INDOT Research

TECHNICAL *Summary*

Technology Transfer and Project Implementation Information

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Asphalt Additives to Control Cracking and Rutting

Introduction

Prior to the implementation of the Superpave asphalt binder specifications, various asphalt modifiers were being promoted to improve the performance of hot mix asphalt (HMA) pavements. Specifying agencies faced many difficult decisions when they chose to specify modifiers. For example, which modifier was best for a given set of circumstances? Modified binders also tended to be significantly more expensive than neat, or unmodified, asphalts. Material costs alone could be 25 to 100% higher than conventional asphalts. Construction costs could also be increased due to the need for higher temperatures, additional equipment and other special handling requirements. These additional costs made it harder to justify the use of modified binders without reliable performance histories.

The implementation of the Superpave performance graded binder specifications introduced a new way to specify an asphalt binder for a particular hot mix asphalt application and was viewed by many as a solution to the problems of dealing with modified binders. Under Superpave, a binder is selected to provide sufficient stiffness to resist rutting at expected high service temperatures and enough flexibility to resist fatigue and thermal cracking at intermediate and low service temperatures. The wider the range of temperatures at which a binder must perform, the more difficult it is to span the range with an unmodified binder. The original purpose of this field trial and laboratory study was to evaluate the performance of seven different asphalt modifiers, representing some of the major types of modifiers, to determine which provided the best, most cost-effective performance improvement in terms of rutting and cracking resistance. All seven modifiers were included in hot mix asphalt mixtures placed on one project on I-465 in 1990. Two control sections using AC-20 were also constructed on the same project.

During the course of this study, the Indiana Department of Transportation (INDOT) adopted the Superpave binder specifications and subsequently the Superpave mix design process. This study then offered an excellent opportunity to evaluate the modified binders used on this project according to the Superpave binder tests and to relate those test results to actual, long-term service performance. It also offered a unique opportunity to evaluate proposed new protocols for modified binder testing under AASHTO MP1a.

Findings

After 11 years of service, the field sections were all performing well in terms of rutting. No appreciable rutting had been measured on any of the sections. The fact that no rutting occurred on this project can be attributed to INDOT's revised Marshall mix design practices, coupled with high quality aggregates and close attention to detail during construction by the agency and contractor.

There are marked differences, however, between the various sections in terms of cracking. Some of the sections cracked extensively within three to six years after construction. Other sections were still performing well after 11 years. It should be noted, however, that the binders did not all meet the same performance grade, so differences could be expected. The best performers included the SBR, PAC and AR. A second tier of performance included the Neoprene, Fibers and MGAC. The worst performers were the unmodified control sections and the Novophalt.

The observed cracking was not merely reflective cracking from the underlying portland cement concrete layer as it did not all correspond to underlying cracks or joints. In addition, the worst performers exhibited extensive longitudinal cracking, which could not be caused by the underlying concrete. Much of the cracking was apparently caused by brittleness of the binder, especially in the Novophalt section. No other significant distresses were noted during field surveys.

The proposed new (MP1a) binder test results identified the polyethylene modifier as the most prone to cracking. The control binder (AC-20) was also identified as likely to crack. This lends credence to the recommended new procedures for testing modified binders. Conventional PG testing, however, also ranked the binders correctly in terms of cracking. With this limited testing, the PG tests appeared to be as accurate as the MP1a testing, which is much more time consuming. At this point and based on this limited data, there does not appear to be a compelling need to implement MP1a. That situation may change in the future as more data is collected and analyzed.

High temperature binder testing revealed that all of the modifiers stiffened the binder. High temperature binder stiffness relates to pavement rutting. As no rutting was observed in the field, no significant laboratory differences were expected. The aggregate framework and overall mix design have a greater influence on rutting than the binder.

Indirect tensile testing performed on selected samples of the modified and control mixtures did not correlate with the observed field performance.

Implementation

The results of this project show that modification of the binder is not necessary to produce pavements that will not rut under heavy traffic. Even the control sections performed well here with only minimal rutting. Good aggregate gradations, proper mix designs and close attention to detail during construction contributed to the good rutting performance. INDOT's approach of using Superpave mix designs, quality control/quality assurance specifications and some warranty specifications as well, help to ensure that good mixes are designed and constructed.

This study also shows that modifiers can improve the cracking resistance of the mixtures in which they are used, provided the modified binders meet the PG grade appropriate for the location. The materials that performed poorly in terms of cracking only met a low temperature grade of -16. Those that met a -22 or -28 grade performed much better.

It appears, based on this limited data from one site with only eight binders, that the conventional PG low temperature tests (MP1) using the BBR were able to rank the binders in terms of cracking resistance as well as the newly proposed tests under MP1a. Thus, while the MP1a testing may be preferred from a theoretical point of view, in this particular case, it does not appear to offer a great improvement in the ability to predict cracking compared to the simpler MP1 testing. Additional information is needed to ascertain whether INDOT should move to adopt MP1a, though based on this data, there does not seem to be a compelling reason to do so. Additional efforts are underway on a national level to verify the need to implement MP1a testing.

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