DRISI
Caltrans Division of Research, Innovation and System Information

Research Results

Performance Related Specifications for Asphalt Rubber Binder

Development of Testing Procedures and Criteria for Performance Based Specifications (PRS) for Asphalt Rubber Binder

Pavement

MARCH 2022

Project Title:
PPRC 17 Performance Related Specifications

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WHAT WAS THE NEED?

In California, crumb rubber from scrap tires is generally added to asphalt binder in a so-called wet process. Caltrans specifications require asphalt rubber binder contain 18 to 22 percent rubber by weight of the binder. The Superpave Performance Grading (PG) procedures were developed for unmodified, polymer-modified, and tire rubber-modified asphalt binders that contain no additives or particles, and are therefore often inappropriate for testing asphalt rubber binders. The larger rubber particle sizes (between 250 µm and 2.36 mm) currently allowed in the Caltrans specifications prevent the use of these criteria for wet process binders. The use of conventional parallel plate testing systems with either 1.0 or 2.0 mm gaps in a dynamic shear rheometer (DSR) results in the rubber particles potentially contacting the plates, leading to measurements dominated by the rheology of the rubber particles instead of the binder. Increasing the gap size to more than 2.0 mm violates the temperature equilibrium of the sample.

The current specification used for testing and acceptance of wet-process asphalt rubber binders is focused mainly on measuring the viscosity in the field using a handheld rotational viscometer. However, viscosity does not relate directly to in-service performance of the binder in a Rubberized Hot Mix Asphalt (R-HMA). Superpave binder tests, i.e., viscosity, DSR, bending beam rheometer (BBR) testing, are not appropriate for testing wet-process asphalt rubber binders due to large rubber particle size.

WHAT WAS OUR GOAL?

The main goal of this research was to recommend appropriate contract acceptance criteria for wet-process asphalt rubber binders used in gap- and open-graded mixes using current Superpave PG equipment with testing procedures that have been modified where appropriate.

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WHAT DID WE DO?

As part of the first and second phases of this research project, a new DSR testing protocol using concentric cylinder geometry was investigated. Refinements to the rolling thin film oven test (RTFO) and to the specimen preparation procedure for BBR testing were also made and evaluated. The following tasks were conducted to complete the development of these performance-based specifications:

- Literature review of recently completed research.
- Laboratory testing to understand short- and long-term aging of asphalt rubber binders and to refine the rolling thin film oven test (RTFO) and pressure aging vessel (PAV) procedures if justified.
- Laboratory testing of field-produced mixes with associated binder testing using both concentric cylinder and 3 mm parallel plate geometries to refine PG grading criteria.
- Design of a round robin study for concentric cylinder geometry tests by laboratories that have invested in the equipment.
- Accelerated pavement testing to compare rutting performance of 1/2 in. and 3/4 in. nominal maximum aggregate size mixes, the use of thicker than currently permitted lift thicknesses, and the use of coarse recycled asphalt pavement (RAP) as aggregate, but not binder replacement.
- Preparing a research report documenting the study.

WHAT WAS THE OUTCOME?

The research report documents the first two phases of a three-phase study to investigate test methods for measuring the performance properties of asphalt rubber binders produced according to Caltrans specifications. Based on the results obtained to date, the concentric cylinder geometry appears to be a potentially appropriate alternative to the parallel plate geometry for quantifying the properties of asphalt rubber binders produced per Caltrans specifications, and specifically for assessing the performance properties of binders containing crumb rubber particles larger than 250 µm. However, the concentric cylinder method requires a longer testing time and a larger binder sample than the parallel plate test method. Initial findings from performance grading and related mix testing indicate that the incompletely digested rubber particles, which have different sensitivities to temperature and applied stress and strain than the asphalt binder, appear to dominate the test results.

WHAT IS THE BENEFIT?

It is generally recognized the environmental benefits of adding recycling tires into asphalt concrete. It is imperative to assess the appropriateness of using the concentric cylinder geometry and modified testing procedures to measure the performance properties of asphalt rubber binders that are produced according to Caltrans specifications using a wet process with large crumb rubber particles. These alternate methods have the potential to be used to establish performance-based contract acceptance criteria to produce asphalt rubber binders, which will in turn lead to more reliable performance in the field.

LEARN MORE

To view the complete report:
https://escholarship.org/uc/item/4mq5p6sd

IMAGES

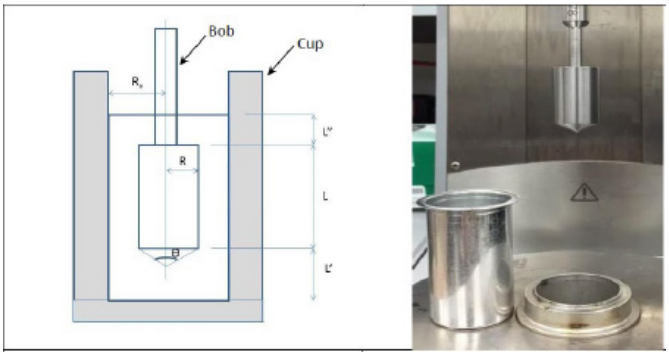

Image 1: Concentric cylinder geometry

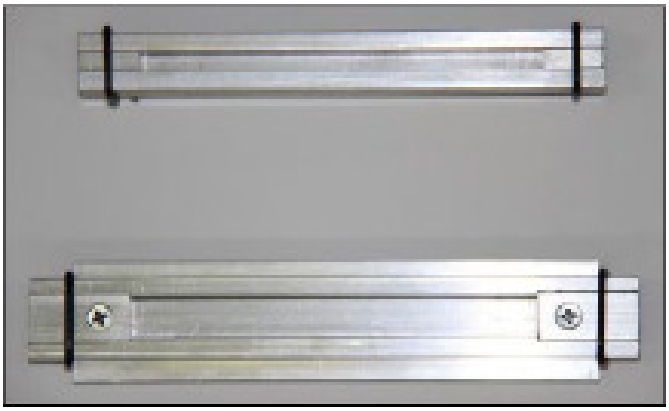

Image 2: Standard (top) and modified (bottom) BBR specimen mold configurations

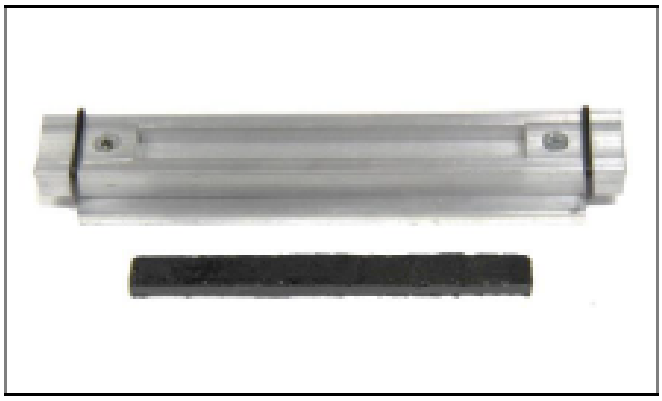

Image 3: Modified mold configuration and beam specimen