

Report No. UT-03.09

**Investigation of Warranty Specification
Implementation for Hot Mix Asphalt
in the State of Utah**

Synthesis

**Prepared For:
Utah Department of Transportation
Division of Research and Development**

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UDOT RESEARCH & DEVELOPMENT REPORT ABSTRACT

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16. Abstract This study was aimed at identifying useful performance bidding techniques, and implementing them into UDOT's guidelines. The main objectives of this project were: 1. Compile information on the effectiveness of techniques used by other agencies related to performance bidding and warranties for major construction and maintenance projects. 2. Recommend various performance bidding methods for use in UDOT's asphalt pavement programs. 3. Aid in the development of the specifications and other provisions for selected techniques. The report contains recommendations for warranties of Hot Mix Asphalt (HMA) pavement implementation and should not be perceived as a final application scenario. The development of warranty specifications would require the partnering of many sections of the industry and the Utah Department of Transportation (UDOT). Those would include the Agency, sureties and contractors, Pavement Management System (PMS) maturity and its ability to support the process, as well as the Quality Control / Quality Assurance (QC/QA) capabilities of the contracting industry.			
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Introduction

In researching the warranty implementation process, I have reviewed several documents that are attached to this paper as appendices. I have personally spoken with many industry representatives involved in this enterprise throughout the country. I have also personally spoken with many contractors in Utah, including Hot Mix Asphalt (HMA) contractors, binder suppliers, and the sureties industry. My opinions put forth in this paper are based on this information and research.

This paper contains recommendations for warranties of Hot Mix Asphalt (HMA) pavement implementation and should not be perceived as a final application scenario. The development of warranty specifications would require the partnering of many sections of the industry and the Utah Department of Transportation (UDOT). Those would include the Agency, sureties and contractors, Pavement Management System (PMS) maturity and its ability to support the process, as well as the Quality Control / Quality Assurance (QC/QA) capabilities of the contracting industry. If any leg of this group is unable to accept the risk / reward of the warranty implementation, the group needs to either abandon the thought process or redefine the risk / reward to make the scenario palatable for all parties. This process may take many years for all parties to be able to accept the risk / reward proposition.

Although this report may contain existing warranty scenarios, it is important that the joint agreement be developed in a partnering environment of all parties so that all groups can have "buy in." The contracting industry needs to have "buy in," otherwise; they will have the perspective of warranties as an additional risk to the contractor and this may be perceived as another way to potentially bankrupt the contractor. This perspective needs to be avoided as the shift of risk may be altered. In reviewing other states' warranty implementation processes there have been some failures in this area. In Ohio, they mandated warranties through legislation. Implementation was unsuccessful due to the lack of industry involvement. Development and review of the HMA warranty specification will require continual involvement of all parties involved in the partnership.

Utah Department of Transportation Goals

One of the key issues in developing a warranty specification is to keep in mind the goal of developing such an application. UDOT would like to reduce premature failures. This includes premature permanent deformation or unexpected stripping due to lack of aggregate/binder compatibility. In the current low bid system with method specifications, each of the partners has different needs.

- Agency needs – Performance (Long-term)
- Contractor Needs – Complete Project (short term)
- Bonding – (Short Term)

All of these needs have to be molded together into a win / win application.

UDOT's goals for this research are to investigate whether adapting HMA warranty specifications would increase quality, reduce premature failure, and reduce life cycle cost. Additionally, UDOT's goal is to make sure they are doing all they can do to ensure the quality of the HMA products in Utah.

Review of Current Acceptance Practices in Utah

With the aggressive implementation of Superpave in the State of Utah, UDOT has led the country in technical advances. Over the last 10 years, Utah has already significantly increased the quality of HMA products and significantly reduced the risk of premature failure.

The current condition of the Pavement Management System (PMS) in Utah is that it can evaluate statewide conditions but it cannot return data detailed enough to meaningfully evaluate individual projects or contractors. In order to implement a warranty specification, UDOT must develop information for each contractor on their previous performance. This may be achieved by selecting a similar previously constructed project and providing that performance information to the contractor prior to bid day.

The current Quality Acceptance Procedure is that UDOT samples the product and performs acceptance evaluation in the following areas:

- a. Gradation (Sieves ½ “, #8, #50, #200)
- b. Asphalt Content (AC)
- c. Voids in mineral aggregate (VMA)
- d. Density (% compaction)
- e. Smoothness

A statistical evaluation is then performed on the tested properties and is sent through a percent within limits (PWL) review. Incentives and disincentives are then applied to the PWL compliance. Currently the contractor QC data is not being used by UDOT for quality evaluation.

Future Recommendations to the Quality Acceptance Procedures

- With the current system, a significant volume of data is not being considered. Some research in the future may produce a synthesis that would provide a methodology to incorporate all data in acceptance (Agency and Contractor).
- Other potential changes to the specification might be to eliminate the voids in the mineral aggregate (VMA) as project acceptance criterion. The VMA should however, be reviewed in the mix design process.
- An air void specification could be adopted with a partnering environment between the agency and the industry. Moving to an air void specification would eliminate the issues with using stone effective specific gravity vs. bulk specific gravity. With absorptive aggregates, field data has shown significant changes in VMA. A voids specification is also easier to calculate and reduces the potential for error. Trial projects need to be developed for an evaluation of the limits to be set for acceptance. A review of current applications with other state DOT's should be done to accelerate the confidence with voids acceptance criteria.
- The number of acceptance sieves should be reduced to the -#200 only, since we will have all of the volumetric and density data. The reason for maintaining the -#200 criteria was the potential impact on binder stiffness as related to fluctuations in the -#200.
- A review of the current incentive program for smoothness should be undertaken to ensure that a proper and just compensation is being met. Current contractor perspective is that the compensation does not appear to reflect the greatly improved product that the department receives.

Warranty Process Evaluation / Warranty Findings

Application of HMA warranties must be very job specific and NOT be expected to be applied state- wide. Job application and selection is critical to the success of the HMA warranty implementation process. Implementation should expect to be slow and methodical to reduce the risk to all parties. Examples of projects that would not be applicable for HMA warranties would be thin overlays and short-term maintenance repairs. Project application should limit the risk of environmental scenarios and mitigate the Equivalent Single Axle Loading (ESAL) estimation from UDOT.

There are several up front requirements in implementing warranty application:

- Industry buy in – The contracting industry needs to be the driving force behind warranty implementation.
- Pavement Management System – Although the system exists, it is difficult to evaluate the effectiveness in a warranty application.
- Contractor previous performance information – Lack of data has caused added fear in the contractors' mind.
- QC/QA System – This allows the contractors to monitor their own performance characteristics. Since 1995 UDOT has successfully implemented this incentive.
- Partnering with bonding companies - The bonding companies do not appear to be concerned with small implementation.
- Warranty criteria development – Partnering with all parties to determine the acceptance thresholds.
- Conflict resolution team development (UDOT, Contractor, Independent) – two people from UDOT, two people from the contractor, and one person as independent consultant.

- Yearly testing – UDOT will need to be prepared to accept the cost of monitoring such items, but not limited to, ESAL's and subgrade conditions for the life of the warranty. Once again, the evaluation monitoring conditions will need to be developed in partnership with all parties involved with the warranty. This researcher is not able to determine this cost. This will need to be evaluated by UDOT. This cost will be directly related to the number of HMA projects that it wishes to put under a warranty contract.
- Bonded contractors – which are currently available.
- Final report documenting the project data developed by UDOT.
- Mix Design – No state approval. Mix design may include but not be limited to Hamburg rut testing and Asphalt Pavement Analyzer (APA) data. Some design criteria may be incorporated to increase UDOT's comfort with the contractors' use of specialty products.
- Meet quality specifications – A project document will need to be developed that will require the contractor to show proof of ability to meet the quality requirements for rutting and stripping.

Benefits and Concerns

There are some perceived benefits from implementing warranty applications. Implementing warranties could increase quality and contractor awareness of their products. It could lower the risk of premature failure. Since premature failure reduction is one of the primary goals of UDOT, this could be a major breakthrough towards these goals. Improved testing techniques on the contractor's side should improve final products. And it is possible that warranty application could bring new products to the market. These are benefits that have been achieved by other states that have implemented warranty application. UDOT has already achieved many of these benefits by implementing Superpave eight years ago.

There are several concerns regarding implementing warranty applications. One of the primary concerns is an issue of premature use. Projects brought under warranty need to be specific to the warranty application. Implementation should not be used statewide. Each project would need to conform to warranty requirements. As stated above, thin overlays and short-term maintenance projects should not be included.

The increase in project cost may negate the reduced maintenance cost. Initial contact with the contracting industry has indicated that an expected increase in unit price would occur. Contact with the surety industry has recommended that a warranty line item should be added, if UDOT implements HMA warranties in Utah, so that UDOT can understand the price of the warranty.

Another concern is that the warranty is only as good as the contractor or Surety Company. If either is not present, the warranty scenario is void. This then effectively eliminates smaller companies from doing warranty work. A consideration needs to be made for a contractor or surety that either does not renew the warranty bond or is no longer in business.

One recommendation that has been put forth is that if a surety or contractor fails to meet the requirements of the warranty contract, then those parties are excluded from providing a HMA pavement warranty project for the next five years. There is great uncertainty with any long-term bonding. The sureties have indicated a possible use of a one-year warranty with renewal each year.

Method specifications used with warranties are a large concern. Concern needs to be raised about the current level of percent with limits (PWL) specifications. This has already required the contractor to maintain a substantial investment in quality control and has increased the quality of the HMA products. The question is, will UDOT actually improve their HMA pavements or will it just cause the unit prices to increase due to the shift of risk to the contractor without receiving the benefit of increased quality in HMA? Through my research, I have not found a state that had initially implemented Superpave, and then implemented warranty specifications; therefore, at this time I cannot answer this question. Also, since the warranty thresholds have not yet been developed for Utah, it would be difficult to tell if the thresholds would further increase quality. UDOT has already substantially increased the quality of HMA products with Superpave specifications. It is unclear whether applying warranties would further increase the quality of HMA products.

The cost to UDOT is another concern. The estimated cost is between -3% to +16%. Project cost increase/decrease is not well documented and may be a positive or a negative experience. This increased cost needs to be reviewed to see if it offsets future maintenance cost incurred by UDOT. The PMS will need to be evaluated and updated to accommodate the yearly monitoring of the warranty pavement. It is unknown how many projects would be under warranty; therefore this cost cannot be determined at this time.

The cost to the contractors is another concern. Existing QC/QA projects have seen contractor cost to be near \$1/ton. Increased shift of risk may further increase the cost. It is unknown how many projects would be under warranty; therefore the increased cost cannot be determined at this time, nor can the increased bonding costs.

Application and Implementation of Warranty Specification

The implementation of warranty projects should be limited to rubbleized PCCP or new construction to mitigate the proliferation of reflective cracking into the warranty thresholds. The applications of warranties for HMA pavements should not be applied to thin HMA overlays until UDOT and the industry can develop long-term confidence in the current process or a new process that may be developed. Pre-existing sub-grade or other environmental issues should not be part of the warranty, or should be taken into account when establishing performance thresholds. Issues of third party damages should also not be part of the warranty. ESAL design life needs to be clearly defined to determine the pavement's expectations. A large concern with the contracting industry is if UDOT is prepared to maintain their pavement design, ESAL expectation, and actual development.

It is recommended that if smoothness is a part of the warranty specification that the application be evaluated on an "as built" requirement for compliance to the design threshold. Then the pavement should be evaluated on a yearly basis for an "information only" scenario. This evaluation will develop new information for UDOT as well as the contracting industry for further development of warranty specifications.

Since a Plant Mix Seal Coat (PMSC), Open Graded Friction Course (OGFC), or Chip Seal is placed over the HMA and is not part of the warranty product, the friction index criteria should not be part of the warranty specification. This negates the AASHTO recommendations for friction index thresholds.

Implementation of Superpave needs to be evaluated and quantified for the further development of HMA warranties. At this time UDOT's current PMS system is not prepared to provide the contracting industry the information on their prior performance. The PMS system will need to be redefined.

It is recommended that if warranties are applied to HMA, that the performance thresholds in the AASHTO primer be doubled until contractor performance can be established. This data development and evaluation may take 3 or 4 years before UDOT can have confidence in the conclusions. The contracting industry will need to be involved in the interpretation of the data to ensure their positive opinion for HMA pavement warranty application.

AASHTO recommendations are that the evaluation would need to be every 1/10 of a mile randomly selected each year using random number table, splitting the project into sections. The evaluation should provide, but not be limited to, the observed distress information and the recommended rehabilitation criteria. The contractor would then complete the recommended repair work in a timely manner. If the contractor is unable to complete the recommended repair work UDOT may elect to perform the necessary work. UDOT would then charge the contractor for said work. If the contractor does not agree with the repair recommendations, a conflict resolution team would be developed to resolve the dispute. The contractor shall pay for the independent consultant. The Agency should expect to bear the cost of annual project review as well as report preparation. This cost can not be determined until the performance criteria are developed.

Local Industry Input

- My contacts with the industry outside of Utah have indicated that a five-year warranty can easily be achieved if the contractor pays attention to the quality details. The performance thresholds need to be set so that they are attainable to the contractor and UDOT or it will result in higher bid prices.
- Bonding capabilities may limit the number of projects that UDOT may wish to have, due to the lack of large contractors (3), and/or the sureties' willingness for long-term liability.
- Higher bid prices may result in the short term. Over time the contractors may develop in both technology and experience; therefore, the bid prices may fall to tolerable levels. Bid prices have shown over time to be equal or lower given the appropriate acceptance thresholds. This increased cost for the project for the life of the pavement may or may not function in the current specification criteria that UDOT has already adopted.
- Based on the consultation with the contracting industry and the perceived shift of risk, it may be anticipated that the primary projects will increase in cost. Ideally, with the raised awareness of product quality, QC/QA should improve the life cycle cost of the HMA's put under warranty. However this evaluation will take time and review to determine the overall advantage to UDOT and the contracting industry. With the current perceived shift of risk to the contractor, it is important for the industry to not perceive the shift to warranties as additional risk to the contractor.
- One recommendation for the implementation of warranties into HMA projects is to partner with an existing project with a "for information only" concept to develop the performance/warranty related specifications. The contracting industry would prefer a slow development of these criteria until they understand their individual performance.

- Coordination and development needs to be a joint effort between all parties to have a successful and long-term relationship between UDOT, the sureties, and the contracting industry for the success of HMA warranty implementation. An additional recommendation from the surety industry is to have a separate line item in the bid and to define the limits of the liability as much as possible (i.e. dollar amount).
- To improve the level of confidence in the contracting industry's previous pavement performance, UDOT and the industry should tour some of the existing road system for its current level of conformance with the proposed warranty thresholds.
- Generally, meeting with the contracting industry regarding warranties has not been well received. There is already the existing concern of the shift of risk to the contractor with the implementation of the Percent Within Limits (PWL) specifications. According to the contractors, the risk has already been shifted too much towards the contractor.
- UDOT needs to estimate the cost of project evaluation. This will involve ESAL determination and environmental implications for warranty compliance. The cost will need to be determined by UDOT and is part of the acceptance scenario that UDOT will have to accept or reject.
- Long- term development will require contractor awareness and continued efforts from UDOT to promote the advantages of having warranty HMA specifications. This awareness from the contracting industry does not exist at this time.
- Potential limitations to the number of contracts under warranty may be limited to the contracting industry's palette for liability or the surety industry's low desire for long-term liability exposure.

Warranty Conclusions and Recommendations

The Transportation Research Board (TRB) has recently voted to continue the development of the HMA Spec software by BRE-Fugro. Functioning software is still a number of years from final development. It is still unknown if it will match up with the 2002 AASHTO Design Guide. Unfortunately, this developmental software will not contain performance data associated with rutting or stripping. Additional software may be developed from the current NCAT accelerated performance track; however, this product should not be expected for several years.

It is very important for UDOT to note that the starting point for other states prior to HMA warranty specifications or Superpave application may explain the perceived improvement in contractor quality awareness and a subsequent improvement in HMA warranty pavements. For example Indiana, before implementing warranty specifications, had utilized Marshall Mix Design with AC-20 as their binder. Therefore, their perceived improvement in quality of HMA products coincided with their implementation of Superpave.

With the progressive nature of UDOT, it is this researcher's perspective that it is important for UDOT to "step back." Make sure that the implementation of Superpave has not already given its users the needs that they want, such as reduced permanent deformation, elimination of thermal cracking and/or reduced life cycle cost.

The implementation of Superpave has been perceived as eradicating thermal cracking and permanent deformation, but can UDOT quantify the improvements? Concept development of improved HMA quality is difficult to quantify. I do not think this information has been quantified. However, if it has been quantified, it has not been disseminated to the contracting industry.

Additional review needs to be considered for incentive / disincentive specifications to encourage contractors' performance and compliance. This review and partnering with the industry will improve quality and long-term life cycle cost which should be UDOT's long-term goal.

With the new recommendations from the Binder Expert Task Group, bumping the high temperature specification (i.e. PG76-28) and the lack of contractors' experience with the use of highly polymerized binders, UDOT application of HMA warranties needs to be very carefully considered until the industry develops its understanding the application. There are additional concerns related to mix design success as well as density compliance.

The current Pavement Management System (PMS) will need to be totally redefined to accommodate the issues associated with HMA warranty in Utah and a new evaluation system will need to be put in place to accommodate the warranty review. I am not able to ascertain this cost at this time, due to the lack of knowledge at this point of the number of projects that would be under warranty.

With the tremendous resistance from the contractors to the perceived risk shift, it is this researcher's opinion that the development of HMA warranties be perceived as a long-term goal and not an application that will be implemented in the short term. With UDOT's lack of experience with warranty HMA pavements, I might suggest that they develop a team of UDOT leaders to approach the industry "with caution" to determine the industry's palate for this type of contracting technique. If the industry, after being approached a second time does not wish to participate in HMA warranty application, then the recommendation is that UDOT should abandon the HMA warranty thought process for the immediate future.

Future application may be attempted. However, at this time with the current opinion of the contracting industry, it is the conclusion that HMA warranties should not be applied until UDOT begins to experience at least the 10 to 15 percent premature failure criteria. With the potential increase in bid prices and the unnecessary "insurance" cost, the warranties may not be the direction UDOT needs to go based on their current success. It is my opinion that UDOT has achieved quality HMA products with the implementation of Superpave and that the implementation of warranties would not further increase the quality of the HMA products and would add to the cost of the HMA products.

If UDOT does want to start to implement warranty specifications anyway, there may be several years worth of implementation and observation needed by UDOT prior to partnering with the industry. The cost in time and resources to implement the recommendations will have to be determined by UDOT. As indicated, the cost to UDOT may not prove fruitful in increasing the quality of HMA products.

Once again, if UDOT does want to continue pursuing warranties, the following items will be necessary.

1. Contractor buy in.
2. Threshold development team.
3. PMS reviewed for warranty evaluation.
4. UDOT's commitment to long-term evaluation cost.
5. Continued review and evaluation of the system.

Superpave implementation and warranty application have similar goals, i.e. to extend pavement life. UDOT's application has been one of specification improvement with Superpave. Either scenario can be successful, and both applications have been shown to be successful. In my research, I have not been able to find an instance where Superpave had been implemented and then warranties implemented subsequently. I believe if UDOT does subsequently implement warranty specification, they may be the first state to do so. It is important to evaluate the cost vs. savings to UDOT. Since the application of Superpave has been successful, it is difficult to ascertain whether additional warranty specifications will further improve the quality of HMA products. With continued pursuit of the development of warranty specification, this could be the beginning point and may bring a higher awareness of both the contracting industry and UDOT's needs. However, UDOT's implementation of warranty HMA projects needs to be tempered by the potential increase in project cost.

One common thread in this investigation of HMA warranties was that if the incentive available to the contractor increases, quality improves. It is my recommendation that a review team be put in place to consider the current incentive system. The team should look at updating the system to provide an attainable incentive of 3% to 5% of the overall contract value. This review should consider the following for incentives:

- Density
- Smoothness
- Air Void Consistency

Although the recommendation to provide 3% to 5% available incentive may seem high at first, I believe that the higher quality contractors will look at those incentive bonuses as a competitive edge on the bid day, and remove some of the bonus from their bid. The result is that UDOT gets the better contractor without significantly increasing the overall cost to the project.

Appendix

1. Indiana Department of Transportation Hot Mix Asphalt Warranty, 18 pages.
2. Wisconsin Department of Transportation Hot Mix Asphalt Warranty, 9 pages.
3. Michigan Department of Transportation Hot Mix Asphalt Warranty, 16 pages.
4. New Mexico SR 44 Contract, 138 pages.
5. AASHTO Primer on Contracting for the Twenty-first Century, 76 pages.
6. NCHRP (National Cooperative Highway Research Program) Report 451 Guidelines for Warranty, Multi-Parameter, and Best Value Contracting, 132 pages.

Additional References

1. NCHRP (National Cooperative Highway Research Program) Report 455 – Recommended Performance Related Specification for Hot Mix Asphalt Construction: Results of the WesTrack Project, 496 pages.
2. Best Practices Guide for Innovative Contracting Procedures by Utah Transfer Center, 42 pages.
3. Pavement Warranties Yield Innovation, Quality. Draft Article for January 2003 Focus. Dave Andrewski (Indiana DOT) John D'Angelo (FHWA). 3 pages.
4. Warranty Issues and Experiences: Tennessee Asphalt Quality Initiative Conference, January 24, 2003 by Lee Gallivan, FHWA – Pavement Engineer, Indiana, 64 pages, Power Point Presentation.
5. Pavement Warranties: Learning from the European Experience, Draft Article for January 2003 Focus, John D'Angelo (FHWA). 5 pages.