

## JUST THE FACTS

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## Evaluation of Dynamic Shear Rheometer Tests for Emulsions

### PROBLEM

Currently, the Louisiana Department of Transportation and Development (LADOTD) requires ductility tests at 25°C according to AASHTO T51 for emulsions and two other tests, namely force ductility ratio at 4°C and elastic recovery at 10°C according to AASHTO T300 and AASHTO T301, respectively, for polymer modified emulsions. The fact that polymer modified asphalt is strain dependent creates questions regarding purchase specifications based on constant strain controlled tests. In developing performance grade (PG) specifications for emulsions, one of the tests proposed in several reports is the multiple stress creep recovery (MSCR) test according to ASTM D7405. This test determines percent elastic recovery and non-recoverable creep compliance and measures the damage behavior in the linear and nonlinear range. Compared with the current binder protocol, a repeated creep tests protocol (or some other method that varies the frequency and strain and measures the accumulated permanent strain of the binder) represents an improvement in the theoretical and practical concepts that will better rate the binder properties related to performance.

### OBJECTIVES

The main objective of this research is to investigate performance related specifications for emulsions through the use of a Dynamic Shear Rheometer (DSR). The emulsions from selected sources listed in the Qualified Product List of LADOTD will be tested and compared with force ductility and elastic recovery test results. Finally, recommendations will be developed for DSR-based test specifications for emulsion residue.

### METHODOLOGY

The LADOTD database and literature on different recovery methods will be reviewed and one of the recovery methods will be selected. In addition, the viscosity of the emulsion state will be determined by dynamic viscosity using sinusoidal loading and by steady state viscosity using rotational loading. Multiple protocols will be examined for emulsion and recovered emulsion testing; tests at high, intermediate, and low temperatures will be conducted. One protocol to be tested is the MSCR test using the DSR at a specified temperature, as recently defined for use in testing for rutting of asphalt binders used in asphalt mixtures. The sample is loaded at constant stress for 1 sec. then allowed to recover for 9 sec. Ten creep and recovery cycles are run at 0.1 kPa creep shear stress followed by 10 at 3.2 kPa creep shear stress. Percent elastic recovery at 0.1 kPa and 3.2 kPa, non-recoverable creep compliance at 0.1 kPa and 3.2 kPa, difference in percent elastic recovery for the two creep stresses, and difference in non-recoverable creep compliance for the two creep stresses will be calculated. The standard protocol will be varied to include

### SPECIAL POINTS OF INTEREST:

- Problem Addressed
- Objectives of Research
- Methodology Used
- Implementation Potential

stress limits such as 50 Pa, 100 Pa, 300 Pa, 500 Pa, 1000 Pa, 3000 Pa, 5000 Pa, and 10,000 Pa and temperatures of 10 °C, 25 °C, and high pavement temperatures to evaluate commonly used LADOTD emulsions. The scope of this research includes: MSCR testing for polymer identification, strain sweep for non-linearity, frequency sweep for aged brittleness, and  $G^*/\sin\delta$  for stiffness/bleeding. A multiple strain fatigue test will also be examined. The behavior of emulsion residue will be represented with a viscoelastic material model to fit data generated in this study.

**IMPLEMENTATION POTENTIAL**

In 2008, Gayle King proposed a “Strawman” PG specification for emulsions that included MSCR, eliminating float, penetration, ductility, elastic recovery, and other tests. The proposed specification was revised in 2009; however, none of the older tests were included in the revised version. Simply eliminating elastic recovery and force ductility will save enough time to justify the cost of a rheometer needed for the proposed purchase specification tests. Moreover, rheological test based specifications drive towards improved methods that are more mechanistic and that simulate real conditions. To this end, this proposal has been prepared to study the applicability of the MSCR test along with a set of DSR-based test methods including a viscosity test, frequency sweep test, and strain sweep test to replace force ductility and an elastic recovery test for emulsions.



*DSR: AR2000ex Rheometer*

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