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MICHIGAN
STATE HIGHWAY DEPARTMENT
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REPORT ON MARYLAND ROAD TEST ONE-MD

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Text based on general news release by Highway Research Board covering progress on Maryland Road Test One-MD, dated January 11, 1951 and a progress report summary presented at the 30th Annual Meeting of the Highway Research Board on January 9-12, 1951 by R. W. Crum, A. Taragin, E. C. Sutherland, H. D. Cashell and Fred Burggraf.

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REPORT ON MARYLAND ROAD TEST ONE-MD

Road tests conducted near La Plata, Maryland have produced results which show that heavily loaded trucks making frequent trips have hastened deterioration of the concrete pavement under test. This test project, which has been identified as Maryland Road Test One-MD, was in operation from June 23 to December 23, 1950 with continuous truck traffic under controlled conditions. Although truck traffic was stopped on December 23, much remains to be done before final conclusions will be drawn. At present, miscellaneous strain and deflection tests with various load combinations are under way. A detailed soil survey will be completed and additional quality tests performed on the concrete to supplement preliminary data.

This research project was proposed by the Interregional Council on Highway Transportation which was formed at Columbus, Ohio on December 5 and 6, 1949. The project is being administered and supervised by the Highway Research Board of the National Academy of Sciences through a small Project Executive Committee and an Advisory Committee, both under the Chairmanship of the Associate Director of the Board, Mr. Fred Burggraf. The Project Executive Committee includes H. S. Fairbank, T. J. Kauer, and A. S. Gordon. The Advisory Committee includes one representative from each participating state, one representative from the Bureau of Public Roads, one representative from the Automobile Manufacturers Association, one from the American Trucking Association, and one representative from the Department of the Army. Other members appointed by the Highway Research Board include the Chairman of the Highway Research Board's Department of Economics, Finance

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and Administration, and of the Department of Design. Mr. A. Taragin of the Bureau of Public Roads is Project Engineer. The participating states are Connecticut, Delaware, Illinois, Kentucky, Maryland, Michigan, New Jersey, Ohio, Pennsylvania, Virginia, Wisconsin, and the District of Columbia.

The cost of this project is shared by the participating States in monetary contributions; by the Bureau of Public Roads in providing test equipment, instrumentation, and personnel to conduct tests and supervise the project; by the petroleum industry in providing gasoline, oil and grease; and by the truck manufacturers of the Automobile Manufacturers Association in providing the test vehicles.

Objectives

The principal object of the test is to determine the relative effects, on a particular concrete pavement, of four different axle loadings on two vehicle types. Information such as will be secured from this experiment is greatly needed for use, (1) in appraising the load-carrying capacities of existing concrete pavements; (2) for use in designing new pavements; and (3) to provide fundamental data which may be used in framing equitable legislation to govern highway transportation.

GENERAL PROJECT INFORMATION

The tests were conducted on a 1.1 mile section of portland cement concrete pavement on US-301 located approximately 9 miles south of La Plata in southern Maryland. The pavement, constructed in 1941, one lane at a time, was nine years old when tests were started, and in excellent condition. It carried a normal traffic load of 2,400 vehicles per day, of which 14 percent are commercial vehicles, 6 to 7 percent of these being heavy vehicles. The truck tests during the 6-month period have produced more than twenty times as much damage as nine years of normal traffic. Before the test, only 233 feet of cracks due to loads had appeared. The accelerated traffic tests have added 4,905 linear feet of cracks.

Test Pavement

The test pavement consists of two 12-ft. lanes of concrete each having 9-7-9-in. cross sections, both reinforced with 59.4-lb. per square foot wire mesh consisting of No. 2 wires spaced 6 inches longitudinally and 12 inches in a transverse direction. The 9-7-9-in. cross section means that each lane is 9 inches thick at the sides and 7 inches thick in the center. Expansion joints are spaced at 120-ft. intervals with two intermediate contraction joints at 40-ft. spacings. Dowel bars 3/4-in. in diameter at 15-in. spacing, have been placed in all transverse joints. The adjacent lanes are tied together with tie bars 4 ft. long, spaced at 4-ft. intervals. The pavement, in load-carrying capacity, is considered by the Bureau of Public Roads officials to be similar to that of a great majority of pavements built throughout the United States.

Concrete Quality

The average flexural strength of the concrete at the time of test was 723 psi. At seven days after construction, flexural strength tests gave a value of 485 psi. The average compressive strength of the concrete, based on cores taken just prior to tests was 6,944 psi. Test cores at age of 4 months gave compressive strength of 4,838 psi. The average modulus of elasticity of the concrete at time of test was 4,800,000 psi.

Soil Characteristics

Preliminary soil surveys indicate that approximately 15 percent of subgrade soils (mainly at the south end under Sections 1 and 2) have granular characteristics and that the remainder are fine-grained plastic soils. The fine-grained soils have been found comparable to soils found under "pumping" pavements in Illinois, Indiana, North Carolina, and Tennessee.

TEST PROCEDURE

In its operation, the test consists primarily of comparing the relative effects on parallel adjoining lanes of two types of trucks, one type being two-axle units with rear single axles loaded to 18,000 and 22,400 pounds, respectively; and the other type being three-axle units with rear tandem axles loaded to 32,000 and 44,800 pounds, respectively. These axle loads were selected because they represent present loading conditions on highways. The single 18,000-lb. axle load is the limit recommended by the American Association of State Highway Officials and is the limit now imposed by a majority of the states. It is also the basic design load for practically all existing pavements. The 22,400-lb. single axle load is now in effect in a few eastern states. The 32,000-lb. tandem axle load is the generally recognized limit for tandem axle loadings. Typical test trucks are shown in Figures 1 and 2.

Test Sections

The 1.1 mile experimental project was divided into four test sections; see Figure 1. The first section, which is the west lane of the southern half-mile of the one-mile pavement under test, has been subjected to 18,000-lb. single axle loads. The second section, which is the adjacent east lane of

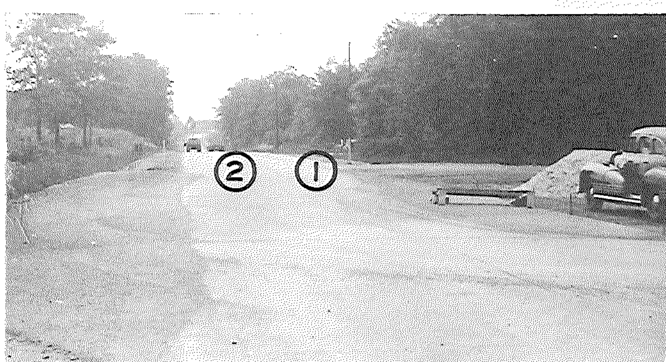
... le 1 vehicle used on Sections 1-2.

Project Field Office

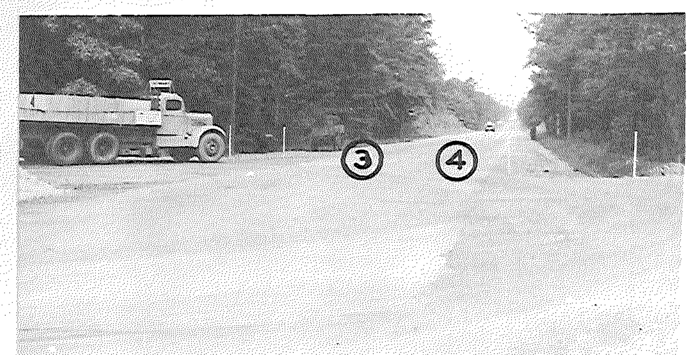
Located between
test sections.

Typical vehicle used on Sections 3-4.

Sections 1 and 2
Looking South from
Field Office



Sections 3 and 4
Looking North from
Field Office



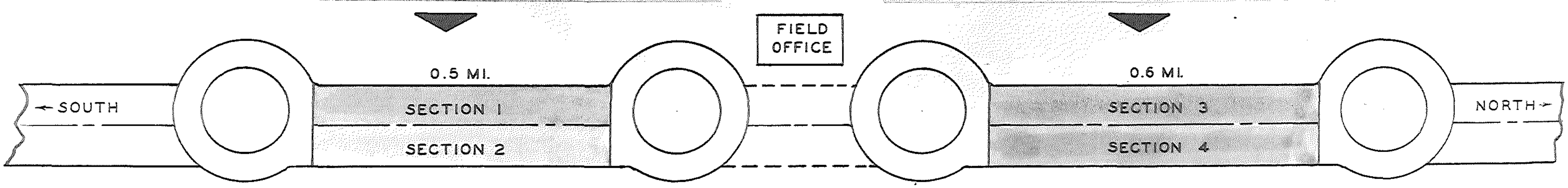


DIAGRAM OF TEST PROJECT

ROUTE US 301

Fig. 1

the southern half-mile, was subjected to 22,400-lb. single axle loads. In this manner, it is possible to compare directly the behavior of the pavement in Sections 1 and 2, since the only major variable between the sections is the axle loadings of the test trucks. Similarly, the behavior of Section 3, the west lane of the northern 0.6 mile with the 32,000-lb. tandem axle loads, can be compared directly with Section 4, the adjacent lane carrying the 44,800-lb. tandem axle loads.

Truck Operations

Two trucks with the same load characteristics were assigned to each test section. The trucks entered their respective test sections at about 10 mph., accelerated as fast as possible to about 38 mph. and decelerated in gear to about 10 mph. before negotiating the turn-around.

The operations of all test trucks were continuous on a 24-hour per day, seven day per week basis, except as it was necessary to interrupt operations for vehicle pavement maintenance and service, for meals and rest stops for the drivers, and for special strain and deflection tests. The frequency of axle loads per hour of operating time for the six month test period was 80 for Sections 1 and 2, and 60 and 58, resepectively, for Sections 3 and 4.

Wheel load positions were varied from the edge of slab to 2 feet in from the edge. One application was made with the outside of the tire at the edge of the pavement; one application with the outside of the tire 2 feet in from the edge, and three applications with the outside tire between the two positions. These positions were indicated in the truck cabs by electrically-operated signal lights.

SUMMARY OF RESULTS

At present, proper comparison of pavement behavior in Sections 1 and 2 under single axle loading with that in Sections 3 and 4 under tandem axle loadings, cannot be made until the characteristics of the subgrade soil under each pavement slab have been determined and other variables such as rate of load application have been studied in detail.

All pertinent data must be carefully analyzed and considered before final conclusions will be drawn. A final report is expected to be ready by June, 1951. However, certain facts relative to the behavior of the test have already been established. The more significant observations which may be made from the test results up to December 23, 1950, after six months of continuous operation, are as follows:

1. Soil tests made on samples obtained throughout the length of the pavement adjacent to the pavement edges and under certain sections of the pavement, indicate that there is reasonable uniformity in the soils on the two sides of the pavement.

2. Based on these same soil tests, there is found to be a definite relationship between soil types and pavement behavior. The more sand and gravel in the soil, the better it supports the road surface and the less cracking develops. The subgrade soils on this project are typical of the soils underlying a very extensive mileage of concrete pavement throughout the country.

3. The progress of cracking and depression of joints in the test sections has a definite relationship to the occurrence of pumping. Previous research and observation has shown that four basic conditions must be present simultaneously to create a pumping slab. They are: (1) frequent heavy

axle loads; (2) subgrade soils of such a nature that they may pump through open joints or cracks or at pavement edges; (3) free water under the pavement; and (4) joints or cracks in the pavement. These conditions were present on this project and pumping resulted.

4. Based on both quality tests and dimension measurements, the concrete in the test sections is of good strength and of the required thickness.

5. All four sections have been damaged to the extent shown in Table I. Rate of crack development is shown in Figure 2.

The project as a whole has demonstrated two noteworthy facts (1) the inter-dependence of all units of the road structure: surface, base, and subgrade in the performance of its load-carrying function and (2) the benefits of cooperation by a number of diverse agencies in research on a problem of mutual importance by pooling their support under the direction of an independent institution devoted solely to the development of facts and new knowledge.

Additional information which will be of great value to designers of future pavements and to those charged with evaluating the load-carrying ability of existing pavements, is being obtained by means of strain measurements of the pavement under various loads and by measurement of the strains induced by warping of the slabs due to temperature differentials between the top and bottom of the concrete.

To secure complete answers to the many questions involved in the interrelationship between loads, pavements, and subgrades, additional test projects under other conditions will be necessary. It is planned to undertake such projects on both bituminous and portland cement concrete types of pavement under other typical conditions.

TABLE I

MARYLAND ROAD TEST ONE-MD
Damage to Pavement as of December 23, 1950

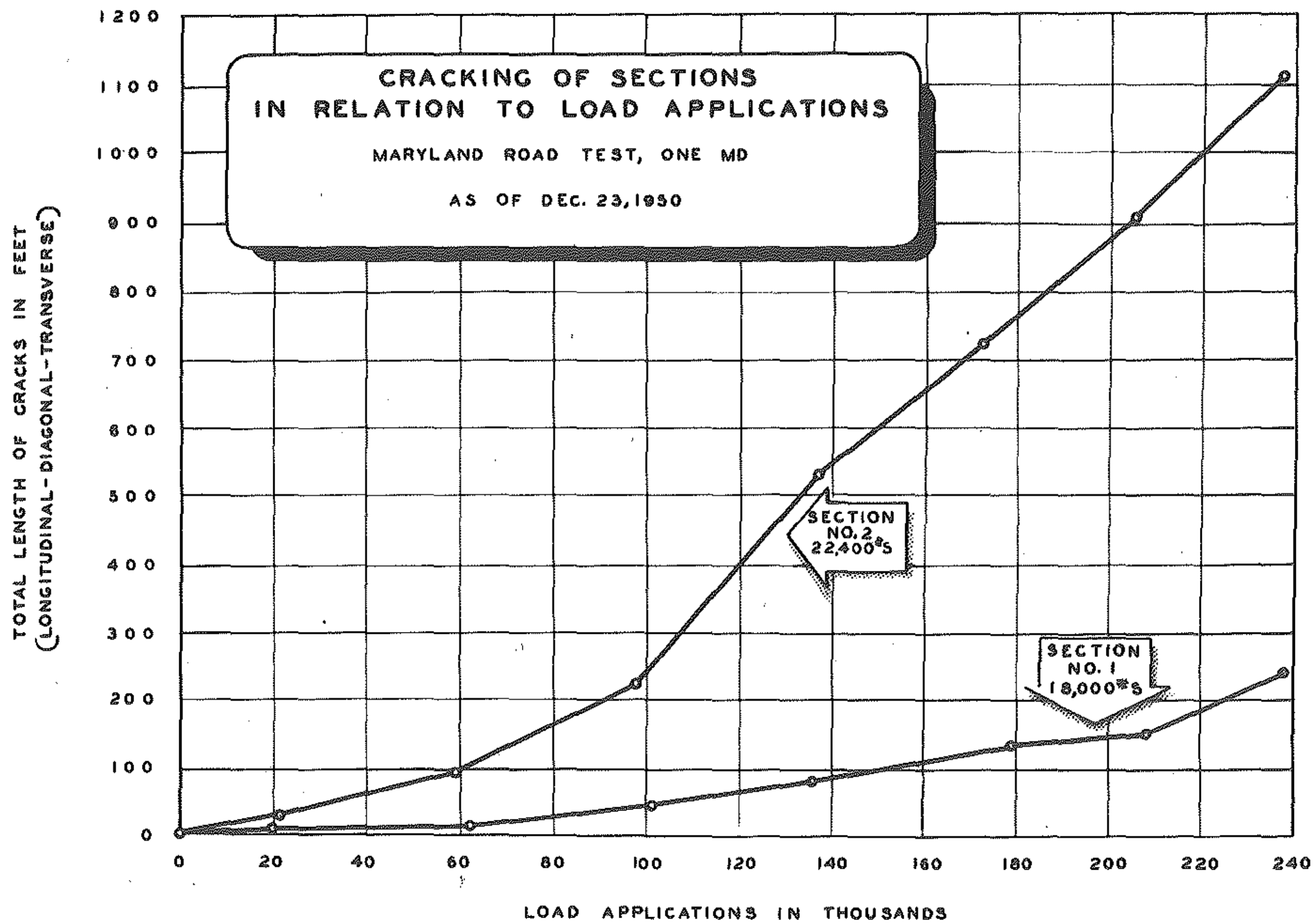
Amount of Slab Cracking:	Trips Made
44,800 lb. tandem axle loads have produced 11 times more cracking than 32,000 lb. tandem axle loads.	20,000 to 92,000 truck loads over a 4-mo. period.
22,400 lb. single axle loads have produced 6 times more cracking than 18,000 lb. single axle loads.	35,000 to 238,000 truck loads over a 5-mo. period.

Number of Cracked Slabs:

44,800 lb. tandem axle loads have cracked 96% of slabs in Sec. 4.	92,000 truck loads to October 13, 1950.
32,000 lb. tandem axle loads have cracked 27% of slabs in Sec. 3.	

Depressed Joints:

44,800 lb. tandem axle loads,	80% of joints depressed, Sec. 4	84,000 truck loads.
32,000 lb. tandem axle loads,	10% of joints depressed, Sec. 3	
22,400 lb. single axle loads,	22% of joints depressed, Sec. 2	137,000 truck loads.
18,000 lb. single axle loads,	2% of joints depressed, Sec. 1	


CRACKING OF SECTIONS
IN RELATION TO LOAD APPLICATIONS
MARYLAND ROAD TEST, ONE MD
AS OF DEC. 23, 1950
SECTION NO. 2 22,400#S
SECTION NO. 1 18,000#S
TOTAL LENGTH OF CRACKS IN FEET (LONGITUDINAL-DIAGONAL-TRANSVERSE)
LOAD APPLICATIONS IN THOUSANDS

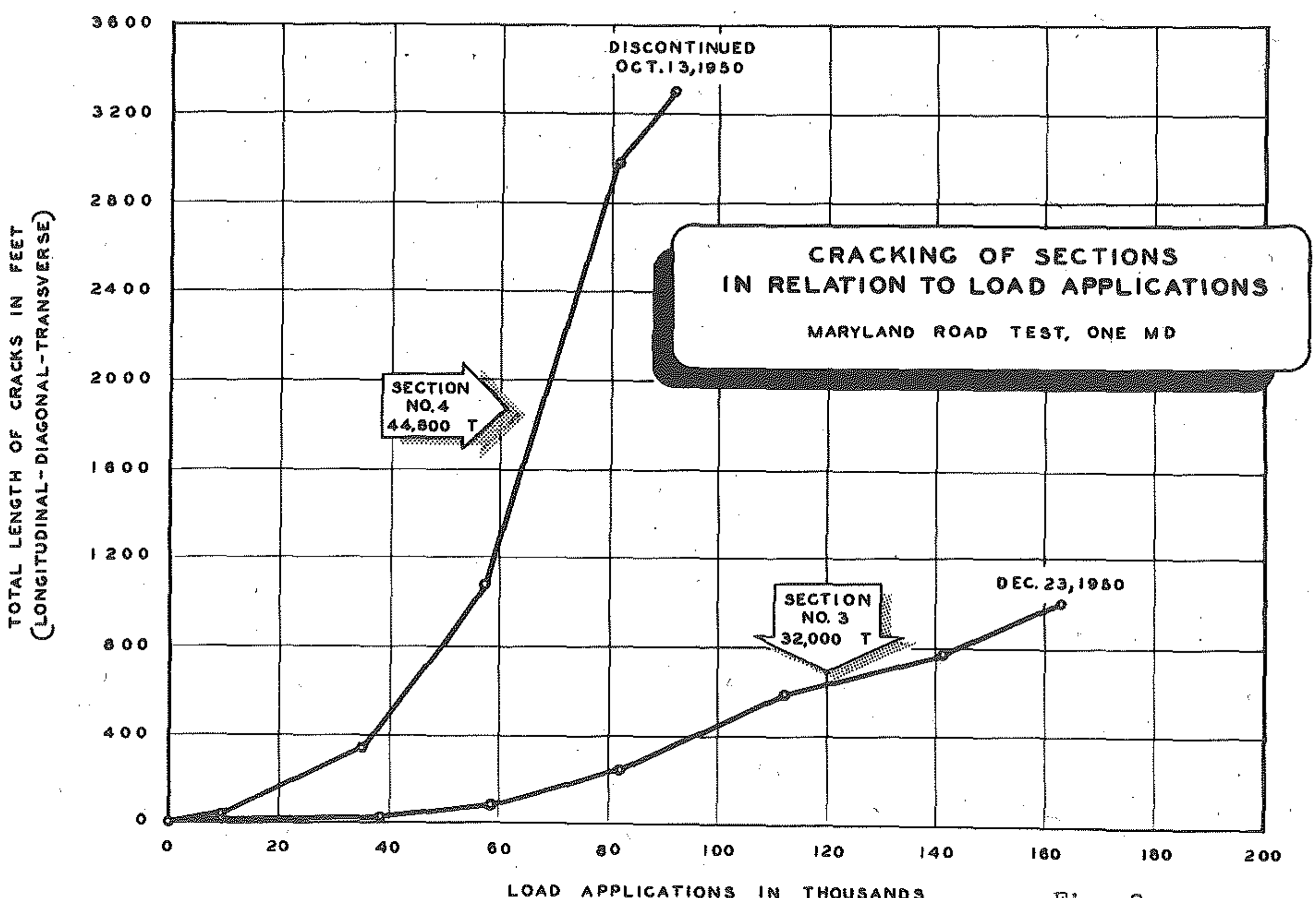

CRACKING OF SECTIONS
IN RELATION TO LOAD APPLICATIONS
MARYLAND ROAD TEST, ONE MD
DISCONTINUED OCT. 13, 1950
SECTION NO. 4 44,800 T
SECTION NO. 3 32,000 T
DEC. 23, 1950
TOTAL LENGTH OF CRACKS IN FEET (LONGITUDINAL-DIAGONAL-TRANSVERSE)
LOAD APPLICATIONS IN THOUSANDS

Fig. 2