three-year term of the warranty. The total cost for the WIM station was \$80,000 per project with a three-year warranty.

Based on the information gathered from the six warranty projects that were available at the time the report was written, the overall additional cost of a warranty project with a three-year term was estimated to be approximately \$85,400. The approximate cost of a warranty project was \$3 million; therefore, the additional cost is approximately 3 percent of the overall warranty project cost.

### *Benefits of Warranties to Indiana*

This paper documents Indiana DOT's experience with implementing warranties. The paper provides information about how the warranty program was developed. Furthermore, the paper presents the results of performance and cost analysis of Indiana's warranted projects.

When developing the warranty specifications the Indiana DOT targeted Interstate routes and selected warranty criteria that emphasize the National Partnership for Highway Quality (NPHQ) survey results. In addition, the DOT wanted the properties to be measured objectively using current technology. As a result, the warranty criteria were based on properties routinely collected for its Pavement Management System (PMS). The performance indicators included in the warranty criteria included smoothness, rutting, cracking, and friction.

Indiana DOT first implemented the HMA warranty program. After the implementation of the HMA program, DOT extended the process to Portland Cement Concrete (PCC) pavements and to pavement preservation activities; that is, microsurfacing. At the time the report was developed, a total of nine warranty projects were constructed. Two of these nine projects required remedial action because the threshold value for friction was exceeded. Warranty thresholds for smoothness, rutting, and cracking have not been exceeded on any of the projects.

In order to determine the benefits of warranties for the Indiana DOT an analysis was conducted. This analysis included those HMA projects that have completed their warranty periods or have at least two years of warranty evaluations completed. The goals of this analysis were:

- quantify the improved performance of warranted HMA pavements,
- estimate their expected life, and
- calculate cost savings of the longer life.

The following results were obtained and documented in the report as a result of Indiana DOT's analysis:

- Warranted HMAC provided a lower and more consistent IRI than non-warranted HMAC. The mean IRI value for the warranted projects was not only significantly lower, but also the standard deviation was significantly lower.
- Warranted HMAC sections had less rutting than non-warranted sections. Furthermore, rut depths were more consistent.
- Performance of the HMAC warranted projects exceeded that of the non-warranted projects. Expected performance for smoothness and rutting before exhibiting the same performance of non-warranted pavements was 24 years, an additional 9 years.
- Using warranted HMAC as a pavement construction strategy required less demand on budget and provided a smoother pavement (lower IRI).
- Predicted 25-year cost to maintain network smoothness at a constant 2002 value was \$1.08 billion dollars using a warranty strategy, and \$1.47 billion dollars using a nonwarranty.
- Initial capital costs for HMAC warranty projects were approximately 10 percent higher than for non-warranty projects.
- Use of warranties for HMAC projects as a pavement preservation strategy can produce a cost savings of 27 percent.
- Indiana HMAC warranties accomplished the initial goals of both the Indiana DOT and the HMAC industry by providing smoother and safer pavements with fewer defects over a longer period of time.

#### *Ohio DOT – Implementation of Warranted Items on Construction Projects*

The Ohio Department of Transportation (ODOT) established a set of warranty contract requirements for implementation in highway construction projects in response to House Bill 163 of the 123rd General Assembly. These specifications include items such as pavements, bridge decks, and other maintenance items for varying warranty periods. This report is part of the requirement from the Director of Transportation to submit a report evaluating the use of warranties, under the Amended Substitute House Bill 163. The report highlights the status of the warranty program implemented by ODOT and addresses warranty issues such as costs,



techniques, quality of warranted and non-warranted items, and recommendations for further use of warranties.

Ohio law requires ODOT to incorporate warranty requirements in at least 20 percent of the department's construction projects. Furthermore, at least 10 percent of the department's capital construction budget that is bid must include pavement warranties. Under this legislation ODOT has developed warranty specifications for 13 different warranted construction items as well as common contract language for warranty processes that could be applied to most warranty items. The specifications address the minimum material and quality control requirements. Each warranty specification requires the contractor to provide a bond and liability insurance for the duration of the warranty period. The 13 work items and their warranty periods have been identified as part of this report.

At the time the report was developed in 2000, ODOT had 69 warranty projects under construction. ODOT was not able to achieve the first requirement set by the legislature; the 69 warranty projects comprised less than 20 percent of ODOT's construction projects for the fiscal year. The reason for this shortfall was attributed to the lack of lead-time, since most of these projects were already designed and warranty provisions could not be added without delaying the bid date. On the other hand, ODOT managed to exceed the second requirement; more than 10 percent of the construction budget that is bid during the fiscal year comprised of warranty projects. The total bid cost of the projects with warranty requirements actually reached to \$1.21 million, or 15 percent of ODOT's total construction budget.

The report indicates that the inclusion of warranty specifications resulted in increased project costs in the form of higher bid prices. Asphalt pavement bid prices were 8.5 percent higher than similar non-warranted asphalt pavements and concrete pavement bid prices were 11 percent higher than similar non-warranted concrete pavements.

A summary of the field reports provided by the ODOT district construction personnel, following the first year of implementation of warranties, is also presented in this report. The overall assessment of the field staff is that contractors are more conscientious about their work and are willing to pay closer attention to the quality of the warranted product. The reports also indicated that maintenance staff saw potential savings in time and materials due to not needing to maintain pavements during the warranty period. However, the construction personnel feel the department has lost control over the product under the warranty provisions. The districts are able

to advise the contractor of obvious visual defects, but cannot stop the progress of the work under the warranty specification requirement. Field reports also indicated that warranties did not reduce the need for inspection. Documentation of existing soil conditions and construction placement were recorded carefully by all parties in case of future claims against the department that could void a warranty.

The report indicates that ODOT, in cooperation with the University of Cincinnati, would conduct 30 months of research in order to develop a system for proper selection of projects with the warranty requirements. Furthermore, the research would develop a system to consistently track the cost associated with reviewing and enforcing the warranty provisions statewide. As part of their effort to improve the warranty program, ODOT was also reviewing the use of warranties in other states such as Wisconsin and New Mexico. The research program was scheduled to commence in January 2001.

*Status Report on Road Warranties – Michigan Department of Transportation, May 2003*

The report provides an update of the status of the Michigan Department of Transportation's (MDOT) use of road warranties as of May 2003. It presents an overview of the different types of construction to which warranties are applied, the components and types of warranties, the investigation process that follows, the program for warranty administration, and some recommendations to improve the effectiveness of warranties in the future.

MDOT has been using pavement warranties since 1996 and has completed a total of 604 projects to date. Out of these 604 projects, 473 were for capital preventive maintenance (CPM) projects and 131 were for reconstruct and rehabilitate (R&R) projects. The warranties used on CPM projects mainly consisted of two-year performance warranties and three-year material and workmanship warranties. The warranties in the R&R projects consist predominantly of five-year material and workmanship warranties. The report summarizes the different projects that have been warranted in Michigan and the type of warranty used on each one of them.

The report defines a number of key components of a warranty that include, but are not limited to, the following: initial acceptance, warranty bond, rights and responsibilities of the contractor, rights and responsibilities of the department, evaluation method, warranty requirements, conflict resolution, and corrective actions.

As defined by MDOT, under a material and workmanship warranty, the contractor is responsible for correcting defects in work elements within contractor control (materials and workmanship) during the warranty period. The contractor does not assume any responsibility for defects due to design errors. Under a performance warranty, the contractor is fully responsible for the pavement performance during the warranty period. The contractor assumes responsibility for some or all design decisions.

MDOT requires contractors to obtain bonds from surety companies to guarantee that the warranty requirements will be met. For CPM projects, the bond is for 100 percent of the contracted work and for R&R projects the bond is for 5 percent of the contract or a fixed dollar amount specified in the contract. The contract will contain specifications that provide for the enforcement of a warranty. A forensic investigation process is currently being developed to evaluate the performance of the pavements by checking all the specifications. The process will define the investigation process and will provide for a series of decision trees for different condition parameters. This process will be followed when an investigation is to be conducted to determine the specific cause of a pavement condition that causes the warranty conditions to be violated during the warranty period. The report shows a draft of the material and workmanship forensic investigation process that has been developed so far. To date, less than 5 percent of the warranties have required corrective action in case of the CPM projects, and less than 2 percent of the projects in case of the R&R projects.

Considering the growing number of warranty projects, MDOT recognizes the importance of developing a uniform criterion for administering warranties and reporting on the warranties. The agency created the Statewide Warranty Administration Team (SWAT) which is moving forward in the development of the Statewide Warranty Administration Database (SWAD). The MDOT report provides a draft version of the SWAD Design Look and Feel. The agency also published “Guidelines for Administering Warranties on Road and Bridge Construction Contracts.” A copy of these guidelines is provided as an appendix in MDOT’s report. The guidelines describe the steps involved in the warranty administration process with the help of flow charts. It identifies two types of inspections that are carried out during the warranty period. The cursory inspection is a simplified inspection to quickly identify segments that may have distresses that exceed the threshold values and the detailed inspection that requires direct measuring and reporting of all observed distress in each segment. Detailed inspection guidelines

are provided for a number of items such as bituminous crack treatment, hot-mix asphalt crack treatment, bituminous overlay, microsurfacing, chip-seals, concrete repair, plain concrete, jointed plain concrete pavement and jointed reinforced concrete pavement, superpave and hot-mix asphalt, bridge painting, concrete deck overlay, field coating of steel structures, and modular expansion joint system.

MDOT has experienced a lot of cost savings through the use of warranties as contractors perform repair work at their own expense and require less oversight by department staff. The department directs more emphasis to materials and workmanship; and intends to obtain longer life out of its pavements, reduce failures, reduce maintenance costs, and incur lower life-cycle costs for pavements. Michigan has not experienced an increase in bid prices for warranty contracts when compared to non-warranty contracts.

The report concludes by providing some recommendations on continual use of warranties on road projects to be in the best interest of the taxpayer and to better manage the department's risk.

### **Other Warranty Related Activities**

Other warranty related activities and reports that were reviewed include European Asphalt Pavement Warranties Scan Report (2), Michigan Local Technology Assistance Program Pavement Warranty Symposium Final Report (13), and Performance Specifications Strategic Road Map (14).

#### *AASHTO/FHWA – Asphalt Pavement Warranties Technology and Practice in Europe*

In September of 2002, a U.S. panel traveled to Europe to conduct the “European Asphalt Pavement Warranties Scan.” According to the report, the scan's objective was to “review and document the policies and strategies used in Europe to determine risk assessment and administer warranty contracts.” Representatives from Spain, Germany, Denmark, Sweden, and The United Kingdom were interviewed. The following items were investigated during the scan:

- methodologies used to determine risk assessment for the government agency and contractor,
- methodologies for administration of warranty contracts,
- methodologies to select criteria to account for traditional performance indicators of rutting, fatigue cracking and low temperature cracking,

- practices to maintain prescribed levels of smoothness and skid resistance,
- criteria used in successful asphalt pavement warranties, and
- pavement performance prediction tools.

*2003 Michigan Local Technology Assistance Program – Pavement Warranty Symposium Final Report*

A warranty symposium was conducted from May 5, 2003, to May 7, 2003, at Grand Rapids, Michigan. The goal was to share the experiences, so as to develop a “collective opinion” about warranties. The report highlights the key findings of the symposium. Eleven SHAs were invited to the symposium. These SHAs completed a questionnaire to provide information about state policies on warranties for pavements and to share practical experiences. The 11 states were Colorado, Florida, Illinois, Indiana, Louisiana, Michigan, Minnesota, New Mexico, Ohio, Virginia, and Wisconsin. The symposium was also attended by representatives from both national and state asphalt, concrete and pavement preservation associations, and the surety industry.

The questionnaire collected information about each state’s warranty program status and posed questions on the history of warranties since inception in the particular state, type and extent of warranties used, methods for evaluating the effectiveness of warranties, warranty threshold values, monitoring of warranty projects, data collection system used, methods for handling disputes, and bonding requirements.

Based on the information provided in the questionnaire by the participating SHAs, the key data and observations were compiled regarding the state’s approach to pavement warranties.

In summary, most SHAs had good experience with using warranties. In some cases, warranties were legislatively driven. Most of the SHAs using warranties have observed innovations on warranty jobs. In Colorado, the contractors achieved new ways of compacting joints and a higher strength with a thinner section of concrete pavement.

The SHAs believe that although the contractors may not be proficient with pavement design today, if the responsibility is shifted to them, they would gain the necessary knowledge. According to the SHAs warranty bonding is there to shift the risk away from the agency, but bonding is still a big issue and needs to be further studied.

According to the SHAs more data needs to be collected on performance indicators and threshold values. SHAs believe that it is important to determine what performance indicators are

appropriate and what threshold values should be set for each performance indicator. The SHAs indicated that the data stored in the pavement management systems cannot be used to determine threshold values.

SHAs indicated that selection of the warranty projects and evaluation of the costs and benefits associated with using warranties are important issues that need to be further studied. Furthermore, the SHAs stated that since pavements are designed to last 15 to 20 years, two- to five-year warranties would not be significant. On the other hand, 10 or more year warranties cost too much.

Representatives from national and state asphalt industry, concrete and pavement preservation associations, and surety industry provided information on their industry's position and knowledge on warranties. The representatives made comments regarding cost impacts on bid prices due to warranties. Most agreed that warranty projects would cost more. All agreed that distress thresholds need to be set at reasonable levels, or else the final product will cost more. Many industry representatives did not believe that the reduced SHA inspection workforce should drive warranty implementation. There was also doubt on the use of innovative materials and practices, as the benefits derived from these factors would not turn up until well after the three- to five-year warranty period.

The representatives from the surety industry said that the general recommended term for a bond was three years, as the surety companies do not have qualified staff to effectively determine the risk of a warranty bond for longer periods.

### *Performance Specifications Strategic Road Map*

Performance Specifications Strategic Road Map (PSR) is developed by FHWA to be a guide to the highway construction community as performance specifications emerge as feasible contracting options. According to PSR, "performance specification (PS) is an umbrella term that incorporates performance-related specifications (PRS), performance-based specifications (PBS), and warranties." PSR specifies four main goals:

- Identify relationships that link design and construction with product performance.
- Develop and implement performance specifications.
- Conduct a communication and training effort.
- Provide organizational support for the Performance Specification Program.

For the purposes of this literature review this report only discusses the sections from PSR related to warranties. The road map provides the following process for implementing warranties:

- Establish what gain is expected and how success of the program will be measured.
- Define the product service life.
- Establish a warranty period and describe the condition of the product at the end of the warranty, including expected remaining service life.
- Describe the sampling and testing plan that will be used to monitor quality during construction and measure quality at the end of the warranty period.
- Eliminate method or prescriptive requirements that conflict with performance requirements or intent. This includes material selection, mix designs, etc.
- Establish some thresholds where warranties are invalidated—traffic, weather, inadvertent maintenance, etc.
- Establish a contract bonding, insurance, or retainer requirement to hold the contractor financially accountable.
- Establish a repair protocol should the product show early distress.
- Establish a mediation board to resolve conflicts.
- Pay according to a pre-determined pay schedule, including incentives and disincentives.
- Monitor, measure, and provide feedback into the performance models.

### *Summary*

Since the formation of the Transportation Research Board's Task Force to evaluate innovative contracting practices in the United States and abroad in 1988, research has been conducted on warranty contracting. The literature reviewed was divided into four categories: past research, key state experiences, other warranty related activities, and current research on warranty contracting.

SHAs develop and implement warranty provisions because of the perceived advantages warranty contracting provides for the agency. Almost all of the literature related to warranties identifies the advantages of warranty contracting. These advantages are listed below:

- compatible with low-bid system,
- reduce manpower requirements for inspection and testing of construction,

- shift risk from agency to contractor,
- encourage contractor innovation,
- reduce project life-cycle costs, and
- improve quality of materials and construction workmanship.

The literature reviewed indicates that the big issues related to warranty contracting are an increase in bid price, the effect on life-cycle costs, anticipated improvements in quality, risks and difficulties in bonding, involvement and cooperation of the industry (contracting and surety), and warranty project selection criteria.

The documented experience of the SHAs that have implemented warranty contracting and analyzed the impacts of this implementation indicates that most of the objectives of warranty contracting have been accomplished in these states. Wisconsin DOT reports that warranted projects performed better than non-warranted projects. Furthermore, it is indicated that the warranted projects may cost less than non-warranted projects from life-cycle cost analysis perspective, but at this time results presented by the SHAs are not conclusive. Colorado DOT reported that the additional cost associated with using warranties was negligible. Indiana DOT indicated that warranted pavements provided a lower and more consistent IRI and resulted in less rutting than the non-warranted pavements. Although the initial capital costs for warranted projects were approximately 10 percent higher than non-warranted projects, it is estimated that the use of warranties as a pavement preservation strategy could produce cost savings of 27 percent. Ohio DOT observed an increase in bid prices for warranted projects. Warranted asphalt pavement bid prices were 8.5 percent higher than similar non-warranted asphalt pavements and warranted concrete pavement bid prices were 11 percent higher than similar non-warranted concrete pavements.

The analysis provided by each SHA was mostly based on the pilot warranty projects that were conducted during the implementation of warranty provisions. Furthermore, the analysis provided by the SHAs relies on a limited number of projects. Until more warranty projects are analyzed it would be difficult to conclude that warranty projects provide a better quality product while reducing the life-cycle cost of these projects. Still, the early results provided by the SHAs are encouraging for the future of warranty contracting in the United States.



## SURVEY QUESTIONNAIRE

Electronic-mail (e-mail) questionnaires were used to collect data from SHAs that were identified as using warranty contracting specifications for hot-mix asphalt concrete, surface treatments, and microsurfacing. The states selected are those included in the FHWA briefing document, *Use of Warranties in Federal-Aid Highway Program* (2003 edition) (4). The basic goal of the questionnaire was to focus on other state agencies' recent experience with warranties, and to gather sample warranty specifications in the three primary areas of hot-mix asphalt concrete, surface treatments, and microsurfacing.

A structured e-mail questionnaire was developed (see Appendix B). Major question areas included:

- number of warranted hot-mix asphalt concrete, surface treatments, and microsurfacing projects completed,
- common criteria involved in warranty projects,
- length of warranties,
- warranty bonds,
- conflict resolution team,
- performance indicators and threshold values,
- maintenance responsibility,
- major barriers to implement warranties, and
- future use of warranties.

Project advisors and industry practitioners reviewed the questionnaire in detail. Both parties were satisfied with the questions asked. They provided suggestions that were incorporated into the final version of the questionnaire. A cover letter (see Appendix B) was prepared to transmit the questionnaire to an SHA after the SHA agreed to participate in the research project. In the cover letter the SHA was given the option of conducting the survey via telephone, e-mail, fax, or mail. All but one of the respondent SHAs opted for the e-mail option. One SHA preferred to conduct the survey via fax.

The researchers targeted 19 SHA for possible participation. Table 4 lists the 19 SHAs by the end product warranted.

**Table 4. State Highway Agencies Targeted for Survey.**

<b>State</b>	<b>Hot-Mix Asphalt Concrete</b>	<b>Surface Treatment</b>	<b>Microsurfacing</b>
California	X	X	
Colorado	X		X
Florida	X		
Illinois	X		
Indiana	X		
Kentucky	X		
Louisiana	X		
Michigan	X	X	X
Minnesota	X		X
Mississippi	X		
Nevada			X
New Mexico	X		
North Carolina		X	
Ohio	X	X	X
Oregon	X		
South Carolina	X		
Utah	X		
Washington	X		
Wisconsin	X		

*Results and Analysis*

This part of the report describes the current use of warranted hot-mix asphalt concrete, surface treatments, and microsurfacing in the U.S., results of the survey conducted, and provides an analysis of warranty specifications collected.

Of the 19 candidate states, 17 were contacted for warranted hot-mix asphalt concrete (90 percent), four states were contacted for warranted surface treatments (21 percent), and five states were contacted for warranted microsurfacing (26 percent). Of the 17 states contacted for warranted hot-mix asphalt concrete, 12 of them responded to the questionnaire (71 percent). Of the four states contacted for warranted surface treatments, two of them responded to the questionnaire (50 percent). Of the five states contacted for warranted microsurfacing, four of them responded to the questionnaire (80 percent). Colorado DOT indicated that they were not using warranted microsurfacing at this time.

Table 5 lists the number of warranty projects completed in each state.

**Table 5. Number of Warranted Projects.**

States	Asphalt Concrete	Surface Treatment	Microsurfacing
California	6	1	1
Colorado	9		
Illinois	7		
Kentucky	1		
Louisiana	2		
Michigan	131	A total of 473 surface treatment + microsurfacing	
Minnesota	4		10
Mississippi	6		
Oregon	3		
South Carolina	6		
Washington	1		
Wisconsin	44		

Of the 12 states that responded to the questionnaire, four of them (33 percent) responded to the question involving the common criteria for the warranted projects. Table 6 illustrates the SHAs and their respective answers to this question.

**Table 6. Common Criteria Involved in Warranty Projects.**

State	Common Criteria
Colorado	The structural design life is at least 10 years, the designer adequately addresses existing conditions, and the engineer and contractors perform a pre-advertisement constructability review.
Illinois	Uncomplicated projects.
Mississippi	Either new construction or overlays with five or more inches of asphalt.
Oregon	Basically look for projects where the pavement has minimal structural problems so that a pavement failure during the warranty period can be attributed to poor material selection or substandard workmanship instead of structural design.

Of the 12 states that responded to the questionnaire, five of them (42 percent) indicated what they thought were the major barriers to implement warranties. Table 7 illustrates the major barriers to implement warranties according to the respondent SHAs.

**Table 7. Major Barriers to Implement Warranties.**

<b>State</b>	<b>Major Barriers</b>
Colorado	Starting the process was difficult.
Illinois	Warranty period too short to be of real use.
Kentucky	Contractor acceptance, bonding.
Mississippi	The term warranty was a major barrier due to third-party liability laws. Bonding issues, contractors fear of the unknown.
Oregon	Bonding capacity, particularly for smaller companies, industry fears, increased initial costs, agency reluctance to “give up control” of specifications.

Of the 12 states that responded to the questionnaire, three of them (25 percent) indicated that their respective SHA intends to use warranties on other products in the future. Three of these five SHAs (60 percent) SHAs indicated that they plan to use warranties for other products in the future. [Table 8](#) shows potential products that can be warranted in the future.

**Table 8. Use of Warranties for Other End Products in the Future.**

<b>State</b>	<b>Use of Warranties</b>
Colorado	Epoxy pavement-marking material to be piloted on two small projects in 2004 construction season.
Illinois	Currently working on warranties for thermo-plastic pavement markings and some coating items.
Mississippi	Two projects being developed as of now.

#### *Analysis of Warranty Specifications*

Sample warranty specifications were received from 11 of the 12 (92 percent) SHAs that responded to the questionnaire. South Carolina DOT (SCDOT) indicated that SCDOT does not have any projects where the DOT specified the warranty provisions in detail. Their general approach is to ask the design-build contractor to state in the proposal what warranty the contractor is providing. The quality of the warranty is then considered in the scoring of proposals, although it may not have a specific point value. In addition to these 11 SHAs, warranty specifications were obtained from Florida and Ohio. With the addition of these two SHAs, 13 warranty specifications out of 19 candidate states (68 percent) were obtained.

A framework was created for comparing these specifications. The framework includes the following key parameters:

- warranty period,
- bonding requirements,
- maintenance,

- conflict resolution team, and
- warranty indicators and threshold values.

The information obtained related to the key parameters listed above was used while developing warranty specifications for TxDOT. The researchers and TxDOT used this information as a point of reference. The length of the warranty period used by each SHA for HMAC, surface treatments, and microsurfacing was considered when determining the warranty period for these end products in TxDOT warranty specifications. Bonding requirements and the penal value of the warranty bonds employed by other SHAs were analyzed before determining the bonding requirements and the penal value of the warranty bond for the TxDOT warranty specifications. Similarly, data obtained for maintenance requirements, conflict resolution team, and warranty indicators and threshold values were reviewed before determining TxDOT warranty requirements.

Table 9 illustrates the warranty period specified by each SHA in years for hot-mix asphalt concrete, surface treatments, and microsurfacing. The average warranty length for hot-mix asphalt concrete is five years, and two years for surface treatments and microsurfacing.

**Table 9. Warranty Period for Different Products (Years).**

States	Asphalt Concrete	Seal Coats	Microsurfacing
California	1	1	1
Colorado	3		
Florida	5		
Illinois	5		
Kentucky	10		
Louisiana	3		
Michigan	7	2	2
Minnesota	5		2
Mississippi	7		
Ohio	5	3	3
Oregon	3		
Washington	5		
Wisconsin	9		

Every state (except Florida) using hot-mix asphalt concrete, surface treatments, or microsurfacing warranties, requires a warranty bond on their warranty projects. Table 10 summarizes the approach each state used for determining the bonding requirements for different products. Florida DOT enforces the warranty by suspending, revoking, or denying the

contractor’s certificate of qualification until the remedial work is satisfactorily performed or full and complete payment for the remedial work is made to Florida DOT.

**Table 10. Summary of Bonding Requirements.**

<b>States</b>	<b>Products Warranted</b>	<b>Bonding Requirements</b>
Colorado	HMAC	Cost of 2 inches of removal and overlay
Florida	HMAC	Warranty bond not required
Illinois	HMAC	50% of contract amount
Kentucky	HMAC	Specified amount
Louisiana	HMAC	50% of full contract amount
Michigan	HMAC	\$1,000,000 or 5% of full contract amount (whichever is less)
	Surface treatment	100% of warranted work for surface treatment
	Microsurfacing	100% of warranted work for microsurfacing
Minnesota	HMAC	20% of the total bid amount for the warranted bituminous pavement
	Microsurfacing	100% of the total bid amount for warranted microsurfacing
Mississippi	HMAC	Specified amount
Ohio	HMAC	90% of the total bid amount for warranted asphalt concrete surface course
	Surface treatment	75% of the total bid amount for warranted surface treatment
	Microsurfacing	75% of the total bid amount for warranted microsurfacing
Oregon	HMAC	Specified amount
Washington	HMAC	Specified amount
Wisconsin	HMAC	Cost of 1.5-inch overlay or a specific amount

There were three basic methods to determine the amount of the warranty bond. The first method required the SHA to specify a certain percentage of the contract value. The Illinois, Louisiana, Michigan, Minnesota, and Ohio highway agencies used a percentage ranging from 5 to 100 percent. For example, Ohio DOT’s Long-Term HMAC Warranty Specification states different percentages of the contract amount for warranty bonds depending on the thickness of the HMAC pavement as shown below:

<u>HMAC Pavement Thickness</u>	<u>Percent</u>
2.0 inches (50 mm) or less	90
2.1 to 4.0 inches (51 to 100 mm)	60
4.1 inches (101 mm) or more	30

Colorado and Wisconsin determined the amount of the warranty bond by estimating the maximum cost incurred to replace or rehabilitate the warranted project. The Colorado DOT estimates the cost of the warranty bond to be equal to a 2-inch removal and overlay for the whole project. The Wisconsin DOT estimates the penal value of the warranty bond to be equal to the cost of a 1.5-inch overlay for the whole project.

The third method used to determine the bond amount was to somewhat arbitrarily select an amount considered appropriate for the project. The amount specified depends on the warranted product and the characteristics of the project.

Several states, such as Mississippi, Ohio, and Wisconsin require the bonding company to have an A.M. Best rating of “A-” or better. They also require that if the bonding company falls below the “A-” rating during the warranty period, the contractor is required to provide a new warranty bond with a company with an “A-” or better rating.

There are differences in the way the contractor must satisfy the bond requirement. SHAs can require a single-term bond, allow a combination of single-year bonds, or a contract bond and a warranty bond for the warranty period. Colorado, Kentucky, Michigan, Mississippi, and Washington specifically state that the bond must be a single-term bond for the duration of the warranty. Wisconsin states in their warranty specification that the bonds can be either a single-term or two-year renewable bond. Typically, the SHA requires that a contractor provide proof of a warranty bond or combination of bonds for the entire warranty period.

Table 11 shows the majority of the specifications obtained indicated that the contractor is responsible for maintenance during the warranty period. Some SHAs also reserve the right to perform routine maintenance during the warranty period. This routine maintenance would not relieve the contractor from its obligation under the warranty requirements. Some SHAs reserve the right to perform emergency maintenance, where conditions require immediate attention for the safety of the public.

**Table 11. Maintenance Responsibility.**

States	Maintenance Responsibility	
	DOT	Contractor
California		X
Colorado		X
Illinois		X
Kentucky		X
Louisiana		X
Michigan	X	
Minnesota	X	
Mississippi		X
Ohio		X
Oregon		X
Washington	X	
Wisconsin		X

All of the states that sent specifications required a conflict resolution team on their hot-mix asphalt concrete, surface treatment, or microsurfacing warranty projects. Functionally there were two different types of CRTs. In the first type, the CRT is responsible for providing a decision on disputes between the department and the contractor regarding application or fulfillment of the warranty requirements. In the second type, the CRT basically functions as a warranty evaluation team, and is responsible for administering the warranty. [Table 12](#) categorizes the CRTs according to their function.

**Table 12. Conflict Resolution Team Functions.**

Conflict Resolution Team Function	States Using CRT Function
CRT is responsible for providing a decision on disputes between the department and the contractor regarding application or fulfillment of the warranty requirements	FL, IL, LA, MI, MN, MS, OR, WA, WI
CRT basically functions as a warranty evaluation team, and is responsible for administering the warranty	CO, KY, OH

Typically the CRTs consisted of two department representatives, two contractor representatives, and one third-party representative who is mutually agreed upon by both the SHA



and the contractor. The SHA and the contractor equally share the cost of the third-party representative. [Table 13](#) compares how some of the conflict resolution teams are organized.

**Table 13. Conflict Resolution Team Types**

<b>Conflict Resolution Team Types</b>	<b>States Using CRT Type</b>
A conflict resolution team is established for each contract consisting of a contractor-appointed representative, a department-appointed representative, and one third-party representative who is mutually agreed upon, and the cost of whom is shared equally by the department and contractor.	IL, MN
A conflict resolution team is established for each contract consisting of two contractor representatives, two department representatives, and one third-party representative who is mutually agreed upon and the cost of whom is shared equally by the department and contractor.	LA, FL, MI, MS, OR, WI
The Pavement Evaluation Team shall consist of three subject matter experts not affiliated with the project. Two of the three members shall be selected by the chief engineer and directly paid by the department. One member will represent the HMAC paving industry and the other will be a private consultant. The last and third member will be a CDOT staff person.	CO
The Joint Evaluation Review Team will evaluate the project for the purpose of administering the warranty. While it is intended that administration of the warranty will be by consensus of the Joint Evaluation Review Team, voting will be as defined in parentheses herein. The team will consist of the following; chief district engineer or designated representative (1 vote), the Project Development Team, consisting of the project manager, the Federal Highway Administration representative, the Kentucky Transportation Center (KTC) representative, and the specifications representative (combined, 1 vote), The Department’s Central Office Team, consisting of a Division of Construction representative, a Division of Materials representative, and a Division of Operations representative (combined, 1 vote), a contractor representative (1 vote), an asphalt or concrete paving industry representative or independent third party that is selected but not employed by the contractor (1 vote).	KY

There were differences in the make-up of CRT organizations as used by the SHAs. Some states had a three-member team while other states had a five-member team. Colorado’s specification was different, because CDOT opted for an impartial team evaluating the project. This difference was accomplished by appointing representatives from outside the contractor’s company. The CRT members must have at least 15 years of experience in one or a combination of the following disciplines:

- pavement management,
- asphalt pavement design,
- asphalt pavement construction,
- maintenance management, or

- asphalt pavement maintenance.

The department representative on the CRT was not directly involved with the project. While other specifications stated that the CRT members should be familiar and trained in determining causes of failure, no other specification required the kind of experience described for Colorado’s conflict resolution team members.

Tables 14, 16, and 18 identify the performance indicators used by different states for hot-mix asphalt concrete, surface treatments, and microsurfacing. The information summarized in Tables 15, 17, and 19 regarding HMAC, surface treatments, and microsurfacing performance indicators was obtained from a survey of SHAs that currently use warranty specifications. The goal of these tables is to show the range of threshold values that have been used for each of the listed performance indicators.

**Table 14. Hot-Mix Asphalt Concrete Performance Indicators.**

<b>Performance Indicator</b>	<b>State</b>
Transverse Cracking	CA, CO, FL, IL, KY, LA, MI, MN, MS, OH, OR, WA, WI
Rutting	CA, CO, FL, IL, KY, LA, MI, MN, MS, OH, OR, WA, WI
Longitudinal Cracking	CA, CO, FL, IL, KY, LA, MI, MN, MS, OR, WA, WI
Bleeding/Flushing	CA, CO, IL, KY, LA, MI, MN, MS, OH, OR, WI
Raveling	CA, CO, FL, IL, KY, LA, MI, MN, MS, OR, WI
Potholes	CA, CO, FL, IL, KY, LA, MN, MS, OR, WI
Alligator Cracking	CA, MI, MN, MS, OH, WA, WI
Block Cracking	CA, IL, KY, MI, MS, OH, WI
Surface Raveling	CA, LA, MN, MS, WI
Edge Cracking	LA, KY, MS, OH
Delamination	CA, CO, FL, MN
Ride Quality	FL, KY, MN, WA
Disintegrated Areas	CA, LA, OH

Every state uses transverse cracking and rutting as performance indicators. Ninety percent of the states used longitudinal cracking as a performance indicator. Eighty-five percent of the states used bleeding/flushing and raveling as performance indicators. Potholes, alligator cracking, block cracking, and surface raveling were the next highest used performance indicators.

**Table 15. Pavement Performance Indicators, Threshold Ranges, and Guide to Remedial Action for Hot-Mix Asphalt Concrete.**

Performance Indicator	Threshold Ranges			Guide To Remedial Action
	Minimum	Average	Maximum	
Rutting	0.25 inch	0.33 inch	0.39 inch	Mill surface with fine-toothed mill to remove ruts, overlay.
Block Cracking	1%	2.50%	4%	Remove and replace distressed layer(s). The removal area will be equal to 110% of the distressed surface.
Alligator Cracking		1%		Remove and replace distressed layer(s). The removal area will be equal to 150% of the distressed surface.
Longitudinal Cracking	2%	6.50%	10%	Rout and seal all cracks with rubberized crack filler or agreed upon equal.
Transverse Cracking	2 cracks	8 cracks	25 cracks	Rout and seal all cracks with a rubberized crack filler or approved equal.
Raveling	1%	4.50%	10%	Apply a one course surface treatment.
Bleeding/Flushing	1%	8.33%	20%	Remove and replace distressed surface mixture full depth.
Debonding	1%	2%	5%	Remove and replace distressed layer(s). The removal area will be equal to 150% of the distressed surface.
Ride Quality (IRI)		110 inch/mile		Level-up, overlay, milling or combinations thereof to correct inadequacies.
Popouts		29/sq yd		Remove and replace distressed layer(s). The removal area will be equal to 100% of the distressed surface.

For block cracking, alligator cracking, raveling, bleeding/flushing, and debonding, threshold ranges are given in percentage of area distressed in an evaluated pavement segment. The evaluated pavement segment is 0.1-mile long. Only one state uses alligator cracking as a performance indicator, and only two states use block cracking as a performance indicator.

For longitudinal cracking, threshold ranges are given in percentage of the evaluated pavement segment length.

For transverse cracking, threshold ranges are given in number of transverse cracks observed in an evaluated pavement segment.

Ride quality and popouts are each used by only one state as performance indicators. Popouts are defined as small pieces of pavement or aggregate broken loose from the surface greater than 3/8 inch in diameter.

**Table 16. Surface Treatment Performance Indicators.**

<b>Performance Indicator</b>	<b>State</b>
Bleeding/Flushing	CA, MI, OH
Loss of Cover Aggregate	CA, MI, OH
Surface Patterns	OH
Surface Cracking	MI

For surface treatments bleeding/flushing and loss of cover aggregate are used by every state as performance indicators. Surface patterns and surface cracking are used by 30 percent of the states.

**Table 17. Pavement Performance Indicators, Threshold Ranges, and Guide to Remedial Action for Surface Treatments.**

<b>Performance Indicator</b>	<b>Threshold Ranges</b>			<b>Guide To Remedial Action</b>
	<b>Minimum</b>	<b>Average</b>	<b>Maximum</b>	
Aggregate Loss	10%	25%	40%	Resurface
Surface Pattern		40%		Resurface
Bleeding/Flushing	5%	23%	40%	Resurface
Surface Cracking		25 Cracks		Resurface

Threshold ranges for surface treatments performance indicators are given in percentage of area distressed in an evaluated pavement segment. The evaluated pavement segment is 0.1 mile long.

Aggregate loss is defined as areas of dislodged and removed aggregate from the chip seal surface caused by the mechanical action of vehicles.

Surface patterns and surface cracking are each used by only one state as a performance indicator. Surface patterns are described as light and heavy lines over the pavement surface. Surface cracking is measured as the total number of defective cracks within a segment. Transverse cracks and longitudinal cracks are converted to defective cracks by the following:

- one transverse crack 6 feet or greater in length = one defective crack,

- five transverse cracks between 6 inches and 6 feet = one defective crack, and
- a total of 125 feet of longitudinal crack(s) = one defective crack.

**Table 18. Microsurfacing Performance Indicators.**

<b>Performance Indicator</b>	<b>State</b>
Delamination	CA, MN, MI
Bleeding/Flushing	OH, CA, MN, MI
Weathering	MN
Raveling	OH, CA, MN, MI
Rutting	OH, CA, MN, MI
Surface Loss	OH

Every state uses raveling, rutting, and bleeding/flushing as performance indicators for microsurfacing. Delamination is used by 75 percent of the states as performance indicators. Finally, weathering and surface loss are used by only 25 percent of the states as performance indicators for microsurfacing.

**Table 19. Pavement Performance Indicators, Threshold Ranges, and Guide to Remedial Action for Microsurfacing.**

<b>Performance Indicator</b>	<b>Threshold Ranges</b>			<b>Guide To Remedial Action</b>
	<b>Minimum</b>	<b>Average</b>	<b>Maximum</b>	
Rutting	0.24 inch	0.25 inch	0.26 inch	Reapply Microsurfacing
Raveling	0.10%	4.50%	8%	Reapply Microsurfacing
Delamination	0.10%	2.30%	5%	Reapply Microsurfacing
Skid Resistance		25 cracks		Reapply Microsurfacing
Bleeding/Flushing	5%	5%	5%	Reapply Microsurfacing

Threshold Ranges for microsurfacing performance indicators are given in percentage of area distressed in an evaluated pavement segment. The evaluated pavement segment is 0.1 mile long.

For raveling, delamination, and bleeding/flushing threshold ranges are given in percentage of area distressed in an evaluated pavement segment. The evaluated pavement segment is 0.1 mile long.

## City Questionnaire

The goal of the city questionnaire was to document the current state of practice of warranty contracting in Texas municipalities. The cities that were contacted were Austin, Houston, El Paso, San Antonio, and Dallas.

Out of these five cities, responses from four cities, namely, Austin, El Paso, Houston, and San Antonio were received. [Table 20](#) summarizes the responses from these four cities.

**Table 20. Texas City Questionnaire Results.**

<b>Issue</b>	<b>Austin</b>	<b>El Paso</b>	<b>Houston</b>	<b>San Antonio</b>
<b>Acceptability at end of one-year warranty</b>	Walk through for visual inspection.	Walk through for visual inspection.	Walk through for visual inspection.	Walk through for visual inspection.
<b>Typical performance indicators</b>	Lab test results of cores, apparent defects.	Obvious failure as reflected by rutting, cracking, bleeding, concrete structure failure.	Obvious failure as reflected by rutting, cracking, bleeding, concrete structure failure.	No written policy on this matter.
<b>Threshold values</b>	Crack sealing required in case of minor cracks, but when cracks are more than a lane wide, replacement is required.	When end use of the facility is impacted directly as a result of failure.	No threshold values.	No written policy on this matter.
<b>Project Rejection</b>	Projects are not rejected. A punch-list of items is developed for the contractor to correct defects.	Projects are not rejected typically. Any defective elements are corrected by the contractor at no additional cost.	No projects have been rejected.	Projects are not rejected typically. Any defective elements are corrected by the contractor at no additional cost.
<b>Warranties longer than one year?</b>	No	One year is the norm.	No. Just one case.	No
<b>Requirement of warranty bond</b>	Bond required, but it is probably a performance bond.	No	Yes	Yes
<b>Liability during the period of warranty</b>	Mostly the City	The City	The City	Mostly the City

The City of Houston employs a one-year maintenance bond on their warranty projects. The contract states that “Contractor shall provide Bond on standard City One-year Maintenance

Bond form, providing for Contractor's correction, replacement, or restoration of any portion of the Work which is found to be not in compliance with requirements of the Contract during one-year correction period required in Section 12.2.”

In summary, the responding cities have more or less the same policies regarding warranties. The cities rely on visual surveys of the roadway to make sure the warranted section performs according to the specifications. There are no set specific performance indicators or threshold values. Liability and bonding are not adequately defined in the cities' specifications or in the survey responses.





## **CHAPTER 3**

### **TXDOT WARRANTY SPECIFICATIONS**

Chapter 3 focuses on the development of warranty specifications for TxDOT Project 0-4498 under Task 2, Program Planning. The methodology for developing the warranty specifications and the developed warranty specifications are discussed.

This research project overlapped with TxDOT's effort to develop a newer set of Standard Specifications, which were later named TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges (2004). According to the original research plan pilot warranty projects were going to be let out for bidding using the 1993 Standard Specifications because the newer Standard Specifications were not yet approved by TxDOT. Consequently, a set of draft warranty specifications was developed for use with the 1993 Standard Specifications. TxDOT published these draft warranty specifications as TxDOT Project 0-4498, Products 1, 2, and 3 (15).

As the research project progressed it became obvious that the warranty specifications developed for use with the 1993 Standard Specifications were not going to be reviewed and approved by TxDOT in time to let out pilot warranty projects before the 2004 Standard Specifications would be in effect. As a result, a newer set of warranty specifications was developed for use with the 2004 Standard Specifications. TxDOT published the newer set of warranty specifications in TxDOT Project 0-4498, Product 4, Draft Warranty Implementation Plan (16). Appendix A presents these specifications. Both sets of warranty specifications were developed using the same methodology and they both have the same specification structure.

#### **METHODOLOGY**

This sub-task was one of the most important as the warranty specification conveys the intent and requirements to the contractor for the warranted product. The development of the warranty specifications was based on the *NCHRP Report 451* research study and the subsequent work performed for the AASHTO Highway Subcommittee on Construction under NCHRP Project 20-7, Task 109 (6).

The model warranty specification previously developed under NCHRP Project 20-7, Task 109 was used as a starting point for developing TxDOT warranty specifications. HMAC and surface treatments warranty specifications were based on the generic warranty specification

framework from Task 109 and modified to accommodate TxDOT requirements. The microsurfacing warranty specification was based on Special Specification 3278, Micro-Surfacing Warranty, which TxDOT had approved for use with TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges (1993). During the development of warranty specifications TxDOT's input was received by conducting several meetings and telephone conference calls with the TxDOT Project Advisory Team. Since every critical decision regarding the warranty specifications was made by the Project Advisory Team, the final warranty specifications developed reflect TxDOT's perspective on warranties.

## **DEVELOPMENT OF DRAFT WARRANTY SPECIFICATIONS**

As stated earlier the research team used the model warranty specification previously developed during NCHRP Project 20-7, Task 109, as a starting point for developing warranty specifications for TxDOT. Warranty specifications for hot-mix asphalt concrete, surface treatments, and microsurfacing obtained from other SHAs during review of the state of the practice in warranties were used as well to guide the development of the TxDOT warranty specifications. The sub-tasks performed during the development of the warranty specifications consisted of the following:

- Review literature related to warranties.
- Review warranty specifications obtained from other state DOTs.
- Identify elements of the warranty specifications.
- TxDOT provides input on elements of warranty specifications.
- Determine general warranty specification structure.
- Develop draft warranty specifications.
- TxDOT reviews draft warranty specifications.
- Modify draft warranty specifications based on TxDOT review.
- Conduct industry interaction forum and obtain industry's input on the draft warranty specifications.
- Revise draft warranty specifications according to the industry input.
- TxDOT reviews draft warranty specifications.
- Modify draft warranty specifications based on TxDOT review.

Earlier in the project the researchers proposed two different approaches for developing the warranty specifications. The first approach involved developing a generic warranty technical provision that would cover items such as:

- warranty bond,
- warranty provisions,
- emergency work,
- exceptions, and
- conflict resolution team.

This approach would also involve developing special warranty provisions for individual products. The special warranty provisions would provide guidance on:

- materials,
- construction,
- maintenance requirements,
- warranty indicators (performance indicators) and threshold values,
- remedial work,
- measurement, and
- payment.

The generic warranty technical provision would be applicable for different end products.

The second approach involved developing a comprehensive warranty specification for each end product. This kind of specification structure would combine the two technical provisions mentioned in the first approach to form a single warranty specification.

TxDOT decided to have the researchers pursue the first approach. The research team believes the first approach provided a more concise and easy to follow specification structure while ensuring uniform warranty provisions for each end product.

The researchers consulted with TxDOT to determine which standard TxDOT specifications would serve as a basis for developing the warranty specifications. TxDOT decided that Microsurfacing Item 350 — Standard Specifications 2004, Surface Treatments Item 316 — Standard Specifications 2004 would serve as the basis for developing the warranty technical provision for these two end products. Dense-graded hot-mix asphalt (QC/QA), Item 341, Standard Specifications 2004, would serve as the basis for the asphalt warranty technical provision.

The warranty specifications developed for TxDOT Project 0-4498 follow TxDOT format. These specifications hold the contractor responsible for correcting defects in work elements during the warranty period resulting from defects in materials and/or workmanship. For HMAC, surface treatments, and microsurfacing, the contractor is responsible for defects associated with the surface layer only (i.e., the warranted product).

## **WARRANTY SPECIFICATION STRUCTURE**

The following generic warranty specifications/provisions were developed based on the 2004 TxDOT Standard Specifications and following TxDOT procedures/formats:

- Special Specification, Item 5XXX Warranted Construction;
- Special Provision to Special Specification, Item 5XXX Warranted Construction;
- Special Provision to Item 3, Award and Execution of Contract;
- Special Provision to Item 5, Control of the Work;
- Special Provision to Item 7, Legal Relations and Responsibilities;
- Special Provision to Item 341, Dense-Graded Hot-Mix Asphalt (QC/QA);
- Special Provision to Item 316, Surface Treatments; and
- Special Provision to Item 350, Microsurfacing.

The Special Specification, Item 5XXX Warranted Construction is a general specification that covers topics such as:

- description,
- warranty bond,
- warranty period,
- warranty requirements,
- warranty evaluation,
- remedial action(s),
- maintenance,
- emergency work,
- exceptions,
- conflict resolution team,

- applicability of Standard Specification Items 1 through 9,
- traffic control, and
- payment.

This special specification is applicable for any warranted construction end product, including hot-mix asphalt concrete, surface treatments, and microsurfacing.

The Special Provision to Special Specification, Item 5XXX, Warranted Construction, contains project specific information including the penal value of the warranty bond, the duration of the warranty period, and the contractor maintenance requirement.

Special Provisions for Item 3, Award and Execution of Contract, Item 5, Control of the Work, and Item 7, Legal Relations and Responsibilities introduce changes that enable the implementation of warranties.

Special Provisions for Item 341, Dense-Graded Hot-Mix Asphalt (QC/QA), Item 316, Surface Treatments, and Item 350, Microsurfacing, were developed to appropriately modify TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges (2004). Special Provision for Item 341 covers items such as payment, warranty requirements, remedial action(s), and pavement markings. The most important information in this special provision is the pavement warranty indicators, threshold values, and possible remedial actions that are presented under warranty requirements. Special provisions for Items 316, Surface Treatments, and 350, Microsurfacing, also have similar sections.

After the draft warranty specifications were developed by the researchers and reviewed by TxDOT, an industry interaction forum was conducted to permit industry involvement during warranty specification development.

## **INDUSTRY INTERACTION FORUM**

On August 11, 2003, an industry interaction forum was held at the Associated General Contractors headquarters in Austin, Texas. The intent of the forum was to share information, discuss issues and concerns, obtain input from different industry participants, and establish a cooperative partnership with the industry for warranty contracting in Texas. The participants included representatives from TxDOT, TTI, general contractors, and a surety firm.

The forum was conducted in two sessions. The first session focused on background information and processes used to develop draft specifications. The second session focused on

industry perspectives on warranties and provided an opportunity to discuss in more detail the draft warranty specifications developed.

### **Background Information Presented**

The goal of the first session of the forum was to provide a brief overview of warranty contracting in the United States and present specific information related to the TxDOT draft warranty specifications developed. The research team conducted four presentations:

- Background and History of Warranties in US,
- Wisconsin Asphalt Pavement Warranties,
- Michigan Warranty Symposium, and
- Basic Structure of the Draft Warranty Specifications.

In summary, during the first presentation, “Background and History of Warranties in US,” the research team indicated that FHWA Special Experimental Project 14 opened the door for warranty contracting in the U.S. Since then, use of warranties has continuously increased. Still, there are barriers to overcome, including:

- contractor acceptance,
- bonding issues,
- surety cooperation,
- lack of understanding,
- fear of risks, and
- potential of increased cost.

The goal of the second presentation, “Wisconsin Asphalt Pavement Warranties,” was to inform the forum participants about Wisconsin DOT’s experience with HMAC warranties. The presentation was comprised of four sections.

First, information was provided about the context in Wisconsin. Wisconsin is a small state with similar weather conditions all around. The HMAC industry is composed of Wisconsin-based family-owned businesses that are vertically integrated. Generally, there are no HMAC contractors from other states working in Wisconsin. There was a strong industry involvement during the implementation of warranties in Wisconsin because the HMAC industry viewed warranty contracting as a tool that would provide them with flexibility in design, so that

they could successfully compete with the Portland cement concrete industry. Furthermore, warranties were viewed as a contracting tool for certain types of construction projects.

Second, information about the history of warranties in Wisconsin was presented. Wisconsin adopted the “crawl, walk, and run” attitude towards warranties. In 1994 the Wisconsin DOT, the FHWA, and the Wisconsin Asphalt Paving Association (WAPA) decided to pursue an innovative contracting method, and as a result developed warranty specifications. These specifications were used to conduct three pilot projects in three different locations. In the following years Wisconsin DOT constructed at least three warranty projects every year. In 2002, they constructed 11 projects with warranties. Currently, 3 to 4 percent of the total HMAC projects in Wisconsin are warranty-based. In eight years, they have had 45 successful warranty projects, adding up to 330 centerline miles. It was emphasized that collaboration, cooperation, and communication were critical success factors.

Third, information about benefits gained by using warranties in Wisconsin was provided. The benefits included:

- increased quality,
- reduced life-cycle cost ,
- reduced Wisconsin DOT delivery costs,
- reduced maintenance expenditures,
- increased contractor innovation in researching and applying new technology, and
- manufacturers assuming responsibility for their products.

Fourth, the main challenges Wisconsin DOT faced while implementing warranties were discussed. The challenges included change in business practice, shift of responsibilities to contractor, and surety bonding.

The industry representatives indicated their perspective of Wisconsin DOT’s experience with warranty contracting. According to the industry Wisconsin DOT had been interested in warranties for two main reasons: first, competition between the HMAC and PCC industries; and second, Wisconsin DOT had problems with their HMAC pavements.

The researchers indicated that although Wisconsin DOT had problems with HMAC in the last decade, they had been fixed before the warranties were implemented. Similar to TxDOT, Wisconsin DOT evolved in improving its product by implementing quality control requirements.

During the third presentation, “Michigan Warranty Symposium,” the researchers summarized the conclusions drawn from a forum conducted by Michigan DOT on quality and warranties. The SHAs that attended the symposium indicated that pavement warranties offer an alternative way to ensure performance, increase pavement quality, and reduce life-cycle cost of pavements. SHAs using warranties have also observed innovations on warranty projects. The industry representatives in the Michigan symposium indicated that the definitions of warranty indicators (performance indicators) and threshold values are paramount, risk allocation needs to be quantified and distributed rationally, and a close partnership is needed among the SHA, the contractors, FHWA, and the surety industry in order to successfully implement warranties.

During the fourth presentation, “Basic Structure of the Draft Warranty Specifications,” the researchers provided information about TxDOT draft warranty specifications. Specific information related to the elements of warranty specifications was presented.

Discussions about the details of the specifications started to take place during this presentation. The industry raised general questions regarding warranties as well as specific questions related to maintenance responsibilities, warranty indicators, and determination of the cause of specific distresses. The industry’s perspective on implementing warranties in Texas is captured in the [following section](#).

### **Industry Perspective**

The objective of the second session of the forum was to identify the industry perspective on warranties and obtain their input for the draft warranty specifications developed under TxDOT Project 0-4498. In the beginning of the forum, the industry presented AGC’s perspective on warranties in highway construction. Several documents opposing the use of warranty contracting in highway construction were provided by the industry. The documents provided are listed below:

- AGC White Paper on The Use of Alternate Contract Award Methods in Highway Construction [\(17\)](#),
- a letter from the National Association Surety Bond Producers [\(18\)](#),
- amendment to HR 2950 by Beilenson of California [\(19\)](#),
- AGC Paper “AGC strongly opposes the Beilenson Amendment on Warranties and Guaranties” [\(20\)](#),



- letter from the Surety Association of America (21),
- draft position of Carolinas AGC titled “Warranties in Highway Construction” (22),
- draft of ARTBA “Revised Policy Position on the Use of Warranties and Guarantees in the Transportation Construction Industry” (23).

In general, the industry representatives indicated that Texas pavements were already in good condition; therefore, there was no reason for TxDOT implementing warranties. Moreover, the industry described the existing TxDOT specifications as “tough” and, if these specifications were followed, there would not be any quality problems with pavements in Texas. In response to this statement TxDOT indicated that they agreed with the industry’s perspective on this issue. However, TxDOT further indicated that implementation of warranties would motivate the contractors to monitor their own work rather than TxDOT inspectors trying to ensure specification requirements are met.

The industry believed that warranties would limit the competition, eliminate small contractors, and increase cost. Furthermore, the industry indicated that they had no control over how their product was used, that is, traffic conditions changing, adverse climatic conditions, etc.; therefore, they could not guarantee the performance of their pavement. Another concern the industry raised was the affect of warranties on contractor liability. According to the industry, warranties could make the contractors liable for accidents occurring on the roadway during the warranty period.

A surety representative indicated that insurance companies would only bond a one-year warranty, if at all. According to the representative a five-year warranty was not really an option due to the uncertainties involved with pavement performance. The surety representative also indicated that warranties were the expected norm in other industries because manufacturers can provide warranties for as long as 20 years since the product they make is expected to last that long. Instead of using warranties, the surety representative suggested that TxDOT develop product specifications that would last as long as the presumed warranty period.

The surety representative indicated that using retainage instead of or with warranties would not really work. According to the representative holding retainage as a warranty bond would put contractors out of business since their survival depends on immediate cash instead of cash at the end of the warranty period.

The surety representative further indicated that medium- to small-size contractors would be hurt if warranties were implemented in Texas.

The industry believed that the premise of implementing warranties was to shift responsibility to the contractors. The industry also wanted to know if the failure rate of pavements was significant enough to substantiate the implementation of warranties. The contractors also asked why only HMAC was chosen as an end product to be warranted, as opposed to Portland cement concrete.

In summary, although the industry was not enthusiastic about the idea of implementing warranties in Texas, the interaction with the industry was very helpful. Many different issues were discussed. The most important issues raised by the industry during this forum were:

- rationale for the need of warranties,
- warranty bond,
- “control” of the work,
- use of retainage to secure the warranty,
- small contractors,
- why no Portland cement concrete warranty,
- applicability of warranty-based specifications for seal coats, and
- liability.

### **Rationale for the Need of Warranties**

One of the questions that the industry raised during the forum was “What is the rationale for the need of warranties in Texas?” The industry believed that most of the roads in Texas were in good condition, which shows that existing TxDOT specifications are successful; therefore, there is no need to implement warranties in Texas.

The rationale for the need of warranties in the highway construction industry can be summarized as follows. A traditional highway construction contracting practice specifies exactly what is built, how it is built, what materials are used, and how traffic is maintained during construction. This type of a contracting method is beneficial for the construction contractors for it minimizes the risk that they bear by building a public project. On the other hand, from the state highway agencies’ point of view, this method causes the projects to be more costly to

administer in terms of state highway agency human resources due to the inspection of construction by the SHA.

In 1990, FHWA began to encourage states to implement new contract methods for improving the efficiency of delivering transportation projects through the Special Experimental Project-14 (SEP-14) program with the objective of evaluating project-specific innovative practices that have the potential to reduce the life-cycle cost of facilities while maintaining product quality (3).

Warranty contracting was one of the recommended contracting methods in SEP-14 in 1990. Warranty specifications promote the optimization of design, construction, and maintenance. The prime reasoning behind this statement is: the specifications encourage the contractor to decide the optimal mix of labor, machinery, structure, and materials necessary to meet the specifications, for the reason that the contractor is made responsible for future maintenance and rehabilitation costs through a warranty. A warranty is not a cost of covering risk, but is a mechanism that utilizes a better allocation of resources at initial construction in order to minimize the resources that would otherwise be spent on maintenance during the life of the road. Similar to traditional specifications, warranty specifications are compatible with the low-bid system (24).

According to the state agencies currently using warranties, the most important reasons for implementing warranties include:

- reducing agency personnel requirements on projects,
- reducing delivery and total construction life cycle costs,
- increasing quality,
- keeping up with changing technology,
- encouraging contractor innovation, and
- finding materials that provide the longest life (3).

In August 2001, the Texas Transportation Commission set a statewide goal to have 90 percent of Texas pavements in “good” or better condition within the next ten years. “Good or better condition” was defined as a Pavement Management Information System (PMIS) Condition Score greater than or equal to 70.

According to TxDOT’s 2003 Annual PMIS Report, 14 percent of asphalt concrete, 20 percent of continuously reinforced concrete, and 41 percent of jointed concrete pavements in

Texas are not in good condition. Another source for the condition of Texas pavements is the ASCE's 2003 Progress Report for America's Infrastructure (25). According to the American Society of Civil Engineers (ASCE), as of July 2003, 29 percent of major roads in Texas were in poor to mediocre condition. FHWA ranks "poor" roads as those in need of immediate improvement. "Mediocre" roads are those that need improvement in the near future to preserve usability.

In summary, at least 14 percent of asphalt concrete pavements in Texas are not in good condition, which means there is room for improvement. Experience and literature indicate that warranty requirements encourage contractors to construct higher quality pavements through innovation and increased motivation, while reducing highway agency personnel requirements.

### **Control of the Work**

During the industry forum, questions were raised regarding the control of the work, that is, what flexibility the warranty-based specifications can provide the contractor to select designs, materials, equipment, methods, etc.

The warranty specification requirements are based on extensive experience, industry standards, and research results – all directed to providing a quality product that adequately performs during the design life of the product. If the warranty period would be set at least equal to the design life of the product, it would be possible to provide the contractor the maximum flexibility to construct the product without detailed specification requirements.

However, the normal warranty period is less than, and usually is only a fraction of, the design life. For example, the design life of an HMAC pavement is about 10 to 12 years, whereas the warranty period may only be 1 to 5 years. Accordingly, certain specification requirements are considered necessary to improve the probability of long life of the product, while the warranty addresses the product condition for only the warranty period.

The warranty specifications should be closely reviewed and appropriately adjusted to provide maximum flexibility for the contractor to select designs, material, equipment, and methods, while maintaining consistency with the post-warranty period objectives.

For example, the contractor should be permitted to develop a mixture design for HMAC. However, the design should be compatible with the specification parameters that have been established considering the long-term life of the HMAC.

It was recommended by the researchers that TxDOT review the specifications for any warranted products and remove any contractor requirements that do not address the longer-term performance of the product.

### **Use of Retainage to Secure the Warranty**

When the warranty specifications were being developed, TxDOT requested that the researchers include language in the specifications that would provide the option for the contractors to either obtain a warranty bond or let TxDOT withhold retainage for securing the warranty. The set of draft warranty specifications presented at the forum included an optional provision for withholding the retainage or a portion thereof for the warranty period. During the forum industry representatives raised concerns regarding the use of retainage as a method to secure the warranty.

TxDOT considered the retainage approach a desirable strategy for short term warranties and a good alternative to a warranty bond, especially for smaller contractors who may have difficulty obtaining a warranty bond. However, deferring the release of the retainage can severely impact a contractor's cash flow and reduce bidding capacity. This strategy was discussed more in detail with TxDOT and further investigated due to the concerns raised by the industry and ultimately was not included in the draft specifications.

### **Small Contractors**

According to the industry representatives, small construction firms would not have the financial support necessary to undertake highway construction projects that include warranty requirements. In addition, small contractors would not likely have the bonding capacity necessary to warrant projects for extended periods of time. A small construction company would not be able to remain solvent for long without the ability to bid and win new projects. Therefore, small businesses would be driven away from highway projects that require warranties and cause the competition for obtaining highway construction projects to decrease. According to the industry this lack of competition would lead to higher costs.

In response to the industry's claims TxDOT reminded the industry that Texas cities were using warranties, and small contractors still do work with these cities; therefore, the utilization of warranties in the cities has not affected the small contractors. This fact suggests that TxDOT's warranties should not create a problem for the small contractors. However, it should be noted

that the warranties used by the cities are for short durations, typically one year, and do not require the contractors to obtain warranty bonds.

### **Why Not Portland Cement Concrete Warranty?**

During the forum the industry asked why only HMAC was chosen as an end product to warrant, as opposed to Portland cement concrete. Warranty specifications can be developed for Portland cement concrete pavements after the initial implementation of warranty contracting. The draft specifications that were developed during TxDOT Research Project 0-4498 are generic and other warranty specifications for different end products can easily be incorporated into the basic structure of these warranty specifications.

### **Applicability of Warranty-Based Specifications for Surface Treatments**

During the industry forum, questions were raised regarding the applicability of warranty-based specifications for surface treatments (seal coats).

The researchers believe that the quality of seal coats is normally manifested during the early life of the treatment. If a surface treatment does not indicate any distress — such as aggregate loss, irregular coverage, or flushing — during the first year (which would include a winter and summer period), it normally would be considered successful. The exception to this belief could be the skid qualities associated with the new surface.

Considering these factors, warranty specifications are considered applicable and appropriate for seal coats. A one- to two-year warranty period would be adequate.

The surface treatment warranty specifications were closely reviewed and appropriately adjusted to provide maximum flexibility for the contractor to select designs, material, equipment, methods, etc., while considering the longer-term requirements, including skid resistance. The specification includes the type, maximum size, and grading of aggregate to ensure the desired, longer-term skid characteristics.

### **Liability**

The industry expressed concern about the possibility of contractors being subject to litigation for accidents during the warranty period when they may not even be on site. On the other hand, in the traditional approach the contractors would no longer be liable for accidents after project completion. The contractors believe that they would be vulnerable to litigation

during the warranty period. One contractor stated that the only way to protect contractors against litigation is to change current laws through legislation.

The contractor is normally considered released from the construction contract (hence their liability is reduced) after final acceptance. It is possible that the contractor would only then be directly liable during any maintenance activities and any remedial action required during the warranty period.

In response to the industry concerns related to the liability issue TxDOT investigated the issue in more detail. The project director contacted Office of General Counsel (OGC) and provided them with the information about the liability issue. Their reaction was that a warranty on a project would not increase the possibility of the contractor being sued in case an accident occurred on that roadway during the warranty period. Furthermore, all of the other DOTs that have experience with warranties indicated that they never had any problems related to the liability issue.

## **ELEMENTS OF WARRANTY SPECIFICATIONS**

In order to determine what items were needed to be included in TxDOT warranty specifications, a review of what other agencies include in their warranty specifications was performed.

After reviewing the warranty specifications, it was determined that the key issues to consider while developing warranty specifications are still the issues that were identified by Anderson and Russell (3). [Table 3](#) lists these issues.

TxDOT's input on the identified elements of warranty specifications was obtained by conducting several meetings and telephone conferences. The main issues discussed are listed below:

- use of warranty bonds,
- length of warranty period,
- responsibility for maintenance during the warranty period,
- use of a conflict resolution team, and
- establishment of warranty indicators and threshold values.

## **Warranty Bonds and Length of Warranty**

A warranty bond is furnished as a guarantee for the protection of the claimants and the department for labor and materials and the faithful performance of all remedial action(s) required by the warranty requirements. A warranty period is a pre-specified time period in which the contractor is required to repair defects in the warranted product.

After analyzing other SHAs' warranty specifications for HMAC, surface treatments, and microsurfacing; and conducting brainstorming sessions with the researchers, TxDOT decided to establish warranty periods of three years for HMAC, one year for surface treatments and two years for microsurfacing, as the warranty period. Furthermore, it was determined that the penal value of the warranty bond would be determined after pilot project selection.

## **Maintenance Responsibility**

The review of the state of practice for warranty contracting indicated that the majority of the SHAs that use warranties require that the contractor be responsible for maintenance during the warranty period.

The Project Advisory Team expressed concern over the concept of holding the contractor responsible for maintenance. One contributing factor underlying this concern was the belief that contractors did not have sufficient experience maintaining pavements; therefore, the contractors may not be able to maintain the warranted pavement as well as TxDOT maintenance personnel. Using contractor-performed maintenance could cause a decrease in the quality of the end product. It was also indicated that contractor's personnel and equipment may not be in close proximity to the warranted project during the warranty period, which may delay the maintenance work necessary. However, the contractor could subcontract maintenance to a private maintenance firm so that the contractor's own personnel and equipment would not need to be mobilized.

A counter argument was presented. If TxDOT would be responsible for maintenance on a pavement that was warranted by a contractor and the pavement performs poorly, the contractor could potentially blame TxDOT for not performing maintenance on time and claim that the contractor would not be responsible for the poor performance of the pavement. Therefore, the contractor could not be held responsible for correcting problems as required under the warranty provisions.



TxDOT decided that the contractor would be responsible for maintenance during the warranty period. However, TxDOT would reserve the right to perform emergency maintenance and the contractor would still be held responsible for pavement performance under the warranty during the warranty period.

### **Conflict Resolution Team**

TxDOT decided to use a CRT to resolve any warranty-related disputes arising during the warranty period between the contractor and the department. The CRT would be invoked if the department and the contractor could not negotiate an acceptable remedial action plan or the contractor disputes the results of the product evaluation survey conducted by TxDOT. The contractor would have 10 calendar days to appeal a department decision, and if the conflict is not resolved within the next 10 calendar days, the dispute would be presented to the CRT. The CRT would be composed of two members from TxDOT, two members from the contractor organization, and one independent member mutually agreed by TxDOT and the contractor. If the CRT fails to resolve the problem, TxDOT's claims system would then be invoked.

The objective of the CRT is to resolve disputes between the contractor and the department efficiently and quickly.

### **Warranty Indicators and Threshold Values**

The researchers decided to use the term “warranty indicators” instead of “performance indicators” to emphasize the point that the specifications developed in this research project are materials and workmanship warranty specifications, and not performance specifications. Warranty indicators are used to evaluate warranted end products during the warranty period. A warranty indicator is either a distress or a condition of the end product that can be measured during the warranty period as part of the product evaluation. Rutting depth is an example of a warranty indicator for HMAC.

A threshold value is an established level for a warranty indicator that would trigger needed remedial action necessary to preserve the pavement and/or to achieve desirable performance levels.

Selecting the appropriate warranty indicators and determining reasonable threshold values for the warranty indicators proved to be a very challenging task for the research team, as was foreshadowed by previous research. In fact, Shober, Whited, and McMullen (1995) noted

that “by far the most difficult problem in the warranty development process was determining the appropriate performance expectations at five years for the three chosen factors (26).”

Furthermore, Anderson and Russell determined that “performance indicators are another area with potential future research. A more advanced method for determining what indicators truly reflect the quality of a constructed product should be determined. Along with that, a more precise method for determining the appropriate threshold levels for each of these performance indicators is needed (3).”

### *Characteristics of Warranty Indicators*

Warranty indicators can fit into one or more of the following three categories:

- Indicator of substandard materials and/or poor workmanship; examples include flushing/bleeding, low skid number, raveling, and rutting.
- Indicator of substandard performance; examples include poor ride quality, low skid number, rutting, and alligator cracking.
- Indicator of needed maintenance; examples include transverse and longitudinal cracking, and potholes.

It was further identified that warranty indicators and threshold values should be:

- Meaningful
  - The selected warranty indicator should be a gauge of materials and workmanship quality and/or a predictor of long-term performance and related to parameters that are controllable by the contractor. Example: If riding quality at the design life is “x,” the threshold value could be set at a value “y” that would represent the value at the end of the warranty period that would be predictive of achieving a value not exceeding “x” at design life.
  - Alternatively, the indicator and threshold value may be a gauge of needed maintenance. Example: Transverse cracking to the extent that crack sealing is necessary to minimize the intrusion of moisture into the underlying base material.

- Understandable
  - The selected warranty indicator and threshold value must be clearly described in terms understandable to both the industry and to TxDOT personnel. Extensive use of photographs is suggested.
- Measurable
  - The warranty indicator must be measurable. TxDOT Pavement Management or Long-Term Pavement Performance (LTPP) program measurement techniques could be employed (27). TxDOT’s proposed automated measurement techniques should also be considered. The measurements must be documented and should be repeatable.
- Fair (Equitable)
  - The warranty indicators and threshold values must be fair to the industry and to TxDOT.

*Initial Effort to Determine Threshold Values*

Originally the researchers made an effort to use historical pavement performance data for determining threshold values for selected warranty indicators for HMAC, microsurfacing, and surface treatments. Potential warranty indicators were identified by reviewing other SHAs’ warranty specifications for HMAC, microsurfacing, and surface treatments. Chapter 2 of this report presents more information about this survey. The review indicated that several of the warranty indicators that other SHAs used were actually being measured by TxDOT and recorded in the PMIS.

An evaluation of the PMIS was conducted to determine if the data stored in the system could be used for determining threshold values for selected warranty indicators.

Tables 21, 22, and 23 illustrate a comparison of the warranty indicators evaluated in TxDOT’s PMIS and the warranty indicators that are currently being used by other SHAs to evaluate warranted HMAC, surface treatments, and microsurfacing projects.

The first column in Table 21 is the list of warranty indicators that can be used to evaluate a warranted asphalt concrete project. These indicators were identified by surveying the states that have experience with warranty contracting. The second column specifies if the warranty indicator is used by any other SHA. The third column identifies the warranty indicators that are

measured in TxDOT's PMIS. The fourth column indicates if the historical PMIS data can be used to determine the threshold value for that specific warranty indicator.

**Table 21. Comparison of TxDOT PMIS and Asphalt Concrete Warranty Indicators (WIs) Used by Other States.**

HMAC Warranty Indicator	Used by Other SHAs	Measured in TxDOT PMIS	TxDOT PMIS Data Can be Used to Develop Threshold Values	TxDOT Pavement Distress Measurement Method Adequate for Warranty Projects
Transverse Cracking	√	√	√	√
Rutting	√	√	X	√
Longitudinal Cracking	√	√	√	√
Bleeding/Flushing	√	Optional	X	√
Raveling	√	Optional	X	√
Potholes	√	X	X	X
Alligator Cracking	√	√	√	√
Block Cracking	√	√	√	√
Surface Raveling	√	X	X	X
Edge Cracking	√	X	X	X
Delamination	√	X	X	X
Ride Quality	√	√	√	√
Disintegrated Areas	√	X	X	X
Failures	X	√	√	√
Patching	X	√	√	√

Note: √ = Yes; X = No

The warranty indicators that do not permit the utilization of the PMIS data for determining appropriate threshold values can be categorized into three groups. The first group consists of warranty indicators that are not even measured in the PMIS.

The second group is composed of warranty indicators that are optional measures in the TxDOT PMIS evaluation. This group contains bleeding/flushing and raveling. The data collected for these two warranty indicators are not sufficient to conduct a statistical analysis.

The third group includes only one performance indicator and that is rutting. The method used to evaluate rutting in PMIS is to rate by area and severity. Area of rutting is measured as a percent of the section's total wheelpath area that is rutted. Severity of rutting is described in terms of rut depth. For example, shallow rutting is defined as ruts that are 0.25 inch to 0.50 inch. The final data that are stored in the PMIS database is the percent rutting area of a roadway section. The survey of other SHAs indicated that typical rutting threshold values were always expressed in terms of rutting depth, which is not stored in TxDOT PMIS; therefore, the historical

rutting data in PMIS cannot be used to determine a threshold value in the normal manner. Furthermore, the PMIS data are not sufficiently definitive to be useful.

The fifth column in the table indicates if the evaluation method in TxDOT PMIS is adequate to evaluate a warranted project. For the warranty indicators that are not evaluated in the PMIS, new methodology for evaluating pavement performance would have to be developed if those warranty indicators are to be used in the warranty projects.

Tables 22 and 23 have the same format as Table 21. Table 22 compares surface treatments warranty indicators, and Table 23 compares microsurfacing warranty indicators.

**Table 22. Comparison of TxDOT PMIS and Surface Treatments WIs Used by Other States.**

Surface Treatment Warranty Indicators	Used by Other SHAs	Measured in TxDOT PMIS	TxDOT PMIS Data can be used to Develop Threshold Values	TxDOT Pavement Distress Measurement Method Adequate for Warranty Projects
Bleeding/Flushing	√	Optional	X	√
Loss of Cover Aggregate	√	X	X	X
Surface Patterns	√	X	X	X
Surface Cracking	√	√	√	√

Note: √ = Yes; X = No

**Table 23. Comparison of TxDOT PMIS and Microsurfacing WIs Used by Other States.**

Microsurfacing Warranty Indicators	Used by Other SHAs	Measured in TxDOT PMIS	TxDOT PMIS Data can be used to Develop Threshold Values	TxDOT Pavement Distress Measurement Method Adequate for Warranty Projects
Bleeding/Flushing	√	Optional	X	√
Raveling	√	Optional	X	√
Rutting	√	√	X	√
Delamination	√	X	NA	X
Weathering	√	X	NA	X
Surface Loss	√	X	NA	X

Note: √ = Yes; X = No

The evaluation of the PMIS data suggested that for several potential HMAC warranty indicators, the data stored in TxDOT PMIS could be used to determine threshold values. These indicators were:

- transverse cracking,
- longitudinal cracking,
- alligator cracking,
- block cracking,

- ride quality,
- failures, and
- patching.

Consequently a pilot data collection effort was initiated for investigating the use of TxDOT PMIS data for developing a methodology for determining threshold values for selected warranty indicators.

The Odessa District was selected as the pilot data collection district. HMAC (Type-D), surface treatment, and microsurfacing projects that were constructed since 1993 were identified. The data collection focused on projects constructed after 1993 because the researchers wanted to select projects that were constructed using the same 1993 TxDOT Standard Specifications related to HMAC, surface treatments, and microsurfacing end products.

Upon receiving and analyzing the PMIS data the researchers determined that the PMIS data could not be used for determining threshold values for warranty indicators for a number of reasons. One of the most important problems for potentially using PMIS data was that PMIS is an indicator of pavement performance/quality at network level as opposed to project level. The researchers needed pavement performance data at the project level. Another problem was that a pavement section identified as an HMAC (Type-D), microsurfacing, or surface treatment end product was not necessarily evaluated every year, which caused problems for the researchers to monitor the performance of that section throughout the years. Furthermore, on some of the identified sections at some time during the life of the pavement maintenance activities were conducted, which meant that the researchers could not use that section in their analysis.

In summary, the researchers determined that the PMIS data as evaluated and stored at this time could not be used for determining threshold values for warranty indicators. An alternative approach for determining threshold values was necessary. This approach would utilize TxDOT expertise on the subject matter by forming an expert TxDOT panel and conducting a workshop to select warranty indicators and determine threshold values for the warranty pilot projects.

#### *Workshop Approach*

In February 2004, a meeting was held to identify HMAC, surface treatments, and microsurfacing warranty indicators and determine appropriate threshold values for the selected warranty indicators that would be used in the warranty specifications. The participants included

the project director and project advisors from TxDOT, the researchers from TTI, and a materials supplier.

In order to develop a common understanding among the panel members and keep the discussions organized, the researchers provided posters for various types of distresses for HMAC, surface treatments, and microsurfacing that were potential candidates to be selected as warranty indicators. The posters included three pictures for each distress type at various severity levels ranging from low to high. Furthermore, the posters provided descriptions, possible causes, and evaluation techniques for each of the distress types from both the TxDOT PMIS and the *Distress Identification Manual for the Long-Term Pavement Performance Program* (27).

#### *HMAC Warranty Indicators and Threshold Values*

The group discussed each indicator and decided whether that indicator should be identified as a warranty indicator for the pilot projects. During this discussion the panel members identified the distress indicators that were mainly caused by poor materials and/or workmanship, which were considered to be under the control of the contractor. If a distress had the possibility of being caused by the contractor's poor performance, then that distress was selected as a warranty indicator. At the end of this elimination stage, several distresses that are not evaluated in TxDOT's PMIS were identified as warranty indicators, due to their value for being a sign of poor contractor performance. These distresses included the following:

- joint failure,
- disintegration,
- shoving, and
- slippage cracking.

After the group identified the warranty indicators they determined appropriate threshold values for each of these warranty indicators. [Table 24](#) provides the results obtained from these discussions. The warranty indicators and their threshold values, as provided in the table, were for guidance purposes only; a district could choose not to use a warranty indicator or modify a threshold value according to the specific conditions present for a given warranty project location. The threshold values indicated are for 0.1-mile segments of the warranted pavement.

**Table 24. HMAC Warranty Indicators and Threshold Values.**

<b>Warranty Indicator</b>	<b>Threshold Value</b>
Rutting	0.5 inch
Alligator Cracking	1 sq yd per segment of alligator cracking
Raveling	1 sq yd per segment of raveling
Joint Failure	20 ft open crack
Disintegration	1 sq yd per segment of disintegration
Shoving	Each Occurrence
Potholes	Each Occurrence
Slippage Cracking	Each Occurrence
Skid Resistance (SN)	20% Reduction in SN from the initial skid measurement
Ride Quality (IRI)	20% Increase in IRI from the initial ride quality measurement

*Surface Treatment Warranty Indicators and Threshold Values*

The same process that was used to identify asphalt concrete warranty indicators and their threshold values was employed to identify surface treatment warranty indicators and threshold values. [Table 25](#) illustrates the results of the discussion.

**Table 25. Surface Treatment Warranty Indicators and Threshold Values.**

<b>Warranty Indicators</b>	<b>Threshold Values</b>
Aggregate Loss	10% per lane
Flushing	10% per lane

*Microsurfacing Warranty Indicators and Threshold Values*

The warranty indicators and threshold values provided in TxDOT’s existing microsurfacing warranty specification were considered as a basis in this evaluation. After discussing each warranty indicator, the panel decided to make only one change to the existing microsurfacing warranty threshold values. The panel changed the threshold value for skid resistance to “20 percent reduction from the initial skid resistance measurement.” [Table 26](#) illustrates the microsurfacing warranty indicators and threshold values.

**Table 26. Microsurfacing Warranty Indicators and Threshold Values.**

<b>Warranty Indicators</b>	<b>Threshold Values</b>
Rutting	1/4 inch during the first 120 days following acceptance or 3/8 inch at the end of the warranty period
Skid Resistance	20% Reduction from the initial skid measurement
Bleeding/Flushing	5% of segment
Raveling	5% of segment
Delamination	2% of segment



## **PILOT PROJECT EFFORT**

As indicated earlier, the research plan included a task for conducting pilot warranty projects to test the warranty specifications developed for TxDOT Project 0-4498. A good candidate for an initial pilot project would be a project that has a high probability of performing well (i.e., low risk, low complexity). When selecting a pilot project, special care should be taken to identify projects where the performance of the warranted product would not likely be affected by factors other than those associated with materials and workmanship. For example, if the department decides to warrant a pavement overlay, it should make sure that there are no underlying structural problems associated with the candidate pavement.

The researchers suggested that pilot projects be selected at the local level. TxDOT selected two pilot projects. Districts that agreed to provide pilot projects for warranties were El Paso (HMAC) and Odessa (surface treatment). The draft warranty specifications that were previously developed were then modified considering project-specific conditions and the district's objectives related to implementing warranties. The warranty indicators and threshold values were tailored to fit the local area and conditions. The modifications made for the pilot project in the El Paso District are presented below:

The generic Special Specification 5XXX, Warranted Construction, was modified by taking out Article 5XXX.7, "Maintenance," which was the language that made the contractor responsible for maintenance during the warranty period. The district had concerns about the contractors' ability to perform pavement-related maintenance.

The generic Special Provision to Special Specification 5XXX was completed by including the penal value of the warranty bond and the warranty period under Article 5XXX.2, "Warranty Bond," and Article 5XXX.3, "Warranty Period." The penal value of the warranty bond was specified to be \$300,000. The warranty period for the hot-mix asphalt concrete warranty project was established as three years.

The generic Special Provision to Item 341, Dense-Graded Hot-Mix Asphalt (QC/QA), was modified by including the warranty indicators and threshold values determined for the potential pilot project under Article 341.7, Item C, "Pavement Warranty Indicators, Threshold Values, and Possible Remedial Actions." Since the district decided to take responsibility for pavement-related maintenance, language that made the contractor responsible for maintenance was taken out.

Table 27 presents the warranty indicators, threshold values, and possible remedial actions that the El Paso District selected for the warranted HMAC project. Table 28 presents the warranty indicators, threshold values, and possible remedial actions that the Odessa District selected for the warranted surface treatment project.

**Table 27. Pavement Warranty Indicators, Threshold Values, and Possible Remedial Actions for Warranted HMAC Project in El Paso.**

<b>WARRANTY INDICATOR</b>	<b>THRESHOLD VALUE</b>	<b>POSSIBLE REMEDIAL ACTION (Alternate remedial actions may be proposed in the plan.)</b>
Rutting	Rut depth equal to 0.5 inch or greater	Mill the distressed area and replace surface. Depth of milling would not exceed the depth of the warranted pavement.
Alligator Cracking	Area of an occurrence of alligator cracking is equal to or greater than 1 sq yd	Remove and replace the distressed layer(s). The removal area should be at least 150% of the distressed surface to a depth not to exceed the depth of the warranted pavement.
Raveling	Area of an occurrence of raveling is equal to or greater than 1sq yd	Remove and replace the distressed layer(s). The removal area should be at least 150% of the distressed surface to a depth not to exceed the depth of the warranted pavement.
Longitudinal Joint Cracking	Total length of longitudinal crack with a width of at least 1/16 inch is equal to or greater than 20 ft	Rout and seal all longitudinal cracks with approved crack sealing material.
Shoving	An occurrence of a localized depression greater than 1 inch	Remove and replace the distressed layer(s). The removal area should be at least 150% of the distressed surface to a depth not to exceed the depth of the warranted pavement.
Potholes	An occurrence of a pothole with an area of 1 sq ft or greater and a depth greater than 1 inch	Remove and replace the distressed layer(s). The removal area should be at least 150% of the distressed surface to a depth not to exceed the depth of the warranted pavement.
Slippage Cracking	An occurrence	Remove and replace the distressed layer(s). The removal area should be at least 150% of the distressed surface to a depth not to exceed the depth of the warranted pavement.
Skid Resistance	20% reduction in SN from the initial post-construction skid measurement	Mill, apply surface treatment, or overlay to correct inadequacy. Remedial treatment should be a minimum of a lane width.
Ride Quality	20% increase in IRI from the initial post-construction ride quality measurement	Level-up, overlay, milling, or combinations thereof to correct inadequacies in the deficient section(s).

**Table 28. Pavement Warranty Indicators, Threshold Values, and Possible Remedial Actions for Warranted Surface Treatments Project in Odessa.**

<b>WARRANTY INDICATOR</b>	<b>THRESHOLD VALUE</b>	<b>POSSIBLE REMEDIAL ACTION (Alternate remedial actions may be proposed in the plan.)</b>
Aggregate Loss/ Shelling	Early evidence of aggregate loss/shelling for more than 20% of length of segment	Fog seal.
	Bare spots in treated surface occurring in more than 20% of length of segment	Apply a surface treatment for full lane width to deficient area(s) using same grade of asphalt and same grade and type of aggregate as used in the original surface treatment. Application rates are subject to approval of Engineer.
Bleeding / Flushing	Initial evidence of flushing in more than 20% of length of segment	Apply pre-coated Grade 5 aggregate from same source as that used on original surface treatment.
	Subsequent flushing (normally occurring with onset of warmer weather) in more than 20% of segment	Apply a surface treatment using same grade of asphalt and same grade and type of aggregate as used in the original surface treatment. Application rates are subject to approval of Engineer.

The generic warranty specifications were modified based on the input received from the El Paso and Odessa Districts. The specifications were submitted to TxDOT for review so that they could be finalized for bidding. At that point TxDOT decided not to conduct pilot warranty projects; therefore, the warranty specifications developed for El Paso and Odessa Districts were not reviewed by the TxDOT Review Committee. These specifications can be found in the appendix to TxDOT Project 0-4498, Product-4 “Draft Warranty Implementation Plan (16).”



## **CHAPTER 4**

### **TXDOT WARRANTY IMPLEMENTATION PLAN**

This section discusses the development of the TxDOT warranty implementation plan. The actual plan is included in TxDOT Project 0-4498, Product-4, “Draft Warranty Implementation Plan (16).”

#### **DEVELOPMENT OF WARRANTY IMPLEMENTATION PLAN**

The researchers used the guidelines documented in *NCHRP Report 451 (3)* as the basis for developing TxDOT Project 0-4498, “Warranty Based Specifications for Construction,” Product-4, “Draft Warranty Implementation Plan.” The guidelines presented in *NCHRP Report 451* were developed based on the practices of those SHAs most active in warranty contracting. Thus, the guidelines follow a logical, structured, and practical approach to implementing warranties.

The report contains comprehensive guidelines for implementing non-traditional contracting methods for highway construction projects; it includes guidelines for warranty, multi-parameter, and best value contracting. The process for implementing warranty contracting is illustrated in the form of a flowchart, including a discussion for each step shown.

The guidelines presented in *NCHRP Report 451* were modified, as necessary, to fit into TxDOT processes for specification development, contracting, and maintenance. Essentially these modified guidelines provided the research work plan for TxDOT Project 0-4498. During TxDOT Project 0-4498, the researchers used the modified guidelines to implement warranty contracting in Texas. The lessons learned from the research project assisted the researchers in developing the warranty implementation plan for TxDOT.

The warranty implementation plan was intended to reflect lessons learned from all the tasks that were identified under the research work plan. The process for implementing warranties is subdivided into the following phases:

- Program Planning,
- Bidding, Contract Award, and Construction;
- Maintenance and Evaluation of Performance, and
- Pilot Project Evaluation and Organizational Program Evaluation.

Pilot projects were not conducted during this research; therefore, only the program planning phase of the warranty implementation plan reflects the lessons learned from this research project.

The goal of the first phase, *Program Planning*, is to create an environment for successful implementation of warranty contracting. The tasks needed to achieve this goal are to determine the objectives for implementing warranties, select candidate end product(s) to be warranted, select pilot projects to test the warranty specification, and develop or modify warranty specifications.

The objective of the second phase, *Bidding, Contract Award, and Construction*, is to construct pilot projects.

The third phase, *Maintenance and Evaluation of Performance*, provides a plan for TxDOT to identify their role and responsibilities during maintenance and evaluation of product performance during the warranty period.

The fourth phase, *Pilot Project Evaluation and Organizational Program Evaluation*, provides a plan for TxDOT to evaluate the pilot projects and propose a state level approach to warranties. This step is necessary because it forms the basis for making decisions to either discontinue the warranty program or expand its level of use.

## **GUIDELINE STRUCTURE AND FORMAT**

Steps and decision points for implementing warranty contracting are presented in the form of flowcharts. Each step is further described in detail using text, bullets, tables, figures, and examples as necessary. For more information about the guideline refer to TxDOT Project 0-4498, “Warranty Based Specifications for Construction,” Product-4, “Draft Warranty Implementation Plan” (16).

## CHAPTER 5 SUMMARY

The Texas Department of Transportation continues to be proactive in finding innovative practices in programming and administering projects, including the construction contracting area. Since warranty specifications have shown the potential to reduce the life-cycle cost of facilities while ensuring the quality of constructed facilities, TxDOT elected to further explore this innovative contracting method.

The goal of TxDOT Project 0-4498 was to develop a warranty contracting implementation plan. The TxDOT plan developed in this project is based on guidelines for warranty contracting previously developed under Project 10-49 for *NCHRP Report 451*. The Project 10-49 guidelines were modified to be consistent with the TxDOT design, contracting, and maintenance systems.

Several tasks were conducted to develop the warranty implementation plan. A TxDOT advisory team was created to confirm TxDOT objectives for the warranty program. The advisory team was formed to maximize TxDOT's role in developing the warranty program and to ensure that the program was designed to meet TxDOT objectives. The team also determined the initial end products to be warranted: HMAC, surface treatments, and microsurfacing. The advisory team consisted of representation from both state headquarters and local offices.

The state of the practice for warranty contracting was reviewed. *NCHRP Report 451* captured the essence of warranty contracting in the form of guidelines. NCHRP Project 10-49 provided background information through 1998. In order to obtain the most recent information, a literature review focusing on the period between 1998 and 2004 was conducted.

A short e-mail informational survey was conducted with those states currently identified as using warranties. The focus of the survey questionnaire was on the recent experiences of state highway agencies using warranties. Sample warranty specifications were gathered for HMAC, surface treatments, and microsurfacing end products. Furthermore, several Texas municipalities including Austin, Dallas, Houston, San Antonio and El Paso were contacted to obtain information about their use of warranties.

The model warranty specification previously developed under NCHRP Project 20-7, Task 109 was used as a starting point for developing TxDOT warranty specifications. HMAC and surface treatments warranty specifications were based on the generic warranty specification

framework from Task 109 and modified to accommodate TxDOT requirements. The microsurfacing warranty specification was based on Special Specification 3278 Micro-Surfacing Warranty, which TxDOT had approved for use with TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges (1993). Warranty specifications for HMAC, surface treatments, and microsurfacing obtained from other SHAs during review of the state of the practice in warranties were used as well to guide the development of the TxDOT warranty specifications. The TxDOT Project Advisory Team provided input during the development of the warranty specifications via several meetings and telephone conference calls. The Project Advisory Team made the critical decisions regarding the warranty specifications; therefore, the warranty specifications developed reflect TxDOT's perspective on warranties.

An industry interaction forum was conducted to share information, discuss issues and concerns, obtain input from different industry participants, and to establish a cooperative partnership with the industry for warranty contracting in Texas. The warranty specifications were modified to address the concerns raised by the industry during the forum.

The warranty implementation plan reflects the lessons learned during this research project. The purpose of the implementation plan was to provide TxDOT local office personnel with the information necessary to successfully implement warranties. The plan provides the steps to take to implement a warranty contracting program. TxDOT offices that plan to implement warranty contracting for the first time and those that have previous experience with warranties can both make use of these guidelines.

The original research plan required conducting pilot projects to test the warranty specifications developed. The pilot projects would also provide valuable lessons that could have been incorporated in the warranty implementation plan. TxDOT decided not to conduct pilot projects at this time. Consequently, the warranty specifications developed under TxDOT Project 0-4498 were not tested. Furthermore, while developing the warranty implementation plan the researchers had to only rely on the experience of other SHAs that have implemented warranty contracting.

If TxDOT elects to require warranties in Texas, they should conduct a review of the draft warranty specifications with the industry and try to mitigate their concerns regarding the possibility of using warranties in Texas. Furthermore, the warranty specifications should be



tested by conducting pilot projects. The warranty implementation guidelines developed during this research project should be modified to reflect the lessons learned from the pilot projects. Conducting pilot projects would also provide a valuable opportunity for TxDOT to verify the objectives set forth for implementing warranties in Texas. TxDOT's goals for investigating the implementation of warranties were to: reduce TxDOT manpower requirements for inspection, testing, and maintenance; reduce project life-cycle costs; and improve quality of materials and construction. Warranty contracting has been used successfully by several SHAs. TxDOT should further investigate if warranties can be effectively implemented and used in Texas.



## REFERENCES

1. Hancher, D. “*NCHRP Synthesis of Highway Practice 195: Use of Warranties in Road Construction.*” Transportation Research Board, National Research Council, Washington, D.C., 1994.
2. “*Asphalt Pavement Warranties Technology and Practice in Europe,*” Federal Highway Administration, FHWA-PL-04-002, Washington, D.C., 2004.
3. Anderson, S.D., and Russell, J.S. “*NCHRP Report 451: Guidelines for Warranty, Multi-Parameter, and Best Value Contracting.*” Transportation Research Board, National Research Council, Washington, D.C., 2001.
4. Yakowenko, J. “*Use of Warranties in Federal-Aid Highway Program.*” Federal Highway Administration Briefing, July 25, 2001, Washington, DC.
5. American Association of State Highway Transportation Officials, “*Primer on Contracting for the 21<sup>st</sup> Century,*” 2001. ([www.aashto.org/download/ContractPrimer.pdf](http://www.aashto.org/download/ContractPrimer.pdf))
6. Anderson, S.D., Blaschke, B., and Russell, J.S. “*Technical Provisions for Innovative Contracting*” Final Report, National Cooperative Highway Research Program, Project 20-7, Task 109, Washington, D.C., 2000.
7. Bayraktar, M.E., Cui, Q., Hastak, M., and Minkarah, I. “*State-of-Practice of Warranty Contracting in the United States.*” Journal of Infrastructure Systems, Vol. 10, No. 2, June 2004, pp. 60-68.
8. Wisconsin Department of Transportation, “*Asphaltic Pavement Warranties Five-Year Progress Report,*” 2001.
9. Aschenbrener, T.B., and DeDios, R.E. “*Materials and Workmanship Warranties for Hot Bituminous Pavement.*” Colorado Department of Transportation, December 2001.
10. Gallivan, V.L., Huber, G.R., and Flora, W.L. “*Benefits of Warranties to Indiana.*” Transportation Research Record: Journal of the Transportation Research Board 1891, 2004 pp. 221-228.
11. Ohio Department of Transportation, “*Implementation of Warranted Items on Construction Projects,*” 2002.
12. Michigan Department of Transportation, “*Status Report on Warranties,*” 2003.
13. “*Pavement Warranty Symposium Final Report.*” Michigan Department of Transportation and Federal Highway Administration, 2003. (<http://www.michiganltap.org/warranty/>)

14. “*Performance Specifications Strategic Road Map.*” Federal Highway Administration, 2004. ([www.fhwa.dot.gov/construction/pssr04.pdf](http://www.fhwa.dot.gov/construction/pssr04.pdf))
15. Anderson, S.D., Blaschke, B., Trejo, D., and Erbatur, O.C. “*Texas Department of Transportation Products 0-4498-1, 0-4498-2, 0-4498-3: Draft Warranty Specifications.*” Texas Department of Transportation, Austin, TX, 2003.
16. Anderson, S.D., Blaschke, B., Trejo, D., and Erbatur, O.C. “*Texas Department of Transportation Report 0-4498-4: Draft Warranty Implementation Plan.*” Texas Department of Transportation, Austin, TX, 2005.
17. The Associated General Contractors of America (AGC) White Paper, “*The Use of Alternate Contract Award Methods in Highway Construction.*”
18. A letter from the National Association Surety Bond Producers.
19. Amendment to HR 2950 by Beilenson of California.
20. AGC Paper “*AGC strongly opposes the Beilenson Amendment on Warranties and Guarantees.*”
21. Letter from the Surety Association of America.
22. Draft position of Carolinas AGC titled “*Warranties in Highway Construction.*”
23. Draft of ARTBA “*Revised Policy Position on the Use of Warranties and Guarantees in the Transportation Construction Industry.*”
24. Hardaway, C. “*New Contract Procedures may Provide Some Incentives.*” Better Roads, 2001. Des Plaines, IL, Vol. # 71(5) pp 56-61.
25. American Society of Civil Engineers, “*Report Card for America’s Infrastructure: 2003 Progress Report.*” <http://www.asce.org/reportcard/index.cfm?reaction=states&page=TX>
26. Shoher, S. F., Whited, G. C., and McMullen, K. W. “*Wisconsin Department of Transportation’s Asphaltic Pavement Warranties,*” Transportation Research Record 1543. Transportation Research Board, National Research Council, Washington, D.C., 1995.
27. Federal Highway Administration, “*Distress Identification Manual for the Long-Term Pavement Performance Program (Fourth Revised Edition).*” FHWA-RD-03-031, 2003. [http://www.fhwa.dot.gov/pavement/pub\\_details.cfm?id=91](http://www.fhwa.dot.gov/pavement/pub_details.cfm?id=91).

**APPENDIX A:**

**GENERIC WARRANTY SPECIFICATIONS AND PROVISIONS BASED  
ON 2004 STANDARD SPECIFICATIONS**



**SPECIAL SPECIFICATION**  
**5XXX**  
**WARRANTED CONSTRUCTION**

- 1. Description.** Warrant the indicated product for the period specified. Perform any required remedial actions to correct deficiencies identified in periodic evaluations. When specified in the plans, maintain the warranted product during the warranty period.

Guarantee the warranty by a warranty bond. (Refer to Article 5XXX.2, "Warranty Bond")

Develop remedial actions for those parts of the warranted product that do not meet the specified standards of the warranty. The remedial actions will be subject to approval. Complete the approved remedial actions at no additional cost to the Department. (Refer to Article 5XXX.6, "Remedial Actions")

When the plans indicate that the Contractor is responsible for maintenance of the warranted product, maintain the product during the warranty period at no additional cost to the Department. (Refer to Article 5XXX.7, "Maintenance")

A Conflict Resolution Team will be formed to resolve any disagreements associated with the warranty. (Refer to Article 5XXX.10, "Conflict Resolution Team")

- 2. Warranty Bond.** Provide a warranty bond in the amount specified that is effective for the period of the warranty, to include time periods required for any remedial actions that may extend beyond the end of the warranty period. Submit the executed warranty bond with the performance and the payment bonds in accordance with Article 3.4, "Execution of Contract."

The penal value of the warranty bond is specified in a special provision to this item.

Furnish the warranty bond as a guaranty for the protection of the claimants and the Department for labor and materials and the faithful performance of all remedial actions required by these warranty requirements. The defects in materials and workmanship referred to in the bond are those evidenced by warranty indicators that exceed the specified threshold levels.

- 3. Warranty Period.** The warranty period for the warranted product is specified in a special provision to this item. The beginning date of the warranty period is the date of final acceptance of the construction phase of the project, unless otherwise specified in the plans, or as determined by the Engineer when an earlier beginning date is considered justified.

Written notice of the effective beginning date of the warranty period will be furnished to the Contractor. Written notice of the final acceptance of the warranted phase of the project will also be provided to the Contractor.

4. **Warranty Requirements.** The warranty indicators used to evaluate the warranted product are listed in the special provision to the specification for the warranted product.
5. **Warranty Evaluation.** Each of the listed warranty indicators will normally be measured annually. More or less frequent evaluations may be conducted as considered necessary by the Engineer. The Engineer will conduct these evaluations at no cost to the Contractor.

The Engineer will notify the Contractor of the evaluation date at least 7 calendar days prior to the date. The Contractor may have a representative(s) present during the evaluation.

The evaluation results will be provided to the Contractor within 14 calendar days of the completion of the evaluation.

If the evaluation results are disputed, provide written notification to the Engineer within 10 calendar days following the receipt of the evaluation results. If the dispute cannot be resolved within the following 10 calendar days, it will be presented to the Conflict Resolution Team. (Refer to Article 10, "Conflict Resolution Team")

The last scheduled evaluation should be conducted a minimum of 90 calendar days prior to the end of the warranty period. This does not preclude the Engineer from conducting subsequent evaluations prior to the end of the warranty period

6. **Remedial Actions.** If the evaluation results exceed the established threshold values for one or more of the warranty indicators, develop remedial actions that will correct the inadequate conditions. Within 30 calendar days of the receipt of the evaluation results, or the resolution of a disputed evaluation, whichever is the later, submit the proposed remedial actions for review and approval. If the Engineer does not approve the proposed actions, or mutually agreeable remedial actions cannot be negotiated within 30 calendar days following the submission of the proposed remedial actions, the issue will be referred to the Conflict Resolution Team for disposition.

The Remedial Actions will comply with the following:

- (1) **Remedial Action Requirements.** Use materials and construction methods that conform to the specification requirements included in the contract for the warranted product and which correspond to the approved remedial actions. When the remedial action includes materials and/or construction methods not included in the contract, use materials and construction methods that conform to the specification requirements included in the *TxDOT Standard Specifications for Construction of Highways, Streets, and Bridges (2004)* and that correspond to the remedial actions. Where there is no corresponding specification, submit appropriate specifications for approval.



- (2) **Schedule for Remedial Actions.** Begin the remedial actions within 30 calendar days following approval of the remedial actions unless a later date is mutually agreed upon with the Engineer.
  - (3) **Warranty on Remedial Action(s).** The warranty period for the remedial actions performed will not extend beyond the original warranty period.
  - (4) **Contractor's Failure to Complete Approved Remedial Action(s).** If the Contractor fails to complete the approved remedial actions within the period of the approved schedule, the Engineer can have the work performed, at the Contractor's expense, with the Department's personnel or through outsourcing.
7. **Maintenance.** When specified in a special provision to this Item, maintain the warranted product during the warranty period.
  - (1) **Maintenance Responsibilities.** The maintenance responsibilities of the Contractor and the Department are specified in the specification and/or the special provision for the warranted product.
  - (2) **Material, Construction, and Maintenance Methods.** Use materials and construction or maintenance methods that conform to the specification requirements included in the TxDOT Standard Specifications for Construction of Highways, Streets, and Bridges (2004) and that correspond to the maintenance action used. Where there is no corresponding specification, submit appropriate specifications for approval.
8. **Emergency Work.** If, in the opinion of the Engineer, conditions of the warranted product require immediate maintenance or remedial action for the safety of the public, perform the required work on a timely basis. If the contractor cannot perform the required work on a timely basis, the Engineer can have the necessary work performed, at the Contractor's expense, with the Department's personnel or through outsourcing. Any work thus performed will not alter the requirements, responsibilities, or obligations included in the warranty.
9. **Exceptions.** During the period of the warranty, the Department will be responsible for repairing conditions of the warranted product that are caused by factors that are determined by the Engineer to be beyond the control of the Contractor. These factors may include, but are not limited to, major accidents, major flooding, and other Acts of God.
10. **Conflict Resolution Team.** A Conflict Resolution Team for Warranty Work (CRT) will be established prior to the initiation of the warranty period to resolve any conflicts regarding the warranty requirements. This team will be composed of two representatives appointed by the Contractor, two representatives appointed by the Engineer, and an independent party mutually agreed upon by the Contractor and the Engineer. Decisions of the CRT will be based on a simple majority vote. The cost of salaries and other expenses of the representatives shall be the responsibility of their parent organizations. The expenses of the independent party will be equally shared by the Contractor and the Department. Any disputes involving the warranty provisions will be initially processed through the CRT. If

resolution is not achieved, the Department's contract dispute and claim procedure will be employed.

- 11. Applicability of Standard Specification Items 1 through 9.** For the time periods during which maintenance, remedial actions or emergency work required by the warranty specification are being performed by the Contractor, the applicable portions of Standard Specification Items 1-9, including Special Provisions thereto, will remain in effect.
- 12. Traffic Control.** Prior to beginning any remedial actions, maintenance work or emergency work, submit a traffic control plan for approval. Comply with the provisions of the 2003 Texas Manual of Uniform Traffic Control Devices, the TxDOT standard sheets for Traffic Control Plans, and the Traffic Control Plans for the project, as applicable. Implement the approved traffic control plan during maintenance, remedial, and emergency work performed by you or your agents.
- 13. Payment.** No direct payment will be made for any work performed to fulfill these warranty requirements.

**SPECIAL PROVISION**

**5XXX--XXX**

**WARRANTED CONSTRUCTION**

For this project, Special Specification Item 5XXX, “Page,” is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

**Article 5XXX.2.Warranty Bond.** is supplemented by the following:

The penal value of the warranty bond for Item \_\_\_\_\_ (Warranted) shall be \$ \_\_\_\_\_.

**Article 5XXX.3.Warranty Period.** is supplemented by the following:

The warranty period for Item \_\_\_\_\_ (Warranted) is \_\_ years.

**Article 5XXX.7. Maintenance.** is supplemented by the following:

Maintain the following warranted product(s) during the warranty period as provided in the special provision to the warranted product specification.

- Item \_\_\_\_\_ (Warranted)

(Note: List the Items requiring maintenance. If maintenance is not required, indicate NONE)

## SPECIAL PROVISION

### 003---XXX

#### AWARD AND EXECUTION OF CONTRACT

For this project, Item 5XXX, “AWARD AND EXECUTION OF CONTRACT,” of the Standard Specifications, is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

**Article 3.4. Execution of Contract.** is voided and replaced by the following:

**3.4. Execution of Contract.** Provide the following within 15 days after written notification of award of the Contract:

**A. Contracts.** Executed by Contractor and Surety.

**B. Performance and Payment Bonds.** Executed performance bond and payment bond in the full amount of the Contract price with powers of attorney. Provide bonds in accordance with [Table 1](#). Furnish the payment and performance bonds as a guaranty for the protection of the claimants and the Department for labor and materials and the faithful performance of the work.

**Table 1 Bonding Requirements**

Contract Amount	Required Bonds
Less than \$25,000	None
\$25,000 to \$100,000	Payment
More than \$100,000	Performance and Payment

**C. Warranty Bond.** Executed warranty bond with powers of attorney, for the dollar amount shown in the contract. Furnish the warranty bond to insure the proper and prompt completion of required warranty work following completion of the construction phase of the project, including payments for all labor performed, equipment and material used in accordance with the specifications.

**D. Certificate of Insurance.** For construction and building Contracts, submit a certificate of insurance showing coverages in accordance with Contract requirements. For routine maintenance Contracts, refer to Article 3.8, “Beginning of Work,” for submission requirements.

**E. Business Ownership Information.** Submit the names and social security number of all individuals owning 25% or more of the firm, or firms in the case of a joint venture, on the Department’s form.

**F. List of Quoting Suppliers and Subcontractors.** For a construction Contract, submit a list of all suppliers and subcontractors that quoted on the Contract. Include names, addresses, telephone numbers, and types of work required.

**SPECIAL PROVISION**

**5---00X**

**CONTROL OF THE WORK**

For this project, Item 5, "Control of the Work," of the Standard Specifications, is hereby amended with respect to the clauses below, and no other clauses or requirements of this Item are waived or changed hereby.

**Article 5.8.D Project Acceptance for Projects Including Warranted Construction.** is added, as follows:

Notwithstanding the project acceptance provisions of Article 5.8, "Final Acceptance," the Contractor is relieved of responsibility for the warranted portions of the construction upon satisfactory completion of the warranty period and acceptance by the Engineer. The Engineer will provide written acceptance of the warranted construction upon expiration of the warranty period or satisfactory completion of any required remedial actions, whichever is the later.

**SPECIAL PROVISION**

**7---00X**

**LEGAL RELATIONS AND RESPONSIBILITIES**

For this project, Item 7, "Legal Relations and Responsibilities," of the Standard Specifications, is hereby amended with respect to the clauses below, and no other clauses or requirements of this Item are waived or changed hereby.

**Article 7.4 is amended by adding the following:**

Maintain insurance as required by this Section for the period of any remedial actions or emergency work required by the warranty provisions of the contract and performed by the Contractor or the Contractor's agent.

## **SPECIAL PROVISION**

### **341--00X**

#### **DENSE-GRADED HOT-MIX ASPHALT (QC/QA)**

For this project, Standard Specification Item 341, “Dense-Graded Hot-Mix Asphalt (QC/QA),” is hereby amended with respect to the clauses below, and no other clauses or requirements of this Item are waived or changed hereby.

**Article 341.1. Description.** is supplemented by adding the following:

When “Dense-Graded Hot-Mix Asphalt (QC/QA)(Warranted)” is specified, comply with the provisions of Special Specification Item 5XXX, “Warranted Construction,” including performing any required remedial actions to correct deficiencies identified in periodic evaluations, performing necessary maintenance, and/or performing required emergency work.

**Article 341.6. Payment.** First paragraph is voided and replaced with the following:

The work performed and materials furnished in accordance with this Item and measured as provided under Article 341.5, “Measurement,” will be paid for at the unit price bid for “Dense-Graded Hot-Mix Asphalt (QC/QA)” and, when specified in the plans, “Dense-Graded Hot-Mix Asphalt (QC/QA) (Warranted)” of the type, surface aggregate classification, and binder specified. Pay adjustments for bonuses and penalties will be applied as determined in this Item. These prices are full compensation for surface preparation, materials including tack coat, placement, equipment, labor, tools, and incidentals. When “Dense-Graded Hot-Mix Asphalt (QC/QA) (Warranted)” is specified, the payment shall also be full compensation for fulfilling the specified warranty provisions, for any maintenance, remedial actions and emergency work required by the warranty provisions; and for replacement of raised pavement markers and pavement markings obliterated by warranty-related work.

**Article 341.7. Maintenance Requirements.** is added as follows:

When Contractor maintenance of the “Dense-Graded Hot-Mix Asphalt (QC/QA) (Warranted)” is required according to Article 5XXX.7, “Maintenance,” the maintenance responsibilities of the Contractor and Department will be as shown below.

- 1. Contractor Responsibility.** Perform all necessary maintenance of the warranted product during the warranty period, except that listed in Section B, “Department Responsibility.” This maintenance includes, but is not limited to crack sealing, pothole repair, correction of bleeding areas, and isolated level-ups. It also includes repair of base failures that result from inadequacies of the warranted product.



May initiate maintenance of the warranted pavement. Perform all necessary warranted pavement-related maintenance within 10 calendar days of Engineer’s notification unless a later date is mutually agreed upon by the Contractor and the Engineer.

- 2. Department Responsibility.** The Department will perform routine maintenance during the warranty period, such as snow and ice removal, including application of de-icing chemicals; repairs to safety appurtenances; pavement markings; mowing, and sign maintenance. The Department will not perform any routine pavement surface maintenance activities, such as crack sealing, pothole repair; correction of bleeding areas and isolated level-ups during the warranty period, except for emergency conditions in accordance with Article 5XXX.8, “Emergency Work.” The Engineer will advise the Contractor when maintenance of the warranted pavement is necessary.

**Article 341.8. Warranty Requirements.** is added as follows:

- A. Warranty Indicators.** The indicators used to measure the pavement condition are listed in Section C, “Pavement Warranty Indicators, Threshold Values, and Possible Remedial Actions.”
- B. Evaluation Parameters and Methods.** The Engineer will conduct the pavement evaluation in accordance with...

It is recommended that TxDOT adopt the procedures outlined in Appendix B of Product 0-4498-4, “Draft Warranty Implementation Plan,” as a standard method of evaluating pavements for warranty purposes. If so the title of the adopted procedures would be inserted here. Otherwise, the appropriate portions of [Appendix B](#) would be inserted in the Specification at this location.

The warranted section of pavement will be divided into nominal 1-mile sections that are further divided into 0.1-mile segments. Pavement evaluation surveys will be conducted on each 0.1-mile segment.

The results of the pavement evaluation and the identification of sections where threshold values have been exceeded, together with the identification of the deficiencies, will be reported to the Contractor.

**C. Pavement Warranty Indicators, Threshold Values, and Possible Remedial Actions.**

WARRANTY INDICATOR	THRESHOLD VALUE	POSSIBLE REMEDIAL ACTION (Alternate remedial actions may be submitted by the Contractor.)

**Article 341.9. Remedial Actions.** is added as follows:

As required in Article 5XXX.6, “Remedial Actions,” submit for approval the proposed remedial action(s) for the pavement areas where the evaluation results indicate that threshold values have been exceeded.

Perform the remedial actions on the entire pavement area identified as exceeding the threshold values unless otherwise noted in Section C, “Pavement Warranty Indicators, Threshold Values, and Possible Remedial Actions.” Restore the design thickness where the pavement thickness is reduced as part of the remedial work and repair any deficiencies in the underlying base material resulting from inadequacies in the warranted layer.

**Article 341.10. Pavement Markings.** is added as follows:

Replace raised pavement markers and/or pavement markings damaged or obliterated due to maintenance, remedial actions or emergency work

**SPECIAL PROVISION**  
**316--00X**  
**SURFACE TREATMENTS**

For this project, Item 5XXX, “AWARD AND EXECUTION OF CONTRACT,” of the Standard Specifications, is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

**Article 316.1 Description.** is supplemented by the following:

When “Surface Treatment (Warranted)” is specified, comply with the provisions of Special Specification Item 5XXX, “Warranted Construction,” including performing any required remedial actions to correct deficiencies identified in periodic evaluations, performing required maintenance, and performing required emergency work.

**Article 316.4 Construction, Section A. General.** is voided and replaced by the following:

Asphalt application season will be as shown on the plans. Asphalt and aggregate rates shown on the plans for asphalt and aggregate are for estimating purposes only. Except for “Surface Treatment (Warranted),” the Engineer will adjust the rates for the existing conditions. For “Surface Treatment (Warranted),” select application rates within the range of rates shown on the plans.

**Article 316.4.G. Asphalt Placement, Section 1 General.** The second paragraph is voided and replaced by the following:

For other than “Surface Treatment (Warranted)” - Select an application temperature, as approved, in accordance with Item 300, “Asphalts, Oils, and Emulsions.” Uniformly apply the asphalt material at the rate directed, within 15°F of the approved temperature, and not above the maximum allowable temperature.

For “Surface Treatment (Warranted)” – Select an application temperature in accordance with Item 300, “Asphalts, Oils, and Emulsions.” Uniformly apply the asphalt material within 15°F of the selected temperature, and not above the maximum allowable temperature.

**Article 316.4.H. Aggregate Placement.** is voided and replaced by the following:

For other than “Surface Treatment (Warranted)” – As soon as possible, apply aggregate uniformly at the rate directed without causing the rock to roll over.

For “Surface Treatment (Warranted)” – As soon as possible, apply aggregated uniformly at the rate selected without causing the rock to roll over.

**Article 316.5. Measurement. Section B Warranted Surface Treatment.** is added as follows:

“Surface Treatment (Warranted)” will be measured by the square yard of warranted surface treatment.

This is a plans quantity measurement and the quantity to be paid for will be that quantity shown in the proposal and on the “Estimate and Quantity” sheet of the contract plans, except as may be modified by Article 9.2 “Plans Quantity Measurement.”

**Article 316.6. Payment.** is voided and replaced by the following:

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit prices bid for “Asphalt,” “Aggregate,” and “Aggregate (Stockpiled),” if required, of the type and grade specified; and for “Surface Treatment (Warranted).” These prices shall each be full compensation for cleaning and sprinkling the existing surface; for furnishing, preparing, hauling, and placing all materials; for protecting existing pavement markers; for rolling, removing excess aggregate, and cleaning up stockpiles; for all freight and heating involved; and for all manipulations, labor, tools, equipment, and incidentals necessary to complete the work. The price bid for “Surface Treatment (Warranted)” will also be full compensation for complying with the provisions of Item 5XXX, “Warranted Construction,” including all maintenance, remedial actions, and emergency work required to fulfill the warranty provisions.

**Article 316.7. Maintenance Requirements.** is added as follows:

When Contractor maintenance of the “Surface Treatment (Warranted)” is required according to Article 5XXX.7, “Maintenance,” the maintenance responsibilities of the Contractor and Department will be as shown below.

**A. Contractor Responsibility.** Perform all necessary maintenance of the warranted product during the warranty period, except that listed in Section 2, “Department Responsibility.” This maintenance includes correction of bleeding areas and aggregate loss. It also includes repair of base failures that result from inadequacies of the warranted product.

May initiate maintenance of the warranted pavement. Perform all necessary warranted pavement-related maintenance within 10 calendar days of Engineer’s notification unless a later date is mutually agreed upon by the Contractor and the Engineer.

**B. Department Responsibility.** The Department will perform routine maintenance during the warranty period, such as snow and ice removal, including application of de-icing chemicals; repairs to safety appurtenances; pavement markings; mowing; and sign maintenance. The Department will not perform any routine pavement surface maintenance involving the correction of bleeding areas and/or loss of aggregate during the warranty period, except for emergency conditions in accordance with Article 5XXX.8, “Emergency Work.” The Engineer will advise the Contractor when maintenance of the warranted pavement is necessary.

**Article 316.8. Warranty Requirements.** is added as follows:

- A. Warranty Indicators.** The indicators used to evaluate the pavement are listed in Section C, “Pavement Warranty Indicators, Threshold Values, and Possible Remedial Actions.”
- B. Evaluation Parameters and Methods.** The Engineer will conduct the pavement evaluation in accordance with...

It is recommended that TxDOT adopt the procedures outlined in Appendix B of Product 0-4498-4, “Draft Warranty Implementation Plan,” as a standard method of evaluating pavements for warranty purposes. If so the title of the adopted procedures would be inserted here. Otherwise, the appropriate portions of [Appendix B](#) would be inserted in the Specification at this location.

The warranted section of pavement will be divided into nominal 1-mile sections that are further divided into 0.1-mile segments. Pavement evaluation surveys will be conducted on each 0.1-mile segment.

The results of the pavement evaluation and the identification of segments where threshold values have been exceeded, together with the identification of the deficiencies, will be reported to the Contractor.

**C. Pavement Warranty Indicators, Threshold Values, and Possible Remedial Actions.**

WARRANTY INDICATOR	THRESHOLD VALUES	POSSIBLE REMEDIAL ACTION (Alternate remedial actions may be proposed in the plan.)

Note: The warranty will not apply to any preexisting bleeding or flushed areas.

**Article 316.9. Remedial Actions.** is added as follows:

As required in Article 5XXX.6 “Remedial Actions,” submit for approval the proposed remedial actions(s) for the pavement areas where the evaluation results indicate that threshold values have been exceeded.

Perform the approved remedial action on the entire lane width of those pavement sections identified as exceeding the threshold values.

**Article 316.10. Pavement Markings.** is added as follows:

Replace raised pavement markers and/or pavement markings damaged or obliterated due to maintenance, remedial actions, or emergency work.

## **SPECIAL PROVISION**

### **350--00X**

#### **MICROSURFACING**

For this project, Item 350, "Microsurfacing" of the Standard Specifications, is hereby amended with respect to the clauses below, and no other clauses or requirements of this Item are waived or changed hereby.

**Article 350.1. Description.** is supplemented by the following:

When "Microsurfacing (Warranted)" is specified, comply with the provisions of Special Specification Item 5XXX, "Warranted Construction," including performing any required remedial actions to correct deficiencies identified in periodic evaluations, performing necessary maintenance, and/or performing required emergency work.

**Article 350.6. Payment.** is voided and replaced with the following:

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per ton for "Microsurfacing," and when specified in the plans, "Microsurfacing (Warranted)." These prices are full compensation for preparing the existing surface (including removing existing raised pavement markers); furnishing, hauling, preparing, and placing materials; and equipment, labor, tools, and incidentals. The price bid for "Microsurfacing (Warranted)" is also full compensation for all materials, equipment, labor, tools, and incidentals for all maintenance, remedial action(s) and/or emergency work required to fulfill the warranty provisions.

**Article 350.7. Maintenance Requirements.** is added as follows:

When Contractor maintenance of the "Microsurfacing (Warranted)" is required according to Item 5XXX.7, "Maintenance," the maintenance responsibilities of the Contractor and Department will be as shown below.

**A. Contractor Responsibility.** Perform all necessary maintenance of the warranted product during the warranty period, except that listed in Section B, "Department Responsibility." This maintenance includes correction of raveling areas, bleeding areas, and delaminated areas. It also includes repair of base failures that result from inadequacies of the warranted product.

May initiate maintenance of the warranted pavement. Perform all necessary warranted pavement-related maintenance within 10 calendar days of Engineer's notification unless a later date is mutually agreed upon by the Contractor and the Engineer.

**B. Department Responsibility.** The Department will perform routine maintenance during the warranty period, such as snow and ice removal, including application of de-icing chemicals; repairs to safety appurtenances; pavement markings; mowing; and sign maintenance. The Department will not perform any routine pavement surface maintenance involving the correction of raveling areas, bleeding areas, and delaminated areas during the warranty period, except for emergency conditions in accordance with Article 5XXX.8, “Emergency Work.” The Engineer will advise the Contractor when maintenance of the warranted pavement is necessary.

**Article 350.8. Warranty Requirements.** is added as follows:

- A. Warranty Indicators.** The indicators used to evaluate the pavement are listed in Section C, “Pavement Warranty Indicators, Threshold Values, and Possible Remedial Actions.”
- B. Evaluation Parameters and Methods.** The Engineer will conduct the pavement evaluation in accordance with...

It is recommended that TxDOT adopt the procedures outlined in Appendix B of Product 0-4498-4, “Draft Warranty Implementation Plan,” as a standard method of evaluating pavements for warranty purposes. If so the title of the adopted procedures would be inserted here. Otherwise, the appropriate portions of [Appendix B](#) would be inserted in the Specification at this location.

The warranted section of pavement will be divided into nominal 1-mile sections that are further divided into 0.1-mile segments. Pavement evaluation surveys will be conducted on each 0.1-mile segment.

The results of the pavement evaluation and the identification of segments where threshold values have been exceeded, together with the identification of the deficiencies, will be reported to the Contractor.

**C. Pavement Warranty Indicators, Threshold Values, and Possible Remedial Actions.**

WARRANTY INDICATOR	THRESHOLD VALUES	POSSIBLE REMEDIAL ACTION (Alternate remedial actions may be proposed in the plan.)

Note: The warranty will not apply to any preexisting bleeding or flushed areas.

**Article 350.9. Remedial Actions.** is added as follows:

As required in Article 5XXX.6, “Remedial Actions,” submit for approval the proposed remedial actions for the pavement areas where the evaluation results indicate that threshold values have been exceeded.

Perform the approved remedial action on the entire lane width of those pavement sections identified as exceeding the threshold values.

**Article 316.10. Pavement Markings.** is added as follows:

Replace raised pavement markers and/or pavement markings damaged or obliterated due to the maintenance, remedial, or emergency work.



**APPENDIX B:**

**SURVEY QUESTIONNAIRE**



**Texas Department of Transportation**  
**Project 0-4498**  
**Warranty-Based Specifications for Construction**  
**Interview Questionnaire – State of Practice**

Name of Person Interviewed: \_\_\_\_\_

Affiliation: \_\_\_\_\_

The objective of this research is to develop a warranty contracting implementation plan for TxDOT. The Texas Transportation Institute, located at Texas A&M University, is working on this project. It is a two-year project scheduled for completion in August 2004. Dr. Stuart D. Anderson is the Principal Investigator (see contact information for Dr. Anderson on page 4).

Warranty specifications will initially be developed for hot-mix asphalt concrete, surface treatments or chip seals, and microsurfacing. These specifications will be tested on pilot projects and a comprehensive plan will be provided to implement warranties on a state-wide basis. Other warranty specifications may be developed later in this research. At this time, the research team is reviewing current state of the practice on warranty contracting. A recent briefing published by the Federal Highway Administration in this context indicates that your state DOT has used warranty contracting on highway construction projects in the past. For the remainder of this questionnaire, the research team would like to ask you some general questions about warranty contracting methods and some specific questions with respect to asphalt, chip seals, and microsurfacing.

Thank you for your interest and help with this research.

## Warranty Contracting Questions

1. How many warranty projects are you aware of that have been implemented at your agency?
2. In general, why is your agency using warranties?
3. What would be the approximate number of projects, that have been completed and the warranty period has elapsed for:  
1) Asphalt Concrete                      2) Surface treatments                      3) Microsurfacing

Based on achieving the objectives of warranties, how many of these projects would you consider being successful for:

- 1) Asphalt Concrete                      2) Surface treatments                      3) Microsurfacing

Approximate number of projects that are complete and the warranty period is not over for:

- 1) Asphalt Concrete                      2) Surface treatments                      3) Microsurfacing

4. How do you determine which projects are suitable for using warranty specifications? In other words, are there common criteria employed to help make this decision?

5. What is the length of warranty for asphalt concrete, surface treatments, and microsurfacing? How were these values determined?

- 1) Asphalt Concrete                      2) Surface treatments                      3) Microsurfacing

6. Was a conflict resolution team established for any of the projects? (If yes) What was the composition of the conflict resolution team?

(If yes) How did you determine when the conflict resolution team would be used?

(If yes) What was the time requirement for conflict resolution process?

7. For this question please refer to Table 1. What are the performance indicators for each end product? Please check all that apply. Other performance indicators may be added at the end of the table.

**Table 1. Typical Asphalt Concrete, Surface Treatment, and Microsurfacing Performance Indicators.**

Performance Indicators			
Asphalt Concrete	Seal Coat	Microsurfacing	
Alligator Cracking	Bleeding	Delamination	
Bleeding	Flushing	Flushing	
Block Cracking	Loss of Cover Aggregate	Weathering	
Delamination	Surface Patterns	Raveling	
Disintegrated Areas		Rutting	
Edge Cracking			
Flushing			
Longitudinal Cracking			
Potholes			
Ride Quality			
Raveling			
Rutting			
Scabbing Skid Resistance			
Slippage Areas			
Surface Raveling			
Transverse Cracking			
Zipper Cracking			

How were performance indicators selected?

How were the threshold values for each performance indicator determined?

Are the performance indicators and threshold values included in the specifications? Yes or No

If yes, would you be willing to send us a copy of the specifications?

If no, would you be willing to send us a copy of the document (or plan sheet) that includes that information?

8. What are typical maintenance activities for the following warranted projects:

Asphalt Concrete Projects:

Surface treatment Projects:

Microsurfacing:

Who is responsible for maintenance during the warranty period?

If contractor is responsible, what is the process for contractor to perform maintenance?

If agency is responsible, what are the advantages of performing maintenance in-house?

If agency is responsible, is the contractor charged for maintenance performed?

9. Has there been a cost analysis completed on your warranted projects? (If yes) What were the results of this analysis?

Would you be willing to send us a copy of this report?

10. What are the major barriers to implement warranties?

11. Does your SHA intend to use warranties on other products in the future? Yes or No  
If yes, what products, and what is the approximate date of implementation?

12. Can you send us any other reports, documents, results available on the subject matter?

Please send the specifications to: Dr. Stuart D. Anderson  
Materials and Pavement Division  
Texas Transportation Institute  
3135 TAMU  
College Station, Texas 77843-3135  
Phone: 979-845-2407  
Fax: 979-845-6554  
Email: [s-anderson5@tamu.edu](mailto:s-anderson5@tamu.edu)

**Texas Department of Transportation  
Project 0-4498  
Warranty-Based Specifications for Construction  
Texas Cities Interview Questionnaire – State of Practice**

Name of Person Interviewed: \_\_\_\_\_

Affiliation: \_\_\_\_\_

The objective of this research is to develop a warranty contracting implementation plan for TxDOT. The Texas Transportation Institute, located at Texas A&M University, is working on this project. It is a two-year project scheduled for completion in August 2004. Dr. Stuart D. Anderson is the Principal Investigator (see contact information for Dr. Anderson on page 4).

Warranty specifications will initially be developed for hot-mix asphalt concrete, seal coats or chip seals, and microsurfacing. These specifications will be tested on pilot projects and a comprehensive plan will be provided to implement warranties on a state-wide basis. Other warranty specifications may be developed later in this research. At this time, the research team is reviewing current state of the practice on warranty contracting. For this questionnaire, the research team would like to ask you some general questions about warranty contracting method and some specific questions with respect to asphalt, concrete, seal coats or chip seals, and microsurfacing.

Thank you for your interest and help with this research.

- 1) Does your city use 1-year warranties for asphalt concrete, seal coat, microsurfacing, or concrete projects?
- 2) What would be the approximate number of projects, that have been completed and the warranty period has elapsed for:
  - a) Asphalt Concrete
  - b) Seal Coats
  - c) Microsurfacing
  - d) Concrete
- 3) Based on achieving the objectives of warranties, how many of these projects would you consider being successful for:
  - a) Asphalt Concrete
  - b) Seal Coats
  - c) Microsurfacing
  - d) Concrete
- 4) How is a warranted project accepted at the end of the 1-year warranty period?
- 5) What are the criteria for project rejection, i.e. what are the typical performance indicators (rutting, transverse cracking, longitudinal cracking, bleeding/flushing, potholes, etc.) and threshold values for each performance indicator during the 1-year warranty period?
- 6) What happens if a project is rejected during, or at the end of the warranty period?
- 7) How often are warranty projects rejected? How many warranted asphalt concrete, microsurfacing, or seal coat projects have been rejected?
- 8) Is the 1-year warranty a standard clause in every construction project?
- 9) Does your city use warranties longer than one year? If yes, what are the end products warranted and what are the typical warranty periods for each product?
- 10) Does your city require the contractors to obtain a warranty bond?
- 11) Who has the liability of a warranted roadway during the 1-year warranty period?



12) Does your city use warranties on other products? If yes, what are the products?

Would you please send us a copy of the specifications and/or provisions for a project that implemented a 1-year warranty?

Please send the specifications to:

Dr. Stuart D. Anderson  
Materials and Pavement Division  
Texas Transportation Institute  
3135 TAMU  
College Station, Texas 77843-3135  
Phone: 979-845-2407  
FAX: 979-845-6554  
Email: [s-anderson5@tamu.edu](mailto:s-anderson5@tamu.edu)

