

EXPERIMENTAL JOINT SPACING PROJECT

Construction Report

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MICHIGAN DEPARTMENT OF STATE HIGHWAYS

EXPERIMENTAL JOINT SPACING PROJECT

Construction Report

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Research Laboratory Section  
Testing and Research Division  
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Michigan State Highway and Transportation Commission  
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## Introduction

This report covers construction of an experimental portion of freeway on Interstate 75 in Michigan to evaluate design features involving load transfer dowels, slab lengths, neoprene seals, and joint groove modifications. The work is being done by the Michigan Department of State Highways and Transportation as a "Category 2" experiment, in cooperation with the Federal Highway Administration.

Concrete pavements have been troubled by joint deterioration prior to general deterioration of the remainder of the slabs. Numerous design changes through the years, including such improvements as reducing the slab length from 99 ft to 71 ft 2 in., removal of the baseplate under the joint, changing from formed to sawed joint grooves, and replacement of poured seals with preformed neoprene, have greatly improved the design of jointed rigid pavements.

Although these improved pavements are not yet old enough to show signs of serious deterioration, it is evident from recent investigations involving the removal of conventional dowels in service for approximately five years that further improvements can be made to prevent dowel corrosion and joint restraint.

Design improvements must be placed in service on an experimental basis in order to allow evaluation over a considerable period of time. The purpose of this study is to evaluate the performance of an experimental concrete jointed pavement in comparison with the standard pavement presently in use.

## Location

The experimental pavement was incorporated into the plans and specifications of Federal Project I 75-3(41)206, Michigan Project I 65041-00947A. The project is located in Ogemaw County, I 75, commencing 0.42 mile east of Ski Park Rd thence northwesterly to the Roscommon County Line (Fig. 1).

## Description

The test roadway consists of three miles of dual 24-ft reinforced concrete pavement. The northbound portion contains an additional 12-ft truck lane throughout the length of the experimental section. The limits on the northbound roadway are from Sta. 692+02 to Sta. 850+15, the southbound limits are Sta. 687+47 to Sta. 845+55. The pavement is of 9-in. uniform

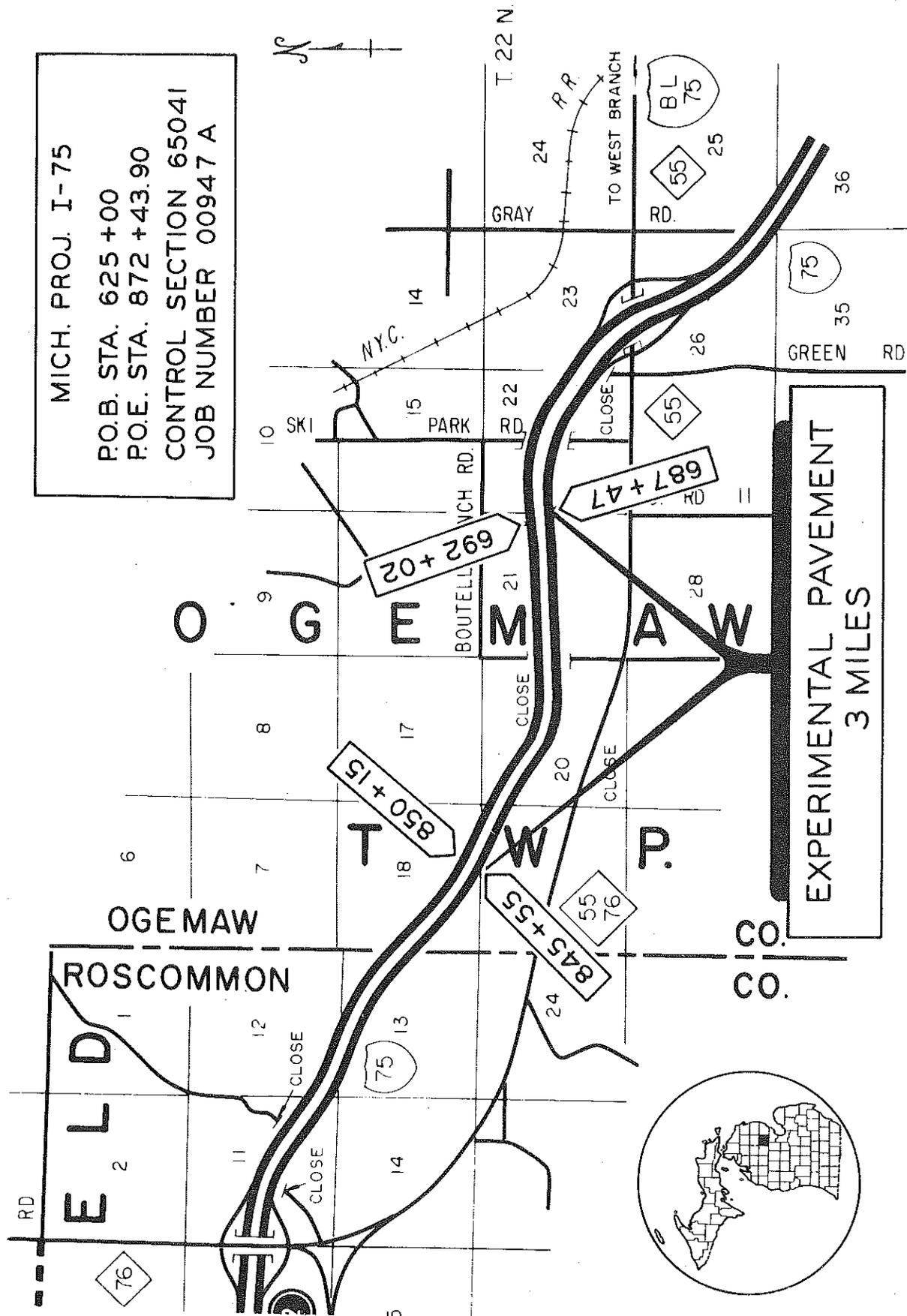


Figure 1. Location of experimental pavement.

thickness with a 1-3/8-in. crown and was placed on 4 in. of aggregate base over 10 in. of sand subbase. The inside shoulders are 4 ft wide, the outside shoulders are 9 ft and 7 ft for the southbound and northbound roadways, respectively. All shoulders are uniform thickness bituminous aggregate applied at a rate of 170 lb/sq yd.

All experimental joints contain load transfer with plastic coated steel dowels. Sections of standard pavement with 71 ft 2 in. slabs and plain steel dowels are included in the experiment for comparison. All joints are sealed with preformed neoprene seals. For ease of construction, reinforcing mat size is the same for all slab lengths. There are no expansion joints in the experimental or control sections. Figure 2 shows the experimental test section layout.

### Experimental Features

The experimental pavement contains two different types of contraction joint load transfer assemblies, three different slab lengths, conventional and modified joint seal grooves, and three different size preformed neoprene seals.

The conventional and plastic coated dowel load transfer assemblies utilized are similarly constructed. In both types of assemblies, load transfer is accomplished by 1-1/4-in. diameter dowels 18 in. long. The dowels are held in a wire frame on 12-in. centers and at mid-depth of the slab. Alternate ends of the dowels are welded to the wire frame. The free ends of the dowels are sawed to maintain roundness and thus minimize resistance to movement. The conventional dowels are coated with liquid asphalt. The coating on the dowels of the experimental assemblies consists of 17 mils of high density polyethylene material extruded on the dowel over 4 mils of adhesive. No additional coating is applied prior to placing the concrete. Figure 3 shows both types of assemblies.

Three slab lengths were incorporated into the design of the experimental pavement. The standard reinforcement mat size, which contains 15 No. 4 gauge transverse wires on 12-in. centers and 24 No. 00 gauge longitudinal wires on 6-in. centers, was employed in all test sections in order to simplify construction. Mat dimensions are 11 ft 6 in. wide by 15 ft long. Slabs were constructed using five, four, and three mats; thus giving slab lengths of 71 ft 2 in., 57 ft 3 in., and 43 ft 4 in. after deducting lapped areas and end clearances.

Figure 4 shows details of special joint seal groove configurations and different size preformed neoprene seals used for the various slab lengths.

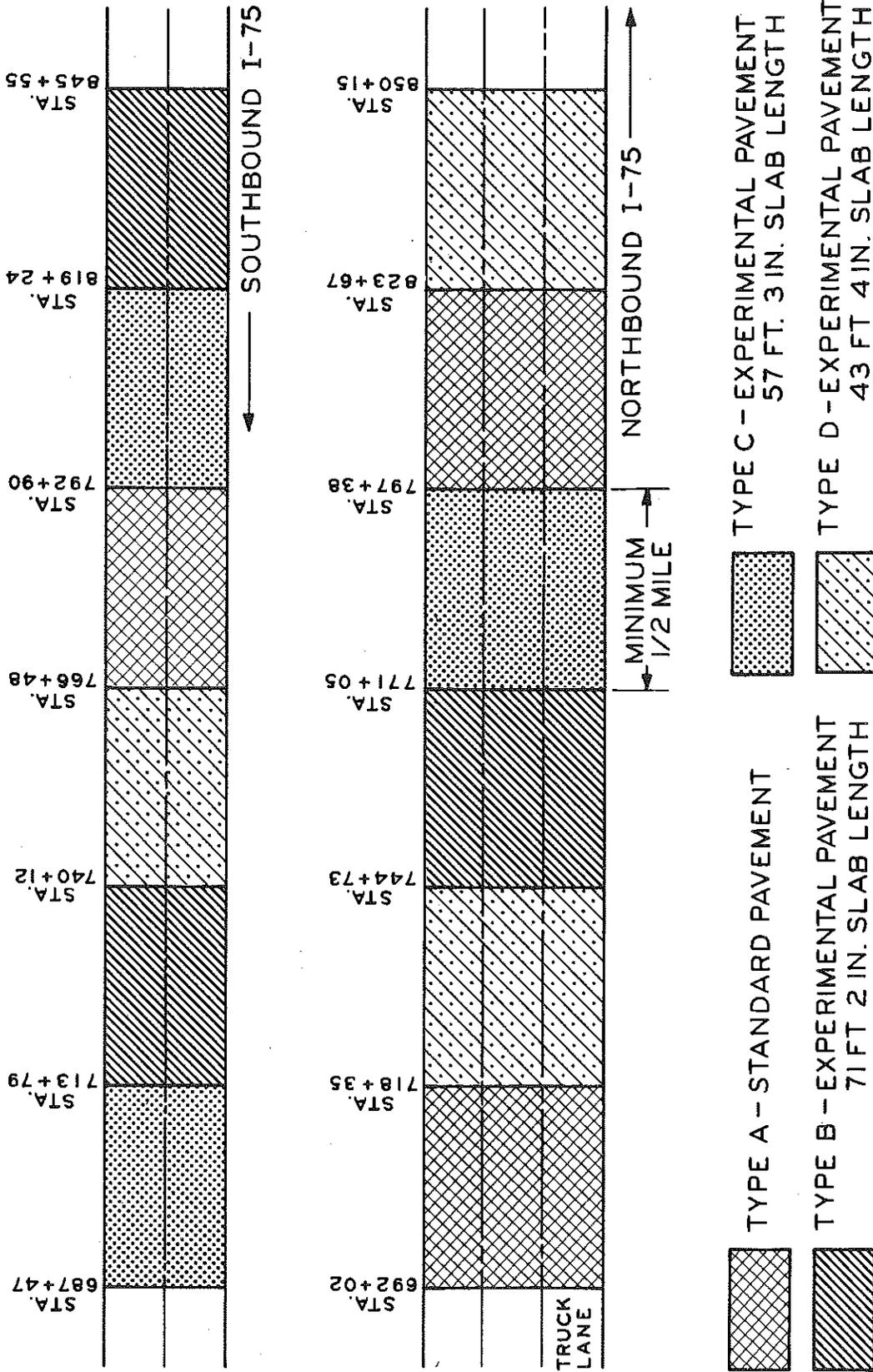


Figure 2. Experimental test section layout.

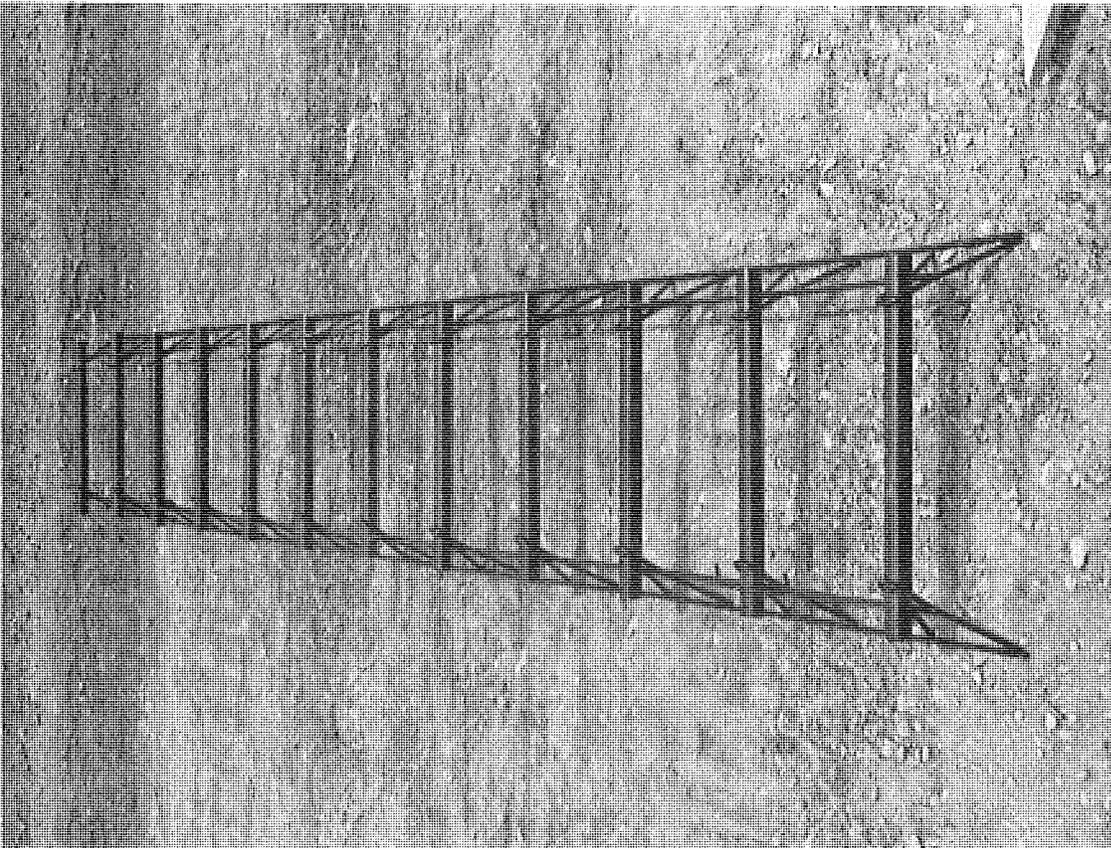
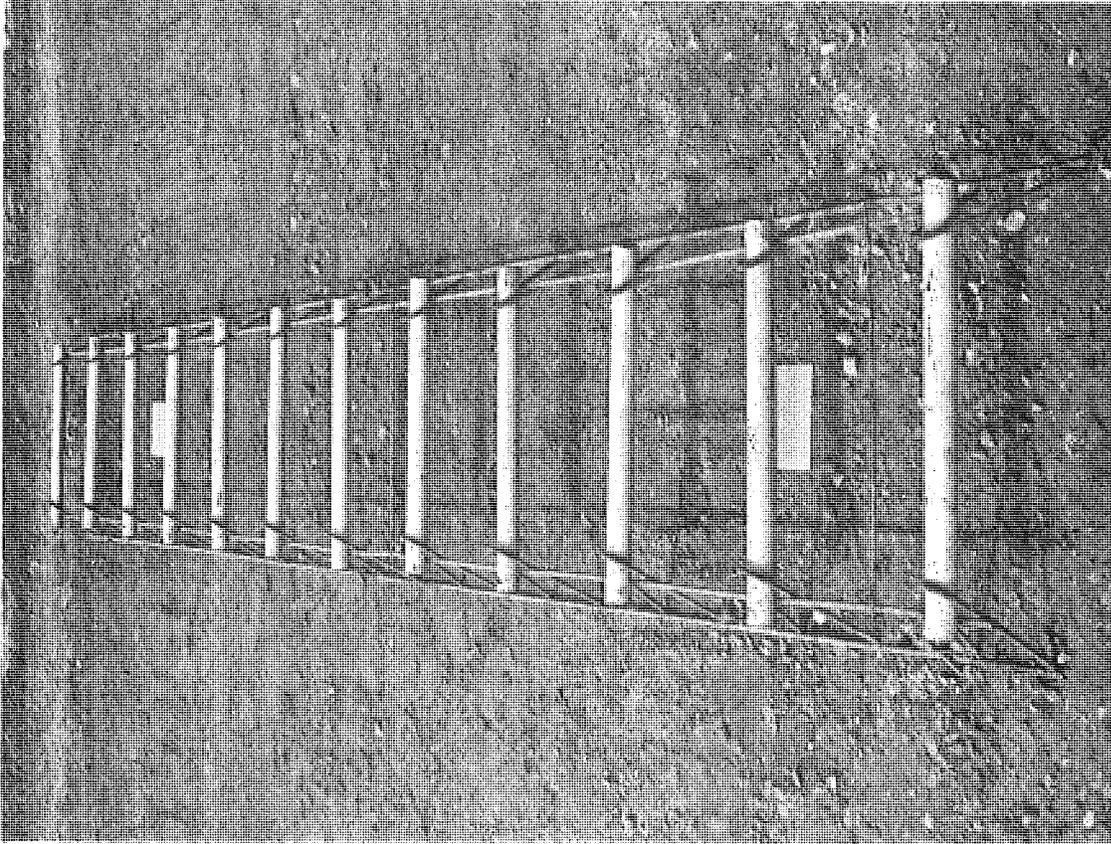
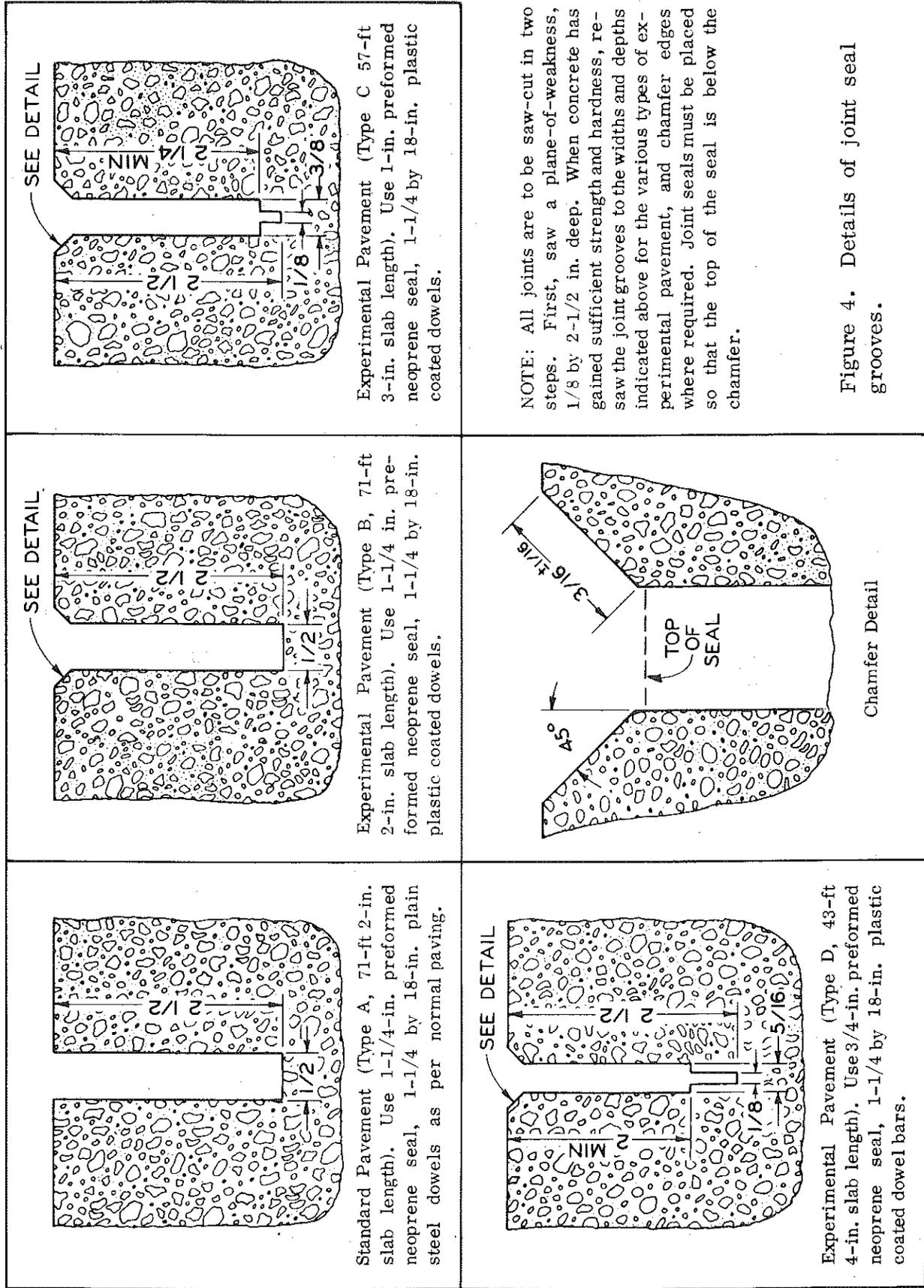


Figure 3. Standard load transfer assembly (left) and plastic coated dowel bar assembly (right).



## Construction

Construction of the experimental pavement section of the project was started July 16, and completed August 24, 1973; the roadway was opened to traffic in November, 1973.

The roadway was constructed by conventional methods using a CMI slip-form paver. Single lane construction was employed, whereby a 12-ft lane is placed and tied to adjacent lanes by use of "wobble" bolts automatically inserted into the side of the fresh concrete at approximately 40 in. spacing (Fig. 5). The longitudinal centerline bulkhead joints were not sawed or sealed.

Concrete was central mixed and transported to the construction site in side-dump trucks. The concrete was placed on the prepared grade in two lifts. The first layer was struck off by the first of two Maxon spreaders approximately 3 in. below the pavement surface and the reinforcement placed at that depth. The second layer was then placed and struck-off at full pavement depth by the second Maxon spreader. The concrete was consolidated and mechanically finished by the CMI paver (Fig. 6). The final surface treatment consisted of hand floating and texturing by transverse hand brooming (Fig. 7). The pavement was protected during the curing period by white membrane curing compound.

Except for a few isolated baskets which contained top wires not properly welded during manufacture, there were no problems encountered in placing the experimental load transfer assemblies. The defective assemblies were field welded prior to pouring of concrete.

Joint seal grooves were sawed using the two-step method. First, a plane-of-weakness cut 1/8 in. wide by 2-1/2 in. deep was made over the center of the load transfer assembly when the concrete had hardened enough to prevent excessive raveling. When the concrete had gained sufficient strength and hardness, the joint grooves were sawed to the widths and depths required for the various experimental slab lengths.

On numerous occasions, the relief cuts were not made soon enough to prevent random cracking of the slabs. Cracking is caused by induced tensile stresses generated by contraction due to cooler nighttime temperatures and shrinkage of the concrete as it hardens. Cracking generally occurs near the area of the joint, since the load transfer device probably acts as a stress concentration. The cracks were quite close to joint grooves in some cases, and repairs were required. This was done by either removing

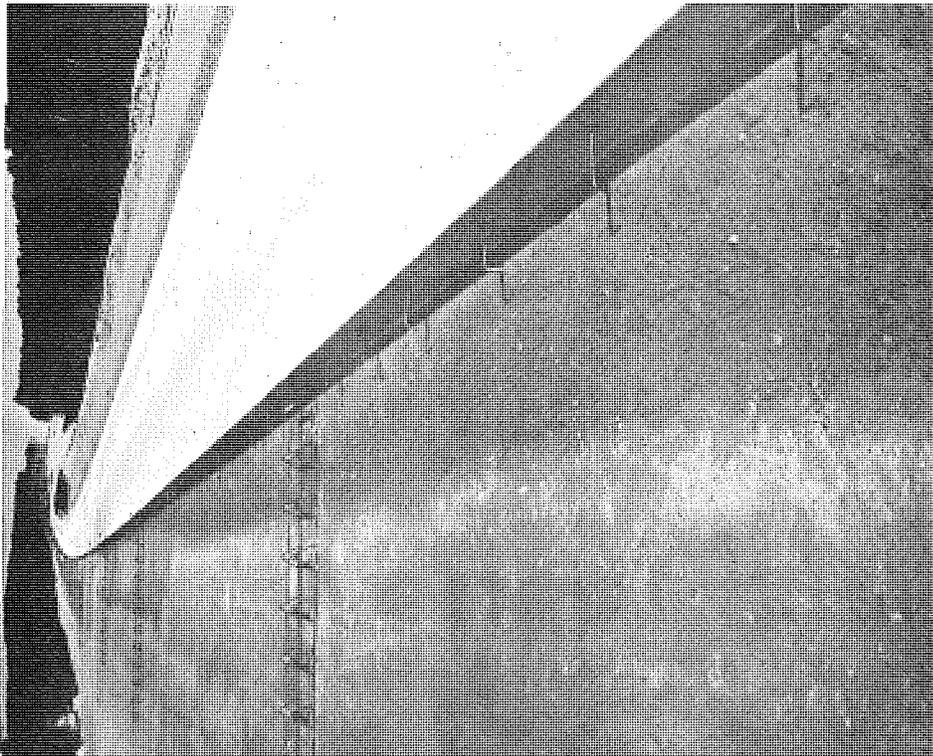


Figure 5. "Wiggle" portion of bolt embedded in existing lane, conventional hook-bolts used to tie-in lane to be added.

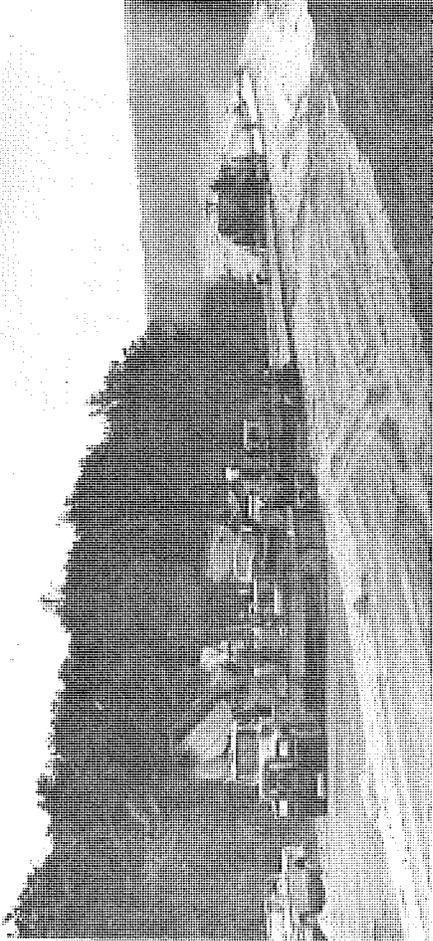


Figure 6. Slip-form paving train placing experimental pavement. Two Maxon spreaders in foreground followed by CMI paver.

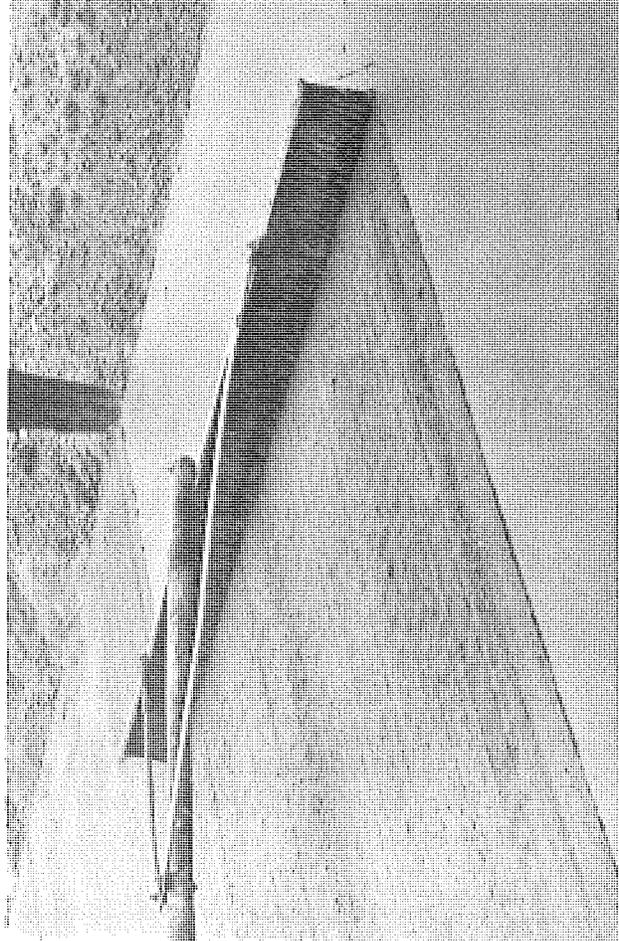


Figure 7. Texturing pavement surface by means of transverse hand brooming.

the damaged area and repouring it or by the use of a structural bond. In cases where the damaged areas were removed, the concrete patch limits were sawed and the concrete removed with air hammers without removal of the reinforcement or load transfer assembly. The distressed area was then repoured with concrete. Structural bond repairs consisted of sealing the crack with wax at the pavement surface and then injecting an epoxy mixture into the opening under pressure to join the two surfaces.

Bevelling of the joint groove edges was performed by the apparatus shown in Figure 8. The machine utilizes a dry carborundum wheel with the cutting edge "dressed" to produce the desired bevel angle; depth of cut and forward motion are manually controlled. The most obvious drawback encountered by using this type of equipment was the inability to produce a uniform bevel. It seems evident that more sophisticated equipment is required in order to produce a uniform bevel at the proper depth. This could probably be done with a machine that would more easily compensate for variations in pavement cross-section and maintain a steady forward motion.

Experimental preformed neoprene joint seals were installed by conventional methods with no serious difficulties encountered.

### Instrumentation

To determine joint movements, all joints included in the experiment (549 total) were instrumented near the outside edge with stainless steel rivets embedded on each side of the joint as shown in Figure 9. In addition, 63 joints of the northbound lanes (36 ft wide) were instrumented along the inside edge to determine variations in joint movements from one side of the joint to the other. Every fifth joint was chosen for instrumentation along the inside edge.

An initial reading or zero reference was obtained before any joint movements occurred.

### Measurements

As stated in the work plan, after construction was completed, an initial condition survey was performed. The survey included measurements of joint movements, transverse cracking, joint groove spalling, and pavement roughness.

Results of the initial survey are given in Table 1.

Figure 8. Machine used to bevel joint groove edges.

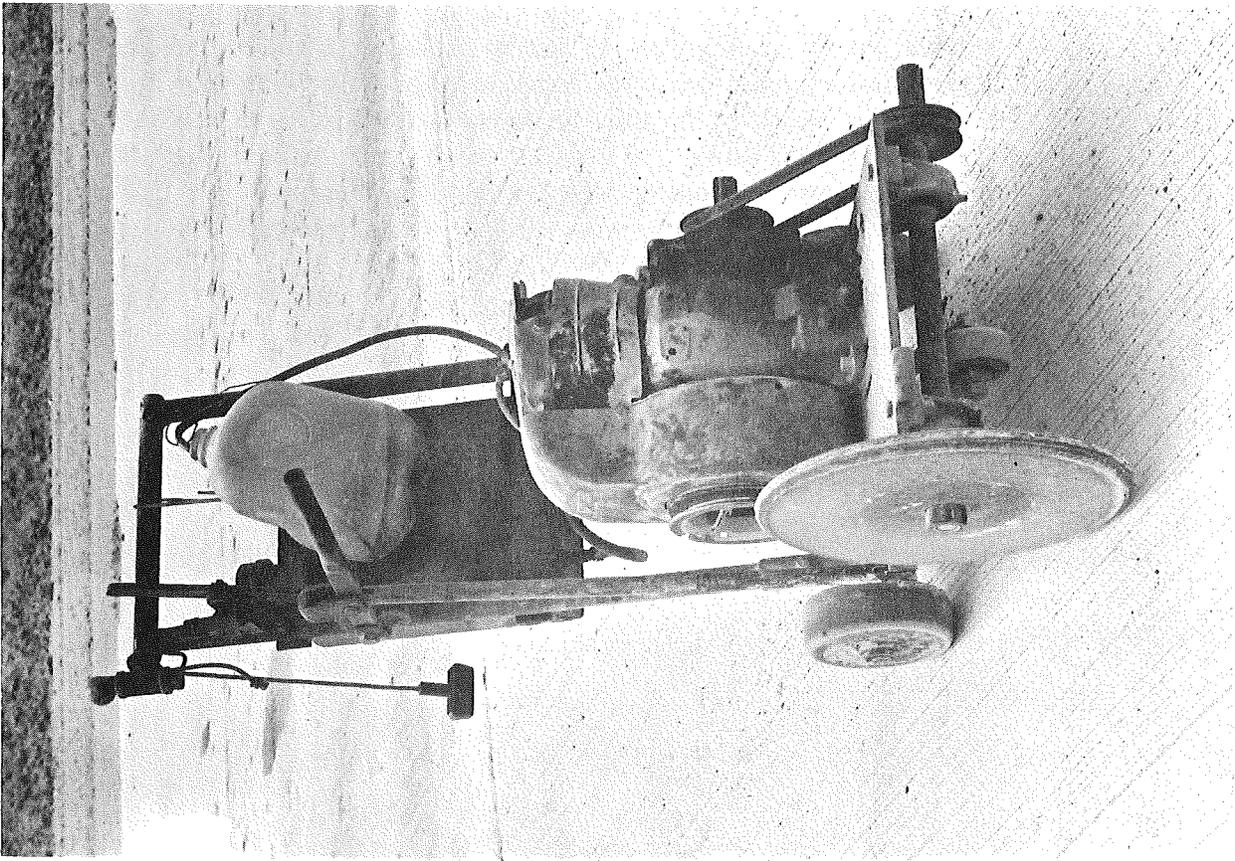


Figure 9. Instrumenting pavement with stainless steel rivets placed on each side of joint. Rivets were set flush or slightly below pavement surface.

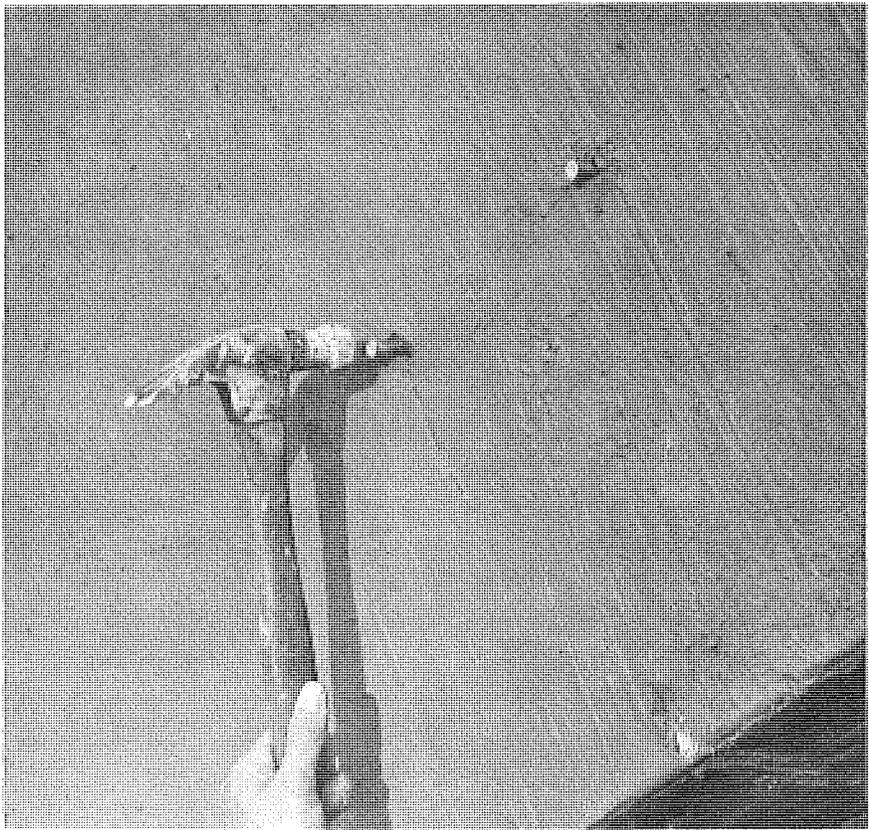


TABLE 1  
RESULTS OF INITIAL SURVEY

Pavement Type	Avg. Joint Movement, in.		Transverse Cracking, lin ft	Avg. Joint Spalling, percent <sup>1</sup>	Equivalent Roughness No., in/mile
	Outside Edge	Inside Edge			
Control	0.251	0.274	66	1.86	164
Type B	0.258	0.259	18	1.45	166
Type C	0.220	0.238	27	1.12	160
Type D	0.165	0.175	236	1.02	180

<sup>1</sup> Percentages computed as follows:  $\frac{\sum \text{Spall lengths}}{\text{Total length of joint face}} \times 100.$

Spalls defined as per Standard Specifications, Section 4.14.18, a.

The average pour temperature was 70 F and 80 F for the instrumented outside and inside lanes, respectively. The average temperature at the time of the survey was 32 F. Since temperature change is one of the primary factors contributing to the joint movements, the difference in pour temperatures between the outside and inside lanes accounts for the slightly larger movements exhibited by joints instrumented along the inside edge.

At this time there is no significant difference in the deviation of movements within the sections.

There is one joint in the "Type D" pavement showing very little movement (0.009 in.). The two adjacent joints show movements close to what would be expected from a slab twice their size. Previous experience has shown this behavior to be indicative of non-working joints, usually caused by tipped load transfer assemblies or misaligned dowels.

The relatively large amount of transverse cracking shown for the "Type D" pavement is due to the fact that two of the three one-half mile test sections are located in areas where the joints were not relief cut before random cracking occurred.

Since there had been little or no public use of the roadway at the time of the initial survey, the values shown for transverse cracking and joint groove spalling cannot be considered as a measure of performance, rather they form the basis for future measurements.

#### Costs

Unit contract costs for the standard and experimental joints were as follows:

Pavement Type	Quantity, lineal ft	Price, per lineal ft
Type A (Control)	8,340	\$4.00
Type B	3,108	\$5.25
Type C	3,864	\$5.00
Type D	5,856	\$4.75

The unit prices shown are for joints in-place, including the load transfer assembly, sawing, sealing, patching and bevelling of experimental joints.

On a sq yd basis, comparative costs are approximately \$.51, \$.66, \$.77 and \$.99 for control, and Types B, C, and D pavements, respectively.

#### Remarks

As stated in the text, many joints required repairs soon after construction in order to re-establish the structural integrity of the slabs. These repairs may adversely affect the performance of joints involved and will therefore be given special consideration during future evaluations.

Performance data will continue to be gathered and compiled by the Research Laboratory. Progress reports will be issued on approximately a yearly basis. Information concerning this project may be obtained by request at any time.