Superpave Binder Specification

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Asphalt Binder Branch, Materials and Tests Division

History

The Superpave Binder specification and the supporting test procedures are products of the Strategic Highway Research Program (SHRP), a 5-year research effort (1987 to 1992) which targeted $50 million for asphalt research.

A Generic Specification

SHRP researchers designed the binder specification to address the asphalt's contribution to three distresses found in asphalt concrete pavement. These distresses are rutting, fatigue and thermal cracking. Performance related tests were developed or adapted to address these distresses. The idea is that the distresses are related to the climate in which the roadway exists. For example, rutting occurs in Alaska and Texas. It looks the same in both locations and is caused by the same phenomenon. The difference is the pavement temperatures at which it occurs. Consequently, the specification developed uses one set of tests and uses the same minimum and maximum values for those tests. The difference is the specification changes the test temperature to measure for those test values. This in effect interjects climate into the specification.

Grade Selection

To specify a performance graded asphalt binder, one needs to determine the temperature extremes under which the pavement must perform. A grade is determined by indicating the high and low temperatures for performance. As an example, we expect PG 64-22 to perform at a high temperature of 64°C and a low temperature of -22°C. The grading system uses increments of 6°C for the high and low temperature designation. The Performance-Graded Binder specification in Item 300 uses high temperatures of 58, 64, 70, 76, and 82 and low temperatures of -16, -22, -8, and -34. The high temperature designation represents the 7-day average high pavement temperature. The low temperature designation represents a single occurrence low pavement temperature.

Any location is subject to mild summers and hot summers, and mild winters and cold winters. This means that at each location, the climate is a statistical distribution. There is an average 7-day high average pavement temperature and average low pavement temperature and associated standard deviations to account for yearly variations. The SHRP researchers recognized this and integrated this into the PG selection process. To be able to select a binder for any location, one needs to know the climate distribution and choose an acceptable risk factor of exceeding the design temperatures. The climate of the location, risk or reliability factors, and the standard grade temperatures will determine the actual PG binder to choose. The specifier can choose to alter the climate grade by using the additional factors of traffic and loading. If there is slower moving traffic, the rutting potential is higher, and the high temperature portion of the binder grade can be "bumped" up one grade (i.e., 64 to 70). If there is standing traffic, the rutting potential is even more, and the high temperature grade can be "bumped" up two levels over the standard climate-based grade (i.e., 64 to 76). In all these modifications, the low temperature grade remains the same. At TxDOT, we have additional criteria for bumping the high grade. This includes mixture type such as SMA and PFC.

The Distresses and Tests

If the pavement lasts long enough, the life of the binder and pavement is very predictable. Binders arrive at the hot mix plant, are aged during the mixing process, and after placement begin a long-term aging process in the road. If the binder is not stiff enough when the pavement is first placed, the mix is susceptible to rutting. If mixtures do not rut, the binder generally get harder and harder (stiffer and stiffer) in the pavement with time and the pavement eventually cracks. Cracking occurs because the binder gets too stiff and cracks when the road contracts at low temperatures or they may fail in fatigue. The effect is the same; the binder is too stiff to handle the stresses applied to it.

Knowing this typical pavement life cycle, the Superpave specification tests for resistance to rutting early in the pavement life and fatigue and thermal cracking resistance later in the pavement life. The equipment used in the specification is several types of ovens (for aging procedures), a dynamic shear rheometer, a bending beam rheometer and a direct tension tester. Asphalt binders are tested in a manner that simulates the stage in pavement life in which various distresses occur. These stages are—unaged, simulated aging through the hot mix plant, and simulated long-term aging in the roadway.

We test as-received (tank) unaged asphalts to ensure that we begin with a material with a minimum amount of stiffness. We want to avoid very fluid materials that age severely through a hot mix plant. We measure binder stiffness with the Dynamic Shear Rheometer.

The Rolling-Thin-Film-Oven (RTFO) simulates the binder aging which occurs through the hot mix plant. We know that binders age, in fact we are counting on some aging. We measure the stiffness of the binder with the Dynamic Shear Rheometer. This is to guard against rutting. We know that as asphalts age in the pavement, they get harder and harder (stiffer and stiffer). If the binder is stiff enough to avoid rutting when placed, it will most likely not rut later in life.

The Pressure Aging Vessel uses RTFO aged binder to simulate long-term aging. This conditioning simulates approximately 5 to 8 years aging in the pavement. This is the time in the pavement's life where we are concerned about fatigue and thermal cracking. The Dynamic Shear Rheometer measures stiffness to indicate the binder's fatigue resistance and the Bending Beam Rheometer measures its resistance to thermal cracking. The direct tension test is used under some circumstances to indicate that even though a binder is otherwise too stiff at low temperatures, it is resistant to low temperature cracking if can endure at least 1% strain at low temperatures

Testing for Compliance

There are two mechanisms for determining the PG binder grade:—Classification and Verification. When the PG grade is unknown, we conduct Classification. This involves a trial-and-error process, performing the tests at various PG temperatures to bracket the specification temperatures at which the material passes and fails to meet the specification requirements. This process usually will require 3 to 5 days elapsed time.

When we are told what the PG grade is supposed to be, we conduct Verification. In this process, we already know the temperatures of test. We test at the specification temperatures only, with either a passing or failing result. The elapsed time for complete testing will be 1.5 to 2.5 days. Most of TxDOT's binder testing falls into this category. We can verify the high temperature portion of the PG binder by testing the RTFO residue with the Dynamic Shear Rheometer. We know the test temperature, so only need to conduct one DSR test. The time schedule for this testing will be—Sample preparation - approximately 1 hr. (oven heating to 135°C and stirring approximately 5 minutes with mechanical stirring device if needed); RTFO aging - 85 minutes; and DSR testing - 30 minutes. This results in a total elapsed time of approximately 3 hours. Person-hour requirements are approximately 1 hour.

Conclusion

SHRP research developed the Superpave binder specification to be generic, performance based and climate driven. It addresses the pavement distresses of rutting, fatigue, and thermal cracking. Complete testing requires a lengthy process in person-hours and elapsed time. Verification testing greatly reduces the time and labor requirements. Verification of the high temperature properties alone require the least resources and if equipment is readily available, can provide results on almost a real-time basis.