Project Summary

Texas Department of Transportation

0-5608: Practical Applications of FTIR to Characterize Paving Materials

Background

Construction of high quality and durable rigid and flexible pavements requires strong quality control/quality assurance programs. The success of these quality control programs depends on analytical techniques capable of elemental and phase characterization which are fast, non-destructive, and reliable. Different well established techniques are available for materials characterization, but these methods are instrument intensive (not field portable), slow, and costly. Cost of such techniques does not allow for testing of large numbers of samples, thereby limiting the quality control program. Fourier Transform Infrared spectroscopy (FTIR) is an alternative technique that is inexpensive to perform and has shown attractive materials characterization attributes allowing it to gain popularity in laboratories of most departments of transportation throughout the United States.

What the Researchers Did

A comprehensive literature search on practical applications of FTIR for characterization of paving materials was performed. Construction materials used in rigid pavements that were investigated in this research include: 1) five different cement samples of cement type I (TX Lehigh), cement type I/II from Alamo, TXI Hunter, Buzzi Maryneal, and Capitol sources, 2) fly ash (both class F and C), 3) curing membrane compounds (TSC-100 and Texas type II), 4) commercial evaporation retardants (Aquafilm, Confilm, EucoBar, Evapre, Sikafilm, and Econ), and 5) commercial spall repair epoxy materials (Delpatch, Flexkrete, Flexpatch, and PaveSaver).

In addition, calibration curves for quantification of polymer content in polymer modified asphalt binders were produced for two batches of asphalt binders received from Valero Ardmore Refinery and Martin Asphalt Company. Calibration curves generated were used to quantify the polymer content of a number of unknown samples received from the TxDOT asphalt laboratory. Quantification of polymers in polymer modified asphalt samples was based on the AASHTO T302-05 standard procedure.

Furthermore, the FTIR fingerprint spectra of two commercial curing membrane compounds, six evaporation retardants, and four concrete spall repair epoxies (compounds A, B, and catalysis where applicable) were documented. Two batches of these materials were collected and analyzed to document uniformity of these products.

Research Performed by:

University of North Texas (UNT)

Research Supervisor:
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Project Completed: 8-31-09

What They Found

A new analysis method was developed. This new method using FTIR for quantification of alkali content in concrete cement is fast and easy. Therefore, testing of a reasonably large number of samples from a cement batch becomes practical. Recently, handheld FTIR spectroscopy devices have been developed and are being marketed that allow field application of this technique. Cost reduction and time saving effects associated with the application of FTIR as compared to other testing methods are significant. Researchers of the TxDOT project 0-4085 suggested that "Some highly reactive aggregates were found to result in substantial cracking in exposure blocks, even though the total alkali loading met the TxDOT maximum alkali loading requirement for plain concrete of 4 pcy of alkalies." This analytical method could potentially be used to analyze aggregates containing alkali provided that aggregates do not contain phases that mask 750 cm^{-1} band of alkali in its FTIR spectrum to interfere with the analysis.

The FTIR technique was proven a highly reliable method for quantification of polymer concentration in polymer modified asphalt binders. Calibration curves for polymer quantification which were generated in this research showed an excellent agreement with those obtained by other researchers. Such calibration curves can be used to reliably measure polymer concentration in unknown asphalt samples.

FTIR fingerprint spectra of commercial concrete spall repair epoxies, membrane curing compound, and evaporation retardants were produced and can now be used to assess uniformity of these materials from one batch to the next and from one supplier to another. Protocols for FTIR fingerprinting of these products were developed. Reliable quantification of polymer content in polymer modified asphalt binders using FTIR based on AASHTO T 302-05 was experienced.

What This Means

Researchers concluded that Fourier Transform Infrared spectroscopy is indeed a feasible alternative technique showing attractive materials characterization attributes such as being inexpensive to perform, reliable, fast and easy, non-destructive, and practical for testing reasonably large numbers of samples.

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