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16. Abstract This document provides the warrant 0-4498. The TxDOT plan is based Cooperative Highway Research Pro the TxDOT design, contracting, and mix asphalt concrete, surface treatm	on guidelines for w gram (NCHRP). T I maintenance syste	arranty contracting hese existing guide m. Warranty speci	developed for the elines were modifie	National ed to fit within
The purpose of the implementation plan is to provide TxDOT local office personnel with the information necessary to successfully implement warranties. The plan provides the steps that the local office has to take to implement a warranty contracting program. Local offices that are planning to implement warranty contracting for the first time and districts that have previous experience with warranties can both make use of this guideline.				
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### **DRAFT WARRANTY IMPLEMENTATION PLAN**

by

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Report 0-4498-P4 Project Number 0-4498 Project Title: Warranty Based Specifications for Construction

> Performed in cooperation with the Texas Department of Transportation And the Federal Highway Administration

> > January 2005

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## CHAPTER 1 INTRODUCTION

#### BACKGROUND

It is desirable that the Texas Department of Transportation (TxDOT) be proactive in finding alternative contracting practices in programming and administering projects, including the construction contracting area. Warranty contracting is one alternative that is being used successfully by many states. 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 reduces the level of inspection required during construction.

The goal of TxDOT Project 0-4498 is to develop a warranty contracting implementation plan. Guidelines for warranty contracting previously developed under Project 10-49 for the National Cooperative Highway Research Program (NCHRP Report 451) served as the basis for the TxDOT plan. These existing guidelines are modified to fit within the TxDOT design, contracting, and maintenance systems. Warranty specifications are developed for hot-mix asphalt concrete, surface treatments, and microsurfacing. TxDOT's objectives for implementing the warranty program are:

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

#### DEVELOPMENT OF WARRANTY IMPLEMENTATION PLAN

Researchers conducted several tasks 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 in order to maximize TxDOT's role in developing the warranty program and ensure that the program was designed to meet TxDOT objectives. The advisory team consisted of representation from both state headquarters and the District 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 (*1*). NCHRP Project 10-49 provided background information through 1998. In order to obtain the most recent

information, the research team conducted a literature review focusing on the period between 1998 and 2004. The literature review consisted of Ohio DOT's Implementation of Warranted Items on Construction Projects Report, Wisconsin DOT's Asphaltic Pavement Warranties Five-Year Progress Report, Wisconsin DOT's Asphaltic Pavement Warranties 2002 Progress Report, Colorado DOT's Materials and Workmanship Warranties for Hot Bituminous Pavement Report, Minnesota DOT's Use of Design/Build and Warranties in Highway Construction Report, and Federal Highway Administration's (FHWA) Asphalt Pavement Warranties Technology and Practice in Europe (4-9).

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

As part of the data collection effort, information was obtained from a warranty symposium that was conducted from May 5, 2003, to May 7, 2003, at the Michigan Local Technical Assistance Program (LTAP) Center, Grand Rapids, Michigan (*10*). The data includes not only information obtained during the symposium, but also the warranty survey that was conducted by the Michigan DOT before the symposium.

The TxDOT advisory team determined end products to be warranted. The end products selected were hot-mix asphalt concrete, surface treatment, and microsurfacing.

The development of the warranty specifications was based on the NCHRP 10-49 research study and the follow on work performed for the American Association of State Highway and Transportation Officials (AASHTO) Highway Subcommittee on Construction under NCHRP Project 20-7, Task 109. The former study developed the steps for developing a warranty specification and included a model warranty specification. This model warranty specification

was used as a starting point for developing the hot-mix asphalt warranty specification. Specifications for surface treatments and microsurfacing were based on the generic warranty specification framework from Task 109. Sample warranty specifications obtained from other states were used as well to guide the development of the hot-mix asphalt concrete, surface treatments, and microsurfacing warranty specifications. During the development of warranty specifications several meetings and telephone conference calls were held with the TxDOT Project Director, Project Coordinator, and Project Advisors to obtain their input.

The warranty specifications developed for TxDOT Project 0-4498 follow the general format for materials and workmanship warranties. 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 hot-mix asphalt concrete pavement (HMAC), surface treatments, and microsurfacing, the contractor is responsible for defects associated with the surface layer only (i.e., the warranted product). The contractor is not normally liable for defects associated with the underlying pavement or base material.

The remaining portion of the warranty implementation guideline includes bidding, construction, maintenance and evaluation of performance during the warranty period, pilot project evaluation, and organizational program evaluation, which were developed by relying on the researchers' previous knowledge experience on warranties. District offices that are interested in warranties will have to conduct their own pilot projects, evaluate the effectiveness of warranties, and decide if they want to continue to use warranties in the future.

Comprehensive warranty implementation guidelines were specifically designed to assist the Department with implementation of a warranty program. The guidelines present specific steps to be followed to successfully implement warranties. They also cover proposed plans specifically related to TxDOT responsibilities during the maintenance and evaluation and pilot and program evaluation steps of the warranty implementation process.

The warranty implementation plan also includes Frequently Asked Questions (FAQ). FAQ provides information about warranty contracting, warranty terms, and warranty specifications and provisions. The objective of the FAQ is to provide answers to questions that may arise during the initial stages of warranty implementation.

#### WARRANTY SPECIFICATION STRUCTURE

The key to implementing warranties is the development of warranty specifications. 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 using 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 with different warranty indicators.

Two key elements of the warranty specification are the warranty indicators that would be evaluated and the threshold values that would invoke the warranty. The warranty indicators proposed to evaluate each warranted product (hot-mix asphalt concrete, surface treatments, and microsurfacing) were identified by a panel that consisted of TxDOT Project 0-4498 Project Director (PD), Project Advisors (PAs), and experts from the Texas Transportation Institute. The panel also determined appropriate threshold values for each of the warranty indicators. The threshold values set for each warranty indicator for the appropriate end product were included in the Special Provisions for Item 341, Dense-Graded Hot-Mix Asphalt (QC/QA), Item 316, Surface Treatments, and Item 350, Microsurfacing.

Pilot projects were selected to test the proposed warranty specifications. Two pilot projects were selected. Pilot projects were selected at the District level. El Paso (hot-mix asphalt concrete) and Odessa (surface treatment) districts agreed to provide pilot projects for warranties, although these projects were not built with warranty specifications. The 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.

#### **GUIDELINE STRUCTURE AND FORMAT**

The purpose of the guideline for warranty contracting is to provide TxDOT personnel the information necessary to successfully implement warranties. Districts that are planning to implement warranty contracting for the first time, and districts that have previous experience with warranties can both make use of this guideline.

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. The Appendices provide additional information.

## CHAPTER 2 GUIDELINES

#### **METHOD DESCRIPTION**

The main objectives of warranty contracting are to decrease the amount of Department resources required on a TxDOT project, to properly reallocate risk, to increase the quality of constructed products, and to reduce the life-cycle costs of projects. Compared to a traditional design-bid-build contracting method, warranty contracting places a greater emphasis on the quality of the constructed product. Furthermore, some of the post-construction risk that the Department has traditionally taken is rightfully transferred to the Contractor. A warranty can be defined as "a guarantee of the integrity of a product and of the maker's responsibility for the repair or replacement of deficiencies. A warranty is an absolute liability on the part of the Warrantor, and the contract is void unless it is strictly and literally performed" (Hancher 1994 (2)).

#### FLOWCHART

The warranty process model described in NCHRP Report 451 was used as the basis for the TxDOT Warranty Implementation Guideline. The warranty process model was further refined in order to accommodate TxDOT formats and procedures. The guideline is presented in the form of flowcharts, as illustrated in Figure 1. This figure is subdivided into four phases:

- 1) Program Planning;
- 2) Bidding, Contract Award, and Construction;
- 3) Maintenance and Evaluation of Performance; and
- 4) Pilot Project Evaluation and Organizational Program Evaluation.

Each phase includes the steps that the District should take to implement a warranty contracting program. The flowchart can be used by Districts with little or no experience with warranties, or Districts that have previous experience with warranty contracting.



**Figure 1. Flowchart Process Model for Implementing Warranty Contracting.** 



Figure 1. Flowchart Process Model for Implementing Warranty Contracting (Continued).



Figure 1. Flowchart Process Model for Implementing Warranty Contracting (Continued).



Figure 1. Flowchart Process Model for Implementing Warranty Contracting (Continued).

#### FLOWCHART DISCUSSION

This section of the plan provides detailed information and explanations about the steps identified on the flowchart process model for implementing warranty contracting. The information is provided to assist the District in making decisions they have to make during the warranty implementation process.

#### **Program Planning Phase**

The goal of the program planning phase 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. Figure 2 illustrates the steps of the program planning phase. During these steps specific characteristics of the District's warranty program would be developed.

#### 1) Interested in Using Warranties?

This is the first step of the implementation plan for the use of warranties in the District. At this point, a decision must be made either to pursue warranty contracting implementation or to use existing contracting methods. The issues the District would like to resolve by implementing warranties should be compared with actual warranty contracting objectives. Several objectives of implementing warranties are listed below:

- Reduce manpower requirements for inspection, testing, and maintenance.
- Reallocate and balance project performance risk.
- Increase contractor innovation.
- Reduce project life-cycle costs.
- Improve quality of materials and workmanship.

The District should define the objectives they desire to achieve through implementation of the warranty program. If the District's objectives can not be achieved by implementing warranties, the District should discontinue investigating warranties.

- If the District is not interested in warranty contracting at this time, proceed to Step 2, Resume Normal Practice.
- If the District is interested in warranty contracting, go to Step 3, Select Candidate End Product(s).



Figure 2. Program Planning Phase Process Model.

#### 2) Resume Normal Practice

If the decision is made that the District not pursue implementing warranty contracting, the District should discontinue its investigation of a warranty program.

#### 3) Select Candidate End Product(s)

- > The end product selected should be chosen to accomplish objectives established in Step 1.
- The District should decide whether it has the necessary resources available to implement the warranty program. In order to implement the warranty program, the District has to reallocate some of the personnel to the warranty implementation process. The assigned personnel will have to carry out tasks such as:
  - o developing or modifying warranty specifications,
  - selecting pilot project(s),
  - o preparing bid documents,
  - o conducting pre-bid conference,
  - o monitoring construction,
  - o collecting cost data,
  - o evaluating the end product during the warranty period,
  - o analyzing this data to determine if any remedial action is necessary,
  - o evaluating warranty effectiveness, and
  - o refining the warranty program.

For the warranty program to be successful, the tasks listed above should be conducted with significant attention. If the District feels that its resources are not sufficient to implement warranties, the District should discontinue pursuing warranties until available resources meet the demand.

As part of TxDOT Research Project 0-4498, specifications have been prepared for warranting the following:

- o hot-mix asphalt concrete (HMAC) pavement,
- o surface treatments, and
- o microsurfacing.

Note that if HMAC, surface treatments, or microsurfacing end products are selected, the District would have the advantage of using the warranty specifications and provisions developed

during TxDOT Research Project 0-4498, "Warranty Based Specifications for Construction (*3*)." If a different end product is chosen, the District will need to develop warranty specifications and provisions for that specific end product.

- > Other possible end products that can be warranted are listed below:
  - o concrete pavement,
  - o concrete pavement jointed seal,
  - o pavement marking,
  - o bridge deck waterproofing membrane,
  - o crack treatment,
  - o bridge painting,
  - o bridge deck joints,
  - o roofs,
  - o intelligent transportation system components,
  - o landscaping,
  - o irrigation systems,
  - o bridge components, and
  - o reflective sheeting for signs.
- For Districts that do not have any experience in warranties, it is recommended that one of the warranty end products (HMAC, surface treatments, or microsurfacing) already developed be selected for piloting warranty implementation in the District.
- 4) Is the Product HMAC, Surface Treatments, or Microsurfacing?
- If the end product selected is HMAC, surface treatments, or microsurfacing, proceed to Step 5, Select Project(s).
- If the end product selected is not HMAC, surface treatments, or microsurfacing, proceed to Step 8, Select Product.

Note: Steps 5, 6, and 7 focus on HMAC, surface treatments, and microsurfacing end products. These steps should be followed only if the selected end product is HMAC, surface treatments, or microsurfacing.

#### 5) Select Project(s)

Steps 5 through 7 assume that the end product selected is HMAC, surface treatments, or microsurfacing. At this step the District should select pilot projects. A pilot project is a project that includes one or more highway segments where warranted work is specified. The pilot project may also include highway segments where no warranted work is specified. Not all construction projects are suitable for warranty implementation. The District should select projects that would enable them to fully understand the implementation process and continuously improve the warranty program.

- The District can select one or more projects for piloting. It is recommended that the District not select more than three pilot projects during the initial warranty implementation process.
- The pilot project process may be repeated in successive years to obtain more experience and information about warranty implementation.
- 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, take special care to identify projects whose performance would not be affected by factors beyond the warranty. For example, if a District decides to warrant a pavement overlay, it should make sure that the performance of the underlying base and/or soil is not highly variable thereby negatively impacting the performance of the overlay, that is, there are underlying structural problems associated with the candidate pavement.
- On the other hand, selecting a project with a high probability of success creates a problem for comparing warranty projects with traditional projects. It should be noted that a warranty project selected this way can be difficult to compare with a typical project because the pilot projects could present a biased view. Care would need to be exercised to ensure that pavement sections that have similar conditions be evaluated.

#### 6) State Headquarters Project Approval

After a pilot project is selected, it is recommended that the District notify the Department about their intent for piloting a warranty project. The District should, at a minimum, provide the project information listed below to State Headquarters:

- county,
- highway number,

- limits of project,
- project CSJ,
- time frame for letting and work,
- end product to be warranted (i.e., type of surface to be placed and warranted),
- estimated cost of the warranted work,
- other work to be included in contract and total cost, and
- condition of the end product (i.e., condition of the pavement; good condition with minor cracking).

### 7A) Modify Warranty Specifications and Provisions

The warranty specifications developed for TxDOT Project 0-4498 follow the general format for materials and workmanship warranties. These specifications hold the contractor responsible for correcting defects in work elements during the warranty period resulting from substandard materials and/or workmanship as indicated by exceeding the threshold values for the indicators. Researchers developed the following generic warranty specifications/provisions based on the 2004 Standard Specifications and following TxDOT procedures/formats (see Appendix A):

- 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 following discussion will address specific issues related to implementing warranties and modifying the generic warranty specifications/provisions.

Special Specification, Item 5XXX, Warranted Construction, should be used for any warranty project when combined with the appropriate special provisions.

- The District can use Special Provision Item 341, Dense-Graded Hot-Mix Asphalt (QC/QA), Item 316, Surface Treatments, or Item 350, Microsurfacing depending on the end product selected to be warranted.
- The District will have to make several modifications to Special Provision for Special Specification Item 5XXX, Warranted Construction. At this point, the District will have to determine the length of the warranty period and the penal value of the warranty bond for the warranted end product. Moreover, the District will have to determine if the contractor will be responsible for routine maintenance during the warranty period. It is recommended that the Districts establish three years for HMAC, one year for surface treatments and two years for microsurfacing, as the warranty period. Appendix C provides the warranty bond form that is used by TxDOT. Appendix D provides information about how other state highway agencies determine the penal value of the warranty bond they require on warranty projects.
- As indicated in Special Provisions for Items 341, 316, and 350, warranted end products are evaluated periodically. Each Special Provision has a warranty requirements article that includes a table with warranty indicators, threshold values, and possible remedial actions if one or more threshold values are exceeded. Appendix B provides more information on HMAC, surface treatments, and microsurfacing warranty indicators.
- The District can include as many of the listed warranty indicators as they require for a warranty project. The District has to determine specific threshold values for each of the selected warranty indicators depending on the conditions of the warranty project. Keep in mind that the Contractor should not be held responsible for defects that occur beyond its control; therefore warranty indicators that identify a problem with the Contractor's selection of materials and/or workmanship have been selected. Tables 1, 2, and 3 present the warranty indicators, threshold values, and possible remedial actions for the pilot projects for the various end products. Table 1 presents the warranty indicators, threshold values, and possible remedial actions that were selected by the El Paso District for a warranted hot-mix asphalt concrete project. Table 2 presents the warranty indicators, threshold values, and possible remedial actions that were selected by the Odessa District for a warranted surface treatment project. Table 3 presents the warranty indicators, threshold values, and possible remedial actions that were selected by the Odessa District for a warranted surface treatment project. Table 3 presents the warranty indicators, threshold values, and possible remedial actions that were selected by the Odessa District for a warranted surface treatment project.

A checklist of potential modifications to the generic warranty specifications and provisions is provided in Table 4.

WARRANTY	THRESHOLD VALUE	POSSIBLE REMEDIAL ACTION
INDICATOR		(Alternate remedial actions may be
In Dicition		proposed in the plan.)
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 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.
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 (SN)	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 (IRI)	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 1. Pavement Warranty Indicators, Threshold Values, and Possible Remedial Actions for Warranted Hot-Mix Asphalt Concrete.

	for warranteu Surrace Treatments.		
WARRANTY	THRESHOLD VALUE	POSSIBLE REMEDIAL ACTION	
INDICATOR		(Alternate remedial actions may be	
		proposed in the plan.)	
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 (See Note)	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.	

# Table 2. Pavement Warranty Indicators, Threshold Values, and Possible Remedial Actions for Warranted Surface Treatments.

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

# Table 3. Pavement Warranty Indicators, Threshold Values, and Possible Remedial Actions for Warranted Microsurfacing.

		8
WARRANTY	THRESHOLD VALUE	POSSIBLE REMEDIAL ACTION
INDICATOR		(Alternate remedial actions may be
		proposed in the plan.)
Rutting	1/4 inch during the first 120	Apply additional microsurfacing to
	days following acceptance. Or	eliminate ruts.
	3/8 inch at the end of the	
	warranty period	
Raveling	5% of 0.1 mile segment length	Remove excess asphalt, if necessary, and
		apply microsurfacing to affected area.
Skid Resistance (SN)	20% reduction from the initial	Apply microsurfacing to eliminate the
	skid measurement following	inadequacies.
	the application of	
	microsurfacing	
Bleeding / Flushing	5% of 0.1 mile segment length	Remove excess asphalt, if necessary, and
(See Note)		apply microsurfacing to affected area.
Delamination	2% of 0.1 mile segment length	Remove delaminated microsurfacing and
		apply a new microsurfacing to the affected
		area.

Note: The warranty related to bleeding or flushed areas will not apply to any preexisting bleeding or flushed areas. Pavement area where the rut depth prior to microsurfacing exceeds one (1) inch are excluded from the rutting-related provisions of the warranty.

Specification/Provision	Modification Item(s)	Remark
Special Specification 5XXX, Warranted Construction	Maintenance Responsibility	Determine if the Department or the Contractor would be responsible for pavement–related maintenance
Special Provision to Special	Warranty Bond	Determine the penal value of the warranty bond for the end product
Specification 5XXX	Warranty Period	Determine the warranty period for the selected end product
	Warranty Indicators	Select warranty indicators
Special Provision to Item 3/1	Threshold Values	Determine threshold values for each warranty indicator
Special Provision to Item 341, Dense-Graded Hot-Mix Asphalt (QC/QA)	Possible Remedial Actions	If available, provide more remedial actions for each warranty indicator
	Maintenance Responsibility	If the Department determines to be responsible for maintenance, modify the special provision
Special Provision to Item 316, Surface Treatments	Warranty Indicators	Select warranty indicators
	Threshold Values	Determine threshold values for each warranty indicator
	Possible Remedial Actions	If available, provide more remedial actions for each warranty indicator
	Maintenance Responsibility	If the Department determines to be responsible for maintenance, modify the special provision
	Warranty Indicators	Select warranty indicators
Special Provision to Item 350, Microsurfacing	Threshold Values	Determine threshold values for each warranty indicator
	Possible Remedial Actions	If available, provide more remedial actions for each warranty indicator
	Maintenance Responsibility	If the Department determines to be responsible for maintenance, modify the special provision

# Table 4. Specification/Provision Modification Checklist.

E

In order to illustrate how the warranty specifications can be modified and tailored to fit the needs of the District, the modifications made for a potential pilot project in the El Paso District are presented below:

• Special Specification 5XXX, Warranted Construction;

The generic Special Specification 5XXX 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.

• Special Provision to Special Specification 5XXX;

The generic Special Provision to Special Specification 5XXX was modified 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 determined to be \$300,000. The warranty period for the hot-mix asphalt concrete warranty project was determined as three years.

• Special Provision to Item 341, Dense-Graded Hot-Mix Asphalt (QC/QA); The generic Special Provision to Item 341 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.

7B) Submit Specifications/Provisions to TxDOT Specification Review Committee for Approval

Note: Steps 8, 9, and 10 have to be followed only if the selected end product is <u>not</u> HMAC, surface treatments, or microsurfacing.

#### 8) Select Pilot Project

Steps 8 through 10 assume that the end product selected is <u>not</u> HMAC, surface treatments, or microsurfacing. Not all construction projects are suitable for warranty

implementation. The District should select projects that would enable them to fully understand the implementation process and fine tune the warranty program. A pilot project is defined as a project that includes one or more highway segments where warranted work is specified. The pilot project may also include highway segments where no warranted work is specified.

- The District can select one or more projects for piloting. It is recommended that the District not select more than three pilot projects during the initial warranty implementation process.
- The pilot project process may be repeated in successive years to obtain more experience and information about warranty implementation.
- 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 whose performance would not be affected by factors beyond the warranty.
- On the other hand, selecting a project with a high probability of success creates a problem for comparing warranty projects with traditional projects. It should be noted that a warranty project selected this way would be difficult to compare with a typical project because the pilot projects may present a biased view. This must be taken into account when evaluating the warranty program.

#### 9) State Headquarters Project Approval

After a pilot project is selected, it is recommended that the District notify the Department about its intent for piloting a warranty project. The District should, at a minimum, provide the project information listed below:

- county,
- highway number,
- limits of project,
- project CSJ,
- time frame for letting and work,
- end product to be warranted,
- estimated cost of the warranted work,
- other work to be included in contract and total cost, and
- condition of the end product.

#### 10) Prepare Warranty Specifications and Provisions

At this step, the District should develop the warranty specifications and provisions for the end product selected at Step 4. As part of TxDOT Research Project 0-4498, "Warranty Based Specifications for Construction," warranty specifications and provisions were developed. A number of the specifications developed can be used for any end product selected to be warranted. Researchers recommend use of the following generic warranty specifications/provisions with different end products (see Appendix A):

- 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, and
- Special Provision to Item 7, Legal Relations and Responsibilities.

These generic specifications will need several modifications as identified in the following discussion.

The District will have to make several modifications to Special Provision to Special Specification Item 5XXX, Warranted Construction. At this point, the District will have to determine the length of the warranty period and the penal value of the warranty bond for the end product. Moreover, the District will have to determine if the contractor will be responsible for maintenance during the warranty period. Table 5 presents a summary of the ranges of warranty periods used by other state highway agencies for each end product listed. Appendix D provides more information about how other state highway agencies determine the penal value of the warranty bond they require on warranty projects for HMAC, surface treatments, and microsurfacing end products. The methods provided in Appendix D do not apply here but could be used in a similar way.

Product	Range of Warranty Period (Years)
Concrete Pavement	5-10
Pavement Marking	2-6
Bituminous Crack Treatment	2
Bridge Painting	2-10

Table 5. Range of Warranty Periods for Different End Products.

- The District will have to develop a special provision for the end product selected at Step 4, Select Candidate End Product(s). The District should take the following steps to develop this special provision.
  - Start with the existing standard TxDOT specification for the end product.
  - Identify the articles that need to be modified. Articles related to description and payment should be modified to accommodate the warranty. For example, in Special Provision to Item 341, Dense-Graded Hot-Mix Asphalt (QC/QA), the following was added to the description article: "When shown on the plans, warrant the base course, the level-up course, the surface course or any combination of these courses. Comply with the provisions of Special Specification Item 5XXX, "Warranted Construction," including performing any required remedial actions to correct deficiencies identified in periodic evaluations."
  - The next step is to prepare the articles that should be added to the existing standard TxDOT specification for the end product. The most important one of these articles is related to warranty requirements. In this article, the District should provide information about the warranty indicators, threshold values, possible remedial actions, and evaluation parameters and methods for the end product selected. Warranty indicators and threshold values are used to evaluate a final product. These indicators must be clearly specified in the special provision.
- The District can include as many warranty indicators as they require for the end product warranted. The District has to determine specific threshold values for each of the identified warranty indicators depending on the conditions of the warranty project. Keep in mind that the Contractor should not be held responsible for defects that occur beyond its control;

therefore warranty indicators that indicate a problem with the Contractor's selection of materials and/or workmanship should be selected.

- Identifying warranty indicators and determining the appropriate threshold values for the warranty indicators is the most challenging part of developing a special provision for a warranted end product. Appendix F presents tables including warranty indicators and threshold values used by other state highway agencies for various end products. These tables can be used to aid in the development of special provisions for end products other than HMAC, surface treatments, or microsurfacing. The protocol used for identifying warranty indicators and determining threshold values for HMAC, surface treatments, and microsurfacing is also presented in Appendix G. The District can use this protocol for identifying warranty indicators and determining threshold values for the end product selected to be warranted.
- The District should develop a draft special provision for the selected end product by considering the issues listed above. After the draft provision is developed, local contractors and other stakeholders in the District should be given an opportunity to comment on the provision.
- The comments received should be considered and appropriate modifications to the draft special provision should be made.
- Submit specifications/provisions to TxDOT Specification Review Committee for approval.

#### 11) Prepare Bid Documents

- The District should follow standard TxDOT procedures in order to submit the Plans, Specifications, and Estimate for final review and approval prior to letting the project out for bid.
- All of the specifications including special specifications, and special provisions with PS&E submittals should be submitted to State Headquarters for approval.
- In order to determine the estimate for the project cost, the impact of using warranty specifications on the unit price cost of items related to warranties should be estimated. A summary of the information related to the impact of warranties on the unit bid prices of warranty related items obtained from other state highway agencies is presented in Appendix E. This information can be used by the District while developing the estimate for
the project cost. In order to be conservative the District should anticipate a 5 to 10 percent increase on the unit bid price, as the cost impact of using warranties.

- Figure 3 illustrates the schedule of activities for a typical pilot project. As can be seen from the schedule, the effort required to prepare and send the bid documents can take approximately four months.
- After the warranty specifications and bid documents are submitted to State Headquarters it would take approximately five months before the bid documents are approved and the project goes out to bidding.

Pilot Project Activity		Month											
	1	2	3	4	5	6	7	8	9	10	11	12	
DEVELOP OR MODIFY BASE WARRANTY SPECIFICATIONS 1. Ensure Compatibility with Standard Specification 2. Incorporate the Changes Required													
DISTRICT - SELECTION OF WARRANTY RELATED PARAMETERS													
Warranty Period     Warranty Bond Amount     Retainage Amount     Private Amount													
<ol> <li>Selection of Warranty Indicators</li> <li>Selection/Approval of Evaluation Measures</li> <li>Establish Threshold Values</li> </ol>													
MODIFY BASE WARRANTY SPECIFICATIONS 1. Incorporate Warranty Related Parameters 2. Finalize Warranty Specifications for Submittal													
BIDDING/CONTRACT AWARD 1. Plans Submission to Austin 2. Specification Submission to Austin													
3. Pre-Bid Conference 4. Pilot Project Bidding/Award Contract													

Figure 3. Example Pilot Project Schedule.

#### **Bidding, Contract Award, and Construction Phases**

Steps 12 through 16 of the warranty process describe the Bidding, Contract Award, and Construction phases of the program. These phases are shown in Figure 4.



#### Figure 4. Bidding, Contract Award, and Construction Phases of Process Model.

#### 12) Conduct Pre-Bid Conference

- It is recommended that Districts with little or no warranty contracting experience conduct a pre-bid conference to educate all parties involved with the warranty process.
- > The District should include all items that a normal pre-bid conference would include.
- The District should also include items specifically related to warranty specifications and provisions. The following list identifies several items that can be covered in the conference:
  - List any special site conditions.
  - o Discuss warranty specification structure.
  - Review Special Specifications and Provisions included in the contract.
  - Visit site.
  - Answer questions regarding right-of-way, utilities, design, and construction issues.

During the site visit, sections that would be excluded from warranty requirements due to previously existing problems such as flushing/bleeding should be identified. Indicate these sections on plans.

#### 13) Let Project Out for Bidding

> A warranty project is advertised following the standard TxDOT procedures.

#### 14) Award Construction Contract

- Following the standard TxDOT procedures, the department awards the contract to the lowest qualified bidder.
- The District should record the unit costs bid by the selected contractor so that a cost comparison with traditional projects can be made.

#### 15) Conduct Pre-Construction Conference

- During this conference, the District should address any questions regarding the plans, specifications, and/or contract.
- > The District should reiterate the warranty requirements.
- The District should encourage the contractor to communicate the warranty requirements information to the field construction personnel, so that everyone understands the consequences of substandard workmanship.
- The Conflict Resolution Team (CRT) should be discussed and a plan to form the CRT should be developed during this conference. Two contractor representatives, two representatives from the District, and an independent party mutually agreed upon by the contractor and the District should be identified. Any disputes involving the warranty provisions will be initially processed through the CRT. The CRT must be established prior to the initiation of the warranty period.
- Prior to the contractor performing a warranted item of work a preactivity meeting should be held to emphasize the warranted construction item.

#### 16) Contractor Performs Construction

The District should monitor construction so that construction methods employed can be compared with the methods used in traditional construction projects. The District should track resources used when implementing the warranties. The resources to be tracked should include personnel, equipment, materials, and production rates necessary to perform the evaluation in Step 31.

#### **Maintenance and Evaluation of Performance Phase**

Steps 17 through 29 demonstrate the Maintenance and Evaluation of Performance phases of the warranty program. Figure 5 illustrates this phase of the warranty program.

#### 17) Initiate the Warranty Period

The beginning date of the warranty period is the date of final acceptance of construction of the project unless otherwise noted.

After Step 17, the process splits into two separate, concurrent paths. Steps 18-26 and Steps 27-29 are cycled through concurrently until the end of the warranty period. The two separate paths represent the simultaneous occurrence of routine maintenance with the distress survey and remedial action process.

#### 18) Evaluate Product

- The decision as to what warranty indicators to measure was made at Step 7, Modify Warranty Specifications and Provisions or Step 10, Prepare Warranty Specifications and Provisions.
- The District must collect distress data on the warranty indicators listed in the specifications to evaluate the warranted end product. If the collected distress data for a warranty indicator exceeds the established threshold value, specific remedial actions would be required. Appendix B provides information on how to measure the warranty indicators for HMAC, surface treatments, and microsurfacing end products.
- The District should normally conduct at least one survey every year. More or less frequent evaluations can be conducted by the District.
- > The District should notify the Contractor at least seven calendar days before the evaluation.
- The last survey should be conducted a minimum of 90 calendar days before the warranty period is complete. This time period will enable sufficient time for the Contractor to conduct any remedial action(s), if one or more threshold values are exceeded. The District may conduct subsequent evaluations prior to the end of the warranty period.

- For warranted pavements; the warranted section of pavement should be divided into nominal 1-mile sections that are further divided into 0.1 mile segments. Standard Department pavement evaluation surveys should be conducted on each 0.1-mile segment.
- The District should accumulate the costs associated with distress surveys and remedial actions during the warranty period.



Figure 5. Maintenance and Evaluation of Performance Phases Process Model.

#### 19) Analyze Distress Data to Determine if Remedial Action is Necessary

- The District should compare the results of the annual survey (or additional surveys, if applicable) to the threshold values established for the selected warranty indicators in the specifications.
- Remedial actions are repair or rehabilitation actions required if threshold values for warranty indicators are exceeded.
- Under the warranty specifications, the Contractor is responsible for conducting any remedial action that is necessary.
- Possible remedial actions for each distress type should be included in the warranty specifications.

#### 20) Remedial Action(s) Necessary?

- If any of the threshold values for the warranty indicators are exceeded as identified in Step 19, then remedial action(s) may be necessary.
  - o If no remedial action is required, proceed to Step 25, Warranty Period Complete?
  - If any remedial action is required, proceed to Step 21, Notify Contractor of Required Remedial Action.

#### 21) Notify Contractor of Required Remedial Action

The District should notify the Contractor in writing of any deficiencies requiring remedial action within 14 calendar days after a survey evaluation is completed.

#### 22) Remedial Action(s) Completed by Contractor?

- Within 30 calendar days of notification of required remedial work, the contractor should submit to the District a proposed plan for completing the remedial work.
- The District should take action within 30 calendar days after submittal. If mutually agreeable remedial action(s) cannot be negotiated within 30 calendar days following the submission of the proposed remedial action(s), the issue would be referred to the Conflict Resolution Team for disposition, go to Step 23 (Employ CRT).
- After the District approves the remedial action plan, the Contractor must start the work within 30 calendar days.

- If the required remedial actions are completed by the Contractor, go to Step 25 (Warranty Period Complete?).
- If the required remedial actions are not completed by the Contractor within the given time limits, go to Step 23 (Employ CRT).

#### 23) Employ CRT

- Any disputes regarding the warranty provisions should initially be processed through the CRT.
- If the Contractor disputes the results of the survey, the process for employing the CRT must be invoked.
- The Contractor has 10 calendar days to appeal a District decision, and if the conflict is not resolved within the next 10 calendar days, the dispute would be presented to the CRT.
- If the CRT cannot resolve the issue, the Department's contract dispute and claim procedure would be employed.

#### 24) Issue Resolved?

- > If the CRT successfully resolves the conflict, proceed to Step 25, Warranty Period Complete.
- If the CRT could not resolve the conflict, proceed to Step 26A, Commence Contractor Default Procedures.

#### 25) Warranty Period Complete?

- If there is time remaining in the warranty period after the remedial actions have been completed, return to Step 18, Evaluate Product. Repeat Steps 18 to 26 until the warranty period is complete.
- If the warranty period is complete, proceed to Step 30, Final Inspection/Warranty Termination.

#### 26A) Commence Contractor Default Procedures

If the Contractor refuses or fails to meet the obligations stated in the contract, and the conflict cannot be resolved by the CRT, TxDOT must notify the surety that the Contractor is in default of obligations under the warranty bond.

#### 26B) Surety Performs Required Remedial Action

Under the terms of the warranty bond, the bonding company will be responsible for the performance of the required remedial work. The work performed will be warranted for any time remaining in the warranty period.

#### 27) Identification of Maintenance Needs

- According to the warranty specifications developed as part of the TxDOT Research Project 0-4498, the Contractor is responsible for performing pavement-related maintenance throughout the warranty period. Due to the interrelationship of maintenance and potential remedial requirements, it is desirable to assign pavement-related maintenance responsibilities to the Contractor during the warranty period. However, few contractors are familiar with maintenance activities and many may be geographically located such that subcontracting with a local contractor to address the maintenance requirements may be an appropriate strategy.
- Districts that elect to be responsible for pavement maintenance during the warranty period can modify the generic warranty specifications accordingly so that the Department would be in charge of pavement-related maintenance.
- Depending on the decision made by the District, the party that is responsible for conducting maintenance during the warranty period is responsible for identifying maintenance needs of the warranted end product.
- Maintenance is distinct from remedial action. Remedial action is repair or replacement of deficient areas when one or more threshold values are exceeded as defined in the warranty specifications. Maintenance is performed in order to prevent a distress from reaching a threshold value.

#### 28) Perform Maintenance

- The District should perform routine maintenance during the warranty period. Examples of routine maintenance include:
  - o snow removal,
  - o salting/sanding,
  - o mowing,
  - o lighting maintenance,

- o sign maintenance, and
- o guardrail maintenance.
- The Contractor should perform preventive maintenance during the warranty period unless the Department is assigned that responsibility at Step 27, Identification of Maintenance Needs. Examples of preventive maintenance include:
  - o minor crack-sealing,
  - o crack-filling,
  - o patching of potholes, and
  - o minor overlays.
- Emergency work should be conducted when some form of distress or product failure presents an immediate safety hazard to the traveling public and/or a threat to the integrity of the infrastructure. Examples of emergency work include:
  - o excessively large potholes,
  - o extremely rough section of roadway, and
  - o severe loss of roadway friction.
- > The District should notify the Contractor about the situation that requires emergency work.
- If the Contractor is unable to perform the required work on a timely basis, the District will perform the emergency work on its own, or through outsourcing.
- If the Contractor does not perform emergency work, the Department can bill the Contractor for the work completed.
- If the Contractor refuses or fails to compensate the Department for work performed, go to Step 23, Employ CRT.
- During the warranty period, the Department would be responsible for repairing conditions of the warranted product that were caused by factors that were determined 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.

#### 29) Warranty Period Complete?

- If the warranty period is not complete, return to Step 27, Identification of Maintenance Needs.
- > When the warranty period ends, proceed to Step 30, Final Inspection/Warranty Termination.

#### **Pilot Project and Organizational Program Evaluation Phases**

Figure 6 illustrates pilot project and organizational program evaluation phases.

#### 30) Final Inspection/Warranty Termination

- The last survey should be conducted a minimum of 90 calendar days before warranty period completion, so that there would be sufficient time remaining in the warranty period for the Contractor to conduct a remedial action, if one or more threshold values are exceeded.
- The Contractor should then perform the necessary remedial actions before the end of the warranty period.
- The Department should conduct a final acceptance evaluation after all final remedial actions are completed, in order to determine whether the remedial actions have been satisfactorily completed.
- If the work has been satisfactorily completed, and the product meets all of the evaluation criteria, the warranty would be terminated at that point.

#### 31) Evaluate Warranty Effectiveness

After warranty period completion, it is recommended that the District evaluate the entire project. This is an important step in evaluating the effectiveness of warranties.

- Some important items the District can evaluate are listed below:
  - o the long-term performance of the final constructed project,
  - o the design and testing/inspection personnel required for the project,
  - o the use of Department and outside expertise,
  - o risk assignment factors,
  - o the amount of claims and litigation, if any, and
  - o total cost (construction plus District management).
- The District should document all the costs in order to evaluate the life-cycle cost of the warranted product.
- In order to evaluate the effectiveness of warranties, the District can compare these costs to the costs of other alternative contract methods.
- The contractors, sureties, and other interested parties, as well as District personnel can be surveyed in order to obtain feedback for warranty effectiveness.

- The District can develop a (lessons learned) document and communicate it to all parties.
  This document would include (lessons learned) during the construction and warranty period.
- The District must take into account that pilot projects may present a biased view of the warranty program's effectiveness. If pilot projects are intentionally chosen as projects with a high probability of success, this information must be considered when evaluating the project's results.



Figure 6. Pilot Project and Organizational Program Evaluation Phases Process Model.

#### 32) Policy Decision: Continue Further Implementation of Warranties?

- It is recommended that the District determine if the pilot project (or projects) has met the objectives.
  - The results of the pilot project(s) must be compared with the objectives established in Step 1 (Interested in Using Warranties?).
  - The District should use the information gathered in Step 31, and determine whether the warranty pilot project(s) was cost effective.
  - o Communicate results with the stakeholders.
- Once the warranty process is established and accepted, the District can repeat the process for any other planned end products.
  - If the District does not wish to continue implementing warranties, proceed to Step 33, Discontinue Use of Warranty Contracting Method.
  - If the District wishes to continue the implementation of warranties, proceed to Step 34, Recommend Changes in Warranty Program.

#### 33) Discontinue Use of Warranty Contracting Method

If the policy decision is made not to continue further implementation of warranties, the District should discontinue the use of warranties as an alternative contracting method.

#### 34) Recommend Changes in Warranty Program

- To continue implementation, it is suggested that the District evaluate the warranty program and, where appropriate, modify the program to include additional best practices and (lessons learned).
- Feedback from all stakeholders involved with previous warranty projects is essential in improving the process.
- The District should identify any problems encountered on the pilot project(s) and take appropriate corrective action.
- > The District can recommend changes for the warranty specifications.
- As more experience is gained with warranty contracting, the specifications can be refined to more effectively accomplish the District's program goals.

- Specifically, the threshold values established for each warranty indicator must be carefully evaluated.
- o The District may eliminate a warranty indicator and/or add additional ones.
- It is important that the threshold values be stringent enough to keep project quality at the desired level, but at the same time reasonable and achievable for the contractor.
- The District can attempt to incorporate any advances achieved by TxDOT in the pavement performance evaluation area into the warranty contracting process. It is advantageous to employ statewide standardized distress measurement methods.

#### 35) Refine Warranty Program Using Recommended Changes

- The District can incorporate the changes recommended in Step 34 into the warranty program through revision of Special Specification 5XXX, Warranted Construction, or Special Provisions for Item 341, Dense-Graded Hot-Mix Asphalt Concrete (QC/QA), Item 316, Surface Treatments, and Item 350, Microsurfacing prepared in Step 7, Modify Warranty Specifications and Provisions, or Step 10, Prepare Warranty Specifications and Provisions.
- It is suggested that the District continue this iterative process of improvement throughout the life of the warranty program.
  - Iterations are especially important for the pilot phase.
  - Special attention should be paid when determining the types of projects for which warranties are deemed appropriate.

#### 36) Continue and Expand Implementation of Warranties

Once the warranty program has been modified and the specifications have been revised, the District can consider implementing warranties on additional projects.

- The District can implement the warranty program again using the revised Special Specification 5XXX, Warranted Construction, and Special Provisions for Item 341, Dense-Graded Hot-Mix Asphalt Concrete (QC/QA), Item 316, Surface Treatments, and Item 350, Microsurfacing on a second project.
- > Other end products can be added to the warranty program.
  - It is recommended that the District follow the pilot process again for each new end product by returning to Step 4, Select Candidate End Product and repeating the pilot development and implementation process for the newly selected end product.

- The District must continue to gather cost and distress data on warranty projects and on the process in general.
- The District should collect and update information on life-cycle costs, and improve the effectiveness of the warranty program constantly.
- Warranties are not the appropriate contract administration method for every project.
   However, the warranty program can be effective if applied correctly under the appropriate conditions.

#### CHAPTER 3 FREQUENTLY ASKED QUESTIONS

Frequently asked questions (FAQ) provides information about warranty contracting, warranty terms, and warranty specifications and provisions. The objective of the FAQ is to present answers to questions that may arise during the initial stages of warranty program implementation in a District.

#### 1) What is a warranty?

A warranty is 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 (Hancher 1994 (2)).

#### 2) Why is TxDOT pursuing warranties?

It is desirable that TxDOT be proactive in finding alternative contracting practices in programming and administering projects, including the construction contracting area. Warranty contracting has been used successfully by many states. 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 reduces the level of inspection required during construction. TxDOT is investigating if warranty contracting can be successfully used in Texas.

#### 3) What are some advantages of using warranties?

Several advantages of using warranties are listed below:

- Being 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.
- Improve quality of materials and construction workmanship.

#### 4) What are the disadvantages?

Several disadvantages of using warranties may include the following:

• reduced number of bidders,

- lack of knowledge and fear of risks on the part of the contractor, and
- increased bid prices.

#### 5) What is a warranty period?

A warranty period is a pre-specified time period, in which the contractor is required to repair defects in the warranted product. Warranty periods vary by type of warranty and type of product (9).

#### 6) How is the length of the warranty period determined?

The ideal warranty period should be long enough to provide assurance of pavement performance, but not so long as to unnecessarily inflate contract prices (9).

#### 7) When does a warranty period begin?

The beginning date of a warranty period is the date of final acceptance of the construction phase of a warranted project or a portion thereof, if specified.

#### 8) Can there be multiple beginning days for the warranty period on given projects?

Yes. If a significant section of a project is constructed while the contractor continues to work on other segments of the project, it may be appropriate to start the warranty period on the completed section of the project when it is opened to traffic.

#### 9) What kinds of projects are suitable for warranties?

Projects where the existing pavement has minimal structural problems are more suitable for warranties. Moreover, it is desirable that warranted end product performance be quantified and measured.

#### 10) Can segments of a project be excluded from warranty requirements?

Yes, segments of a project can be excluded from warranty requirements provided that those segments have a pre-existing distress that cannot be corrected/rectified by the warranty project. For example, if a segment of a pavement project exhibits flushing/bleeding before construction, that segment could be excluded from warranty requirements because it may not be the contractor's fault if that segment shows signs of flushing after construction. This excluded segment must be identified prior to the letting.

## 11) How is it guaranteed that the contractor would fulfill his responsibility under warranty provisions?

It is guaranteed that the contractor would fulfill the warranty, because he has to provide a warranty bond.

#### 12) What is a warranty bond?

The 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.

#### 13) What should the penal amount of warranty bond be?

When determining the penal value for the warranty bond, the Department should consider the worst–case scenario, which is when the contractor does not fulfill the warranty requirements. The penal amount set for the warranty bond should be sufficient to ensure that the warranty requirements can be met during the warranty period either by the surety bonding company or the Department. For further information on how to determine the penal value of the warranty bond, refer to Appendix D.

#### 14) What is a warranty indicator?

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 warranty indicator for HMAC.

#### 15) What is a threshold value?

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.

#### 16) What are the responsibilities of the Department during the warranty period?

The Department's responsibilities during the warranty period include the following:

- Conduct annual evaluations of the warranted product.
- Analyze distress data to determine if remedial action is necessary.
- If remedial action is necessary, notify the Contractor.
- If the conditions require immediate attention for the safety of the public, and the Contractor can not perform the required work on a timely basis, the District should

have the necessary work performed, at the Contractor's expense, with the District's personnel or through outsourcing.

- Review and approve or disapprove Contractor's proposed remedial action plan.
- If remedial action is not completed by the Contractor, employ the conflict resolution team (CRT).
- If the CRT can not resolve the dispute, notify the surety of contractor default.
- Repair conditions of the warranted product. These factors may include, but are not limited to, major accidents, major flooding, and other Acts of God.
- Conduct a final inspection of the warranted product, and terminate the warranty if inspection is satisfactory.

#### 17) Who is responsible for maintenance under the warranty provisions?

Under the warranty provisions developed for TxDOT Project 0-4498, the Contractor is responsible for maintenance.

#### **18)** How are emergency repairs handled?

If, in the opinion of the Engineer, conditions related to the warranty indicators require immediate attention for the safety of the public, the Contractor should perform the required work on a timely basis. If the contractor cannot perform the required work on a timely basis, the Engineer should have the necessary work performed, at the Contractor's expense, with the District's personnel or through outsourcing. Any work thus performed would not alter the requirements, responsibilities, or obligations included in the warranty.

### **19**) Why is it desirable to provide the Contractor as much flexibility as practical to select materials, methods, etc. for the warranty project?

It is desirable to provide the Contractor with as much flexibility as practical to select materials, methods, etc. for the warranty project for two main reasons. First, when more flexibility is provided to the Contractor, it is more likely that the contractor would employ the use of innovative materials and/or methods, which can increase the quality of the product while keeping the life–cycle cost of the project low. Second, if the Contractor is constrained by the Department to select certain materials and methods for the warranty project and one or more threshold values are exceeded during the warranty period, the Contractor can blame the Department's constraints for the inadequate performance of the warranted end product.

#### 20) Are the selected warranty indicators within the control of the Contractor?

Yes, the selected warranty indicators are within the control of the Contractor. The warranty indicators selected were identified to be the ones that could be caused by the Contractor using lower quality materials or employing inadequate construction methods.

### 21) Who is responsible for product deficiencies that result from accidents or other events outside the control of the Contractor?

The Department is responsible to correct deficiencies that result from accidents or other events that are outside the control of the Contractor.

#### 22) When does the contractor submit the warranty bond?

The contractor submits the warranty bond within 15 days after written notification of award of contract.

## 23) Is the completed remedial action covered by warranty requirements? If so, what is the warranty period?

Yes, the completed remedial action is covered by warranty requirements. However, the warranty period for the remedial action(s) performed does not extend beyond the original warranty period.

#### 24) How frequently should evaluations be conducted?

Each of the listed warranty indicators should normally be measured annually. More or less frequent evaluations may be conducted as considered necessary by the Department.

#### 25) Do all evaluations have to be formal (i.e., evaluate each 0.1-mile segment)?

No, all evaluations do not have to be formal. The Department can conduct a formal evaluation on each 0.1–mile segment or just on those segments where one or more distresses are evident.

## 26) Will the Department consider remedial actions other than the "Possible Remedial Actions" listed in the specifications?

Yes, the Department will consider remedial actions other than the "Possible Remedial Actions" listed in the specifications.

## 27) Why is the final scheduled evaluation required to be conducted at least 90 days before the end of the warranty period?

The final scheduled evaluation should be conducted a minimum of 90 calendar days before the warranty period completion, so that there would be sufficient time left for the Contractor to conduct a remedial action(s), if one or more threshold values are exceeded.

# 28) Can the Department conduct evaluations within the last 90 days of the warranty period?

Yes, the Department can conduct evaluations within the last 90 days of the warranty period if considered necessary.

#### 29) When should the Conflict Resolution Team be formed?

The conflict resolution team should be discussed and a plan to form the CRT should be developed during the pre-construction conference. The CRT should be formed prior to the initiation of the warranty period.

#### CHAPTER 4 SUMMARY

The Texas Department of Transportation has continued to be proactive in finding innovative practices in programming and administering projects, including the construction contracting area. Warranty specifications have shown potential to reduce the life-cycle cost of facilities while ensuring the quality of constructed facilities. Further, the use of warranty specifications has reduced the level of inspection required during construction.

This document provides the warranty contracting implementation plan developed for TxDOT Project 0-4498. The TxDOT plan is based on guidelines for warranty contracting developed for the National Cooperative Highway Research Program. These existing guidelines were modified to fit within the TxDOT design, contracting, and maintenance system. Warranty specifications were developed for hot-mix asphalt concrete, surface treatments, and microsurfacing.

The purpose of the implementation plan is to provide TxDOT District personnel with the information and decision points necessary to successfully implement warranties. The plan provides the steps that the District has to take to implement a warranty contracting program. Districts planning to implement warranty contracting for the first time and districts that have previous experience with warranties can make use of these guidelines.

#### REFERENCES

1. 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.

2. Hancher, D., *NCHRP Synthesis of Highway Practice 195: Use of Warranties in Road Construction*. Transportation Research Board, National Research Council, Washington, D.C., 1994.

3. Anderson, S.D., Blaschke, B., Trejo, D., and Erbatur, O.C., *Texas Department of Transportation Report 0-4498-1: Draft Warranty Specifications*. Texas Department of Transportation, Austin, 2003.

4. Ohio Department of Transportation, *Implementation of Warranted Items on Construction Projects*, 2002.

5. Wisconsin Department of Transportation, *Asphaltic Pavement Warranties Five-Year Progress Report*, 2001.

6. Wisconsin Department of Transportation, *Asphaltic Pavement Warranties 2002 Progress Report*, 2003.

7. Aschenbrener, T.B., and DeDios, R.E., *Materials and Workmanship Warranties for Hot Bituminous Pavement*. Colorado Department of Transportation, December 2001.

8. Minnesota Department of Transportation, *Use of Design/Build and Warranties in Highway Construction*, 1999.

9. Federal Highway Administration (FHWA), *Asphalt Pavement Warranties Technology and Practice in Europe, Executive Summary*, European Asphalt Pavement Warranties Scanning Tour, 2004.

10. Warranty symposium that had been conducted from May 5, 2003, to May 7, 2003, at the Michigan Local Technical Assistance Program (LTAP) Center, Grand Rapids, Michigan.

### APPENDIX A GENERIC WARRANTY SPECIFICATIONS AND PROVISIONS BASED ON 2004 STANDARD SPECIFICATIONS

2004 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:

**A. 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.

- **B.** 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.
- **C. Warranty on Remedial Action(s).** The warranty period for the remedial actions performed will not extend beyond the original warranty period.
- **D.** 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.
  - **A. 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.
  - **B.** 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 bolding Requirements					
Contract Amount	<b>Required Bonds</b>				
Less than \$25,000	None				
\$25,000 to \$100,000	Payment				
More than \$100,000	Performance and Payment				

 Table 1 Bonding Requirements

- **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.

2004 Specifications

#### **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.
2004 Specifications

## **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; 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.

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, 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.

**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 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 this report 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.

#### 3. 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

2004 Specifications

## 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 this report 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	THRESHOLD VALUES	POSSIBLE REMEDIAL
INDICATOR		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 this report 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 actionss 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 WARRANTY INDICATORS FOR HMAC, SURFACE TREATMENTS, AND MICROSURFACING

#### TXDOT PROJECT 0-4498 WARRANTY BASED SPECIFICATIONS FOR CONSTRUCTION GUIDELINE FOR MEASURING WARRANTY INDICATORS FOR WARRANTED HOT-MIX ASPHALT CONCRETE PAVEMENTS

The objective of this guideline is to provide information related to the identified HMAC warranty indicators. Not only the guideline provides a description for each of the warranty indicators identified, but also, it presents possible causes of these distresses, and measurement procedure for each warranty indicator. The threshold values determined and possible remedial actions for each of the warranty indicators are presented in TxDOT Special Provision Item 341--00X, "Dense-Graded Hot-Mix Asphalt (QC/QA)."

The identified warranty indicators are listed below:

- Rutting
- Alligator Cracking
- Raveling
- Longitudinal Joint Cracking
- Shoving
- Potholes
- Slippage Cracking
- Skid Resistance (SN)
- Ride Quality (IRI)

#### Rutting

"A rut is a longitudinal surface depression in a wheelpath (Figure B.1). Rutting in the rated lane may be observed in one or both of the wheelpaths. Consolidation or lateral movement of the pavement materials due to traffic loads causes rutting. Significant amounts of rutting indicate that one or more of the pavement layers is inadequate to support the applied loads."(2) When the warranted pavement layer is severely rutted, the pavement along the edges of the rutted area may be raised. Usually, rutting occurs gradually along the wheel path, reaching to a maximum depth in the center of the wheel path. Rutting is indicative of a structural problem and may lead to the onset of serious structural failures. "Moreover, when water begins to pond in the wheel path, hydroplaning of fast moving vehicles becomes a possibility, and the safety of the motoring public is jeopardized. In cold climates this water may freeze, creating a slick condition."(1)

Several possible causes of rutting are listed below:

- densification of the pavement materials due to insufficient initial compaction,
- improper mix design,
  - o excessive asphalt binder,
  - o excessive filler material,
  - o too many rounded particles in coarse and/or fine aggregates,
  - o asphalt that is too soft for the condition, and
  - o aggregate gradation too close to maximum density line.

#### How to Measure

Rutting is measured throughout the 0.1-mile warranty evaluation segment using an approved method of measurement (a minimum of a 6-foot straight edge or string and a measuring device). Each wheelpath is measured separately as shown in Figure B.2. Rutting is rated by recording the maximum rut depth in inches rounded to the tenths for the 0.1-mile evaluation segment. This method of measurement is used only when the automated measurement method is not able to accurately test the pavement or when a 'manual' audit is being performed.



Figure B.1. A Typical Case of Rutting.



Figure B.2. Measurement of Rutting with a Straightedge.

#### **Alligator Cracking**

"Alligator cracking consists of interconnecting cracks which form small, irregularly shaped blocks that resemble the patterns found on an alligator's skin (Figure B.3). Blocks formed by alligator cracks are less than 1 foot by 1 foot (0.3 meter by 0.3 meter)."(2) Vertical or horizontal movement of the pavement resulting from traffic loads creates tension in the pavement layers resulting in alligator cracking.

In alligator cracking, cracks surface initially as a series of parallel longitudinal cracks within the wheel path that progress with time and lead to a more branched pattern that begins to interconnect. The stage, at which several discontinuous longitudinal cracks begin to interconnect, is defined as alligator cracking. Eventually the cracks interconnect sufficiently to form many pieces, resembling the pattern of an alligator.

Several possible causes of alligator cracking are listed below:

- poor pavement drainage, and
- burned or aged asphalt binder in the warranted layer.

#### How to Measure

Alligator cracking is measured in square yards. Alligator cracking is measured by recording the area of each alligator cracking occurrence in the 0.1-mile evaluation segment.



Figure B.3. A Typical Case of Alligator Cracking.

#### Raveling

"Raveling is the progressive disintegration of a HMAC layer from the surface downward as a result of the dislodgement of aggregate particles."(1) Figure B.4 illustrates typical raveling of a hot-mix asphalt concrete pavement. A raveled pavement may create a safety problem if a depression deep enough to hold water forms in the pavement surface, which could cause hydroplaning.

Several possible causes of raveling are listed below:

- using dirty, dusty, or soft aggregate;
- inadequate compaction during construction;
- insufficient asphalt content in the mix;
- excessive heating during mixing (oxidation or hardening of asphalt);
- asphalt hardening due to aging;
- segregation of aggregate; and
- construction of pavement during wet and/or cold weather.

#### How to Measure

Raveling is measured in square yards. Raveling is rated by recording the area of each raveling occurrence in the 0.1-mile evaluation segment.



Figure B.4. Raveling in HMAC Pavement.

#### Longitudinal Joint Cracking

When placing HMAC, paving the full width of the pavement in a single pass is usually impossible; therefore, most bituminous pavements contain longitudinal construction joints. Premature deterioration of multilane HMAC pavements can occur at these longitudinal joints in the form of cracking. Longitudinal joint cracks are individual cracks that run parallel to the centerline of a roadway as shown in Figure B.5. This distress is caused by relatively low density and surface irregularity at the joints. "These cracks allow water to penetrate into the underlying layers, possibly softening the nonstabilized layers and accelerating the development of alligator cracks radiating outward from the longitudinal crack."(1)

Several possible causes of longitudinal joint cracking are:

- improper compaction of the joint area, particularly at the edge of the lane paved first;
- not creating proper taper on first pass;
- developing improper overlap for the second pass;
- placing insufficient material in the second pass to match final grade between two passes; and
- mix segregation at the outside edge of each pass.

#### How to Measure

Longitudinal joint cracking is measured in feet. Cracks that are less than 1/16 inch in width are not rated. Longitudinal joint cracking is measured by recording the total length of the crack in the 0.1-mile evaluation segment.



Figure B.5. A Typical Case of Longitudinal Joint Cracking.

#### Shoving

"Shoving is a longitudinal and/or transverse displacement of a localized area of the pavement surface. It is generally caused by braking or accelerating vehicles, and is usually located on hills or curves (transverse), or at intersections."(*3*) Shoving occurs when there is shear flow of asphalt mixture or slippage between layers. Figure B.6 illustrates a typical case of shoving.

Several possible causes of shoving are:

- excessive asphalt binder in mix,
- excessive filler material in mix,
- too many rounded particles in coarse and/or fine aggregates,
- unstable mix, and
- asphalt that is too soft for the condition.

#### How to Measure

Localized depressions greater than 0.5-inch in depth as measured by a 10-foot straightedge are rated as shoving. Shoving is rated by recording the total number of shoving occurrences in the 0.1-mile evaluation segment.



Figure B.6. Shoving.

#### Potholes

Potholes are bowl-shaped voids or depressions that penetrate all the way through the surface of HMAC under warranty and into the base course. Potholes form when moisture seeps into the pavement and weakens it. Furthermore, traffic loosens the pavement even more, and it eventually crumbles and pops out; thus a pothole is created. Freeze-thaw cycles exacerbate this problem. Figures B.7 and B.8 show several potholes.

Several possible causes of potholes are:

- poor pavement drainage,
- water infiltration to the base,
- insufficient pavement thickness,
- use of insufficient asphalt content in mix,
- use of excess or insufficient amount of fine aggregate in mix,
- poor bonding of pavement layers during construction, and
- neglecting to fix other types of pavement distresses as shown in Figure B.8.

#### How to Measure

Potholes greater than 1.0-square foot in area and 1.0 inch in depth should be rated. If multiple smaller potholes as shown in Figure B.7 form in the evaluation segment, the total area covered by these smaller potholes should be measured. Potholes are rated by recording the total number of pothole occurrences in the 0.1-mile evaluation segment.



Figure B.7. Typical Potholes.



Figure B.8. Alligator Cracking Turns into a Pothole.

#### **Slippage Cracking**

"Slippage cracks typically occur as a result of poor bond between the HMAC surface and the underlying layer."(1) Insufficient bond between surface layer and the course beneath is due to improper tack coat, dust, oil, dirt, rubber, and/or water between the layers. These cracks are most likely to occur where vehicles brake, turn, or accelerate. Slippage cracks form a distinctive crescent-shape. Figure B.9 illustrates a typical case of slippage cracking occurrence on a bus stop, where buses brake and accelerate.

#### How to Measure

Slippage cracking is measured in number of occurrences. Slippage cracks are rated by recording the total number of slippage crack occurrences in the 0.1-mile evaluation segment.



Figure B.9. A Typical Case of Slippage Cracking.

#### **Skid Resistance**

Skid resistance is defined as the force developed when a tire that is prevented from rotating slides along a wetted pavement surface. Skid resistance is an important pavement evaluation parameter for the reasons listed below:

- It is a measure of how quickly a vehicle can be stopped.
- It is an important safety-related property of the pavement surface.
- It is a measure of serviceability.

#### How to Measure

Standard TxDOT Skid Resistance measurement procedure will be used to evaluate the warranted pavement. Standard TxDOT procedure is a modified version of the ASTM Standard E 274, "Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire." The modifications consist of the following:

- Test speed will be 50 mph.
- Smooth tire will be used.
- Water will be applied at 35 gpm from the pavement wetting system.

#### **Ride Quality (Roughness)**

Pavement roughness is generally defined as an expression of irregularities in the pavement surface that adversely affect the ride quality of a vehicle. Ride quality is measured in terms of International Roughness Index (IRI). "The IRI is a scale for roughness based on the response of a generic motor vehicle to roughness of the road surface. Its true value is determined by obtaining a suitably accurate measurement of the profile of the road, processing it through an algorithm that simulates the way a reference vehicle would respond to the roughness inputs, and accumulating the suspension travel. Thus, it mathematically duplicates a road meter."(4)

#### How to Measure

Ride quality will be evaluated by measuring the average IRI for the 0.1-mile evaluation segment. Ride quality will be measured as described in TxDOT Special Specification Item 5880, "Ride Quality for Pavement Surfaces."

#### TXDOT PROJECT 0-4498 WARRANTY BASED SPECIFICATIONS FOR CONSTRUCTION GUIDELINE FOR MEASURING WARRANTY INDICATORS FOR WARRANTED SURFACE TREATMENTS PAVEMENTS

The objective of this guideline is to provide information related to the identified surface treatments warranty indicators. The guideline not only provides a description for each of the surface treatments warranty indicators identified, but also, it presents possible causes of these distresses, and how to measure each warranty indicator. The threshold values determined and possible remedial actions for each of the warranty indicators are presented in TxDOT Special Provision Item 316--XXX, "Surface Treatments."

The identified warranty indicators are listed below:

- aggregate loss/shelling, and
- flushing/bleeding.

#### **Aggregate Loss/Shelling**

Perhaps the most common problem in surface treatments is the loss of some or all of the cover aggregate after pavement is opened to traffic. Figures B.10 and B.11 illustrate typical cases of aggregate loss. Several possible causes of aggregate loss in surface treatments are listed below:

- insufficient asphalt binder,
- poor rolling of longitudinal seam between applications,
- lack of timely or insufficient rolling to properly seat the aggregate,
- dusty aggregate,
- asphalt may have cooled too much, and
- weather not warm enough when treatment applied.

#### How to Measure

Aggregate loss is measured in percentage of lane length that is distressed by loss of aggregate. Aggregate loss is rated by recording the total length in feet affected on each warranted lane during the evaluation segment and dividing that by the total length of the evaluation segment. This measurement is linear and not dependent on the area of the aggregate loss.



Figure B.10. Aggregate Loss/Shelling



Figure B.11. Aggregate Loss/Shelling

### Flushing/Bleeding

Flushing is indicated by an excess of bituminous material on the pavement surface which presents a shiny, glass-like reflective surface that may become sticky in hot temperatures. Figures B.12 and B.13 illustrate typical cases of flushing. Several possible causes of flushing are listed below:

- excess asphalt application,
- insufficient or excess covering aggregate application,
- lack of proper rolling during placement, and
- failure to protect a newly constructed surface from traffic until the asphalt has cured sufficiently.

#### How to Measure

Flushing loss is measured in percentage of lane length that is distressed. Flushing is rated by recording the total length in feet affected on each warranted lane during the evaluation segment and dividing that amount by the total length of the evaluation segment. This measurement is linear and not dependent on the area of the flushing.



Figure B.12. Severe Flushing.



Figure B.13. Moderate Flushing.

#### TXDOT PROJECT 0-4498 WARRANTY BASED SPECIFICATIONS FOR CONSTRUCTION GUIDELINE FOR MEASURING WARRANTY INDICATORS FOR WARRANTED MICROSURFACING PAVEMENTS

The objective of this guideline is to provide information related to the identified microsurfacing warranty indicators. The guideline not only provides a description for each of the warranty indicators identified, but also, it presents possible causes of these distresses, and rating procedure for each warranty indicator. The threshold values determined and possible remedial actions for each of the warranty indicators are presented in TxDOT Special Provision Item 350---00X, "Microsurfacing."

The identified warranty indicators are listed below:

- rutting
- skid Resistance (SN)
- flushing/bleeding
- raveling
- delamination

#### Rutting

"A rut is a longitudinal surface depression in a wheelpath (Figure B.14). Rutting in the rated lane may be observed in one or both of the wheelpaths. Consolidation or lateral movement of the pavement materials due to traffic loads causes rutting. Significant amounts of rutting indicate that one or more of the pavement layers is inadequate to support the applied loads."(2) When the warranted pavement layer is severely rutted, the pavement along the edges of the rutted area may be raised. Usually, rutting occurs gradually along the wheel path, reaching to a maximum depth in the center of the wheel path. Rutting is indicative of a structural problem and may lead to the onset of serious structural failures. "Moreover, when water begins to pond in the wheel path, hydroplaning of fast moving vehicles becomes a possibility, and the safety of the motoring public is jeopardized. In cold climates this water may freeze, creating a slick condition."(1)

Several possible causes of rutting are listed below:

- densification of the pavement materials due to insufficient initial compaction,
- improper mix design,
  - o excessive asphalt binder,
  - o excessive filler material,
  - o too many rounded particles in coarse and/or fine aggregates,
  - o asphalt that is too soft for the condition, and
  - o aggregate gradation too close to maximum density line.

#### How to Measure

Rutting is measured throughout the 0.1-mile warranty evaluation segment using an approved method of measurement (a minimum of a 6-foot straightedge or string and a measuring device). Each wheelpath is measured separately as shown in Figure B.15. Rutting is rated by recording the maximum rut depth in inches for the 0.1-mile evaluation segment. This method of measurement is used only when the automated measurement method is not able to accurately test the pavement or when a 'manual' audit is being performed.



Figure B.14. A Typical Case of Rutting.



Figure B.15. Measurement of Rutting with a Straightedge.

#### **Skid Resistance**

Skid resistance is defined as the force developed when a tire that is prevented from rotating slides along a wetted pavement surface. Skid resistance is an important pavement evaluation parameter for the reasons listed below:

- It is a measure of how quickly a vehicle can be stopped.
- It is an important safety-related property of the pavement surface.
- It is a measure of serviceability.

#### How to Measure

•

Standard TxDOT Skid Resistance measurement procedure will be used to evaluate the warranted pavement. Standard TxDOT procedure is a modified version of the ASTM Standard E 274, "Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire." The modifications consist of the following:

- Test speed will be 50 mph.
- Smooth tire will be used.
- Water will be applied at 35 gpm from the pavement wetting system.

#### Flushing/Bleeding

Flushing is indicated by an excess of bituminous material on the pavement surface which presents a shiny, glass-like reflective surface that may become sticky in hot temperatures. Figures B.16 and B.17 illustrate typical cases of flushing. Several possible causes of flushing are listed below:

- excess asphalt application,
- insufficient or excess covering aggregate application,
- lack of proper rolling during placement, and
- failure to protect a newly constructed surface from traffic until the asphalt has cured sufficiently.

#### How to Measure

Flushing loss is measured in percentage of lane length that is distressed. Flushing is rated by recording the total length in feet affected on each warranted lane during the evaluation segment and dividing that amount by the total length of the evaluation segment. This measurement is linear and not dependent on the area of the flushing.


Figure B.16. Severe Flushing.



Figure B.17. Moderate Flushing.

## Raveling

"Raveling is the progressive disintegration of a flexible pavement layer from the surface downward as a result of the dislodgement of aggregate particles."(I) Figure B.18 illustrates a typical case of raveling. A raveled pavement may create a safety problem if a depression deep enough to hold water forms in the pavement surface, which could cause hydroplaning.

Several possible causes of raveling are listed below:

- using dirty, dusty, or soft aggregate,
- inadequate compaction during construction,
- insufficient asphalt content in the mix,
- excessive heating during mixing (oxidation or hardening of asphalt),
- asphalt hardening due to aging,
- segregation of aggregate, and
- construction of pavement during wet and/or cold weather.

#### How to Measure

Raveling is measured in percentage of lane length that is distressed. Raveling is rated by recording the total length in feet affected on each warranted lane during the evaluation segment and dividing that by the total length of the evaluation segment. This measurement is linear and not dependent on the area of raveling.



Figure B.18. A Typical Case of Raveling

# Delamination

Delamination is a physical separation of the microsurfacing from the underlying pavement surface.

## How to Measure

Delamination is measured in number of occurrences. Delamination is rated by recording the total number of delamination occurrences in the 0.1-mile evaluation segment.

#### **References for Appendix B**

- 1. Roberts, F., Kandhal, P.S., Brown, E.R., Lee, D.Y., and Kennedy, T.W., "Hot-Mix Asphalt Materials, Mixture, Design, and Construction," NAPA Education Foundation, Lanham, Maryland, 1996.
- 2. Texas Department of Transportation Pavement Management Information System Rater's Manual for Fiscal Year 2003.
- 3. "Distress Identification Manual for the Long-Term Pavement Performance Project," Strategic Highway Research Program, Washington, D.C., 1993.
- 4. Gillespie, T.D., "Everything You Always Wanted to Know about the IRI, But Were Afraid to Ask," Road Profile Users Group Meeting, September 22-24, 1992, Lincoln, Nebraska.

# APPENDIX C TXDOT WARRANTY BOND FORM

A typical wa	rranty bond	document used b	y TxDOT is	provided below.
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	•			
WARRANTY BOND	CONTRACT NO. XXXXXXX COUNTY XXXXX ET			
	BOND NO.			
KNOW ALL PERSONS BY THESE PRESENTS, t	hat we as Principal, and the			
other undersigned as Surety, are held and firmly bound unto the	State of Texas, as Obligee, in the penal sum			
of Dollars (\$ <u>000,000.00</u> ), la	wful money of the United States, well and			
truly to be paid to the State of Texas, and we do bind ourselves,	our and each of our heirs, administrators,			
executors, successors, and assigns, jointly and severally, by thes	e presents.			
WHEREAS, the above bounden Principal has entered in Texas attached hereto;	nto the foregoing Contract with the State of			
WHEREAS, the State of Texas requires that the Princi guarantee for the warranty period as specified in the Contract af defects in materials and workmanship which may become appar	ter approval by the State of Texas against all			
NOW THEREFORE, THE CONDITIONS OF THIS OBLIGATION ARE SUCH that if the Principal shall indemnify and save harmless the State of Texas from all costs and damage that the State of Texas may sustain by reason of any defective materials or workmanship which become apparent during the warranty period as specified in the Contract from the date of acceptance by the State of Texas of the work, and shall fully reimburse and repay the State of Texas all outlay and expense that the State of Texas may incur in remediating any defective materials or workmanship, then this obligation shall be void, otherwise to remain in full force and effect.				
PROVIDED FURTHER, that the Surety for value received, hereby stipulates and agrees that no change, extension of time, alteration or additions to the terms of Contract between the Principal and the State of Texas, or the work to be performed thereunder, or the specifications accompanying the same, shall in any way affect its obligation under this bond. The Surety does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the Contract, work, or specifications, unless otherwise specified in the Contract.				
WITNESS our hand this, day of	, 20			
<u>xxxxxxxxxxx</u>				
CUDETV (Drint Firm Manne and Carl)	By:			
<b>SURETY</b> (Print Firm Name and Seal)	(Title)			
*By:(Title)	By:			
(Title)	(Title)			
SURETY (Print Firm Name and Seal)	SURETY (Print Firm Name and Seal			
*By:	*By:			
*Note: A Power of Attorney, showing that the surety officer such obligation, must be impressed with the corporate seal a				
This form has been approved by the <b>ATTORNEY GENERAL OF INSURANCE.</b>	OF TEXAS & TEXAS DEPARTMENT			

# APPENDIX D WARRANTY BONDING SUMMARY

This Appendix summarizes the warranty bonding information obtained from other state highway agencies (SHAs) that are currently using warranty contracting. Every state using hotmix asphalt concrete, seal coats, or microsurfacing warranties except for Florida require a warranty bond on their warranty projects. Table D.1 is a summary of the approaches each state used for determining the surety bonding requirements for different products.

Table D.1. Summary of Donuing Requirements				
States	Products Warranted	Bonding Requirements		
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		
	HMAC	\$1,000,000 or 5% of full contract amount (whichever is less)		
Michigan	Seal Coat	100% of warranted work for seal coat		
	Microsurfacing	100% of warranted work for microsurfacing		
Minnesota	НМАС	20% of the total bid amount for the warranted bituminous pavement		
Willinesotu	Microsurfacing	100% of the total bid amount for warranted microsurfacing		
Mississippi	HMAC	Specified amount		
	HMAC	90% of the total bid amount for warranted asphalt concrete surface course		
Ohio	Seal Coat	75% of the total bid amount for warranted seal coat		
	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		

 Table D.1. Summary of Bonding Requirements

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 of range 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 course as shown below:

<u>Course 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 cost 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 simply specifying an amount. The amount specified depends on the warranted product and the characteristics of the project. A different bond amount can be specified for each project. For example, Mississippi DOT (MISSDOT) required a warranty bond of \$1,100,000 on one of their hot-mix asphalt projects.

Typically, the SHA requires that a contractor provide proof of a warranty bond or combination of bonds for the entire warranty period. Several states, such as Mississippi, Ohio, and Wisconsin require the bonding company to have an "A.M. Best Company" 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 supply the bond. SHAs can require a single term bond, or 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 a two-year renewable bond.

# APPENDIX E UNIT PRICE COST IMPACT OF WARRANTIES

## EEFECTS OF WARRANTIES ON UNIT PRICE COSTS IN OHIO, WISCONSIN, COLORADO, AND MICHIGAN

The objective of this paper is to provide information about the effects of implementing warranty contracting on the unit price costs of warranted items. In order to accomplish this objective reports published by several state highway agencies were reviewed. The reports reviewed include "Ohio DOT - Implementation of Warranted Items on Construction Projects," "Wisconsin DOT - Asphaltic Pavement Warranties: 2002 Progress Report," "Colorado DOT - Materials and Workmanship Warranties for Hot Bituminous Pavements: A Cost – Benefit Evaluation," and "Michigan DOT - Status Report on Road Warranties."

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

In 1999, Ohio Department of Transportation (ODOT) established a set of warranty contract requirements for implementation in highway construction projects. The warranty specifications developed, as shown in Table E.1, cover pavements, bridge decks and other maintenance items with varying warranty periods. This report provides cost comparison, techniques, and quality comparisons for warranted and non-warranted items and recommendations for future use of warranties. This paper focuses on the cost comparison between warranted and non-warranted items.

		Application	
	Period		
Asphalt Pavement	5 & 7 years	Designed rehabilitated/new pavement 3 inches or greater	
-		overlay thickness	
Asphalt Pavement	3 years	Other overlays on multilane, divided, trial	
Concrete Pavement	7 years	Designed pavement structure, overlay	
Deck Overlay	2 years	First overlay only	
Class S Concrete	7 years	New bridge deck	
High Performance	7 years	New bridge deck	
Concrete			
Bridge Paint	5 years	Existing superstructure steel only	
Micro-surfacing	3 years	For existing asphalt pavement from average to good	
		conditions	
Chip Seal	3 years	For existing asphalt pavement average to good	
		conditions	
Hot Recycling	3 years	For existing asphalt pavement average to good	
		conditions and good structure	
Crack Seal	2 years	For existing asphalt pavement average to good	
		conditions	
Saw & Seal	2 years	As part of rehabilitation overlay for existing asphalt	
		pavement	
Pavement Marking	3 & 5 years	All markings; Warranty period depends on marking	
	-	type	

**Table E.1. ODOT Warranty Specifications.** 

When ODOT published the report in 2000, it had 69 warranty projects under construction and 94 warranty projects scheduled for construction in fiscal year 2001. The DOT has observed that the inclusion of warranty specifications has raised the project cost in the form of higher unit bid prices as shown in Table E.2.

Item Description	Unit	Warranty	Average Unit Cost		Percent
		Duration	Wannantad	Nor	Price
		(Years)	Warranted	Non Warranted	Increase
Asphalt Pavement	Cubic Yard	5 and 7	\$50	\$46	9%
Asphalt Pavement	Cubic Yard	3	\$68	\$63	8%
Concrete Pavement (11")	Square Yard	7	\$30	\$28	7%
Concrete Pavement (12" & 13")	Square Yard	7	\$31	\$27	15%
Pavement Markings	Miles	3	\$788	\$291	171%
Pavement Markings	Miles	5	\$1,710	\$1,571	9%
New Concrete Deck, class S	Cubic Yard	7	\$484	\$457	6%
New Concrete Deck, HPC	Cubic Yard	7	\$514	\$499	3%
Bridge Painting	Square Yard	5	\$5.11	\$4.06	26%

Table E.2. Fiscal Year 2000 Warranty Cost Comparison.

Even though ODOT has developed microsurfacing and chip seal warranty specifications, at the time there were no projects implemented; therefore unit bid price data was not available.

#### Wisconsin DOT - Asphaltic Pavement Warranties: 2002 Progress Report

In 2003, Wisconsin Department of Transportation (WisDOT) published a report documenting its experience with asphaltic pavement warranties. This paper focused on the cost comparison between warranted and non-warranted items as provided in the report.

Since 1995 WisDOT has been building asphaltic concrete pavements with a warranty specification. As of 2002, 45 asphaltic warranty projects were built. The development of the asphaltic concrete warranty specification was a cooperative effort between WisDOT, the Wisconsin Asphalt Pavement Association (WAPA) and the Wisconsin Division Office of the Federal Highway Administration (FHWA). The warranty process allowed WisDOT to define the final product in terms of condition and performance.

On asphaltic warranty projects, the contractor is responsible for the asphaltic mixtures (including mix design, materials, quality control, and construction) and any required warranty work for a period of five years following opening the pavement to traffic. Under newer warranty contracts, the contractor also assumes responsibility for crack sealing during the first five years.

As indicated in the report, assessing cost effectiveness of a warranty program is difficult until there is sufficient performance data to indicate long-term trends. At the time this report was published, WisDOT decided to compare the project costs of warranted and standard (nonwarranted) contracts. In order to create a valid comparison basis, a list of cost factors were developed for each contract type as listed below:

#### Costs included in Standard Contracts

- mixture bid price
- asphalt bid price
- tack coat bid price
- quality management bid price
- state delivery costs
- state maintenance costs for 5 years

#### Costs included in Warranty Contracts

- asphalt pavement warranted bid price
- state delivery costs (reduced from standard contracts)

Table E.3 provides the results of the costs analysis. As an illustration, cost items included in standard contracts for the year 2001 are provided below:

Standard Contracts 2001 (medium volume mix)

(Average values statewide for projects of similar size in 2001)	
Mixture bid	\$17.77/ton
Asphalt bid	\$10.01/ton
Tack Coat bid	\$0.13/ton
Quality Management	- \$0.51/ton
State Maintenance	- \$2.07/ton
STANDARD TOTAL (w/o delivery costs) = \$30.49/ton	

Year	Standard Contracts Costs (\$/ton)		Warranted Contracts Costs (\$/ton)
	Without Delivery Costs	With Delivery Costs	
1995-1999	27.72	28.05	24.34
2000	31.25	31.57	29.45
2001	30.49	30.81	26.66

Table E.3. Comparison of Project Costs.

In summary, warranty projects cost less per ton than standard projects. For the first 45 warranty projects, the available data indicates that warranties are cost-effective, that is, they not only cost less, but they also produce a better performing pavement. However, it should be noted that there have been a few warranty project bids that have been rejected due to differences between the engineer's estimate and the bids.

There is a general interest by the Department in improving the accuracy of the project cost estimates. Warranty projects represent one small aspect of this emphasis area. The Asphaltic Pavement Warranted item is most often the major difference between the bid price and the engineer's estimate.

# **Colorado DOT - Materials and Workmanship Warranties for Hot Bituminous Pavements:** A Cost – Benefit Evaluation

In order to determine the cost effectiveness of warranties in Colorado, Colorado Department of Transportation (CDOT) published a report in December of 2001. In this report, CDOT provides background information, methodology of cost evaluation, and results of the cost analysis. CDOT evaluated six warranty projects that included three projects whose warranty terms had expired. Each warranty project was compared to a similar non-warranted project. The cost comparisons included costs for the initial Hot Bituminous Pavement (HBP), maintenance, pavement evaluation team, weigh-in-motion station, and construction engineering. An analysis was also conducted on the competition, performance, and use of experimental features.

According to the report, there was 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. The exception was the longitudinal cracking on the C-470 project.

A list of all the short-term, materials and workmanship HBP projects included in the report is shown below:

- Region 2: IM 0252-312, I-25 South of Fountain (constructed summer of 1998)
- Region 6: NHS 4701-085, C-470 from Santa Fe to Wadsworth Blvd. (constructed summer of 1998)
- Region 4: C 0361-157, US-36, E&W of Superior Interchange (constructed summer of 1998)
- Region 2: IM 0251-157, I-25, North of Pueblo (constructed summer of 2000)
- Region 3: IM 0702-222, I-70, Eagle to Avon (constructed summer of 2000)
- Region 3: NH 0501-038,US-50, East of Kannah Creek (constructed summer of 2001)
- Region 2: SH-67 (constructed summer of 2001)

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

As 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.

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 equal or greater level of attention to testing and quality control than normal projects, and three of the five projects had 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 was a result of the QC / QA initiative that started about 10 years ago in Colorado. 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. According to the report, the warranty task force should reconvene to evaluate the areas of concern that developed after the construction of these five projects.

The initial cost was objectively analyzed four different ways using the six projects available at the time. The average initial cost from those 24 analyses is that warranties cost \$0.85 per ton or 1.6% less than non-warranted projects. Subjective evaluation by the Cost Benefit Evaluation Committee and the survey of the contractors on these six projects indicated that the initial warranty cost was negligible.

Considering the variability in the data and the limited number of projects, the initial cost of the three-year warranty was considered negligible. With the limited data, the cost of the warranty on new construction is slightly less expensive than overlays. The key point should be the scoping of the project. If the rehabilitation selected is appropriate, then the risk and associated cost will likely be negligible.

The selection of binder grading merits some discussion. On five of the six projects, the contractor had used low-temperature binder grading recommended by CDOT. This meant that CDOT was responsible for the thermal cracking on five of the projects. On the sixth project the contractor used an inferior low-temperature grade of binder and also took the responsibility for filling the transverse cracks. CDOT had no requirements for the selection of the high temperature binder grade. The warranty specification required the contractor to perform remedial action when the rutting was greater than 8 mm in depth. For a comparison of HBP costs refer to Figure E.1.



Annual Region Avg DAvg Bid - Same Grading Estimate Warranty Project Control Projects Contro

The summary of the overall additional cost analysis for the three-year pavement warranty projects as compared to the control projects is shown in Table E.4.

Item	Cost Differential per Project
Initial Bid	Negligible
(Based on 6 projects) Maintenance (Based on 3 projects)	Negligible
Pavement Evaluation Team	\$ 5,400
Weigh-In-Motion Station	\$ 80,000
Total	\$ 85,400

Based on the information from the six warranty projects that were available at this time, the overall additional cost of a warranty project with a three-year term was estimated to be

approximately \$ 85,400, which is equal to 2.85% of the total cost of a project. The approximate cost of a warranty project was \$3 million.

#### Michigan DOT – Status Report on Road Warranties

One of the leading users of warranty contracting, Michigan Department of Transportation (MDOT), published a report in May 2003 to provide information on the status of road warranties in Michigan. The report includes a background on warranties, forensic investigation process of MDOT, warranty administration, and recommendations for future use of warranties. The report does not offer a detailed warranty cost analysis, but the effects of warranties on initial bid prices is briefly mentioned in the report.

According to this report, MDOT has been using warranties since 1996. The warranty projects completed each year after that has increased from one in 1996 to 152 in 2002. During this span, MDOT has used warranties on a total of 604 projects. According to the report, before the implementation of warranties MDOT expected that over a period of time, bids on warranty projects would be higher than the non-warranty ones as a result of the risk being transferred from MDOT to contractor. After 604 warranty projects, MDOT has not seen an increase in the bid costs to date. In fact, there is cost savings associated with warranties since these projects require less construction oversight by MDOT. However, it is noted in the report that there are significant costs associated with administering the warranty program. This is mainly due to the large number of warranty projects that have been undertaken by MDOT. The rest of the report discusses this problem and introduces a database and guidelines for administering warranties.

# APPENDIX F WARRANTY INDICATOR TABLES FOR VARIOUS END PRODUCTS

Identifying warranty indicators and determining the appropriate threshold values for the warranty indicators is the most challenging part of developing a special provision for a warranted end product. Tables including warranty indicators and threshold values used by other state highway agencies for various end products are presented in this Appendix. These tables can be used to aid in the development of special provisions for end products other than HMAC, surface treatments, or microsurfacing. The tables are taken from NCHRP Report 451, "Guidelines for Warranty, Multi-Parameter, and Best Value Contracting."

State		Threshold Level	Corrective Action Required
	Indicator		_
ME	Water leakage through the joint.		
ME	Separation of the seal from the steel or concrete substrate.		
ME	Failure of materials such as cracking, chalking, scaling, peeling, and splitting.		Damaged seals shall be removed and replaced with new seals. Seals that are
ME	Sagging of elastomeric seal.		displaced shall be completely removed; the joint shall be cleaned, and the seal
ME	Warping of the steel plate or extrusion detrimental to the functioning of the joint.		may be reinstalled if not damaged during removal. Steel components that are damaged or misaligned shall be restored in accordance with standards.
ME	Separation of the steel plate or extrusion from the deck concrete.		
ME	Spalling or delamination of the deck concrete within 0.5m either side of the joint.		

Table F.1. Performance Indicators for Bridge Deck Joints.

State	Performance Indicator	Threshold Level	Corrective Actions Required
MI		control section fail.	Reseal or refill all failed work in the entire control section.

State	Performance	Threshold Level	Corrective Actions Required
	Indicator		
IN	Visible Rust or Rust Breakthrough	1% of the surface area of any painted structural member.	Repair to meet acceptance criteria set forth in the painting specifications.
IN	Paint Blistering	Occurrence.	Repair to meet acceptance criteria set forth in the painting specifications.
IN	Peeling	Occurrence.	Repair to meet acceptance criteria set forth in the painting specifications.
IN	Scaling	Occurrence.	Repair to meet acceptance criteria set forth in the painting specifications.
IN	Non-removed Slivers	Occurrence.	Repair to meet acceptance criteria set forth in the painting specifications.
IN	Damage to Coating System Caused by Contractors	Occurrence.	Repair to meet acceptance criteria set forth in the painting specifications.
IN	Paint Applied over Dirt, Debris, or Rust	Occurrence.	Repair to meet acceptance criteria set forth in the painting specifications.
IN	Coating Thickness	As stated in specifications.	Repair to meet acceptance criteria set forth in the painting specifications.
MD	Blistering	1%-10% failure of	
MD	Chalking	a bridge element or	Remove defective paint, rust, etc.
MD	Peeling	component.	Recoat.
MD	Rust	10% or more failure	Evaluate entire component or
MD	Scaling	of a bridge element or component.	element, totally reclean and repaint entire member if necessary.
MD	Fascia	Considered unsightly by the Administration.	Recoat fascia beam.
ME	Visible Rust or Rust Breakthrough	Occurrence.	Repair as directed by paint manufacturer's technical department.
ME	Blistering, Peeling, or Scaling of Paint	Occurrence.	
ME	Paint Applied over Dirt, Debris, Rust Products, Blasting Debris, or Mill Scale Products	Occurrence.	

Table F.3. Performance Indicators for Bridge Painting.

	I I G	ſ	
	Incomplete Coating		
_	or Coating		
ME	Thickness Less	Occurrence.	
	than Specified by		
	the Manufacturer		
	Damage to Painting		
	System Caused by		
ME	Design-Builder's	Occurrence.	
	Operations during		
	Construction.		
ME	Fading or Chalking	0	
ME	Paint	Occurrence.	
<b>х</b> лт	Rust/Rust	0	Repair in accordance with the painting
MI	Breakthrough	Occurrence.	specifications.
		Occurrence.	Repair in accordance with the painting
MI	Paint Blistering		specifications.
	<b></b>		Repair in accordance with the painting
MI	Peeling	Occurrence.	specifications.
			Repair in accordance with the painting
MI	Scaling	Occurrence.	specifications.
			Repair in accordance with the painting
MI	Unremoved Slivers	Occurrence	specifications.
	Damage to Coating		
MI	System Caused by	Occurrence.	Repair in accordance with the painting
1011	Contractors	Occurrence.	specifications.
	Incomplete Coating		
	or Coating		
MI	Thickness Less	As stated in	Repair in accordance with the painting
MI	than the Minimum	specifications.	specifications.
	Specified		
MI	Paint Applied over	0	Repair in accordance with the painting specifications.
	Dirt, Debris, or	Occurrence.	
	Rust		*

State		Threshold Level	Corrective Actions Required
2	Indicator		· · · · · · · · · · · · · · · · · · ·
	Color RD	75% Minimum.	
FL	Red-Green Reflectance	(-5) to (+5)	Replace.
	Yellow-Blue Reflectance	(-10) to (+10).	
FL	Durability	50% loss of thermoplastic material.	Replace.
FL	Retroreflectivity	<150 mcd/l*m <sup>2</sup> for 5 years after installation.	Replace.
MN	Retroreflectivity, White	275 mcd/l*m <sup>2</sup> Initial. 150 mcd/lxm <sup>2</sup> After one winter.	Remove and replace.
MN	Retroreflectivity, Yellow	180 mcd/l*m <sup>2</sup> Initial. 120 mcd/l*m <sup>2</sup> After one winter.	Remove and replace.
MT	Color	Color does not reasonably match the specified federal standard color chips.	Replace material.
MT	Durability	Average line width less than 90% of specified width in any one-mile segment, or deterioration affects reflectivity.	Replace material.
MT	Retroreflectivity, Yellow	Initial: 150 mcd/(m <sup>2</sup> *lux). Semi-annual: 100 mcd/(m <sup>2</sup> *lux).	Repair or replace (at the discretion of the engineer) all lines that drop below minimum level within 6 months of request.
MT	Retroreflectivity, White	Initial: 195 mcd/(m <sup>2</sup> *lux) Semi-annual: 130 mcd/(m <sup>2</sup> *lux).	Repair or replace (at the discretion of the engineer) all lines that drop below minimum level within 6 months of request.
PA	Retroreflectivity, White	Average retroreflectivity within any 528 ft (161m) section less than 125 mcd/(m2*lux).	Replace material using equal or better material; \$500 per hour lane rental; \$2000 per day for each day more than 30 after notification (weather permitting).

 Table F.4. Performance Indicators for Pavement Marking.

			1
		Average	
PA	Retroreflectivity,	retroreflectivity within	
	Yellow	any 528 ft (161m)	
		section less than 100	
		mcd/(m2*lux).	
		Markings are	
		discolored or exhibit	
		pigment loss, and are	
		determined to be	
		unacceptable by the	
РА	Discoloration or	three-member team**	
ГA	Pigment Loss	based on a visual	
		comparison with the	
		sample color plates	
		with glass beads	
		originally submitted by	
		the contractor.	
	Missing	15% of total area of a	
PA	Missing	line within any 161-	
	Segments	meter section.	
		White markings must	
	Calar Canturat	provide a minimum	If threshold values are not maintained,
UT	Color Contrast	yellow index of 30	the product is subject to a 100% refund
	and Stability***	measured with a	of the installed price of the material as
		mobile colorometer.	bid in the original plans.
		90% of the surface area	
		of the markings on any	
		1000 ft segment must	
UT	Durability	be present as measured	
	(presence)***	by ASTM D-913	
		Number 6 Clipping	
		Chart.	
		125	
UT	Retroreflectivity ***	millicandles/ft2/foot	
		candle.	
L	1		I

\*Loss of material due to snowplow damage or abnormal wear during warranty period is allowed.

\*\*Pennsylvania's warranted pavement is evaluated at maximum intervals of 12 months by a 3-member team consisting of one member from the Department, one member from the Contractor, and one member who is mutually acceptable to the Department and the Contractor.

\*\*\*The work of the contractor and any subcontractors must be warranted by the material manufacturer for these items.

\*\*\*\*Loss due to pavement failure will not be included in the percent loss.

	Performance		
State	Indicator	Threshold Level	Corrective Actions Required
ME	Cracking	Deeper than 15 mm for total length of 100 m.	Epoxy injection (contractor must demonstrate that the injection is complete and effective), or removed and replaced from curb to curb with transverse joints square to the centerline.
М	Debonding from Deck	Occurrence.	Remove and replace from curb to curb with transverse joints square to the centerline.
ME	Spalling	$>10,000 \text{ mm}^2$ . cumulative area $>10\text{m}^2$ .	None specified.
ME	Chloride Penetration	Content of 175 g/m <sup>2</sup> or greater to a depth $> 25$ mm.	Remove and replace from curb to curb. Transverse joints must be square to the centerline.
UT	Corner Breaks	Crack is not spalled for more than 10% of its length; There is no measurable faulting; and the corner piece is not broken into two or more pieces. 2 panels per 1.5 lane kilometers.	Full depth repair.
UT	Durability ("D") Cracking	Existence of crescent shaped hairline cracking with no loose or missing pieces.	Total slab replacement.
UT	Longitudinal Cracking	Cracks of width less than 3mm, no spalling, and no measurable faulting; or well sealed and with a width that cannot be determined. 4 slabs per 1.5 lane kilometers.	Full depth slab replacement.
UT	Transverse Cracking	Low severity cracks of width less than 3mm, no spalling, and no measurable faulting; or well sealed and with a width that cannot be determined. 4 slabs per 1.5 lane kilometers.	Seal low severity cracks. If cracking exceeds low severity, replace slab full depth.

Table F.5. Performance Indicators for Co	oncrete Pavement.
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UT	Transverse Joint Seal Damage	Joint sealant damage as described by SHRP. Extrusion, hardening, adhesive failure, cohesive failure, or complete loss of sealant over 10% of joint length per 1.5 lane kilometers.	Reseal joints.
UT	Longitudinal Joint Seal Damage	Joint sealant damage as described by SHRP. Extrusion, hardening, adhesive failure, cohesive failure, or complete loss of sealant over 10% of joint length per 1.5 lane kilometers.	Reseal joints.
UT	Spalling of Longitudinal Joints	Low severity spalls less than 75mm wide, measured to the center of the joint, with loss of material, or spalls with no loss of material and no patching. Low extent = less than 5% of joint length per 1.5 lane kilometers or 25% of an individual joint.	Fill void with hot pour sealant if severity is low. If low severity is exceeded, then repair partial depth.
UT	Spalling of Transverse Joints	Low severity spalls less than 75mm (3 in.) wide, measured to the center of the joint, with loss of material, or spalls with no loss of material and no patching. Low extent = less than 5% of joint length per 1.5 lane kilometers or 25% of an individual joint.	Fill void with hot pour sealant if severity is low. If low severity is exceeded, then repair partial depth.
UT	Surface Crazing	5% of surface area per 1.5 lane kilometers.	Seal.

UT	Scaling	Deterioration of upper concrete surface over 5% of surface area per 1.5 lane kilometers.	Seal.
UT	Map Cracking	Existence of cracks that extend only into upper surface of slab compromising structural capacity of pavement.	Total slab replacement.
UT	Polished Aggregate	Surface mortar and texturing worn away such that skid resistance is less than 40 at the end of 4 and 9 years.	Abraid or grind surface to exceed skid resistance values required.
UT	Popouts	3 or more small pieces of pavement broken loose from surface per square meter.	Replace as needed.

State		Threshold Level	Corrective Action Required
	Indicator		
ME	Membrane Leakage.	Evidence on the bottom of the bridge deck indicating membrane leakage.	Deveryon of the own one the
ME	Potholes or Shoving.	Physical damage to the membrane caused by the potholes or shoving.	Pavement removed to expose the affected membrane and allow replacement membrane to be applied in accordance with the manufacturer's recommendations. The affected
ME	Other damage resulting from pavement rehabilitation during construction or required warranty repairs caused by the Design- Builder.	Existence.	membrane shall be completely removed and replaced, the pavement removed to expose the affected membrane shall be replaced, in addition to all pavement markings and rumble strips affected.

 Table F.6. Performance Indicators for Bridge Deck Joints/Waterproof Membranes.

# APPENDIX G PROTOCOL DEVELOPED FOR DETERMINING WARRANTY INDICATORS AND THRESHOLD VALUES FOR HMAC, SURFACE TREATMENTS, AND MICROSURFACING

## Warranty Based Specifications for Construction Performance Indicators and Threshold Values Meeting Protocol

As provided in the agenda, the meeting would start with an introduction from TTI, which would include a brief project overview. TTI would emphasize the meeting objectives and provide information about the importance of choosing appropriate distress indicators for the evaluation of a warranted project. TTI would also provide information about the potential warranty indicators for asphalt concrete, surface treatments, and microsurfacing products. TTI would provide posters for various types of distresses for asphalt concrete and surface treatments products. The posters would include three pictures for each distress type at various severity levels ranging from low to high. Moreover, the posters would provide descriptions and evaluation techniques for each of the distress types from both the TxDOT Pavement Management System (PMIS) and the Distress Identification Manual for the Long-Term Pavement Performance Project (LTPP Manual).

# Warranty Indicator Ranking Process

The steps for the warranty indicator selection process are listed below.

- Hang all asphalt concrete posters on the walls side-by-side, and group the distresses into three categories:
  - 1. Indicator of substandard materials and/or poor workmanship
    - Examples: Flushing, low skid number, raveling, rutting, etc.
  - 2. Indicator of substandard performance
  - Examples: Poor ride quality, low skid number, rutting, alligator cracking, etc.
  - 3. Indicator of needed maintenance
    - Examples: Transverse and longitudinal cracking, potholes, etc.
- Discuss if any other warranty indicator that is not identified on the posters should be added to the list of potential warranty indicators.
- Ask each member to rank the warranty indicators according to their importance as a warranty indicator in a warranty project.
- Let *n* equal the total number of candidate warranty indicators for an end product (either asphalt concrete or surface treatments). An example for the point system is provided at the end of this Appendix.
  - Each  $1^{st}$  place vote a warranty indicator will receive "*n*" points.
  - Each  $2^{nd}$  place vote a warranty indicator will receive "*n*-1" points, and so on.
  - For a last place vote, a warranty indicator will receive 1 point.
- A member may decide not to rank a warranty indicator he/she thinks is not applicable. In such a case the warranty indicator will receive 0 points from that member.
- The warranty indicators would be ranked using post-it notes. Each member can make his/her ranking and then write the rank for each warranty indicator on a separate post-it note. The post-it notes will then be attached to the respective poster.
- The votes for each warranty indicator would then be computed using the point system described earlier.

• The warranty indicators would then be listed on a blackboard with their points in descending order.

If at this stage a warranty indicator that is currently not being measured in TxDOT PMIS is selected, it should be noted that a new methodology for evaluating that warranty indicator has to be developed by TxDOT.

## **Determine the Threshold Values for the Identified Warranty Indicators**

The steps to determine the threshold values for the selected warranty indicators are listed below.

- Leave the posters of the identified asphalt concrete warranty indicators on the wall.
- Ask the members to indicate an appropriate range of threshold values for each warranty indicator on a post-it note and attach on the respective posters. Each member should provide a minimum and a maximum value for each warranty indicator. (Make sure everyone uses the same unit of measurement.)
- Calculate the average minimum and maximum threshold value for each warranty indicator.
- On the blackboard, next to the list of identified warranty indicators, write the calculated threshold values for the corresponding warranty indicator.
- Discuss with the panel whether the listed threshold values are appropriate.
- Modify the threshold values according to the discussion.
- Finalize the threshold values for each asphalt concrete warranty indicator.

Repeat the same procedures to rank the surface treatments and microsurfacing warranty indicators and determine the appropriate threshold values.

#### **Meeting Deliverables**

The final output of this meeting would be a guidance report for the Districts. The guide would include a set of warranty indicators and threshold values for both asphalt concrete, surface treatments, and microsurfacing products. Furthermore, the guide would provide information on how the identified warranty indicators would be measured.

# **Example Point System**

Assume there are 10 potential warranty indicators and 6 panel members. Longitudinal Cracking has received 2 first place, 1 third place, 1 fourth place, 1 fifth place, and 1 seventh place vote. The aggregate score for Longitudinal Cracking can be calculated by:

= (2\*10) + (1\*8) + (1\*7) + (1\*6) + (1\*4) = 45 points out of 60 = 75%

Placement 1997	Points
1	10
2	9
3	8
4	7
5	6
6	5
7	4
8	3
9	2
10	1

## TXDOT PROJECT 0-4498 WARRANTY BASED SPECIFICATIONS FOR CONSTRUCTION MEETING AGENDA

9:00 - 9:05 am	Opening Remarks and Introductions
9:05 - 9:15 am	Meeting Objectives and Process
9:15 – 9:30 am	Discuss Potential Pilot Projects
9:30 – 10:00 am	Overview of Potential Asphalt Concrete Performance Indicators
10:00 - 11:00 am	Rank Asphalt Concrete Performance Indicators Describe the Selection Process Voting on the Posters Count the Votes on the Posters List the Performance Indicators on board Determine which Performance Indicators to Select
11:00 – 12:00 pm	Determine the Threshold Values for Asphalt Concrete Performance Indicators Describe the Process Estimate the Threshold Values for the PIs List the range of Threshold Values on the board
12:00 – 1:00 pm	Lunch
1:00 – 1:45 pm	Discuss results - Finalize PIs and TVs
1:45 – 2:15 pm	Overview of Potential Surface treatments Performance Indicators
2:15 - 3:15 pm	Rank Surface treatments Performance Indicators
3:15 – 4:15 pm	Determine the Threshold Values for Surface treatments Performance Indicators
4:15 – 4:50 pm	Discuss results - Finalize PIs and TVs
4:50 – 5:00 pm	Wrap Up