PUMPING OF CONCRETE PAVEMENTS IN TENNESSEE COOPERATIVE STUDY

By Tennessee Department of Highways and Portland Cement Association

A cooperative study was made during March and April, 1944 to determine the nature, extent, cause and remedy of pumping in Tennessee. Approximately 290 miles of pavement on the main traffic routes connecting the principal cities were studied in the survey. The projects studied were representative of the range of traffic, loadings, pavement designs and subgrade soils encountered over the State.

Reconnaissance surveys were made to obtain a quantitative measure of pumping of pavements under different traffic loads on various soil types. Three stages or classes of pumping were recognized; slab ends where pumping occurred without accompanying faulting; pumping accompanied by faulting; and pumping and faulting accompanied by a broken slab end. The number of joints and cracks and the number of pumping joints and cracks of each class were recorded for each project.

The reconnaissance surveys were followed by detail studies of traffic, pavement design and soils on individual projects. Sections of individual projects were mapped and sampled. Mapping included sketches showing pavement jointing, cracking, pumping, typical soil section, location of sampling, with notes on soil condition and pertinent construction data. Undisturbed as well as disturbed soil samples and water content samples were taken from under both pumping and non-pumping pavement joints and cracks. Density tests, routine soil-constant tests, mechanical analysis, compaction tests, consolidation tests and triaxial compression tests were made to determine the relationships between soil types, soil condition and pumping.

The results of the reconnaissance surveys showed that where pumping occurred it was about equally distributed between transverse expansion joints, contraction joints and cracks. The smallest number of pumping joints and cracks per mile occurred with the longest expansion joint spacing. The use of ¾-in. dowels spaced at 12-in. centers did not materially influence the number of pumping joints, but did result in less faulting at such transverse joints. The range of pavement thicknesses used in Tennessee was small. For this reason conclusive data showing any relationship between pavement thickness and pumping for given traffic soils and soil conditions could not be obtained.

Water content determinations made on fine grained soils taken under pumping joints and on similar soils from under nonpumping joints show that pumping occurs when the average water content is 3 to 4 percentage points above the average plastic limit of the soils. Densities of soils under non-pumping joints averaged 6 lb. per cu. ft. greater than densities of similar fine grained soils under pumping joints.

Undisturbed samples of soils taken under pumping joints and tested for consolidation in the laboratory showed approximately twice the percentage reduction in height of that obtained on similar soils taken from under non-pumping joints for the same unit loads. They also compressed at a slower rate than did the soils from under non-pumping pavements. Triaxial compression tests on undisturbed samples of soil gave data of the same nature as that obtained in the consolidation tests.

Pumping did not occur on sandy soils derived from the coarse grained sandstones of north central Tennessee, nor in the sandy soils of the coastal plains deposits of west central Tennessee. Pumping on soils of loess origin was limited to a few miles in the metropolitan area of Memphis and between Memphis and an outlying ordnance plant and training station. Because of the uniformity of the loess soils and the uniformity of pavement design in the loess area, the data indicates the approximate minimum traffic loadings which cause pumping of existing pavements on the loess soils. The most severe pumping occurred on fine grained soils derived from limestones, cherty limestones and shales.

Pumping in Tennessee did not occur on soils having combined sand and gravel fractions in excess of 55 per cent of the total material. Soils having more than 45 per cent silt and clay

combined pumped under medium as well as heavy traffic except in the loess area where pumping on soils having more than 45 per cent silt and clay was limited to the metropolitan and war plant traffic at Memphis.

Subgrade treatments consisting of 2 to 4 in. of loose river sand mixed with the existing clay subgrades resulting in 4 to 6 in. compacted depths were studied on two projects in Tennessee. Where the sand and gravel content of the mixture was greater than 55 per cent of the total material, no pumping was found.

REPORT OF COMMITTEE ON ORIGIN AND DESTINATION SURVEY TECHNIQUES

By D. Grant Mickle

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In December, 1944, the Congress passed the Federal Aid Highway Act of 1944, which amended the Federal law so as to recognize the needs of urban highway development. The law makes Federal-aid funds available for projects in urban areas, and authorizes the designation of a National System of Interstate Highways which will be a network of limited mileage, connecting and penetrating the major centers of population.

These far-reaching changes in national policy are the result of 10 years of research carried on through the state highway planning surveys. Begun in 1935 by the various highway departments, in cooperation with the Public Roads Administration, the surveys made possible the writing of those two milestones in American highway history: "Toll Roads and Free Roads" (1939) and "Interregional Highways" (1944).

The studies were designed to inventory the nation's highway systems, mile by mile; to find out what services are rendered, who pays for the facilities, and to generate the factual data on which an orderly development of highways in accordance with needs can be charted.

The highway planning surveys were confined largely to rural highways and their usage. It is a paradox of our times that the studies which produced such extensive data on rural highways should be the ones to disclose the urgency of urban improvements where comparable factual information is not generally available.

Because of the high property values involved in improvements and the unusual lack of present street efficiency in urban areas, the need for data on the volume and characteristics of highway travel are especially acute. These data must point the way to the proper location and design of new city expressways, and the most efficient use of other traffic facilities. To meet this requirement, the Public Roads Administration, again working with the State highway departments, and also with city engineering or planning offices, began research on ways of determining, quickly and inexpensively, the travel habits of urban dwellers.

Late in 1943 the Traffic & Operations Department of the Highway Research Board appointed a project committee to study origin and destination survey techniques. This report briefly reviews the various methods used, and describes in some detail the results obtained to date. It is a report of the Project Committee of the Highway Research Board, and was prepared by its secretary, John T. Lynch, of Public Roads Administration, who drew heavily upon the results of many of the city traffic origin and destination surveys now under way. Every member of the committee assisted in the preparation of the report by providing data, valuable suggestions and critical review.