Soil Stabilization with Lime-Flyash Mixtures: Special Discussion*

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●THE paper by Dr. Chu and associates has been read with interest. G. and W. H. Corson, Inc., for a number of years has been investigating the use of lime and flyash in soil compositions, both in the laboratory and as an active participant in the evaluation of numerous roads which have been constructed using these materials. It is quite pleasing to find that an organization such as the Iowa State College Engineering Experi-

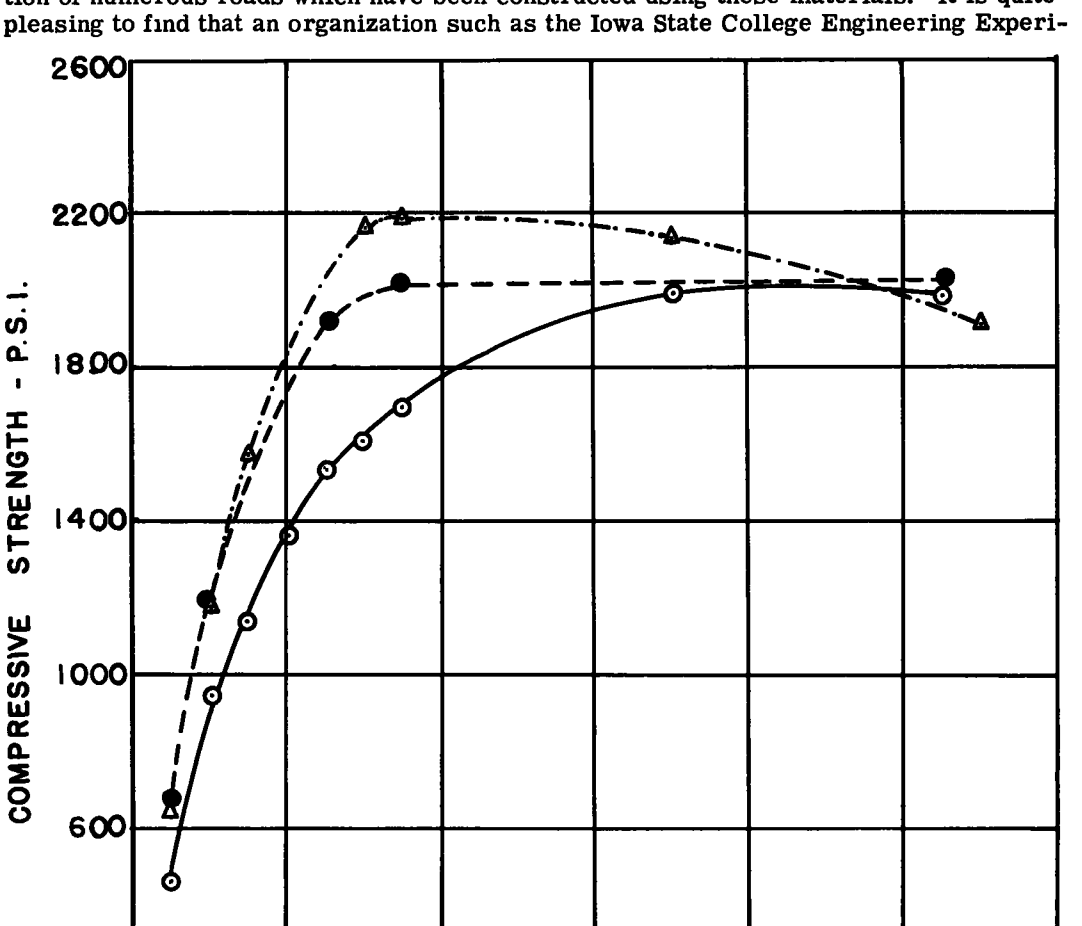

Figure A. Rate of set for lime-flyash soil compositions compacted at optimum density.

* Through an oversight, this discussion was inadvertently omitted from the publication of the original paper, by T. Y. Chu, D. T. Davidson, W. L. Geocker and Z. C. Moh, in HRB Bulletin 108. It is presented here to make available the data and chart included and the authors' closing discussion.

ment Station has carried out the study that it has, and that their findings are in substantial agreement with those that have been reported previously.

Several suggestions to be made in connection with the work of these investigators are believed to be pertinent to studies of this type. First, in connection with the curing of the laboratory samples it should be pointed out that it is of definite benefit to include in the program conditions of alternate wetting and drying cycles or even high-low humidity cycles. The recrystallization of soluble lime hydrates, as well as the autogenous healing which is a function of the bicarbonate reaction in which lime deposits calcium carbonate crystals, are well known phenomena that have an important bearing on the performance of the lime-flyash soil compositions.

In connection with the authors' comments relating to high-temperature curing, lime-flyash reactions are known to proceed over long periods of time; in fact, over many months and years. A rapid laboratory test which endeavors to simulate the long-term effects and assure reactivity of the components must of necessity be carried out at temperatures somewhat above 70 F. Figure A illustrates the type of rate curves which are obtained with accelerated curing at 140 F. Three different series of soils mixtures were tested here, and it will be noted that a plateau is reached within from 5 to 14 days, at which ages the maximum strength is attained. The same specimens when cured at 70 F. will reach these ultimate strength values only after six months to a year of storage. While it might be preferable to make tests at the extended ages, it is felt that where time is a factor, the use of a somewhat elevated temperature is justifiable.

One other suggestion to be made regarding contemplated freezing and thawing studies is that consideration be given to the use of nondestructive sonic methods of test. These have been found very helpful for compositions of this type and may, in fact, yield information which is more significant than that obtained from the wire brush procedure frequently employed by testing laboratories.

The use of lime and flyash with fine-grained and plastic soil has also been reported by other investigators. Of particular interest is a patent[1] issued in January 1955 to Havelin and Kahn, and an interesting paper by R. H. Miller.[2]

D. T. DAVIDSON and R. L. HANDY, Closure — We are highly pleased at Dr. Minnick's interest in our paper presented at the 1955 Annual Meeting, and even following the unavoidable publication delay the remarks are still timely. More recent research at the Iowa Engineering Experiment Station throws light on some of the problems mentioned by Dr. Minnick, and the following discussion draws on these findings. While this is not exactly fair to the discussor, it does enable us to bring out the most recent developments.

Specific points to be mentioned are as follows:

1. Alternate wetting and drying in some cases benefits strength gain more than ordinary moist curing. The reason for this is not definitely known. Comparable results with soil-cement show that wet-dry cycles are in effect an improved moist cure, since average moisture retention is higher (1). Highest strengths with soil-cement and with lime-flyash were realized by a preliminary moist cure followed by continual soaking (2).
2. Lime is less soluble at high temperatures, and recrystallization of lime undoubtedly adds to strength. However, it is believed that the recrystallization effect is mainly one of improving the lime-soil grain contact so as to improve any lime-soil reactions which might take place. Recrystallization would also increase the intimacy of contact between lime and flyash grains and improve the pozzolanic reaction. This was discussed at the Annual Meeting of the ASTM (1).
3. Although our original paper states that carbonation is not a very important factor, in our recent research we have tried to further minimize the effects from carbonation to more closely duplicate conditions in a road. Specimens are molded, double wrapped in plastic sheet and aluminum foil, sealed with tape, and dipped in paraffin. This was found to increase the long-term strength at ages of six months or more (2).
4. Our work indicates that high-temperature curing, while highly desirable from the

[1] U. S. No. 2,698,252.
[2] Proceedings, National Lime Association, 1954.

standpoint of time, may occasionally give erroneous results. In general, strengths with high temperature curing are much more susceptible to differences in the mineralogical compositions and specific surfaces of the soils. In our experience, with certain soils the strengths after 7 days of curing at 140 F. are not always reached by prolonged moist curing. As an illustration, with one silt from Kentucky (2, soil No. 4) and 75: 8. 3: 16. 7 soil-lime-flyash, a strength of 3,200 pounds was realized after seven days curing at 140 F. The high-temperature strength gain leveled off after 14 days with a strength of 4,000 pounds. During moist curing at 70 F. the strengths of wrapped specimens tested at two, six, and twelve months were only 405, 640, and 960 pounds. Extrapolation of the strength gain curve suggests that it would take many years of moist curing for strengths to reach 4,000 pounds.

References

1. Laguros, J. G., Davidson, D. T., Handy, R. L., Chu, T. Y. Evaluation of lime for stabilization of loess. Presented at the 59th Annual Meeting of ASTM, June 17-22, 1956.

2. Goecker, W. L., Moh, Z. C., Davidson, D. T., and Chu, T. Y. Soil stabilization with lime-flyash admixtures: studies with fine and coarse-grained soils. Presented at the 35th Annual Meeting of the Highway Research Board, January 17-20, 1956.