EVALUATION OF LIME AS AN ADDITIVE TO SOIL-ASPHALT STABILIZATION

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This report presents the results of a limited investigation of the use of lime as an auxiliary additive for improving the stabilization of soils with cutback asphalts. It is felt that the data obtained presents additional information on the subject of asphalt stabilization.

Materials used

The soil was a Kansan-age glacial till from southwestern Iowa. Characteristics of the soil are given in Table I.

The lime was commercial calcitic hydrated, $Ca(OH)_2$, from U. S. Gypsum Company, brand name "Kemikal".

The asphaltic materials were MC-0 and MC-2 cutbacks from Texaco Inc.

Table I. Properties of soil used

Textural:	
Sand (2 to 0.074 mm)	32.7%
Silt (0.074 to 0.005 mm)	30.8%
Clay (less than 0.005 mm)	36.5%
Consistency limits:	
Liquid limit	42%
Plastic limit	15%
Plasticity index	27
Chemical:	
Organic matter	0.1%
Cation exchange cap.	20 me/100g
A.A.S.H.O. Classification: A-7-6(13)	

Methods of Procedure

The amounts of cutback asphalt were calculated as a percentage of the weight of the oven dry soil. The amounts of fluids were determined by oven drying the samples at 110°C; they include the weight of water plus volatiles.

Tests specimens were prepared from batches mixed in a Hobart C-100 kitchen mixer at the lower speed. The required amount of soil and lime were first machine mixed for one minute. Then, water was added and machine mixed for two minutes. The asphaltic material was poured into the bowl and premixed by hand. The cutback MC-0 was used at room temperature; MC-2 was previously heated to 150°F. Next, the materials were machine mixed for one minute, the sides of the bowl hand scraped, and the materials mixed again for one additional minute.

Immediately after mixing, 2 in. diameter by 2 in. high specimens were molded to near standard Proctor density (2). The specimens were cured as indicated in Table II, and then tested in unconfined compression with a load travel rate of 0.1 in. per minute.

The most favorable type of curing for compacted soil-asphalt mixtures is air drying to permit evaporation of moisture and other volatile products. For soil lime mixtures it is best to retain the moisture, essential to the formation of cementitious reaction compounds. In order to properly evaluate the stability of a mixture after the required period of curing, it should be submitted to unfavorable conditions which simulate what may occur in the field. One of the most unfavorable conditions that may affect the stability of a stabilized soil base or sub-base is water saturation.

Presentation and discussion of results

The soil-lime cutback combinations tested and the results obtained are presented in Table II. The mixing water added was suggested by a previous investigation made with the same soil (3).

It should be mentioned here that during the process of mixing 6 percent MC-2 cutback with the soil, without lime, at a moisture content of 16 percent, slightly below the optimum for maximum density, the materials formed an unyielding paste, and mixing was discontinued. In previous tests, a similar mixture gave such high resistance to mixing that it broke the mixer (3). When lime was added, even in the smallest amounts, the mixing process proceeded normally. The above difficulties were not experienced with MC-0 cutback. This may be explained by the fact that MC-0 has a lower viscosity than MC-2. It is also possible that MC-2 lost its fluidity, due to heating, when it came in contact with the unheated soil.

Taking into account that only one soil was used in a limited number of mixtures, the observation of mixtures and the results obtained suggest the following comments:

a) With respect to the mixing:

The addition of small amounts of lime improves the mixing of asphaltic materials with cohesive soils. In the case of MC-2 cutback, it was impossible to mix it with the moist clay soils, but previous addition of 1.5 or 3 percent lime to the soil made it possible to obtain an uniform mixture with the asphalt. Visual observations show that uniform mixtures were obtained when lime was used as additive, regardless of the quantity of lime used. With 6 percent MC-0, a good mix was obtained with and without lime as an additive.

b) With respect to strength:

It was observed that only ghe specimens of mixtures with MC-2 stood one day immersion after 7 days of air curing. However the specimens that withstood immersion did not retain much strength, the maximum being 87 psi for the mixture with 3 percent lime and 10 percent MC-2. Seven day air cured specimens of mixtures with MC-0 failed during immersion. On the other hand, soil-lime specimens containing as little as 2 percent lime showed about 90 psi after 7 days moist curing and one day immersion. This may indicate

Table II. Data and results obtained with soil-lime-asphalt mixtures

Mixture No.	Lime, %	Asphalt %	Asphalt Type	Dry density, pcf	Fluids Content, % At molding	Fluids Content, % After 7 days air curing	Fluids Content, % After immersion in water	Unconfined Compressive Strength, psi 7 days air cured plus 1 day immersion	Unconfined Compressive Strength, psi 7 days moist cured plus 1 day immersion
1	3	6	MC-2	105.0	14.8	2.8	14.9	30	ND*
2	3	6	MC-2	103.2	16.2	2.6	20.0	20	ND
3	3	6	MC-2	102.5	18.4	2.8	15.0	60	ND
4	1.5	8	MC-2	105.8	15.6	2.5	20.0	15	ND
5	3	8	MC-2	105.3	16.0	2.5	10.6	60	ND
6	3	10	MC-2	102.0	16.8	3.0	11.5	87	ND
7	3	6	MC-0	105.2	17.2	2.0	ND	0	ND
8	1	6	MC-0	104.4	17.5	1.8	ND	0	ND
9	0	6	MC-0	104.7	17.5	1.8	ND	0	ND
10	6	0	None	102.2	15.0	ND	ND	ND	88
11	6	3	MC-2	102.0	15.0	ND	ND	ND	64
12	2	0	None	107.7	18.0	ND	ND	ND	99

*Not determined

that lime alone is more effective for soil stabilization than cutback asphalts with or without lime additives. There was also some correlation between the fluids content of the mixtures, after immersion, and the decrease in immersed strength. This shows the beneficial effects of the waterproofing characteristics of asphaltic materials.

A comparison of strengths for mixtures 1, 2 and 3 shows that higher strengths were obtained when the amount of fluids was 18.4 percent, which is greater than the optimum for maximum density. This does not correspond with previous findings using a different test to evaluate stability (3).

Additions of small amounts of cutback asphalt to soil-lime mixtures (compare mixtures 10 and 11) may decrease strength by interference with the formation of the cementitious compounds. The consequent reduction of strength apparently is not compensated for by the benefitial effects, if any, of the asphalt.

Conclusions

The following conclusions are based on the observations and tests results obtained in this investigation:

1. Lime can be used in asphalt stabilization of cohesive soils as a mixing aid.

2. However, the stabilization of Kansan till with cutback asphalts does not appear to be promising, even when the soil is treated with lime to facilitate mixing. The same strengths can be obtained with small amount of lime at a lower cost than using cutback asphalt.

3. The addition of small amounts of cutback asphalt to clayey soil-lime mixtures to improve stabilization does not appear promising with conventional methods of mixing. It is possible that lime pretreatment of soils might be promising in connection with techniques of mixing using foamed asphalt (1,4).

References

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