



## DEPARTMENTAL INFORMATION EXCHANGE



Texas  
Department of Transportation  
In cooperation with the  
Federal Highway Administration  
U.S. Department of Transportation

## Research Summary Report

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Summary Report 1157-1S

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# DETERMINING THE CURING RATE OF ASPHALT EMULSION

## PROBLEM STATEMENT

In 1990, the Texas Department of Transportation (TxDOT) placed more than 14,000 lane miles of chip seals. In 1988, according to the Division of Materials and Tests (D-9), TxDOT used more than 200,000 tons of asphalt emulsion—mostly in the construction of chip seals. Asphalt emulsions are generally used quite successfully and extensively in chip seal construction; however, there are many documented cases where emulsion takes an excessively long time to cure, and thus, good bonding is delayed. This leads to shelling of the stones from the pavement surface, sometimes within a few days or even hours after construction.

Obviously, these types of failures cut deeply into the highway maintenance/resurfacing budget. User costs in terms of delays, asphalt coated automobiles and frustration are also a major concern of any highway engineer who has come face to face with an angry motorist. Previous field reports revealed that, on occasion, asphalt emulsion chip seals required excessively long times to adequately cure, despite the fact that the emulsions met with all specifications.

## OBJECTIVES

The Texas Transportation Institute (TTI) conducted study 1157, *Guidelines and Specifications for Asphalt Emulsion Seal Coats*, in cooperation with TxDOT and the Federal Highway Administration (FHWA) to develop a laboratory test procedure which could be used to determine the setting or curing time of asphalt emulsion chip seals. This procedure will help to clarify specifications for asphalt emulsion, identify future problems, and ensure better performance. Investigation of several test methods led to the development of the TTI Cohesion Test, which is based on concepts originally used in a test for determining the cure time for slurry seals. Results from laboratory testing reveal the success of the TTI Cohesion Test in monitoring the curing process of asphalt chip seal samples.

## FINDINGS

### Processes of TTI Cohesion Test

The TTI Cohesion Test requires the preparation of an emulsion chip seal sample in the laboratory. The sample is then placed under a pneumatically actuated rubber foot, and pressure is then applied to the sample. The rubber foot is twisted by means of a motor which is connected to a torque sensor thereby supplying a plot of torque versus displacement of the rubber foot. The test is repeated at different time intervals, and an undisturbed site on the sample is selected for each time-interval test. The testing continues until the torque remains constant, which indicates the sample has cured.

Two parameters taken from the Cohesion Test may be used as qualitative indicators of the curing process of asphalt emulsion chip seals — Curing Index and  $t_{95}$ . The Curing Index is the percentage of the total cure that has occurred at six hours. The  $t_{95}$  value is the time required to reach 95% of the maximum

torque value, or the time at which 95% of the total cure has occurred.

### Laboratory Curing Times

Based on this study, a laboratory chip seal prepared with rapid setting emulsion should have a Curing Index of 75 or greater. In other words, in six hours, it should have reached 75% of its total cure. A rapid-setting emulsion laboratory chip seal should also have  $t_{95}$  values of 35 hours or less—meaning it should have reached 95% of its total cure within 35 hours.

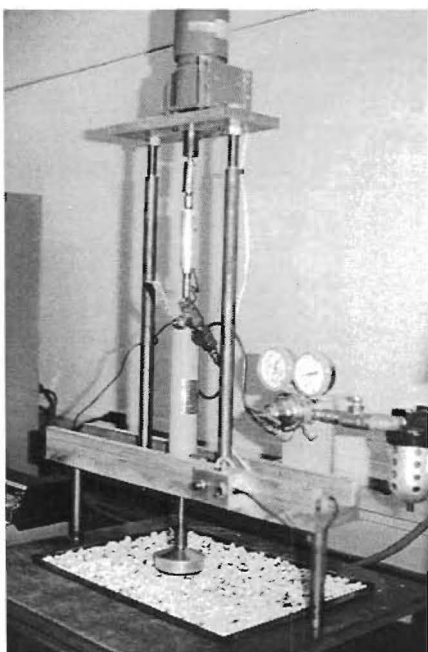
The curing times measured using this device are under laboratory conditions. In the field, however, it is likely that the action of rolling equipment, traffic, and wind would result in shorter curing times. The values presented here can be used as a guideline for controlled, laboratory conditions to identify potential problems.

### Specifications and Guidelines

Preliminary recommended specifications for rapid-setting emulsions are as follows:

- Curing Index should be 70 or more,
- $t_{95}$  value should be 40 hours or less.

#### *TTI Cohesion Tester*



## Two Parameters Serve As Qualitative Indicators of the Curing Process of Rapid-Setting Emulsion Chip Seals

Curing Index	70% of Its Total Cure Is Reached in 6 Hours
T <sub>95</sub> Value	Should Have Reached 95% of Its Total Cure Within 40 Hours

The study also has revealed that aggregates in a saturated, surface-dried condition can adversely affect the curing rate of laboratory, emulsion-chip seals. However, damp aggregates are proclaimed by some to be a benefit in early performance of emulsion-chip seals. It may be worth considering aggregate moisture in the standard specifications. A moisture content could be specified and controlled with a test, or the desired level of moisture in the aggregate could be visually determined by the engineer.

Two hours after construction of emulsion-chip seals, traffic speed should be controlled through the use of pilot vehicles. This could help accelerate the cure rate of the seal and minimize early aggregate loss.

### CONCLUSIONS

The following research recommendations resulted from this study:

1. Perform more laboratory testing and field verification using the TTI Cohesion Test before specifications are adopted. The range of values for all available emulsions should be fully characterized.
2. Modify the TTI Cohesion Test so that it could be used in the field to

characterize field curing rates and correlate to laboratory performance.

3. Obtain samples of emulsion which have been reported as causing performance problems in the field. Perform the Cohesion Test on these materials to determine if problems can be identified with the test procedure. This opportunity did not exist throughout the course of this study as there were no field reports of problems attributed to the emulsion.

*—Prepared by Kelly West, Science and Technology Writer, Texas Transportation Institute*

The information in this summary is reported in detail in TTI Research Report 1157-1F, "Investigation of Laboratory Test Methods to Determine Curing Rate of Asphalt Emulsion," Cindy K. Estakhri, Donald Saylak, Joe W. Button, and Paul Jenkins, November 1991. The contents of the summary do not necessarily reflect the official views or policies of the FHWA or TxDOT.