LTRC
Louisiana Transportation Research Center

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TECHNICAL SUMMARY

Summary of Report Number 292

COMPATIBILITY OF AGGREGATE, ASPHALT CEMENT AND ANTISTRIP MATERIALS

INTRODUCTION

The department was aware that a potential shortcoming existed in both the procedure used for antistrip product qualification and department policy which allowed a contractor to select any approved additive from the qualified product list; the shortcoming is that all additives were qualified with a standard aggregate so that compatibility of materials which were project specific to field mixtures was not established. A 1982-84 task order study for the FHWA established that this problem was more extensive than originally anticipated. Four of ten construction projects studied exhibited signs of stripping ranging from slight to severe. These pavements were between nine and sixty months of age at the time of sampling. Each of these projects met specifications and used qualified antistrip additives. The Louisiana ten-minute boil test was used to evaluate the materials used on these construction projects. Those combinations which stripped in the field failed the boil test, while those which did not strip in the field performed well.

A limited scope laboratory study using four of these aggregate sources (three which stripped, one which did not strip), two asphalt cement sources and fourteen antistrip products considered to be the manufacturer's best products was initiated. The results indicated that for specific mix designs, materials compatibility should be examined; significant differences in boil test performance were found to be dependent on each source material. On this basis, the qualified products list was reduced to five products, storage of hot mix in silos was limited to 24 hours maximum and major revisions were made to the boil test procedure which included: the use of several aggregate sources, several asphalt cement sources, crushed aggregate, 24 hour heat stability and an increase in the retention of asphalt in the boil test to 90 percent over the range of materials used to reduce subjectivity. Also, the boil test used for job mix approval was instituted so that project specific materials combinations would be tested for performance.

Although the boil test appeared to correlate with field performance on the limited scale presented above, the nature of the test is subjective and presents difficulties implementing its use in field or district laboratories for job mix formula approval. There were, however, several objective test procedures being developed at the initiation of this study which appeared promising: the freeze-thaw pedestal test examined by the Laramie Energy Technology Center and modified by Texas and the indirect tension test developed by Lottman and modified by others. The development of one or both of these tests for Louisiana use would provide the objectiveness necessary for full implementation of water susceptibility testing.

OBJECTIVES AND SCOPE

The long-term objective of this study was to further understand the stripping phenomenon using Louisiana specific materials by developing an objective moisture susceptibility test correlated to the boil test and field experience which could be used for materials compatibility testing in the field. Specific aims included:

- expanding the materials compatibility data base of the boil test by examining the most prevalent combinations of materials used throughout the state;
- developing the pedestal water susceptibility test for use with Louisiana materials and determining possible correlation with the boil test; and,

- developing the indirect tensile test (Lottman procedure or a modification thereof) for use with Louisiana materials and determining possible correlation with the boil test.

Thirteen aggregate sources representative of all districts, five asphalt cement sources and eight antistrip additives (4 high efficiency, 4 low efficiency) and one "super" antistrip additive were used in various combinations. Also, hydrated lime in both a slurry and dry condition was evaluated.

RESEARCH APPROACH

Materials

The Materials Test System, MATT, data base was used to identify the three most used aggregate sources in each district. Thirteen aggregate sources were identified and sampled for use in this study. Ten gravel sources, two limestone sources and one syenitic granite source were included. Job mix formulas (JMF) for the field projects were also obtained from the MATT data base.

Five AC-30 asphalt cements representative of those supplied to the state were selected for use. All asphalt cements reported in the JMFs were included in this group.

Four of the antistrip manufacturers were requested to submit both their best product (high efficiency) from the approved qualified products list (QPL) and another product (low efficiency) which had previously been on the QPL but deleted after work reported earlier. In addition, a relatively new "super" antistrip was included. Nine antistrip additives were submitted. Hydrated lime was also included as a moisture damage inhibitor. The lime was used both dry and in a slurry form.

TEST PROCEDURES

Louisiana Ten-Minute Boil Test

Louisiana's standard test procedure TR 317-87 was used. A full factorial of thirteen aggregate sources, five asphalt cement sources and ten antistrip treatments (including no additive) was evaluated by laboratory personnel. The dosage rate of antistrip additive was 0.5 percent by asphalt weight according to the department's existing specification.

In addition, partial replicate factorials were evaluated using three aggregate sources to determine reproducibility and to evaluate differences between the antistrip additives and hydrated lime in both a slurry and dry condition. Also, using three aggregate sources the effect of increasing the antistrip dosage to 1.25 percent by asphalt weight was evaluated in a partial factorial.

Indirect Tensile Test

The original Lottman procedure was used while limiting saturation to 55-80 percent and a target air void of 7 percent with a limiting range of 6-8 percent. Because of Louisiana's high annual rainfall and the amount of stripping found in a previous study, the more severe freeze-thaw conditioning rather than the 24 hour soak was used. The length of the cycle was modified to 16 hours freeze and 8 hours thaw to accommodate standard work hours.

Mixtures were prepared according to the job mixes for each of twelve aggregate sources (one of the limestone sources was not used in this analysis). Three asphalt cement sources and seven antistrip treatments were evaluated including four antistrip additives (two high efficiency, two low efficiency), none, lime slurry and lime dry.

Freeze-Thaw Pedestal Test

The Texas modified pedestal test was used in this study. Unlike the boil test which evaluates only the coarse aggregate and the indirect tensile test which evaluates the total mixture, the pedestal test was used to examine both full aggregate mixtures proportioned according to job mixes and individual aggregate components believed to contribute to moisture problems in either the boil or indirect tensile tests. Duplicate pedestal tests were conducted on either full mix gradation, coarse aggregate only, coarse sand only or fine sand only in a partial factorial. For each individual aggregate material or combination, two asphalt cements and seven additive treatments including four antistrip additives (two high efficiency, two low efficiency), none, lime slurry and lime dry were evaluated.

FIELD EVALUATION

The MATT system was searched to identify field projects which were constructed using the coarse aggregate sources used in this study. Two field projects were selected for each aggregate source, one project constructed during the conduct of the study and an older project if possible. At each of five locations on each project a core was sampled and returned to the laboratory for further evaluation. In the lab, specific gravities were determined for air void calculations and then each core was evaluated for external and internal stripping. A subjective scale of 0 to 5 was used with 0 having no signs of moisture damage and 5 being completely stripped. The field experience was analyzed with respect to the laboratory tests evaluated in the study.

CONCLUSIONS

- Each test evaluated, the Louisiana ten-minute boil test, indirect tensile test (Lottman) and the freeze-thaw pedestal test (Texas), was effective in identifying moisture susceptible mixes or individual aggregate components.
- These test methods indicate that most commonly used Louisiana materials and mixes are moisture susceptible and that the current addition rate of 0.5 percent antistrip may not be sufficient to prevent stripping. Addition of

1.25 percent antistrip additive improved boil test results.

- The boil test was discriminating with respect to aggregate source, antistrip source and asphalt cement source. Even though this is a subjective test, no differences were found between raters. Replicate samples produced reproducible ratings.
- The hydrated lime in a slurry form and high efficiency additives performed better than the low efficiency additives. Lime dry performed similarly to several low efficiency antistrips. All additives performed better than no additive.
- An increased antistrip dosage improved the boil test results for two of three aggregates evaluated indicating the potential to use this test for determining antistrip dosage rate for job mix approval. The increase in dosage is necessary because only one aggregate source would meet the current 90 percent retained coating at a 0.5 percent dose. Improvement with increased dosage was also demonstrated to be affected by antistrip source; increased rates did not improve the performance of all antistrip additives.
- The ITT (Lottman) was able to distinguish performance between different aggregate asphalt cement sources. It was not able to determine differences in performance between antistrip additives. Hydrated lime slurry provided ITT results significantly better than antistrip additives. Hydrated lime added dry performed similarly to the low efficiency antistrip additives and the use of no additives.
- As a diagnostic test, the freeze-thaw pedestal test correctly identified potential moisture problems for 8 of 12 mixtures or aggregate components as determined by field experience. The ITT, using a 75 percent retained strength criteria, also identified these same mixtures as being moisture susceptible but incorrectly identified two mixtures which have not demonstrated field stripping. The boil test has similar success in identifying potential moisture problems depending on failure selection criteria.
- The pedestal test was capable of discriminating between all antistrip additives including hydrated lime but did not demonstrate differences in performance between lime slurry and lime added dry as did the other test methods. Also, most of the full mixes tested in the pedestal test did not indicate poor performance which may not make this test useful for establishing job mix performance.

RECOMMENDATIONS

1. The boil test, because it is a quick, easily conducted test, should be used to establish the quantity of antistrip to be used to prevent moisture damage of the coarse aggregate. The current 90 percent retained coating requirement should be continued. The total quantity of antistrip should be limited to no more than the 1.25 percent used in this study. Quantities of antistrip additive above this amount may induce stripping because of the emulsifying agents in the additive. The boil test will discriminate between antistrip additives.

2. The ITT should be used to confirm mix performance as part of the job mix approval. The required tensile strength ratio should be 75 percent, minimum.

3. The pedestal test should be used as a diagnostic tool to identify individual mix components which may contribute to moisture susceptibility. Additional work should be continued to determine the effect of increased antistrip dosages in this test method and determine why the use of no antistrip in the full mixture performed so well. Pending successful results, the pedestal test could be used to supplant the boil test for QPL approval of antistrip additives. While it would take longer to approve the additives, the results would be more objective.

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