Texas A&M Transportation Institute

PROJECT SUMMARY

Texas Department of Transportation

0-6881: Recycled Engine Oil Bottoms and Polyphosphoric Acid in Texas Binders

Background

A Superpave performance grade (PG) binder specification was one of the products from the Strategic Highway Research Program (SHRP). Many state departments of transportation have adopted the Superpave PG specification since the completion of SHRP in 1993. A much wider range of crude oil sources are now being used to produce asphalt binders. Materials such as re-refined engine oil bottoms (REOB), polyphosphoric acid (PPA), bio-binders, and ground tire rubber (GTR) are increasingly being used to formulate and manufacture asphalt binders for pavement mixtures and asphalt seal coat binders. Although asphalt binders used these days still meet the requirements of the PG specification, many highway agencies in the United States are increasingly experiencing premature failures of newly constructed pavements. These failures include distresses such as low- and intermediate-temperature cracking and raveling, aggregate loss, and instances of total surface course loss within five years. Many pavement engineers express concerns about embrittlement and a lack of adhesion and tackiness of the asphalt binders. The Texas Department of Transportation (TxDOT) has become increasingly aware of these issues so that new research on REOB was initiated to address it in 2015.

This study:

- Established REOB detection methods.
- Evaluated the impact of REOB on asphalt binder properties, asphalt mixture properties, and seal coat performance.
- Recommended the maximum allowable amount of REOB in asphalt binders and seal coat binders.

What the Researchers Did

Researchers first reviewed the literature published over the last 30 years on the use of REOB in asphalt binders and identified the critical issues and challenges. Based on the literature review results, researchers developed and verified scientific methods to detect and quantify the amount of REOB used in both asphalt binders and hot-applied seal coat binders using a handheld or benchtop x-ray fluorescence (XRF) instrument (Figure 1). Researchers conducted a comprehensive study of the impact of REOB on asphalt binders, asphalt mixtures, and seal coat performance through a series of laboratory tests. Multiple sources of binders, aggregates, and REOB (including recycled binders, PPA, and GTR) were used in the study.

Based on the results, researchers made recommendations on the maximum allowable amount of REOB in asphalt binders and hot-applied seal coat binders.

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Figure 1. Benchtop and Handheld XRF Instrument Used in This Study.

What They Found

The presence and intensities of some key elements (e.g., Ca, Cu, K, Mo, Zn, and P) from XRF testing can be used to detect whether or not REOB exists in the asphalt binders and the seal coat binders. If so, the intensities of these elements can be used to estimate the amount of REOB. Researchers also found that binders produced with the same target PG but with different modification techniques can have quite different rheological and embrittlement properties. Specifically, the parameter ΔTc from the bending beam rheolometer is a good parameter for asphalt binder quality or embrittlement. It was also identified that adding more than 5 percent REOB by weight of the total binder can negatively impact the rutting and cracking resistance of asphalt mixes. The same is true for seal coats because REOB negatively impacts the adhesive property of seal coat binders.

What This Means

TxDOT should keep the current upper limit of 5 percent REOB in asphalt binders. TxDOT should also consider establishing an upper limit of 5 percent REOB in seal coat binders. The tools (the benchtop and handheld XRF) and associated detection methods for REOB were developed. The implementation of these tools and recommendations will make pavements last longer as intended.

For More Information

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