0-6616: Validate Surface Performance-Graded (SPG) Specification for Surface Treatment Binders

Background

The design and selection of surface treatment binders is currently based on experience and traditional specifications that are not performance related and do not directly consider climate. A surface performance-graded (SPG) specification for these materials was developed and initially validated previously in Texas Department of Transportation (TxDOT) Project 0-1710. This SPG specification utilizes the equipment and format of the performance-graded (PG) binder specification for hot-mix asphalt (HMA) binders and ensures adequate surface treatment performance in service in terms of aggregate loss and bleeding by measuring binder properties at critical high and low surface pavement temperatures. In this project, the original SPG specification was revised and further validated with field performance.

What the Researchers Did

The SPG specification was revised with additional binder testing proposed since TxDOT Project 0-1710 and further validated by monitoring the field performance of 30 highway sections during their critical first year of service. Surface treatment binders included both hot applied asphalt cements and emulsion residues to capture performance in service. First, a standard emulsion residue recovery method was selected based on the evaluation of two warm oven methods developed to more closely match the field process of water evaporation without disturbance of polymer networks in modified binders. Second, the exclusive use of the dynamic shear rheometer (DSR) was investigated by comparing predicted low temperature properties from DSR testing to measured low temperature properties from bending beam rheometer (BBR) testing that requires substantial material and reheating of the material that may alter the properties of modified binders. Third, the thresholds for both high and low temperature performance-related properties at critical aging states were further field validated by comparing the laboratory SPG grades based on measured properties, the binder properties required by the highway section climate, and field performance in terms of aggregate loss, bleeding, and overall performance. Additional binder testing was also completed including the multiple stress creep recovery (MSCR) and the DSR frequency sweep recommended in a modified SPG specification from National Cooperative Highway Research Program (NCHRP) Project 14-17 to evaluate the possibility of adding criteria to the SPG specification.

What They Found

A reliable performance-related specification for surface treatment binders was developed as shown in Table 1. The Texas warm oven method (American Association of State Highway and Transportation Officials [AASHTO] PP 72-11 Procedure B) is recommended for use with this specification to recover emulsion residue for further testing.

The laboratory results generally identified modified binders as superior to unmodified binders. From the comparison of the laboratory and field results, the thresholds for one high temperature property ($G^*/\sin \delta$) and one low temperature property (creep

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stiffness S) were maintained with a tie to field performance for the majority of 30 field sections in this study and 45 from TxDOT Project 0-1710. The threshold for one intermediate temperature property (minimum percent strain at $0.8G_i^*$) was revised to 17.5 percent minimum based on field performance of more than 25 sections. The final recommendation to improve the SPG specification was to remove the m-value due to lack of a tie with field performance.

What This Means

The revised SPG specification shown in Table 1 is ready for implementation that will provide further validation with additional highway sections, corresponding climates, and a wider variety of materials. Additional statistical analysis using classification and regression trees (CART) is recommended to further validate the binder property thresholds that ensure adequate surface treatment performance in service in terms of bleeding and aggregate loss over a wide range of temperatures during the critical first year. The low temperature property (S) can likely be predicted from the DSR frequency sweep, and further research is needed to determine an additional property to specifically address bleeding. Since this SPG specification is limited to binder properties in service, it must be used in conjunction with other established specifications, quality control processes, and design and construction guidelines to ensure good performance.

Table 1. Revised SPG Specification.

The SPG grades are examples, and they can be extended in both directions of the temperature spectrum using 3°C increments.	Performance Grade											
	SPG 64				SPG 67				SPG 70			
	−13	−16	−19	−22	−13	−16	−19	−22	−13	−16	−19	−22
Average 7-day Maximum Surface Pavement Design Temperature, °C	<64				<67				<70			
Minimum Surface Pavement Design Temperature, °C	>−13	>−16	>−19	>−22	>−13	>−16	>−19	>−22	>−13	>−16	>−19	>−22
Original Binder												
Dynamic Shear AASHTO T 315/ASTM D7175 *G*/sin δ*, Minimum: 0.65 kPa Test Temperature @10 rad/s, °C	64				67				70			
Dynamic Shear Strain Sweep AASHTO T 315/ASTM D7175 % strain @ $0.8G_i^*$, Minimum: 17.5 Test Temperature @10 rad/s linear loading from 1–50% strain, 1 sec delay time with measurement of 20–30 increments, °C	25				25				25			
Pressure Aging Vessel (PAV) Residue (AASHTO R30)												
PAV Aging Temperature, °C	100				100				100			
Creep Stiffness AASHTO T 313/ASTM D6648 S, Maximum: 500 MPa Test Temperature @ 8s, °C	−13	−16	−19	−22	−13	−16	−19	−22	−13	−16	−19	−22
Shear Strain Sweep G_i^*, Maximum: 2.5 MPa Test Temperature @10 rad/s linear loading at 1% strain and 1 sec delay time, °C	25				25				25			

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