Laboratory Performance of Liquid Anti-Stripping Agents in Asphalt Mixtures used in South Carolina

In Cooperation with:

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Overview

Stripping is a phenomenon involving the loss of adhesion or bond between the asphalt binder and the aggregate in an asphalt mixture. In general, stripping results from the presence of water combined with the loss of adhesion between the aggregate and the asphalt binder under repeated traffic loading. Most State Highway Agencies (SHAs) require the use of an anti-strip additive to control moisture damage. The bond between the aggregate and the binder should last the entire life of the pavement. Several mechanisms, such as infiltration of water; hydraulic scouring due to tire pressure and pore pressure within the pavement structure; film rupture; and spontaneous emulsification can break the bond between the aggregate and the asphalt binder. Stripping usually begins at the bottom of the pavement layer and travels upwards gradually. In many cases, the gradual loss of strength over the years causes various types of surface defect manifestations like rutting, corrugations, shoving, raveling, cracking, etc., which makes the identification of stripping in the pavement very difficult. The main objectives of this proposed research project were to a) evaluate the use of liquid anti-strip additives (ASAs) and hydrated lime in high-volume PG 64-22 asphalt mixtures typically used in various parts of the state; and b) provide recommendations regarding dosage rate of the liquid ASAs in various mixtures. A secondary objective included comparison of the laboratory performance of liquid ASA mixtures to that of mixtures containing hydrated lime with respect to moisture susceptibility.

Literature Review

Researchers identified six contributing mechanisms that might produce moisture damage: detachment, displacement, spontaneous emulsification, pore pressure-induced damage, hydraulic scour, and the effects of the environment on the aggregate-asphalt system (Taylor and Khosla 1983, Kiggundu and Roberts 1988, Terrel and Al-Swailmi 1994). However, it is apparent that moisture damage is usually not limited to one mechanism but is the result of a combination of many processes. From a chemical standpoint, the literature is clear that although neither asphalt nor aggregate has a net charge, components of both have non-uniform charge distributions, and both behave as if they have charges that attract the opposite charge of the other material.

Results

Mix designs were performed according to SCDOT specifications utilizing one PG 64-22 asphalt binder source, six aggregate sources, six reclaimed asphalt pavement (RAP) sources corresponding to the six aggregate sources, and one hydrated lime source. The mixtures containing hydrated lime were considered the control mixtures; thus, the same gradation and optimum binder content in each hydrated lime mixture was used with the five liquid ASA sources. Two dosage rates [0.7% and either 0.5% or 0.07% by weight of the binder] for each liquid ASA were utilized for comparison purposes. The lower dosage rate in each case was recommended by the respective liquid ASA supplier. Figures 1 and 2 show dry and wet ITS values of Surface Type B mixtures containing liquid ASA I and hydrated lime and made with aggregate sources A-F. In general, it was found that the dry and wet ITS values of mixtures containing aggregates A and E were lower than the ITS values from the other aggregate sources. Additionally, all of the wet ITS values were much higher than the minimum SCDOT requirement for moisture susceptibility of 448 kPa (65 psi).

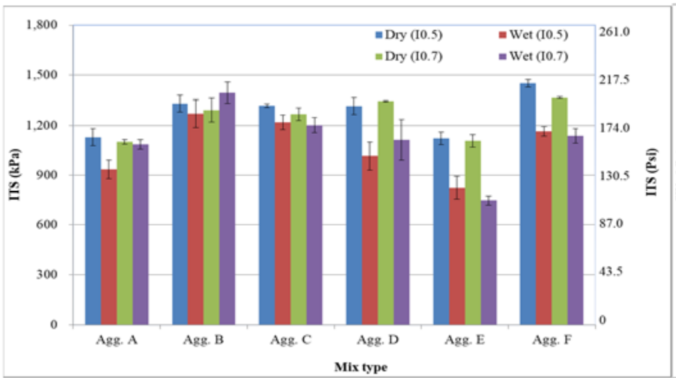

Figure 1. Dry and Wet ITS Values of Surface Type B Mixtures Containing Liquid ASA I

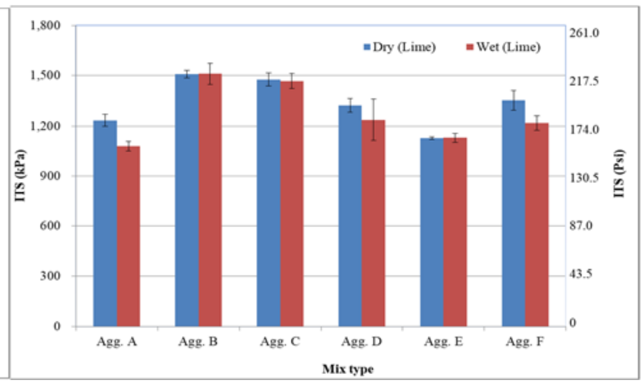

Figure 2. Dry and Wet ITS Values of Surface Type B Mixtures Containing Lime

Conclusions

The results indicated that both liquid ASAs and hydrated lime could improve the moisture sensitivity of HMA. In addition, those ASAs also had influence on pavement behaviors such as rutting, fatigue, raveling and so forth. The results of testing indicated that the wet ITS values of all mixtures were greater than 65 psi (448 kPa) regardless of aggregate source, ASA type, and mixture type, which met the minimum wet ITS requirements for mix design per SCDOT 2007 Standard Specifications. There were statistically-significant differences between the wet ITS values of mixtures made with various liquid ASA sources when used with aggregate sources E and A but not with the other aggregate sources. The wet ITS values of aggregate sources A and E and/or 0.07% liquid ASA source V were much lower than the corresponding dry ITS values. All mixtures containing hydrated lime produced TSR values that were greater than 85%, regardless of mix type and aggregate source. When aggregates A and E were utilized with some liquid ASA sources, the TSR values were found to be less than 85%. The dosage rate of liquid ASAs affected the moisture susceptibility of mixtures in some cases. For instance, in some cases, the liquid ASA was not as effective at a lower dosage rate compared to the higher dosage rate tested in this research project. Thus, the SCDOT's currently-recommended dosage rate of 0.7% (by weight of base binder) was necessary for some liquid ASAs to be effective. It is recommended that SCDOT consider specifying the use of liquid ASAs in Surface Type B mixtures as well as in Intermediate Type A and Intermediate Type B mixtures on a case-by-case basis at the mix design stage based on the results of ITS values, TSR values, and boiling test results of the specific aggregate and ASA sources.

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