soil-cement mixture the particles are cemented together at their contact faces.

Since the oldest cement-stabilized road is only 6 years old and it has not been subjected to the most severe climatic conditions, it would be dangerous to make a prediction as to the probable life of this type of construction. It is the writer's belief that little or no consideration should be given to an attempt to stabilize soils with cement in Iowa in 1924. The work done at that time was very similar to the present practice with two very important exceptions. In the 1924 work, the mixture of soil and cement was not wetted artificially and it was not rolled. The dry mixture of cement and soil was smoothed off and left to be moistened by rains and compacted with traffic. The road was never considered a success, and now, 15 years after it was constructed, there is no evidence that the soil is different from what it was originally. It is unfortunate that this old road was not properly wetted and compacted so that we would now have some reliable evidence as to the durability of this type of construction built according to modern practice.

Constant improvements are being made in methods for constructing soil-cement roads. There is one point where further improvement would seem possible. It has been observed that the density obtainable by the Proctor method, immediately after the water has been incorporated into the mixture, is considerably greater than it is on the material that has been allowed to stand two or three hours. With the road-mix method of construction now followed, a considerable period of time elapsed between the addition of the water and the compaction of the mixture. It would seem worthwhile to consider some method that would reduce this delay.

The present method used for designing the mixture consumes more than a month. This length of time is much too great to meet situations frequently encountered in highway work. Haunsel has mentioned this and has suggested the possibility that the void-cement ratio might be a criterion which could be used. Serious consideration should be given this or some other substitute for the present method for routine work.

STABILIZING GRAVEL AND STONE ROADS WITH TAR

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I believe that all of us are interested in developing a secondary road type that will stand a reasonable amount of heavy traffic and yet not cost so much as to keep it out of the reach of any of our counties. It was with this idea in mind that in our county we interested ourselves in the use of tar as a road-
building material. Early in 1938 we developed a program and bought enough tar to construct four miles of road. We selected three roads in different localities which would represent as nearly as possible a cross-section of our roads. We also selected roads very heavily traveled. One road has a very heavy clay base, another a sand, and another a muck and clay.

One was a new road completed just before the tar treatment. Here a 4-inch spread of gravel and clay was made over the width of the road. On the other roads no new material was added. The roads were scarified to a depth of about 6 inches,
and the loose material was bladed with power graders until pulverized. All oversized stones were removed. Then tar was applied until we had about 0.9 of a gallon per sq. yd. of road surface, or approximately 2 percent by weight. This amount was found to be enough for the processing of the base. We found that upon laying out and rolling the mixture, we had about 6 inches of compacted material. Then a tack- or light-seal-coat was applied and covered with pea gravel. Later a seal-coat was applied. Here we use about 0.3 of a gallon per sq. yd. and again apply all the pea gravel the tar will incorporate. After such an operation, your road is now finished and you have in one operation built a road adequate for any except the most excessive traffic conditions. At no time is it necessary to close the road.

This method builds what we call a “tar-processed base road.” The short period of time required to build these roads makes them very economical and adapted not only to county operation but to state and federal work as well. Our experience indicates that a mile of road can easily be completed in 5 working days or less.

We used 55,427 gallons of TM-2 and 15,014 gallons of TH. Our estimated total sq. yds. of surface was 51,981. We used a trifle over 4,000 gallons of TM-2 as a base treatment for one-half mile of road on which we spread a course of asphaltic road oil mix.

The saving in time is quite as important as the low cost per mile. The materials’ cost, in place, per mile of seal and base processing, was $1,550 for a finished road. It cost us $1,390 per mile to process the base to a depth of 4” to 6” exclusive of the seal cost. The rate of application and cost per
mile are governed by local conditions, climate, topography, and soil. It must be kept in mind that this processed base is then ready for any of the standard types of bituminous surfaces.

After the first mile we decided that three power graders, a multiple-blade maintainer, and a roller were all the equipment needed to build these roads. At least one of the power graders should be equipped with a windrow eliminator. The first step in operation was to scarify the road to a depth of between 4 and 6 inches. This scarified material was windrowed and turned until pulverized. Then the material was split into two windrows for more efficient mixing. One windrow was then spread out wide enough to receive an application of tar of about 0.3 gallon per sq. yd. This was bladed and mixed, and an additional shot of about 0.2 gallons was applied. After a thorough blading, this was laid out, and the second windrow was treated in the same manner. When complete, the surface was struck off with a power grader with a windrow eliminator attached. The base was compacted with a 10-ton, 3-roller followed by a multiple-blade maintainer. A light tack-coat must be applied and covered lightly with fine aggregate as soon as the rolling is completed. Under no circumstances should the application of the tack-coat be delayed.

To date, these roads have shown no failures. With one exception, they are holding much better than expected. One road was not sealed or tack-coated for some time after treatment, and this road has one bad spot near the end which will have to be repaired. On the others, there have been no signs of distress to date. These roads have a hard, smooth, non-skid surface and seem to be the answer to construction and maintenance problems of our secondary roads.

A GENERAL DISCUSSION OF ROAD STABILIZATION

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We are all more or less familiar with the general character, appearance, and composition of the granular materials used in Indiana, such as limestone, sand, gravel, and slag. No doubt some of you have encountered difficult problems in the handling of these materials in various types of construction work. But let us try to visualize some of the many complex characteristics of the various soils with which you have to deal in stabilization; then you can readily see that some of the problems in soil stabilization may become somewhat involved.

Soils are of mineral origin and are formed from the disintegration of rock through the agency of wind, water, ice, frost, temperature changes, chemical action, plant growth, animal life, and decomposition. A soil may differ considerably