LTRC RESEARCH PROJECT CAPSULE

JANUARY 2009

04-3B

TECHNOLOGY TRANSFER PROGRAM

Comparative Analysis of Modified Binders: Original Asphalts and Materials Extracted from Existing Pavements

JUST THE FACTS

Start Date:
July 1, 2007

Duration:
24 months

End Date:
June 2009

Funding:
Federal

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SPECIAL POINTS OF INTEREST:

- Problem Addressed
- Objectives of Research
- Scope
- Methodology Used
- Implementation Potential

PROBLEM

Of all the hot mix asphalt (HMA) pavements, more and more newly constructed roads have been using polymer modified asphalt cement (PMAC) for better pavement performance. More often than not, elastomers became the asphalt modifiers of choice due to their excellent elasticity and good compatibility with asphalt species. A new analytical tool needs to be developed for assessing the presence and quantification of the elastomer modifier amount, both in a supplied PMAC and in a liquid extracted from pavement cores. It will enable analysis of polymer modified binders in all stages from the cradle to grave, i.e., from the inception of a project to the recovery of the aged pavement as a recyclable RAP material.

OBJECTIVES

The first objective of this research is to develop a procedure and standard for using the gel permeation chromatography (GPC) method as an analytical tool to define the percent amounts of polymer modifiers in polymer modified asphalt cements soluble in eluting GPC solvents. Part of this objective will address quantification of GPC solvent insoluble crumb rubber modifier present in crumb rubber modified binders for which a repeated solvent/non-solvent precipitation procedure will be developed. The second objective will be the assessment of the extent of oxidative aging of modified asphalt binders by using both GPC and chemical analyses.

SCOPE

This project will be sub-divided into two phases including (1) development of procedures to define the percent content of polymers in polymer modified binders and (2) analysis of plant polymer modified binders and field binder extraction and characterization. Phase I will include (1) the development of a procedure and standard to define the percent amounts of soluble polymer modifiers in polymer modified asphalt cements by GPC and (2) the development of a solvent/non-solvent precipitation procedure to define the percent amounts of GPC solvent insoluble crumb rubber modifier present in crumb rubber modified binders. During Phase II, binder tests will be based on chemical component analysis and binder characterization that will include (1) Fourier transform infrared (FTIR) spectroscopy measurements, (2) potentiometric titration of acid groups, (3) GPC measurements, (4) dynamic shear modulus (DSR) and phase angle measurements, (5) bending beam rheology (BBR) and forced ductility tests, (6) multiple stress creep recovery (MSCR) of liquids, and (7) dynamic mechanical analysis (DMA) of mixture samples made of polymer modified binders and sand.

METHODOLOGY

Multiple asphalt sources will be tested at three points of the process: first at the point of asphalt modification, second at the point of production of HMA, and then again after six months of aging after HMA placement.

A polymer modified asphalt binder can be regarded as a true solution in which the polymer is homogeneously blended with the components of the base asphalt cement, such as the case of styrene-butadiene styrene (SBS) and styrene-butadiene rubber (SBR) polymer modified asphalt cements (PMACs). Because there is a large difference (approximately two orders of magnitude) between the molecular mass of polymer molecules and the mass of asphalt components, the polymer can easily be visualized through a size exclusion analysis, such as GPC. As shown previously, the polymer and asphalt components of polymer modified asphalt cements could be separated completely using gel permeation chromatography (1-5). This is shown in figure 1 which illustrates GPC traces of PMAC from tetrahydrofuran (THF) solution and of SBS from decaline solution. Any species eluting at less than 22 ml is of molecular weight higher than that of the largest asphalt species.

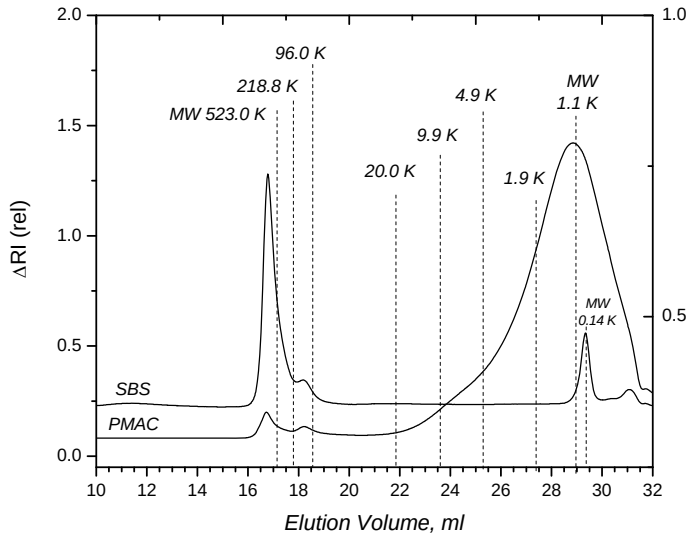

Figure 1
GPC traces of PMAC from THF solution and of SBS from decaline solution
(molecular weight of decaline MW = 140 Daltons)

The polymer eluted at volumes corresponding to polystyrene species of molecular weights of > 530,000 and 90,000 Daltons. The asphalt peak appears at MW = 1.1 K. The decaline is seen as a peak of low intensity at MW = 0.14 K. The development of regional impact (DRI) scale was displaced for clarity.

The GPC and Strategic Highway Research Program (SHRP) binder tests will be recorded at each point described. In addition, duplicate and triplicate samples will be obtained during the course of the study to identify the GPC's potential to serve as a source approval test.

IMPLEMENTATION POTENTIAL

The research will potentially impact HMA producers, asphalt producers, the highway paving contractors, and the LADOTD. All could benefit from the utilization of this new analytical tool in order to monitor the amount of the polymeric material (elastomer) in a polymer modified asphalt binder from the inception of a project to the placement of the pavement. The results will also provide information in regard to the aging and oxidative behavior of modified asphalts.

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