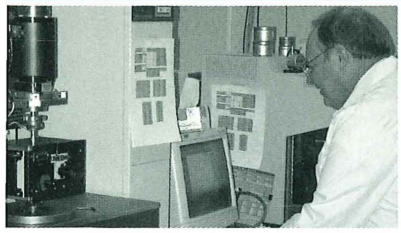

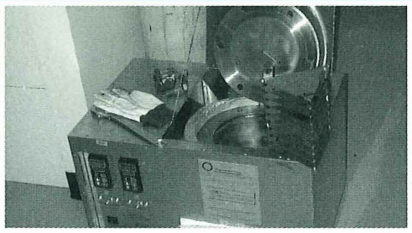


BINDER RHEOLOGY LABORATORY FACT SHEET

Research that is Essential, Indispensable, and Connected to our Customers.

PURPOSE

The Binder Rheology Laboratory conducts Superpave® performance-based binder (asphalt) specification testing, research and development, and advanced rheological research in binders (asphalts, modified asphalts, and mastics [binder and rock dust]) to improve the durability, longevity, quality, and life-cycle cost of asphalt pavements. One way to understand and consequently extend pavement life is by studying the flow and deformation—the rheology—of the paving material.

BACKGROUND

The United States spends more than $15 billion each year on the construction and resurfacing of roads with hot-mix asphalt (HMA). This annual investment requires more than 500 million tons of HMA, which is held together by 30 million tons of liquid asphalt binder. The investment in the asphalt binder itself exceeds $5 billion each year.

Today, asphalt binders for HMA are primarily purchased using the Superpave system specified by the American Association of State Highway and Transportation Officials (AASHTO) under the standard specification for performance-grade asphalt binders. In May 2000, 48 States were using the Superpave system for binder grade selection and procurement.

Although the Superpave system is a vast improvement over previous practices, research conducted by the Federal Highway Administration (FHWA) has identified shortcomings in the Superpave binder specification's ability to characterize the performance of modified asphalt binders. The modifiers, which include polymers and other additives, are principally used in areas of high traffic volume, heavy loading, and extreme climatic conditions, and many appear to be quite effective. Modifier usage varies widely among state highway agencies, but is steadily increasing nationwide. Currently, modifiers are employed in approximately eight percent of the HMA that is placed on the roads.

DESCRIPTION

Three types of research are conducted here:

- Staff research projects conducted within the laboratory.
- Research support for other research groups within the FHWA Asphalt Pavement Team.
- Partner-supported research.

The laboratory is equipped with state-of-the-art instrumentation and other support devices to more effectively study pavement rheology:

- Dynamic Shear Rheometers (DSR).
- Bending Beam Rheometer (BBR).
- Direct Tension Tester (DTT).
- Pressure Aging Vessel (PAV).
- Rolling Thin Film Oven (RTFO).
- Rotational Viscometer (RV).

MAJOR COMPONENTS

- The DSR is used for rheological characterization of paving asphalts in the intermediate to high temperatures ranging from 7°C (42°F) to temperatures approaching 100°C (212°F). Fatigue cracking of pavements takes place mostly at intermediate ambient temperatures, while rutting (permanent deformation) takes place mostly at high pavement temperatures.
- The BBR and DTT are used both individually and in combination to determine the low-temperature (thermal) cracking temperatures of asphalts.
- The PAV is used with the RTFO to simulate long-term aging of asphalts and, hence, pavements. Rheological properties of asphalt binders may thus be measured indicative of pavement conditions after years of service.
- The RV is used to determine the steady-state viscosity of asphalt binders at high temperatures above 100°C (212°F), such as 115°C to 220°C (240°F to 424°F).

ACCOMPLISHMENTS

Recent Activities:

- Developed a rheological unification technique so that the Materials Volumetric-Flow Rate (MVR) could be used to get the same information as that obtained from the DSR. This experimental procedure is a simpler, easier, faster, and much less expensive method for getting the high-temperature

The Turner-Fairbank Highway Research Center (TFHRC) has more than 24 laboratories for research in the following areas: safety; operations, including intelligent transportation systems; materials technology; pavements; structures; and human centered systems. The expertise of TFHRC scientists and engineers covers more than 20 transportation-related disciplines. These laboratories are a vital resource for advancing this body of knowledge created and nurtured by our researchers. The Federal Highway Administration's Office of Research, Development, and Technology operates and manages TFHRC to conduct innovative research to provide solutions to transportation problems both nationwide and internationally. TFHRC is located in McLean, Virginia. Information on TFHRC is available on the Web at ***www.tfhrc.gov****.*

rutting parameter for the Superpave binder specification.

- Derived the refinement of the Superpave specification parameter for high-temperature performance grading of asphalt and suggested the use of the parameter $|G^*|/(1-(1/\tan\delta\sin\delta)$ instead of $|G^*|/\sin\delta$.
- Established the proper procedure for fatigue testing of binders using the DSR.
- Developed a method for determining the low-temperature cracking temperature directly from the BBR binder stiffness data by using the intersection of the two asymptotes on the thermal stress curve to predict the point of failure. This procedure is much simpler than obtaining critical cracking temperatures from the BBR's binder stiffness data and the DTT's binder strength data.
- Established a procedure to estimate the rheological properties of aged asphalts from unaged asphalts without actually going through the laboratory aging simulation.
- Demonstrated a method for determining the optimum temperature for mixing aggregates and polymer-modified asphalts using a rheological study of the mastics. This procedure emphasizes the quality of the mix and helps choose the temperature that would give the best dispersion of the fine aggregates.

Current Activities:

- Seeking an asphalt mastic test to predict pavement performance by comparing the predictions from the binder tests with those from the mastic tests.
- Testing of binders for the polymer-modified program currently underway as part of the Accelerated Loading Facility (ALF) activities.
- Characterizing the various chemically modified crumb rubber asphalts developed by the chemistry group.
- Providing rheological data for the validation of the Laboratory Asphalt Stability Test for modified asphalts currently under evaluation.

EXPERTISE

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LAB PARTNERS

The Binder Rheology Laboratory personnel provide technical representation and expertise for FHWA to such groups as:

- Superpave Binder Expert Task Group (ETG).
- National Cooperative Highway Research Program (NCHRP) panels.
- Highway Innovative Technology Evaluation Center (HITEC) panels.
- Transportation Research Board (TRB) committees.
- National Institutes of Occupational Safety and Health.

Collaborative laboratory work is conducted with:

- Western Research Institute.
- Binder ETG.
- North Carolina State University.
- Others as mutually beneficial opportunities arise.