FIELD STUDIES ON STABILIZATION

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This is a report of the progress that has been made in the study of stabilization problems in Indiana, including some observations and conclusions that were obtained during the construction and testing of five test roads.

Indiana, in common with many states, has advanced with remarkable progress in the construction and improvement of her primary highways. Without one dollar of bonded indebtedness, Indiana has almost 100 per cent of her state system mileage surfaced for all-weather use. The rapid improvement in the primary system has created a wide margin of difference between the secondary roads and the main highways. Funds for the improvement of the secondary and county systems are extremely limited, and, as a result, attempts are being made to provide a low-cost improvement.

It is in this phase of development that research must play its part to produce methods, procedures, or information that can be used to construct a more durable road at a lower cost.

Research in Stabilization

Field. With this object in mind, the program of research in stabilization was formed to include parallel studies in the laboratory and in the field. Following a preliminary laboratory investigation, the construction of the first stabilization test road was undertaken. A soil profile was made of the proposed site, specifications were drafted, and testing procedure was outlined for the construction and testing of thirteen sections of stabilized materials representing seven different admixtures and two distinct types of stabilization.

The common materials available for this type of work in Indiana were selected, and admixtures representing those types in common use were designated as stabilizing agents. Two sections were constructed using crusher-run stone; three sections consisted of soil stabilized with portland cement; and six pit-run gravel sections were stabilized with calcium chloride, sodium chloride, tar (TM-2), road oil (SC-3), two asphaltic emulsions, and two gravel sections without admixtures.

In constructing the sections it was desirable that the material be plant-mixed rather than mixed in place, although in the case of two soil-cement sections, a small road-mixing device was used. A ten-cubic-foot-capacity concrete mixer served to mix the stabilized materials before placing to a loose depth of nine inches. In compacting the materials at the optimum moisture content, a tractor-drawn sheepsfoot roller was used in conjunction with a five-ton flat-wheeled finishing roller.

Since it was the object of the investigation to study these sections during their service after each of two stages of construction, the testing program was based upon a two-year schedule. The first year the sections served as wearing courses, and controlled traffic was maintained throughout the different seasons. Following stage-construction practice, the road was repaired and a surface treatment was constructed at the end of the first year. The second year was devoted to testing and observing the stabilized materials serving as base courses. Inasmuch as this particular road was not a part of a highway system, it was necessary to provide traffic. The controlled traffic used in the testing consisted of dual-tire dump trucks loaded to a gross weight of 8,000 pounds and making 200 to 300 passes per day.

The effect of the traffic upon the stabilized sections was recorded in terms of deformation of the cross-section measured by level and rod, and by use of a profilometer. The amount of maintenance was recorded as well as visual observations of the amount of dusting, raveling, checking, cracking, and the degree of firmness of each section. Certain tests, principally the determination of density of the sections and the migration of the chemical admixtures, were performed between the two testing periods.

During August, 1939, a 70-pound surface treatment was placed on the surface of the sections, using No. 9 and No. 12 stone plant-mixed with RC-3. One-half of the area of each section was sealed with an additional coat of RC-3 and sand to enable a study to be made of the relative waterproofing action of "open" and sealed surface treatments. Testing of these sections was completed following the spring season of 1940.

In order that the stabilization program might be broadened to include a variety of soil types, construction procedures, and design methods, several stabilization jobs in the state were observed during the summer of 1940. In each case a soil profile was made of the road, and the material to be stabilized was tested to determine the gradation characteristics and soil test limits. During construction, records were made of the quantities of water, soil, and admixture added to the material to be stabilized. Mixing and compaction data, moisture contents, and densities were recorded and assembled for use in analyzing future performance of these roads and in determining the importance of certain factors in material properties or construction procedures.

These test roads form a part of the field stabilization work that is contemplated. Already observations have been made on the use of a tar admixture to a silty soil, and road oil with an intermediate soil. These two test roads together with the local test road give an opportunity to observe these admixtures under a variety of conditions and circumstances. A third test road is the surface consolidation experiment constructed in one of the nearby counties. These three test roads observed by staff members during the last summer will be supplemented by additional test roads constructed with other admixtures and perhaps in other soil types.

Laboratory. Paralleling the field work is a series of laboratory studies each intended to evaluate some of the factors of stabilization. The resistance of stabilized materials to failure is being studied by means of the tri-axial shear testing device that imposes a horizontal supporting pressure upon the test specimen at the time vertical loads are applied. The minitrack testing equipment is doing similar work in measuring the resistance of various mixtures to deformation under moving wheel loads. The effect of admixtures upon the permeability of a soil and the desirable thickness of bases is being studied by means of photoelastic determinations of load distribution.

Associated Studies. From the broad stabilization program have grown several studies of importance to stabilization, among which may be found the migratory characteristics of chemical admixtures, subgrade soil temperatures, and groundwater, soil-moisture studies. Each of these factors has an important bearing upon the service life of stabilized mixtures.

There have been numerous facts tabulated concerning stabilization, but since many of them are contingent upon special conditions, only the more general observations will be included in this report. Therefore, in contemplating a stabilization project it is imperative that the following items be given careful consideration.

Conclusions

1. Essentially, the function of admixtures in stabilized materials is to control the effect of moisture on the fine soil particles either by waterproofing, by chemically uniting the particles, or by minimizing the moisture fluctuation.
2. Disregarding swell, most soils can be economically compacted to a degree that will prevent the entrance of water in quantities sufficiently large to be damaging. Therefore, sufficient compaction is of prime importance.
3. Initial compaction of soil-cement mixtures must be adequate because, unlike other types of stabilization, traffic loads do not continue to compact the material after it has "set-up".
4. Highly plastic soils should be avoided whenever possible because they lose stability when wet. The harmful effects of plastic soils are functions of the amount of soil in the mix as well as the plasticity index of the soil.

5. In general, admixtures which minimize the amount of moisture in the stabilized mix seem to provide the most satisfactory bases.
6. In constructing stabilized roads using bituminous admixtures the moisture content should be kept as low as possible to maintain good mixing and compacting conditions.
7. The amount of admixture required depends largely upon the gradation of the material to be stabilized; increasing amounts of fine material require more admixture.
8. In stage construction, stabilized bases should receive a light seal coat as a temporary protective covering. In soil-cement mixtures and mixtures containing bituminous admixtures low in cohesion, this seal coat should be applied as soon as possible.

MIGRATION OF CALCIUM AND SODIUM CHLORIDES IN SOIL

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The study of chemical migration in soil, as far as the Joint Highway Research Project was concerned, resulted from three conditions. First, the Staff had become interested in investigating the permanence in soil of calcium and sodium chlorides, since road treatments with these chemicals are periodically repeated. If such roads must be retreated once or twice a year, what becomes of the salts? Second, the Project had already constructed two test roads, both of which included sections stabilized with calcium and sodium chlorides and from which samples could be readily obtained. Third, the Project's work on frost action in chemically stabilized bases and subgrades had revealed that two or three per cent of either calcium chloride or sodium chloride could practically eliminate frost heaving in certain soils at temperatures as low as -15° F.

Naturally, the Directors and Advisory Board of the Project became interested in investigating the permanence and distribution in soil of such water-soluble, inorganic salts as calcium chloride and sodium chloride. In recent years, the trend in the use of these low-cost compounds has been directed toward their utilization in highway bases as a stabilizing chemical and in highway subgrades as a means of preventing frost damage.

The following discussion will be limited to chemical movement in the Joint Highway Research Project's Test Road No. 1. This test road was constructed in the fall of 1937 to study the effect of weathering, without traffic, on subgrade and stabilized