EFFECTS OF BASE COMPACTION ON MAINTENANCE COSTS AND PERFORMANCE

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SYNOPSIS

Emphasis in this paper is placed on the importance of proper compaction of highway embankments and the necessity of a certain time passing before the complete stabilization of the materials can be accomplished. In the desire to open a road as quickly as possible, this time element is often overlooked. The maintenance man frequently finds that the beautiful road turned over to him soon settles and breaks up, requiring repairs soon after completion. The psychological effects of seeing holes being drilled in new pavements to allow mudjacking operations to correct faulty compaction is undesirable. It is likewise expensive.

As the conditions under which embankments are placed can seldom be controlled to an ideal, uniform compaction cannot be secured by mechanical means alone. Time must be allowed for complete adjustment of the particles. Experience gained on maintenance work indicates that at least one year's time should elapse before placing a high type costly pavement. During such time a temporary surface such as gravel, crushed stone or cheap bituminous treatment should be applied.

The discussion is also true for the so-called lower type pavements. Even though these receive mechanical compaction, some time should be allowed for final adjustment to take place before they are subjected to the maximum traffic.

The object of this paper is to emphasize the importance of the proper compaction in highway construction work and the time element that is so necessary to bring about the complete and final stabilization of the materials used. The time element is often overlooked in the hurry to get the road opened to traffic.

The effects of faulty rapid construction bring about maintenance operations that are costly and at the best unsatisfactory. How often does the maintenance man find the beautiful road turned over to him, settling out of shape, breaking up, and needing repairs in less than a month after it is completed? All of the patching, mudjacking or other efforts, that are most costly, cannot bring a pavement that has settled out of shape, back to the condition it should have been in when completed. Naturally the psychological effect is bad to see maintenance crews drilling holes in a new pavement or performing other operations necessary to correct faulty compaction of materials in construction.

In the grading operations, it is seldom that conditions are ideal to bring about uniform or final compaction by mechanical means alone. In rolling a fill, if the materials are too wet, they will muck; if just moist, they will become tough and bridge over; and if too dry, they will break down into powder. Even if an effort is made to control the moisture content, as called for in some specifications, time must also be allowed for a complete adjustment of particles. From the experience gained with the maintenance of many miles of new pavement, it appears a year is the minimum time before a high type, costly pavement can be laid on a grade, with safety. During this period the grade should be thrown open to traffic and a temporary surface maintained with crushed stone, gravel or other materials. Dust on such a road could be held to a minimum by one of the dust palliatives in common use, or by a cheap bituminous surface treatment.

Such a procedure may be considered a step backward, but public opinion will soon be behind the engineer, who can

build a road that will stand up and take the traffic it is subjected to instead of one that starts to fail a month after it is completed.

The above argument has dealt only with the grade. The same principles that apply to the grade are only too true for the so-called lower type pavements. Surfaces made of sand-clay, soils, gravel or crushed stone must have time to compact thoroughly before they will carry their maximum capacities without failure. Even though assisted by mechanical means these types need time to take a final adjustment. Bituminous surface treatments on these lower types will surely fail if applied before traffic and weather conditions have been allowed to have their effect.

Again it is most disconcerting to the maintenance man, and at the same time puzzling to the public, to take over a new bituminous surface treated road that in a few months begins to fail. All who have had experience with the lower type roads have seen many first bituminous treatments fail within a year.

This could be prevented by allowing more time for the surfacing materials to cure and take their final compaction. Assisted by dust palliatives and the proper machining operations, roads constructed with sand-clay, soil or other low type materials will carry traffic most comfortably while the setting up process is in progress.

There are cases where the low type surfaces, that have been allowed time to consolidate, are carrying the same traffic as the higher types on the same road and at no more maintenance cost.

Optimum moisture content is usually defined as the amount of water necessary to be mixed with soil to produce the maximum compaction with a sheepsfoot roller or other mechanical means. This sounds simple enough, but it is doubted if many of the states are actually carrying this procedure to actual practice. The whole matter seems to be looked upon with suspicion and will be until

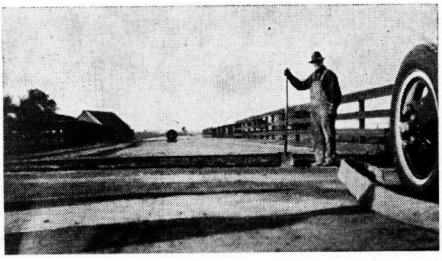

Figure 1. Settlement of a Concrete Pavement Slab Next to a Bridge

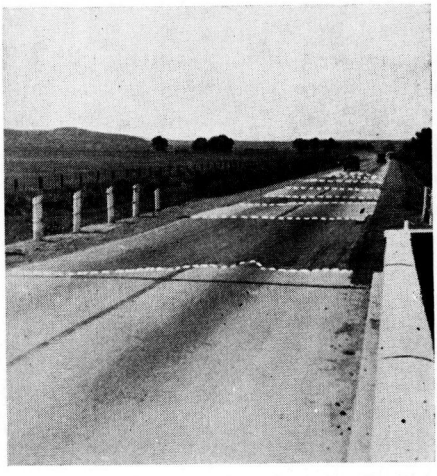

Figure 2. Settlement of a Concrete Pavement Slab Over a Low Fill

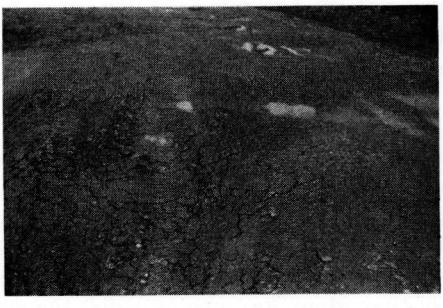

Figure 3. Failure of Bituminous Surface Over a Poorly Compacted Base and Fill

further knowledge on the subject is made general. Quoting from a leading engineer, who has had many years of experi-

ence, he has the following to say. "It is unfortunate indeed that so many engineers have only a slight knowledge concerning soil behavior and are little concerned about it. To many, 'dirt is dirt,' and their designs are usually made massive to take care of the worst anticipated conditions, with no thought or provision for possible modification of the soil itself." Further quoting from the same source, "Many bases have failed, not because of poor quality, but because they were not consolidated, and the surface placed thereon became distorted later as further compaction occurred under traffic."

Figures 1, 2 and 3 show the results of faulty compaction.

DISCUSSION ON BASE COMPACTION

MR. W. W. MACK, *Delaware Highway Department:* A pavement about 20 years old on a heavily traveled route—heavy truck traffic—began to show failure and we began to resurface it. It was noticeable that it was in good condition in some localities and in others it was in very bad condition. It was decided to patch it with concrete and resurface it with bituminous material and before proceeding with it cores were taken throughout the job and soil samples were taken underneath the pavement. The point of interest to me was that in 95 per cent of the samples the strength of the concrete varied in proportion to the soil classification. The soil classification ranged from A1 to A9 and in the A9 soil it was impossible to remove the core and in the A1 soil there was a good quality of concrete. It showed conclusively that the failure was not due to nonuniformity of concrete but rather to nonuniformity of subgrade material.

MR. W. H. ROOT, *Iowa Highway Commission:* I have always felt that the maintenance division of a highway department has two distinct functions: First, the maintenance organization is supposed to keep the highways repaired so that they are usable, and second—and probably of more importance—they are supposed to detect errors made in design and construction. Unless these errors are found and corrected we are not fulfilling our job. Speaking of specific instances we are beginning to have failures in concrete pavements built 10 or 12 years ago most of which are due to corner breaks occurring in cuts where we now know that the subgrade was unsatisfactory. We are not placing pavements on that type of subgrade any more, but it took us a long time to find that out. In that connection I would like to point out one other thing. I am not sure that those pavements in soft cuts would even have stood up if our loads had had a legal limit of 4 tons per wheel. In the weighing of vehicles, we are finding that one out of three vehicles violates our laws, not only in weight but in other respects. A good many are carrying 10 and 12 tons to the wheel. I think the roads are just beginning to get these big loads which break them down.

MR. W. R. MACATEE, *The Asphalt Institute:* Has there been any increase in the contact areas of the tires? Mr. Root indicates that there has been considerable increase in weight. How about the increase in contact area?

MR. C. N. CONNER, *Public Roads Administration:* A number of speakers at these sessions have very properly called attention to the importance of designing subgrades. By experiment and analysis we know something about loads and their bell-shaped distribution of stress through flexible pavements to the underlying subgrades. We know, also, that the intensity of pressure on subgrades under flexible pavements is greater than the unit pres-

sure under rigid pavements. However, there is no generally accepted rational formula for the design of subgrades or for flexible type surfaces.

Wherever soil mixtures under pavements have been designed and constructed to have a uniform and known bearing power sufficient to support the pavement and its live load without subgrade displacement, the life of the pavement has been increased and its maintenance cost reduced. Experience in California, Massachusetts, Michigan and elsewhere has shown that the cost of preparing a proper subgrade can be justified whether the pavement is of the rigid or the flexible type.

A practical and useful discussion of subgrade design and construction utilizing low-cost local soils may be found in a report submitted to the Design Department by Bernard Gray at the Joint Session of soils and Design on December 5.[1]

C. M. UPHAM, *Chairman:* Mr. Poulter, have you an opinion as to why some of these failures do not occur right away?

[1] "Present Design Practice and Construction Developments in Flexible Pavements," See page 175 this Volume.

MR. JOHN W. POULTER, *Koehring Machine Company:* The causes may start four or five years back or develop rather slowly depending on the amount and nature of the traffic. The action of traffic over the slab may cause a shifting of the water under it, more particularly at a joint or crack. This may cause a slight washing effect, very little at first and increasing in rate, very slowly, as traffic continues to use the pavement until enough subgrade material is washed out to allow the slab to break down.

MR. FORRER: To substantiate Mr. Poulter's statement, the condition we are finding in Virginia is this: that on our heavy traveled roads that were built of concrete—some of the newer pavement joints began to pump in less than a year's time. The amount of heavy traffic is a controlling factor. Pavements carrying a small amount of heavy traffic do not develop the pumping action as soon as pavements that are continually pounded by a large amount of heavy traffic. Subgrade treatment seems, for the time being at least, to be solving the problem of pumping action but even then if too much water is allowed to get under the pavement trouble can be expected.