PHYSICAL CHARACTERISTICS OF ROCK ASPHALT

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The investigation of rock asphalt and its performance as a road surface was started for the purpose of studying the inherent characteristics of the material that contribute to the construction of satisfactory and unsatisfactory pavements. The most logical starting place for such an exploratory study was the quarries from which the material was produced. Accordingly, two of the large producers in the southwestern part of Kentucky were approached, and they agreed to furnish the necessary samples of material for this study.

Curing and the consequent changes in physical properties of rock asphalt—including moisture and asphalt contents, penetration of the recovered asphalt, and stability of the rock asphalt—were studied under various conditions.

The effects of manipulation and road curing on the properties of rock asphalt were studied on three 1938 highway resurfacing projects. Samples were taken at different construction steps from the time the material was received at the job until it was in place on the road surface. After the surface was completed, the three roads were sampled at periodic intervals until they had been in service for approximately 300 days.

Three quarries were investigated during this study. They fell into two geological formations, one being in the Pottsville series and two in the Chester series. In most cases, the quarry lying in the Pottsville series consisted of rock asphalt that contained a softer asphalt than the quarries in the Chester series. For this reason, the designation of hard and soft rock asphalt in this paper refers to material from the Chester and Pottsville series respectively. The line of demarcation between hard and soft material was arbitrarily set at 100 penetration of the recovered asphalt, the hard rock asphalt being below and the soft material above this figure. The investigations revealed considerable lack of uniformity of content and consistency of the asphalt in the sandstone.

Quarry B in the Chester series contained material having a low average asphalt content of 3.5% with a low penetration of 26. However, Quarry C, in the same geological stratum, had an average penetration of 199. Quarry A in the Pottsville series contained asphalt with an average penetration of 264. Variations were also apparent at different faces and horizons in the same quarries. Penetrations of the asphalt in Quarry A, sampled along the same horizon for a distance of 100 feet, varied from 267 to 459. The asphalt contents varied from 6.02 to 8.73 per cent.

Quarry B contained asphalt with penetrations from 26 to 347, the harder asphalt being confined to the south face of the quarry. The lower horizon of this quarry contained harder asphalt than the upper. Quarry C showed that the south face contained harder asphalt than either the east or west faces. These irregularities are controlled to a certain extent by hand selection and blending of the quarry stones by the workmen and by close laboratory control at the plant.

Sieve analyses showed that the sand grains that have been freed from asphalt were not closely graded and fell mainly between the No. 40 and No. 200 U. S. Standard sieves. Examination of these results also showed that the graduations of the sand did not vary greatly between different quarries.

Stockpile curing was observed at the laboratory by periodic sampling and testing of two 1,000-pound stockpiles, one containing hard and the other soft rock asphalt. Fig. 1 shows the effect of stockpile curing on penetration of the recovered asphalt from a soft rock asphalt. The upper curve represents material from the interior of the stockpile, and the lower curve was obtained from results on samples taken from the exterior crust (constituting about ½ inch of the stockpile.) It will be seen from the lower curve that the crust dropped from an original penetration of 166 to an average of 42 (or 75%) during curing. The interior or bulk of the stockpile dropped from 166 to 142 during curing, for a total drop of only 14%.

Fig. 2 shows the effect of stockpile curing on Hubbard-Field stability values of the same soft rock asphalt that was used for the curves on Fig. 1. The upper curve represents the crust and the lower curve shows results from the interior of the stockpile. This upper curve indicates that the stability of soft rock asphalt from the crust increases rapidly with curing up to 90 days, after which the stability remains fairly constant. The high stability shown at 202 days of curing was attributed to difficulties encountered in sampling the stockpile and was disregarded as a significant change. The stability increased from an original value of 950 to an average value of 2,000 lbs. during this test. The material from the interior of the stockpile represented by the lower curve likewise increased with curing, but the increase over the original stability was only 250 lbs. as contrasted with the 1,050 lbs. increase in the crust.

Fig. 3 shows the effect of stockpile curing on penetration values of asphalt from a hard asphaltic sandstone. The curves reveal that with such a hard original asphalt, having a penetration of only 23, the susceptibility to change in penetration is slight either in the crust or interior of the stockpile.

Fig. 4, showing the effect of stockpile curing on Hubbard-Field stability values of hard rock asphalt, parallels the results shown in Fig. 3, in that stockpile curing of a hard rock asphalt has little effect on the physical properties studied either in the crust or material from the interior.

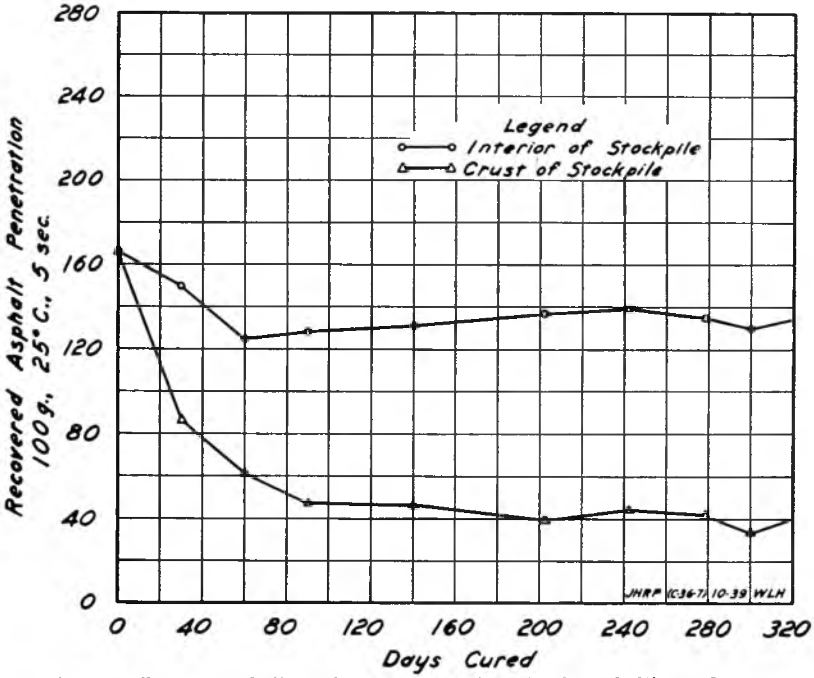

Fig. 1. Effect of stockpile curing on penetration of soft asphaltic sandstone.

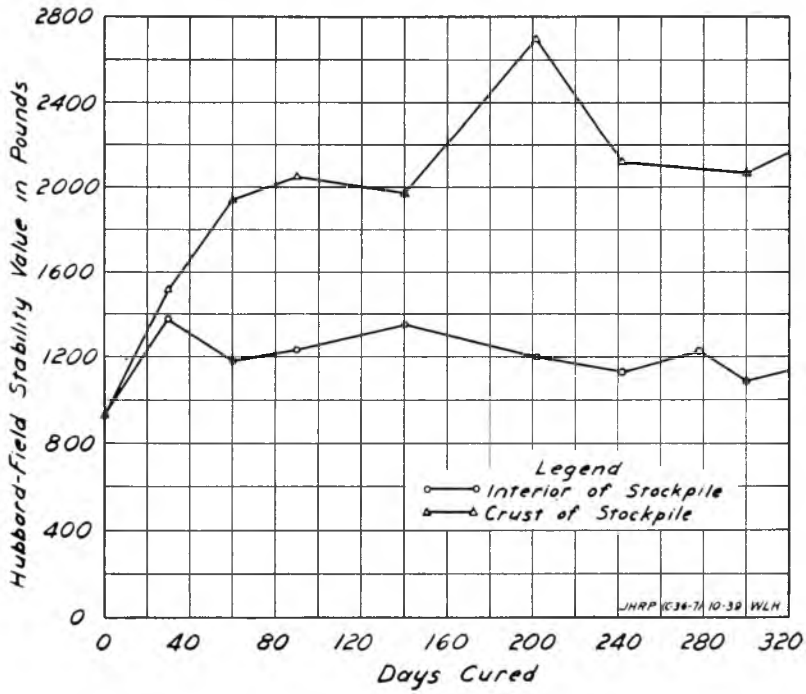

Fig. 2. Effect of stockpile curing on Hubbard-Field stability values of soft rock asphalt.

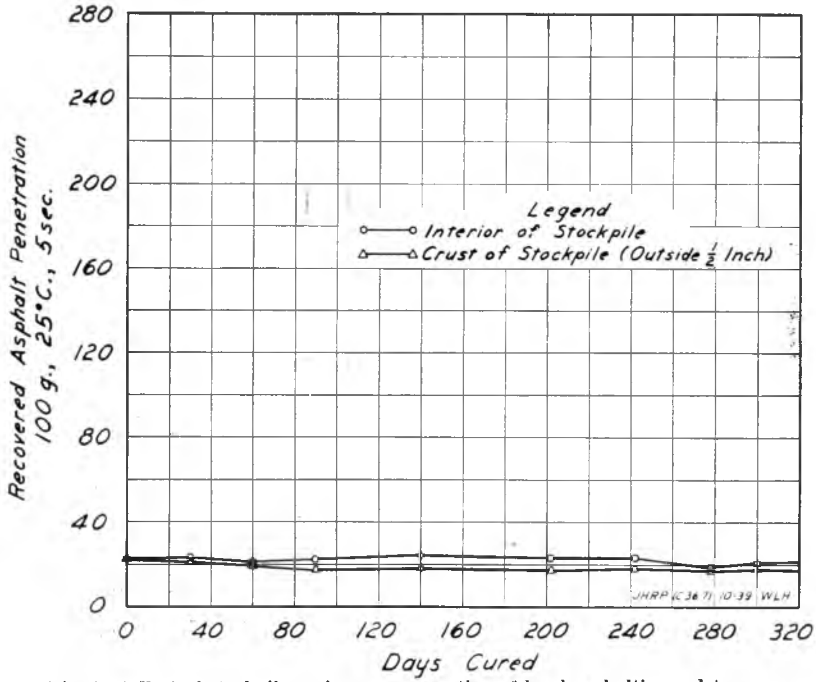

Fig. 3. Effect of stockpile curing on penetration of hard asphaltic sandstone.

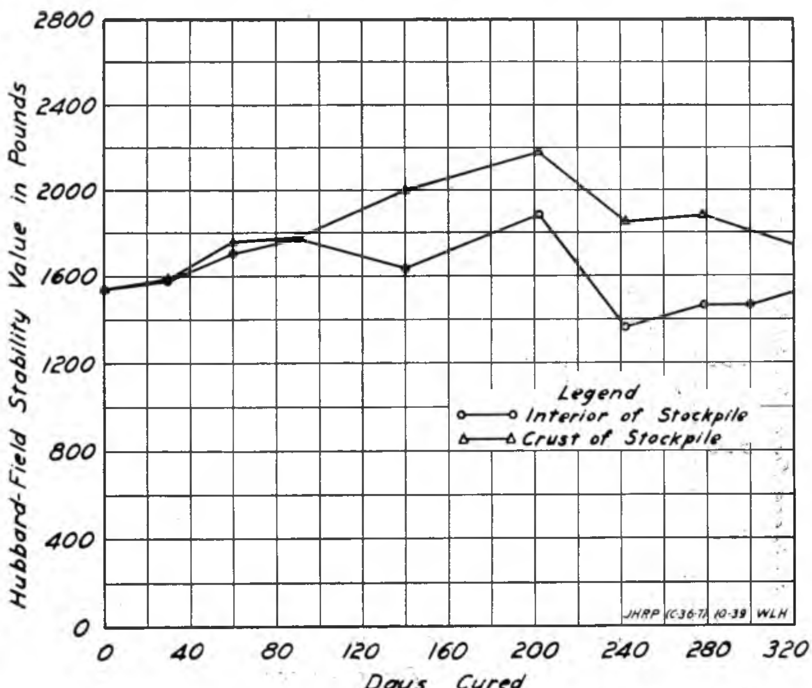

Fig. 4. Effect of stockpile curing on Hubbard-Field stability values of hard rock asphalt.

The changes in physical properties during laying and after service in the road were investigated on three Indiana highways in the northern, central, and southern parts of the State. Fig. 5 shows the locations of the three road projects studied. The projects were selected in different parts of the State in order to reveal any effect of climate on the physical properties

Fig. 5. Outline map of Indiana. Rock asphalt resurfaces on three 1938 highways.

with 300 days of road curing. These roads were resurfaced under maintenance contracts and considerable credit is due to the inspectors and engineers on these jobs for their cooperation.

Fig. 6 is a composite curve from the results obtained on soft rock asphalt from the three road projects. Each point on the curve is an average of results on five samples from each of the three roads, and therefore represents fifteen samples. The changes in physical properties with manipulation and road curing are shown by increases or decreases in penetration of the recovered asphalt. Observation of the left portion of the curve reveals that steaming in the cars to facilitate removal softened the asphalt slightly, but that during transportation to the road and spreading this penetration was decreased. Steaming also added moisture to the rock asphalt by approximately one per cent, but again, spreading on the road before rolling allowed most of this added moisture to evaporate.

Traffic and natural weathering of the rock asphalt in the compacted road surface hardened the asphalt over a period of 300 days, with the greatest rate of drop in penetration occurring during the first 30 days. After 30 days the penetration lowered gradually, and the curve tends to level off at 240 days.

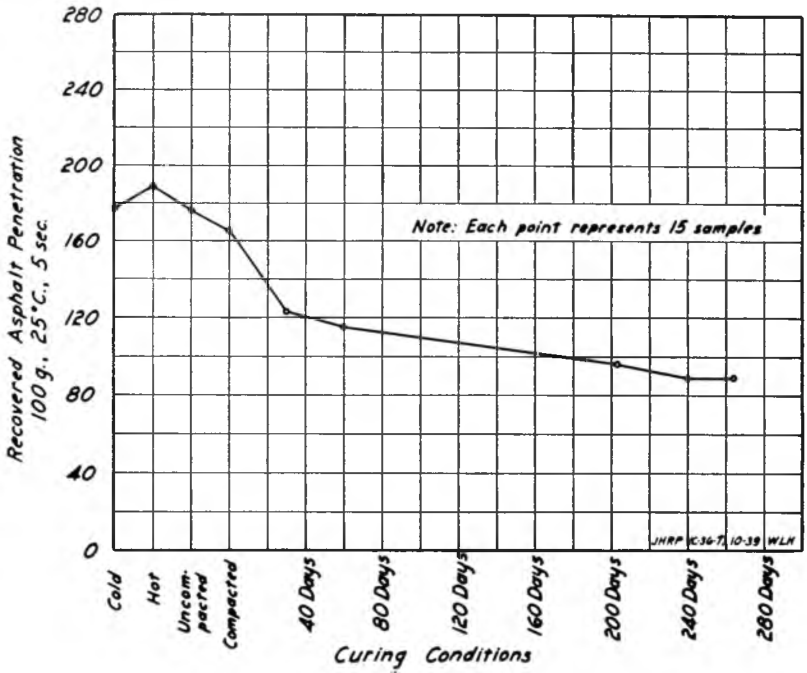

Fig. 6. Composite chart showing effect of road curing on penetration of soft rock asphalt in three roads.

Conclusions

A few conclusion from this exploratory investigation are offered in the following statements. Some of these are based on careful observations, but the majority are founded on results from experimental data obtained during this investigation and are substantiated by numerous check tests.

1. Although there was a lack of uniformity in the hardness or consistency of the asphalt in the original sandstones, the differences were not apparent upon observation of the service performances of the materials.

2. Curing in stockpiles without disturbing the material was less effective for increasing the stability or decreasing the penetration of the asphalt from the interior than on samples taken from the crust.

3. Carefully controlled steaming in the cars increased the moisture content of the rock asphalt slightly, but the aeration period between spreading and compaction allowed this moisture to evaporate to a percentage closely approximating that in the original material.

4. Road service for 300 days decreased the penetration of both the hard and soft rock asphalts. Different climatic conditions apparently caused no differences in penetration changes as evidenced by the comparison of the curing curves of the northern and southern projects.

5. Failures in rock asphalt surfaces were attributed chiefly to lack of sufficient bases and poor drainage conditions. The failures observed on some of the roads constructed in 1936 were tentatively assigned to the following causes: (a) uneven distribution of the asphalt on the sand particles, (b) excess inherent and added moisture in the rock asphalt, and (c) insufficient aeration of the loose material before rolling.

6. A comparison of the test results on hard and soft asphaltic sandstones showed considerable differences in the physical properties. Soft rock asphalt exhibited greater rutting tendencies under rubber-covered wheels of a minitrack testing machine than did the hard material, especially in the first 30 days. Soft rock asphalt was more susceptible to changes in penetration and stability under all curing conditions studied. A higher average compacted density was attained with the soft rock asphalt than with the harder material. More moisture was retained in the softer rock asphalt after compaction than was noticed in the harder rock asphalt.

7. Surfaces have been built that have given satisfactory performances for nine years and longer on good bases in territories providing good drainage facilities.

This paper has given a brief resumé of the contents in Engineering Bulletin of Purdue University, Research Series No. 78, entitled "Natural Sandstone Rock Asphalt".