RESEARCH
PROJECT CAPSULE [14-5PF]
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TECHNOLOGY TRANSFER PROGRAM

Design and Analysis Procedures for Asphalt Mixtures Containing High RAP Contents and/or RAS

JUST THE FACTS:

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POINTS OF INTEREST:

Problem Addressed / Objective of Research / Methodology Used Implementation Potential

PROBLEM

Asphalt recycling has become an important instrument used to minimize production costs of new pavements as well as to mitigate its impacts of the environment. Some of the benefits of utilizing recycled materials include the conservation of nonrenewable natural resources, such as virgin aggregates and asphalt binder; reduction in the amount of construction debris disposed of in landfills; decrease of the variability in material expenditures; and potential reduction of the overall life-cycle costs. Recycling also helps to cut greenhouse gas emissions by reducing the energy spent on the extraction and processing of petroleum products and aggregates. Moreover, the increasing price of asphalt binder along with more restrictive environmental legislation has forced the highway agencies and contractors to search for novel materials and construction techniques. Such efforts are aimed at fulfilling the current sustainability needs without compromising the pavement quality and performance. There is currently considerable emphasis on the use of reclaimed asphalt pavement (RAP) as preferred recycled material for highway construction due to its abundance and successful prior experiences. Recycled asphalt shingles (RAS) have also become another promising recycling candidate due to their potential use in asphalt mixtures. However, to ensure successful use of RAP and/or RAS, many concerns relating to the chemical and physical interactions among virgin and recycled materials as well as the durability of the produced mixture must be addressed.

Despite recent advancements in the design of asphalt mixtures containing RAP, many states are still cautious in their regulations to avoid durability problems related to the recycling process. In many states, RAP is currently not allowed in highest-class asphalt mixtures and in polymer-modified asphalt products. In addition, high percentages of RAP exceeding 25% are not commonly used in practice. On the other hand, other state agencies are taking a more aggressive approach by considering increasing the allowable percentages of RAP in asphalt mixture to take full advantage of this promising technology. For instance, up to 50% RAP has been used in some asphalt mixtures, which produced an acceptable level of performance. In addition, reclaimed asphalt shingles (RAS), defined by the American Association of State Highways and Transportation Officials (AASHTO) MP 23-14 *Standard Specification for Use of Reclaimed Asphalt Shingles as an Additive in Hot-Mix Asphalt (HMA)* as "any type of waste roofing asphalt shingles that have been processed into a recyclable product," have become another promising candidate of recycling, also because of the high compatibility with paving asphalt mixtures. However, to ensure successful use of RAP and/or RAS, confidences in the mixture design procedure require addressing many concerns related to the interaction between virgin and recycled materials and durability of the produced mixture. Current AASHTO recommendations make it difficult to design asphalt mixtures with high RAP and/or RAS contents. Modifications to the current specifications are needed to assure

agencies that satisfactory performance will result from the use of asphalt mixtures containing high RAP and/or RAS content.

OBJECTIVE

The objectives of this research are to (1) establish mechanistic test criteria, that ensure pavement durability, for asphalt mixtures (warm and hot) containing high RAP and/or RAS content; and (2) propose asphalt mixture specifications that incorporate these mechanistic test criteria as tested on plant produced specimen and/or roadway cores based on the results of the study.

The validation of the proposed methodology will be carried out on plant produced mixtures and roadway cores (depending on availability of those cores). Testing of plant-produced mixtures and roadway cores will allow for the evaluation of the impacts of higher RAP and/or RAS content on the durability of the evaluated asphalt mixtures.

METHODOLOGY

It is anticipated that two field projects from each participating state will be included. Each project will consist of a mixture containing high RAP and/or RAS content and a companion conventional mixture. Thus, a total of four mixtures will be evaluated from each participating state. Further, participating states are expected to provide, at a minimum, the following: job mix formula; sufficient loose mixture for physical and mechanical tests (conventional mixture, high RAP and/or RAS mixture, and RAP and RAS sources); field cores (depending on availability); and plant and field project QA/QC documentation.

Two laboratory experiments will be conducted to ascertain the fatigue/fracture cracking susceptibility of mixture containing high RAP and/or RAS content as compared to the companion conventional asphalt mixture. The first experiment will characterize the physical and chemical properties of the raw materials (aggregates, RAP, RAS, and asphalt binder). Tests performed during the first experiment will include physical properties (gradation, specific gravities, etc.); performance grading of the extracted RAP, RAS, and virgin binders; and High Pressure Gel Permeation Chromatography (HP-GPC). The second experiment will assess the fatigue/fracture resistance of the mixtures evaluated. Five mechanistic tests will be performed, namely, Semi-Circular bend test, Dissipated Creep Strain Energy test, Beam Fatigue test, Texas Overlay test, and Direct Tension Cyclic test.

The data from the five fatigue/fracture mechanistic tests will be appropriately reduced and compared amongst each other. A score card type of ranking system with weights varying from 0 to 5 will be used for a qualitative analysis for each fatigue/fracture test. An example of the items considered in the development of the ranking system include availability of standard test method, field verification and associated test result criteria, cost of equipment, ease of operation, time required for sample preparation, time required for testing, potential of implementation in QA/QC specifications, data reduction time, consistency of results, and ability to detect the effect of RAP and/or RAS on the fatigue/fracture performance of asphalt mixtures.

IMPLEMENTATION POTENTIAL

It is anticipated that results from this study will provide specification recommendations for asphalt mixture containing high RAP and/or RAS content. The recommendation will incorporate a mechanistic test and associated criteria as tested on plant produced specimen and/or roadway cores.