# USE OF BITUMINOUS MATERIALS AS A CORRECTIVE FOR PUMPING CONCRETE PAVEMENTS—OHIO

By Charles W. Allen, *Acting Chief Engineer*, and Harry E. Marshall, *Geologist*, *Bureau of Tests, Ohio Department of Highways*

Prior to 1940, pumping of concrete pavements was not prevalent in Ohio. However, the considerable concentration of war industries in the State with its attendant increase in truck loads and in volume of truck traffic has resulted in a very rapid increase in both the distribution of pumping concrete pavements and the rate of pumping.

Pumping is particularly prevalent over silty-clay and clay soils, Public Roads Administration Classes A-6, A-7 and plastic A-4. However, it is not confined exclusively to these types.

It is generally agreed that most of the water contributing to pumping is surface water. A number of observations made in Ohio substantiate this point. On a project constructed about 12 years ago which had shown no signs of distress until wartime restrictions on a refinery in the southern part of the State resulted in a tremendous increase in truck shipments, pumping occurred generally throughout the section except for areas where the joints were tightly sealed, preventing the entrance of surface water. Further evidence that the water is derived principally from the surface is afforded by the fact that on most of the projects observed there is practically no difference in the amount of pumping on fill and in cut sections. It has also been noted on several projects that less pumping occurs in areas where there is a paved gutter at the edge of the pavement which carries off the surface water before it has an opportunity to reach the subgrade.

In connection with our study of pumping pavements during the past 2 years, a considerable number of samples have been taken of subgrade through holes drilled in the pavement, in an effort to learn something of the moisture condition of the subgrade soil.

Average test results for samples of the subgrade soil taken on several projects which were investigated during the unusually dry summer just past show considerable variation in the moisture contents of the subgrade soil in the various soil groups. However, in about two-thirds of the cases in which samples were obtained at different depths beneath the pavement, the moisture content of the subgrade soil was highest immediately beneath the pavement and decreased with the depth through the range sampled.

The treatment of pumping may be divided into two parts, (1) measures which tend to check pumping on existing roads and (2) treatments during construction which tend to minimize or eliminate entirely the conditions which are conducive to pumping.

The use of steel reinforcing, load transfer devices, and the spacing and type of joints all have an important bearing on the susceptibility of a pavement to pumping. Pumping has been particularly severe on pavements constructed without load transfer devices of any kind. It has been noted that in pavements which are practically continuously under compression the severity of pumping is very much reduced.

Perhaps the most generally accepted means of prolonging the life of the pavement is by improvement of the subgrade. During the past several years sub-base courses consisting of predominantly granular materials have been provided under many of our new pavements. The thickness of the material used varies from 6 to 24 in. for different subgrade soils and traffic conditions. In a few instances pumping has been noted in such base courses and it has been observed that the material used had very low permeability. To assure more positive drainage of sub-bases, the grading specifications have been changed to require more open graded materials.

After experimenting with various soil-bituminous-portland cement mixtures and several grades of semisolid asphalts, it was found that an oil asphalt filler was most satisfactory for filling the voids under pumping concrete slabs.

In the summer of 1942 in an attempt to find a material more satisfactory than the mud mixtures, the following materials were used: Mixtures of slow-curing liquid asphalt and

powdered asphalt were found to be impractical because of the difficulty of pumping the material with the equipment available and because the fluxing of the powdered asphalt with the liquid asphalt was very slow.

Approximately a thousand joints and cracks were treated with 60–70 penetration asphalt in 1942 and only a very few of them were pumping mud in the early fall of 1944. However, there were some instances of exuding of the asphalt cement from the cracks and joints. About 200 joints were treated this same year with the 50–60 penetration asphalt cement and although this asphalt showed less exuding than the 60–70 penetration material, it was thought that a higher melting point material with a lower temperature susceptibility would be desirable. Therefore, in 1943 and 1944, the Ohio Department of Highways' Specification M-5.4, F-1, approximating the A.A.S.H.O. Oil Asphalt Filler Grade A, Designation: M 18-42 was used. This material has given very satisfactory results to date and no difficulty has been experienced with bitumen exuding from the joints or cracks. In a few instances it has been necessary to go back over the pavement after the first treatment and retreat some joints that still pump.

As an indication of the amount of material necessary to treat pumping joints, it was found on one project treated this past summer that an average of 40 gal. per joint was used to treat 284 joints. The quantity of material, of course, varied considerably for individual joints. At some joints, as much as 60 gal. of material have been used without raising the slab. Our maintenance bureau outlines the following equipment and procedure that has been used satisfactorily in forcing the bituminous material into the voids under a concrete slab:

A short trench is dug to slightly below the depth of the pavement slab at each end of the joint or crack to be pumped. A hole is drilled through the pavement usually located about 1 ft. ahead of the joint in the direction of travel and 1 to 2 ft. away from the center longitudinal joint. Water and mud are blown out by forcing compressed air into the hole using a special nozzle. In especially wet areas, it is desirable to blow out the water and the mud immediately before injecting the asphalt. In dry areas, this operation may be carried out considerably in advance of pumping asphalt under the slab.

The asphalt to be used is heated to from 350° to 400° F. The injector nozzle is attached to the patching hose of a standard bituminous distributor and driven into the hole.

Pressures of from 20 to 35 lb. per sq. in. have been found to be entirely adequate in filling the space beneath the slab and even raising the slab.

The pumping is continued until the asphalt exudes from under the pavement at the observation trench or until the slab starts to raise.

The use of bituminous material pumped beneath the slab to stop pumping of concrete pavements in this State has been much more successful than the various types of mud mixtures tried. In all probability one of the principal reasons for the success of this material is the fact that it forms a tight seal beneath the pavement and thus prevents the entrance of surface water. Further its stability is not appreciably affected by water which may reach it through the subgrade. Bituminous material is considerably easier to control when being pumped beneath the pavement since it apparently spreads more evenly than slurries. There is considerably less likelihood of cracking the slab than with slurry and it is easier to keep from raising the slab, or to control the amount by which the slab is raised if this is necessary. Although the costs using asphalt are somewhat higher than for slurries, at least a portion of this cost differential is made up in the labor saved in assembling and mixing of the various materials.

From the experience gained to date, it is our opinion that bituminous materials show considerable promise as an effective treatment for the pumping of concrete pavements.