

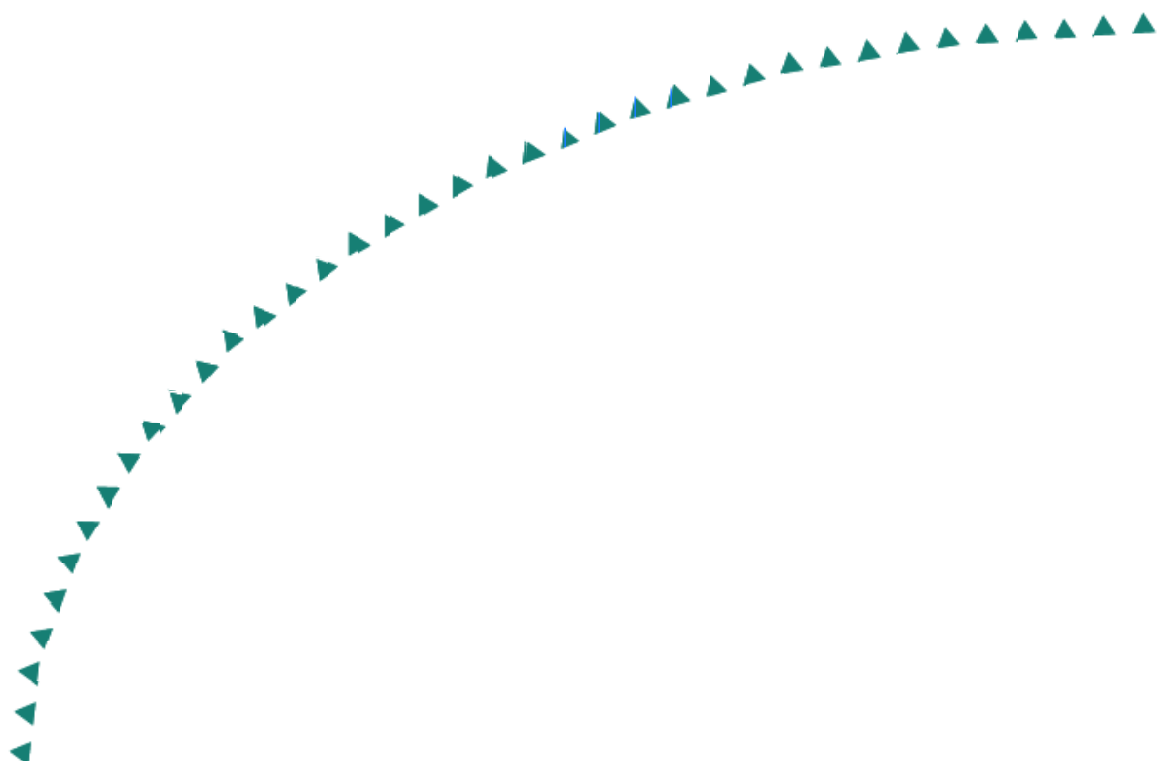
2004-40

Final Report

Use of Warranties
In
Highway Construction



Research



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USE OF WARRANTIES IN HIGHWAY CONSTRUCTION

FINAL REPORT

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EXECUTIVE SUMMARY

The use of warranties in roadway construction is a hot topic at the state and local level. Agencies across the board are looking for innovative ways to deliver construction projects and reduce maintenance costs and time commitments. This report examines how warranties may offer some relief.

Why are state and local agencies looking into using warranties for roadway construction? The answer is an increased expectation for quality, along with a changing agency structure that results in smaller staffs, **less** inspection, and **less** control over projects.

This report is an update of a 1999 report also published by the Minnesota Local Road Research Board (LRRB) Research Implementation Committee (RIC). Since then, the Minnesota Department of Transportation (Mn/DOT) has worked to incorporate 2- and 5-year warranties into their bituminous pavement specifications and has also initiated several design-build projects. In response to that, and due to the increasing interest in the use of warranties and performance specifications on local projects, the RIC asked that the 1999 report be updated with additional guidance for implementing a warranty program at the local level.

In addition, National Cooperative Highway Research Program (NCHRP) Report 451, titled *Guidelines for Warranty, Multi-Parameter, and Best Value Contracting*, was recently published. This report outlines recommendations for agencies interested in implementing a warranty and its synthesis may offer assistance to local agencies considering the use of warranties in roadway construction. That report is summarized in this document, along with 34 steps for an agency to consider on its way to implementing a warranty program.

The current status of warranty use in Minnesota and other states is also provided.

You can download and print a number of documents incorporated within this report by reference. Since the links to these documents are scattered throughout the report, we have listed them below for your convenience.

Use of Warranties in Highway Construction (the electronic version).
<http://www.lrrb.org/pdf/200440.pdf>

Pavement Warranty Symposium Final Report
http://www.tdcfiles.com/Warranty_Symposium_Final_Report.pdf

ASPHALTIC PAVEMENT WARRANTIES FIVE-YEAR PROGRESS REPORT - JUNE 2001 -
<http://www.dot.wisconsin.gov/library/research/docs/finalreports/tau-finalreports/warranties.pdf>

Contract Administration and Oversight Guidelines for Projects Containing Warranty Work
http://www.michigan.gov/documents/IM02-23_54178_7.pdf

NCHRP Report 451, Guidelines for Warranty, Multi-Parameter, and Best Value Contracting
http://trb.org/publications/nchrp/nchrp_rpt_451-a.pdf

Mn/DOT Bituminous Web site
<http://www.mrr.dot.state.mn.us/pavement/bituminous/bituminous.asp>

I. INTRODUCTION

Agencies are experiencing pressure to improve cost, time, and quality in project development and delivery. They are also looking to implement more innovative delivery systems. Warranties may be the answer to some of these issues. They are attractive because they encourage best construction practices, uniform materials and high quality workmanship. They also allow some transfer of the pavement performance risk and accountability to the parties that actually construct the pavement. Warranties may also encourage contractor innovation and reduce agency resources needed to administer construction projects.

What is driving the move to more warranties? The answer is an increased expectation for quality in highway construction, along with a changing agency structure, which results in fewer people, more design-build projects, less inspection available from the owner's side, and reduced control over projects.

Warranty contracting places a greater emphasis on the quality of the constructed product rather than the traditional design-bid-build contracting method and shifts some of the post-construction performance risk for facility products from the state agency to the contractor. Under a warranty specification, quality is measured based on actual product performance and not on the properties of the construction materials. A warranty is 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."

Warranties can include a combination of quality control (QC) and quality assurance (QA) specifications with performance-based specification. Warranty specifications are a form of performance specifications, but they also often contain QC requirements. Similar to performance-based specifications, the contractor is responsible for the performance of their product and must have experience with QC procedures to monitor the production. With a warranty, the contractor assumes both construction and post-construction performance risk. Annual inspection of the end product by the agency supplements the construction QA portion of the typical QC/QA specifications.

Under a warranty program, the contractor may have more freedom to select the materials and construction methods than under a traditional methods-based specification. A contractor may develop a tailored QC program to fit each project. With warranties, a contractor's knowledge and experience may be fully used without the restrictions inherent in methods-based specifications.

NCHRP Report 451, titled *Guidelines for Warranty, Multi-Parameter, and Best Value Contracting*, outlines recommendations for agencies interested in implementing a warranty. The report examined six critical issues:

1. Selection criteria – Project size, complexity, type
2. Bidding system – Compatibility with low bid system
3. Agency resources – Compatibility with less staff at agency level
4. Risk allocation – Assign more risk to contractor and less to agency
5. Bonding requirements – May change requirements and affect project quality or cost
6. Quality aspects – Improved quality and performance should result

Research for this study was performed in two phases:

1. A survey of current practices in warranties. In addition, contract methods in non-transportation construction industries were studied. Seven products were proposed for warranties, and three were selected, including warranties with emphasis on hot-mix asphalt concrete paving (HMAC).
2. Guidelines were developed for each contracting method.

This report will provide information to local agencies interested in implementing a warranty program. A status report is given for warranty use in Minnesota as well as warranty use across the United States. The advantages and disadvantages of requiring warranties are outlined. Finally, guidelines for implementation are provided.

II. STATUS OF WARRANTIES IN MINNESOTA

HISTORY

Mn/DOT has been working to incorporate warranties into pavement projects since the mid 1990s, when both Wisconsin and Michigan began using two- and five-year warranties.

Some of the milestones in pavement warranties are listed below:

- 1996 The FHWA ruled that warranties are no longer experimental.
- 1998 The New Mexico design-build warranty project on Highway 44 included a 20-year pavement warranty and maintenance requirement at a cost of \$62 million.
- 1999 Minnesota LRRB Report 1999-37 recommends two-year warranties.
- 2001 Mn/DOT design-build project on TH 14/218 includes a five-year pavement warranty.

During fall 2001, the Mn/DOT Bituminous Warranty Task Force developed a short-term asphalt pavement warranty. The Task Force was a joint effort between Mn/DOT, Minnesota Asphalt Pavers Association, and the FHWA. The task force met three times in fall 2001 and developed a pilot bituminous overlay two-year warranty specification for use in 2002 on three projects. The warranty covered transverse cracking, longitudinal joints, debonding, raveling, flushing, popouts and rutting. Those three projects that were bid using the two-year bituminous overlay warranty specifications were:

1. SP 2512-10, Highway 60 from TH 63 to TH 52 – a 3-inch overlay, 12 miles over two lanes
2. SP 8604-30, Highway 25 from TH 12 to Buffalo – 3-inch mill and overlay, 10 miles over two lanes
3. SP 2744-54, Highway 212 from Pioneer Trail to I-494 – 3.5 inch mill and overlay, three miles over four lanes

Table 1 – Bid Analysis for Three Minnesota Pilot Projects

State Project No.	Number of Bidders	Bit. Mix Type	Low Bid \$/ton	Range all Bidders \$/ton	District Average Non-warranty \$/ton
2512-10	3	SP (2, B) SP (2, E)	20.77 24.30	20.77-27.00 24.30-37.00	All SP: 23.08
8604-30	3	LV3WE LV3NW SP (3, B)	20.70 19.09 24.93	20.70-24.00 19.09-22.50 24.93-27.00	All LV: 22.07 All SP: 24.51
2744-54	4	SP (2, B) SP (4, E)	36.15 37.15	36.15-44.00 37.15-44.00	All SP: 34.74

Mix Type: SP = Gyratory Mix Design
LV = Marshall Mix Design

General observations from Mn/DOT's first three warranty projects are:

1. In all three projects, the low bid price per ton appeared reasonable compared to the non-warranty average in the area.
2. One of the projects had a small quantity of non-warranty mix that was bid at \$0.40 per ton less than the identical warranted mixtures.
3. The first two projects were rural and had total project bids less than the Engineer's estimate.
4. The third project was a metro, nighttime paving project and had a total project bid greater than the Engineer's estimate.
5. Some of the bidder unit price ranges on these projects were relatively large. However, since most of the bidders had no previous experience with pavement warranties, the large variations in unit bid prices are not considered unusual.

After the pavement construction projects were completed, project engineers and contractors were asked for feedback. In general, the contractors noted the following:

- Warranted projects went the same or better than non-warranted projects.
- In some cases, they used higher quality materials.
- They paid special attention to the longitudinal joint construction.
- They indicated the need to receive warranty plans and proposals sooner to allow more time for bonding, traffic research, surface distress analysis, and the need for standard Mn/DOT acceptance forms.

The Mn/DOT project engineers indicated the following:

- The warranted projects went the same as the non-warranted projects.
- All three engineers noted no change in material quality.

The Warranty Task Force met again in fall 2002, and it was determined that the three pilot projects were initially successful and recommended that two-year warranty projects be constructed in each Mn/DOT District in 2003. The Task Force also developed a two- and five-year warranty for new bituminous pavements and recommended its use on two to three pilot projects in 2003. The five-year warranty is similar to the two-year warranty, except it includes fatigue cracking. Both of the warranty specifications are available online at <http://www.mrr.dot.state.mn.us/pavement/bituminous/bituminous.asp>

CURRENT WARRANTY PROJECTS

Mn/DOT continues to explore the use of warranties and has expanded their use to additional construction items. Warranties proposed or under construction on Mn/DOT projects are listed in Table 2.

Table 2 – Current Warranty Projects Proposed or Under Construction

District	State Proj No.	Letting Date	Location	Description	Completion Date
1*	1601-59	11/22/02	Hwy 61	Bituminous Overlay Lake/Cook County Line – CSAH 1	2-year warranty
2	6802-25	11/19/04	Hwy 11	Box Culvert Replacement	9/1/2004
2*	1102-59	2/28/03	Hwy 2	Bituminous Overlay 8.7 mi E, CSAH 10-CSAH 18	2-year warranty
3	7316-11	7/23/04	Hwy 55	Mill/Overlay, Culverts (grading/culvert warranty)	Fall 2004
3	7315-10	10/22/04	Hwy 55	Bridge Replacement (Bridge Approach Warranty)	Fall 2005
3	4912-48	4/22/05	Hwy 371	Grade, Surface, Bridge	Fall 2006
4*	2101-20	7/1/03	Hwy 27	Bituminous Overlays I-94 to Highway 29	2-year warranty
6		11/1/02	Hwy 52	Grading, Concrete/Bit Paving, Bridge, Noise Wall, Signals	8/31/2006
6*	7901-41	5/21/04	Hwy 42	Bituminous Overlay Highway 247- Highway 61	2-year warranty
7*	0804-73	3/26/04	Hwy 14	New Bituminous Pavement New Ulm (2.4 miles of reconstruction)	5-year Warranty
Metro	2735-172	2/8/02	Hwy 100 Duluth St. Interchange	Grading, Concrete/Bit Paving, Bridge, Noise Wall, Signals	7/1/2004
Metro		5/4/04	I-494 from Hwy 5 to Carlson Pkwy	Grading, Concrete/Bit Paving, Bridge, Noise Wall, Signals	Fall 2006
Metro		11/7/05	Hwy 169 at I-494	Grading, Concrete/Bit Paving, Bridge, Noise Wall, Signals	1/7/2007
Metro	6227-60	10/22/04	Hwy 120	Bituminous Overlays 4th Maplewood – Co. Rd. D	2-year warranty
Metro	6280-317	7/23/04	I-35E	New Bituminous Pavements Edgerton over I-694	5-year warranty

* Project was developed by the Bituminous Office.

EFFECT OF DESIGN-BUILD CONTRACTING ON USE OF WARRANTIES

Mn/DOT also uses multiple-year warranties on design-build projects. The multiple-year warranty period was selected after reviewing design-build warranties being used by other states. The design-build warranties cover concrete and bituminous pavements, bridges, and roadway noise wall settlements. They are working toward a one-year warranty on all items included in the design-build projects.

In 2001, Mn/DOT required a warranty on several items included in the TH 14/218 design-build project. A summary of those items is presented in Table 2.

Requirements for acceptance, bonding, rights and responsibilities of Mn/DOT; rights and responsibilities of the contractor; evaluation method for each warranted item; corrective action requirements; emergency repairs; and specifications for each item were developed and are outlined in the TH 14/218 Design-Build Project Memorandum, available online at <http://www.dot.state.mn.us/const/forms/Warranties.pdf>.

Table 3. Summary of Project Warranties on TH 14/218 Project

Item	Warranty Period (after Final Acceptance)
Flexible Pavements: Cracking	5 years
Flexible Pavements: Debonding	5 years
Flexible Pavements: Raveling	5 years
Flexible Pavements: Flushing	5 years
Flexible Pavements: Rutting	5 years
Rigid Pavements: Cracking	5 years
Rigid Pavements: Joint Deficiencies	5 years
Rigid Pavements: Surface Defects	5 years
Structural Concrete	5 years
Bridge: Elastomeric Bearings	5 years
Bridge: Expansion Joints	5 years
Geotechnical: Settlement	5 years
Signing (Permanent)	5 years
Landscape and Turf Establishment: Plantings, Trees, and Grasses	1 year

III. HISTORY AND USE OF WARRANTIES IN THE U.S.

In May 2003, the Federal Highway Administration (FHWA) and the Michigan Department of Transportation sponsored a Warranty Symposium. This symposium brought those DOTs with experience in pavement warranties together to share their practical experiences. At the symposium, participants also projected ahead to discuss the future of warranties and actions needed to improve warranty practices for better use. The full symposium report is available on line at http://www.tdcfiles.com/Warranty_Symposium_Final_Report.pdf

Eleven states were invited and participated in the survey. They included Departments of Transportation from Colorado, Florida, Indiana, Illinois, Louisiana, Minnesota, Wisconsin, New Mexico, Ohio, Virginia, and Michigan. Representatives from Ohio were not able to attend. All of the states represented had developed and executed at least one warranty project. Michigan has taken the lead in warranty projects, having executed approximately 650. Ohio and Wisconsin follow next in line, with 88 and 48 projects, respectively. The Colorado DOT has executed 12 projects.

Of the two types of warranties being used, materials and workmanship warranties (M&W) far outnumber performance warranties. No formal national definitions for either of these warranties are available. General definitions are given as follows:

- **Materials and Workmanship:** The warranty requires the contractor to correct defects in the pavement caused by elements within his or her control but assumes no responsibility for the design.
- **Performance:** The warranty requires the contractor to assume responsibility for the actual pavement performance.

Contractors and contractor association executives from the concrete pavement, asphalt pavement, pavement preservation, general contractors and surety industry were also invited to attend the workshop. Of the associations invited, the Surety Association of America is the only one to formally publish a warranty policy; the other national groups generally believe it to be a discretionary issue for consideration at the local and state level.

The summary report states "...most acknowledge that the issues of bonding, distress thresholds, and the transfer of unknown risks to the contractor must be addressed cautiously and carefully. The combination of warranty length and number of performance threshold values exponentially exacerbate potential conflict. Several representatives question the real impact on overall product performance, which they believe must ultimately be the driver for warranties to be of value. All acknowledged the value and importance of the agency and the industry working together on the issue prior to implementation or adoption."

At the symposium, bond industry representatives discussed the impact that warranties are having on their industry. In general, shorter warranties can be handled through a bond but can accumulate and impact the bidding capacity of the contractor.

Prior to the symposium, participants were asked to complete a questionnaire. Ted Ferragut, primary author of the symposium summary report, compiled the following key statistics and observations:

- 1. Warranty Policies.** Eight of the 11 states have formal warranty policies.
- 2. Standard Application.** Michigan and Wisconsin use warranties as a standard practice; all other states are in the evaluation or trial mode. Florida may move to the standard practice category in 2004, pending experience with their asphalt guarantee program.
- 3. Desired Benefits.** The desired benefits of using a warranty were to:
 - Improve quality
 - Improve innovation
 - Address shortages in state personnel
- 4. Project Selection.** Nearly all states agreed that warranties should be used selectively and that project selection was critical.
- 5. Warranty Length.** The average length of a materials and workmanship warranty was three to five years. Several states are now experimenting with performance warranties that extend from five to seven years. Several states are experimenting with 10+ year warranties generally linked to design-build contracts, although most are using short-term warranties. The longer the warranty period, the more likely it is tied to financing, operations, and planned maintenance requirements within the contract.
- 6. Bonds.** Ten of the 11 states require surety bonds to assure that the contractor provides warranty services, should the warranty be invoked. Only the Florida DOT has abandoned bonds and will be moving to a guarantee linked to future contractor bid qualifications. The price of the bond varies from two percent (2%) of the contract amount to a price linked to a percentage of repair costs. The surety bond issue is very much an open issue that requires direct communication between DOTs and the surety industry; the development of more standard options within the bonding concept; and the development of concepts to replace the bond option entirely through guarantees, insurance, or other mechanisms.

7. **Warranties Impact on Bidding.** While many industry officials publicly stated that warranties could restrict future contractor bidding, there was no quantifiable evidence to support that claim.
8. **Threshold Values.** States vary in what distresses they warrant. Nearly all require a warranty on cracking and spalling distresses, and to a lesser degree, smoothness and skid. Two states warrant stripping. None to date warrants noise. Values changed based on the function of the type of traffic and climatic conditions. In all cases, however, specific warranty clauses and thresholds were developed during joint sessions between the state and industry.
9. **Material Requirements and Method Specifications.** Both material property specifications and method specifications normally remained as part of the warranty contract, although they were addressed in the discussions between the state and the industry. The Wisconsin and Indiana DOTs transferred mix design and some construction practices to the contractor.
10. **Contractor Quality Control.** Nearly all states had transferred contractor quality control requirements to the contractor prior to instituting the warranty program.
11. **Invoking Warranties.** Several states invoked warranty requirements. No state reported problems in invoking the warranty requirements and performing fixes. No state reported having to invoke the mediation or conflict resolution clauses. It should be noted that many warranty periods were still in effect at the time of this symposium.
12. **Warranty Management Programs.** The Michigan and Wisconsin DOTs are moving towards establishing formal warranty management programs. The other states see the need but do not have the volume of warranty work to justify a full program. The key point is that personnel will be required to manage a warranty program, negating some of the perceived benefits of the warranty. Most of the states are still resolving internal processes for identifying warranted projects and for managing the warranty during and after construction. Table 4 lists several states and the significant warranty end products that they are including in their projects.

Table 4 - State Warranty Programs

State	Significant Warranty End Product
Indiana	Asphalt pavement
Maryland	Bridge painting
Michigan	Asphalt pavement, bridge painting, chip sealing, microsurfacing, crack treatment
North Carolina	Intelligent transportation system components
Pennsylvania	Pavement marking
Wisconsin	Asphalt pavement, Portland cement concrete pavement

Source: NCHRP Report 451

A February 2003 Mn/DOT Report to the Legislature contained the information presented in Table 5. The FHWA developed this table based on surveys sent to Departments of Transportation in 2001 and 2002.

Table 5. Partial Summary of Pavement Warranty Activities

Midwest States	IL	IN	IA	KS	MI	MN	MO	NE	ND	OH	SD	WI
No. of Projects	6	8	0	1	300+	10+	2	0	0	70	1	28
HMA	3	8			35	6				66		24
PCC	3			1	10	3				4	1	3
Pavement Preservation					300	10	2			5		1
Legislative Mandate?	Y	N	N	Y	Y	N	N	N	N	Y	N	N
Typical Warranty Period (yrs)	5	5		15	3-5-7	2-5	3			2-3-5-7	5	
HMA	5	5		15	3-5	5-2	3			3-5-7		5-7
PCC				15	2-3	5				7	5	5
Pavement Preservation						2				2-3		2

Source: NCHRP Report 451

WISCONSIN

The Wisconsin DOT (WisDOT) pavement warranty program was implemented in 1995. Contractors are generally required to provide a five-year warranty and are responsible for providing maintenance whenever the threshold is exceeded. Warranty specifications are based on specific pavement distresses rather than ride or other factors. WisDOT determined the critical distress levels by using those typically found on pavements five years old by their pavement management system.

To date, they have found that warranted pavements are performing better than typical pavements, based on a comparison of ride and distress. Based on limited data, warranted pavements appear to cost less per ton than non-warranted pavements when the decreased inspection costs are included. The use of warranties has increased contractor innovation and has resulted in high quality and good performing pavements. WisDOT believes that warranted pavements are a cost-effective initiative and will continue to expand their warranty program.

The warranty program was set up to give contractors as much freedom as possible and assure a quality product. Wisconsin contractors are very supportive of the program, and several have participated in it. The specification was developed to allow contractors the freedom to select their own materials, mix designs, quality management programs, construction techniques, and inspection programs. It is intended to require contractors to provide pavements meeting acceptable performance criteria for seven years.

WisDOT provides the contractor with the pavement design and typical section, along with performance requirement, so that bids may be evaluated and awarded based on low bid. The warranty process means that WisDOT pays the contractor to take a certain, but reasonable risk. WisDOT minimizes the risk by selecting projects to include in the warranty that have a high potential for success.

WisDOT's five-year progress report (published in June 2001) is available online at <http://www.dot.wisconsin.gov/library/research/docs/finalreports/tau-finalreports/warranties.pdf>

MICHIGAN

The Michigan Department of Transportation (MDOT) has been a pioneer in the area of pavement warranties. Their preventative maintenance program requires contractors to warranty their pavements for typically two to three years. Like WisDOT, MDOT requires a conflict resolution team (CRT) to judge when the pavement is meeting performance criteria. The CRT consists of five people: two from MDOT, two contractors, and one by mutual agreement. Michigan has been very pleased with their preventative maintenance program and will continue to require warranties from contractors on that type of work.

In 2002, the Michigan State Transportation Commission adopted a pavement warranty policy directing the MDOT to continue developing its road-warranty program. MDOT has been promoting a plan requiring pavement warranties on major projects in an effort to protect taxpayers' investments in the construction and reconstruction of state highways.

The pavement warranty policy reads as follows: “The department shall continue the development of highway warranties that encourage contractor innovation, as feasible, with an associated and appropriate level of contractor accountability for the performance of the highway. The enhanced opportunity for contractor input and control should be balanced by a greater assumption of warranty liability by the contractor. In general, contractor liability should be with regard to matters over which the contractors have an opportunity to exercise control, including circumstances in which contractors are given the opportunity to enhance a standard highway design to assure it will meet the Department's desired performance standards.”

An instructional memorandum entitled, “Contract Administration and Oversight Guidelines for Projects Containing Warranty Work” is available online at http://www.michigan.gov/documents/IM02-23_54178_7.pdf It offers insight into how MDOT structures its pre-bid and pre-construction meetings, and how it handles warranty and non-warranty elements on the same construction item, inspection and documentation.

IV. BENEFITS OF WARRANTIES

From a local perspective, there are many advantages and benefits to requiring warranties on highway construction, including encouraging innovation, promoting a higher quality product, and reducing the need for agency resources, including inspection and maintenance. Other potential benefits include:

- Increased product quality with a resulting lower life-cycle cost.
- Lowered risk to the owner by providing assurance that the contractor will correct early failures from materials or workmanship that may have escaped notice during traditional construction.
- Encouraged development of better testing equipment and techniques for construction, including more uniform best-construction practices.
- Less maintenance required by owners due to improved construction and contractor maintenance work.
- Improved public perception due to improved construction product.

The authors of NCHRP Report 451 surveyed states using warranties in highway construction. Advantages of using warranties identified in the survey are as follows:

1. Compatibility with the low bid system.
2. Reduction of agency human resource needs.
 - Using warranties reduces the number of inspection and testing personnel required on a project. Since the contractor is responsible for quality control, the agency may reduce its quality assurance function.
3. Improvement in quality of constructed projects.
 - Warranty contracting appears to increase the quality of the completed project. Since the contractor runs the risk of returning to repair or replace work that fails to meet product threshold levels, there is a greater incentive to construct a high quality product from the beginning, rather than merely meet the minimum levels set by a specification requirement.
4. A shift in risk from agency to contractor.
 - The agency shifts some of the post-construction performance risk of the warranted project to the contractor.

5. Contractor innovation.

- Under a warranty, contractors can be less constrained by traditional methods-based specification. Thus, they have the latitude to use alternative or innovative construction methods and techniques that would otherwise not be allowed under traditional specifications. In the long run, innovation by contractors may increase product quality and decrease life-cycle cost. In addition, manufacturers promoting new products may benefit from a warranty requirement. For example, state highway agencies will be more likely to allow the use and evaluation of new products if a reasonable warranty is provided.

V. DISADVANTAGES OF WARRANTIES

Although warranties in highway construction continue to gain interest, issues and concerns remain. They include:

- The owner must monitor the project in greater detail over the warranty period and make measurements to see if any of the warranted parameters have been exceeded. This potentially can require a significant amount of time and labor to do the monitoring. In Michigan, for instance, where warranties are legislated, there are now more than 300 projects with warranty provisions. The MDOT is in the process of reorganizing their pavement monitoring unit, because their monitoring requirements exceed the capabilities of that unit. In Minnesota, the DOT estimates that if 50 percent of the projects let each year required a warranty; the number of projects to be monitored could easily exceed 500 in any one-year period.
- The impacts of warranties on initial and total life-cycle costs of facilities may negate any maintenance savings.
- Agency uncertainty regarding the ability to administer contracts with warranties and to enforce them over extended periods. The length of the warranty period required to observe deficiencies caused by poor materials or construction is of particular concern.
- Warranties are only as good as the contractor and the surety company involved. Of most concern are the problems associated with obtaining warranty work if the contractor goes out of business.
- Uncertainty of whether surety companies will provide long-term bonding guarantees required for warranties on large projects, which carry much larger risks. Bonding and insurance companies have very little experience in warranting this type of work and do not have a good idea of the risk they are assuming. Since the September 11 terrorist attacks, these agencies have become even more conservative and now are more reluctant to provide medium- and long-term bonds.
- Small or disadvantaged contractors may be eliminated from the bidding process if they are unable to acquire bonding.
- Difficulty identifying measurement methods and standards for deficiencies and warranty violations.
- Determining responsibility for work not done by one contractor that affects work done by another. An example is one contractor constructing pavement over a grade or base that was constructed by another.

Disadvantages of using warranties identified in the NCHRP survey are as follows:

1. Impact on open competition.
 - The number of bidders on warranty projects may decrease compared to traditional methods-based specification projects.
2. Ease of implementation with respect to resources, data, systems and expertise.
 - The establishment of a warranty contracting program requires the investment of up-front resources for training. Additional expertise is also required to write and implement the warranty specifications, and large amounts of data are required. In particular, the establishment of threshold levels for distress indicators for some products, such as pavements, requires a large amount of research or a well-kept product management system from which to extract data.

The NCHRP survey found that the following issues were unresolved as to the affect of warranty use:

1. Project applicability.
 - Warranties appear to be most applicable to small- or medium-sized projects that are not overly complex. However, they have also been applied to large, complex projects. To build a program, an agency should probably start with smaller projects, and build on these successes to expand the program.
 - Smaller, less complex projects with warranties will allow for a larger number of contractors to bid, while larger, complex projects will most likely have a smaller number of bidders.
2. Reduction of project completion time.
 - Warranty contracting may increase project completion time. Contractors will be reluctant to complete their work until all other factors that may affect performance of their project have been addressed. For example, a paving contractor may not want to pave over a flaw in the subbase as this may affect the condition of the overlying pavement. Innovative construction methods, however, may help reduce project completion time.

Both advantages and disadvantages should be considered when determining if a warranty program is appropriate for your agency.

VI. RECOMMENDATIONS FOR LOCAL GOVERNMENTS

The FHWA has declared warranties operational, but they require further refinement and development for consistently successful implementation in highway construction contracts. NCHRP Report 451 outlines recommendations for agencies interested in implementing a warranty program. Recommendations from the report are summarized below. The full report is available online at http://trb.org//publications/nchrp/nchrp_rpt_451-a.pdf

As noted earlier, NCHRP Report 451 examined six critical issues:

1. Selection criteria - project size, complexity, type
2. Bidding system - compatible with low bid system
3. Agency resources - compatible with less staff at agency level
4. Risk allocation - assign more risk to contractor and less to agency
5. Bonding requirements - may change requirements and affect project quality or cost
6. Quality aspects - improved quality and performance should result

In addition to the survey mentioned earlier, contract methods in non-transportation construction industries were studied. Seven products were proposed for warranties, and three were selected, including warranties with emphasis on hot-mix asphalt concrete paving (HMAC).

Guidelines for implementing those warranties follow in this section.

GENERAL IMPLEMENTATION ISSUES

When considering the implementation of a warranty program, agency decision makers must recognize what changes are required and the impact these changes may have on agency personnel and the design consulting, testing laboratories, and contracting community with which agency personnel will work. Recommended evaluation issues are outlined in Table 6.

Table 6 – General Implementation Issues for Applying New Contracting Methods

General Issues	Major Considerations in Implementation
Fit within low bid system	<ul style="list-style-type: none"> • Method meets existing statutory requirements for low bid system • Special requirements for implementation to ensure contract method fits within low bid system (pre-qualification) • Requires enabling legislation for implementation because method will not meet low bid laws
Impact on budget, schedule, and/or quality	<ul style="list-style-type: none"> • Increase, decrease, and/or no impact on project cost and/or project time • Enhances long-term performance of finished product
Impact on agency personnel resources	<ul style="list-style-type: none"> • Increase, decrease, and/or no impact on number of agency personnel required for project • Increase, decrease, and/or no impact on project work hours required for agency personnel for project • Requirement for new knowledge, abilities, skills, and experience of agency personnel
Selection of appropriate project for application	<ul style="list-style-type: none"> • Factors that drive use of method must be understood and evaluated in decision to implement on specific project • Characteristics of projects must be congruent with agency objectives/requirements for implementing contract methods
Affect on bonding	<ul style="list-style-type: none"> • Additional requirements for bonding • Impact on surety companies and contractors
Allocation of risk to each project participant	<ul style="list-style-type: none"> • Shift more risk to contractor in areas of cost, time, and quality • Impact of risk shifting on agency project development and execution process
Ease of implementation	<ul style="list-style-type: none"> • Training requirements for successful implementation • Type of expertise/qualifications of personnel leading the implementation effort • Information system needed to support method requirements • Changes required in project development and execution procedures

Table 6 – General Implementation Issues for Applying New Contracting Methods (cont'd)

General Issues	Major Considerations in Implementation
Acceptance by industry	<ul style="list-style-type: none"> • Impact on open competition – number of bidders and size of contractors bidding projects • Establishing industry cooperation and involvement in implementing new contracting process
Impact on legal environment	<ul style="list-style-type: none"> • Understanding legal ramifications of new contract method • Contract requirements with appropriate legal language incorporated

Source: NCHRP Report 451.

Other issues not identified in the NCHRP Report include bonding requirements specific to Minnesota, staff training needs, and cooperation with contractors. These are outlined below:

1. Bonding Requirements

Many projects have been completed nationally and in the State of Minnesota that require warranties on items, and they provide examples for local agencies wishing to implement warranty programs in their own jurisdiction. The bidding documents and technical memoranda for many projects are available online, and several have been referenced in this document. The Minnesota Surety Association recommends less than three years on warranty and a maximum bond of 30 percent of the construction contract total. The Highway 52 Design-Build Project in Rochester required a 10 percent bond for five years.

2. Staff Training Needs

Including a warranty in your projects requires that the owner be able to assess the pavement condition and assess damages. Local governments may have difficulty finding the time or money to train staff to conduct the pavement condition ratings. The primary option would be to hire a consultant well versed in the Mn/DOT Pavement Distress Manual. Mn/DOT may be able to provide basic support and instruction.

3. Convincing Contractors to Become Involved in Warranty Projects

Mn/DOT holds a pre-bid meeting for all warranty projects where they provide contractors with typical Mn/DOT road performance data. At this meeting, Mn/DOT also outlines expected life of projects and repairs, use pavement management data to develop thresholds for repairs, and explain this process to prospective contractors. Agencies should evaluate the project history in their area and provide that data to contractors. This may alleviate

contractor's fears of not meeting warranty requirements and result in more bidders on a warranty project.

Also, forming partnerships with contractors and surety companies early in the warranty development process helps to facilitate communication and reassure all parties that the requirements of the warranty program are fair, reasonable, and equitable. Early input identifies and addresses potential problems and also allows for ongoing input from each party throughout the process.

The NCHRP Report identified a conceptual planning process for agencies to work through as they contemplate a warranty program. The authors of the report also developed a flowchart for guiding users through the decision-making process, which is available by accessing the full report online at http://trb.org/publications/nchrp/nchrp_rpt_451-a.pdf

GUIDELINE STRUCTURE AND FORMAT

The guidelines below present steps for consideration before first time implementation. The guidelines must also incorporate local boards, council, and attorneys whose support is critical to program success.

These guidelines were designed for first-time warranty users. Experienced users can also find reference materials with which they can compare their practice with, which might lead to modifications or confirm that their current approach is consistent with the guidelines proposed.

Step 1: What is the Agency's Current Level of Experience with Warranty Contracting?

1. *No experience:* first time users should begin with Step 2 below, which is determining motivation for implementing warranties.
2. *Low to moderate experience:* Those agencies with limited experience using warranties on one to five projects. This could also describe agencies that have experience with a particular end product and who wish to expand their warranty program to include more end products. These users are encouraged to look at the entire process to formalize their program. However, they can begin with Step 6 (Select Candidate End Product) or start with Step 3 (Review and Understand Best Practices for Warranty Contracting).
3. *High level of experience:* those agencies that have completed more than five warranty projects and are comfortable with their process should begin with Step 8 (Prepare Warranty Specifications).

Step 2: Determine Motivation for Implementing Warranties

The first step is for the agency to determine their reasons for wanting to begin warranty contracting. Their objectives may include:

- Improving performance.
- Redistributing of product performance risk to the party that can most effectively control it.
- Reduction of the number of agency design, testing, and inspection personnel.

The agency must review its available personnel and determine how warranty contracting will affect the personnel requirements of a project.

Step 3: Review and Understand “Best Practices” for Warranty Contracting

One of the most important steps in moving to a warranty program is to understand industry best practices for warranty contracting. A best practice is defined as a way or method of accomplishing a function or process that is considered to be superior to all other known methods.

The complete NCHRP Report lists many resources for understanding the implications and components of warranty contracting. Many are referenced throughout this report as well. Additional best practices are summarized later in this report.

Step 4: Still Interested in Warranties?

If, after identifying your objectives for wanting to begin using warranties and familiarizing yourself with the issues, concerns, and best practices, your agency is still interested in requiring warranties on projects, you should progress to the next step.

A critical issue is obtaining local board or council support within your agency.

CRITICAL SUCCESS FACTORS

The NCHRP Report identified eight critical factors in determining the success of a warranty program. As an agency proceeds with implementing a warranty program, they should consider and include the critical factors in the planning. These factors include:

- **Training**

All parties involved must be made aware of and understand their roles and responsibilities under the warranty specification system. Training is required for both agency and contractor personnel.

- **Appropriateness of Method for Projects**

Define criteria to determine what projects are candidates for a warranty contracts. Project selected must match the agency objectives for implementing warranty contracts.

- **Communication**

Clear communication of expectations and roles must exist between the agency, contractor, inspectors, surety companies, suppliers, and the public. Conflict resolution must be clear and the process well defined.

- **Initial Agreement**

All involved parties must bring their expectations into agreement early in the process. They must also understand and accept the warranty program early.

- **Post-award Agreement**

A working relationship among all involved parties must evolve and continue throughout the project duration.

- **Integration of Design, Construction Methods and Techniques, and Sequence of Work**

The warranty process must be incorporated early in a project's development, as the design, scope of work, specifications and bidding documents are all affected.

- **More Up-front Investment by Agency**

The agency must be willing to invest more resources initially in the development process, which includes program planning, specification development, data collection, and training.

- **Support of Agency Boards, Councils, and Management and Industry Buy-in**

Agency management must approve and support the warranty contracting program for it to be successful. Moreover, without participation and acceptance by the local construction industry, the program will fail.

Step 5: Select Candidate End Product

The end product should be chosen to achieve the objectives established in Step 2. Decide whether your agency has the necessary sources available to implement the warranty program. The following end products are currently being warranted by state highway agencies:

- Asphalt pavement
- Concrete pavement
- Pavement marking
- Bridge deck waterproofing membrane
- Crack treatment
- Microsurfacing
- Bridge painting
- Bridge deck joints
- Chip sealing
- Roofs
- Intelligent transportation system components
- Landscaping irrigation systems
- Bridge components
- Reflective sheeting for signs

The NCHRP Report on warranty implementation recommends that agencies select one end product to include in a pilot process.

The Technical Advisory Panel for this project recommends using warranties on the following items:

- Asphalt pavement
- Gravel roadways
- Concrete pavement
- Trenches and backfill
- Subgrade preparation
- Underground utility placement

Step 6: Establish Cooperation and Communication Between the Agency, Contractors, Sureties, Suppliers, and Other Relevant Parties

Include all affected parties in the warranty program development early in the process. Key steps are outlined below:

- Identify and Contact Involved Parties

Major participants include contractors, surety companies and material suppliers. Their input is required when determining the end product to warrant, performance indicators, and the threshold values upon performance will be evaluated. The input of surety companies is critical for developing practical bonding criteria.

- Educate Involved Parties

Important elements of this are:

- Educating agency personnel about their roles in this new program and the need to allow the contractor new latitude while completing warranty work;
- Educating the contractors about their new roles, the historic ability of the product to meet the performance thresholds, and how their work can affect the product performance;
- Educating the surety community that these performance thresholds can be met.

- Form Partnerships to Implement the Warranty Process

Important partners include the contractors, agency staff, and surety companies. With everyone's input, the program can be fair, reasonable and equitable to the partners. Early and continuous input is important to the evolution and success of the program.

Step 7: Prepare Warranty Specifications

All current Mn/DOT low bid bituminous pavement warranties can be found on the Bituminous Web site at:

<http://www.mrr.dot.state.mn.us/pavement/bituminous/bituminous.asp>

The following should also be considered when writing a specification:

- Traditional specifications require the contractor to provide the materials required, constructed in a specified method. With method and materials specifications, the contractor is not responsible for the performance of the end product. This inhibits contractor innovation. Performance based specifications allow the contractor more freedom to select methods and materials, provided that the resulting performance meets the specified requirements.
- A warranty specification requires the guarantee of the integrity of a product and of the contractor's responsibility for the repair or replacement of deficiencies. A warranty specification can be a combination of QA/QC and performance specifications, and often contain QC requirements. The contractor who is responsible for performance during and after construction has more freedom to select materials and methods, and can develop their own QC program.
- Warranty specifications should be compatible with other agency specifications.
- Performance indicators and threshold values must be clearly stated, and will minimize the uncertainty regarding warranty risks for contractors and surety companies. For the products that are currently warranted (as outlined in Table 3

above), many sample specifications are available from other state agencies. Select performance indicators that directly affect the road user and allow the contractor to determine how best to technically produce the results desired by the road user.

- Developing a warranty specification is difficult, and must include many items that are not included with traditional specifications. The key elements of a model warranty specification are outlined below:

1. Description

- Describe what the specification covers and the work that is required.
- Describe the design criteria used, such as traffic load, volumes, design life, work conditions, payment schedule, prevailing wages, disadvantaged contractor participation, and progress schedule.

2. Warranty Length

- Establish the length of the warranty, which can be fixed or varied using the A-B system outlined below.
- Establish the criteria for determining the beginning and end dates for the warranty period.
- Work with contractors to determine the appropriate warranty period.
- Consider the time required for problems with the end product to appear.
- Consider using an A-B system:
 - A = project costs
 - B = credit for each additional year of warranty that the contractor bids beyond a required period. The credit is used for bid comparison only, not for payment. Determine amount for the credit by estimating the cost to replace work and divide it by length of warranty period.

3. Bonding Requirements

- Establish the penalty value of warranty bonds or retainage system.
- Establish acceptable bond rating.
- Determine acceptable combination of bonds.
- Determine bond requirements if surety company falls below specified rating during the warranty period.

4. Maintenance

- Establish who is responsible for maintenance activities.

- Establish how maintenance activities will be approved.

5. Conflict Resolution

- Determine if a conflict resolution team (CRT) will be established especially for items with many causes for failure, such as asphalt and concrete pavement.
- Determine the composition of the CRT.
- Determine when CRT will be used.
- Determine length of conflict resolution process.

6. Contractor Responsibilities

- Establishment and submission of a QC plan and QC data.
- Liability insurance requirements.
- Design of end product.
- Selection of materials and construction methods.
- Elective/preventative action.
- Warranty of the end product for the entire length of the warranty.
- Remedial action if any threshold levels are met or exceeded.

7. Agency Responsibilities

- Specify special requirements, such as a QC plan.
- Establish procedures for emergency situations on warranty project and if contractor cannot remedy within prescribed time period.
- Establish length of time that contractor can remedy in an emergency situation.
- Establish initial acceptance criteria, such as end of construction and start of warranty period date.
- Approve liability insurance and bonds.
- Determine how and when the end product will be inspected.
- Periodic inspection of end product.
- Provide an annual written report to contractor on performance of product.
- Approve remedial actions and elective/preventative action.

8. Performance Indicators

- Establish performance indicators and threshold levels. Indicators and levels can be determined from Infrastructure Management System, manufacturer's recommendations, and/or engineering judgment.
- Determine what factors that cause distress are beyond contractor control.

9. Requirements for Corrective Action

- Typically, agency approves corrective action.
- Establishment of remedy period.
- Establish what activities are exempt from warranty corrective action by contractor such as destructive testing procedures by the agency or utility work.

10. Method of Measurement

- Establish how warranted end product will be measured.

11. Basis of Payment

- Establish how end product will be paid for.
- Determine if any maximum levels of payment.
- Establish amount and payment schedule for performance payment system.

Step 8: Review Specifications and Determine if They Are Ready for Implementation

New agency specifications must be thoroughly reviewed by agency staff responsible for carrying out the warranty program. This is especially important for construction staff, which must enforce the specifications in the field. Contractors and surety companies may also review the specifications, which provide an opportunity for resolution of issues before the project is sent out for bid.

Step 9: Select a Pilot Project

A pilot project is a good way to test all the elements of a warranty program with reduced risk to the agency. This allows the agency to fine tune the process as it moves onto bigger projects with additional warranted items. Select a pilot project with a high probability of success and with low complexity.

Step 10: Prepare Bid Documents

Include warranty specifications as a supplemental specification or as a special provision. For a pilot project, include some explanation of the warranty program.

Step 11: Hold Pre-Bid Conference

The success of the warranty program depends on many things, including the willingness of contractors and surety companies to participate and the ability of the agency to manage the project. Educating the contractors and surety companies prior to bidding will help them understand the requirements, and expose errors, omissions or uncertainties in the bidding documents. A pre-bid conference also allows the agency to assure the contractor that the performance thresholds as specified are obtainable. Mn/DOT backs this up with historical distress data for similar roadways, which it presents at the pre-bid conference.

Specific items to be covered are listed below:

1. Project description, including warranty requirements and length.
2. The reason the agency is requiring warranties.
3. A description of the contractor's responsibilities, especially those that are different from a traditional project.
4. An explanation of how and why the warranty period was selected.
5. A reiteration of design and submittal requirements.
6. An outline of QA/QC requirements and who is responsible for each.
7. An explanation of retainages.
8. An explanation of emergency repair policy and standards.
9. A description of measurement or evaluations procedures that will be used.

Step 12: Select Lowest Responsible Bidder and Award Contract

This process may be the same as for a traditionally bid project.

Step 13: Conduct Pre-Construction Conference

At this meeting, address all questions regarding the plans, specifications, or contract. Discuss the warranty requirements. Invite the contractor's field personnel to attend. Form a conflict resolution team (CRT), which consists of agency representatives, contractor representatives, and representatives mutually agreed to by both the agency and the contractor. The CRT is called in to mediate only when the contractor and agency disagree on the results of the pavement condition surveys.

Step 14: Construction Phase

Document the agency costs associated with project management and inspection on the project. This will be useful later when comparing the cost of warranty projects with traditional projects. Keep notes on how the process is going. Specifically, keep note changes and procedures developed for QA/QC to evaluate later.

MAINTENANCE AND EVALUATION OF PERFORMANCE PHASE

Step 15: Initiate Warranty Period

The initiation of the warranty period may occur at any of the following points during construction:

- The point of substantial completion
- The point of final acceptance
- The opening of the project to traffic

The project may be divided into sections and warranty periods initiated at different dates for each.

Step 16: Collect Performance Data

The agency must collect performance data on the indicators listed in the specifications to evaluate the warranty end product. Generally, this is done annually. For pavement, the warranted project is split into segments, and each segment is split into sections. One predetermined section in each segment is evaluated, along with a random section in each segment. The end product may be thoroughly inspected, if practical, or a representative sample may be inspected as an alternative. Continue to monitor and document the costs associated for the warranty surveys and remedial actions throughout the warranty period.

Step 17: Analyze Performance Data to Determine Necessary Remedial Action

Compare the annual survey results to the established threshold values to determine if remedial work is required. Routine or emergency maintenance are not remedial actions.

Step 18: Is Remedial Action Necessary?

If remedial actions are necessary, move to Step 19. If not, move to Step 23.

Step 19: Notify contractor of Remedial Action

Establish a maximum allowable time after completing the survey for the agency to notify the contractor of remedial action requirements. Notify the contractor in writing of all deficiencies requiring remedial action.

Step 20: Assess Quality of Remedial Action

Within a specified number of days of notification, the contractor should submit a proposed plan for completing the remedial work for approval by agency staff in a timely manner. Establish a maximum allowable time period in which the contractor may complete the work. If the contractor completes the remedial work, go to Step 23. If not, go to Step 21, which involves employing the CRT.

Step 21: Employ Conflict Resolution Team (CRT)

If the contractor does not accept responsibility for the distress or disputes the cause of the distress, the CRT must get involved in the process. Generally, there is a specified time period during which the contractor may appeal the agency decision to the CRT and another specified time period during which the conflict must be resolved.

If the CRT fails to resolve the issue within a specified amount of time and the contractor fails or refuses to perform the required remedial work, the agency may have the work performed or perform the work itself and bill the contractor for the cost. If the contractor refuses or fails to compensate the agency for the cost of the performed remedial actions, notify the surety that the contractor is in default of the warranty bond.

If the CRT is unable to resolve the conflict, the agency may resort to its existing legal claims policy.

Step 22: Is the Issue Resolved?

If the CRT has successfully resolved the conflict, go to Step 23. If not, go to Step 25.

Step 23: Is the Warranty Period Complete?

If time remains in the warranty period once the remedial actions have been completed, return to Step 16 to collect performance data for the next year of the warranty.

If the warranty period is complete, go to Step 28.

Step 24: Notify Surety of Contractor Default

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

Step 25: Identify Maintenance Needs

The agency and/or the contractor may identify maintenance needs for the end product, and both may perform some types of maintenance throughout the warranty period. Maintenance is not the same as remedial action. Table 7 outlines the different types of maintenance and the party responsible for each.

Write the warranty specification to clearly describe what remedial actions consist of so that a distinction can be made between routine maintenance and remedial actions.

Table 7. Types of Maintenance Under a Warranty Specification

Type of Maintenance	Description	Responsibility
Routine	<ul style="list-style-type: none">• Signage removal and repair• Snow removal• Salting and sanding• Mowing• Guardrail improvements or repairs• Traffic attenuators• Lights and signals	Agency
Preventative	Smaller, less serious forms of remedial action performed to prevent a distress from reaching a threshold level	Contractor
Remedial Action	Repair or replacement of deficient areas, as defined in the warranty specifications	Contractor
Emergency	Any distress or product failure that presents an immediate safety hazard to the traveling public	Contractor (However, the agency may perform this if the contractor is not able to perform in a timely manner)

Source: NCHRP Report 451

Step 26: Perform Maintenance

The three types of maintenance are as follows:

1. Routine maintenance – includes the maintenance that agencies frequently perform, including snow removal and salting/sanding. General maintenance includes mowing and traffic light, sign and guardrail upkeep as listed above in Table 7.
2. Preventative maintenance – includes maintenance performed before a distress has exceeded a threshold level, or to prevent a distress from reaching its threshold level. Examples include minor crack sealing, microsurfacing, crack filling, pothole patching, and thin overlays.
3. Emergency maintenance – includes maintenance to repair some form or distress or failure that presents an immediate safety hazard to the traveling public and/or a threat to the infrastructure integrity. Examples include excessively large potholes, roadway collapse or undermining, severe loss of roadway friction, and concrete blow-ups.

Emergency maintenance may need to be done immediately, and the agency may or may not have time to notify the contractor before completing the repairs. If the contractor is unable to perform the work in a timely manner, or time is not available for notification, the agency may elect to perform the maintenance on its own or through other means. Note that the agency must determine ahead of time what constitutes a timely fashion for both notification of the contractor and completion of the emergency maintenance.

If the contractor does not perform the emergency maintenance, the agency can bill the contractor for the work completed. If the contractor refuses to pay the agency for work performed, the agency can file a claim with the surety against the contractor's warranty bond. If the distress necessitating emergency maintenance can be determined to be the result of something other than the contractor's work, do not hold the contractor responsible.

Step 27: Is the Warranty Period Complete?

If the warranty period is not complete, return to Step 25 and continue to identify maintenance needs and perform maintenance. Proceed to Step 28 when the warranty period has ended.

EVALUATION PHASE

Step 28: Final Inspection and Warranty Termination

The agency must perform a final inspection at the end of the warranty period to ensure that the product meets the specified threshold levels:

- Complete the final annual survey within one month of the end date of the warranty period.
- The contractor should then perform the remedial actions necessary within the specified amount of time following the final pavement distress survey.
- Once all final remedial actions are completed, conduct a final acceptance evaluation to determine whether the remedial actions have been satisfactorily completed.
- If the work has been satisfactorily completed and the product meets all performance criteria, terminate the warranty.

Step 29: Evaluate Warranty Effectiveness

Once the warranty period has been completed, evaluate the entire project. This is an important step in evaluating the effectiveness of your warranty program.

Important issues include:

- Long-term performance of the final constructed product
- Design and testing/inspection personnel required
- Use of agency and outside expertise
- Risk distribution factors
- Claims and litigation, if any
- Total cost (construction plus agency management costs)

Compile costs to determine the life cycle costs of the warranted product, and compare them to costs of items constructed with traditional contract methods to evaluate the warranty effectiveness.

Obtain feedback from contractors, sureties, agency personnel, and other interested parties.

Step 30: Program Assessment Considerations

After collecting relevant data, the agency should evaluate the pilot project effectiveness, costs, and process. Determine if the pilot project was cost-effective and if the primary objectives for implementing a warranty were met.

Modify the warranty program to address deficiencies, concerns and problems encountered during the pilot program.

Continue the iterative process of constructing and evaluating throughout the life of the warranty program. Pay special attention to determining the types of projects for which warranties are appropriate.

Step 31: Continue and Expand Warranty Implementation

Once the warranty program has been modified and the specifications revised, you may consider the use of warranties on additional projects.

Apply the use of warranties to more projects as you become more comfortable with the method, and expand the process to warrant additional end products. Continue to gather cost and performance data on warranty projects and on the process in general.

Most importantly, collect and update information on life cycle costs, and continually improve the effectiveness of your warranty program.

VII. SUMMARY AND CONCLUSIONS

Participants at the FHWA warranty symposium held in 2002 believe that warranties will continue to grow for use on selected projects. Nearly half the participants see warranties evolving as standard practice. The states also believe that they need to develop guide specifications, best practices, and practical case studies in order to improve the warranty value.

Mn/DOT also continues to develop warranty specifications and guidelines on state projects. We can expect to see warranties in concrete pavement construction, and as experience is gained and acceptance grows within the contractor community, it will become easier for local agencies to implement their own warranty programs.

Many tools have been referenced or included in this report to assist the local engineer with developing a warranty program. Additional resources and experts exist at the Minnesota Department of Transportation. Those local agencies interested in implementing a warranty program are encouraged to identify a pilot project, and follow the steps listed in Section VI of this report. Continuous evaluation and revision is required for a successful warranty program at the state or local level.

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