DEPARTMENTAL INFORMATION EXCHANGE

Summary Report 1156-1S
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THE WHY, WHEN AND WHERE OF FOG SEALS AND REJUVENATORS FOR BITUMINOUS PAVEMENT SURFACES

PROBLEM STATEMENT

Fog seals have been used for maintenance purposes in Texas for several years with varying degrees of success. A fog seal is a light application of slow-setting or medium-setting asphalt emulsion diluted with water. The principal reasons for using fog seals are: (1) to stop shelling on chip seals and surface treatments, (2) to reduce the rate of raveling and cracking on asphalt concrete pavements, and (3) to reduce the potential for air and water to enter into the pavement structure.

Rejuvenators have been used to a limited degree in the state. The purpose of a rejuvenator is to penetrate into the asphalt concrete and soften (rejuvenate) the asphalt binder. It also helps to seal the pavement and minimize future oxidation.

Application of fog seals and rejuvenators appears to be economically attractive. Many highway districts in Texas routinely use these products and techniques and believe they are cost-effective remedies, while other districts see no value in these maintenance treatments. Information on the value of these treatments is not well documented; however, a number of knowledgeable people feel that fog seals have a significant economic value.

OBJECTIVES

The Texas Transportation Institute (TTI) conducted study 1156, "Economic Effectiveness of Rejuvenating Agents and Diluted Asphalt Seals," in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA) to address the following issues:

- use of fog seals and rejuvenators in Texas,
- the use of fog seals as a maintenance treatment for chip seals,
- the evaluation of fog seals for asphalt concrete,
- an evaluation of rejuvenators for asphalt concrete mixtures, and
- the cost-effectiveness of fog seals and rejuvenators.

Researchers conducted a survey of maintenance personnel in all of the highway districts to determine how and to what extent fog seals and rejuvenators are used across the state. They also conducted an initial laboratory study to determine the appropriate fog seal application quantities needed to effectively improve the aggregate retention properties of chip seals. In a second laboratory study, they sought to determine the effectiveness of fog seals when applied to laboratory-molded samples at reducing the rate of age-hardening in an asphalt concrete mixture. Rejuvenators were also laboratory and field tested to determine the effects on asphalt concrete.

FINDINGS

Fog Seals as a Maintenance Treatment for Chip Seals

Researchers monitored four test roads to evaluate the effectiveness of fog seals for chip seals. In every test road, the fog seal improved the aggregate retention rate over that of the corresponding controls. Even as little as 0.03 gallons per square yard residual binder resulted in improved aggregate retention.

The critical time for fog seal applications on a chip seal is prior to its first winter. On every test road evaluated in this study, almost no stone loss occurred in the second year for either the control or the fogged sections, indicating a stabilized condition is reached by the second year.

Texas
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In cooperation with the
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A Vialet test was used to evaluate the effectiveness of different application rates of fog seals on Grade 4 laboratory chip seals. No improvement in aggregate retention rate was observed with a 0.05 gallon per square yard residual application rate. However, a significant improvement was observed with 0.10 gallons per square yard.

Fog Seals as a Maintenance Treatment for Asphalt Concrete

Asphalt concrete specimens were molded in the laboratory using asphalt from three different sources. Half of the samples were treated with a fog seal and aged at 140° F for six weeks to determine the effectiveness of fog seals at sealing the surface to reduce the rate of age-hardening within the mixture. Resilient modulus and indirect tensile tests were used to evaluate mixture stiffness. All mixtures showed an increase in stiffness after aging. No significant improvement was noted in the samples which were treated with a fog seal.

A fog seal placed on an asphalt concrete pavement was monitored for two years. No visual differences were observed between the fogged and control sections.

Based on the laboratory information obtained in this study, fog seals applied at residual asphalt rates of 0.05 gallons per square yard are not effective at sealing the surface to reduce the rate of aging in the mix. They can be used more effectively to correct specific surface problems such as raveling or loss of surface fines. There is insufficient information in this study to conclude when and how much fog seal to apply on asphalt concrete to reduce aging.

Rejuvenating Seals as a Maintenance Treatment for Asphalt Concrete

A laboratory investigation performed in this study on mixtures with high void contents (10 to 12 percent) showed that rejuvenators can significantly reduce the mixture stiffness. Another laboratory experiment evaluated the effects of three different rejuvenators applied to asphalt concrete samples molded with asphalts from three different sources. The results indicated that the combination of the asphalt source in the mix and the type of rejuvenator used can influence the effectiveness of the rejuvenator. Extreme caution should be exercised when applying a rejuvenator to a pavement surface because it can significantly reduce skid resistance. An effective method of controlling the skid resistance when using a rejuvenator was determined through a field experiment. The rejuvenator should be applied to the pavement and allowed to penetrate the surface 45 minutes to one hour prior to sanding. Sand should then be applied and lightly rolled. Approximately two hours after sanding, the surface should be swept. Using this method, the pavement's skid resistance was back to its original condition within 24 hours.

Fog Seals are most effective when used to correct specific surface problems such as raveling or loss of surface fines.

CONCLUSIONS

Design guidelines were developed in this study for determining fog seal application rates for chip seal surfaces. Information from the study can be used to determine the following:

1) when fog seals should be applied, if at all;
2) whether pavement conditions warrant a fog seal or a rejuvenator;
3) how a fog seal or rejuvenator affects the cost of the pavement surface as compared with other maintenance treatments such as chip seals.

Design charts are also presented to aid in estimating appropriate application rates.

Based on the information obtained in this study, fog seals can be cost-effective for reducing the rate of stone shelling in chip seals if placed at the proper application rate and before the first winter season following the chip seal. Fog seals placed after the first winter season do not appear to be cost-effective in reducing the rate of stone shelling. Some districts have maintained a practice of routinely fog sealing bituminous pavements every three to four years. Results from this study indicate that this type of practice is not cost-effective. Fog seals are most effective when used to correct specific surface problems, such as a loss of stone from chip seals or loss of surface fines in asphalt concrete.

In the area of using fog seals as a maintenance treatment for asphalt concrete, for a fog seal to be as cost-effective as a chip seal, it would need to be effective at delaying further rehabilitation for approximately 18 months — based on an annualized cost analysis.

A rejuvenating seal costs approximately $.15 per square yard. For a rejuvenator to be as cost-effective as a chip seal, it would need to be effective at delaying further rehabilitation for approximately two years — based on an annualized cost analysis.

The information obtained in this study reveals that it is not cost-effective, and not recommended, for rejuvenators to be applied to asphalt concrete pavements (ACP) with an air void content less than seven or eight percent. Application of rejuvenators to ACP with an air void content greater than seven or eight percent can reduce the stiffness of the mixture (thereby improving its resistance to cracking); however, this may unfortunately increase its potential for permanent deformation (rutting and shoving).

The results of this study are primarily targeted at maintenance engineers, superintendents, and supervisors. Guidelines are presented to aid in the decision-making process of how maintenance funds can best be allocated. Results will best be implemented through the distribution of the summary report to all districts. The full research report can be used to convey details to those interested.

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The information described in this summary is reported in detail in TTI Research Report 1156-1F, "Effectiveness of Fog Seals and Rejuvenators for Bituminous Pavement Surfaces," Cindy K. Estakhri and Harish Agarwal, April 1991.

The contents of this summary do not necessarily reflect the official views of the Texas Department of Transportation or the Federal Highway Administration.