Project Summary

Texas Department of Transportation

0-5091: Analyze Existing Fog Seal Asphalts and Additives

Background

This work was conducted for the purpose of assessing the effectiveness of fog seal treatments as an aid to highway maintenance managers in making sound decisions for fog seal treatments. Specifically, the objectives of this project were:

- to evaluate the physical and durability properties of fog seal binders;
- to determine whether fog seal treatments penetrate into the pavement and, if so, whether they perform any significant sealing of the pavement;
- to investigate the effects of the fog seal treatments on the *in situ* binder, possible rejuvenation of the binder, and possible effects to retard binder aging; and
- to review the data of this project to assess the effects of air voids or binder content on binder aging in pavements.

What the Researchers Did

Replicate cores from both treated and untreated sections sampled a variety of pavements. The project covered multiple types of treatments, and pavements sampled included both highways and general aviation airports. Treatments included standard materials such as MS-2 and CSS-1 emulsions, and coal-tar based products meeting Federal Aviation Administration (FAA) Engineering Brief EB44. They also included some specialty products that are advertised for fog seal applications such as PASS and COS-50.

Analysis of the original fog seal materials used size exclusion chromatography (SEC) chromatograms and viscosity master curves. The chromatograms assisted in determining to what extent the treatments might have penetrated into the pavement. Two methods assessed the effects of the treatment materials on whole-cores:

- water permeability (to evaluate possible reductions in permeability due to the sealing treatments), and
- susceptibility to permanent deformation using the asphalt pavement analyzer (APA).

Replicate cores were sawed into one-quarter inch slices through the top inch of the core and the slices were individually analyzed for total air voids and accessible air voids. The binder in each slice was extracted and recovered to give binder content and then analyzed for oxidative aging and rheology, and to search for the presence of fog seal material.

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What They Found

The fog seal materials studied in this project were of two basic kinds: asphalt emulsions and coal-tar type materials (a light, primarily aromatic, hydrocarbon material). The asphalt materials in the emulsions typically were 1,000 to 3,000 poise, approximately AC-10 to AC-30 viscosity grade, but one was quite high at 30,000 poise.

Based upon the whole-core and one-quarter inch slice data, the conclusion seems clear that if the fog seal is penetrating into the pavement, it is not doing so to a detectable level (it is either draining off the side of the pavement or it is draining through the pavement and away from the top surface of the pavement). The permeability of the pavement is not significantly reduced. Furthermore, APA tests did not show that treatments resulted in any softening of the pavements.

The project evaluated several possible effects of the fog seal treatments on the pavement and its *in situ* binder. The effects of the treatments that were primarily of interest were rejuvenation of the binder and retardation of binder aging. Researchers reached the following conclusions.

- Generally, the dynamic shear rheometer (DSR) map plots of binder recovered from the several slices of the pavement showed no clear effects. By comparing the DSR map to SEC chromatograms, the differences between the untreated and treated slices seem more likely due to original binder variability with depth than to the fog seal treatments. The one exception seems to be for the coal-tar treatments, which appear to harden the top layer.
- No effect of the fog seal treatments on hardening susceptibility was observed.
- A paired *t*-test statistical analysis of recovered binder stiffnesses showed that practically the only significant effect on the rheology of the *in situ* binder was by the EB44 coal-tar type material, in that it stiffens the binder, and that this effect is primarily restricted to the top one-quarter inch or so of the pavement.

In addition to the above results, the project investigated the effect of air voids, and accessible or interconnected air voids in particular, on binder oxidation. The results are only qualitative because of the nature of the experimental data. Nevertheless, they support previous work, that the aging rates of asphalt binders are decreased by very low accessible air voids.

What This Means

Effects of fog seals on pavement durability appear to be minimal with respect to binder rejuvenation or sealing. Cosmetic effects or possible protection against shelling or raveling remain as possible benefits, although they were not assessed by this project. In response to this work, engineers should reassess the cost-benefit balance of fog seal treatments.

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