National Cooperative Highway Research Program

NCHRP Synthesis 195

# Use of Warranties in Road Construction

## A Synthesis of Highway Practice

Transportation Research Board
National Research Council

National Cooperative Highway Research Program

# Synthesis of Highway Practice 195

# Use of Warranties in Road Construction

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## PREFACE

A vast storehouse of information exists on nearly every subject of concern to highway administrators and engineers. Much of this information has resulted from both research and the successful application of solutions to the problems faced by practitioners in their daily work. Because previously there has been no systematic means for compiling such useful information and making it available to the entire highway community, the American Association of State Highway and Transportation Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Transportation Research Board to undertake a continuing project to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series reports on various practices, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems. The extent to which these reports are useful will be tempered by the user's knowledge and experience in the particular problem area.

## FOREWORD

*By Staff*
*Transportation*
*Research Board*

This synthesis on the use of warranties in road construction will be of interest to administrators, engineers, designers, and contractors involved with highway design and construction and the procurement process for these services. Experiences with use of warranties in Europe and the United States are cited and the potential impacts, benefits, and concerns of using warranties in the United States are identified. Actions needed to facilitate the use of warranties for highway projects in the United States are also discussed.

Administrators, engineers, and researchers are continually faced with highway problems on which much information exists, either in the form of reports or in terms of undocumented experience and practice. Unfortunately, this information often is scattered and unevaluated, and, as a consequence, in seeking solutions, full information on what has been learned about a problem frequently is not assembled. Costly research findings may go unused, valuable experience may be overlooked, and full consideration may not be given to available practices for solving or alleviating the problem. In an effort to correct this situation, a continuing NCHRP project, carried out by the Transportation Research Board as the research agency, has the objective of reporting on common highway problems and synthesizing available information. The synthesis reports from this endeavor constitute an NCHRP publication series in which various forms of relevant information are assembled into single, concise documents pertaining to specific highway problems or sets of closely related problems.

The use of warranties in road construction is relatively widespread in the European highway industry compared to practice in the United States, where use has been limited. This report of the Transportation Research Board describes the various methods used in Europe for highway industry warranties and identifies the issues that need to be addressed

before construction warranties can be translated to U. S. practice. Recent congressional proposals call for the use of warranties to be allowed on federal-aid highway projects. This has caused varied reactions from the parties involved in the design and construction of highways, resulting in a General Accounting Office study on methods for improving the quality of federal-aid highways, including the use of warranties. Ultimately, the owner will have to decide whether to use warranties in highway construction projects. Some of the potential benefits and concerns of using warranties, plus needed actions for successful implementation are presented in this synthesis, which is considered a "snapshot" of the issues at the time of publication.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from numerous sources, including a large number of state highway and transportation departments. A topic panel of experts in the subject area was established to guide the researcher in organizing and evaluating the collected data, and to review the final synthesis report.

This synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now at hand.

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# USE OF WARRANTIES IN ROAD CONSTRUCTION


## SUMMARY

The European practice of requiring warranties of contractors to assure the quality and performance of their constructed products is receiving much attention. Reports on this practice in the European highway industry have prompted many people to question why it has not been adopted in the United States. Despite considerable activity and publicity about the use of warranties for highway construction projects, reaction from the highway industry has been cautious and often pessimistic.

The desire for innovation in highway contracting practices has resulted in recent Congressional action where legislation was introduced to encourage the use of warranties by state agencies for highway projects. During consideration of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), an amendment was proposed by Rep. Anthony Beilenson (H.R. 2950) which would allow, for the first time, the removal of the federal prohibition on the use of warranties in federal-aid highway construction contracts.

There was much opposition to this amendment from engineering and contracting organizations, and the amendment was defeated. A conference committee agreed instead to a 24-month study by the Comptroller General, General Accounting Office, to address means for improving the quality of highways constructed with federal assistance to examine the impact that warranties would generate.

This synthesis was initiated in response to the interest in warranties for highway projects. The scope of the study included a review of the use of warranties in Europe and in the United States, the identification of the potential impact of using warranties on the parties involved, the need for further evaluation, the potential benefits and concerns of using warranties, and the identification of actions needed to facilitate the use of warranties for highway projects in the United States.

The terms warranty and guarantee are used interchangeably in industry. In this report the term warranty is used unless connected to quoted materials. For most highway projects the work of contractors is guaranteed by surety (bonding) companies through a "guaranty" (bond). The following definitions are offered for the two terms, warranty and guaranty:

*Warranty*: A guarantee of the integrity of a product and of the maker's responsibility for the repair or replacement of deficiencies.

*Guaranty*: A promise to cover the failure or default of another party. (Example: performance bond)

Warranties for materials and workmanship are common in the construction industry with most performance bonds covering such items for 1 year following completion of a project. However, the new emphasis on warranties for highway construction involves the guarantee of the long-term performance of highways. Typically, a long-term warranty is considered to cover a period from 2 to 5 years. It is beyond the generally accepted standard warranty period of 1 year. This creates a very different situation and one that

involves a very high degree of uncertainty with our current state of practice and technology in the United States highway construction industry.

The use of warranties for highway construction is widely accepted as standard procedure in Europe. Contractors there are also allowed much more opportunity for input into design and production method decisions. Work is still awarded on a competitive basis, although more opportunities are afforded to negotiate design alternates. Owners feel that warranties motivate contractors to build better quality into projects. Security deposits for warranties are mostly 5 percent or less of the contract price. The success of innovative methods employed in European countries, which have excellent pavement performance, make it tempting to assume that such practices would produce excellent pavement performance in the United States. However, this may not be the case because of economic and societal differences. A very noticeable societal difference in Europe is that government/contractor disputes are usually settled administratively, rather than through litigation. It is also common for a few very large and stable firms to do a major part of the contract volume in a country. Several of the practices followed there would not be allowed by legal constraints in the United States. Also, there are many more roads in the United States and much lower road-user taxes to support construction.

Based on the data collected, it appears that less than half of the state departments of transportation in the United States are using warranties for their highway construction projects. Those that do are primarily using them for premanufactured products on projects; however, some states are using warranties for road construction items.

Transportation agencies are interested in the use of warranties for highway construction projects but are not ready to undertake such a practice without more information or without Federal Highway Administration (FHWA) approval. At this time most contractors and surety companies are very skeptical about the use of warranties. A major concern is that only a few very well-organized and financially solvent construction companies would be able to function in such a system. Since minority and small businesses currently have difficulty in securing bonding for projects, long-term performance warranties would make it even more difficult for such firms to compete.

The FHWA Special Experimental Project No. 14 shows promise for the use of warranties on a variety of federal-aid highway projects. It is still too early to evaluate the success of these projects as compared to traditional approaches to doing the same type of work. However, all of the DOTs involved are encouraged by these efforts and are willing to try more such projects. Good documentation of the results achieved on these projects is important.

Ultimately, the owner will have to decide whether to adopt the use of warranties for highway construction projects. Obviously, the views of other participants in the highway construction industry and legislative bodies will also affect this final decision. Some of the potential benefits and concerns of using warranties, plus needed actions for successful implementation are presented in this report.

CHAPTER ONE

# INTRODUCTION

## INNOVATIONS IN HIGHWAY CONTRACTING PROCEDURES

Many have extolled the virtues of the United States' system of highways and its positive impact on the development of the country as it exists today. Americans value their highways and the freedom offered by this system of paved passageways to all corners of the nation. They desire high-quality roadways and bridges that are well-maintained and safe for travel. Research studies have led to technological advances that yield safer and more effective operations, more efficient construction and reconstruction procedures, more effective designs, and more economical, durable materials that offer great promise for the future. Although some innovations have been implemented, the construction process in the U.S. transportation industry continues to follow the status quo rather than change (*1*).

Several innovative developments have been adopted in foreign countries in recent years, especially in the area of contracting procedures. One European practice receiving much attention is the requirement of long-term warranties of contractors to assure the quality and performance of their constructed products. Reports on new practices in the European highway industry have prompted many questions as to why the United States is slow to adopt more progressive methods in its contracting and design procedures. The immensity of the highway construction process and the potential impacts of changes, demand further understanding of new practices to allow the parties involved to accept and implement them.

It is important to note that there are major differences in operating conditions and practices used for road construction in European countries as compared with the United States. Some of the European practices, such as the bidding procedures, would not be allowed in the United States, where there are many more roads and much lower road-user taxes to support construction. The direct application of European practices must be carefully considered before implemention in the U.S. industry.

To help develop this understanding and to facilitate greater innovation in government and industry, the Transportation Research Board formed a Task Force on Innovative Contracting Practices to develop a position on this topic. The Task Force's report (*TRB Circular 386: Innovative Contracting Practices*) (*1*) is recommended reading for persons interested in this topic. One of its areas of recommendation was contract bidding procedures. Two recommendations related to warranties were included (a warranty is a guarantee of the integrity of a product and the maker's responsibility for the repair or replacement of deficiencies):

- "The potential for use of warranties should be investigated with a goal of delineating standards and procedures for maintaining data on highway segments built with warranties."
- "An industry-wide awareness program dealing with warranties or guarantees should be initiated; success obtained in other industries or countries should be publicized."

Despite all of this activity and publicity, reaction from the highway industry has been cautious and often pessimistic. There are several factors hindering the adoption of innovative practices for highway construction that must be addressed.

## FACTORS HINDERING INNOVATION

Perhaps the biggest hindrance to change is tradition (*2*), a rigid system of contracting practices that has been in place for many years and is well understood by all involved. The attitude of many is "It works, why change it?" Bids are awarded to the low bidder, what is to be built and how to build it are specified in detail, materials and test procedures are set, and procedures for payment and dispute resolution are usually well-defined. Once the project is completed and accepted by the owner, the contractor is generally free of further responsibility. Within a highly litigious environment, many people are reluctant to change this process.

Public procurement laws are intended to protect the integrity of the procurement process, to establish open, equitable, competitive procedures for the spending of public funds, and to assure all qualified private goods and services suppliers of a fair and equal opportunity to do business with the government. To achieve these objectives, however, it is necessary for the government to describe very clearly what goods or services are desired. Procurement practices based on lowest first costs rather than service life costs are most often used by highway agencies. Lowest first costs are easily computed and compared, while the tools needed to determine service life and to evaluate future performance are still limited in number and reliability.

When coupled with the requirement in public-procurement laws to award a contract to the "lowest, responsible and responsive" bidder, the detailed prescriptive specification becomes a formidable barrier to innovation. If a bidder proposes to meet the stated specifications for the lowest price, it is difficult for a highway agency to award a contract to another bidder at higher costs, even though the quality of the alternative bidder's product may be higher than that of the low bidder. Thus, the private supplier of goods and services under the public-procurement system, to compete successfully in the marketplace, must seek to supply the materials, services, and products that meet the minimum requirements of the specifications at the lowest costs (*1*).

The competitive process, in turn, may drive the highway agency to develop ever more restrictive specifications on procedures and material tests to assure the quality level it seeks. An obvious alternative for the highway agency would be to specify performance in the procurement process rather than prescriptive specifications that attempt to control quality. This would allow competitors the opportunity to develop and incorporate innovative technologies in materials, equipment, and construction processes. If warranties were offered for performance levels and service lives, then life-cycle costs could be part of the basis for awarding contracts. The

primary deterrent to the use of performance specifications and life-cycle costs is the lack of accelerated acceptance tests that correlate reliably with long-term performance.

Finally, a factor that may dampen innovation in the highway program is the sometimes negative risk/reward environment for employees in highway agencies. Established, proven, accepted processes, designs and materials offer the lowest risk, and practitioners are more likely to be rewarded for stability than for taking risk. Innovative concepts bring with them the potential for failure and many undesirable results: adverse publicity and possible political ramifications, interruptions of service to the highway user, reduced levels of safety, adverse environmental effects, and the ever present issue of liability. Because of this environment, many highway agencies have been slow to implement innovations (*1*).

## RECENT WARRANTY LEGISLATIVE ACTIONS

The desire for innovation in highway contracting practices has resulted in recent Congressional action where legislation was introduced to encourage the use of warranties by state agencies for highway projects. During consideration of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), an amendment was proposed by Rep. Anthony Beilenson (H.R. 2950) which would allow, for the first time, the removal of the federal prohibition on the use of warranties in federal-aid highway construction contracts.

The Federal Highway Administration regulation which presently restricts the use of warranty clauses on federal-aid projects is 23 CFR 635.413 (see Appendix A). Except for limited warranties on electrical and mechanical equipment, or other products a state feels is common trade practice, this regulation prohibits the requirement of a contractor to warrant materials or workmanship or to otherwise maintain the work for a specified period of time after it has been accepted. A major concern is that such requirements could result indirectly in federal-aid participation in maintenance costs (see Appendix A). It should be noted that states that have exempted their non-National Highway System (NHS) projects, per provision 1016 of the 1991 Intermodal Surface Transportation Efficiency Act, have the latitude to follow their own procedures and include warranty provisions on these projects to the same extent they are allowed to apply them on state-funded only projects.

The Beilenson amendment (see Appendix B) would have allowed:

> The Secretary of Transportation to permit a state highway department in accordance with standards developed by the Secretary in such regulations to include a clause in a contract for engineering and design services or for the construction of a Federal-aid highway project requiring the designer, contractor, state highway department, and Department of Transportation to warrant the services, materials, and work performed. The warranty clause shall be reasonably related to the services, materials, and work performed, and shall not be construed to require the construction contractor to perform maintenance.

There was much opposition to this amendment from engineering and contracting organizations such as the American Society of Civil Engineers (ASCE), the National Society of Professional Engineers (NSPE), the Associated General Contractors of America (AGC), and the American Road and Transportation Builders Association (ARTBA).

ASCE opposed the warranty amendment because of the belief that adequate protection already exists for owners in the form of contract and negligence laws backed up by engineers' professional liability insurance and contractors' performance bonds. ASCE also expressed the conviction that warranty contracting would impose extreme hardships on small engineering and contracting firms.

NSPE concerns over the Beilenson amendment centered around the engineering and design provisions of the amendment. NSPE vigorously opposed the imposition of warranties on engineering services for the following reasons: 1) engineering is a professional service, such as medicine and law, rather than a product and is based on professional judgment, which cannot be warranted; 2) there are many factors in construction over which the engineer has no control, yet may be required to warrant; and 3) most professional liability insurance policies will not cover professional acts when the professional warrants his or her work. NSPE also stated that more research is required to determine the effects of warranties in highway construction.

AGC opposed the warranty amendment based on their belief that the warranties would hold contractors responsible for a design they did not create and for subsequent uses of the highway over which they have no control (e.g., overweight vehicles). AGC also expressed concern over the surety industry's negative reaction to warranty contracting, indicating that small contractors would be severely hurt by this change in contracting procedure. ARTBA opposed the amendment for much the same reasons, and also pointed out that the real motivation for the amendment was to invoke European practices into the U.S. system without regard to the vast differences in the contracting practices of the two systems.

The only major construction group not opposing warranties at this time is NAPA, the National Asphalt Pavement Association. Although not adopting a formal position on the Beilenson amendment, they have testified to some support for warranties under certain conditions before a House committee. However, they pointed out that initial clauses should be reasonable and not an excuse to shift all of the responsibility and none of the rewards for highway quality to industry. The American Concrete Pavement Association, ACPA, did not take an official position on the issue.

On November 25, 1991 Congress passed comprehensive surface transportation legislation (ISTEA) minus a provision that would have permitted engineers to warrant their design work and contractors to warrant their materials and workmanship. A conference committee agreed instead to a 24-month study by the Comptroller General, General Accounting Office (GAO), to address means for improving the quality of highways constructed with federal assistance to examine the impact that such a requirement would generate. The study is to cover: 1) alternative modifications to current design standards including the impact they would have on serviceability, maintenance, expected life and costs (engineering and design, construction maintenance, operation and replacement costs); 2) potential costs and benefits of guarantee and warranty clauses, their impact on liability, bond and insurance requirements, and the implications for small, minority, or disadvantaged businesses; and 3) means of enhancing the maintenance of the Federal-aid Highway System to ensure protection of the public investment. See Appendix B.

## DEFINITION OF WARRANTY/GUARANTY

The terms warranty and guarantee are used interchangeably in industry and in this report. For most highway projects the work of

contractors is guaranteed by surety (bonding) companies through a "guaranty" (bond). Although these terms sound the same, in a strict legal sense they have entirely different meanings and should not be construed to mean the same thing. The following definitions are offered for the terms, warranty (guarantee) and guaranty (*3*):

*Warranty*: A guarantee of the integrity of a product and of the maker's responsibility for the repair or replacement of deficiencies.

*Guaranty*: A promise to cover the failure or default of another party.

A warranty is an absolute liability on the part of the Warrantor, and the contract is void unless it is strictly and literally performed. It binds a party to the terms of his or her contract. It usually is applied to manufactured products and their qualities, although it could apply to design and construction.

A guaranty is a promise, entirely collateral to the original contract, and not imposing any primary liability on the Guarantor, but binding him or her to be answerable for the failure or the default of another. It binds a third party to the terms of another's contract; a good example is a performance bond.

Warranties for materials and workmanship are common in the construction industry with most performance bonds covering such items for one year following completion of a project. However, the new emphasis on warranties for highway construction involves the guarantee of the long-term performance of highways. Typically, a long-term warranty is considered to cover a period from 2 to 5 years. It is beyond the generally accepted standard warranty period of 1 year. This creates a very different situation and one that involves a very high degree of uncertainty with our current state of practice and technology in the United States highway construction industry.

CHAPTER TWO

# EUROPEAN WARRANTY CONTRACTING PRACTICES

## OPERATING CONDITIONS

In 1990, a team of asphalt concrete pavement specialists from the United States visited six European countries in an effort to study advances in highway technology in those nations. The six countries visited were Sweden, Denmark, Germany, Italy, France, and the United Kingdom. The European Asphalt Study Tour (EAST) went to observe innovations in design, materials, construction methods, equipment, and contracting procedures (*4*).

The six nations have much in common with the United States. All are industrialized, have extensive highway and roadway systems, and rely increasingly on motor vehicles to move people and freight. The countries have modern, capable highway agencies and a mature construction industry. Some also have extensive highway research facilities. Despite these similarities, the six nations differ significantly from the United States and from each other in many ways. The following tables illustrate some of the differences in demographics, including density of population (Table 1); vehicle and roadway density (Table 2); and taxable income used for government financing of roads (Table 3).

The impression that the study team received was that the asphalt concrete pavements on European motorways and truck routes are in excellent condition. The extreme forms of distress that are evident in many parts of the United States, such as rutting, raveling, cracking, and potholes, were rarely seen. Even pavements that were being rehabilitated were in good condition by U.S. standards. This is true even though motor truck usage is much higher in Europe, around 20 percent of the total traffic, with volumes growing on many highways, and European axle weights substantially exceed those allowed in the United States. These weights may also be carried in Europe on "super singles," a tire configuration that concentrates much of the weight of the vehicle (truck) in a fairly narrow path.

There are several differences in the practices followed in the European highway industry that must be considered when evaluating such practices for application in the United States. Working priorities and relationships are vastly dissimilar, including design life, research emphasis, industry and government relationships, and construction contracting practices.

Many European countries use a 40-year design life, instead of the 20-year life used in the United States. In the 40-year analysis, several European highway agencies consider the life and cost of the initial pavement design and various rehabilitation strategies. Most European countries place heavy emphasis on building a sound subgrade and base. Structurally sound design practices are generally used even when they impose higher construction costs through excavation and replacement of subgrade material or incorporation of active drainage systems. Strong, well-drained bases and subbases are the norm in these countries, rather than the exception. This structural predictability has helped to make some innovative forms of contracting for surface courses work effectively (namely, functional contracts and warranties).

The emphasis placed on highway research appears much stronger in Europe than in the U.S., especially by contractors. Many countries have large centralized research facilities and capa-

TABLE 1
NATIONAL DEMOGRAPHICS

| Nation | Population (Millions 1990) | Population Density (person/km$^2$ 1986) | Percent Urban (1985) | Auto Expense as percent of spending (1980-85) |
|---|---|---|---|---|
| Denmark | 5.2 | 118.8 | 86 | 5 |
| France | 55.4 | 101.3 | 73 | 3 |
| Italy | 57.4 | 190.0 | 67 | 3 |
| Sweden | 8.2 | 18.6 | 86 | 2 |
| United Kingdom | 55.8 | 231.9 | 92 | 4 |
| United States | 248.0 | 25.7 | 74 | 6 |
| West Germany | 60.7 | 245.6 | 86 | 4 |

Source: 1990 European Asphalt Tour (*4*)

TABLE 2
NATIONAL HIGHWAY FACTORS

| Nation | Vehicles (Millions 1987) | Persons/Vehicle (total/car) | Vehicle Density (vehicle/km$^2$) | Highway Density (km/km$^2$) |
|---|---|---|---|---|
| Denmark | 1.88 | | n/a | n/a |
| France | 24.85 | 2.2/2.5 | 40.0 | 1.46 |
| Italy | 24.72 | 2.3/2.5 | 77.5 | 1.01 |
| Sweden | 3.63 | 2.3/2.5 | 7.6 | 0.40 |
| United Kingdom | 23.02 | 2.5/2.8 | 74.1 | 1.53 |
| United States | 179.04 | 1.4/1.8 | 14.5 | 0.67 |
| West Germany | 30.11 | 2.0/2.1 | 113.9 | 1.98 |

Source: 1990 European Asphalt Study Tour (*4*)

TABLE 3
NATIONAL TAXATION EFFORTS

| Nation | Total tax receipts as % of 1985 GNP | Road taxes as % of Total Receipts | % of user fees spent on roads |
|---|---|---|---|
| Denmark | 49.2 | 6.2 | 31 |
| France | 45.6 | 15.0 | n/a |
| Italy | 34.7 | n/a | n/a |
| Sweden | 50.5 | 6.3 | 34 |
| United Kingdom | 38.1 | 11.5 | 23 |
| United States | 29.2 | 4.7 | 100 |
| West Germany | 37.8 | 3.7 | 64 |

Source: 1990 European Asphalt Study Tour (*4*)

bilities, including full-scale pavement testing devices and test tracks (France and U.K.), wheel-tracking tests for rutting, accelerated wheel-wearing devices for evaluating surface treatments (Sweden and Germany), rolling compactors for preparing large test specimens, and extensive laboratory capabilities. Research and development by private contractors is not only common, but much more extensive than in the United States. This is reflected in the diverse array of specialized paving mixtures and equipment that contractors have developed to compete in European markets outside their own countries.

The business climate in the European paving industry differs significantly from that in the United States with regard to the relationship of government and industry. Government and industry cooperate to obtain quality, even though costs may be higher. Industry plays a much more active role in research, product development, and new product testing than in the United States. The national governments cooperate with industry by helping to develop or approve standardized tests, by arranging field trials of new industry products, and by setting specifications that ensure adequate performance, but permit sufficient freedom to include innovative industry products.

The method used to select contractors may also affect the quality of highways. The practices used in the European countries visited during the 1990 Asphalt Tour are different from those used in the United States. In Sweden only a few large, well-qualified companies are able to offer the necessary assurances required under their performance-warranty system. The U.K. allows only a few qualified contractors to bid on some projects. A combined system of cost and quality-related factors is used in Germany to select the most acceptable contractor. In each of these countries, however, government officials have greater latitude to limit the competition to well-qualified contractors, and to consider their past perform-

ance and quality of work in the selection process. More discussion of European contracting practices is included in the next section of this report.

A U.S. tour of European concrete highways (U.S. TECH) was held from May 22 to June 6, 1992. Twenty-one representatives from several transportation agencies and the concrete construction industry conducted a tour similar to that of the 1990 European Asphalt Study Tour group. They observed highways and met with experts in France, Austria, Germany, the Netherlands, and Belgium. They also heard presentations by experts from Italy, Portugal, Spain, and Switzerland, concerning portland cement pavements. A joint statement of the tour members was released by the American Association of State Highway and Transportation Officials (*5*) in June of 1992 and offered several findings (many similar to those of the Asphalt Tour) related to European practices:

- Concrete pavements built for quality with less emphasis on cost,
- Excellent concrete pavements on thick, well-drained bases,
- Pavements built with the best technology, much of which was developed in the United States,
- A cooperative attitude among the various components of the European highway community—researchers, government engineers, contractors, suppliers, etc.,
- 30- to 40-year design life versus the 20-year life in United States,
- Highways carry a large volume of trucks with allowable axle weights substantially above those in the United States, and
- Commitment to early preventive maintenance and to undertaking timely rehabilitation and reconstruction.

In summary, Europeans are building excellent concrete pavement systems, and they are building and rebuilding their highways for very large loads and long life.

## GENERAL CONTRACTING PROCEDURES AND WARRANTY METHODS

One of the most impressive features of the European paving practice is the capability of these countries to stimulate innovations from contractors and to apply these ideas within a competitive environment. These innovations include the use of modifiers and additives within asphalt binders, the use of high-quality aggregates, and new mix designs. There are basically two features that differ from the current U.S. bidding procedure: 1) specifications are broader than most of the method specifications used in the United States, allowing contractors greater leeway to select materials and designs, and 2) contracts require contractors to offer warranties that extend 1 to 5 years after the work is completed. The first feature gives the contractor greater responsibility in selecting an effective strategy. The second holds the contractor responsible for that choice.

The arrangement apparently provides a good working relationship that taps the experience and ingenuity of the contractor while maintaining sufficient control to ensure that public funds are spent effectively. Contractors appear to accept the warranty requirement, at least in part because of the existence of good quality pavement designs that, in many cases, they had a role in planning. Several large contractors dominate the work in most countries.

In June of 1992, two highway engineers with the Federal Highway Administration, Stephen Gaj and Peter Markle (*6*), traveled to Europe to review the construction contract administration procedures of four countries: Sweden, Denmark, Germany, and France. They found many similarities and some differences. Two practices that they found in all four countries were the requirement of warranties and the encouragement of bid alternatives for road construction contracts. These practices are common operating procedures in all four countries. Warranties are accepted as a required part of the contract process for all projects in Sweden, Germany, Denmark, and France (*6*). Owners feel that warranties motivate the contractors to do better quality work on projects. Most require a bond to insure the warranty, although often not for full coverage of the contract price.

The findings of the 1990 European Asphalt Study Tour (*4*), the 1992 European Concrete Highways Tour (*5*), the 1992 FHWA Study Tour (*6*) and information obtained by the researcher have been summarized for eight European countries (Austria, Denmark, France, Italy, Norway, Sweden, United Kingdom, and Germany) for their practices on warranties, including some related contracting practices. The findings for each country are summarized below. Sample contract documents for warranties in various countries are included in Appendix C.

## WARRANTY METHODS OF DIFFERENT COUNTRIES

### Austria (*7*)

Highway contracts in Austria can be initiated either by an open tendering (bidding) process for standard types of projects or by a selective tendering process for contractors pre-qualified to bid on special types of projects. In either case, the contractor must adhere to general contract conditions for government contracts. Fixed price contracts are preferred; however, the bids can be evaluated on both cost and technical presentations. Work specifications are approved by the government and bonds similar to those in the United States are required.

A "warranty bond" is required on all highway projects. This warranty may be met by a cash deposit, a bank, an insurance company or a deposit of domestic trustee securities. The deposit represents a security against the failure of the contractor to fulfill his duties in case of liability claims. The period of warranty for highway contracts varies from 3 to 5 years. The warranty bond is deducted from the final invoice and must be repaid to the contractor not more than 30 days after the end of the liability period.

The contractor warrants that the work has been performed in accordance with the specifications of the contract and that generally accepted industry performance has been attained. The warranty cannot be limited because of close supervision of the performance of the work by the government authority. Strict rules cover the repair of certain classes of defects and penalties for non-compliance. During the warranty period the contractor is liable for all defects of the road pavement, except defects caused by influence beyond one's control. In general Austrian road contractors are obliged to warrant their work for 3 years; however, there are exceptions, such as:

| | |
|---|---|
| Single surface dressing | 1 year |
| Hot mix asphalt pavement (less than 45 kg/m$^2$ or 9.2 lb/ft$^2$) | 2 years |
| Unbounded base course without wearing course | 2 years |
| Doubled or improved surface dressing | 2 years |
| Hot mix asphalt pavement (45 kg/m$^2$ to 60 kg/sqm or 22.5 lb/ft$^2$) | 2 years |
| Hot mix asphalt pavement (greater than 110 kg/m$^2$ or 22.5 lb/ft$^2$) | 5 years |
| Cement concrete pavement | 5 years |

Warranties are required and are rigidly administered. Quality testing is the responsibility of the contractor and reports must be submitted to the owner. Additional tests over disputes must be done by an independent laboratory and paid for by the party doubting the results. If defects are found the contractor is liable to make repairs immediately.

### Denmark (*4,6*)

Road projects in Denmark are advertised similarly to those in the United States; however, bids are evaluated on the basis of lowest life-cycle cost (LCC). It is believed that bids awarded on low bid for initial cost only result in lower quality. The structural design is the responsibility of the Danish Road Directorate (DRD), not the contractor. The DRD defines the basic guidelines, such as the structural number, for the road and the contractors select the mix design within these guidelines. Alternate bid designs are encouraged and contractors can supply longer warranties for their designs to enhance bids. The contractor is responsible for routine quality testing, with periodic checks by the DRD. If problems arise the fault of failure is evaluated and fixed by the liable party. Disputes are resolved by a binding arbitration process.

The Danish Asphalt Pavement Association's laboratory is well-equipped and appears to be used mainly for testing mixes and mix design. The tests basically give contractors a level of comfort with their designs, an important factor because of the warranty requirement on all major highway projects.

Denmark requires a 5-year warranty on highway pavements covering smoothness, durability, and skid-resistance. A retainer equal to 5 percent of the contract price is withheld during the warranty period. A 2-year warranty is required for subbase and a 1-year warranty is required for earthwork. During the warranty period, the burden of proof is on contractors to show that any failures are not their fault. For road failures, contractors pay for the repairs less a percentage reduction for the passed service life of the road since construction. After the warranty period, failures are the responsibility of the government. The DRD feels that the 5-year warranty is best, with less than 2 percent of the projects having problems.

### France (*4,6*)

The system used in France to initiate construction projects for their major motorways, similar to our Interstate system, is somewhat unique. Most of the motorways are toll facilities designed, built, and operated by toll authorities called concessionaires. The Ministry of Public Works handles the preliminary work for projects and then transfers the responsibility to the concessionaires. There are eight of these authorities, with seven quasi-public agencies and one fully private; each represents a geographic region of the country.

Concessionaires contract out all phases of their road projects. After a project is advertised, the contractors submit their bid packages with their technical proposals, plus a bid price, information on the persons to be involved, financial data on the company, and a quality control plan for the project. This latter information is used to pre-qualify bidders for the project. The proposals of pre-qualified bidders are then evaluated for technical quality of the base design and alternates proposed. Awards are based on the information in the bid announcements with the low bidder selected; negotiations on alternates can be made with the low bidder.

The French system encourages innovation by giving contractors the opportunity to use their own technology in pavement design and construction. For example, specifications usually identify desired end results. The proposer of an innovative solution, however, must be able to demonstrate to the owner's satisfaction that the desired results can be achieved. This public/private cooperative approach seems to result in excellent pavements.

Laboratories of the major contractors are well equipped, generally with equipment designed by the Central Laboratory of Bridges and Roads. One result of this is that contractors are confident when testing their mixes because the government will use the same model of equipment and the same tests. Agreements on test procedures to be used were worked out over 2 years of discussions between the private and public sectors.

All construction contracts for toll roads require a 10-year warranty to correct major failures that are the fault of the contractor. Any failures occuring during the first year of the warranty are totally paid for by the contractor. After the first year, the costs for correction may be shared by the contracting agency and the contractor; this is negotiated on a case-by-case basis.

### Norway (*8*)

The Norwegian Public Roads Administration (NPRA) is in charge of the planning, construction, and maintenance of the national and county highways. Currently, about 50 percent of the financial volume of road construction is carried out by private contractors, mostly larger projects. The rest is administered by the NPRA, typically using hired private machines and 1,600 employees.

Unit price contracts are most commonly used; however, the NPRA has tried some design and build contracts with varying degrees of success. The best experiences have been for medium-size bridge projects. All contractors seeking a project must be evaluated on the basis of their bids only. They can bid alternative methods of construction if deemed proper. Of all bids accepted as responsive, the final award can be for the "best bid" and not just the "lowest bid." Quality and future maintenance costs are also considered as major factors other than base bid price for contractor selection.

Some experimenting has been done using the "function contract" for paving projects (not the same as Sweden's "functional contract

concept," which is described in the next section). Contractors offer both a price and a warranted studded-tire resistance index. A bonus or reduction is given based on the pavement's studded-tire value.

The NPRA requires a warranty on all projects. The warranty period was set at one year but has now been changed to 3 years registered from the date of completion. A surety bond equal to 15 percent of the contract amount is required during construction. At the date of transfer of the project to the NPRA, the surety bond during the warranty period will drop to 3 percent the first year, 2 percent the second, and 1 percent the third year. This reduction is due to the likelihood of serious faults showing up early in the warranty period.

### Sweden (*4,6*)

Highway contracting in Sweden is similar to that in other European countries except for an innovative contract system initiated there called a "functional contract." Between 1980 and 1990, Sweden performed four projects with completely functional (design/build/maintain) specifications, including a maximum tolerated rut depth, smoothness, and friction. No defects were allowed and warranties of 5 years were required. These projects were successful, and the use of functional contracts was favored by large contractors, but not by small contractors. Swedish officials awarded a functional contract for a large road project in the summer of 1992 and are tentatively planning to build at least 30 percent of the new roads in the future using such contracts.

Private/public sector cooperation in Sweden is effective. In general, Sweden operates under a quality assurance process and requires warranties for all highway construction projects. A 2-year warranty is required for road construction, a 3-year warranty on pavement, and a 5-year warranty is required for bridge projects. The warranty system is generally accepted by both the government and industry. The required surety of up to 5 percent of the contract price is released after satisfactory completion of the warranty.

Warranties are accepted as a standard operating procedure despite fairly rigid specifications on failures during warranty. If a failure occurs during the warranty period, the contractor is required to repair the road. If it fails a second time, the contractor must replace the road and rewarranty the project. If the problem is in an underlaying layer on a resurface job, the contractor is not responsible. If there is a dispute on a failure, it is resolved by a dispute resolution board. Since only about 2 percent of new pavements have failures, the chance for disputes is low.

### United Kingdom (*4*)

The United Kingdom uses a 40-year design period, with planned surface replacement in 20 years. New specifications are being developed to identify a small number of "preferred mixes" for various applications with the hope of reducing the large number of mixes in use today. Generally, current specifications are of the method type. In the revised version, U.K. officials are striving for more end-result specifications. Warranties, per se, are not required in the United Kingdom; however, the contractor must maintain the project for 1 year, after which any needed corrections are made and it is given final acceptance. During that time, 1.5 percent of the contract cost is retained. U.K officials are considering moving to a quality control/quality assurance system. Although they do have some concerns, contractors are very interested in such a system, and have recommended that the United Kingdom adopt the use of warranties as many other European countries do.

### Germany (*4,6*)

Highways in Germany are built under very detailed contract procedures and specifications. Typical structural sections have been developed for asphalt and portland cement concrete pavements on the basis of traffic volume and classification. Mix designs are selected the same way. These structural sections and designs are based on experience, an approach the Germans are quite satisfied with. Specifications seem to reflect a combination of method and end result. The contractor does the mix design within limits shown in the government's recipes for different mixes. The contractor also does the quality control, but the government does the quality assurance, either with its own staff or, most often, through private labs. The German government appears to exercise considerable oversight of contractor operations; however, the contractor has more responsibility than contractors in the United States for mix design, production, and laydown operations.

Contracts are awarded on the basis of lowest initial cost for the design outlined in the bid specifications; however, contractors are encouraged to submit alternate designs. Contractors can also propose a faster completion time for a project, which is considered in the bid review and is judged on safety merits not road-user costs. After the low bidder is awarded the project, alternates may be negotiated if the agency desires. Alternate designs are judged for several factors, such as maintenance, experience of contractor, constructability, time of traffic interruption, cost, etc. Germany is not in favor of using design/build contracts in the future. They are considered too costly and introduce legal questions on liability.

Warranties are required by law for all contracts with very detailed warranty procedures. A 4-year warranty is required on highway contracts and a 5-year warranty is required for bridges or earthwork. On most projects, an amount equal to 5 percent of the bid price is retained during the warranty period; this may be reduced to 3 percent if the job is proceeding smoothly. The contractor is responsible for any defects that occur during the warranty period. Once a failure is fixed, the work must be rewarrantied for a minimum of 2 years. If the quality is improved significantly by the repairs, the contractor may be able to negotiate additional compensation for the work.

## SUMMARY OF EUROPEAN PRACTICES

The use of warranties for highway construction is widely accepted as standard procedure in Europe. Generally, contractors are also allowed much more opportunity for input into design and production method decisions than their U.S. counterparts. Work is still awarded on a competitive basis, although more opportunities are afforded to negotiate design alternates. Owners feel that warranties motivate the contractors to build better quality into the projects. The security deposits for warranties are mostly 5 percent or less of the contract price. Since this is often not enough security

to cover major failures, the owners must trust the contractors to stand by their contracts.

The success of innovative methods employed in European countries, which have excellent pavement performance compared to the United States, make it tempting to assume that the employment of such practices will produce the same results in the United States. However, this may not be the case because of economic and societal differences. A very noticeable societal difference in Europe is that little litigation is involved in government/contractor disputes; they are usually settled administratively. It is also common for a few very large and stable firms to do a major part of the contract volume in a country.

Contracting practices followed in the European highway industry differ from U.S. practices in several ways. In the United States almost all projects are awarded to the lowest-price bidder, are performed under strict method specifications, and are inspected by the owner or an agency designated by the owner. Although most European projects are bid competitively, several differences are encountered:

- Bid alternatives are widely encouraged and can be negotiated with the successful bidder to a different contract price, sometimes based on life-cycle cost.
- Completion dates can be bid with price and awards made on the basis of time.
- Contractors have much more input into design, many through bid alternatives for designs other than in bid documents and some through design/build contracts.
- Contractors often do testing for projects and send reports to the owner, who makes random checks to verify a contractor's testing program.
- Several countries use end-result specifications instead of method specifications.

The European methods should be researched thoroughly to determine their potential effects when and if they are implemented in the United States.

CHAPTER THREE

# UNITED STATES EXPERIENCES WITH WARRANTIES

## INTRODUCTION

The use of warranties for highway or related construction projects is not a new practice, although they were usually referred to as guarantees in earlier times. In 1889 George W. Bartholomew proposed the first portland cement concrete pavement to city officials of Bellefontaine, Ohio (*9*). He was allowed to try his new road material only after donating all the materials, and posting a $5,000 performance bond and guarantee that the pavement would last for 5 years. The resulting pavement was a success.

Municipalities were very concerned about the quality of asphalt pavements early in their history and required a maintenance guarantee of the contractor. A court in New Jersey in 1898 noted that the quality of pavements could not be ascertained without the test of time and that contractors should submit to a guarantee. The fact that guarantees were not entirely satisfactory is indicated by a quote from an *Engineering News Record* editorial of July 23, 1898 that "the guarantee clauses of paving contracts are the source of endless litigation."

At the Asphalt Paving Conference of 1930 a report (*10*) was made of the research findings of the Committee on Pavement Guarantees, which was chaired by Roger L. Morrison of the University of Michigan. They reported that New Jersey was the only state highway department requiring a maintenance guarantee for all work performed in a contract, a 1-year period of coverage. Iowa had a law requiring a 4-year guarantee on streets in cities and towns, but not state highways. The U.S. Bureau of Public Roads did not require or permit such maintenance guarantees. Of 97 cities surveyed in 1930, 64 required some form of guarantee, 3 allowed the option for guarantees and 30 required none.

The 1930 Committee cited several advantages and disadvantages of guarantees for pavements and concluded that: the contractor should be held responsible without time limit for repairs due to non-compliance with the specifications; carefully drawn specifications, competent inspection and complete records will reduce contractor failures; guarantees may be justified for new pavement types or when the city lacks proper capabilities to monitor the work; and finally that if all parties conduct their duties carefully and stand by their actions, that guarantees should be eliminated (*10*).

Mr. Frank Gaus of Superior Services International of Bonita Springs, Florida reported on the use of warranties for sealing joints in concrete pavements at a 1992 U.S. Army Corps of Engineers workshop (*11*). He noted that many contracts issued by military agencies for sealing or resealing such joints have required a 5-year warranty against any type of failure, with the failures spelled out, with very successful results. Contracts will require that a performance bond for the 5-year term shall be furnished by the contractor, who in turn can require the same from the manufacturer of the sealant. Many commercial airports have used a 10-year warranty on joint sealing with very good success.

Mr. Richard Morgan, Vice President of the National Asphalt Pavement Association, reported on the results of a survey of the NAPA membership about warranties for public or private contracts (*12*). In an October 2, 1991 letter to members of the NAPA Warranty Task Force, he noted that many of the 99 respondents gave warranties with those in the public sector being mostly for cities. The common duration was one year. Allen County and Ft. Wayne, Indiana require a 3-year maintenance bond; Portland, Oregon--2 years; Milwaukee and Racine, Wisconsin--3 years; Wichita, Kansas--2 years; Oklahoma City--5 years; and Eastchester, New York also requires 5 years.

In further follow-up with several cities cited, Morgan found that while they are called maintenance bonds or guarantees, they in essence cover materials and workmanship only. Wichita requires a true maintenance bond requiring the contractor to maintain the project and hold the city harmless for 2 years. Allen County, Indiana's is a true maintenance bond aimed at developers of subdivisions. Eastchester, New York requires a 5-year guarantee and full maintenance by the contractor, but it is not known whether it is enforced. Most cities require a bond, either an extension of the performance bond or a separate maintenance bond.

## SURVEY OF CURRENT USE OF WARRANTIES IN THE UNITED STATES

A major objective of this synthesis was to ascertain the level of the use of warranties by state transportation agencies for highway construction projects. Therefore, a survey document was developed and sent to all 50 state agencies and several other transportation agencies, including some non-U.S. agencies. The survey document and a summary of the responses are included in Appendix D. A further objective was to ascertain the opinions of leading companies in the highway surety business concerning warranty guarantees (or warranty bonds) for highway construction projects. A survey was also developed for sureties; this document and a summary of the responses are included in Appendix E. This survey was sent to the 11 sureties identified by the Surety Association of America as the top suppliers of bonds to the highway industry. The responses and results of these two surveys are summarized below.

### Transportation Agency Surveys

Forty-five agencies, including four non-U.S. agencies, responded to the survey, a very high return rate (see Appendix D). Of those responding, 20 indicated that they currently use warranties for their construction projects (see Table 4). The respondents were asked to rank the types of projects where warranties were used and the items being warranted. Most of the warranties being used are for premanufactured products such as electrical components,

TABLE 4
USES OF WARRANTIES BY TRANSPORTATION AGENCIES

| Agency | Items Covered by Warranty |
|---|---|
| Alaska DOT | Final Product Performance (traffic equipment)<br>Maintenance Work Items<br>Construction Workmanship<br>Construction Materials |
| Arizona DOT | Final Product Performance<br>Construction Materials<br>Construction Workmanship<br>Maintenance Work Items |
| Arkansas DOT | Final Product Performance (traffic equipment) |
| California DOT | Final Product Performance (pre-manufactured equipment and materials)<br>Construction Workmanship<br>Construction Materials |
| Connecticut DOT | Final Product Performance (pre-manufactured equipment and materials) |
| Georgia DOT | Final Product Performance (traffic marking)<br>Construction Materials<br>Maintenance Work Items |
| Indiana DOT | Final product Performance (pavement marking, landscaping)<br>Construction Materials<br>Construction Workmanship |
| Louisiana DOT | Final Product Performance (pre-manufactured equipment and materials)<br>Construction Materials<br>Construction Workmanship<br>Maintenance Work Items |
| Maine DOT | Construction Materials<br>Final Product Performance (landscaping, traffic marking, pre-manufactured equipment and materials) |
| Massachusetts DOT | Construction Materials<br>Final Product Performance (pre-manufactured equipment and materials) |
| Missouri DOT | Construction Workmanship<br>Final Product Performance<br>Construction Materials |
| New Jersey DOT | Construction Materials<br>Construction Workmanship |
| Ohio DOT | Construction Workmanship<br>Construction Materials<br>Final Product Performance (pavement marking, pre-manufactured materials) |
| Oklahoma DOT | Construction Workmanship<br>Construction Materials<br>Maintenance Works Items |
| Oregon DOT | Construction Materials<br>Final Product Performance (landscaping, traffic marking) |
| Texas DOT | Final Product Performance (traffic equipment, pre-manufactured equipment) |
| Washington DOT | Final Product Performance (pre-manufactured equipment and materials) |
| Alberta, Canada | Construction Workmanship<br>Construction Materials<br>Maintenance Work Items<br>Final Product Performance (pre-manufactured equipment and materials) |
| Newfoundland DOT | Construction Workmanship |
| Ontario, Canada | Final Product Performance (landscaping, traffic equipment) |

pumps, and plastic pavement markings. Those covering actual work performed are typically 1-year maintenance bonds and not long-term performance of pavements.

Agencies not using warranties were asked about their future plans for using warranties. Responses were about equally split between plans to use, not use, and uncertain. Most indicated that they would like more information before deciding. If they do use warranties, most agencies will use them for final product performance, i.e. manufactured products, followed by requirements for materials and workmanship.

All respondents were asked to rate the agency's position on the feasibility and desirability of using warranties for highway projects. A rating of 1 was a "very low" evaluation, while a rating of 5 indicated a "very high" evaluation. Of those responding it appears that the feasibility of using warranties effectively is believed slightly below a neutral position (2.58), while the desirability of using warranties is slightly above neutral (3.27).

The respondents were asked to list major roadblocks to their agency using warranties, potential benefits to using warranties, and major concerns of their agencies about the use of warranties. With respect to major issues confronting the use of warranties, the top two issues were industry resistance (by sureties and contractors) and legal prohibition (including FHWA disallowment for federal-aid projects). Close behind were two other issues, organizational problems (internal disagreement over warranties and over eliminating method specifications) and specification development problems (many items of concern). Of these four issues, the specification problem will require the most effort to develop a solution, while resolution of the other three issues would require a change of attitude.

The major benefits anticipated by the respondents from the use of warranties were improved construction quality (of products and contractor performance) and the potential for elimination or reduction of maintenance costs due to an improved product.

Several concerns were given related to the use of warranties. The top three concerns were the unknown cost impact of using warranties, the ability to define performance required and measurement methods (related to specifications problem), and the inability to determine the true cause and responsibility for failures on projects (thus legal disputes). Other major concerns included the ability of the agencies to manage and enforce the warranties, plus the ability or willingness of contractors and sureties to supply and honor any commitments made in warranties.

### Surety Company Surveys

Six of the eleven major sureties bonding highway construction responded to the survey. Only one of the respondents was currently writing warranties for highway projects. This respondent is writing warranties for transit, bridge, and road projects; they cover workmanship and materials plus maintenance work. It is expected that some of the other companies are providing maintenance bonds for some customers, but they do not consider these warranties. Of the five not using warranties, four indicated they have no interest in providing warranties, while one did not reply. Five of the respondents indicated their position on the feasibility and desirability of using warranties for highway construction. They all gave very low ratings to both items; obviously, sureties are not supportive of warranties.

The major issues listed for sureties' reluctance to provide warranties were the unacceptable risk exposure of long-term warranty periods (typically greater than 2 to 5 years) and the legal problems expected with disputes over failures. Another issue was the contractors' inability to control the use or loads imposed on highways that they must warrant. No potential benefits were given for the use of warranties. There was also concern for the possible inability to determine the true causes and responsibility for failures, for reduced competition (less bidders able to get warranties) and for higher costs.

Mr. Dennis Wine, Vice President of The Surety Association of America, also provided input to the study based on his many years of experience in the surety business. He noted that the current impetus for warranties for highway projects is based on European practices, which are significantly different from the system used in the United States to design and build roads. He felt that changing to the European system would greatly change the contracting and surety practices in the United States to a much more conservative approach. The resulting cost of building and warranting 40-year roads could be much more expensive than current roads. He offered the following comments to questions in the survey for sureties:

> Sureties and their contractor clients, whether involved with highway construction or other types of construction, are generally willing to provide 1-year warranties for defective materials and workmanship. If the warranty term expands beyond 1 year, the surety underwriting becomes increasingly difficult. Once the warranty term reaches 4 or 5 years, sureties become very cautious and frequently decline bonding requests. Exceptions would generally be limited to situations where the contractor is unusually sound financially.
>
> It is also important to recognize that warranties which go beyond defective materials and workmanship, may create underwriting difficulties. For example, warranties that include efficiency, performance or design guarantees, significantly increase the risk.
>
> The types of projects covered with warranties will depend on the duration and the type of warranty required, as well as the project type and dollar size. Obviously, a design/build contract for a $50 million bridge will be a much riskier proposition than a design/build contract for a $1 million highway project.
>
> Warranties against defective workmanship and materials for a term of 1 year are commonly accepted, as are 1-year warranties for maintenance work items. Warranties for final product performance (roadways) could be difficult. Such warranties are usually sought where the contractor is responsible for the design. If the product doesn't perform as specified, the remedy could be very expensive, creating high-risk for the surety.
>
> Sureties will rate the feasibility and desirability of using warranties for road construction very low for two reasons: first, such warranties would be tied to design/build projects, and second, contractors and sureties would not be interested in providing long-term warranties for projects designed by others.
>
> The major issue confronting the writing of warranties is the duration. Beyond 1 or 2 years, the risk is greatly increased. If a road fails prematurely, the cost to repair or replace could be enormous. Also the probability that the contractor is no longer in business increases. Sureties fear that 50 percent of the contractors in business today will not be in business 6 years from now. Thus, the surety may be the only party available to make good on the warranty with the chance of recovery from the contractor remote.
>
> There is also speculation that considerable litigation might arise under a long-term warranty agreement. For example, disputes could arise over issues such as: what constitutes a failure; what caused the failure; who is responsible for correcting the failure; what constitutes an adequate correction of the failure; and who is the "maker" of the product that failed. Carefully drawn contract documents might alleviate some of the potential for litigation, but will most likely not address all issues.
>
> No benefit is seen accruing to a surety out of issuing a long-term warranty for highway projects.

### FHWA Special Experimental Project No. 14

In 1987, the Transportation Research Board, with Federal Highway Administration (FHWA) cooperation, initiated a task force effort to identify innovative contracting practices. The task force recommended establishing a special experimental project to evaluate its recommendations. The FHWA subsequently approved Special Experimental Project No. 14 (SEP 14) to evaluate innovative contracting proposals suggested by the TRB task force or those that states may propose.

The FHWA has approved under SEP 14 a warranty approach which has as its objective "to encourage a better quality of construction and contractor accountability while not shifting the maintenance burden to the contractor." Under this concept, the state holds the performance bond for several years after completion of the project. This, in effect, provides warranty coverage for materials and workmanship on the project for the specified period. Ordinary wear and tear damage caused by others and routine maintenance remain the responsibility of the state.

Several experimental projects using warranties are currently approved in a number of states as part of the SEP 14 initiative. If such usage of warranties has a positive effect on contractor quality, efforts may be undertaken to revise the FHWA regulatory restriction on warranties through rule making. A brief description of five experimental projects is given below:

#### *Michigan, Warranties on Bridge Painting*

This project was started in 1991 and includes nine contracts with a total of fifteen bridges throughout the state of Michigan.

Two-year warranties (supplemental performance bonds) are required for each project. Four contracts have been completed with final warranty inspections in late 1993 or 1994. The other five contracts were let in 1992. Based on preliminary evaluations, the costs for the warranty projects are consistent with the projects without the warranty clause. MDOT has inspected seven warranty paint bridges and four control paint bridges and has found similar performance and quality. There has been some localized peeling on five warranty bridges and three control bridges; the cause of the failures is still under investigation with the contractor responsible for the repairs. MDOT is ready to use the warranty concept on more projects. The MDOT special provision for the performance warranty, warranty agreement and supplemental performance bond requirement are included in Appendix F.

*Michigan, Warranties for Concrete Pavement Patching*

This project involves the requirement of a satisfactory performance bond for a 2-year period after concrete patching work is completed. Several physical characteristics must be met at the end of the 2-year period or the contractor must remove and replace the deficient work with no cost to MDOT. Two contracts were let in the fall of 1992 for full-depth concrete patching (plus dowels), each for approximately $400,000. Two separate contractors from Michigan were awarded the contracts. The MDOT special provision for the performance warranty, warranty agreement, and supplemental performance bond requirement are included in Appendix F.

*Missouri, Warranty for Rubber Asphalt Overlay*

This project was completed in the summer of 1991 and involves the mix design and construction of 3 linear miles of rubber asphalt overlay on an Interstate highway. The contractor was required to provide a warranty (extended performance bond) for the materials, work, performance, and maintenance for 3 years from the final acceptance date. The performance specification (included in Appendix F) detailed requirements for mix design approval and supplier notarization, performance measurements of smoothness and rutting, plus full maintenance requirements during the warranty period. The Missouri Highway and Transportation Department was pleased with the project and feels that the quality was quite good. A second rubber asphalt overlay project using warranties has been approved by the FHWA.

*Montana, Warranty for Pavement Markings*

This project was awarded in July of 1992 and involves the installation of durable pavement markings on 335 centerline miles of portions of I-15 and U.S. 87. The contractor will be allowed to select any marking material(s) other than the routinely used, standard traffic paints. After initial application, the contractor will be required to warranty the product(s) for a 4-year period. The contract special provisions require the expeditious replacement of failed material within the 4-year period. Detailed material, payment, testing and time requirements were also included in the special provisions. Only two bids were received, both out-of-state contractors, with the winning bid below the engineer's estimate. Local contractors were upset since they could not get the necessary bonding to provide the 4-year warranty.

*Washington, Warranty for Bridge Deck Expansion Joint Systems*

This project was awarded in 1991 as part of a bridge replacement project and involves the installation of bridge deck expansion joint systems. Some latitude was granted to the contractor as to the systems selected, but the specifications outlined general administration, material, fabrication, and inspection requirements for the project. The warranty clause required the contractor to provide a 5-year written warranty for the operation and durability of the expansion joints. Broken welds or bolts, cracks in steel members, fatigue, loss of precompression in springs or bearings, debonded tetrafluorethylene (TFE), breakdown of corrosion protection, and leakage constituted unsatisfactory operation and durability of the joints. Replacement or repair of any joint parts within the first 5 years, commencing from the date of completion of the contract, was covered under the warranty. The contractor was to replace or repair any joint parts within the period of the warranty at the contractor's expense.

## SUMMARY OF WARRANTY EXPERIENCES IN THE UNITED STATES

Based on the data collected it appears that less than half of the state departments of transportation are using warranties for their highway construction projects. Those that do are primarily using them for premanufactured products on projects and not for actual road construction items. Since the requirement of warranties for premanufactured products is quite common, even for federal-aid projects, there is probably a higher percentage of the DOTs using warranties but they did not reply affirmativly to the survey since it was really aimed at construction work in-place. Of those who indicated that they do warrant construction work, most are actually requiring a 1-year extended performance or maintenance bond of the contractor, which is easy to obtain.

Transportation agencies are interested in the use of warranties for highway construction projects but are not ready to undertake such a practice without more information or without FHWA approval. Several questions pertaining to actions that would be required to implement a feasible program for warranties in public transportation agencies and several concerns must be addressed. At this time, most contractors and surety companies are very skeptical about the use of warranties. A major concern is that only a few very well-organized and financially solvent construction companies would be able to function in such a system, especially for large projects and projects involving design/build concepts. Sureties do not want to be involved in long-term warranties.

The FHWA Special Experimental Project No. 14 is showing promise for the use of warranties on a variety of federal-aid highway projects. It is still too early to evaluate the success of these projects as compared to traditional approaches to the same type of work. However, all of the DOTs involved are encouraged by these efforts and are willing to try more such projects. Good documentation of the results achieved on these projects will be important to evaluate success.

CHAPTER FOUR

# IMPACTS OF WARRANTIES ON HIGHWAY CONSTRUCTION

## INTRODUCTION

Traditionally, the use of warranties in highway construction in the United States has been limited to materials and workmanship. The successful use of warranties in other countries, and the perceived increase in pavement quality, has prompted much debate about the increased use of warranties in the United States. These warranties would attempt to hold the contractor responsible not only for the materials and workmanship employed in the construction process, but also for the performance of the pavement, without transferring the burden of routine maintenance activities. The use of performance warranties could also provide added assurance to the owner (taxpayer) as to the quality of the road.

It is important to note the difference between warranties for performance and warranties for materials and workmanship. Current technology permits warranties to be written for materials in terms of physical criteria and workmanship. Warranties for performance are much more complex. Pavement performance depends on many factors, e.g., design, performance characteristics of the materials, quality of construction, environmental distress, and the traffic loading. Furthermore, methods and tests for measuring the performance characteristics of materials in order to adequately predict the future performance of pavements are not functional at this time. Much more work needs to be done to ensure the success of using warranty contracting for pavement performance.

Warranty contracting for performance shifts the ultimate responsibility for the project from the governmental agency to the private contractor. In order to be held responsible, the contractor must be assured that sufficient control of the project will exist to adequately determine that the project is properly designed, that the contractor's responsibility is adequately defined, and that job monitoring for performance will be adequately prescribed and conducted during the warranty period. However, if the contractor does not have the opportunity to participate in the design and to help define the specifications, materials, and processes for the project, such a shift in responsibilities cannot be accomplished; and if attempted would most likely not succeed, risking a litigious situation. If implemented carefully and fairly, the use of warranties in highway construction affords potential benefits (see Chapter 5) to all parties to the contract.

Warranties for pavement performance may contain criteria defined for the following categories:

- Performance characteristics: rideability, skid resistance, rutting, cracking, joint displacement, etc.
- Environment: natural and imposed stress.
- Traffic load: vehicle types and weights, traffic volumes, etc.
- Maintenance: ordinary wear and tear, premature failures, accidental damage, and routine maintenance responsibility.
- Time: short-term for premature failures and long-term for general performance characteristics.

Hereinafter, any reference to warranty contracting means warranting for performance rather than materials and workmanship.

## INHIBITORS TO IMPLEMENTATION

Several factors inhibit the successful implementation of warranties into the U.S. highway construction industry (*2*). First, federal restrictions and other legal barriers prohibit or limit warranties on federal-aid projects. These restrictions are primarily designed to prevent the use of federal highway funds for routine maintenance. There is a fear of intense litigation if better performance tests are not developed first and if contractors are not more involved in design decisions. There is also a need to allow designers to design for the lowest life-cycle cost and not merely the first cost of construction.

Finally, the surety bonding consequences of warranting a highway for an extended time period are very uncertain (*13*). Because contractors are generally required to be bonded, the question arises as to whether surety companies will be willing to accept the risk associated with 2- to 5-year warranty periods and, if so, would it only be acceptable for large, well-established, and financially solid companies? Also, would the surety companies be willing to warrant the contractor for long-term pavement performance (2 to 5 years) if the design was not the responsibility of the contractor and the contractor had no control over the use of the highway during the warranty period? These are questions that must be examined and resolved before sureties will seriously participate in the use of warranties for highway projects.

## IMPACTS ON CONTRACTORS AND SUPPLIERS

U.S. contractors are not accustomed to being responsible for a highway after the initial construction phase of the life-cycle. Current procedures state in detail how to design and perform the work. The use of warranties will necessitate a shift in responsibility for the final quality of the project from the highway agency to the contractor. This may include all or part of the design, construction methods, or quality control. From the standpoint of the contractor, it would be unrealistic to have a pavement constructed in accordance with the engineer's specifications, covering every detail of workmanship and materials, and then force the contractor to warrant the results. In other words, it is unfair to make the contractor warranty the soundness of the engineer's ideas as well as the contractor's own work. This is especially true when the specifications are contrary to the contractor's experience and judgment as to what will produce the best results. Therefore, procedures must be developed that allow the contractor more input into the design and use of the highway during the warranty period.

An advantage to the contractor working with warranties could be the ability to use more innovative construction methods to be

more competitive. Also, better bids could be developed due to a better understanding of the scope of work. There are, of course, disadvantages which may occur, most stemming from the current lack of procedures for using warranties and of adequate performance test methods. There is a shortage of historical data about the impact of the use of warranties on competitive bidding, and on insurance and bonding for contractors, particularly small or minority contractors. Research could eradicate many of these obstacles.

What effect will a warranty requirement have on bid prices? Contractors, faced with the task of bidding on contracts with long-term warranties with very little historical data, will be forced to develop an estimate that raises the contract price sufficiently to cover all potential risks on the project. Some believe that a standard type of pavement, if properly designed for the existing conditions, would require very little repair in the early years of life, i.e. during the warranty period. Consequently, it is very doubtful that contractors would increase their bids by more than enough to cover the cost of the bond premiums, slight loss of interest on warranty money, if retained, and some cost for minor road repairs during the warranty period. This approach is very dependent on the contractor's knowledge of the existing conditions and the type of pavement installed. If the contractor is unsure of conditions or is experimenting with a new type of pavement or construction method, and attempts to raise the bid price to cover risks, he or she gambles with being noncompetitive.

The risk involved with warranty contracting may exclude small contractors who lack the financial reserves to obtain long-term bonding. At this point, it is uncertain whether the surety industry will bond warranty contracts, even for large contractors. Obviously, if the prime contractor is required to provide a warranty bond for a project, there will be warranties required of subcontractors and suppliers as well. Also, agencies will require assurances of subs and suppliers for special designs, equipment, or processes to be used for projects.

## IMPACTS ON OWNERS AND ENGINEERS

States currently have the ability to use warranties on non-federal-aid projects or non-National Highway System projects, but many do not use them except for pre-manufactured items. If the federal policies are changed, it is uncertain whether warranty contracting will increase significantly. State highway agencies are responsible for the construction, operation, and maintenance of their road systems. The use of warranties will require a transfer of more responsibility from the highway agency to the contractor for design, construction, inspection, and maintenance of roadways. The state would take on the role of defining what was desired when testing the quality of the end result. This is necessary to avoid obliging the contractor to warrant the design of the engineer, which could lead to litigation problems. Highway agencies that adopt the use of warranties will need to develop well-defined criteria to specify expectations and detailed historical databases of actual projects to monitor the process. The change from detailed method specifications to performance-based specifications will be a major change.

The concept underlying the use of warranties in highway construction is that by transferring long-term responsibility for a road to the contractor, the initial quality of the road will be higher and the total life-cycle cost for the owner (taxpayer) will be lower. In theory, a warranty gives the contractor a financial incentive to build a better product and to use innovative methods and materials to his advantage. A required warranty will likely eliminate contractors with weaker financial status from larger, more complex projects. This may be construed as an advantage to the owner, but may reduce the level of competition.

The impact of warranties on design engineers, especially those in private practice who do heavy amounts of highway-related design is somewhat uncertain. Those in public agencies will have a different role if more responsibility is transferred to the contractor for design and inspection. However, there will still be important tasks to perform to assure that good quality is received. Those in private practice may find themselves doing design as part of joint ventures with, or as subcontractors to, contractors or may actually be employed by contractors directly. Although this may be a better system for the owner, many consulting engineers may not find this new situation to their liking. Consulting engineers are also greatly concerned about problems arising from litigation for public liability tort claims.

## IMPACTS ON INSURANCE AND BONDING COMPANIES

Perhaps the industry participant most critical to the adoption of warranties for highway construction is the surety. Almost all public highway projects require the contractor to have adequate insurance and to provide adequate bonds to assure the owner that the project will be completed as specified. The impact on insurance will not be as serious as long as the contractor can pay the premiums required, except for liability insurance. Some companies may be reluctant to provide design liability insurance to contractors who desire to do their own design, although it should be feasible to evaluate the competence and experience of their design personnel in a timely manner. Such is not the case for sureties who are asked to provide long-term warranties for the constructed product.

Although they do provide the owner some protection, bonds are not insurance (*13*). Insurance is a loss-funding mechanism that is designed to protect the insured against adverse events. All those insured in a group pay premiums into a funding pool to cover individual losses as they occur. The individual, in effect, transfers his risk of loss to the group. Key to this risk is the fact that losses are anticipated. Suretyship, on the other hand, is a loss-avoidance mechanism that is designed to pre-qualify individuals based on certain criteria set by sureties, primarily the contractor's character (reputation), capacity (capability and experience), and capital (financial stability). The economic risk of contract default stays with the contractor, as he or she must sign an indemnity agreement holding the surety harmless. Of course this assumes that the contractor stays in business. This is less risky to the surety for current projects since they are short in duration and they feel capable of predicting conditions for 1 or 2 years in the future. Sureties have expressed strong concerns about writing warranties for long periods of time.

Acquiring bonds, in terms of difficulty, is basically a small contractor problem. Firms with adequate financial resources and good experience have few problems in obtaining bonding, small firms have major problems. Since most Disadvantaged Business Enterprises (DBEs) are typically small firms, bonding can be a serious problem for them. Small highway contractors have two problems with bonds, availability and cost. It is very probable that small firms, and even some larger firms, will have great difficulty

in obtaining warranty backing from sureties until the warranty process is much better defined and utilized for awhile.

Surety companies are rigorous in evaluating contractors for bonding, and they believe that they operate on too close a profit margin to loosen their requirements. One thing is certain, anything that increases the risk for the surety company, such as warranties, will result in increased cost and decreased availability of bonds. Many sureties have expressed reservations concerning the acceptance of the additional risks involved in warranty contracting. If bonding becomes too difficult to obtain, alternatives such as letters of credit, self-bonding, and cash equivalent negotiable instruments may have to be considered. The impact of these alternate methods on all the parties involved is uncertain at this time.

## QUESTIONS FOR FUTURE CONSIDERATION

Implementation of warranties in highway construction should not begin before many questions are answered about their effects. Current studies by TRB, FHWA, GAO and other organizations may provide much needed insight into the use of warranties. Some of the many questions that need to be answered include:

- What effect would warranties have on the quality of the final product? Would quality be improved by producers wishing to reduce the risk of having to perform work under warranty, or would producers be willing to accept the risk of repair or replacement in lieu of costly initial quality?
- Would required warranties add to the cost of construction? If so, would it be offset by a reduced life-cycle cost of the resulting pavement?
- What would be the effect on competition because of required warranties? Would smaller or minority companies be at a serious disadvantage?
- Should warranty requirements cover poor performance or defects caused by materials and workmanship? How are such defects and poor performance to be measured in the field?
- Would warranty requirements result in disputes over actual causes of failure and whether failures were covered? How should responsibility be assigned for failure due to design, equipment, material, or workmanship among manufacturer, material producer, owner, and contractor?
- How should a warranty period be established for a specific project? When does the warranty period become too long such that work items that should be normal maintenance operations are claimed as warranty items?
- What items lend themselves to being accepted by warranty clauses and are there items that should remain under the traditional construction inspection procedure?
- What alternate methods can transportation agencies accept from contractors to ensure compliance with warranty or guarantee requirements (i.e. bonds, cash deposits, retainages on payments, stocks and bonds, etc.)?
- How will contractors have input into the total design process if they are to be willing to warrant the products from the design?
- How is performance of the final product to be specified and measured in the field to determine acceptable contract compliance or the need for remedial work?
- What changes in contract documents will be required to accomodate the use of warranties for highway projects?

## MAJOR ISSUES RELATED TO WARRANTIES

All of the questions identified concerning the feasible use of warranties are important and require answers specific to the design and construction of highways in the United States for warranties to be accepted in practice. However, the experiences of design and construction methods for other industries may be applicable and would reduce the development time significantly. The three issues described below are believed to be very important.

### Technology Development Needs

The TRB Task Force on Innovative Contracting Practices identified several new concepts that could be used in highway construction to the mutual benefit of all parties involved. It was pointed out in Chapter 1 of this report that many barriers inhibit the adoption of new practices, such as warranties and others. It is also true that new operating procedures and new technologies are needed to take advantage of new concepts. However, it has been noted in this chapter that performance design procedures and predictive tests of long-term pavement performance are not adequate at this time. The premature adoption of warranty requirements for pavement performance may result in failures and costly litigation, thus many feel their use should be delayed until the technology exists to support their implementation.

### Contractor Input Into Design

There are several methods for a contractor to have design input for a project. A contractor can be hired as a consultant to the project for design input. A value engineering team including a contractor could evaluate a design before it went to letting. A construction manager (CM) could be hired for the project to assist with design and to handle the contract lettings. However, the contractor who is to build the job in the public sector must be identified early in the process to have design input.

One method would be to have standard design alternatives for all elements of the highway system and allow contractors to bid on the project using any of the approved elements. The project can be awarded to the low bidder that meets the project requirements. This technique is used in some European countries, which also encourage the contractors to submit design alternates that can be negotiated with the low bidder after contract award.

Another method to provide contractor input is the design/build concept. Design/build can be a viable procurement method in which a single entity provides all the professional design and construction services necessary to build all or a portion of a facility for the client. This single-source responsibility distinguishes the design/build concept from other methods of project delivery. Design/build contracts are now being used by many government agencies, although not for highway contracts. The concept could be feasible for the successful implementation of warranties for highway projects.

### Performance-Related Specifications

A major concern for the implementation of warranties for highway projects is the need to develop technical specifications that

identify the responsibilities of the parties, set the standards of performance for the elements of the project and define the methods to be used to measure the performance standards in the field. Such specifications are significantly different from the typical methods specifications used currently for most projects, where the contractor is required to follow step-by-step procedures using specified materials and equipment.

The need for performance-related specifications has been a concern in the highway industry for some time. Considerable effort is currently being expended on the study and development of such specifications by several transportation agencies. They are statistically based specifications (*14*) and are key to the establishment of quality assurance and quality control programs. More time is needed to develop these new specifications systems.

CHAPTER FIVE

# FUTURE USE OF WARRANTIES IN THE UNITED STATES

Strong interest in the use of warranties for highway construction projects in the United States has been sparked by the reported European success of warranties in improving the quality of highways. There is considerable activity in the political arena with current legislation requiring the GAO to study means for improving the quality of federal-aid highways, including the use of warranties. The warranties portion of the GAO study was initiated, in part, by the strong opposition to the Beilenson Amendment to the Intermodal Surface Transportation Efficiency Act of 1991 (H.R. 2950) from engineering and construction organizations such as the American Society of Civil Engineers, The National Society of Professional Engineers, the Associated General Contractors of America, and the American Road and Transportation Builders Association. Future political activity is certain.

Transportation agencies are interested in the use of warranties or guarantees for highway construction projects but are not ready to undertake such a practice without more information or without FHWA approval. It appears that few of the state departments of transportation are using warranties for their highway construction projects, and those that do are primarily using them for pre-manufactured products. At this time many DOTs, contractors, and surety companies are very skeptical about the use of warranties. A major concern is that only a few very well-organized and financially solvent construction companies would be able to function in such a system, especially for large projects and projects involving design/build concepts. Sureties do not want to be involved in long-term warranties.

The FHWA Special Experimental Project No. 14 is evaluating the use of warranties on a variety of federal-aid highway projects. It is still too early to evaluate the success of these projects as compared to traditional approaches to doing the same type of work. However, all of the DOTs involved are somewhat encouraged by these efforts and are willing to try more such projects. Good documentation of the results achieved on these projects will be important to the evaluation process.

Several questions pertaining to actions that would be required to implement a feasible program for warranties in public transportation agencies and several concerns must be addressed before such implementation. Key questions, possible impacts, and concerns related to the use of warranties have been expressed in several sections of this report. Much more study with teams of all involved participants is needed to develop mutually acceptable plans of action for implementing warranties in the highway construction process.

It is the owner that will ultimately have to decide whether to adopt the use of warranties for highway construction projects. Obviously, the views of other participants in the highway construction industry and legislative bodies will also affect this final decision. Some of the potential benefits and concerns of using warranties, plus actions believed necessary for successful implementation are presented in the remainder of this report.

## POTENTIAL BENEFITS OF USING WARRANTIES

- The major benefit anticipated by owners from using warranties is the increased quality of the products they purchase with a resulting lower life-cycle cost.
- Warranties will lower the owner's risk by providing assurance that the contractor will correct early failures from materials or workmanship that may have escaped notice during construction. This would eliminate or reduce unnecessary costs of early maintenance due to poor performance.
- The requirement of warranties would induce a higher concern for total quality in contractors, designers and suppliers of transportation facilities and systems.
- Earlier involvement of contractors in the planning process may lead to fewer disputes, better bids, better products, and reduced risk of liability losses for all parties involved.
- The use of warranties could encourage the development of better testing equipment and techniques for construction projects, with reduced inspection and contract administration responsibilities for the owner.
- A warranty, when used in association with performance-related specifications, provides the contractor with the incentive to pursue more innovative technologies and methods for highway projects. This could lead to economic benefits for all parties involved in the highway construction process.
- A warranty may be very desirable when the design, contract administration or inspection capabilities of the owner are inadequate for a project.
- The use of warranties with improved contracting procedures for design and construction could lead to fewer contract disputes and reduced litigation in the long term.
- Larger, more qualified and more stable firms may develop to do all tasks for major transportation projects. This may lessen the risk to both owners and sureties for large projects.

## CONCERNS OF USING WARRANTIES

- Highway construction in the United States is different from such construction in Europe. The premature use of warranties without adequate technology or processes to handle the contracts may lead to increased disputes and costly litigation, and could harm the long-term adoption and potential benefits of using warranties in the United States.
- The impact of warranties on initial and total life-cycle costs of facilities may negate any maintenance savings.
- Owners are unsure of their ability to administer contracts with warranties and to enforce them over extended periods. The length of the warranty period required to catch deficiencies caused by poor materials or construction is of particular concern.
- Warranties are only as good as the contractor and the surety company involved. Will the contractor stay in business for the

length of the warranty and will the surety honor the warranty if a problem arises?

- It is highly uncertain if surety companies will provide the long-term bonding guarantees required for warranties on large projects. Much higher risk is involved for sureties.
- Small or minority contractors may be eliminated from the bidding process because of the difficulty in acquiring bonding or proof of financial responsibility that results from the high-risk climate of long-term warranties.

## ACTIONS NEEDED TO FACILITATE THE USE OF WARRANTIES

- More in-depth evaluation of current warranty activities, or new research studies, are needed to address the impact of the use of warranties for highway construction projects and the actions necessary to develop and implement a feasible warranty contracting system. This should include the development of contract documents specific to the use of warranties.
- Cooperative meetings with representatives of DOTs, designers, contractors, and sureties are needed to identify the concerns of all the parties related to the use of warranties and to seek remedies to these concerns.
- Efforts must be continued to develop performance-related design, specification, and inspection procedures for highway construction projects.
- Analysis procedures are needed to determine when a warranty is feasible for public interest for a highway project.
- Guidelines for contracting procedures using warranties for highway construction projects are needed and could be developed from the results of the previously described action items.

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# APPENDIX A

## FHWA 23 CFR 635.413 AND FHWA RESPONSE (3/04/93)

TITLE 23 - HIGHWAYS

CODE OF FEDERAL REGULATIONS

PART 635 - CONSTRUCTION AND MAINTENANCE
Subpart D - General Material Requirements

Sec. 635.413 Guaranty and warranty clauses.

(a) Except as provided in paragraph (b) of this section, clauses that require the contractor to guarantee or warrant materials and workmanship or to otherwise maintain the work for a specified period after its satisfactory completion by the contractor and its final acceptance by the State, will not be approved for use in Federal-aid contracts. Work performed and materials replaced under such guaranty or warranty clauses after final acceptance of work are not eligible for Federal participation.

(b) Contracts which involve furnishing and/or installing electrical or mechanical equipment should generally include contract clauses that require:

(1) Manufacturer's warranties or guarantees on all electrical and mechanical equipment consistent with those provided as customary trade practice, or

(2) Contractors' warranties or guarantees providing for satisfactory inservice operation of the mechanical and electrical equipment and related components for a period not to exceed 6 months following project acceptance.

2/26/92

BRIEFING

ISSUE: Use of Warranty Clauses in Federal-Aid Highway Contracts

BACKGROUND:

Except for contracts which involve furnishing and/or installing electrical or mechanical equipment, the FHWA regulations (23 CFR 635.413) presently restrict the use of warranty clauses on Federal-aid projects located on the National Highway System*. There is no provision in 23 U.S.C. which specifically prohibits or restricts the use of warranty clauses. The regulation was an administrative action taken in 1976; however, FHWA previously had a longstanding policy against the use of warranties based on the rationale that such requirements in contract specifications would indirectly result in Federal-aid participation in maintenance costs.

CURRENT ACTIVITIES:

Recently there has been a renewed interest in the use of warranties as a means of encouraging contractor's attention to quality and as a necessary element in certain innovative contracting approaches such as design/build/warrant contracting.

Efforts and activities to-date relative to the use of warranties in highway construction include:

TRB Task Force and SEP 14

In 1987, the Transportation Research Board (TRB), with the cooperation of FHWA, initiated a task force effort to identify innovative contracting practices. The task force asked the FHWA to establish a special experimental project to evaluate task force recommendations. The FHWA subsequently approved Special Experimental Project No.14 (SEP 14) to evaluate innovative contracting proposals which the TRB task force or States may propose.

Under SEP 14, the FHWA has approved warranty concepts with the objective of encouraging improved quality and contractor accountability without shifting the maintenance burden to the contractor. Under one of the approved concepts, the State holds the performance bond for a specified period after the completion of the project. In effect, this provides warranty coverage for materials and workmanship on the project for the specified period. Ordinary wear and tear damage caused by others and routine service maintenance remain the responsibility of the State. States evaluating use of warranties under SEP 14 include:

- Michigan; 2-year warranty on bridge painting projects; 2-year warranty on concrete pavement repair projects; and 2- or 4-year warranty on a pavement marking project (length of warranty dependent on pavement type).

- Washington; 5-year warranty for a bridge deck expansion joint system.
- New Hampshire; 2-year warranty on bridge painting project.
- Montana; 4-year warranty on a pavement marking project.
- Missouri; 3-year warranty on a asphalt rubber concrete pavement projects.

### European Asphalt Study Tour

The 1990 European Asphalt Study Tour (EAST) during its visit of six European countries observed evidence that requiring a contractor to warrant work that was bid had a very profound positive effect on assuring quality. It was noted that most of the countries visited allow contractors greater latitude, than in the United States, to select effective materials and design's, but hold the contractor accountable for its choice by requiring warranties that extend 1 to 5 years after the work is complete. Further it was recommended that industry be given a role in mix design; AASHTO develop warranty guidelines and procedures; and FHWA encourage, through SEP 14, the use of warranties and specifically for paving contracts the use of 5-year warranties for wearing surfaces.

### Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA of 1991)

Section 1043 of the ISTEA requires the Comptroller General (GAO) to conduct a 2-year study on means to improve the quality of Federal-aid highways, including the use of warranty clauses. Regarding the warranty clauses aspect, the GAO study report is to address as a minimum the effects of inclusion of warranty clauses in contracts with designers, contractors and State highway departments, relative to the:

- potential costs and benefits of such clauses,
- liability or insurance constraints or concerns,
- implications for small, minority or disadvantaged businesses,
- current options to States to require these clauses without additional Federal legislation, and
- the effect/implication to the public such clauses may have on availability of insurance/bonds for designers and contractors.

The study is to be completed and the report of findings submitted to Congress by December 1993.





### NCHRP Synthesis; Project 20-5, Topic 23-07, "Use of Warranties in Road Construction"

The TRB currently has underway an effort to produce a synthesis on the "Use of Warranties in Road Construction." The synthesis will study the merits and drawbacks of a warranty system in the United States and document the systems of highway construction quality and performance warranties in use in the U.S. and Europe. It will analyze the systems of warranties for their applicability to road construction and address possible ways to enhance the merits and overcome the drawbacks. It's estimated a final synthesis will be published in 1993. The synthesis is being developed by Mr. Donn Hancher of the University of Kentucky.

### Design/Build/Warrant Study

The FHWA has initiated a consultant study on the prerequisite technology necessary to successfully implement design/build/warrant contracting on highway projects. The objectives of the 6-month study are to:

- identify the technology necessary for implementation;
- determine the implementation steps, giving consideration to legal and economic impacts; and
- assess the value and benefits of design/build/warrant contracting.

The study is being conducted by Mr. Gary Byrd, Alexandria, Virginia. Results are anticipated to be available in early CY 1993.

### European Contract Administration Scan

From June 16 through 26, 1992, two FHWA contract specialists visited four European countries (Sweden, Denmark, Germany and France) to ascertain what they are doing relative to innovative contract administration practices which may have some application to our highway program. Specific attention was given to usage of warranties and design/build/warrant contracting.

**SUMMARY:**

FHWA has the legal flexibility to either revise the current regulation (23 CFR 635.413) which restricts the use of warranties on Federal-aid projects or to simply abolish it. There is no Federal statute which specifically prohibits the use of a warranty.

FHWA does not plan any regulatory change to 23 CFR 635.413 until the ongoing activities and studies (i.e., SEP 14; results of the TRB synthesis effort; design/build/warrant consultant study report; and findings of the GAO study and possible European contract administration study tour) are concluded and the results relative to the use of warranties can be evaluated. Then based on the findings, the FHWA policy may be modified accordingly though a rulemaking action.

In the meantime, we encourage the use of warranty clauses and design/build/warrant contracting as acceptable approaches for evaluation under SEP 14.

- NOTE: The FHWA has recently clarified, that pursuant to provisions of the 1991 ISTEA, the warranty restrictions of 23 CFR 635.413 do not apply to exempt non-NHS projects. Therefore, on these type projects, States may use warranty requirements which are in accordance with procedures used on State-funded projects.

# APPENDIX B

## BEILENSON AMENDMENT AND ISTEA SECTION 1043

**Beilenson Amendment**
(H.R. 2950)

SEC._____ GUARANTY AND WARRANTY CLAUSES.

(a) IN GENERAL. — Section 114 of title 23, United States Code, is amended by adding at the end the following new subsection:

"(c) GUARANTY AND WARRANTY CLAUSES. — The Secretary, by regulations, may permit a State highway department in accordance with standards developed by the Secretary in such regulation to include a clause in a contract for engineering and design services or for the construction of any Federal-aid highway project requiring the designer, contractor, state highway department and Department of Transportation to warrant the services, materials and work performed. The warranty or guarantee clause shall be reasonably related to the services, materials, and work performed, and shall not be construed to require the construction contractor to perform maintenance."

(b) REGULATIONS. — Not later than 90 days after the date of enactment of this Act, the Secretary shall initiate a rulemaking proceeding for developing standards under section 114(c) of title 23, United States Code.

**Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA)**

105 STAT. 1994 PUBLIC LAW 102-240—DEC. 18, 1991

SEC. 1043. REPORT TO CONGRESS ON QUALITY IMPROVEMENT. 23 USC 307 note.

(a) REPORT TO CONGRESS ON QUALITY IMPROVEMENT.—The Comptroller General shall submit within 24 months following the date of the enactment of this title a report to Congress addressing means for improving the quality of highways constructed with Federal assistance. This report shall address Federal design standards, engineering and design services, and construction of Federal-aid highway projects.

(b) SCOPE OF THE REPORT TO CONGRESS.—In preparing such report, the Comptroller shall address, at a minimum, the following:

(1) Alternative modifications to current Federal and State minimum design standards, including but not limited to, the anticipated impacts these alternatives would have on the serviceability, maintenance, expected life, and costs (including engineering and design, construction maintenance, operation and replacement costs).

(2) Inclusion of guarantee and warranty clauses in contracts with designers, contractors, and State highway departments to address, at a minimum, potential costs and benefits of such clauses; any liability or insurance constraints or concerns; implications for small, minority, or disadvantaged businesses; currently existing options for States to require these clauses or other means with similar effect without additional Federal legislation, and the effect these or similar clauses may have on the availability of insurance and bonds for design professionals and contractors and the implication to the public of any change in such availability.

(3) Means of enhancing the maintenance of the Federal-aid Highway System to ensure the public investment in such system is protected.

# APPENDIX C

## SAMPLE WARRANTY SYSTEMS USED IN EUROPE

AF2.46 Guarantee period

AF2.461 Guarantee period for the contract

The guarnatee period shall be three years for wearing course types HAB(Hard asphalt concrete, normally with binder P180), ABS(asphalt concrete), TOP(Topeka)> 80kg/m2. Two years for the bituminous courses(including Heating, Repaving. For regulating courses < 60kg/m2, Y1G(single surface treatment on a gravel layer) and sealing the guarantee period shall be one year.

The guarantee period shall be ..... year/s.

For the different guarantee periods within the same group are stated in the table

Guarantee periods

| Group | Object | 3 yrs | 2 yrs | 1 yr |
|---|---|---|---|---|
| ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... |

AF2.5 LIABILITY

AF2.51 Penalties

For each week by which the Contractor exceeds the Time for Completion, he shall pay a penalty in accordance with the following.

The Contract Price $\leq$ 10_MSEK

The penalty to be paid corresponds to 0,5% of the Contract Price.

The Contract Price $\geq$ 10_MSEK

The penalty to be paid is 50.000SEK plus an amount corresponding to 0,25% of that part of the contract price which exceeds 10 MSEK.

The penalty for the delay of a main section is calculated only on the amount for that main section.

AF2.57 Claims for Damages

The Contractor is responsible for damages which can arise from defective traffic arrangements and/or defective road maintenance. If traffic arrangements or road maintenance are neglected the Employer reserves the right to remedy the damages at the Contractor's expense.

AF2.617 Regulations for deductions for paving works SWEDEN-2

Only applicable text is to be included.

General

For deviations from the requirements on voids ratio, binder content, grading curve or surface regularity, the work can be approved if its execution otherwise is satisfactory. Cost adjustments for deviations shall be made through deductions from the agreed unit prices.

The deduction, for deviations from stated requirements on voids ratio and binder content, shall be calculated for that area/quantity which each sample and the mean of the samples respectively represent.

The regulations shall be applied to every laid course respectively. Deductions can be made for several courses in the same surfacing material through the summation of the respective percentages. The Employer reserves nevertheless the right, in such cases, to decide on other measures.

Voids content

Deductions: For every percentage by volume which the voids content exceeds the permissible according to BYA table 7:02-7 and 7:02-8 respectively according to the following:

| Percentage by volume exceeding | Deduction from unit price |
|---|---|
| $\geq$ 0.1 - $\leq$ 1 | 10% |
| $\geq$ 1.1 - $\leq$ 2 | 25% |
| $\geq$ 2.1 - $\leq$ 3 | 50% |

Other measures are decided upon for voids content >3%.

Binder content

Deductions: 3% for the first 0,1 unit percent and thereafter with an increase of 4%(7,11%) for every 0,1 unit percent above the permissible tolerance in accordance with BYA 84 with which the binder content in the asphalt mix falls short of or exceeds that value which is determined in the working mix.

For AEBÖ(Coarse cold mix with binder type bitumen emulsion) applys, 2% for the first 0,1 unit percent and thereafter with 2%(4,6%) increase for every 0,1 unit percent above the permissible tolerance, in accordance with BYA 84, with which the residual binder content falls short of that value which is determined in the working mix.

AF ADMINISTRATIVE CONDITIONS

SWEDEN-3

Grading curve

Deductions: 0,5% for every unit percentage by weight which the grading curve for chippings for surface dressing falls below the upper, exceeds the lower particle size limit respectively by more than 5%. The calculation for Y2(Double surface treatment) shall be done on respective layers but the deduction shall be made on half the unit price.

Admixing of special aggregates

Deductions: For paving with admixture of special aggregates the average of three samples, taken consecutively, of the admixture amount must not differ by more than 2 percent by weight below/over that determined in the mix specification. For lower amounts of admixture, deductions are applied to the unit price constituting 2% for every percent by which the amount of admixture falls short of these limits.

Surface regularity

2000SEK for every surface irregularity, which exceeds the maximum allowable according to BYA 84 if the Employer does not demand that the defect shall be remedied.

AF ADMINISTRATIVE CONDITIONS



AF2.62 Payment

Payment is normally made once a month and only against invoice.

Payment is made according to measurment or on account after the Employer's approved assessment of the executed work.

AF2.623 Advance payment

Advance payment is granted, if the request is stated in the Tender, for at most 10% of the Contract Price.

For advance payment, bank guarantee shall be left or other similar surety e.g. insurance in an insurance institution .

AF2.624 Invoicing

Payment of advance payment is not made before surety is given. Invoice for advance payment shall be accompanied by surety.

Invoicing must not be done before the Work in question is carried out.

The final invoicing must not be made until after approved final inspection. The final invoice shall be accompanied by the priced Bill of Quantities which shows the final quantities.

Charges for invoicing, service or the like are not approved.

AF2.625 Interest

Penalty interest on arrears is paid after the date of expiry in accordance with the law on interest.

AF2.63 Surety for obligations

AF2.631 Surety for the Employer

The Contractor is obliged to provide surety for his obligations in accordance with AB 72 chapter 6 §§ 15 and 16 only if the Employer so demands.

Surety shall be in the form of bank guarantee in a Swedish bank, credit insurance or other real surety. The above means that neither personal guarantee nor company guarantee is accepted. Surety may not be dated.

The cost of surety shall not be included in the Tender but is paid specially by the Employer.

If three consecutive cores have a percentage of Volume of Voids > 8.0 for GAB 0, > 9.0 for GAB I and > 10 for GAB II, the Contractor shall document the conformity with the requirements of tolerances by testing 6 more new core samples from the road section in question.

Light Aggregates
The minimum values for the reflection factor, measured or described in section 2.2.1, is 0.09 at lighted streets and 0.075 at unlighted streets.

By measurements of the percentage of light aggregates V, after visual sorting of friction aggregates, is required $V \geq 0.9\ N$, where N is the specified percentage of light aggregate.

## 6. GUARANTEE PERIODS (AS PER GENERAL CONDITIONS, AB 72, PARA. 22.1)

The following "Defects of Liability" periods are valid for:

| | |
|---|---|
| .Evenness | 6 months |
| .Profile | 6 months |

.Durability, coefficient of friction and rutting depths:

| | |
|---|---|
| PA on bituminous layers | 3 years |
| PA on other surfaces | 1 year |
| AB t, AB å, SMA and ABS | 5 years |
| GAB 0, GAB I and GAB II | 5 years |

The guarantee periods are also valid for "recycling in situ".

For multi-year contracts, certificates of completion are issued for sections of road, when these are completed and opened to traffic.

The following conditions shall govern during the maintenance period:

GAB 0
For ADT ≥ 4.000 the wearing course shall be laid at the latest within the calendar year following the year of completion, and the wearing course shall be functional as specified throughout the guarantee period for the base course.

For ADT < 4.000 the wearing course shall be laid before the end of the second calendar year after the year of completion.

GAB I
For ADT ≥ 4.000 the GAB 0, or the wearing course shall be laid before the end of the calendar year of completion.

For ADT < 4.000 the GAB 0, or the wearing course shall be laid at the latest one (1) year after completion.

The wearing course shall be functional as specified throughout the guarantee period for the base course.

GAB II
The layer is assumed to be covered with GAB 0, GAB I or similar base materials within six (6) months after being laid, and must not be opened to traffic until overlaid.

6.1 GUARANTEE REPAIR

Repairs and replacements during the guarantee period shall take place only as agreed with the Employer. Repair materials of different composition than the original materials used shall be agreed by the Employer before being installed.

Areas of pavement laid which do not fully meet the requirements may remain if the Employer so decides, in return for an extended guarantee period.

If unsatisfactory areas of pavement laid are concentrated within certain sections of road only, and if replacement or repair of these areas will bring the pavement as a whole into a satisfactory condition, then such a replacement will be approved.

If the areas of pavement laid, constitute one third ore more of the total area laid, are or can be required repaired or replaced then the guarantee period for the remaining area of pavement may be extended.

§ 10

## Liabilities of contracting parties

1. The contracting parties are liable to each other for their own fault and for the faults of their legal representatives and of persons whose services they employ in the fulfilment of their commitments (articles 276, 278 of German Civil Code).
2. (1) If, in connection with the performance of the contract, a third party sustains loss or damage for which both contracting parties are liable under the statutory liability provisions, then the general statutory provisions shall apply for the settlement between the contracting parties, unless otherwise agreed in individual cases. If the loss or damage sustained by the third party is a direct consequence of a measure which the client has so ordered to be performed, then the latter shall be solely liable for the loss or damage if the contractor has, in accordance with § 4, No. 3, drawn his attention to the risk involved in executing the work in the manner ordered.

   (2) The contractor shall be solely liable for the loss or damage if he has provided cover for it by insuring against his statutory liability, or could have provided cover for it with an insurer authorized to conduct business in the Federal Republic of Germany at normal rates of premium (i.e. not calculated to cover exceptional conditions) under the general insurance conditions approved by the supervisory authority.
3. If the contractor is liable under article 823 ff. of the German Civil Code to indemnify a third party for trespass on or damage to property adjoining the site, for removing or piling soil or other materials outside the areas designated for this purpose by the client, or for the consequences of unauthorized blocking of roads or water courses, then he shall be solely liable for the loss or damage vis-à-vis the client.
4. In the relationship between the contracting parties, the contractor shall be solely liable for the violation of any patent or proprietary rights if he himself proposed the use of procedures or items thus protected, or if their use has been specified by the client, but with due reference to established rights.
5. If one of the contracting parties is exempted from liability to compensate the other in accordance with Nos. 2, 3 or 4 above, then this exemption shall also extend to that party's legal representatives and agents, unless these have acted with intent or with gross negligence.
6. If one of the contracting parties is presented by a third party with a claim for damages which under Nos. 2, 3 or 4 is to be borne by the other contracting party, then the first party may require the other to release it from its obligations to the third party. The first party shall not acknowledge or meet the claim without having first given the other party to the contract an opportunity to state its views.

§ 11

## Penalty

1. If penalties have been agreed, articles 339 to 345 of the German Civil Code shall apply.
2. If a penalty has been agreed for the case where the contractor fails to complete within the term set for execution of work, then it shall become payable when the contractor is in default due to delayed performance.
3. If the penalty is calculated on the basis of days overdue, then only working days shall count; if calculated on a weeks overdue basis, each working day of an incomplete week shall count as one-sixth of a week.
4. If the client has accepted the work he may only demand payment of the penalty if he has reserved himself this right at the time of acceptance.

§ 12

## Acceptance

1. If, on completion of the work, which may be prior to expiry of the term set for its execution, the contractor calls on the client to inspect the work for acceptance purposes, the latter shall do so within 12 working days, unless a different term is agreed.
2. On request, the following shall be accepted separately:
   a) parts of the work complete in themselves;
   b) other parts of the work which, when execution proceeds, will no longer be accessible for examination and assessment.
3. If serious defects are discovered on inspection of the work, acceptance may be refused until they have been made good.
4. (1) Formal acceptance shall be carried out if so required by one of the parties to the contract. Either party may call in an expert at its own expense. The findings shall be recorded in writing, the wording being agreed by the parties concerned. Any reservations in respect of known defects or penalties shall be included in this record, as well as any objections put forward by the contractor. Each party shall receive one copy of the record.

   (2) Formal acceptance may be carried out in the absence of the contractor if the date of acceptance was agreed, or if the client's invitation to the contractor to attend was made in good time. The result of the acceptance inspection shall be communicated to the contractor as soon as possible.
5. (1) If an acceptance inspection is not required, the work shall be deemed accepted 12 working days after written notification of its completion has been made.

   (2) If the client has begun to use the work or part of the work, then it shall be deemed accepted six days after its first utilization, unless otherwise agreed. The use of parts of a structure already completed in order to proceed with the execution of the rest shall not count as acceptance.

   (3) The client shall put forward any reservations in respect of known defects or penalties not later than the times designated in clauses 1 and 2 above.
6. On acceptance, the risk shall pass to the client unless he already bears it in accordance with § 7.

§ 13

## Guarantee

1. The contractor shall guarantee that his work possesses at the time of acceptance the characteristics assured in the contract, that it conforms with the recognized rules of sound engineering practice, and is free from defects which would nullify or diminish its value or usefulness for normal purposes or for the purpose foreseen in the contract.
2. In the case of works executed to a specimen, the characteristics of the specimen shall be deemed to be assured, except for discrepancies which in commercial usage may be regarded as negligible. This also applies to specimens which are accepted as such subsequent to the conclusion of the contract.

3. If the cause of a defect may be attributed to the specification of works or to the orders given by the client, or to the materials or components supplied or specified by him, or to the quality of an advance performance of another contractor, then the contractor shall be exempt from liability in respect of these defects, unless he has neglected to notify the client of the defects to be apprehended, as he is obliged to do under § 4, No. 3.

4. If no limitation period has been agreed in the contract for the guarantee, then this shall be taken to be two years for structures and timber diseases, and one year for site works and for parts of heating plant in direct contact with fire. The period shall commence with the acceptance of the whole work; it only commences with the acceptance of parts of the work if these are complete in themselves (cf. § 12, No. 2a).

5. (1) The contractor is obliged to make good at his own expense all defects occurring during the limitation period which can be attributed to improper performance, if the client so requires in writing prior to expiry of the period. Any claim for the making good of defects complained of shall become invalid by prescription on expiry of the periods specified in No. 4 above, calculated from the receipt of the written demand, but not prior to expiry of the agreed period. After the work carried out to make good the defects has been accepted, the standard periods specified in No. 4 shall commence for this work, unless otherwise agreed.

   (2) If the contractor fails to comply with a demand to make good defects within a reasonable term set by the client, then the client shall be entitled to have the defects made good at the expense of the contractor.

6. If the defect cannot be made good, or if that would be disproportionately expensive, and the contractor refuses to make it good for this reason, the client may demand a reduction in the remuneration he is to pay (cf. article 634 clause 4 and article 472 of German Civil Code). The client may, exceptionally, also require a reduction in the remuneration to be paid in cases where it is unreasonable to expect him to make good the defect.

7. (1) If a serious defect, which appreciably impairs the fitness for use, is to be attributed to a fault of the contractor or his agents, then the contractor shall also be obliged to compensate the client for loss or damage to the structure, for the construction, maintenance, or alteration of which the work found to be defective was intended to serve.

   (2) He is only obliged to compensate for loss or damage over and above this,

   a) if the defect is the result of wilful action or gross negligence;

   b) if the defect is the result of a breach of the recognized rules of sound engineering practice;

   c) if the defect consists in the lack of a characteristic assured in the contract;

   d) and in so far as the contractor has provided cover for it by insuring against his statutory liability, or could have provided cover for it with an insurer authorized to conduct business in the Federal Republic of Germany at normal rates of premium (i.e. not calculated to cover exceptional conditions) under the general insurance conditions approved by the insurance supervision board.

   (3) Otherwise than specified under No. 4 above, the statutory limitation periods shall apply in so far as the contractor has or could have provided insurance cover in accordance with clause 2, or in so far as special insurance cover has been agreed.

   (4) Limitation or extension of liability may be agreed in special cases where such is justified.

## § 14
## Settlement of accounts

1. The contractor shall present accounts for work executed in a form that can be verified. The invoices shall be clearly itemized in the proper sequence, using the designations stipulated in the contract document. The computations of quantities, drawings and other documentary evidence needed to verify the nature and extent of the work executed shall be submitted together with the invoices. Amendments of, and supplements to, the contract shall be identified in the invoice, and on request are to be invoiced separately.

2. The assessments of the work required for invoicing purposes shall, wherever possible, be made jointly as the work progresses. The provisions regarding settlement given in the technical specifications and other contract documents shall be taken into consideration. The contractor shall apply in good time for a joint assessment to be made of works which, as the work progresses, become increasingly difficult to assess.

3. The final invoice shall, unless otherwise agreed, be submitted at the latest 12 working days after completion in the case of works which are due to be executed within not more than three months, this term being extended by six days for each three month increase of the term set for execution.

4. If the contractor does not submit a verifiable invoice, although the client has set him a reasonable term for doing so, then the client may draw up the invoice himself at the expense of the contractor.

## § 15
## Hourly wage work

1. (1) Hourly wage work shall be charged for in accordance with the contractual agreement.

   (2) If no agreement has been reached for the remuneration due, then the local rates shall be paid. If these cannot be established, then the contractor's expenses for

   site-related wage and salary costs and incidental wage and salary costs, costs of plant, equipment, machinery and installations on site, freight, carriage and loading charges, social security contributions and special costs

   shall, if consistent with efficient management, be paid for, together with reasonable extra sums to cover overheads and profit (including contractor's risk), plus value added tax.

2. If the client requires that the hourly wage work be supervised by a foreman or another person in charge, or if supervision is required by the relevant accident prevention regulations, then No. 1 shall apply accordingly.

3. The execution of hourly wage work shall be notified to the client before it is started. Unless otherwise agreed, the contractor shall submit, depending on commercial usage, either daily or weekly, lists (time sheets) showing the hours worked and the costs incurred, due for separate reimbursement, with respect to material consumption, provision of equipment, plant, machines and mechanical installations, freight, carriage and loading charges, as well as any special costs. The client shall return the time sheets after he has certified them without delay, at the latest six working days after their receipt. He may then give separate written notice of any

# APPENDIX D

## WARRANTY QUESTIONNAIRE FOR TRANSPORTATION

**NCHRP Project 20-5, Topic 23-07** **Agency** _____

SURVEY OF TRANSPORTATION AGENCIES IN THE UNITED STATES

**"Use of Warranties in Road Construction"**

**A warranty is defined as: "a long-term guarantee of the integrity of a product and of the maker's responsibility for the repair or replacement of deficiencies."**

1. Does your agency currently use warranties for any of its highway construction contracts?

   _____ YES _____ NO

2. If the answer to #1 was YES, rank the following types of projects from 1 to N (N=3 if you don't add other types), with 1 being the most likely for the use of warranties by your agency and N being the least likely. Also check off the types for which you have used warranties to the left of each listed.

| Used | Project Types | Rank |
|---|---|---|
| ___ | Road Construction | ___ |
| ___ | Bridge Construction | ___ |
| ___ | Transit Construction | ___ |
| ___ | Others - _____ | ___ |
| ___ | _____ | ___ |

3. If the answer to #1 was YES, rank the following items to be warrantied from 1 to N (N=4 if you don't add other items), with 1 being the most likely to be warrantied by your agency and N being the least likely. Also check off the items you have warrantied to the left of each.

| Warrantied | Items Warrantied | Rank |
|---|---|---|
| ___ | Construction Workmanship | ___ |
| ___ | Construction Materials | ___ |
| ___ | Maintenance Work Items | ___ |
| ___ | Final Product Performance | ___ |
| ___ | Others - _____ | ___ |
| ___ | _____ | ___ |

4. If the answer to #1 was NO,

   a. Has your agency previously used warranties, and if so, why did you discontinue using them?

      _____ YES _____ NO

**NCHRP Project 20-5, Topic 23-07** **Agency** _____

4. b. Is your agency considering the use of warranties in the near future?

——— YES ——— NO ——— UNCERTAIN

If so, please rank the following items to be warrantied from 1 to N (N=4 if you don't add other items), with 1 being the most likely to be warrantied by your agency and N being the least likely.

| **Items to be Warrantied** | **Rank** |
|---|---|
| Construction Workmanship | ___ |
| Construction Materials | ___ |
| Maintenance Work Items | ___ |
| Final Product Performance | ___ |
| Others - _____ | ___ |
| _____ | ___ |

5. Please indicate on the scale below your agency's position on the feasibility and desirability of using warranties for road construction in the U.S. in the near future.

a. Feasibility: Very Low 1 2 3 4 5 Very High

b. Desirability: Very Low 1 2 3 4 5 Very High

6. What major issues (organizational, legal, industry resistance, etc.) confront your agency's use of warranties?

**NCHRP Project 20-5, Topic 23-07** **Agency** _____

7. What potential benefits would your agency expect to result from the use of warranties for road construction projects?

8. What are your agency's concerns about the use of warranties?

9. If your agency has used warranties, please provide any sample contract documents which would illustrate or describe their use. Of special interest is the warranty period (i.e. length of time enforced) and methods used to assure compliance with warranty (e.g., bonds, retainages, etc., including dollar amounts or percentages involved).

10. Person completing this form:

Name: _____ Phone #: _____

Title: _____

Please complete survey and return (with other information) to:

Dr. Donn E. Hancher
Dept. of Civil Engineering
University of Kentucky
Lexington, KY 40506-0043

TEL (606) 257-5309 Office in KTC
TEL (606) 257-4856 Civil Engr. Dept.
FAX (606) 257-1815 Kentucky Transp. Center

- Question 1TA

Number of returned questionnaires = 45
Number of agencies currently use warranties = 19
Number of agencies not using warranties = 26
Number of non-US agencies = 4

- Question 2TA

Projects likely being used by agencies:

| Items<br>Weighting = | Rank 1<br>(4) | Rank 2<br>(3) | Rank 3<br>(2) | Rank 4<br>(1) | Average |
|---|---|---|---|---|---|
| Road Construction | 7 | 1 | 3 | 0 | 3.36 |
| Bridge Construction | 3 | 5 | 1 | 0 | 3.22 |
| Transit Construction | 1 | 1 | 0 | 1 | 2.67 |
| Other Construction* | 10 | 0 | 0 | 0 | 4.00 |

* Number of Traffic Projects = 4
Number of Landscape Projects = 2
Number of Pavement Marking Projects = 2

- Question 3-TA

Items likely being warrantied by agencies:

| Items<br>Weighting = | Rank 1<br>(5) | Rank 2<br>(4) | Rank 3<br>(3) | Rank 4<br>(2) | Rank 5<br>(1) | Average |
|---|---|---|---|---|---|---|
| Construction Worksmanship | 5 | 1 | 4 | 1 | 0 | 3.91 |
| Construction Material | 5 | 6 | 1 | 2 | 0 | 4.00 |
| Maintenance Work Items | 1 | 1 | 2 | 3 | 0 | 3.00 |
| Final Product Performance | 11 | 2 | 1 | 0 | 0 | 4.71 |
| Other Items | 0 | 1 | 0 | 0 | 0 | 4.00 |

- Question 4a-TA

Number of agencies not using warranties = 26
Number of agencies has previously used warranties = 1
Number of agencies never used warranties = 25

- Question 4b-TA

Number of agencies considering to use warranties (Y) = 7
Number of agencies not considering to use warranties (N) = 10
Number of agencies uncertain of using warranties (U) = 8

Question 4b-TA (continued)

Items likely being warrantied by agencies:

| Items Weighting = | Rank 1 (5) | Rank 2 (4) | Rank 3 (3) | Rank 4 (2) | Rank 5 (1) | Average |
|---|---|---|---|---|---|---|
| Construction Worksmanship | 0 | 2 | 4 | 0 | 0 | 3.33 |
| Construction Material | 1 | 4 | 1 | 0 | 0 | 4.00 |
| Maintenance Work Items | 0 | 0 | 1 | 4 | 0 | 2.20 |
| Final Product Performance | 6 | 0 | 0 | 0 | 0 | 5.00 |
| Other Items | 0 | 0 | 0 | 0 | 0 | 0.00 |

- Question 5-TA

Agency's position on the feasibility and desirability of using warranties:

| Rating = Items | 1 Very Low | 2 | 3 | 4 | 5 Very High | Average |
|---|---|---|---|---|---|---|
| Number of responses on Feasibility | 7 | 9 | 8 | 4 | 3 | 2.58 |
| Number of responses on Desirability | 4 | 4 | 8 | 8 | 6 | 3.27 |

- Question 6-TA

Major issues confronting agencies' use of warranties:

| Issues | Number of responses |
|---|---|
| Industry (sureties/contractors) resistance | 18 |
| Legal prohibition (including FHWA disallowment) | 15 |
| Specification development problems (roles/enforcement) | 12 |
| Organizational problems (internal DOT disagreement over use of warranties/eliminating method specs) | 11 |
| Does contract remain open for warranty period | 4 |
| Must give contractor design input | 3 |
| Lack of existing major quality problems | 2 |
| Impractical for out-of-state (external) contractor | 1 |

- Question 7-TA

Potential benefits from using warranties:

| Potential benefits | Number of responses |
|---|---|
| Higher quality products | 20 |
| Eliminate/reduce maintenance costs to owner | 16 |
| More quality conscious contractors | 16 |
| Longer life of products | 6 |
| Reduced inspection and contract administration | 6 |
| Better testing equipment/techniques developed | 5 |
| Reduced litigation | 1 |

- Question 8-TA

Agencies' concerns about the use of warranties:

| Concerns | Number of responses |
|---|---|
| Unknown cost impact on projects/life cycle costs | 13 |
| Ability to define performance measurements required | 10 |
| Management and enforcement over extended time period | 8 |
| Will contractor stay in business for life of warranty | 7 |
| Inability to determine true causes of/responsibilty for failures | 5 |
| Needed length of warranty period to catch problems | 5 |
| Long term guarantee only as good as bonding company | 4 |
| Will bonding company honor commitment | 3 |
| Overlapping of maintenance and warranty responsibilities | 3 |
| Quality control concerns | 2 |
| Disputes could be very time consuming and costly | 1 |
| Wider range of design means long-term problem for agency | 1 |
| Ability to prevent employees from negating contract conditions | 1 |

# APPENDIX E

## WARRANTY QUESTIONNAIRE FOR SURETIES

**NCHRP Project 20-5, Topic 23-07** **Company** _____

SURVEY OF SURETY COMPANIES IN THE UNITED STATES
**"Use of Warranties in Road Construction"**
(Feel free to write on the backs of the pages)

**A warranty is defined as: "a long-term guarantee of the integrity of a product and of the maker's responsibility for the repair or replacement of deficiencies."**

1. Does your company currently supply warranties for any of its highway construction contracts?

   ——— YES ——— NO

2. If the answer to #1 was YES, rank the following types of projects from 1 to N (N=3 if you don't add other types), with 1 being the most likely for the use of warranties by your company and N being the least likely. Also check off the types for which you have used warranties to the left of each.

| Used | Project Types | Rank |
|---|---|---|
| ___ | Road Construction | ___ |
| ___ | Bridge Construction | ___ |
| ___ | Transit Construction | ___ |
| ___ | Others - _____ | ___ |
| ___ | _____ | ___ |

3. If the answer to #1 was YES, rank the following items to be warrantied from 1 to N (N=4 if you don't add other items), with 1 being the most likely to be warrantied by your company and N being the least likely. Also check off the items you have warrantied to the left of each.

| Warrantied | Items Warrantied | Rank |
|---|---|---|
| ___ | Construction Workmanship | ___ |
| ___ | Construction Materials | ___ |
| ___ | Maintenance Work Items | ___ |
| ___ | Final Product Performance | ___ |
| ___ | Others - _____ | ___ |
| ___ | _____ | ___ |

4. If the answer to #1 was NO,

   a. Has your company previously used warranties for road jobs, and if so, why did you discontinue using them?

      ——— YES ——— NO

**NCHRP Project 20-5, Topic 23-07 Company** _____

4. b. Is your company considering the use of warranties in the near future?

——— YES ——— NO ——— UNCERTAIN

If so, please rank the following items to be warrantied from 1 to N (N=4 if you don't add other items), with 1 being the most likely to be warrantied by your company and N being the least likely.

| **Items to be Warrantied** | **Rank** |
|---|---|
| Construction Workmanship | ___ |
| Construction Materials | ___ |
| Maintenance Work Items | ___ |
| Final Product Performance | ___ |
| Others - _____ | ___ |
| _____ | ___ |

5. Please indicate on the scale below your company's position on the feasibility and desirability of using warranties for road construction in the U.S. in the near future.

a. Feasibility: Very Low 1 2 3 4 5 Very High

b. Desirability: Very Low 1 2 3 4 5 Very High

6. What major issues (organizational, legal, cost, risk, etc.) confront your company's use of warranties?

**NCHRP Project 20-5, Topic 23-07 Company** _____

7. What potential benefits would your company expect to result from the use of warranties for road construction projects?

8. What are your company's concerns about the use of warranties?

9. If your company has used warranties, please provide any sample contract documents which would illustrate or describe their use. Of special interest is the warranty period (i.e. length of time enforced), dollar amounts or percentages involved, restrictions imposed, etc.

10. Person completing this form:

Name: _____ Phone #: _____

Title: _____

Please complete survey and return (with other information) to:

Dr. Donn E. Hancher
Dept. of Civil Engineering
University of Kentucky
Lexington, KY 40506-0043

TEL (606) 257-5309 Office in KTC
TEL (606) 257-4856 Civil Engr. Dept.
FAX (606) 257-1815 Kentucky Transp. Center

- Question 1-SC

Number of returned questionnaires = 6
Number of sureties currently using warranties = 1
Number of sureties not using warranties = 5

- Question 2-SC

Projects likely for sureties to warrant (only 1 response):

| Items Weighting = | Rank 1 (4) | Rank 2 (3) | Rank 3 (2) | Rank 4 (1) | Average |
|---|---|---|---|---|---|
| Road Construction | 0 | 0 | 1 | 0 | 2.00 |
| Bridge Construction | 0 | 1 | 0 | 0 | 3.00 |
| Transit Construction | 1 | 0 | 0 | 0 | 4.00 |
| Other Construction | 0 | 0 | 0 | 0 | 0.00 |

- Question 3-SC

Items likely being warrantied by sureties (only 1 response):

| Items Weighting = | Rank 1 (5) | Rank 2 (4) | Rank 3 (3) | Rank 4 (2) | Rank 5 (1) | Average |
|---|---|---|---|---|---|---|
| Construction Worksmanship | 1 | 0 | 0 | 0 | 0 | 5.00 |
| Construction Material | 1 | 0 | 0 | 0 | 0 | 5.00 |
| Maintenance Work Items | 0 | 1 | 0 | 0 | 0 | 4.00 |
| Final Product Performance | 0 | 0 | 0 | 0 | 0 | 0.00 |
| Other Items | 0 | 0 | 0 | 0 | 0 | 0.00 |

- Question 4a-SC

Number of sureties not using warranties = 5
Number of sureties previously using warranties = 1
Number of sureties never used warranties = 4

- Question 4b-SC

Number of sureties considering use of warranties (Y) = 0
Number of sureties not considering use of warranties (N) = 4
Number of sureties uncertain of using warranties (U) = 0

Items likely to be warrantied by sureties:

| Items Weighting = | Rank 1 (5) | Rank 2 (4) | Rank 3 (3) | Rank 4 (2) | Rank 5 (1) | Average |
|---|---|---|---|---|---|---|
| Construction Worksmanship | 0 | 0 | 0 | 0 | 0 | 0.00 |
| Construction Material | 0 | 0 | 0 | 0 | 0 | 0.00 |
| Maintenance Work Items | 0 | 0 | 0 | 0 | 0 | 0.00 |
| Final Product Performance | 0 | 0 | 0 | 0 | 0 | 0.00 |
| Other Items | 0 | 0 | 0 | 0 | 0 | 0.00 |

- Question 5-SC

Sureties' position on the feasibility and desirability of using warranties:

| Items | Rating = 1 Very Low | 2 | 3 | 4 | 5 Very High | Average |
|---|---|---|---|---|---|---|
| Number of responses on Feasibility | 5 | 0 | 0 | 0 | 0 | 1.00 |
| Number of responses on Desirability | 5 | 0 | 0 | 0 | 0 | 1.00 |

- Question 6-SC

Major issues confronting sureties' use of warranties:

| Issues | Number of responses |
|---|---|
| Unacceptable risk exposure due to long term warranty period | 5 |
| Burden of proof and legal ramifications | 3 |
| Contractors' inability to control the use/burden of highways | 2 |
| Unknown/increased cost impact | 1 |
| Unpredictable weather and other job conditions | 1 |
| U.S. highway systems/controls differ from those of Europe | 1 |

- Question 7-SC

Potential benefits from using warranties:

| Potential benefits | Number of responses |
|---|---|
| NO BENEFITS STATED BY SURETIES. | |

- Question 8-SC

Sureties' concerns about the use of warranties:

| Concerns | Number of responses |
|---|---|
| Unacceptable risk exposure due to long term warranty period | 5 |
| Warranty period is too long | 5 |
| Inability to determine true causes of failures | 2 |
| Tends to reduce/lessen competition (competitive bidding) | 1 |
| Higher cost to owner | 1 |

# APPENDIX F

## SAMPLE WARRANTY SYSTEMS USED IN UNITED STATES

SAMPLE WARRANTY CLAUSES

**City of Milwaukee, Wisconsin**
SECTION 307 GUARANTEE PROVISIONS

307.1 Guarantee—
The work shall be constructed in such manner that no defects resulting from faulty workmanship or materials shall appear therein during the guarantee period. The guarantee period will be three years beginning with the actual completion date as described in Part 2 for all work under the contract.

307.2 Guarantee Bond—
The guarantee required by Section 307.1 and incorporated as a part of the contract form shall be executed by the bidder and by an approved licensed Surety Corporation. The surety shall be bound in accordance with the provisions of the contract documents.

307.3 Repairs by Contractor—
In the event of the failure of any part of the work to conform to the specific requirements during the guarantee period, the contractor shall make such repairs as are ordered by the Commissioner to restore the work to an acceptable condition.

307.4 Pavement Cuts During Guarantee Period—
During the guarantee period, the applicant for a permit to cut the pavement shall furnish the City with a guarantee that the pavement opened will be restored properly. The commissioner will decide the sufficiency of the guarantee.

**City of Racine, Wisconsin**
Detailed Specifications
VI. Guarantee
The contractor shall agree and guarantee that the materials and workmanship supplied by him shall be free from all defects and strictly in accordance with the Plans and Specifications at the time of its completion and acceptance by the City and for a period of three (3) years thereafter. In case any cracks, leaks, settlement or any other defects as to materials or workmanship shall exist or appear in any part of the work constructed by him within three (3) years thereafter, the contractor agrees to forthwith repair the same upon notification by the City, using the same material required by the Specifications, and in case the contractor shall fail to make such repairs or cause the same to be made, the contractor shall agree to pay on demand the cost thereof, to said City upon completion of such repairs. The contractor further agrees and guarantees to pay for all labor and materials used in or about the construction of said work in this contract which may become a lien or claim against the City. Such agreement and guarantee shall be made a part of the contract, and the fulfillment thereof shall be secured by the bond of the contractor.

**Town of Eastchester, New York**
Description of Work

These specifications are designed to accomplish the work of resurfacing various streets as described in the attached list within the Town of Eastchester, New York.

The work to be performed under this contract shall consist of resurfacing existing pavements with asphalt concrete, adjusting the existing manholes and catch basins to conform to the finished grade of pavement after resurfacing.

NOTE: The contractor shall key all intersection of streets by notching the existing pavement. Twelve inches (12") wide minimum and three (3") deep. Joint sealer (hot asphalt concrete) shall be applied where new pavement meets old pavement. Keyways shall also be cut around all existing catch basins not raised to grade to provide adequate thickness and bonding of new pavement.

The furnishing and placement shall conform to current Standard Specifications, construction and materials, New York State Department of Transportation. The contractor is responsible for the basic maintenance and protection of traffic at all times. No vehicle traffic shall be permitted for at least 90 minutes. All other work required to complete this contract in all its parts shall be to the satisfaction of the Superintendent of Highways. The Superintendent will designate the order in which the streets are to be resurfaced.

Each bid shall be accompanied by a statement from the bidder stating the location of the plant in which the asphalt concrete shall be mixed.

All work shall be guaranteed for a period of five years and maintained during that time by the contractor without expense to the Town of Eastchester and to the satisfaction of the Superintendent of Highways.

MICHIGAN
DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS

Special Provision
for
Performance Warranty on Bridge Painting



Performance Warranty

The Contractor shall unconditionally warrant to the Michigan Department of Transportation (MDOT) the paint system applied to the bridge to be free of defects, as hereinafter defined and determined by visual inspection and paint thickness measurements, for a period of two years from the date of final inspection by the Engineer. On projects that extend over more than one year in contract duration, the Engineer may accept portions of the painting at the end of each annual work period and the warranty period shall be for two years from the acceptance date for each portion respectively. The warranty called for shall be on a warranty form furnished by the state, a copy of which is attached. This warranty shall be submitted to the MDOT Financial Services Division prior to the award of the contract.

The paint system will be considered defective if any of the following conditions are discovered within the two year warranty period:

1. The occurrence of visible rust or rust breakthrough, paint blistering, peeling, or scaling.

2. Paint applied over dirt, debris, blasting debris, or rust products not removed during blast cleaning.

3. Incomplete coating or coating thicknesses less than the minimums specified in the painting specifications.

4. Damage to the coating system caused by the Contractor while removing scaffolding or performing other work.

Warranty Evaluation

During the month before the end of the two end warranty period(s), or earlier, the Engineer will inspect the bridge thoroughly for the paint system defects listed. This inspection will be done using Department maintenance personnel and equipment. The Contractor may accompany the Engineer during this inspection. The Engineer will determine if there are defective areas present as defined above.

Acceptance by the Engineer of any portion of the work during the original contract cleaning and painting will not relieve the Contractor of the requirements of this warranty.





Corrective Work

All defective areas identified by the Engineer shall be repaired by the Contractor in accordance with the painting specifications. The repair procedures and Progress Schedule shall be submitted in writing to the Engineer for review and approval prior to any work. All paint repair work will be done the same season as the inspection, unless the seasonal limitations stated in the painting specifications prevents the completion that season. In this case the corrective work will be completed the following season. The Engineer shall be given at least two weeks notification before the Contractor begins the corrective work and shall be allowed full inspection of all operations and provided safe access to the areas being repaired.

The Contractor shall supply verification to the MDOT Financial Services Division that the required liability insurance is in effect during the period the corrective work is being done.

Special Supplemental Performance and Lien Bonds

The Contractor shall furnish, in addition to the regular performance and lien bonds for the contract, a supplemental performance bond to the Department. The bond shall be in the sum of 15 percent of the original total contract amount. The bond is to secure the performance by the Contractor of correction work on any paint system defects that he/she is directed by the Department to perform and shall be in force for the period covering the two year warranty and the time required to perform any corrective work covered by the warranty. The Contractor shall use the form provided by the Department, a copy of which is attached, and executed in accordance with the requirements of this special provision. If corrective work is required the Contractor shall provide a supplemental lien bond (form provided by the department) that is in effect for the duration of the corrective work. The supplemental performance and lien bonds must be in all respects satisfactory and acceptable to the Department, executed by a surety company authorized to do business in the State of Michigan.

Upon completion of the work and final inspection of the project, the supplemental performance bond shall become effective and shall continue in full force and effect until such time as the Department will, in accordance with the Paint Quality Warranty, advise the Contractor that there are either no paint system defects, or, if the Contractor has been notified that there are paint system defects, said paint system defects have been repaired by the Contractor to the satisfaction of the Department as specified under the Paint Quality Warranty. The Engineer shall withhold in reserve an amount equal to 15 percent of the total contract amount until the Supplemental Performance Bond has been received.

Measurement and Payment

All costs associated with performance of the work and the required maintenance traffic, described under the Performance Warranty on bridge painting and the required supplemental performance bond, will not be paid for separately but will be considered to be included in the Contractor's overhead and administrative costs.

MICHIGAN
DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS

CD/JDC 1 of 2 11-15-89

WARRANTY

PAINT QUALITY

THIS WARRANTY, made by _____ (Contractor)
of _____
hereinafter called "Warrantors", in favor of the Michigan Department of Transportation, hereinafter called "Department";

W I T N E S S E T H:

RECITALS:

1. The Department has contracted for the cleaning and painting structural steel on the _____ Bridge on the _____ Highway in _____ County, Michigan.

2. Under the provision of Contract No._____ , pertaining in part to painting on structural steel, entered into by _____ (Contractor) , and the Department in which _____ (Contractor) is required to furnish the Department a written warranty for the paint system warranting against defect as stated in said contract for a period(s) of two years from the date(s) of final inspection by the Engineer, of _____ (Contractor) work under said contract.

MICHIGAN
DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS

CD/JDC 2 of 2 11-15-89

WARRANTY

PAINT QUALITY

NOW, THEREFORE, in consideration of the foregoing, Warrantor hereby agrees and warrants that in every case in which any defect, as described in Contract No._____ , occurs within said two year period(s), Warrantor shall, forthwith upon receipt of written notice of such defect repair said defective area.

It is expressly understood and agreed that the warranty and obligations herein set forth are made and undertaken by Warrantor to and for the benefit of the Department.

IN WITNESS WHEREOF, Warrantor have set his/her hands as of this _____ day of _____ , 19 _____ .

_____ (Contractor)

ATTEST: BY: _____

_____ TITLE: _____

MICHIGAN
DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS

CD/JDC 1 of 2 11-15-89

SUPPLEMENTAL PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS, That we _____

as principal, and _____

as surety, a corporation duly organized and existing under and by virtue of the laws of the State of _____ and duly authorized to transact the business of surety in the State of Michigan, are jointly and severally held and bound unto the Michigan Department of Transportation in the sum of _____ Dollars, for the payment of which we jointly and severally bind ourselves, our heirs and executors, administrators, successors and assigns firmly by these presents.

Whereas, the principal herein as, on the _____ day of _____ , 19 ____ , made and entered into a certain agreement with the State of Michigan, by and through the Michigan Department of Transportation, which agreement is more fully described as _____ _____ , Contract No. _____ , under which agreement the principal agrees to furnish certain materials and to perform certain work which he/she agrees to do in accordance with the terms, conditions and requirements as set out in said agreement, and whereas, in connection with said contract, the principal has executed a written warranty, a copy of which warranty is attached hereto and by this reference made a part hereof;

MICHIGAN
DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS

CD/JDC 2 of 2 11-15-89

SUPPLEMENTAL PERFORMANCE BOND

And, whereas, the principal has therein undertaken to warrant the work of cleaning and painting structural steel against any defects, as therein defined, for a period(s) of at least two years from the date(s) of final inspection of the project by the Engineer.

NOW, THEREFORE, the condition of this bond is such that if the principal herein shall faithfully and truly observe and comply with the terms of such warranty and shall well and truly perform all matters and things by him undertaken to be performed under said warranty upon the terms proposed therein and shall do all things required of said principal by the laws of this state and shall indemnify and save the harmless the State of Michigan and MDOT against any direct or indirect damages of every kind and description that shall be suffered or claimed to be suffered in connection with or arising out of the performance of the said warranty by the Contractor or subcontractors, then this obligation is to be void, otherwise to remain in full force and effect.

In no event shall the obligations under this bond be terminated without written consent of the Michigan Department of Transportation.

Signed and sealed this ____ day of _____ , 19 _____ .

SURETY _____ PRINCIPAL _____

BY _____ BY _____
(Attorney-in-fact) (Official Capacity)

Countersigned:

_____ Attest: _____
Resident Agent Secretary

Missouri State Department of Transportation

## PERFORMANCE SPECIFICATION FOR RUBBER ASPHALT MATERIALS

**1.0 DESCRIPTION.** This item shall consist of furnishing the mix design, materials, equipment, construction procedures, and any additional specifications necessary for producing and placing asphalt rubber material, including two Asphalt Rubber Concrete (ARC) mixtures and an interlayer, in conformance with the lines and grades shown on the plans or as designated by the engineer. In addition, the contractor shall be responsible for a warranty providing for the performance and maintenance of the finished roadway, as described herein, for three years after final acceptance. The Asphalt Rubber Supplier (ARS) is responsible for furnishing the design, specification, and procedures needed to place the asphalt rubber materials.

**1.1** This specification shall apply to an approximate three linear miles of the northbound lane, approximately 40 feet in width including the driving lane, passing lane, and both shoulders of this project, from Station 0+00 to 163+26.7.

**1.2** It is expected that this work will follow work described in other parts of the contract for the same area, including but not limited to, full or partial depth patching, undersealing, and installation of edge drains.

**1.3** This work includes, but is not limited to, additional patching and crack sealing, milling 12 feet wide in the driving lane to an approximate level of 1/2" below grade to remove ruts, installation of a 3/4 inch thick Gap Graded ARC (1 1/4 inch in the driving lane), covered by an Asphalt Rubber Stress Absorbing Membrane Interlayer (SAMI), and finally covered with a one inch Open Graded ARC.

**1.4** The term "final acceptance", as used in this specification, shall be either project final acceptance, or project partial acceptance of the total area affected by this provision, as defined in Sec 105.15. It does not include the warranty period.

**1.5** Unless otherwise stated, specification section references are from the version, in effect at the time of this contract, of the Missouri Standard Specifications for Highway Construction and its supplements.

**2.0 WARRANTY.** Prior to final acceptance, the contractor shall furnish to the engineer a notarized letter signed by an authorized representative, stating that the contractor will warranty materials, work, performance, and maintenance as described by this specification, for three years from the final acceptance date. This three year period is the "warranty period".



**2.1** At the end of the warranty period, the contractor will be released from further maintenance or responsibility, provided the following criteria have been satisfied.

**2.1.1** The performance requirements of this provision shall be met.

**2.1.2** The maintenance requirements of this provision shall be satisfied.

**2.1.3** There shall be no evidence of imminent failure of any of the asphalt rubber materials as evidenced by substantial existing patches, raveling areas, alligator cracking, or other failure modes.

**2.2 Commission Reimbursement.** If the warranty criteria are not satisfied, the contractor shall reimburse the Commission for the full contract price of all items covered by this specification.

**2.2.1** Total reimbursement due the Commission under the warranty provisions of this specification will be limited to the amount of the bond supplied under this provision. However, that is not to be construed so as to limit the contractor's responsibility to fulfill the intent of this specification, nor is it to be considered as a monetary limit on the cost of any activities necessary by the contractor to fulfill the warranty portion of this contract.

**2.2.2** Any materials necessary for maintenance, repair, or replacement under this specification are the responsibility of the contractor and are not considered to be a part of the reimbursement.

**3.0 BONDING AND LIABILITY INSURANCE.** Prior to final acceptance and in addition to other bonding required by the Commission for normal contract work, the contractor shall furnish a bond and proof of liability insurance. Any agreements made between the contractor and any material suppliers to furnish either of these items shall be noted, however the contractor is considered to be the responsible party until the end of the warranty period.

**3.1** The bond shall be in a sum equal to the contract price for items covered in this specification as described in the Basis for Payment and in accordance with applicable portions of Sec 103.4. It is to insure the proper and prompt completion of any required work following the final acceptance, including payment for all labor performed and materials consumed or used in accordance with this specification. The bond shall be in effect for the warranty period.

**3.2** The liability insurance shall be supplied by the

contractor in accordance with Sec 107.14, covering any contractor or contractor authorized operations, persons, and equipment while the roadway maintenance operations required herein are being performed. The liability insurance is for the maintenance operations and is not required to cover design deficiencies or other roadway incidents that may or may not be attributable to the ARC surface. The insurance shall be in effect for the warranty period.

**4.0 ARS SUPPLEMENTAL SPECIFICATIONS.** Prior to bidding, the ARS shall furnish to prospective bidders an itemized list and detailed specifications for: 1) preliminary work to be done to the milled surface prior to placement of any bituminous material including crack sealing, necessary surface patching, and tack coat application, 2) the Gap Graded ARC layer, 3) the SAMI layer, 4) the Open Graded ARC layer, and 5) required maintenance procedures following final acceptance. The specifications shall include, but are not limited to, any equipment, material, or procedural requirements deemed necessary to complete the project in a manner suitable to the ARS and to the engineer as described in this specification. Any allowable limits or deviations shall be included. Actual mix design work is not required to be done by this time, however the approximate material percentages and any gradation or density limits shall be furnished. If not specified by the ARS, any applicable provisions from the Missouri Standard Specifications for Highway Construction shall apply.

**4.1 A NOTARIZED COPY OF THE ASPHALT RUBBER SUPPLIER SPECIFICATIONS, SIGNED BY THE SUPPLIER, SHALL ACCOMPANY THE CONTRACTOR'S PROPOSED BID. PRIOR TO BID OPENING, ANY PARTICIPATING ASPHALT RUBBER SUPPLIER SHALL FURNISH A COPY OF THE EXACT SAME INFORMATION TO W. L. TRIMM, DIVISION ENGINEER, MATERIALS AND RESEARCH, P.O. BOX 270, JEFFERSON CITY, MO 65102. THE COPIES SHALL BE CONSIDERED AS ADEQUATE INSTRUCTIONS TO COMPLETE THIS PORTION OF THE PROJECT TO THE ASPHALT RUBBER SUPPLIER'S SATISFACTION. ANY SUBSEQUENT CHANGES SHALL BE AGREED TO BY THE CONTRACTOR, THE ASPHALT RUBBER SUPPLIER, AND THE ENGINEER, AT NO COST TO THE COMMISSION, EXCEPT AS REQUIRED BY THE ENGINEER.**

**5.0 JOB CONTROL.** The engineer will control the work and provide quality control in a normal manner, subject to any ARS specifications and limits specified, with the exception of unusual tests specific to asphalt rubber material which may be performed by the ARS.

**5.1 ARS Representative.** Prior to the start of this work, the contractor shall furnish the engineer with the name and phone number of an ARS job representative, in writing. That person shall be considered to be the contact person for the ARS, accessible during the contract and warranty period and capable of making decisions as might be needed in order for work to progress without delay. In the absence of an ARS representative, the



engineer will make any necessary decisions, but that shall not absolve the ARS from any responsibility or refusal to accept such work.

**6.0 MATERIALS.** All materials shall conform to Division 1000, Materials Details unless otherwise noted.

**6.1** Bituminous materials shall meet applicable sections of the Missouri Standard Specifications for Highway Construction and its supplements.

**6.2** Asphalt rubber material shall be a uniform, reacted mixture of asphalt cement, ground rubber, and extender oil, if required. The ground rubber shall be between 15 and 25 percent, by weight, of the asphalt rubber. The exact percentage and physical characteristics of the blend shall be specified by the ARS.

**6.3** Ground rubber shall be recycled, vulcanized ground rubber produced from processing of automobile and truck tires by ambient temperature grinding methods. The physical characteristics shall be specified by the ARS.

**6.4** All aggregates used for this specification shall meet the quality requirements of Sec 1002. Gradations or other physical requirements shall be as specified by the ARS.

**6.5** The coarse aggregate for the Open Graded ARC shall be porphyry.

**6.6** Patching and joint sealing material shall be as specified by the ARS.

**6.7 Asphalt Rubber Mixture Designs.** At least 30 days prior to placement of the SAMI or either ARC mixture, the contractor shall furnish to the engineer a copy of the mix design, for each mixture to be used, as supplied by the ARS. No material placement shall be done until the information is approved by the engineer.

**6.7.1** For each mix used, the mix design submitted to the engineer shall contain the following information:

a. Source and grade of asphalt cement.

b. Source, type, grade, and actual gradation of ground rubber.

c. Percentage of ground rubber in the asphalt rubber, by weight of the asphalt rubber.

d. Physical properties of asphalt rubber and test method.

e. Source, type (formation, etc.), ledge number if applicable, and gradation of aggregates.

f. Bulk specific gravity and absorption of each coarse aggregate fraction, determined in accordance with AASHTO T85.

g. Bulk specific gravity and absorption of each fine aggregate fraction, determined in accordance with AASHTO T84.

h. Percent of each aggregate component, by weight based on total mix.

i. Combined gradation of the job mixture.

j. Percent asphalt rubber, by weight based on total mix.

k. Bulk specific gravity by AASHTO T166 Method A of laboratory compacted mixture and the method of compaction.

l. The percent air voids in the laboratory compacted mixture.

m. Stability, flow values, and other information derived from testing of the laboratory compacted specimens, including the method of testing.

n. Voids in the mineral aggregate and voids in the mineral aggregate filled with asphalt rubber.

o. Maximum specific gravity as determined by AASHTO T209.

p. Recommended mix production temperature.

q. Recommended mix compaction temperature.

r. Recommended in-place density range of compacted mixture, including the minimum acceptable value as a percentage of the laboratory compacted mixture.

s. If required by the job mix formula, the source of anti-strip additive and the percent of anti-strip agent, by weight of the asphalt cement.

**7.0 CONSTRUCTION.** Full and partial depth pavement patching, undersealing, and edge drain placement is to be done under other provisions of this contract and completed for this roadway section prior to the following work.

**7.1 Coldmilling.** The driving lane shall be coldmilled for a width of 12 feet for leveling purposes, to the depth necessary for removal of the ruts, in accordance with other provisions of this contract. It is anticipated that this could remove material to approximately 1/2 inch below the original



grade.

**7.2 Additional Patching.** Any patching or crack sealing specified by the ARS shall be done using the ARS recommended materials.

**7.3 Tack Coat.** All original and milled surfaces shall be tacked, unless otherwise specified by the ARS. The material, application rate, and procedure shall be as specified by the ARS.

**7.4 Bituminous Mixtures.** The design, materials, placement, and compaction for the SAMI and both ARC mixtures shall be as specified by the ARS.

**7.5 Smoothness.** Prior to acceptance of any work done under contract or during the warranty period, the riding surface shall meet the profilograph requirements in Sec 403 as specified elsewhere in this contract. For work done prior to final acceptance, adjustments in the contract price will be applied to the contract price prior to final acceptance. For replacement and rehabilitation work done during the warranty period, there will be no incentive payment made, however for profiles that would result in less than 100 percent of contract price, reimbursement shall be due the commission for the difference based on the contract price of the replacement materials.

**8.0 MAINTENANCE.** During the warranty period, the following maintenance work shall be performed at no cost to the department and using any procedures or materials specified by the ARS.

**8.1** The contractor is responsible for monitoring of the affected pavement and determining when and what maintenance is required. The contractor shall also supply, for the department's use, a phone number and contact person available between the hours (CST) of 8:00 am and 5:00 pm on weekdays. While department personnel will perform any maintenance procedures deemed necessary as an emergency to maintain traffic as desired, the contractor will be held responsible for any follow-up work, permanent replacement, or other maintenance required for the roadway surface to perform satisfactorily.

**8.2** The contractor shall clean and seal all longitudinal and transverse joints or cracks greater than or equal to 1/4 inch in width, at least annually, with a recommended joint sealant.

**8.3** Any spalls or pot holes that appear in the ARC shall be patched by the contractor using an approved mixture. This includes all cavities greater than 2 inches in width and with a depth equal to or greater than the surface lift thickness.

**8.4** Raveled areas shall be removed and replaced as

described elsewhere in this contract.

**9.0 PERFORMANCE.** The following criteria shall be met prior to final acceptance and any time during the warranty period.

**9.1 Rutting.**

**9.1.1 Method of measurement.** Rut depths will be measured and evaluated on a lane basis.

**9.1.2 Requirement and acceptance.** No work will be accepted if the average rut depth is greater than 1/4 inch. Deformation of layers below those applied in this contract will not be cause for non-acceptance.

**9.1.3 Correction and penalties.** Rut depths greater than 1/4 inch and less than 1/2 inch shall be corrected by surface texturing or replacement of at least the top lift of bituminous material, at the ARS choice. In lieu of that, the Commission shall be reimbursed for the contract price of the Open Graded ARC material. Rut depths greater than 1/2 inch shall be corrected by removal and replacement of all ARC layers determined to be affected. In lieu of that, the Commission shall be reimbursed for the price of all materials covered under this provision. For rut depths greater than 1/2 inch, coldmilling, grinding, or other surface re-profiling shall not be an acceptable method of correction.

**9.2 Patching.**

**9.2.1 Method of measurement.** The square footage of all maintenance patches will be determined by the engineer and evaluated on a segment basis. Maintenance patches do not include replacement and rehabilitation as allowed elsewhere in this contract. Areas patched as a result of failure not related to ARC material will not be included in this quantity.

**9.2.2 Requirement and acceptance.** Any segments the width of either lane or either shoulder will not be accepted when more than 10 percent of the segment area for a minimum of a tenth mile length has been patched.

**9.2.3 Correction and penalties.** If a segment is determined to be unacceptable, the affected area shall be removed to the affected depth and replaced as described elsewhere in this contract.

**10.0 TRAFFIC CONTROL.**

**10.1 Construction.** During construction, one lane shall be kept open at all times. One lane may be closed overnight with proper signing. Signing shall be as specified in other portions



of the contract.

**10.2 Maintenance.** During maintenance operations , all signing operations shall be as approved by the engineer and in accordance with the Manual on Uniform Traffic Control Devices. One lane may be closed for daytime work, but none are to be closed at night.

**11.0 REPLACEMENT AND REHABILITATION.** If, at any time the contractor elects to, or is required to, replace or refurbish any portion of the surface, all work shall be done in accordance with the original project requirements, and all performance criteria will be applied to that section for the remainder of the warranty period.

**12.0 BASIS OF PAYMENT.** Payment for the above described work including all materials, equipment, labor, and any other incidental work necessary to complete this item shall be considered as completely covered by the contract unit price. The accepted quantities will be paid for at the unit price 1) per square yard of cold milling, 2) per square yard of tack coat, 3) per ton of Gap Graded Asphalt Rubber Concrete, 4) per square yard of Asphalt Rubber Stress Absorbing Membrane Interlayer (SAMI), and 5) per ton of Open Graded Asphalt Rubber Concrete. There will be no payment for additional patching or joint sealing as required by the ARS.

**12.1** Any aggregate for blotter material will be paid for at a fixed unit price of $8.00 per ton.

SPECIAL PROVISIONS
FEDERAL-AID PROJECT NO. STPX 0002(39)

The following special provisions are hereby made a part of this contract and shall supplement and/or supersede any sections of the Standard Specifications for Road and Bridge Construction of the State Highway Commission of Montana, 1987 Edition, and all supplements thereto in conflict therewith.

The following books are also hereby made a part of this contract and are available upon request to the Montana Department of Transportation, Contract Plans Section, Helena, Montana 59620.

(1) The book entitled "Standard Specifications for Road and bridge Construction," 1987 Edition.

(2) Loose-leaf set of drawings entitled "Standard Drawings," 1984 Edition, which are supplemental to the Standard Specifications for Road and Bridge Construction.

1. PROJECT SCOPE

The purpose of this project is to use for the first time an innovative contracting process for the installation of durable pavement markings. Portions of I-15 and U.S. 87 in the Havre Division and U.S. 2 in the Kalispell and Havre Divisions will be marked. The contractor will be allowed to select any marking material(s) other than the routinely used, standard traffic paints. After initial application, the contractor will be required to warranty the product(s) for a four-year period. These special provisions require the expeditious replacement of failed material within the four-year contract period.

2. PROJECT ADMINISTRATION

The project will be administered by the Great Falls District Engineer.

3. PROJECT LIMITS

This project is located on roadways within the Kalispell and Havre maintenance areas, as follows:

| HIGHWAY ROUTES & ROUTE SEGMENTS BY MILEPOST | | MILES |
|---|---|---|
| (P-1) | U.S. 2 - MP 171.0 to MP 446.3<br>Primary, 2-lane asphalt | 275.3 |
| | Exclude 204.0 to 255.0 | -51.0 |
| | 308.0 to 321.0 | -13.0 |
| | 394.0 to 404.0 | -10.0 |
| | 430.0 to 446.3 | -16.3 |
| | P-1 TOTAL | 185.0 |
| (P-10) | U.S. 87 - MP 52.5 to MP 111.3<br>Primary, 2-lane asphalt | 58.8 |
| | Exclude 52.5 to 72.3 | -19.8 |
| | P-10 TOTAL | 39.0 |
| (I-15) | I-15 MP 328.1 to 398.2<br>Interstate, 4-lane asphalt, including both northbound and southbound lanes | 140.2 |
| | Exclude northbound lane 328.0 to 335.0 | -7.0 |
| | Exclude northbound and southbound lanes 354.0 to 365.2 | -22.4 |
| | I-15 TOTAL | 110.8 |
| | 13 Interchanges & Cross Roads | |
| | TOTAL CENTERLINE MILES | 334.8 |

All pavement lines, words and symbols within the specified project limits shall be installed by the contractor in accordance with the Manual on Uniform Traffic Control Devices (MUTCD) and the Department Pavement Markings Manual unless otherwise specified herein or at the direction of the engineer.

Pavement symbols include, but are not limited to: crosswalks, stop bars, crosshatching and other short-line work. Currently existing markings, in conflict with the new markings, shall be removed by the contractor to the satisfaction of the Engineer.

A listing of the pavement markings and their locations is included in the contract documents.

4. PAYMENT SCHEDULE

Contract bid items will be paid as per the following schedule:

Mobilization is to be used for the initial marking application only. It is not intended to be used for subsequent replacement of failed material.

Retro-Reflectometer Package will be processed for payment at 100% of bid item upon delivery to MDT.

A new Truck-mounted Impact Attenuator and Spare Parts Package will be processed for payment at 100% of bid item upon delivery to MDT. The impact attenuator and a complete spare parts package will become the property of the MDT at the completion of the initial marking operation.

Marking line method of measurement - the quantity of marking lines will be paid by the actual number of linear feet of pavement marking lines satisfactorily placed. The quantity of linear, solid lines shall be the summation in length of solid line of each width and color actually placed. The quantity of broken lines shall be the summation in length of broken line of each width and color actually placed. The quantity of crosswalks, stop bars, crosshatching and other short line work shall also be paid by the actual length of each width and color placed. Words and symbols quantities shall be paid by the actual total of square feet satisfactorily placed. Configuration of markings placed shall match existing markings unless otherwise directed by the Engineer.

Markings will be paid as per the method of measurement provided above. Initial and subsequent yearly payments will be made after testing and satisfactory replacement of failed materials. Such work and payment shall be full compensation for all work covered by this provision including, but not limited to: cleaning the pavement, obliteration of existing marks where in conflict with new marks, furnishing the pavement marking material, installing the pavement markings, replacement of deficient or failed pavement markings, tools, equipment, labor, mobilization, and all other requirements necessary to satisfactorily complete the work.

PROJECT PAYMENT SCHEDULE
(IN PERCENTAGES OF BID PRICE)

| | 1992 | 1993 | 1994 | 1995 | 1996 | Total % Item |
|---|---|---|---|---|---|---|
| | | 12 months | 24 months | 36 months | 48 months | |
| % ITEM Initial Application | 60 | 10 | 10 | 10 | 10 | 100 |

5. MARKING MATERIALS

This project consists of the furnishing, installation and maintenance of a durable reflective pavement marking material for a four-year period in the form of lines, words, and symbols of the type specified and shown in these special provisions. These markings shall be installed at the locations described herein or where



directed by the Engineer. The contractor shall furnish all materials, services, labor and equipment necessary for all pavement preparation and shall remove all old markings where in conflict with new markings specified herein. The contractor shall provide sufficient personnel experienced in handling and application of the pavement marking materials to assure that the work is done in a safe and otherwise acceptable manner.

Routinely used latex, alkyd, other solvent-based or water-based traffic paints are not acceptable on this project. The contractor may use any other durable marking material(s) which he or she believes will provide four years of service. Any replacement markings must use materials equal to or better than those used in the initial application.

6. MARKING STANDARDS

All markings will be applied as per standards established by the Manual on Uniform Traffic Control Devices and the Montana Department of Transportation's Standard Specifications for Road and Bridge Construction, 1987 Edition.

Because of the reflectivity, color and durability standards, there are no materials specifications in the contract. The contractor, however, is required to provide to the Department a complete list of materials, and the manufacturers and suppliers of those materials prior to their use on the project.

7. COLOR AND DURABILITY

The color of white shall match the color chip of Federal Standard #595a, Table 9. The color of yellow shall match the color chip of Federal Standard #595a, Table 5. The contractor shall furnish 12 samples of each color chip with glass beads (yellow and white) to the Department for approval not less than ten days before the date of intended use. After approval, the chips will be retained by the Department for the term of the contract for use in determining color deterioration/retention of the markings on the roadway. Marking color and line deterioration will be evaluated during the same periods that the retro-reflectivity is being evaluated. Replacement or other correction will be required when color changes/fades and line deterioration are determined to be significant. Examples are:

1) Color pigment loss to the point the yellow doesn't reasonably match the color chips.
2) White discoloration to the point it doesn't reasonably match the color chip and/or it begins to blend into the roadway surface.
3) Line deterioration will be considered significant when the loss of marking material affects the reflectivity, or reduces the average line width to less than 90% of the specified width in any one-mile segment. Deterioration caused by abrasive action from sanding aggregates, effects of liquid deicers and snow plow damage will be considered normal deterioration and line replacement necessitated by such deterioration will be the responsibility of the contractor.

The Department shall have the sole authority in determining whether or not the color is reasonably close to the color chip and if line deterioration is considered significant.

8. REFLECTIVITY STANDARDS AND TESTING

The initial acceptance and the semi-annual inspection will be based on the quality level of the line averages in five-mile segments. Markings that fail to meet the quality level shall be replaced or corrected.

A. Initial Acceptance Standards

1. Bench Mark Quality Levels. The bench mark quality level shall not be less than 150 Mcd/$M^2$/Lux for yellow, and not less than 195 Mcd/$M^2$/Lux for white, measured as specified, for initial acceptance.

The bench mark quality level will be the line average determined according to the following provisions on testing. The bench mark quality level will be established on the first five-mile segment of each material type and color. The bench mark quality level will be based on retro-reflective readings taken within 48 hours of initial application. Individual readings that are less than the specified minimum quality level will not be used to determine the line average for the bench mark quality level.

The segment shall be replaced or corrected and new readings taken if the line average falls below the minimum bench mark quality level listed above.

2. Standards for Initial Acceptance of the Application. Testing for initial acceptance will be done within ten working days after application.

Markings that have line averages less than 80% of the bench mark quality level will not be accepted for payment. Re-testing after replacement or other corrective work will be done with a new random selection of test locations.

B. Semi-Annual Acceptance

1. Minimum Quality Levels. Markings shall retain reflectivity readings of not less than 100 Mcd/$M^2$/Lux for yellow and not less than 130 Mcd/$M^2$/Lux for white, measured as specified, throughout the life of this contract.

2. Standards for Semi-Annual Acceptance. Semi-annual testing will be conducted in March and August of each year.

The contractor will be notified at least thirty (30) days before the scheduled testing. The contractor shall be responsible for any cleaning necessary before testing. The contractor shall have a representative present at all times during testing.

Line averages of markings shall exceed the minimum levels when tested as specified.

C. Testing

Each five-mile segment of roadway will be tested. Three test locations per line will be selected at random within the segment. Three readings will be taken on each line at each test location. Each principal line (centerline and two shoulder lines) in each segment will have a total of nine readings.



The highest and the lowest reading on each line will be discarded. The remaining seven readings will be averaged to determine the line average.

For semi-annual testing, when the average readings of the individual line falls below minimum standards, additional tests will be performed at random locations within each mile of the five-mile line segment. The entire line within the segment will be considered as failing minimum standards if more than 10% of the location average readings are less than the minimum standard.

Retro-reflective testing (readings) will be accomplished by Department personnel using the Mirolux 12 retro-reflectometers furnished under this contract. Retro-reflectometers will be calibrated and operated according to procedures established by the manufacturer.

D. Failed Material

Material that has failed the retro-reflectivity standards or has failed the color and durability standard shall be replaced within forty-five (45) calendar days of written notice. Written notice will be provided within the first week of April and September following the semi-annual testing or immediately after any significant segment failure during the interim period.

Segments where significant failure is visibly apparent may be tested without regard to semi-annual test periods.

9. RETRO-REFLECTOMETER PACKAGE

The requirement of this special provision consists of purchasing and delivering to MDT Havre Maintenance office two (2) Mirolux 12 Retro-reflectometer packages for testing pavement marking reflectivity during the term of this contract.

A Mirolux 12 retro-reflectometer package, manufactured by Miro-Bran Assemblers, Inc., shall include the following items: 1 Mirolux 12 Reflectometer, an A.C. Adapter, a black-white test plate, two (2) rechargeable battery packs, charger, one (1) carrying case, one (1) 12-volt vehicular adapter with a 30' cord, and two (2) spare bulbs.

Retro-reflectometer packages must be furnished to the Department prior to the start of any marking work.

The quantity of Mirolux retro-reflectometer packages measured, as provided above, will be paid for at the contract unit price each for "Retro-reflectometer Package". Such price and payment shall be full compensation for all work covered by this provision including, but not limited to, furnishing and delivering the package to MDT.

10. TRUCK-MOUNTED IMPACT ATTENUATORS (TMA)

Requirements of this special provision consist of furnishing a new, truck-mounted impact attenuator (TMA). The TMA may be installed on a truck owned by the contractor, and may be used by the contractor during the initial marking operations.

The TMA shall be designed for installation at the back of MDT trucks with between 30,000 and 34,000 pounds gross vehicle weight rating. The TMA shall be so designed that when impacted head-on by a full-sized car of typical American manufacture, weighing approximately 4,500 pounds and traveling at 55 mph, the car and impact attenuator will absorb at least 65% of the impact energy. No

more than 35% of the impact energy may be absorbed by the motionless vehicle and carrier when projecting the vehicle forward.

The TMA shall include a steel backup support assembly of sufficient size and strength to permit mounting on an MDT truck chassis by means of brackets. The brackets shall position the supporting housing to provide a clearance of between 8 to 12 inches between the bottom of the housing and the roadway. The TMA mounting system shall be designed to tilt the TMA in a near vertical position for transportation.

Before beginning installation of the TMA, the contractor shall furnish to the engineer detailed brochures, specifications, and other manufacturer's data which completely describes the TMA, including installation drawings and instructions.

All materials shall be subject to the approval of the engineer.

During all marking operations, the contractor shall utilize a shadow truck equipped with a properly mounted TMA meeting all the requirements as specified herein. Multiple operations separated by more than 1,200' shall each utilize such a TMA equipped shadow truck.

The TMA may be the one supplied under this contract or another supplied by the contractor at their own expense. All TMA's shall be maintained so that they will function as designed in the event they are struck by traffic. Damage, caused for any reason, to the TMA in use on the project shall require the contractor to expedite repairs so that it will be available for operation within 24 hours. During the process of repairing the TMA, the contractor shall furnish adequate means approved by the engineer to provide a safe means for the control of traffic through the construction area or suspend all construction activities requiring the use of the TMA until it is restored to a functional, like-new status.

The contractor shall furnish two TMA spare parts packages.

Each spare parts package shall have a sufficient assortment of nuts, bolts and spare hardware to repair the system after it has been impacted, to whatever extent damage is incurred.

The spare parts packages shall be ordered at the same time as the TMA. Whenever all or part of a spare parts package is used to repair a TMA, a replacement spare parts package shall be ordered immediately and paid for by the contractor at no cost to the State. The contractor shall maintain two complete spare parts packages. The stockpile location shall be on the project or at a location near the project which has been approved by the engineer.

Upon completion of the initial marking operation, the TMA, less vehicle, and two complete spare parts packages will be delivered to the MDT Havre office and will become the property of the Montana Department of Transportation.

One (1) TMA, as provided above, will be paid for at the contract unit price each for "Truck-Mounted Impact Attenuators".

Two (2) TMA spare parts packages, as provided above, will be paid for at the contract unit price each for "Truck-Mounted Impact Attenuator Spare Parts Packages".





The above prices and payments will be full compensation for all work covered by this provision, including, but not limited to, furnishing, installing, operating, maintaining and repairing, moving and relocating all TMAs and all spare parts packages.

11. TRAFFIC CONTROL

The following traffic control measures shall be provided during pavement marking operations:

(a) A shadow truck equipped with a TMA shall follow the pavement marking vehicle within 500 to 1,000 feet during pavement striping operations.

(b) Each vehicle shall be equipped with an arrow board with minimum dimensions of 30" x 60" facing rear-approaching traffic.

(c) On interstate roadways, the display mode shall be the sequential arrow.

(d) On two-lane, two-way roadways, the arrow board shall be in a hazard warning mode and shall not display the lane-shift mode.

(e) For stationary marking operations, a traffic control plan will be submitted by the contractor for approval by the engineer before the start of work.

Cost of all traffic control, except for providing the TMA and TMA spare parts packages, shall be absorbed in other items of this contract.

12. CONTRACT TIME

The project will be completed exactly forty-eight (48) months after the completion of the initial application of markings in the designated project locations. The initial application must be complete in all designated locations by October 2, 1992. Liquidated damages for work not completed within the specified time frame for both the initial application and failed material replacement will be $500.00 per calendar day.

13. ENTRY ON RAILROAD RIGHT-OF-WAY

The contractor shall complete and sign the "Contractor Requirements and Acknowledgement for Working on Railroad Right-of-Way" found elsewhere in the contract before entering on railroad property. Signed copies shall be sent to the particular railroad and to the Engineer. No work will be allowed on railroad property until the Engineer has a signed copy.

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Washington State Department of Transportation

# Bridge Office Experimental Work Plan for the Expansion Joint Systems for the Transition Spans

## Lacey V. Murrow Bridge Replacement

### Objective

Bridge expansion joints pose a special problem in the Washington State Department of Transportation's (WSDOT) Bridge Deck Management System. These devices are subject to repeated heavy dynamic loading, and in many cases premature failure has occurred. Construction is also a problem. The ability to place concrete with good consolidation around the expansion joint requires good field quality control. Concrete air voids behind the expansion dam are sometimes found, and epoxy injection is necessary. Delaminations from a corrosion-related salt contamination is also a common problem.

It is the policy of WSDOT, as part of the Bridge Deck Management System, to make expansion dams watertight. This will allow surface water to run off the deck to the bridge or roadway drain inlets. Expansion dams that are not watertight allow water to run onto the substructure. This enhances the potential for corrosion in locales where deicing salts are used and causes unsightly staining of substructures everywhere.

For floating bridge construction, the transition span from shore to the floating portion of the structure is subject to longitudinal movement in combination with horizontal and vertical rotation. These large movements pose special problems for the expansion joint system at both ends of the transition span. The expansion joint system selected for these conditions must accommodate the wide range of movements involved and remain watertight, corrosion free, and crack free.

The purpose of this experimental project is to gain knowledge about the effectiveness of the modular expansion joint system over time and to gain knowledge about field installation techniques and structural performance. Due to weld cracking in similar expansion joints used in the existing SR 90 Third Lake Floating Bridge, it is deemed prudent to require a five-year warranty on the expansion joints on this project. The state will monitor the performance during the warranty period.

### Project Description

Contract 4016, SR 90, Lacey V. Murrow Bridge Replacement, contains the plans and specifications for the construction of the modular expansion joint systems for the transition spans. The expansion systems will be located at Piers 8 and 9 and at Pontoons A and T. The contractor, per specs, has been given an option of selecting one of four alternative expansion systems.

The contractor is to submit details of the expansion joint system along with installation and waterproofing plans to the state for approval prior to fabrication of the joint. In addition, the contractor is to design all structural support elements including all springs and bearings. The design shall include a fatigue analysis for over 2 million cycles for all elements.

A total of approximately 216 lineal feet of expansion joint will be used at Piers 8 and 9 and at Pontoons A and T. The contract cost is expected to exceed $0.5 million.

### Control Section

The installation of another brand or type of expansion joint system to serve as a control would be the optimum in experimental design. However, the state has no standard expansion joint system. The fact is that each brand or type of system has its own unique performance history so that installing any particular type as a control would not add additional information to what is known from our past experience and what has been reported in the literature concerning each particular system.

Our intent, then, is to use the documented performance histories from our own experience as well as those reported in the literature as the control for the experimental joint systems. This will include the use of the results from FHWA Experimental Project No. 5 *Bridge Deck Expansion Joints*, the objective of which was to compile the performance histories reported by a number of states on virtually all of the commonly used expansion joint systems. The data sheet that will be used to evaluate the expansion joint system in this study will be the same one used in Experimental Project No. 5, so results from the two studies should be compatible.

### Tests

Visual ratings of each joints performance will be collected once a year over a period of five years. The data sheet from FHWA Experimental Project No. 5, a copy of which is attached, will be used with evaluations made in the categories of general appearance, condition of anchorage, debris accumulation, water tightness, surface damage, noise under traffic and ease of maintenance.

### Reporting

A post-construction report documenting the installation of the joint systems will be prepared within 90 days of the completion of the project. Annual FHWA Form 1461 will be issued documenting the performance of the joint systems during the five year evaluation period. No other reporting will be required until the issuance of a final report due at the end of the evaluation period.

**General Requirements**

1.01 Description

A. This item of work shall consist of furnishing materials, services, labor, tools, equipment, and incidentals necessary to design, fabricate, inspect, test, and install the expansion joint system for the transition span as specified.

C. Guarantee

1. The joint manufacturer shall provide a five year written guarantee for the operation and durability of the expansion joints. Replacement or repair of any joint parts within the first five years, commencing from the date of completion of the contract per Section 1-08.5, shall be the responsibility of the joint manufacturer.

ACCEPTANCE WARRANTY

In addition to section 1.09.10 of the 1990 Standard Specifications for Construction, the following will apply:

A. One of the conditions of acceptance of the work will be furnishing a satisfactory performance bond sufficient to cover completed items of work on the project for a two-year period after the last concrete patch is completed.

B. At the end of the two-year period noted above, the Engineer shall inspect the project accompanied by the CQC System Manager to determine any corrective actions necessary before release of the performance bond. The physical characteristics that are acceptable are as follows:

1. Vertical and horizontal alignment of installed concrete patch must match the adjacent existing pavement with a ±1/4" tolerance.

2. The concrete patch must not be cracked.

3. The surface texture must not be spalled, but comparable to the texture at the time of intial placement.

4. The joint sealer must remain intact as initially installed including no separation of concrete, no breaks or signs of fatigue.

C. After the two-year period, if any of the above noted deficiencies occur, the Contractor will remove and replace the deficient area of work at his expense with no cost to the Michigan Department of Transportation.

**THE TRANSPORTATION RESEARCH BOARD** is a unit of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. It evolved in 1974 from the Highway Research Board, which was established in 1920. The TRB incorporates all former HRB activities and also performs additional functions under a broader scope involving all modes of transportation and the interactions of transportation with society. The Board's purpose is to stimulate research concerning the nature and performance of transportation systems, to disseminate information that the research produces, and to encourage the application of appropriate research findings. The Board's program is carried out by more than 270 committees, task forces, and panels composed of more than 3,300 administrators, engineers, social scientists, attorneys, educators, and others concerned with transportation; they serve without compensation. The program is supported by state transportation and highway departments, the modal administrations of the U.S. Department of Transportation, the Association of American Railroads, the National Highway Traffic Safety Administration, and other organizations and individuals interested in the development of transportation.

The National Academy of Sciences is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce Alberts is president of the National Academy of Sciences.

The National Academy of Engineering was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. Robert M. White is president of the National Academy of Engineering.

The Institute of Medicine was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Kenneth I. Shine is president of the Institute of Medicine.

The National Research Council was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Bruce Alberts and Dr. Robert M. White are chairman and vice chairman, respectively, of the National Research Council.

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