ASPHALTIC PAVEMENT WARRANTIES

Innovative Contracting Practices
Special Experimental Project # 14

THREE-YEAR PROGRESS REPORT

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THREE YEAR PROGRESS REPORT

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

In 1995, the Wisconsin Department of Transportation (WisDOT) and the Wisconsin Asphalt Pavement Association had developed and began constructing asphaltic pavements with a warranty specification. By the end of 1997 nine warranted pavements were constructed. The warranty period is five years and requires the contractor to perform remedial (corrective) work whenever a distress threshold is exceeded. The warranty specifications are based upon specific pavement distresses (rather than ride or any other factor). Distress thresholds were established at levels which WisDOT's pavement management system indicated were typical for five-year old pavements.

Based upon three years of experience, the warranted pavements are performing better than typical pavements (considering ride values and all distress factors). For example, the typical international roughness index (in meters per kilometer) for a standard pavement at three years of age is 1.36, while the warranted at three years averages 0.80 - significantly better. The distress index is also lower for the warranted projects.

The costs figures required to make a full, bona fide comparison between the warranted and standard projects are lacking. However, based upon limited data and considering all factors, it appears that warranted pavements cost less per ton than standard projects. Accordingly, warranty projects appear to be cost-effective since they cost less and perform better. Warranties appear to be a superior means for delivering asphaltic pavements to the public.

Warranties appear to have reduced State construction delivery costs. This is an area that requires more data in order to assess the cost-effectiveness of warranties.

No distress thresholds have been exceeded, which means no remedial work (warranted) has been performed.

Warranties have allowed contractors to be innovative in quality management, paving, use of additives, etc. In addition, warranties have proven to be an innovative means for contract administration.

For future warranty projects, industry and WisDOT are considering the possibility of "tightening-up" the performance criteria for the same five-year time period, or, allowing the performance criteria to remain the same but increasing the warranty period. Either change in the warranty specifications would tend to assure an even better quality, longer lasting pavement.

An incentive provision could be made to reward the contractor for an exceptionally good performing pavement. The incentive provision would help assure the customer of a superior pavement while giving the contractor the incentive to provide it. The reward for such a provision could be monetary or a reduction in the warranty period once the exceptional performance is documented.

ASPHALTIC PAVEMENT WARRANTIES

INTERIM REPORT

INTRODUCTION

The Wisconsin Department of Transportation began building asphaltic concrete pavements with a warranty specification in 1995. By the end of 1997, nine asphaltic warranty projects had been built. The purpose of this report is to briefly discuss the interim results/findings of this warranty program in order to:

A. keep interested parties informed of the progress of this new initiative,

B. see if modifications to the warranty program are needed, and

C. help chart the future use of warranties.

BACKGROUND

In the past, when WisDOT operated under traditional method specifications, asphaltic concrete (AC) pavement contractors were told what materials to use and how to produce and place hot mix asphalt. Wisconsin's state highway managers were involved in all stages of road building and maintenance. They developed the formula for everything that went into the construction of the roadway and posted inspectors on the job site to manage the construction and assure that contractors built it to exact specifications (method specifications). However, rapid advancements and changes began in the late 1980's, by 1994 WisDOT was operating under a very comprehensive quality control/quality assurance (QC/QA) program which included almost 100 percent of the AC placed on the State Trunk Highway System. A logical progression in AC pavement specifications was the development of warranty specifications.

Prior to 1991, FHWA had a long-standing policy that restricted the use of warranties on Federal-aid projects to electrical and mechanical equipment. The rationale for the restriction was that a warranty requirement might indirectly result in Federal-aid funds participating in maintenance costs - - the use of Federal-aid funds for routine maintenance is prohibited.

Under Special Experimental Project No. 14 (SEP 14), *Innovative Contracting Practices,* FHWA approved state-proposed warranty concepts which encouraged improved quality and contractor accountability without shifting routine maintenance to the contractor.

The warranty Final Rule was published in the April 19, 1996, Federal Register. Following the Final Rule publication, warranties are no longer considered experimental

for National Highway System (NHS) projects. With the FHWA Division Administrator's concurrence, a state may include a warranty for a project on the NHS. For Federal-aid projects off of the NHS, warranty clauses may be used in accordance with state procedures and no FHWA approval is required.

In early 1994, the development of an asphaltic concrete warranty specification began as a cooperative effort between WisDOT, the Wisconsin Asphalt Pavement Association (WAPA) and the Wisconsin Division Office of the Federal Highway Administration (FHWA). From the onset, the three parties agreed to pursue a fresh, non-restrictive approach to the warranty concept. The team came to several common understandings.

- The warranty process allows WisDOT to define the final product in terms of condition and performance.

- Warranties offer the potential for improving quality and reducing state project delivery costs.

- There are shared risks – WisDOT has the risk of less than desired pavement performance and the contractor has the risk involved in remedial-corrective work.

- The contractor should decide how to construct the pavement.

It was also determined that warranties offer contractors greater opportunities to use cost effective means to perform the work and the freedom to try innovative methods. Thus, under the warranty concept, the contractor becomes a full partner in the road building process.

The first warranted projects were built in 1995 and the process has continued each year since. On 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 the opening of the pavement to traffic. For some projects the contractor also assumes responsibility for crack sealing during the first five years.

PURPOSE

The purpose of WisDOT's warranty specification is as follows:

1. To focus evaluations on actual performance of the final product; not on ingredients, the process or surrogate tests for performance.

2. To tie WisDOT's pavement management system to construction by using the pavement management system to define acceptable performance for a warranty specification.

3. To begin focusing performance evaluations not only on the final product, but on factors considered important by the highway user.

4. To continue to strive for the goals of quality highways, built on time and at a reasonable cost.

5. To afford the contractor the freedom to be innovative and creative, while maintaining WisDOT standards.

6. To lower WisDOT project delivery costs by reducing testing, supervision and staff involvement in the construction process.

7. To progress from method specifications and from the QC/QA concept to end result, performance-based specifications. Thus, WisDOT will let the contractor know what performance is desired and the contractor will decide how to accomplish it.

8. To gain experience in the elements of warranty specifications, such as bond requirements.

9. To help the national effort by exploring innovative specifications and alternative contracting methods.

10. To enhance pavement quality.

INTENTS AND CONSTRAINTS

The intention of the warranty effort is to give the contractors as much freedom as possible while assuring a quality product. Thus, the warranty specification allows contractors to select their own materials, mix design, quality management program, construction techniques, inspection, etc. It is further intended to hold contractors responsible for acceptable pavement performance for five years, but not to hold them responsible for factors/conditions beyond their control. The intent of this effort is to relieve WisDOT of construction inspection and quality assurance testing, and, instead, to concentrate its efforts on evaluating the final product.

There are several necessary constraints upon the contractor. WisDOT specifies the location of the projects, the schedule for completion, the thickness of the pavement, and the type of base. The pavement thickness and type of base are specified so that each project could be bid on an equal basis within the low-bid environment.

In essence, the warranty process incorporates the concept of paying the contractor to take a certain, but reasonable, risk. For these first projects the risk for both parties was minimized by mutually selecting projects where the potential for success was high. WisDOT's risk includes paying more for a pavement that has performance similar to that of the past.

ANALYSIS OF BIDS

Scope

This review is focused on nine projects and it includes three projects from each of the following years: 1995, 1996 and 1997. Some general observations about this small sample of projects include:

- **Contract amounts**. The contracts ranged between $0.5 and $2.5 million.
- **Single bids**. Five of these projects were awarded as single bids.
- **Low bids**. Awards ranged from 5% below the engineering estimate to 18% above the engineering estimate.
- **Prime contractors**. Five different prime contractors have been awarded warranty projects.
- **Districts involved**. AC warranty projects were awarded in six of eight WisDOT districts.

Analysis

This section will focus on project level comparisons of: (a) bid prices and engineering estimates; (b) warranty versus non-warranty unit prices; and, (c) project engineering costs. In addition, some general observations about single bids will be made.

It must be noted that project level comparisons should be used with caution. In general, it can be difficult to pair similar projects because individual project features will vary. As such, a comparison of costs or prices can only indicate where further analysis is desired since cost data are too limited in scope to fully reflect project differences.

Specifically, for warranted projects, there are only a few projects so the sample size is small. Also, the evaluation of a warranted project is different than the more common highway contract because a different product or service is being purchased. The benefits of lower risk for the State and the potential for increased quality and better performance are captured in total life cycle cost analysis. As such, it is too early to draw conclusive findings on projects that are, at most three years old. In addition to a small sample size, the projects selected for warranties have been carefully selected to minimize risk and may not represent an actual distribution of conditions or real potentials for success.

Bid prices and manager estimates. In most cases the warranty was attached to the project after the design was completed and the engineer's estimate was prepared. The delayed inclusion of the warranty did not foster the best estimate possible, especially considering the unknown value of the five-year warranty.

For all warranty projects, a close inspection of the bid price and the engineer's estimate reveals that the Asphaltic Pavement Warranted item is most often the major difference between both total amounts. This result should be expected given the novel or experimental nature of this warranted product. This outcome has occurred on all AC warranty awards (both over and under estimate). Differences between the estimated unit price and the bid price per ton of Asphaltic Pavement Warranted has ranged from $10.60 below estimate to $10.80 above estimate. In instances where two or more bids were available, bid prices from the first and second bidder are either both higher or both lower than the engineer's estimate.

Mobilization and crushed aggregate base course were two common bid items which sometimes contributed to the higher than estimated costs. Mobilization is a lump sum item and it can be used as a hedge on risky projects. Crushed aggregate base course prices can be affected by restricted access and longer hauls. Project specific considerations can impact both items and they can be difficult to estimate.

Warranty versus Non-Warranty Cost Unit Price Comparisons. On a limited basis, unit price comparisons between paired or similar warranted asphaltic and standard asphaltic concrete pavement projects can be made. Two such projects were built in 1995 by Northeast Asphalt in the same district on adjacent sections of roadway. Some of the findings include:

a) Unit prices differed for items like crushed aggregate base course ($3.80 and $4.19 per ton, warranted and non-warranted, respectively), mobilization ($28,000 and $1,000, warranted and non-warranted, respectively), and several others. It was estimated that the impact of these unit price differences was a $30,000 higher cost for the warranty project.

b) The difference between the warranted project's asphaltic bid items and the standard asphaltic concrete pavement item (including related items such as asphaltic material for plant mixes and asphaltic tack coat) was estimated to be $4.44 per ton higher for the warranted item.

Construction managing costs. The State delivery costs (includes State staff charges) directly charged to warranty projects have ranged between 2.2% and 5.2%, with an overall average of 3.8%. When overhead costs (based on a 1.75 factor) are included, project delivery costs have ranged between 4.1% and 7.7%, with an overall average of 6.2% These figures are significantly lower than the STH Rehabilitation specific cost index of 13.7% in FY 1995 and 14.9% in FY 1996, with an average of 14.2%. The 14.2% value includes all types of 3R projects and is likely high for asphaltic paving projects. Nevertheless, using these averages, staff charges directly to warranty projects are less, and appear to reduce total project costs by as much as 8% (14.2% minus 6.2%).

Again, on a limited basis, it is possible to compare project construction engineering costs between a paired warranted and non-warranted project. The delivery costs for the

warranted project totaled 2.2% and the delivery costs for the non-warranted project totaled 3.1%, yielding a savings in delivery costs of 0.9% for warranty projects.

At this time, it appears warranty projects have reduced State construction delivery costs in the order of 1% to 8%. It seems likely the best estimate of delivery cost savings would be an average value of 4 or 5%.

Single bids. Five of the nine AC warranty projects were awarded as a single bid. This is consistent with the general trend in asphalt paving in Wisconsin since asphalt paving contracts are more likely to be awarded by a single bid than by multiple bids.
In total, the single bid asphalt warranty projects were 1.4% over estimate. As a comparison, based on asphalt paving contracts between July, 1990, and January, 1996, the total amount awarded through single bid was 2.5% below the engineer's estimate. Generally, during this same time period for all contracts, a 7% below estimate figure was commonly experienced.

QUALITY MANAGEMENT ISSUES

Specification Changes

The original specification was drafted in the fall of 1994 and the first projects were let to bid in the winter and spring of 1995. The same specifications were used on the 1996 projects for AC over a granular base. The specifications were expanded to include warranted asphaltic pavement over jointed concrete pavement for a project that was to be constructed in 1996. The 1996 through 1998 specifications were essentially the same but included a provision that the contractor was responsible for routing and sealing of all cracks in the summer of the third year. After review and discussion, this provision will be reevaluated for revisions for the 1999 specifications. The other revision that is being considered for 1999 is to add two years to the warranty period (using the existing thresholds), or, to leave the warranty period at five years but to "lower" the threshold values.

Possible Variations of the Warranty Concept

Alternate bids could be tried where all projects would be bid conventionally and with a warranty. Under this plan, WisDOT would award the project based on the conventional bid and decide whether or not they wanted to buy the warranty.

Quality Control and Independent Assurance Testing (IAP)

It is the contractor's decision on the course of action for quality control and assurance. In most cases, the contractor initially ran QC much the same as a conventional project, but reduced the testing frequency after production stabilized. In some cases this happened sooner than others, but in all cases the contractor continued with a QC program at a reduced rate depending on consequence of error. WisDOT did not conduct formal independent assurance program inspections on any warranty projects but did conduct

sampling for informational purposes. These informational samples did confirm the contractor's data.

PAVEMENT PERFORMANCE

The warranty specification contains thresholds for visible distress. These thresholds are based on statistical analyses of pavement performance data. Once a threshold is reached the contractor is responsible for conducting the specified remedial action for five years. The thresholds are based on historical data from Wisconsin's Pavement Management System. The thresholds were set at levels that were typically (historically) attained by AC pavements in Wisconsin. A key evaluation criterion is tracking how the warranty projects are performing in relation to this historic database.

The 1998 performance data for the nine projects constructed from 1995 to 1997 are summarized in Appendix A, with project specific data shown in Appendix B. The three AC warranty projects constructed in 1995 were all pavement type 1 (AC over flexible base). Three AC warranty projects were constructed in 1996, two were pavement type 1 and STH 23 was type 3 (AC over PCC). The three AC warranty projects constructed in 1997 were all pavement type 1.

Distress evaluations are made annually on each warranted pavement. Pavement distress values are not pay items, but they do establish whether or not a threshold has been exceeded and whether or not remedial action is required under the warranty. These values are also used to monitor pavement performance over time. For general performance monitoring, individual distresses may be collectively incorporated into the Pavement Distress Index (PDI) which ranges from zero (perfect condition) to 100 (worst possible condition). A plot of PDI over time is a useful tool for assessing pavement performance.

Ride evaluations are made biennially for each pavement. Ride is neither a pay item, nor is any remedial action required based on ride measurements. Ride is measured with WisDOT's Profiler over a nominal one-mile section of pavement and reported as International Roughness Index (IRI) in metric units (m/km). IRI ranges in value from zero (perfect ride) to an indefinite upper-end (four is considered a very rough ride).

Overall Evaluation

In appendix B, the specific distress and ride data is shown for each section of each project. In addition, the threshold limits are shown for each distress. Transverse cracking (TRANSCR) and longitudinal cracking (LONGCR) are the only two distresses with any entries. As an aid in understanding Appendix B, consider a three in the TRANSCR column - - this means there are three cracks in that segment. When there is no entry in a distress column that means no distress was noted during the survey (showing all the zeros would make the report needlessly difficult to read).

Distress thresholds have not been exceeded on any project. In fact, all projects are well below the threshold limits. For example, on STH 11 a few segments have longitudinal cracking but all are less than the threshold of 1000 feet and a few segments have 1 to 3 transverse cracks (threshold is 25). Sometimes a couple of transverse cracks will show a PDI rating of zero, this means the cracks were narrow and had no band cracking (multiple cracks close to, and running parallel to, the main crack). Sometimes a single transverse crack will show a PDI of four, this means the crack is more than a simple, narrow crack.

A simple summary of overall comparative pavement performance is shown below.

Type 1 Pavements

Performance Indicator	Pavement Age			
	New	1 year	2 years	3 years
State Average IRI - **Non Warranted**	1.00	1.12	1.29	1.36
Average IRI - **Warranted**	0.80	0.83	0.79	0.80
State Average PDI - **Non Warranted**	0	4	11	18
Average PDI - **Warranted**	0	2	5	8

Based on the values shown above, the average distress performance of the warranted pavements over three years is better than historic distress performance. The ride values are significantly better than historic performance of non warranted pavements. This can be an important consideration since it relates directly to customer expectations.

Specific Evaluation

From the distress data gathered to date, the following observations can be made regarding 1995 warranty projects.

1. The STH 11 project has very little distress and very good ride.

2. The STH 85 project has good ride but the distress has been slightly above normal. In fact, some sections of STH 85 show PDI's as high as 27 due to the presence of rather serious band cracking. This band cracking may require maintenance during the warranty period.

3. The USH 45 project was built in part under warranty and in part under a standard construction contract (this is a control section built using standard QC/QA). At three

years, the ride is essentially the same on warranty and control sections of USH 45 (0.71 for warranted and 0.74 control) and the distress is the same for both projects (PDI of 7).

From the distress data gathered to date, the following observations can be made regarding the 1996 warranty projects. The STH 35 and 70 projects had virtually no distress for the one-year and two-year surveys; the ride values were significantly better than normal for one-year old pavements. The STH 23 project is the only type 3 (AC over rigid base) warranty project to date. For the STH 23 project, the one-year survey value for PDI was 2 and the two-year PDI was 3, compared to a statewide average of 15 at two years. Thus, the PDI was better than the statewide average. The IRI on STH 23 is better than average for a type 3 pavement. The above results can be observed graphically in Figures 1 and 2.

ASSESSING COST - EFFECTIVENESS

The typical type 1 asphaltic pavement (heavy or medium volume mix) in Wisconsin has an expected life of approximately 15 years at which time the PDI will be in the 65 to 75 range and the IRI will average approximately 2.5, Figures 1 and 2. Distress (not ride) generally controls the life of an AC pavement. Shown below are the typical asphaltic pavement ratings for PDI and IRI during the first 5 years.

Year	Typical PDI		Typical IRI	
	Type 1	Type 3	Type 1	Type 3
New	0	0	1.00	1.10
1	4	6	1.12	1.17
2	11	15	1.29	1.23
3	18	22	1.36	1.30
4	23	25	1.41	1.40
5	29	30	1.55	1.44

Figure 1: AC WARRANTY RIDE PERFORMANCE

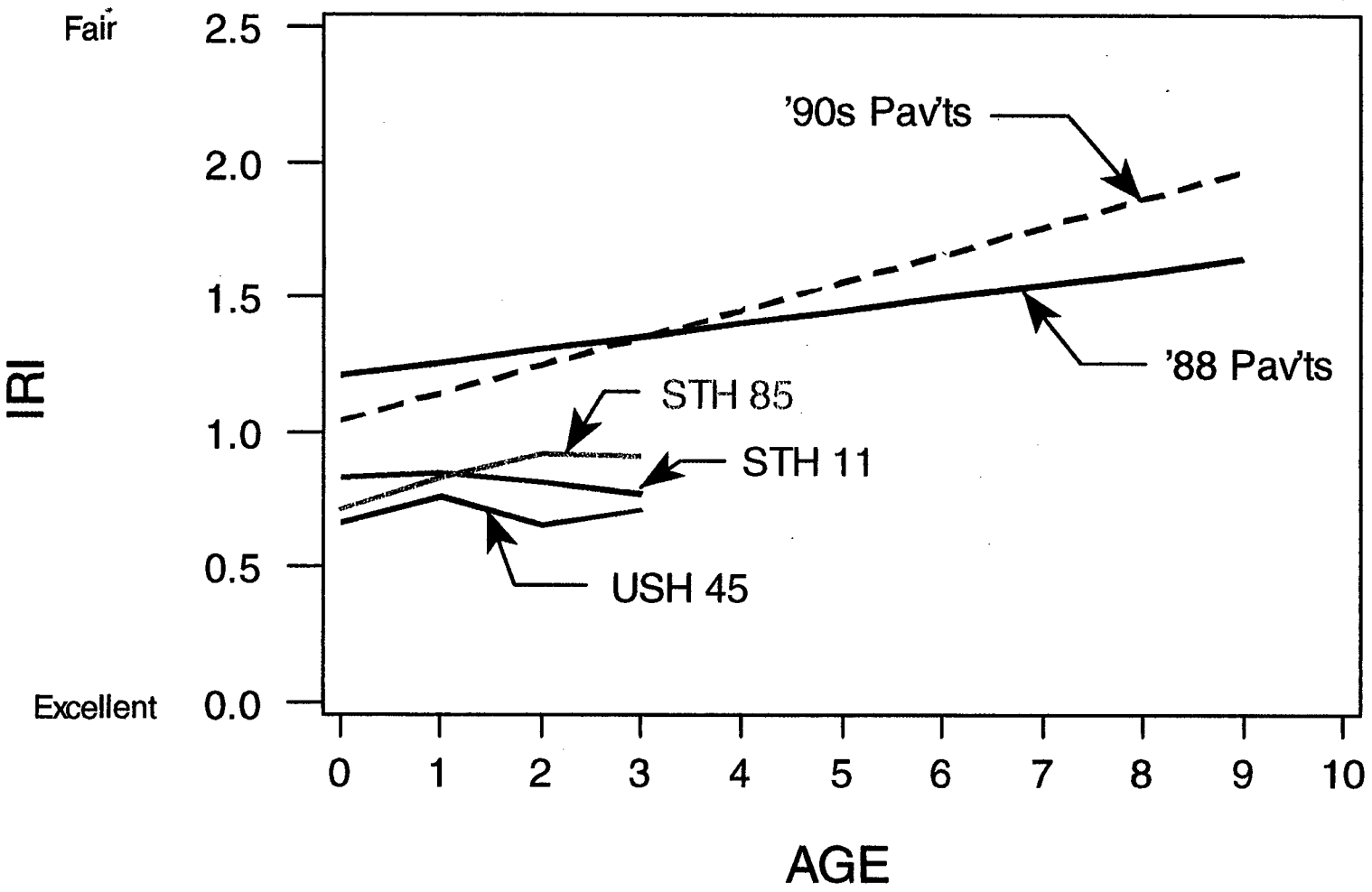
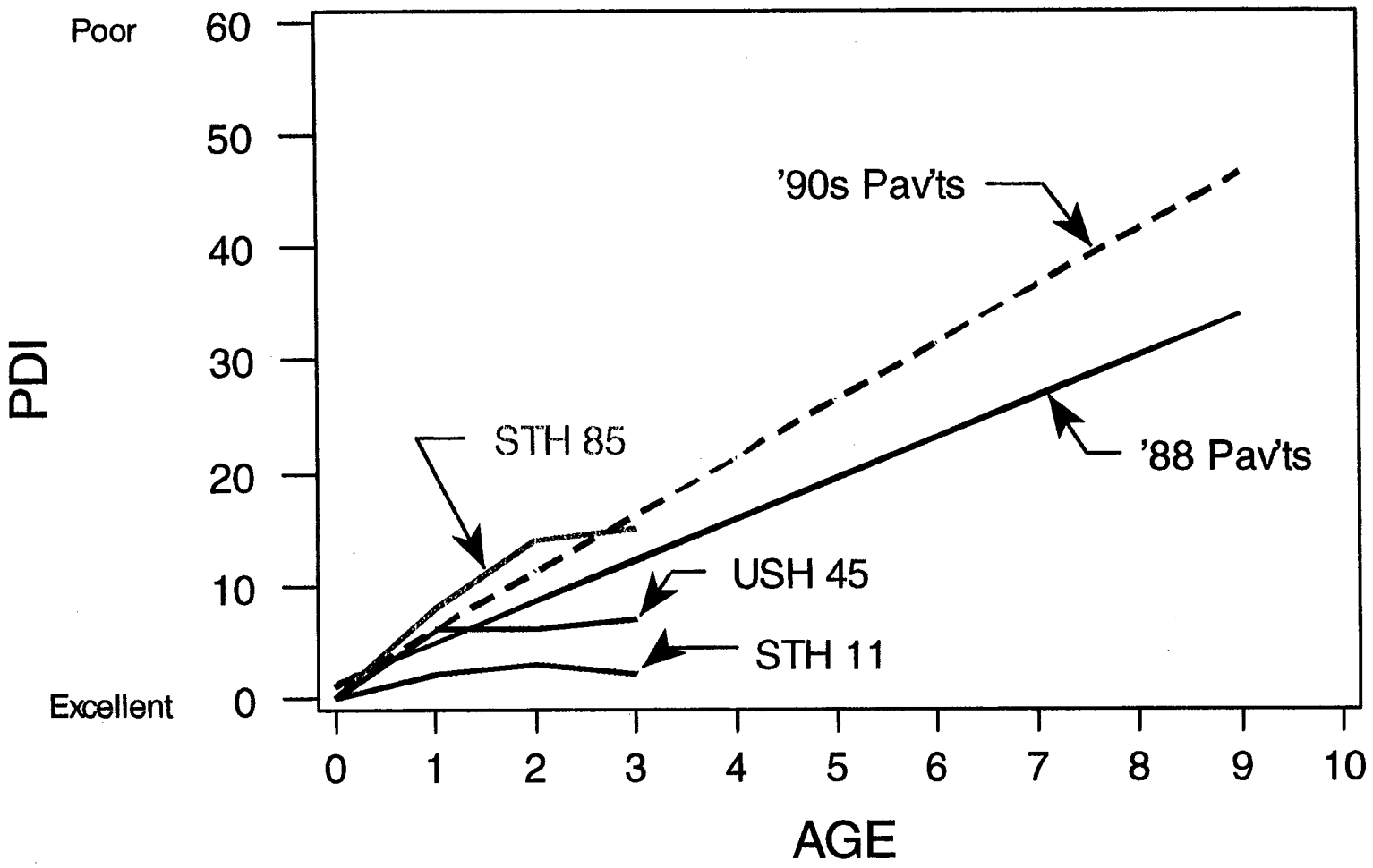


Figure 2: AC WARRANTY DISTRESS PERFORMANCE



Assessing cost effectiveness of a warranty program is difficult until such time that there is sufficient performance data to indicate long-term trends. Until such trends are developed, the performance of warranty projects can merely be plotted in comparison to typical pavements in order to get a "glimpse" of comparative performance. The extra "benefit" delivered via warranty, Figures 1 and 2, can ultimately be compared to the project costs to see if warranties are cost-effective. Of course, such an analysis has to include all the "other" costs experienced by WisDOT and the contractor during the first five years of pavement life in order to make a valid comparison.

A listing of cost factors required to make a valid (apples to apples) comparison is shown below.

Cost to be Included in Standard Contracts

1. Mixture bid price
2. Asphalt bid price
3. Tack coat bid price
4. Quality management bid price
5. State delivery costs
6. State maintenance costs for 5 years
7. Conflict resolution (found to be negligible, so not considered from here on)

Costs to be Included in Warranty Contracts

1. Asphalt pavement warranted bid price
2. Training and use of conflict resolution team costs
3. State delivery costs (reduced from standard contracts)
4. Extra distress surveys and reports for warranties
5. Extra tests for disputes, traffic counts, etc.

WisDOT is gathering data to refine and enable this comparison in future years. For the present, the comparison is based upon the following.

The worth of the preventive maintenance (crack routing and sealing at three years of age):

> WisDOT's Pavement Management System indicates a typical AC pavement will have approximately 8000 linear feet of cracking (longitudinal and transverse) per

roadway mile at three years of age. Routing and sealing typically cost WisDOT $0.90 per linear foot, or $7200 per roadway mile ($3600 per lane mile). For a five-inch pavement thickness this translates into **$0.74/ton** for crack sealing once in the five year period.

Thus, the cost estimates required for a comparison are:

1. Typical State maintenance costs for 5 years (5-inch thickness).

   a) Crack routing and sealing ---------- $0.74/ton} a+ b) = $0.77/ton

   b) Seal coating ---------- $0.03/ton}
   (Based upon 140 lane miles typically seal coated out of 1000 lane miles constructed per year. One third of the seal coats are placed on pavements five years or less in age).

2. Quality Management bid prices ---------- $0.60/ton

3. Extra distress surveys & reports ---------- $0.02/ton

4. Training and use of Conflict Resolution ---------- $0.04/ton

5. Extra testing for disputes and traffic counts ---------- $0.01/ton

6. State construction delivery costs. These figures are sketchy, at best. As stated previously, a savings of 4 - 5% in state delivery costs seems reasonable at this time. This analysis will use a conservative value of 4%.

Simply put, the comparison of costs can be made as follows (with and without a 4% delivery cost savings for the warranty projects – if applied, the 4% difference in delivery costs is added to the standard).

Standard Contracts (medium volume mix)

1. Mixture bid + Asphalt bid + tack coat bid ---------- $24.16/ton
   ($15.94/t + 5.5% x $146.42/t + $0.17/t)
   (average values statewide for projects of similar size in 1996 and 1997)

2. Quality Management ---------- $0.60/ton
3. State Maintenance ---------- $0.77/ton

STANDARD TOTAL (w/o delivery costs) = $25.53/ton

STANDARD TOTAL (with delivery costs) = $26.55/ton

Warranted Contracts

1. Asphalt Warranted bid price (average of nine projects) ---------- $24.75/ton (those with the routing and sealing clause averaged $24.74/t while those without it average $24.78/t).

2. Training and use of conflict resolution team ---------- $0.04/ton

3. Extra distress surveys and reports ---------- $0.02/ton

4. Extra tests for disputes and traffic counts ---------- $0.01/ton

WARRANTED TOTAL $24.82/ton

Not considering construction delivery costs, the standard projects averaged $25.53/ton versus $24.82/ton for the warranted. Considering an estimated delivery cost, the standard projects averaged $26.55/ton versus $24.82/ton for the warranted. It is obvious that the warranted projects cost less per ton.

The 1995 projects (without a routing and sealing clause) averaged $24.78/ton verses $24.74/ton for the more recent projects with the clause. The projects with such a clause should cost more; perhaps the familiarity of contractors with warranties in 1996 and 1997 allowed them to reduce "unknown risk and uncertainty" cost by approximately the additional costs of routing and sealing.

In conclusion, the warranty projects **cost less** per ton than standard projects and the difference appears significant. For the first nine warranty projects, the available data indicate warranties are cost-effective – they not only cost less, but they also give better performance.

Possible reasons why warranties cost less are:

1. Warranty projects have been carefully selected by WisDOT and industry to assure a win-win situation. This means potentially poor performing projects have not been warranted. This has reduced the risk that industry must assume.

2. Contractors have employed good materials science and construction practices. Thus, good science, craftsmanship and skilled administration by the contractors seems to be more effective in producing a quality product than State supervision, inspection and testing.

3. There are cost savings inherent in removing prescriptive QC/QA procedures and eliminating State inspection, enabling the contractor to concentrate efforts on project specific needs rather than routine tests/inspections that are generic in nature.

Perhaps a better estimate of costs would be to consider all costs per mile of pavement rather than a per ton cost. The per mile costs would include mobilization, base course,

etc., and would represent a more reliable evaluation. A per mile analysis will be considered in the next progress report.

FHWA PERSPECTIVE

Viewpoints

FHWA believes that warranties will protect the long-term investment in the infrastructure by minimizing maintenance and repair costs which result from premature failures due to poor construction methods or quality of materials.

The use of warranties should benefit small or specialty contractors with new products/methods. Previously, some states were reluctant to try new products that did not have an established performance record. The warranty concept will allow the use of such products with the state highway agency receiving a specific product warranty.

Warranties have been successfully used in other countries and by some states on non-Federal projects, to protect investments from early failure.

Future of Asphaltic Pavement Warranties in Wisconsin

Since the initial three warranty projects were let under SEP-14, WisDOT has let an additional six asphaltic pavement warranty projects using essentially the same performance criteria. The performance criteria for warranted projects were based on pavement management distress data for similar type projects under similar environmental conditions. In other words, the performance criteria used to date establish distress threshold levels equal to what could be expected for a well constructed non-warranted pavement. Now that the contractors and WisDOT have gained experience in the use of warranties, it is the recommendation of the FHWA Division Office that the performance criteria be upgraded so that a successful warranted project guaranties a better quality, longer lasting pavement than could be obtained under a traditionally administered project.

WISCONSIN INDUSTRY PERSPECTIVE

Some of the perspectives and concerns of the asphalt industry with warranties are shown below.

- The contractors would like to know if all the distresses that are measured now predict pavement performance or are there only a few that need to be measured? Presently WisDOT evaluates warranted pavements for: Alligator cracking, Block cracking, Edge raveling, Flushing, Longitudinal cracking, Distortion, Rutting, Raveling, Patching and potholes. WisDOT believes all these distress factors are essential for a comprehensive warranty to protect the public interest.

- There appears to be a lack of acceptance of warranty contracts by the designers. From the contractor's point of view, it appears that this may be an obstruction. WisDOT believes the problem is often timing, i.e., many projects were designed before warranties were implemented. As time passes and with some training, warranties should come to be more commonplace and be designed into the project.

- Not all projects are suitable for warranty. Warranty projects can become too expensive when design parameters are not placed on warranted projects. The concern is that the warranty has to be designed into the project not added on to it. If it is not designed into a project and the conditions are not correct, the contractor has to increase the price to defend against failure (which would add dollars to repair costs).

- It must be kept in mind that the Hot Mix Asphalt industry can only warranty the product that they directly produce. One of the concerns with Asphaltic Pavement Warranted is that the paver is not responsible for the subgrade which is an intregal part of the pavement structure. Asphalt pavers are concerned that a poor subgrade can cause a failure in the best of pavements and in most cases the paving contractor has no control over the subgrade. The fact that the warranty specification is designed to not hold the contractor responsible for such occurrences is helpful, but may not be the total solution.

- How long will it be until the industry and WisDOT feel that a five year warranty should be extended or the threshold distress levels be changed? Contractors are looking to revise the specification including adjusting the warranty length.

- Warranty projects have promoted the team concept among the contractor's employees. The results are an improved quality product. You can not inspect quality into a project. You must produce quality. In the warranty projects the contractor's employees and subcontractors are more aware of the value of their phase of the paving process and greater attention is paid to producing a quality project.

- When needed, the contractor can react immediately to a change in the process. This quick reaction time helps produce a quality product. The contractor is responsible for the product. With this philosophy the contractor can make adjustments when necessary, saving time and money.

Industry Innovation on Warranty Projects

- Proving durability of the mix design before producing the pavement, i.e., testing using the Georgia Loaded Wheel Tester, Homberg Tester and Superpave Level III testing. Frees up contractor to make adjustments without needing approval from the state agency saving valuable time and money.

- Using mix designs that require better materials than meet present WisDOT specifications.

- Closer tolerance in monitoring of the quality control process. The contractor is totally responsible for the product including quality control.

- Contractor quality assurance (QA) of all control systems. The contractor is totally responsible for the product and it's quality.

- Subcontractors and suppliers are required to meet strict specifications. Responsibility is distributed to all that have an interest in the product not just the paving contractor.

- Risk sharing with subcontractors and suppliers. The contractor now has to look at the best sub- contractor not necessarily the low bid.

- Rubblizing concrete pavement instead of the planned base patching with asphalt or concrete. Warranties allow for contractor innovation, for example, experimentation with a rounded sand interlayer to retard reflective cracking and use of different combinations of polymers, additives and performance graded asphalt to see which performs the best.

- After using innovative construction procedures, the contractor tracks and monitors performance for the following years to see what process is cost effective and what is not.

- Scheduling the work progress, when possible so that traffic can use lower lifts of pavements before the final lift is put down. This tests pavement and grade performance immediately before the project is finished.

WisDOT DISTRICT PERSPECTIVE

A warranty contract is a positive direction for both WisDOT and the contractors. We have seen more awareness on the part of the contractor for both quality of workmanship and quantity of personnel, machinery, and material. For example, the contractor has taken more initiative in determining where additional material is most beneficial with stringlines, profilograph, and visual inspections prior to placement of the binder and surface courses. Other observations include:

1. contractor had four rollers on the project to start the warranty work, and at times used all of them,

2. contractor profilographed entire warranty segment on the binder course on both lanes, and

3. contractor's awareness of the bid price pay for 5% over the plan quantity (this helped assure no major overruns).

The experience with the AC warranty projects has been positive. Under their own initiative, contractors use the best practice, methods and procedures.

District staff required on warranty projects is minimal. A delivery cost savings is usually experienced. It is, however, difficult to know where to draw the line in construction operations as to when our project management people should do something or do nothing because of the contractor's responsibility for five years. There is still some concern over what Maintenance can do on these projects or what is still a contractor responsibility.

The districts have not had to use the conflict resolution procedure, or do bond work. However, the designated players that are knowledgeable about each individual contract will change in time. This might get very confusing and hard to track/administer as these type of projects get more prevalent.

Concerns by the contractor that they would not want to pave unless minor subgrade deflections are removed created very stressful project situations and a great deal of expense to correct the subgrade prior to the warranty specification being used. Differences of opinion as to what would support the new base and asphalt caused many arguments.

The contractors spend a lot of time and money documenting items they believe are wrong in the design in order to prepare their case for when something may go wrong with the surface in the future. The district believes that when the contractor deviates from standard practices, the warranty specification should state that material records, construction practices, etc. be provided to the State, so the State can learn along with the contractor as how to best evaluate any new technology.

Districts hope that warranty projects do not become a shortcut for implementing research projects. No formal work plan is required or provisions to evaluate these sections, as is typical for research projects. New ideas tie in nicely with an attitude of constant improvement; accordingly, WisDOT should be informed of innovative construction procedures so a monitoring plan can be developed to evaluate if the procedure should become part of the standard contracts.

UNRESOLVED CONCERNS

In addition to the concerns expressed elsewhere in this report, there is another concern that can not be resolved at this time, but will ultimately have to be addressed for a comprehensive evaluation of the warranty program. The concern is as follows.

> Governmental agencies are traditionally self-insured because of large resources which make protection against catastrophic loss unnecessary. However, if only WisDOT is a "buyer" for warranty projects then there is no sharing of warranty costs with other agencies. As a result, a contractor cannot distribute the cost of their risks among multiple buyers. If counties and local units of government do not buy into warranties, or if the industry does not market this concept, then the risks are not born by multiple clients.
>
> Contractors have to build the costs of expected remedial work into their bids. The complete cost for the estimated risk is either borne by the sole buyer or absorbed by the contractor. If there are no remedial action expenditures over the five years, then the contractor profits by keeping all the remedial action costs built into the bid. An expanded program of warranty use among other clients would allow the contractors to reduce their risk costs on each project.

SUMMARY

Estimating. There is a general interest by the Department in improving the accuracy of our project cost estimates. Warranty projects represent one small aspect of this emphasis area but it is an area that should benefit from a commitment to increase awareness of designers to the cost impact of warranty special provisions. The Asphaltic Pavement Warranted item is most often the major difference between the bid price and the engineer's estimate.

Unit price comparisons. Warranty projects cost less than standardly administered projects. Even when ignoring State construction delivery costs (which would add still more costs to the standard projects), the warranty projects averaged $24.82 per ton compared to $25.53 per ton for standard projects.

Construction engineering costs. The early indications are that the Department's project delivery costs are lower on warranted projects than standard asphaltic pavement projects. A preliminary estimate, based upon a small sample, indicates the construction delivery costs savings to be in the range of 1% to 8%.

Single bids. Since it is clear that the majority of single bids in Wisconsin occur in asphalt paving, efforts should be made to introduce competition in other forms into this arena. It is assumed that by giving individual contractors more items other than costs upon which to compete, like time and quality, the number of contractors willing to compete may expand. Warranty projects may or may not offer a viable option for counteracting the single bid trend in Wisconsin in asphalt paving.

Performance and Quality. In general, considering ride and all forms of distress, the warranty projects are performing better than typical pavements of equal age.

Thresholds. No threshold has been exceeded; thus, there has been no need for remedial work.

Innovation. The contractors have been innovative in quality control, paving, use of additives, etc. In addition, the warranty concept has proven to be an innovative means for contract administration.

Cost effectiveness. The performance and costs of warranty projects indicate that warranties are indeed a cost-effective option for a state highway agency.

RECOMMENDATIONS

1. An incentive provision could be made to reduce the warranty period or to pay the contractor for an exceptionally good performing pavement. Such a program would reward exceptional performance by giving the customers a superior pavement, and by creating an incentive for contractors to maximize performance. Maximizing performance would be based upon a pavement significantly exceeding typical performance. The warranty period would only be reduced once the exceptional performance is documented.

2. It is recommended that either the performance criteria be "tightened up" (adjusted to be more restrictive) for the same five year time period or the criteria remain the same but the warranty period increased. In either case, a warranted project would help assure a better quality, longer lasting pavement than could be obtained under a traditionally administered project.

3. The warranty concept must be factored earlier into the design process. WisDOT must foster the mindset that warranty work is an acceptable not experimental way of delivering a project.

4. Investigate the possibility of bidding all projects conventionally and with a warranty. WisDOT would award the bid based upon the conventional bid and then decide whether or not they wanted to buy the warranty.

5. A change in practice should be considered in which standard asphaltic pavement projects are identified as reasonable candidates for warranted projects. Candidate projects could be selected based on pre-established factors or combination of factors (for example, based on proximity, length, contractor, initial cost estimate, etc.).

6. Pavements with subgrade deficiencies may not be good candidates for warranty projects and should not be considered for warranties unless the subgrade deficiencies are properly addressed.

7. Warranty projects can be fertile ground for innovation. However, WisDOT should be informed of such innovation so a monitoring plan can be developed. Accordingly, if a new product or test sections are built, the materials records, construction practices, etc. should be provided to the State. The mutual evaluation of the innovation may lead to implementation in other contracts.

8. Since WisDOT takes the risk of designing the pavement cross section and establishes the design concept (overlay, rehabilitation, reconstruction, etc.), any innovative change to the typical section (of the plan) must be approved by the WisDOT district office.

9. WisDOT should consider pursuing a full warranty implementation program (all projects being warranty candidates). For projects with "poor" subgrades, WisDOT should correct the problem and pave with a warranty.

10. Subgrade variability and quality has a large influence on pavement performance. WisDOT should develop a method of evaluating subgrade conditions prior to, or during, the construction phase so the issue of subgrade quality is eliminated from pavement performance evaluations.

APPENDICES

APPENDIX A - PAVEMENT PERFORMANCE SUMMARY

APPENDIX B - 1998 SPECIFIC PROJECT PERFORMANCE

APPENDIX C - NATIONAL EXPERIENCE

APPENDIX A PAVEMENT PERFORMANCE SUMMARY

HWY	FROM RP	PLUS DIST	TO RP	PLUS DIST	ROJEC LENGTH	PROJECT PERFORMANCE																	
						1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
						AVG IRI	AVG PDI	AVG IRI	AVG PDI	AVG IRI	AVG PDI	AVG IRI	AVG PDI	AVG IRI	AVG PDI	AVG IRI	AVG PDI	AVG IRI	AVG PDI	AVG IRI	AVG PDI	AVG IRI	AVG PDI	AVG IRI	AVG PDI
1995 CONSTRUCTION																							
11E	111		116	0.54	4.87	0.85	2	0.81	3		2												
85E	23		27T		4.05	0.83	8	0.92	14		15												
45N	261		270		8.12	0.76	6	0.65	6		7												
1996 CONSTRUCTION																							
35N	197		204		6.70			0.79	0		0												
70E	180	0.16	192		7.98			1.02	0		0												
23E	198		208A		7.97			0.77	2		3												
1997 CONSTRUCTION																							
21E	4		15		14.63			0.74			0												
54E	259		265		4.38			0.89			1												
63N	21A		31		10.20			0.87			0												
1998 CONSTRUCTION																							

Note: STH 11E Welsh Rd. has a climbing lane in west bound direction. Ride data averages include climbing lane. PDI is the driving lane only.

Note 2: Change in PDI Values is due to Band Cracking and Crack Filling

ROCK CO.
STH 11E ORFORDVILLE - FOOTVILLE
PROJECT ID : 1701-06-72

WARRANTY PROJECT SUMMARY

ASPHALTIC CONCRETE PAVEMENT
OVER FLEXIBLE BASE

1995 CONSTRUCTION

SURV. YEAR (Date)	FROM Feature	TO Feature	SECTION LOCATION: TEST SEG.	DIST TO SEG	SECT. LENGTH	FROM RP	PLUS DIST	TO RP	PLUS DIST	DISTRESS THRESHOLDS: ALLIGCR	BLOCKCR	EDGERAV	FLUSH	LONGCR	LONGDIS	RUT	SURFRAV	TRANSCR	TRANDIS	PATCH	POTHOLE	EAST RUT	EAST IRI	WEST RUT	WEST IRI	W CLIMBI LANE RUT	W CLIMBI LANE IRI	RIDE AVG IRI	PDI
							THRESHOLD LEVELS			10% of area in segment		10% seg lgt	20% seg lgt	1000 Lin ft	1% seg lgt	.25 in.	Slight	25/seg ***	1% seg lgt	150 Lin ft	any								
1996																													
3-21-96	STH 213	PLYMOU	Control	.3	0.84	111		112														0.09	0.89	0.14	0.80			0.84	
			Random	.5										<500'				1											13
	PLYMOU	WELSH	Control	.3	1.70	112		114														0.10	0.80	0.13	0.85			0.82	
			Random	1.0																									
	WELSH	S.FOOT	Control	.3	0.99	114		115														0.08	0.79	0.16	0.88	0.11	0.85	0.84	
			Random	.4																									
	S.FOOT	SECT. LI	Control	.3	1.34	115		116	0.54													0.10	0.78	0.15	0.99			0.88	
			Random	.6																									
	VERAGE																											0.84	2
1997																													
6-13-97	STH 213	PLYMOU	Control	.3	0.84	111		112						<100'				2										0.90	
			Random	.5										<100'				4											7
	PLYMOU	WELSH	Control	.3	1.70	112		114																				0.77	
			Random	1.0																									
	WELSH	S.FOOT	Control	.3	0.99	114		115						<500'				3										0.81	13
			Random	.4										<500'															
	S.FOOT	SECTIO	Control	.3	1.34	115		116	0.54									1										0.81	
			Random	.6																									
	VERAGE																											0.81	3
1998																													
3/25/98	STH 213	PLYMOU	Control	.3	0.84	111		112						59'														0.76	
			Random	.5										57'				3											7
	PLYMOU	WELSH	Control	.3	1.70	112		114																				0.74	
			Random	1.0																									
	WELSH	S.FOOT	Control	.3	0.99	114		115						528'				2										0.79	7
			Random	.4										100'				2											
	S.FOOT	SECTIO	Control	.3	1.34	115		116	0.54									1										0.80	
			Random	.6																									
	AVERAGE																											#####	2
1999																													
	STH 213	PLYMOU	Control	.3	0.84	111		112																					
			Random	.5																									
	PLYMOU	WELSH	Control	.3	1.70	112		114																					
			Random	1.0																									
	WELSH	S.FOOT	Control	.3	0.99	114		115																					
			Random	.4																									
	S.FOOT	SECTIO	Control	.3	1.34	115		116	0.54																				
			Random	.6																									
	AVERAGE																											0.00	
2000																													
	STH 213	PLYMOU	Control	.3	0.84	111		112																					
			Random	.5																									
	PLYMOU	WELSH	Control	.3	1.70	112		114																					
			Random	1.0																									
	WELSH	S.FOOT	Control	.3	0.99	114		115																					
			Random	.4																									
	S.FOOT	SECTIO	Control	.3	1.34	115		116	0.54																				
			Random	.6																									
	AVERAGE																											0.00	
2001																													
	STH 213	PLYMOU	Control	.3	0.84	111		112																					
			Random	.5																									
	PLYMOU	WELSH	Control	.3	1.70	112		114																					
			Random	1.0																									
	WELSH	S.FOOT	Control	.3	0.99	114		115																					
			Random	.4																									
	S.FOOT	SECTIO	Control	.3	1.34	115		116	0.54																				
			Random	.6																									
	AVERAGE																											0.00	

Note: *** Band cracking threshold is 25 cracks per segment of which 25% are banded.

Note: STH 11E RP114, Welsh Rd. has a climbing lane in west bound direction. Ride data averages include climbing lane. PDI is the driving lanes only.

APPENDIX B - 1 (Cont.)

WARRANTY PROJECT SUMMARY

MONROE CO.
STH 21E
SPARTA - TOMAH
PROJECT ID : 7605-06-71

ASPHALTIC CONCRETE PAVEMENT
OVER FLEXIBLE BASE

1997 CONSTRUCTION

SURVEY YEAR (Date)	FROM F	TO FEA	SECTION LOCATION: TEST SEG.	DIST TO SEG	SECT. LENGTH	FROM RP	PLUS DIST	TO RP	PLUS DIST	DISTRESS THRESHOLDS: ALLIGCR	BLOCKCR	EDGERAV	FLUSH	LONGCR	LONGDIS	RUT	SURFRAV	TRANSCR	TRANDIS	PATCH	POTHOLE	EAST RUT	EAST IRI	WEST RUT	WEST IRI	CLIMBING LANE RUT	CLIMBING LANE IRI	RIDE AVG IRI	PDI
										10% of area in segment		10% seg lgt	20% seg lgt	1000 Lin ft	1% seg lgt	.25 in.	Slight	25/seg ***	1% seg lgt	150 Lin ft	any								
									THRESHOLD LEVELS																				
1998																													
3/11/98	CTH A	SECT. LI	Ctrl	.3	1.11	4		5																				0.86	
			Random	.6																									
	SECT. LI	TN OF L	Ctrl	.3	1.22	5		6																				0.64	
			Random	.4																									
	TN OF L	CTH BB	Ctrl	.3	1.22	6		7																				0.61	
			Random	.4													1												4
	CTH BB	SECT. LI	Ctrl	.3	1.56	7		8																				0.81	
			Random	.7																									
	SECT. LI	TN GRE	Ctrl	.5	0.97	8		9																				0.78	
			Random	.6																									
	TN GRE	X RD	Ctrl	.3	0.98	9		10																				0.60	
			Random	.4																									
	X RD	BUCKLE	Ctrl	.3	1.50	10		11																				0.61	
			Random	.9																									
	BUCKLE	CTH E	Ctrl	.3	1.35	11		12																				0.62	
			Random	.5																									
	CTH E	CTH M	Ctrl	.3	1.78	12		13																				0.72	
			Random	.7																									
	CTH M	BUCKLE	Ctrl	.3	1.16	13		14																				0.73	
			Random	.4																									
	FLINT A	USH 12	Ctrl	.3	1.78	14		15																				0.70	
			Random	.9																									
AVERAGE																												0.00	0

Note: *** Band cracking threshold is 25 cracks per segment of which 25% are banded.

APPENDIX B -2 (CON'T)

WARRANTY PROJECT SUMMARY

FOND DU LAC CO.
STH 23E RIPON - ROSENDALE ROAD
PROJECT ID : 1430-00-71

ASPHALTIC CONCRETE PAVEMENT
OVER RIGID BASE

1996 CONSTRUCTION

SURVEY YEAR (Date)	FROM Feature	TO Feature	TEST SEG	DIST TO SEG	SECT. LENGTH	FROM RP	PLUS DIST	TO RP	PLUS DIST	ALLIGCR	BLOCKCR	EDGERAV	FLUSH	LONGCR	LONGDIS	RUT	SURFRAV	TRANSCR	TRANDIS	PATCH	POTHOLE	EAST RUT	EAST IRI	WEST RUT	WEST IRI	CLIMBING LANE RUT	CLIMBING LANE IRI	RIDE AVG IRI	PDI
										DISTRESS THRESHOLDS																			
									THRESHOLD LEVELS	1% of area in segment		10% seg lgt	20% seg lgt	1000 Lin ft	1% seg lgt	.25 in.	Slight	50/seg ***	1% seg lgt	150 Lin ft	Any								
1997																													
4-22-97	DOUGLAS	BRANDO	Control	.3	0.80	198		199																				1.06	
			Random	.4																									
	BRANDO	SILVER C	Control	.3	0.74	199		200A																				0.88	
			Random	.2																									
	SILVER C	WILLOW	Control	.3	1.04	200A		201C																				0.85	
			Random	.7														5											7
	WILLOW	CTH KK	Control	.3	1.75	201C		203F																				0.93	
			Random	.9														4											7
	CTH KK	CTH M	Control	.3	1.13	203F		205										5										1.05	7
			Random	.5														4											7
	CTH M	SECTION	Control	.3	1.01	205		205	1.01									1										1.08	4
			Random	.2																									
	SECTION	STH 26	Control	.3	1.50	205	1.01	208A																				1.24	
			Random	.1																									
AVERAGE																												#DIV/0!	2
1998	DOUGLAS	BRANDO	Control	.3	0.80	198		199																					
3/17/98			Random	.4																									
	BRANDO	SILVER C	Control	.3	0.74	199		200A																					
			Random	.2																									
	SILVER C	WILLOW	Control	.3	1.04	200A		201C						425'															7
			Random	.7														10											7
	WILLOW	CTH KK	Control	.3	1.75	201C		203F										1											
			Random	.9														4											7
	CTH KK	CTH M	Control	.3	1.13	203F		205										4											7
			Random	.5														5											7
	CTH M	SECTION	Control	.3	1.01	205		205	1.01									1											
			Random	.2																									
	SECTION	STH 26	Control	.3	1.50	205	1.01	208A										1											
			Random	.1																									
AVERAGE																													3
1999	DOUGLAS	BRANDO	Control	.3	0.80	198		199																					
			Random	.4																									
	BRANDO	SILVER C	Control	.3	0.74	199		200A																					
			Random	.2																									
	SILVER C	WILLOW	Control	.3	1.04	200A		201C																					
			Random	.7																									
	WILLOW	CTH KK	Control	.3	1.75	201C		203F																					
			Random	.9																									
	CTH KK	CTH M	Control	.3	1.13	203F		205																					
			Random	.5																									
	CTH M	SECTION	Control	.3	1.01	205		205	1.01																				
			Random	.2																									
	SECTION	STH 26	Control	.3	1.50	205	1.01	208A																					
			Random	.1																									
AVERAGE																													0

Note: *** Band cracking threshold is 25 cracks per segment of which 25% are banded.

APPENDIX B - 3 (CON'T)

WARRANTY PROJECT SUMMARY

PEPIN CO.
STH 35N STOCKHOLM - PEPIN ROAD
PROJECT ID : 7180-09-75

ASPHALTIC CONCRETE PAVEMENT
OVER FLEXIBLE BASE

1996 CONSTRUCTION

SURVEY YEAR (Date)	FROM Feature	TO Feature	SECTION LOCATION: TEST SEG.	DIST TO SEG	SECTION LENGTH	FROM RP	PLUS DIST	TO RP	PLUS DIST	DISTRESS THRESHOLDS: ALLIGCR	BLOCKCR	EDGEAV	FLUSH	LONGCR	LONGDIS	RUT	SURFRAV	TRANSCR	TRANDIS	PATCH	POTHOLE	EAST RUT	EAST IRI	WEST RUT	WEST IRI	CLIMBING LANE RUT	CLIMBING LANE IRI	RIDE AVG IRI	PDI
			THRESHOLD LEVELS							10% of area in segment		10% seg lgt	20% seg lgt	1000 Lin ft	1% seg lgt	.25 in.	Slight	25/seg ***	1% seg lgt	150 Lin ft	Any								
1997																													
4-24-97	CTH N	CTH CC	Control	.3	0.92	197		198										1										0.67	
			Random	.5																									
	CTH CC	LAKEPOF	Control	.3	1.01	198		199																				0.65	
			Random	.9																									
	LAKEPOF	LOST CR	Control	.3	1.35	199		200																				0.79	
			Random	.4														1											
	LOST CR	SECTION	Control	.3	1.32	200		200	1.32																			0.87	
			Random	.6														1											
	SECTION	CTH JJ	Control	.3	1.04	200	1.32	203																				0.93	
			Random	.7																									
	CTH JJ	CTH J	Control	.3	1.06	203		204																				0.77	
			Random	.1																									
AVERAGE																												#####	
1998																													
3/12/98	CTH N	CTH CC	Control	.3	0.92	197		198										1											
			Random	.5														2											
	CTH CC	LAKEPOF	Control	.3	1.01	198		199																					
			Random	.9																									
	LAKEPOF	LOST CR	Control	.3	1.35	199		200																					
			Random	.4														2											
	LOST CR	SECTION	Control	.3	1.32	200		200	1.32																				
			Random	.6														1											
	SECTION	CTH JJ	Control	.3	1.04	200	1.32	203																					
			Random	.7																									
	CTH JJ	CTH J	Control	.3	1.06	203		204																					
			Random	.1																									
AVERAGE																													0
1999																													
	CTH N	CTH CC	Control	.3	0.92	197		198																					
			Random	.5																									
	CTH CC	LAKEPOF	Control	.3	1.01	198		199																					
			Random	.9																									
	LAKEPOF	LOST CR	Control	.3	1.35	199		200																					
			Random	.4																									
	LOST CR	SECTION	Control	.3	1.32	200		200	1.32																				
			Random	.6																									
	SECTION	CTH JJ	Control	.3	1.04	200	1.32	203																					
			Random	.7																									
	CTH JJ	CTH J	Control	.3	1.06	203		204																					
			Random	.1																									
AVERAGE																													

Note: *** Band cracking threshold is 25 cracks per segment of which 25% are banded.

APPENDIX B -4 (CON'T)

WARRANTY PROJECT SUMMARY

LANGLADE CO.
USH 45N CTH B - CTH J
PROJECT ID : 1602-04-71

ASPHALTIC CONCRETE PAVEMENT
OVER FLEXIBLE BASE

1995 CONSTRUCTION

SURVEY YEAR (Date)	FROM Feature	TO Feature	SECTION LOCATION: TEST SEG	DIST TO SEG	SECT LENGTH	FROM RP	PLUS DIST	TO RP	PLUS DIST	DISTRESS THRESHOLDS: ALLIGCR	BLOCKCR	EDGERAV	FLUSH	LONGCR	LONGDIS	RUT	SURFRAV	TRANSCR	TRANDIS	PATCH	POTHOLE	EAST RUT	EAST IRI	WEST RUT	WEST IRI	WEST CLIMBIN LANE RUT	WEST CLIMBIN LANE IRI	AVG RUT 1996	RIDE AVG IRI	PDI
			THRESHOLD LEVELS							10% of area in segment		10% seg lgt	20% seg lgt	1000 Lin ft	1% seg lgt	.25 in.	Slight	25/seg ***	1% seg lgt	150 Lin ft	any									
1995																														
3-24-96	CTH B	CTH C	Control	.3	1.02	261		262										2				0.06	1.45	0.12	1.22			0.09	0.81	7
			Random	.2														4												
	CTH C	BRANCH	Control	.3	1.48	262		264										4				0.07	1.61	0.11	1.51			0.09	0.75	7
			Random	1.0										<500				2												
	BRANCH	CTH V	Control	.3	0.97	264		265										1				0.06	1.18	0.10	1.15			0.08	0.75	
			Random	.6																										7
	CTH V	CTH J	Control	.3	0.94	265		266														0.05	1.00	0.12	0.98			0.08	0.79	
			Random	.8														3												7
	CTH J	SECT LIN	Control	.3	1.57	266		268										3				0.06	1.11	0.11	1.12			0.08	0.79	7
			Random	1.4										<500				1												7
	SECT LIN	SECT LIN	Control	.3	1.07	266	1.57	266	2.64					<500				1				0.05	1.06	0.10	1.07			0.07	0.69	7
			Random	.5										<500				2												7
	SECT LIN	CTH J	Control	.3	1.07	266	2.64	270						<500				3				0.06	1.03	0.08	1.07			0.07	0.74	13
			Random	.6										<500				4												13
AVERAGE																												0.08	#####	
1997																														
4-23-97	CTH B	CTH C	Control	.3	1.02	261		262										2											0.67	16
			Random	.2														3												
	CTH C	BRANCH	Control	.3	1.48	262		264										5											0.64	7
			Random	1.0										<500				2												
	BRANCH	CTH V	Control	.3	0.97	264		265										1											0.71	
			Random	.6																										7
	CTH V	CTH J	Control	.3	0.94	265		266										2											0.59	
			Random	.8														3												7
	CTH J	SECTION	Control	.3	1.57	266		268										4											0.62	7
			Random	1.4										<500				1												
	SECTION	SECTION	Control	.3	1.07	266	1.57	266	2.64					<500				1											0.66	
			Random	.5										<500				2												7
	SECTION	CTH J	Control	.3	1.07	266	2.64	270						<500				3											0.69	22
			Random	.6										<500				4												13
AVERAGE																													#####	
1998																														
3/17/98	CTH B	CTH C	Control	.3	1.02	261		262										3											0.75	7
			Random	.2														2												
	CTH C	BRANCH	Control	.3	1.48	262		264										5											0.73	7
			Random	1.0										85'				2												
	BRANCH	CTH V	Control	.3	0.97	264		265						60'				1											0.76	
			Random	.6										475'																7
	CTH V	CTH J	Control	.3	0.94	265		266										2											0.66	
			Random	.8										125'				3												13
	CTH J	SECTION	Control	.3	1.57	266		268										4											0.65	7
			Random	1.4										315'				1												7
	SECTION	SECTION	Control	.3	1.07	266	1.57	266	2.64					270'															0.69	7
			Random	.5										380'				3												13
	SECTION	CTH J	Control	.3	1.07	266	2.64	270						500'				4											0.75	13
			Random	.6										500'				5												13
AVERAGE																												0.00	0.71	7

Note: *** Band cracking threshold is 25 cracks per segment of which 25% are banded.

APPENDIX B -5 (CON'T)

WARRANTY PROJECT SUMMARY

KEWAUNEE CO.
STH 54E
STUMP RD - LUXEMBURG
PROJECT ID : 4130-04-72

ASPHALTIC CONCRETE PAVEMENT
OVER FLEXIBLE BASE

1997 CONSTRUCTION

SURVEY YEAR (Date)	FROM Feature	TO Feature	SECTION LOCATION: TEST SEG	DIST TO SEG	SECTION LENGTH	FROM RP	PLUS DIST	TO RP	PLUS DIST	DISTRESS THRESHOLDS: ALLIGCR	BLOCKCR	EDGERAV	FLUSH	LONGCR	LONGDIS	RUT	SURFRAV	TRANSCR	TRANDIS	PATCH	POTHOLE	EAST RUT	EAST IRI	WEST RUT	WEST IRI	CLIMBING LANE RUT	CLIMBING LANE IRI	RIDE AVG IRI	PDI
							THRESHOLD LEVELS			10% of area in segment		10% seg lgt	20% seg lgt	1000 Lin ft	1% seg lgt	.25 in.	Slight	25/seg ***	1% seg lgt	150 Lin ft	any								
1998																													
3/17/98	CTH P	BROWN (	Cntrl	.3	0.70	259		260																				0.83	
			Random	.4														5											7
	BROWN (	CTH H	Cntrl	.3	1.02	260		262																				0.84	
			Random	.7																									
	CTH H	RENDEZ	Cntrl	.3	1.01	262		263																				0.94	
			Random	.9																									
	RENDEZ\	STH 163N	Cntrl	.3	1.01	263		264																				0.85	
			Random	.2																									
	STH 163N	HERITAG	Cntrl	.4	0.64	264		265																				1.05	
			Random	.5																									
AVERAGE																												0.00	1
1999																													
	CTH P	BROWN (	Control	.3	0.70	259		260																					
			Random																										
	BROWN (	CTH H	Control	.3	1.02	260		262																					
			Random																										
	CTH H	RENDEZ	Control	.3	1.01	262		263																					
			Random																										
	RENDEZ\	STH 163N	Control	.3	1.01	263		264																					
			Random																										
	STH 163N	HERITAG	Control	.3	0.64	264		265																					
			Random																										
AVERAGE																													
2000																													
	CTH P	BROWN (	Control	.3	0.70	259		260																					
			Random																										
	BROWN (	CTH H	Control	.3	1.02	260		262																					
			Random																										
	CTH H	RENDEZ	Control	.3	1.01	262		263																					
			Random																										
	RENDEZ\	STH 163N	Control	.3	1.01	263		264																					
			Random																										
	STH 163N	HERITAG	Control	.3	0.64	264		265																					
			Random																										
AVERAGE																													

Note: *** Band cracking threshold is 25 cracks per segment of which 25% are banded.

APPENDIX B -6 (CON'T)

WARRANTY PROJECT SUMMARY

PIERCE CO.
USH 63 N
ELLSWORTH - BALDWIN
JECT ID : 7210-07-71

ASPHALTIC CONCRETE PAVEMENT
OVER FLEXIBLE BASE

1997 CONSTRUCTION

SURVEY YEAR (Date)	FROM Feature	TO Feature	SECTION LOCATION: TEST SEG	DIST TO SEG	SECTION LENGTH	FROM RP	PLUS DIST	TO RP	PLUS DIST	DISTRESS THRESHOLDS: ALLIGCR	BLOCKCR	EDGERAV	FLUSH	LONGCR	LONGDIS	RUT	SURFRAV	TRANSCR	TRANDIS	PATCH	POTHOLE	EAST RUT	EAST IRI	WEST RUT	WEST IRI	WES CLIMBIN LANE RUT	WES CLIMBIN LANE IRI	RIDE AVG IRI	PDI
										10% of area in segment		10% seg lgt	20% seg lgt	1000 Lin ft	1% seg lgt	.25 in.	Slight	25/seg ***	1% seg lgt	150 Lin ft	any								
									THRESHOLD LEVELS																				
1998																													
3/12/98	USH 10E	STH 72E	Control	.3	1.50	21A		23																				0.80	
			Random	.4																									
	STH 72E	570TH A	Control	.3	1.12	23		24																				0.93	
			Random	.2																									
	570TH A	CTH G	Control	.3	1.01	24		25																				0.85	
			Random	.7																									
	CTH G	CTH N	Control	.3	0.97	25		26																				0.95	
			Random	.5																									
	CTH N	690TH S	Control	.3	1.03	26		27																				0.82	
			Random	.9																									
	690TH S	730TH A	Control	.3	1.00	27		28																				0.75	
			Random	.6																									
	730TH A	CTH Y	Control	.3	1.60	28		30M																				0.84	
			Random	1.2																									
	CTH Y	STH 29E	Control	.3	1.97	30M		31																				0.98	
			Random	1.1																									
AVERAGE																												0.00	0
1999																													
	USH 10I	STH 72I	Control	.3	1.50	21A		23																					
			Random																										
	STH 72I	570TH A	Control	.3	1.12	23		24																					
			Random																										
	570TH A	CTH G	Control	.3	1.01	24		25																					
			Random																										
	CTH G	CTH N	Control	.3	0.97	25		26																					
			Random																										
	CTH N	690TH S	Control	.3	1.03	26		27																					
			Random																										
	690TH S	730TH A	Control	.3	1.00	27		28																					
			Random																										
	730TH A	CTH Y	Control	.3	1.60	28		30M																					
			Random																										
	CTH Y	STH 29I	Control	.3	1.97	30M		31																					
			Random																										
AVERAGE																													

APPENDIX B -7 (CON'T)

WARRANTY PROJECT SUMMARY

ONEIDA CO.
STH 70E NORTH COUNTY LINE - USH 51
PROJECT ID : 9070-03-70

ASPHALTIC CONCRETE PAVEMENT
OVER FLEXIBLE BASE

1996 CONSTRUCTION

SURVEY YEAR (Date)	FROM FE	TO FEAT	SECTION LOCATION: TEST SEGMENT	DIST TO SEG	SECTION LENGTH	FROM RP	PLUS DIST	TO RP	PLUS DIST	DISTRESS THRESHOLDS: ALLIGCR	BLOCKCR	EDGERAV	FLUSH	LONGCR	LONGDIS	RUT	SURFRAV	TRANSCR	TRANDIS	PATCH	POTHOLE	EAST RUT	EAST IRI	WEST RUT	WEST IRI	CLIMBING LANE RUT	CLIMBING LANE IRI	RIDE AVG IRI	PDI
			THRESHOLD LEVELS							10% of area in segment		10% seg lgt	20% seg lgt	1000 Lin ft	1% seg lgt	.25 in.	Slight	25/seg ***	1% seg lgt	150 Lin ft.	Any								
1997																													
4-23-97	VILA / ON	SQUIRRE	Cntrl	.3	1.29	180	0.16	183																				0.75	
			Random	.6																									
	SQUIRRE	BELLWO	Cntrl	.3	1.72	183		185										1										0.72	
			Random	.8														1											
	BELLWO	CHIMPMU	Cntrl	.3	1.60	185		187																				0.87	
			Random	.4																									
	CHIMPMU	HOWER F	Cntrl	.3	1.29	187		189																				0.73	
			Random	.7																									
	HOWER F	BLUMST	Cntrl	.3	1.27	189		191																				0.78	
			Random	.2																									
AVERAGE																												#####	0
1998																													
#####	VILA / OI	SQUIRRI	Control	.3	1.29	180	0.16	183																					
			Random	.6																									
	SQUIRRI	BELLWC	Control	.3	1.72	183		185																					
			Random	.8														1											
	BELLWC	CHIMPM	Control	.3	1.60	185		187																					
			Random	.4																									
	CHIMPM	HOWER	Control	.3	1.29	187		189										1											
			Random	.7																									
	HOWER	BLUMST	Control	.3	1.27	189		191																					
			Random	.2																									
AVERAGE																													0
1999																													
	VILA / C	SQUIRR	Control	.3	1.29	180	0.16	183																					
			Random	.6																									
	SQUIRR	BELLW	Control	.3	1.72	183		185																					
			Random	.8																									
	BELLW	CHIMP	Control	.3	1.60	185		187																					
			Random	.4																									
	CHIMP	HOWER	Control	.3	1.29	187		189																					
			Random	.7																									
	HOWER	BLUMS	Control	.3	1.27	189		191																					
			Random	.2																									
AVERAGE																													

Note: *** Band cracking threshold is 25 cracks per segment of which 25% are banded.

APPENDIX B -8 (Cont)

WARRANTY PROJECT SUMMARY

EAU CLAIRE CO.
STH 85 E DURAND - EAU CLAIRE ROAD
PROJECT ID : 7120-01-71

ASPHALTIC CONCRETE PAVEMENT
OVER FLEXIBLE BASE

1995 CONSTRUCTION

SURVEY YEAR (Date)	FROM Feature	TO Feature	TEST SEG	DIST TO SEG	SECTIO LENGTH	FROM RP	PLUS DIST	TO RP	PLUS DIST	ALLIGCR	BLOCKCR	EDGEAV	FLUSH	LONGCR	LONGDIS	RUT	SURFRAV	TRANSCR	TRANDIS	PATCH	POTHOLE	EAST RUT	EAST IRI	WEST RUT	WEST IRI	WE CLIMBI LANE RUT	WE CLIMBI LANE IRI	RIDE AVG IRI	PDI
										10% of area in segment		10% seg lgt	20% seg lgt	1000 Lin ft	1% seg lgt	.25 in.	Slight	25/seg ***	1% seg lgt	150 Lin ft	any								
									THRESHOLD LEVELS																				
1996																													
3-20-96	DUNN/E	SECT LI	Control	.3	0.96	23		23	0.96									8				0.09	0.89	0.14	0.80			0.80	7
			Random	.4														10											7
	SECT LI	MAPLE D	Control	.4	1.00	23	0.96	25										4				0.10	0.80	0.13	0.85			0.88	7
			Random	.5														5											7
	MAPLE D	CEMETE	Control	.3	1.02	25		26M						<500				6				0.08	0.79	0.16	0.88	0.11	0.85	0.83	13
			Random	.7														5											7
	CEMETE	STH 37	Control	.3	1.07	26M		27T										6				0.10	0.78	0.15	0.99			0.81	7
			Random	.1														6											7
	VERAGE																											0.83	
1997																													
4-24-97	DUNN/E	SECTIO	Control	.3	0.96	23		23	0.96									8										0.75	32
			Random	.4														14											7
	SECTIO	MAPLE	Control	.4	1.00	23	0.96	25										7										0.89	7
			Random	.5														7											7
	MAPLE	CEMETE	Control	.3	1.02	25		26M						<500				6										0.69	13
			Random	.7														5											27
	CEMETE	STH 37	Control	.3	1.07	26M		27T										7										1.36	7
			Random	.1														7											7
	VERAGE																											0.92	13
1998																													
3/12/98	DUNN/E	SECTIO	Control	.3	0.96	23		23	0.96									8										0.88	7
			Random	.4														12											7
	SECTIO	MAPLE	Control	.4	1.00	23	0.96	25										7										0.97	7
			Random	.5														8											7
	MAPLE	CEMETE	Control	.3	1.02	25		26M						<500				7										0.83	13
			Random	.7														5											27
	CEMETE	STH 37	Control	.3	1.07	26M		27T										7										0.94	27
			Random	.1														7											27
	AVERAGE																											0.91	15

Note: *** Band cracking threshold is 25 cracks per segment of which 25% are banded

Note 2: The difference in PDI Values is due to Band Cracking.

Note 3: The difference in PDI Values 1997 and 1998 is due to Crack Filling occurring between the surveys.

APPENDIX C

NATIONAL EXPERIENCE

Prior to the rule making noted in the background section, eight states have participated in the evaluation of warranties under SEP 14. Of these, Michigan has been the forerunner. Michigan began using warranties on State-funded bridge painting contracts in 1990; and on a select number of Federal-aid projects, under SEP 14, beginning in 1991. Contracts have been let with two-year warranties for a total of 15 Federal-aid bridges. The State reports that they received good competition and that the warranty contract prices have been consistent with regular painting contracts. They are very satisfied with the warranty paint concept. Thus far the warranty period has been reached for 8 bridges. The final inspection of these bridges revealed that 5 required very minor repair and 3 required substantial repair. All of the bridges were satisfactory at the completion of the painting work and no explanation has been made for the extensive repairs needed on the 3 bridges. Michigan has also used its warranty approach on two Federal-aid concrete pavement repair projects (I-75 & M-28, both let in the summer of 1992, each with a two year warranty).

North Carolina has used a four-year warranty on an epoxy pavement marking project. Pavement failures may effect warranty results.

Missouri has constructed two rubberized asphalt overlay projects (I-29, let spring 1991 & I-44, let fall 1992), each with a three-year warranty.

The State of Washington has used a five-year warranty provision for a bridge deck expansion joint system on the transition spans of the I-90 floating bridge across Lake Washington let in late 1991.

Montana has included a four-year warranty in a $1.6 million pavement marking project let in June and completed in September 1992. By January 1993 significant failures had occurred in certain locations. The contractor has made repairs in conformance with the warranty. The State has indicated satisfaction with the concept and was approved to let a second pavement marking project in the summer of 1995 for approximately $0.6 million. The warranty period was three years.

California used a warranty on two rubberized asphalt pavement projects, let in 1993, one of three-years duration and the other of five-years.

Wisconsin has used a five-year warranty for nine hot mix asphalt projects that were awarded starting in the 1995 construction season. In addition, in 1998 WisDOT will construct three Portland cement concrete warranty projects.

Indiana used a five-year warranty on a pavement rehabilitation project located on I-70 approximately 12.8 km east of Indianapolis. The contract specifications for the warranty

provision contain mix design specification requirements (using Superpave mix criteria), bonding requirements, contract QC/QA provisions and the creation of a "Resolution Team" to manage warranty remedial action.

RELATED REPORTS

Past reports which serve as the basis for FHWA's decision to issue the Warranty Rule making include the following:

Transportation Research Board (TRB) Synthesis of Highway Practice 195 - "Use of Warranties in Road Construction" in the U.S. and Europe. The final report was released in 1994.

A general Accounting Office (GAO) study, mandated by the Section 1043 of the 1991 ISTEA, which addresses the effects of inclusion of guaranty/warranty clauses in contracts with designers, contractors and State highway departments. The study titled "Highway Infrastructure - Quality Improvements Would Safeguard Billions of Dollars Already Invested" is dated September 1994.

A study tour on Contract Administration Techniques for Quality Enhancement was undertaken from September 20 through October 1, 1993, in four European countries (Germany, France, Austria and Spain). All four countries utilize warranty clauses on their projects. While time frames vary, the typical time limit was 2 years on AC pavement, 5 years on PCCP pavement, and 5 years on bridges. The tour was considered a success and a report titled "FHWA Contract Administration Techniques for Quality Enhancement Study Tour (CATQEST)" is available from FHWA.