INVESTIGATION OF CONCRETE PAVEMENT PUMPING—OHIO

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This paper describes the investigations that were made and the conclusions and recommendations that resulted in connection with transverse joint pumping on S. N. Federal-Aid Project No. 626-H(1) and S. N. Federal-Aid Project No. 240-A(3) located on U. S. Route 52 in Scioto County, Ohio, near the village of Franklin Furnace.

The length of the project is 4.39 miles and the plans provided for the placing of a portland cement concrete wearing surface 9 in. thick by 24 ft. wide. It was further provided that the "concrete pavement shall be placed and finished in single lane widths as separate operations and the longitudinal joint separating lanes thus placed shall be a key joint."

Because of war time restrictions, the pavement was designed without reinforcing steel or load transfer bars at any of the joints. The use of portland cement containing vinsol resin was required in such amounts that the reduction in weight of the concrete of from 4 to 8 lb. per cu. ft. would be effected.

Most of this project is on new grade and alignment. As a consequence, a considerable quantity (230,000 cu. yd.) of earthwork was involved, more than 60 per cent of which was to be secured from roadway, structure, and channel excavation. A soil profile was prepared by the Highway Testing Laboratory which set forth the information obtained from the analysis of 112 samples taken throughout the length of the project. This profile shows that the predominant soil types are silt soils, P.R.A. Classification A-4, S.H.T.L. Classifications 8, 9, and 11. Since these soils are subject to detrimental capillarity and subsequent frost heave it was decided that, wherever this material would be encountered at subgrade elevation, it would be removed to a depth of at least 18 in. and replaced with a suitable granular material. Deep longitudinal drains were provided adjacent to these backfilled areas leading to the nearest convenient disposal points. This treatment was provided for seven areas which covered 7858 lin. ft. measured along the centerline.

Slab Pumping Observations

After the pavement had been opened to traffic for between 2 and 3 months the first evidences of pumping became apparent. During this time the weather had been relatively mild and exceedingly dry. Within 30 days after the first pumping was observed action had increased at such an alarming rate that it was decided to determine the extent to which it had progressed and to investigate any and all contributing factors.

In order to compare the action of pavement of this design with that built with reinforcing steel and load transfer bars at all joints, the investigation was made to include Federal-Aid Grade-Crossing Project No. 240-A(2) which adjoins this project and which was placed during the late fall of 1941.

For purposes of easy identification, the originally described project will be referred to as the "Plain-slab" project.

As a general statement it may be said that pumping was much more extensive and severe where the pavement slab was placed on soil subgrade. It will be noted that where pumping did occur over classified embankment areas the large portion of this action was confined to the low side of superelevated curves. The typical section included edge curb and the water was carried to sod gutters spaced at frequent intervals and directed across the berm. During the construction of this project, the sod gutters were placed 1 in. below the pavement edge. It was thought that this would be sufficient to allow for ordinary growth and fluffing of the sod and still have drainage away from the pavement. The sod built itself up to such an extent that, combined with an accumulation of ice control material, drainage was impeded so that water was ponded along the gutter line. This ponding with resultant splashing under traffic could have set up a condition which caused the pumping to develop. On the plain slab project the highest percentage of pumping occurred at the contraction joints regardless of the type of subgrade material. Pumping

on the reinforced slab project was generally more severe at all types of joints.

A series of observations were made to determine the deflection of the pavement slab under traffic. The device used consisted of a metal stake and bracket to which two Ames gauges were attached. The metal stake was driven at such locations that one of the gauges was in contact with each of the pavement slabs adjacent to the transverse joint.

Observations were confined to the action resulting from the passage of medium and heavy trucks and buses at normal operating speed of approximately 35 mph. In certain instances, trucks were stopped and asked to proceed at very slow speed, and it was observed that greater deflections resulted than when normal speeds were allowed. While the amount of the individual deflection is small (0.002 to 0.025 in.) there is every reason to believe that over a period serious trouble will develop. This is substantiated by observations on the reinforced slab project. In the two years that this pavement has been in place, serious spalling has occurred at some transverse joints. The data show that the movement is comparable to that on the plain slab project.

In order to check the functioning of the No. 46 size (¾-in. to No. 4) porous backfill material that was used over the longitudinal roadway drainage pipe placed adjacent to classified embankment areas, the material was removed at one location down to the top of the pipe and more or less vertical faces of undisturbed material were exposed. It was observed that 8 in. of heavily silted aggregate was in place immediately above the top of the pipe. Above this was approximately 20 in. of aggregate with a very small amount of silt. Above this was a layer, approximately 12 in. thick, composed of predominately silty material.

During the course of construction operations, it became necessary to change the design of the drains to the following: The open joints in the line of pipe were wrapped with burlap and No. 6 (⅜ to No. 8) size porous backfill aggregate was placed around the pipe and up to a point 6 in. above the top of the pipe. From here to the flow line of the ditch classified embankment material was used. An examination was made of one section, and it was found to be functioning satisfactorily with very little silt having filtered into the porous material. It was observed, however, that the flow line of the ditch was built up with deposited silt to a greater extent than in the two previous places that were examined where No. 46 size aggregate was used.