FINAL REPORT

LABORATORY INVESTIGATION OF HYDRATED LIME AS AN ANTISTRIPPING ADDITIVE

by

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ABSTRACT

The purpose of this laboratory study was to determine the effectiveness of hydrated lime as an antistripping additive when used in bituminous mixes incorporating aggregates frequently used in such mixes in Virginia. The application of 1% hydrated lime to dry aggregate deterred stripping in 60% of the mixes tested. Applied at the same rate to wet aggregate, the hydrated lime decreased the stripping susceptibility to or very near an acceptable level for all but one mix. An aggregate dust coating reduced the effectiveness of the lime in one mix.

It has been recommended that the use of hydrated lime as an antistripping additive be allowed.

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PROBLEM

Various antistripping additives have been and are being used successfully to control stripping in bituminous mixes. Chemical liquid additives are used most frequently, and Virginia has been using chemical amine type additives for approximately 10 years. There has been some concern nationally and statewide about the long-term effectiveness of the amine type,[1] and should they prove not to be effective for certain combinations of asphalts and aggregates, effective alternatives would be needed. One possible alternative, hydrated lime, has been used successfully in several states; primarily states in the central and midwestern parts of the country. A Utah report states that "the addition of hydrated lime in a bituminous mixture has been observed to increase the mixture's value of immersion compression for some aggregate sources and reduce the rate of increase of viscosity of in-place asphalt cement."[2] This statement indicates that hydrated lime not only benefits the stripping resistance of some mixes, but also possibly improves the characteristics of asphalt cement that influence durability.

New Mexico uses 1.5% hydrated lime in about 80% of their plant mix. They report that lime has been very effective in preventing stripping, and that the mix performs better when the lime is applied to wet aggregate or when it is applied in a slurry than when applied to dry aggregate. Wyoming has used hydrated lime for about 10 years, and while they also use chemical additives, the trend is toward increased use of hydrated lime because of better pavement performance.

Although used successfully in other states, there was no assurance that the hydrated lime would perform acceptably well with the asphalts and aggregates used in Virginia. It had, however, been used in two test sections here in 1982, and stripping tests performed on the mixes predicted better performance from the hydrated lime than from conventional additives. Consequently, the work reported here was undertaken.

PURPOSE AND SCOPE

The purpose of the research was to determine the effectiveness of hydrated lime as an additive in bituminous mixes used in Virginia. Laboratory stripping tests were performed on mixes into which the hydrated lime had been introduced by several methods. The mixes contained a variety of the geologic types of aggregates used frequently in Virginia.

TESTING PROGRAM

For the testing program, 14 mixes were fabricated in which hydrated lime was applied to dry, crushed, coarse aggregates of the following types: Granite (8 mixes), traprock (2 mixes), gravel (2 mixes), quartzite (1 mix), and marble (1 mix). The mixes contained various combinations of fine aggregate, including the types of crushed aggregate just mentioned and natural sands. The hydrated lime (1.0%) was dry-mixed with the aggregate before mixing with the asphalt cement.

A shortened version of the stripping test reported at the 1979 annual meeting of the Transportation Research Board was used to assess the effectiveness of the hydrated lime.(3) Six mixes without lime were tested by the normal method and the results combined with those of 8 similar tests by the Virginia Department of Highways and Transportation's Materials Division to obtain the correlation illustrated in Figure 1. The correlation produced nearly a one to one relationship, particularly near Virginia's acceptance level of 0.75 tensile strength ratio (TSR).

The short version, which was used to allow the testing of a large number of mixes, did not incorporate curing of the mixture at 140°F. (60°C) prior to compaction and the freezing period was changed from 15.0 to 5.5 hours. The short version could be performed in 3 days, whereas the normal method required 1 week.

When it was found that 9 of the mixes tested gave low TSR values, these 9 were duplicated but with the lime being applied to wet aggregate, (2% moisture) which had been reported to give better results than applying the lime to dry aggregate.(4)

Two of the mixes that still gave TSR values less than desirable with the lime being added to the wet aggregate were duplicated using 1.5% lime. Also, for one of the mixes the coarse aggregate was washed before the lime was applied.

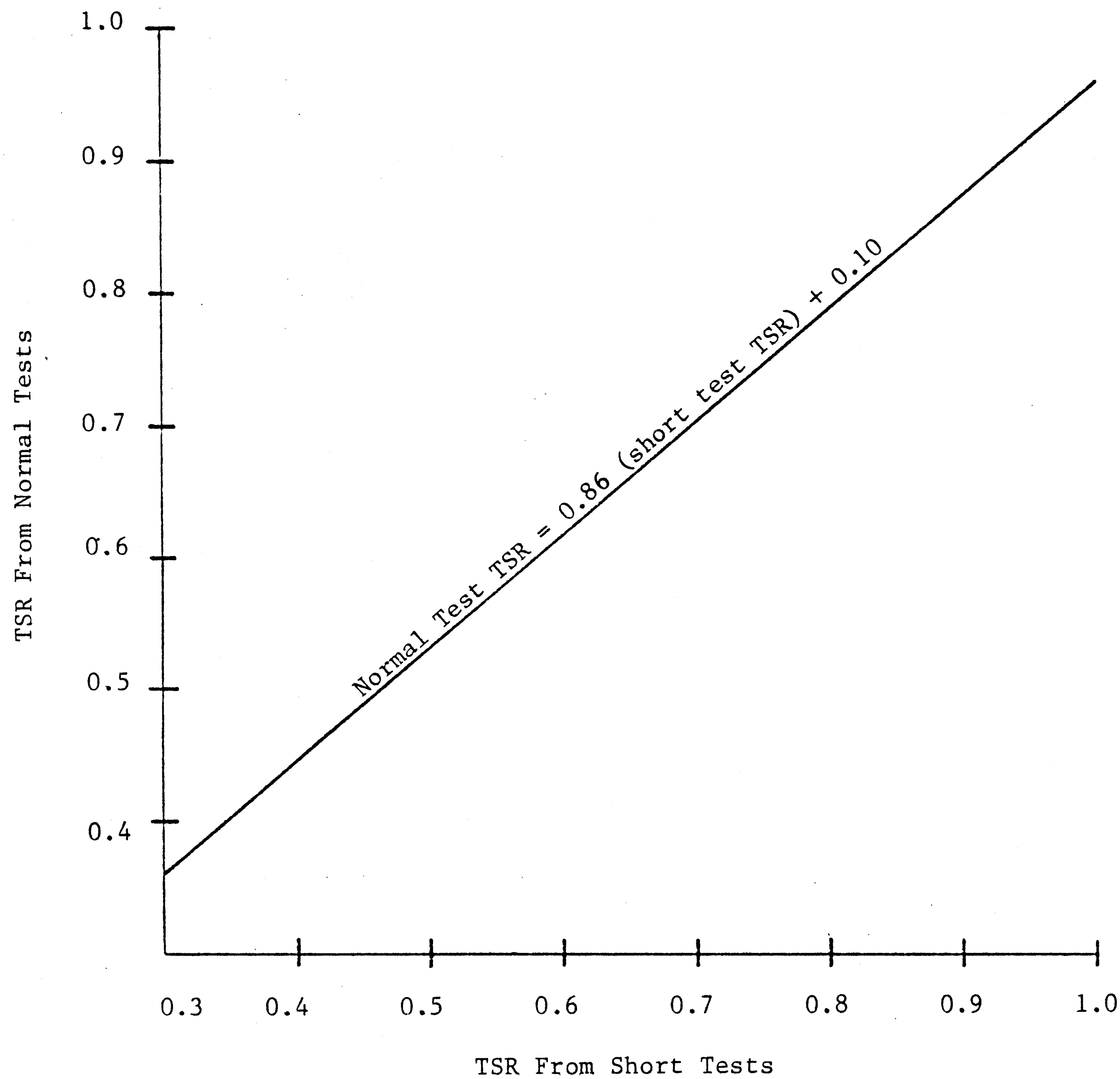

Figure 1. Correlation of normal and short tests.

RESULTS

The results obtained with the short test method are tabulated in Table 1, which also includes the combined Research Council--Materials Division results from previous tests on mixes without lime. The latter values are not considered exact because the quantities and types of fine aggregate used in some of the mixes tested differed slightly from those used in the present investigation.

The application of hydrated lime to the dry aggregates improved the average TSR by 0.26 over the average TSR of mixes with no additive, and for the wet aggregate application the improvement was 0.44. It should be noted, however, that the application to dry aggregate improved the TSR no more than 0.05 in 6 of the 14 mixes. Three of these 6 showed considerable improvement when duplicated with the lime being applied to moist aggregate.

Table 1. Tensile Strength Ratios from Stripping Tests

Mix No.	Coarse Aggregate Source	Dry Aggregate	Wet Aggregate	No Additive*
1	Trego Stone Co., Skippers	0.91		0.40
2	Martin Marietta, Red Hill	0.73	0.88	0.50
3	Luck Quarries, Fairfax	0.67	0.90	0.50
4	Vulcan Materials, Manassas	0.62	0.74	0.60
5	Burkeville Stone, Burkeville	0.85		
6	Boscobel Granite Corp., Manakin	0.60	0.84	0.50
7	Vulcan Materials, South Boston	0.69	0.92	0.65
8	Richmond Crushed Stone, Chesterfield	0.73		0.45
9	Dale Quarry, Chester	0.66	0.84	0.40
10	Lone Jack Limestone Co., Glasgow	0.57	0.63	0.30
11	P. C. Goodloe & Son, Inc., Fredericksburg	0.47	0.72	0.50
12	Massaponax Sand & Gravel, Fredericksburg	0.71		0.70
13	Blue Ridge Stone Corp., Lynchburg	0.69		0.65
14	Rockville Stone, Rockville	0.59	0.73	0.55
10a	Lone Jack (washed +30 aggregate & applied to wet aggregate)		0.80	0.30
10b	Lone Jack (applied to wet aggregate with 1.5% lime)		0.67	0.30
11a	P. C. Goodloe (applied to wet aggregate with 1.5% lime)		0.82	0.50

*Combined results from present study and file data.

It is possible for stone dust to prevent the hydrated lime from adequately coating the aggregate and thus reduce its effectiveness. The amount of stone dust coating was determined as the difference in the -#200 material measured by wet and dry gradations, and an attempt was made to correlate the TSR with the amount of stone dust coating for the 14 mixes. Although the correlation was poor (r = 0.56), it was significant at a 95% confidence level, which means that there is a 95% chance that there is a correlation between the TSR and -#200 material (dust). It was expected that the correlation would be poor because other important factors, such as aggregate mineralogy and texture, are known to affect stripping. The correlation did, however, demonstrate that the amount of dust coating influenced the susceptibility of the mix to stripping.

Two of the mixes, nos. 10 and 11, were selected to determine if other methods of lime treatment would be more effective. These two mixes, which had shown only slight and average improvements, respectively, when 1.0% lime had been applied to wet aggregate were treated by adding 1.5% hydrated lime to the wet aggregate. The additional 0.5% lime increased the TSR of mix no. 10 by 0.04 and that of mix 11 by 0.10. However, in a practical application this small increase in TSR would probably not justify adding the extra lime.

Because it had been noted that the aggregate used in mix no. 10 was rather heavily coated with dust, this mix was duplicated with the +30 aggregate being washed and then coated with 1.0% lime while it was wet. With the washed aggregate there was a definite improvement in the TSR from 0.63 to 0.80.

SUMMARY

The application of 1.0% hydrated lime to dry aggregate prevented stripping in 60% of the mixes tested. Application of the lime to wet aggregate (2% moisture) decreased the stripping susceptibility to or very near an acceptable level for all but one of the mixes. Additional tests on the problem mix indicated that the dust coating on the aggregate particles probably had prevented the hydrated lime from coating the aggregate properly.

RECOMMENDATIONS AND IMPLEMENTATION

Based on the results of the laboratory investigation reported here, preliminary results of a concurrent field study,[5] and the successful use of hydrated lime by other states, it is recommended that its use as an antistripping additive in bituminous mixes be allowed.

When hydrated lime is used an an antistripping additive, it is preferable to apply it to damp aggregate or as a slurry rather than to apply it to dry aggregate.

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