Bituminous Concrete Pavement Surface Damage from Soil Action

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Commonwealth of Kentucky
Department of Highways

Report

on

BITUMINOUS CONCRETE PAVEMENT SURFACE DAMAGE FROM SOIL ACTION

by

James H. Havens
Assistant Director of Research

Highway Materials Research Laboratory
Lexington, Kentucky

February, 1960
MEMO TO: A. O. Neiser  
Assistant State Highway Engineer

SUBJECT: Bituminous Concrete Pavement Surface Damage from Soil Action

The attached memo of J. H. Havens' summarizes our observations and testing as a result of an inquiry from the Construction Division on the New Circle route in Fayette County. The sections of pavement involved had the appearance of having been patched. Construction records showed the asphalt cement, aggregates and mix design to be within the normal tolerances. Cores from the pavement were examined.

The surface appearance may be the most serious objection to the phenomenon noted. We intend to continue observations of the project to see if the places will heal under traffic.

I believe that new pavements should be protected from excessive soil spillage during shouldering, final dressing or other construction procedures. There are probably several clay soils in the state that will under similar conditions produce the same affect on pavements. We will be glad to make available additional copies of Mr. Havens' memorandum or prepare the data in another form if you feel that it should be distributed.

Please advise if you would like any further information or action from this Division.

W. B. Drake  
Associate Director of Research

WBD: dl  
Enc. Memo.
MEMO TO: W. B. Drake  
Associate Director of Research  

SUBJECT: Plucking Action of Soil on a Bituminous Pavement Surface

During the last week of August, Mr. J. S. Riley, Supervisory Construction Engineer, Area D, called our attention to a unique problem which arose during the final dressing of the most recent extension of the New Circle Road in Fayette County. Because of the uniqueness of the situation, the memo is intended to be a record of the phenomenon observed and a report of our investigation and analysis of the circumstances related thereto.

The surface, Class I, Type B, with natural sand had been laid approximately two weeks, and the final dressing on the shoulders and median were in progress. Mr. Riley became alarmed at the development of some extra-ordinary blemishes in the pavement surface (see Fig. 1) and requested our assistance in the problem. At first glance, these blemishes appeared to be patches or splotches where diesel fuel or other solvent had been spilled. However, further inspection of the area disclosed two spots about 6 in. in diameter where soil had been spilled on the road and compressed under construction traffic. These two soil pats were in the process of drying out, following a light rain the previous afternoon; and though they were firmly adhering to the pavement surface, the edges were shrinking and curling slightly and thus lifting part of the bituminous surface. Luckily these soil pats afforded a clue as to the possible cause of the larger blemishes. It was then surmised that previously such soil had been spilled at the blemished areas, had been compressed, dried, shrunk, had lifted some of the surface mixture, and had subsequently been pressed back in place and the soil blown or washed away. Probing into the blemishes revealed some veins of soil under the blemished surface and thus lent further support to the above hypothesis.
It was obvious elsewhere on the road that other soil had been spilled without causing such astonishing results. A cursory inspection of the soil piled on the median strip disclosed two or three rather large chunks similar in appearance to the suspected troublesome soil. In due course, samples were taken for study in the laboratory. At the same time, it was observed that soil along the edge of the median was shrinking and pulling an inch or so width of pavement loose (see Figs. 2 and 3; note: (1) bituminous curb had not been installed, and (2) source of troublesome soil seemed to be a rather thin strata immediately overlying limestone bedrock barely visible in upper right of Fig. 2).

In order to dispel any skepticism or disbelief in the explanation offered, a day or so later, a thick slurry (mud) was made of the suspected soil, and two pats 8 or 10 inches in diameter were placed on the pavement (see Fig. 4). No compression was applied. Figures 5, 6 and 7 record in sequence the drying of the pat shown in Fig. 4. Figures 8, 9 and 10 similarly record the drying of the second pat. The action portrayed occurred over a period of about two hours.

While no attempt was made to complete the cycle through the replacement of the lens-shaped piece of pavement and subsequent removal of all traces of soil on the surface, the demonstration is fairly convincing that the drying tensions and shrinkage strengths of the suspected soil were sufficient to cause the damage.

Apparently certain conditions have to exist in order for the plucking or lifting process to take place. For instance, at the time damage occurred and the demonstration was made, the weather was hot, sunny, and dry; and the soil was quite moist. The pavement was rather hot, and of course incapable of offering very much resistance to slow, steady, peeling tensions. Drying of the soil pat would naturally be attended by some cooling of the pavement at the contact interface. Hence, the weaker plane would be at some depth below the pavement surface and along an imaginary boundary of the cooling zone. Concurrently, the wet strength and adhesion of the soil to the pavement surface would have to exceed the peeling resistance offered along the above mentioned boundary.

In order to further demonstrate that the difficulty was inherent in the soil, a pat was placed on the driveway at the Research Laboratory. This pavement was several years old, the surface was somewhat weathered, and the surface aggregate exposed. Although the soil did not life a lens-shaped mass there, it did pluck some of the bituminous mortar from between the aggregate particles.

Obviously the distinctive features of the soil would be a high degree of plasticity as normally exemplified by bentonitic-type clays, montmorillonites, nontronites, etc. We were able to show by x-ray
diffraction analysis that the suspected soil contained appreciable amounts of expanding lattice-type clays belonging to the general mineralogical family just mentioned and also appreciable amounts of hydrous mica (Illite) clay which is the predominate clay occurring in Bluegrass soils. The troublesome clays encountered in the Bluegrass area are usually inter-bedded with limestone and are commonly referred to as bentonites. Other features of the soil are cited in the following tabulation:

<table>
<thead>
<tr>
<th>Test</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Limit</td>
<td>71.3</td>
</tr>
<tr>
<td>Plastic Limit</td>
<td>34.8</td>
</tr>
<tr>
<td>P.I.</td>
<td>36.5</td>
</tr>
<tr>
<td>Shrinkage Limit</td>
<td>16.3</td>
</tr>
<tr>
<td>Approx. Sp.G.</td>
<td>2.76</td>
</tr>
<tr>
<td>% - 5 micron clay</td>
<td>60</td>
</tr>
<tr>
<td>% - 1 micron clay</td>
<td>44</td>
</tr>
</tbody>
</table>

This report recognizes and records an interesting phenomenon, which may be rather rare.

James H. Havens
Assistant Director of Research

JHH:dl