Construction of the U. S. No. 41 Test Road

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The State Highway Commission of Indiana and the Bureau of Public Roads constructed an experimental project, during 1949, designed as a test road for the purpose of studying means of preventing pavement pumping on highways that carry a high traffic volume with a normal distribution of heavy axle loads. The completed pavement was opened to traffic on November 11, 1949.

Fig. 1. Location of test road.
Fig. 2. Pavement cross-section.

Fig. 3. Cross-section of permeable subbases.
This project is located in the north west corner of Indiana, in Lake County, on a section of U.S. Road No. 41, beginning approximately 4.5 miles south of Cook and terminating at the south edge

**CROSS SECTION**

**of**

**DENSE GRADED STONE SUBGRADE TREATMENT**

\[ D = 3, 5 \text{ or } 8'' \]

**CROSS SECTION**

**of**

**SOIL-CEMENT SUBGRADE TREATMENT**

\[ D = 3 \text{ or } 5'' \]

Fig. 4. Cross-section of dense subbases and soil-cement stabilization.

**PLAN OF SUBSECTIONS**

**ON**

**FOUR MILE SUBGRADE TREATMENT PROJ.**

**U.S. 41 LAKE COUNTY, IND.**

1\text{st} MILE

\[
\begin{array}{cccccc}
3'' & 5'' & 8'' & - & 3'' & 5'' \\
\text{DENSE GRADED STONE} & \text{UNT.} & \text{SOIL CEMENT} & \text{OPEN GRADED STONE} & \text{TILE THRU SHOULDER}
\end{array}
\]

2\text{nd} MILE

\[
\begin{array}{cccccc}
5'' & 3'' & - & 3'' & 5'' & 8'' & 3'' & 8'' & 5'' \\
\text{SOIL CEMENT} & \text{UNT.} & \text{DENSE GRADED STONE} & \text{OPEN GRADED STONE} & \text{TILE THRU SHOULDER}
\end{array}
\]

3\text{rd} MILE

\[
\begin{array}{cccccc}
5'' & 8'' & - & 3'' & 8'' & 5'' & 3'' & - & 3'' & 5'' \\
\text{OPEN GRADED STONE} & \text{DENSE GRADED STONE} & \text{UNT.} & \text{SOIL CEMENT} & \text{TILE THRU SHOULDER}
\end{array}
\]

4\text{th} MILE

\[
\begin{array}{cccccc}
3'' & 5'' & 8'' & - & 3'' & 5'' & 8'' & 5'' & 3'' \\
\text{OPEN GRADED STONE} & \text{UNT.} & \text{SOIL CEMENT} & \text{DENSE GRADED STONE} & \text{TILE THRU SHOULDER}
\end{array}
\]

Fig. 5. Plan showing location of various subbases constructed on test road.
of Cook. U.S. Road No. 41 at this location consists of two twenty-four foot dual concrete pavements. The experimental sections are limited to a net length of four miles on the west pavement carrying only south bound traffic. Due to a peat deposit and unsuitable subsoil stratification, exceptions to the experiment are found in the second and third miles.

The concrete pavement for the entire project is 24 feet wide, 9 inches thick at each edge and 8 inches thick at the center. Two
alternate miles, the second and fourth, have wire mesh reinforcing and contraction joints (with load transfers) spaced at 40 foot intervals. The first and third miles are plain concrete with contraction joints spaced at 15 foot intervals without load transfers.

Each mile of the carefully controlled test sections is divided into nine subsections with each subsection having a different type foundation or depth of subbase. Each of the subbases (except for the method of draining the permeable course) are repeated in each of the four miles. The nine subsections consist of the following: One section without special construction (pavement placed directly on the natural soil), two sections of soil-cement stabilization, and six sections of granular subbase courses. The granular subbase courses were constructed of crushed stone that was well graded and carefully controlled to produce two types of subbase, one that is dense or relatively impervious and one that is permeable. Each of these granular types were constructed in three, five, and eight inch depths.

Permeable subbases are provided with two types of drainage. Continuous outlets are provided in the sections where the subbase is extended through each shoulder. Where four inch tile drains are used for outlets they are placed through each shoulder at both the third and fifth joints.

Fig. 8. Trailer laboratory.

Fig. 9. Section showing installation of six Bouyouces moisture electrodes.
Fig. 10. Location of precise level points placed in the concrete pavement.

(making the spacing 45 and 75 feet respectively) on the plain concrete sections, and at every joint and every other joint (making the spacing 40 and 80 feet respectively) on the reinforced concrete sections.

Dense graded subbases were placed in trench sections 26 feet wide without drainage.

Fig. 11. Equipment for obtaining roughness index of finished pavement.
Soil-cement subbases were constructed in trench sections 26 feet wide by mixing 14 per cent cement with the natural soil to obtain standard soil-cement stabilization mixtures of three and five inch depths.

The natural soils for the project are shaley clays of the Valparaiso moranic area originally deposited by the Wisconsin glacier. Pedologically the predominate soils belong to the Miami, Brookston and Carrington Catena or the mottled subsoil phase of the Carrington silt loam. Any soils that did not meet our desired soil classification requirement or contained organic matter, were excavated to a depth of three feet and replaced with suitable borrow or were excepted from the experiment. The upper three feet of the subgrade, which was carefully tested and logged, is made up of soils ranging in classification from A-6(6) to A-6(12) and from A-7-6(10) to A-7-6(17).

Carefully controlled moisture and density tests were made on all subsections of the subgrade, and subbases. Detailed gradation tests on all granular materials show that they were closely controlled and repeated throughout the four miles. Depths of all subbases were carefully controlled and repeated throughout the four miles. Undisturbed triaxial specimens for all soil types were taken from the subgrade just prior to paving and run by both the Bureau of Public Roads and Indiana. In place C.B.R. loadings were run in each subsection on both the subgrade and subbase courses.

Concrete test beams, yield tests and air entraining measurements were made for each subsection. All phases of construction were completely and minutely covered. A complete log of weather during construction was kept.

Fig. 12. Weighing and measuring axle spacing.
Fig. 13. Instrumentation for determining speed and lateral placement of trucks.

A 14 by 20 foot field laboratory was constructed on the project for the control of all field testing. This building will remain on the project until the 10 year study is complete.

In addition to the field laboratory the Bureau of Public Roads trailer laboratory was used at various locations on the project during construction.

A total of 72 Bouyouces moisture-electrodes were installed throughout the project for the purpose of securing a continuous record of the moisture content of the subgrade and subbase courses.

Two thousand precise level plugs (requiring 14 permanent bench marks) were placed in the concrete pavement throughout the length of the job. These points were so located to permit the plotting of a complete profile.

A roughness index for the finished pavement was obtained with B.P.R. equipment in addition to other detailed measurements before the pavement was opened to traffic.

A permanent traffic counter was installed near the field laboratory at the time the pavement was opened to traffic. Since the opening a very detailed study of traffic has been kept to date. Traffic is typed and weighed at least four times a year.

Lateral spacing and the speeds of trucks has been determined at two locations on the project.

To date we have kept a very detailed performance record of the pavement. This program is to be continued for a minimum of 10 years.
The original plan for this project includes a series of deflection studies. Pavement deflections to be determined under both moving and static loads.

It is suggested that these studies begin with axle loads of 10,000 pounds and increase in one to two thousand pound increments until the entire range of the heavier vehicles are covered. For moving loads, speeds and placement would be varied. Investigations have shown that deflection under moving loads can be successfully measured with "Linear Variable Differential Transformers". It is hoped that the proposed negotiations for this type of measurement and analysis can be completed with the Engineering Mechanics Department and the Joint Highway Research Project here at Purdue.

From an experimental point of view this project is well planned since it contains sections ranging from those that are obviously under-designed to those that should safely carry our present traffic loads.

Although the project is not too well known since none of the data has been published, engineers from other States who have discussed the project or visited the site manifest a keen interest and in expressing their opinion feel that it is one of the better highway research projects in existence today.

Fig. 14. Equipment for plate bearing tests.