A Concrete Pavement Without Transverse Joints [Jan. 1956]

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MEMO TO:  D. V. Terrell
Director of Research

For a period of more than six years the Research Division has had under observation the concrete pavement built without transverse joints on U. S. 31-W between Franklin and the Tennessee Line. The primary reason for observing performance year after year is to record the incidence of cracks and other more serious defects; but also the grooving of cracks in 1949 and the application of different joint sealing materials became an important part of the observations.

In the three years which have elapsed since the time of the last report on this project, relatively slight changes in its over-all condition have occurred. The average crack and joint (construction) interval has decreased by only 8 feet, or less than 12 percent of the 70.8-foot average determined in December 1952. Spalling of concrete at the cracks has almost doubled so far as the number of cracks affected is concerned, but apparently its general severity has not increased appreciably in the three-year interval.

Faulting at cracks and joints has developed in twelve locations, whereas there was no evidence of this displacement at those points three years ago. However, faulting has not become prominent at any of these locations.

With regard to sealing of cracks, both cold mastic and hot-poured rubber-asphalt sealers are continuing their excellent performance, while the OA-2 asphalt cement sealer has been worthless - the latter point having been made even before the 1952 inspection. Also, it is still evident that early grooving and sealing of the cracks is highly desirable, and it is recommended that the Division of Maintenance groove and effectively seal the cracks that have not been thus treated on this road.

A final point of interest is the traffic using the road. As indicated in the tabulation which follows, there has been an appreciable increase in moderately heavy axles on the road since 1952, and possibly some increase in extremely heavy axles during the same period.
D. V. Terrell - 2 - March 22, 1956

<table>
<thead>
<tr>
<th>Classification</th>
<th>1952</th>
<th>1955</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Vehicles</td>
<td>3581</td>
<td>4549</td>
</tr>
<tr>
<td>(24-hr. count)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Trucks</td>
<td>1213</td>
<td>1450</td>
</tr>
<tr>
<td>(24-hr. count)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Axle Load Distribution (lb.)*

<table>
<thead>
<tr>
<th>Axle Load Range</th>
<th>1952</th>
<th>1955</th>
</tr>
</thead>
<tbody>
<tr>
<td>9,000 to 11,000</td>
<td>123</td>
<td>128</td>
</tr>
<tr>
<td>11,000 to 13,000</td>
<td>143</td>
<td>130</td>
</tr>
<tr>
<td>13,000 to 15,000</td>
<td>160</td>
<td>185</td>
</tr>
<tr>
<td>15,000 to 17,000</td>
<td>145</td>
<td>198</td>
</tr>
<tr>
<td>17,000 to 19,000</td>
<td>45</td>
<td>107</td>
</tr>
<tr>
<td>19,000 to 21,000</td>
<td>22</td>
<td>21</td>
</tr>
<tr>
<td>21,000 to 23,000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>23,000 and over</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

*Based on 24-hr. classification with 16-hr. weighing period and less than 50 percent of trucks larger than 1 1/2-ton class in 16-hr. period actually weighed.

In view of the increase in traffic and other factors having a bearing on the life of a pavement, it is apparent that this pavement is giving good service thus far, and that it has not been handicapped by the omission of transverse joints.

Present indications are that the interval of joint spacing normally used at the time of construction on a pavement of this particular type will not be reached for a period of at least three more years, or approximately ten years after the time of construction. Observations to determine the actual progress will be made annually for the next few years. Judging by the incidence of faulting at cracks and joints, the pavement is suffering much more from limited depth of insulation course than it is from lack of weakened planes to control cracking.

Respectfully submitted,

L. E. Gregg
Assistant Director of Research

Copies to: Research Committee
J. C. Cobb (3)
Commonwealth of Kentucky  
Department of Highways

Report No. 5

on

A CONCRETE PAVEMENT WITHOUT TRANSVERSE JOINTS

by

D. H. Sawyer  
Research Engineer

January, 1956

During the past few years the Research Division has made periodic inspections and issued progress reports on the performance of a concrete pavement without transverse joints. These reports give an account of the materials used in the pavement, construction methods, and the developments in pavement condition and performance since its completion. Progress Reports which have been distributed throughout the Department and their date of release are as follows:

Report No. 1 ........ July 1949
Report No. 2 ........ December 1949
Report No. 3 ........ January 1951
Report No. 4 ........ December 1952

The pavement under observation is a section of U. S. 31W in Simpson County and was designated as F1239(4). The section is approximately 5.75 miles in length and extends from the Tennessee State Line to the South City Limits of Franklin, Ky. (see layout plot). The pavement was completed on June 30, 1949.
The 22-ft. pavement was placed over an insulation and leveling course that consisted of 1 1/2 in. of compacted No. 10 limestone. Air entrainment in the concrete was obtained through the use of a cement containing the agent interground.

Except for the longitudinal joint along the center of the pavement there were no joints used other than the conventional butt-type at the end of each run. In other words, the pavement was built without transverse joints and allowed to crack at intervals of maximum stress.

Detailed accounts on the method of grooving and sealing of these cracks, the different types of joint sealer materials used and previous maintenance records are fully illustrated in the above mentioned Progress Reports.

The object of this report is to discuss the condition of the pavement as noted at the time of the latest inspection, which was December 7, 1955. Attention is given to the actual or existing features of the pavement which were prevalent at this time, rather than to the development of possible causes which created these ultimate effects. Previous reports, however, cover the influence of construction methods, subgrade conditions, joint maintenance, and their relationship to the overall performance of this pavement.

Crack Interval

Since the time of the last reported crack survey in October, 1952, only two surveys have been made. The prolonged inspection interval was recommended by members of the Research Committee when
this project was last reported. The principal reason which influenced this decision was the fact that the crack interval had become somewhat stabilized and that additional cracking was expected to have little effect on the crack interval established at that time.

Data taken at the two latest surveys, April and December, 1955, justified the assumption of the Research Committee - since the average crack interval at present, including the 41 construction joints, is 62.8 ft. This compares to a crack interval of 70.8 ft. as reported some 3 years ago. Actual crack spacing, exclusive of construction joints, was 75 ft. in December, 1955, as compared to 78.5 ft. at the time of the October 1952 inspection. The decrease in the average crack interval then, during this period, was only 3.5 ft. It is interesting to note that 72 percent of the 440 cracks which have developed in the 30,230 ft. of pavement since its completion in June 1949, occurred within the five months immediately following completion of the pavement. Also of interest is the fact that 21 percent of the total number of cracks listed are limited to a single lane in width and that 60 percent of these are located in the north-bound lane.

Figure 1 shows the variation in average crack interval for the various surveys over the past 5 1/2 years.

Spalling and Faulting

Spalling, as applied to this latter survey, includes all cracks and construction joints which showed evidence of deterioration, either along the crack edges, or at the corners of the individual slabs.

A total of 97 cracks were found to exhibit spalling at various
FIG. 2
Crack at Sta. 51+90 sealed with hot asphalt-rubber in Oct. 1950. The condition shown here is typical of most cracks.

FIG. 3
Condition of crack at Sta. 19+35 sealed in Oct. 1950 with OA-2 cut back with MC-3. Cracks in this condition were limited, for the most part, between Sta. 9+11 and Sta. 20+00.
FIG. 4
Crack at Sta. 98+80 extending across the pavement. This crack appeared between Feb. 1952, and April 1955.

FIG. 5
Spalling in foreground located at Sta. 172+98. Condition noted here appears the same as when first recorded in Oct. 1949. Similar situations elsewhere indicate that pavement condition of this type is not progressive.
degrees. In most instances, however, the degree to which spalling had developed along the cracks was rather limited. The cracks designated as spalling represent approximately 20 percent of the total number of combined cracks and construction joints. At the time of the 1952 report, 57 cracks were listed as showing evidence of spalling.

No attempt was made during this past survey to measure the amount of faulting or movement at the individual joints. Cracks and joints listed under this classification exhibited visible displacement which was verified by use of a straight edge placed across the joints. Nine construction joints and three cracks were found to have undergone sufficient vertical movement to warrant classification in the faulting category. The 12 cracks and joints listed here are in addition to the three locations on the pavement where there has been excessive maintenance in the form of mud-jacking and patching. Faulting other than that prevalent at these three locations is of limited magnitude and at present is not considered to be prominent.

A summary of pavement data showing the location of spalling and faulting in the different sections is given in Table I.

Joint Seal Materials

The necessity for adequate and early treatment of cracks as they occur in the pavement is most evident in view of the contrast which exists at several cracks in the pavement. In one section, for example, a large number of the cracks are open and the sealing material is almost completely absent in some instances. This situation is limited
TABLE I. Summary of Pavement Data

<table>
<thead>
<tr>
<th>STATION (Sections)</th>
<th>Approx. Distance in Feet</th>
<th>Number of Constr. Joints</th>
<th>Number of Cracks</th>
<th>Number of Faulted Joints Constr. Cracks</th>
<th>Number of Cracks Spalling</th>
<th>Approximate Ave. Crack Int. (Ft.) Discount Constr. Joints</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 + 11 to 50 + 00</td>
<td>4089</td>
<td>8</td>
<td>70</td>
<td>3</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>50 + 00 to 100 + 00</td>
<td>5000</td>
<td>6</td>
<td>70</td>
<td>2</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>100 + 00 to 150 + 00</td>
<td>5000</td>
<td>7</td>
<td>83</td>
<td>2</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>150 + 00 to 200 + 00</td>
<td>5000</td>
<td>5</td>
<td>77</td>
<td>2</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>200 + 00 to 250 + 00</td>
<td>5000</td>
<td>7</td>
<td>73</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>250 + 00 to 300 + 00</td>
<td>5000</td>
<td>6</td>
<td>57</td>
<td>0</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>300 + 00 to 311 + 00</td>
<td>1140</td>
<td>2</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>30230</strong></td>
<td><strong>41</strong></td>
<td><strong>440</strong></td>
<td><strong>9</strong></td>
<td><strong>3</strong></td>
<td><strong>97</strong></td>
</tr>
</tbody>
</table>

* Distances are computed without regard to equations noted on layout plot.

Average interval for both cracks and construction joints = \( \frac{30230}{481} = 62.8 \text{ Ft.} \)
for the most part between Sta. 9 + 11 and Sta. 20 + 00. In this instance there was no initial grooving or cleaning of any of the cracks before the first application of the sealer material which was OA-2. These cracks were grooved and resealed in 1950 with OA-2 cut back with a small quantity of MC-3. However, this material has become brittle and most of it has been chipped from the cracks by the action of traffic.

Similar treatment was given to all cracks insofar as grooving of the cracks was concerned, yet those sealed with the cold mastic type sealer and with the hot asphalt-rubber sealer are still in very good condition after 5 1/2 years of service. Thus, equally important to the grooving operation is the selection and use of a suitable joint sealing material. Observations noted in the aforementioned Progress Reports in regard to the necessity for grooving all cracks to maintain adequate seal was well demonstrated in the early maintenance procedures on this project.

Maintenance

Pavement maintenance in addition to that associated with initial joint sealing has been negligible except at three locations. The pavement at one location (between Sta. 170 + 00 and 171 + 00) required mud-jacking in 1950. A concrete patch 7 by 10 ft. was placed near Sta. 200 + 00 in 1951. In 1952 a section between Sta. 263 + 00 and 264 + 00 also required mud jacking. Pavement settlement was responsible for these failures and previous reports trace developments leading to these conditions of failure.
Concrete patch near Sta. 220+25, placed during the summer of 1951. Excessive cracking and spalling can be seen adjacent to this patch.

Fill settlement near Sta. 263+50 led to cracking and faulting shown here. This section was mud-jacked in 1952.
Summary

The general performance of the pavement since the time of the previous report in December 1952, has been satisfactory and shows little or no variation from conditions noted at that time. This is particularly true of the average crack spacing which appears to be somewhat stabilized at 75-ft. intervals. The overall average crack interval, including the 41 construction joints, is 62.8 ft.

The condition of cracks which were sealed with cold mastic type sealer and hot poured asphalt-rubber sealer are in excellent condition in view of the time in service. The well-sealed condition of these cracks at this time indicates not only favorable performance of these sealing materials, but also that the grooved crack is particularly suited for sealing and retaining acceptable materials. Whether irregularity of the crack, such as occurs when the grooving procedure is used, contributes substantially to the ability of the crack to retain the sealer has not been definitely established, but it appears that this situation is advantageous in maintaining a proper seal.

The condition of spalling as noted in relation to all cracks was approximately 20 percent. The extent to which this condition has developed varies in magnitude both along the length of the crack and in distance progressed from the crack. The overall picture insofar as spalling in and around the joints is concerned appears satisfactory and this feature is not expected to warrant any serious consideration within the near future. Likewise, the degree of faulting recorded for
construction joints at this time is considered insignificant in magnitude, if not in percentage of the total number of joints. Faulting was listed at 22 percent of the construction joints as compared to less than one percent of the grooved cracks.

A complete listing of all cracks in the project is shown on the appended strip map. The system of classifying cracks used in previous reports has been abandoned at this time because of the difficulty in maintaining the degree of correlation as originally established. Thus, the strip map shows only the location of the cracks and offers no distinction between conditions surrounding the various cracks.