STUDY OF DAMAGE IN MIXTURE OF ASPHALT AND CONCRETE CAUSED BY MOISTURE

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Abstract:- This study validates an analytical approach based on surface energy aimed at assessing moisture damage. Two types of bitumen and three aggregates are evaluated in the study. The two types of bitumen represent very different chemical extremes and the three aggregates (a limestone, siliceous gravel, and granite) represent a considerable range in mineralogy. Moisture damage was monitered as a change in dynamic modulus with load cycles. The analysis demonstrates the need to consider mixture compliance as well as bond energy in order to predict moisture damage. Pavements are a major part of the infrastructure in the United States. Moisture damage of these pavements is a significant problem. To predict and prevent this kind of moisture damage a great deal of research has been performed on this issue in the past.

1. INTRODUCTION

Since late 1970s and early 1980s it has been recognized that moisture has a detrimental influence on asphalt concrete pavements. Premature rutting, raveling, and wear have been observed in many pavements. Distress and deterioration in large number of pavements as a result of moisture damage is an indication of the significance and the severity of the problem. Moisture damage can be generally classified in two mechanisms: (a) loss of adhesion and (b) loss of cohesion (1).

The loss of adhesion is due to water getting between the asphalt and the aggregate and stripping away the asphalt film. The loss of cohesion is due to a softening of asphalt concrete mastic. The two mechanisms being interrelated a moisture damaged pavement may be a combined result of both the mechanisms. Further the moisture damage is a function of several other factors like the changes in asphalt binders, decreases in asphalt binder content to satisfy rutting associated with increases in traffic, changes in aggregate quality, increased widespread use of selected design features, and poor quality control(2).

A number of test procedures have been developed and used to evaluate the moisture damage potential of asphalt-aggregate mixtures in the past. These tests are performed on loose or compacted HMA (Hot Mix Asphalt) to determine water sensitivity of the paving material and they do not couple the effects of moisture on material properties with pavement performance prediction; hence they cannot be used directly to rationally predict performance.

Test methods and pavement performance prediction tools need to be developed that couple the effects of moisture on the properties of HMA mixtures with performance prediction to estimate the behavior of the mixture in resisting rutting, fatigue, and thermal cracking when it is subjected to moisture under different traffic levels in various climates. Many public agencies use the test methods listed in AASHTO and ASTM standards.

AASHTO T283,"Resistance of compacted bituminous mixture to Moisture Induced Damage" is the standard used for test methods performed to predict moisture damage effect in asphalt concrete mixes. Recently Strategic Highway Research Program (SHRP) has recommended the use of AASHTO T283 to evaluate the water sensitivity of HMA within the Super pave volumetric mixture design system(2).

Methods of treatment to reduce moisture damage, particularly stripping, include use of good aggregate, pretreatment of aggregates, and use of additives. One such additive is hydrated lime. Based on the laboratory and field testing in the last several years, it has been proved that hydrated lime improves the composition of the mastic and produces multifunctional benefits in the mixture. Work done in the United States and several ther countries has proved that hydrated lime can substantially improve the resistance of the HMA to permanent deformation damage at high temperatures.

Hydrated lime substantially improves low temperature fracture toughness without reducing the ability of the mastic to dissipate energy through relaxation. Hydrated lime acts as filler and reacts with bitumen resulting in some of the beneficial mechanisms in terms of strength. It has been also proved that there are also benefits of reduced susceptibility to age hardening and improved moisture resistance. There is a need for a simple and repeatable test that can evaluate the multifunctional aspects of pavement performance in presence of moisture.

Some of such tests and methods have been developed in recent years to evaluate the permanent deformation in Asphalt concrete mix in wet conditions in presence and absence of such fillers. Developing more test methods to predict the performance of asphalt mix would always add to the available knowledge regarding effects of additives in asphalt concrete. One such method has been tried to develop here which shows the effect of Hydrated lime and influence of two different binder types on the dry and wet asphalt concrete mixes in terms of permanent deformation.

2. RESULT ANALYSIS

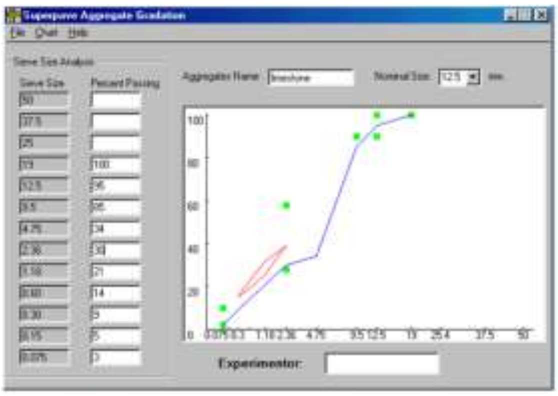

Figure-1 A gradation chart for Texas Limestone

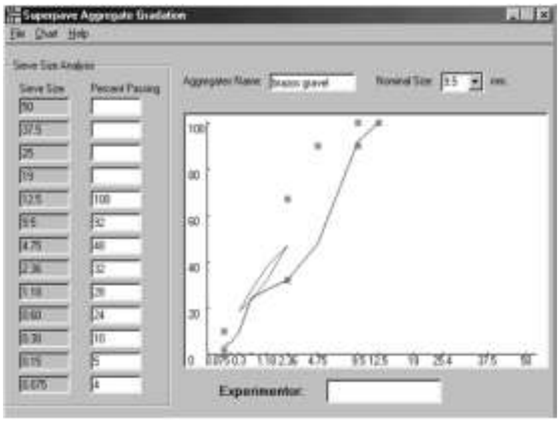

Figure-2 A gradation chart for Brazos gravel

As mentioned above, asphalt concrete samples are subjected to repeated dynamic compressive loading on MTS (Materials testing system) machine. Output obtained from this machine is in terms of permanent micro strain due to deformation occurring in the sample at intermediate loading cycles. The stress level is kept constant throughout the test. The strain values are measured up to 20,000 loading cycles, each cycle with loading and rest period in it

3. DRY AND WET TEST COMPARISONS OF VARIOUS AGGREGATES WITH TWO BINDERTYPES

A. Brazos Gravel

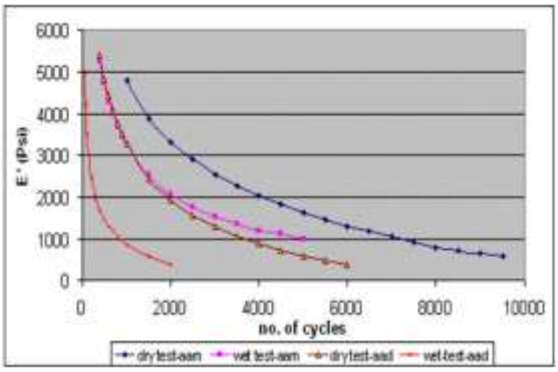

Figure-3 Dry and wet test modulus values of Brazos gravel with AAD-1 and AAM-1

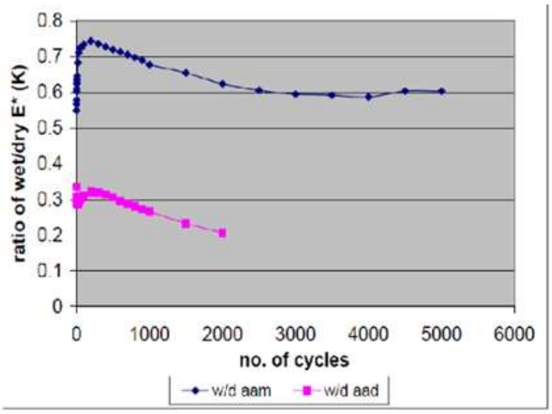

Figure-4 Ratio (K) of wet/dry test modulus vs. no. of loading cycles for Brazos gravel

4. CONCLUSIONS

Following observations were made out of the analyzed data:-

1. Asphalt concrete mix using AAM-1 asphalt showed less moisture induced damage compared to the one with AAD-1 in case of all the aggregate types. Similar kind of results is obtained from the values obtained by calculating combined surface free energies of asphalt concrete mix.
2. Dynamic modulus values for mixes with AAM-1 asphalt were higher than the one withAAD-1.
3. From the data obtained the percentage of aggregate surface exposed to water, P, is higher in case of wet tests compared to dryones.
4. Mixes with Georgia granite as aggregate and both the types of asphalts showed highest wet/dry ratio in terms of dynamic modulus compared to other two aggregate mixes. Even surface energy values exhibit similar result.

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