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This report evaluates a new construction technique involving a machine developed for the purpose of inserting a plastic strip in fresh concrete to form a transverse weakened plane joint. Cores were taken through joints so constructed for examination. Adequacy of installation was verified from cores taken on two paving projects. Performance of this type of joint under traffic appears to be equal or superior to sawed joint construction. A proposed specification for the new technique is included.

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HIGHWAY RESEARCH REPORT

TRANSVERSE WEAKENED PLANE JOINTS BY PLASTIC INSERT

68-26

STATE OF CALIFORNIA

TRANSPORTATION AGENCY

DEPARTMENT OF PUBLIC WORKS

DIVISION OF HIGHWAYS

MATERIALS AND RESEARCH DEPARTMENT

RESEARCH REPORT

NO. M & R 635148-3

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STATE OF CALIFORNIA—TRANSPORTATION AGENCY

RONALD REAGAN, Governor

DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
MATERIALS AND RESEARCH DEPARTMENT
5900 FOLSOM BLVD., SACRAMENTO 95819

January, 1968

Research Report
M&R No. 635148(3)
SWO 39157

Mr. J. A. Legarra
State Highway Engineer
Division of Highways
Sacramento, California

Dear Sir:

Submitted herewith is a research report titled:

TRANSVERSE WEAKENED PLANE JOINTS
BY PLASTIC INSERT

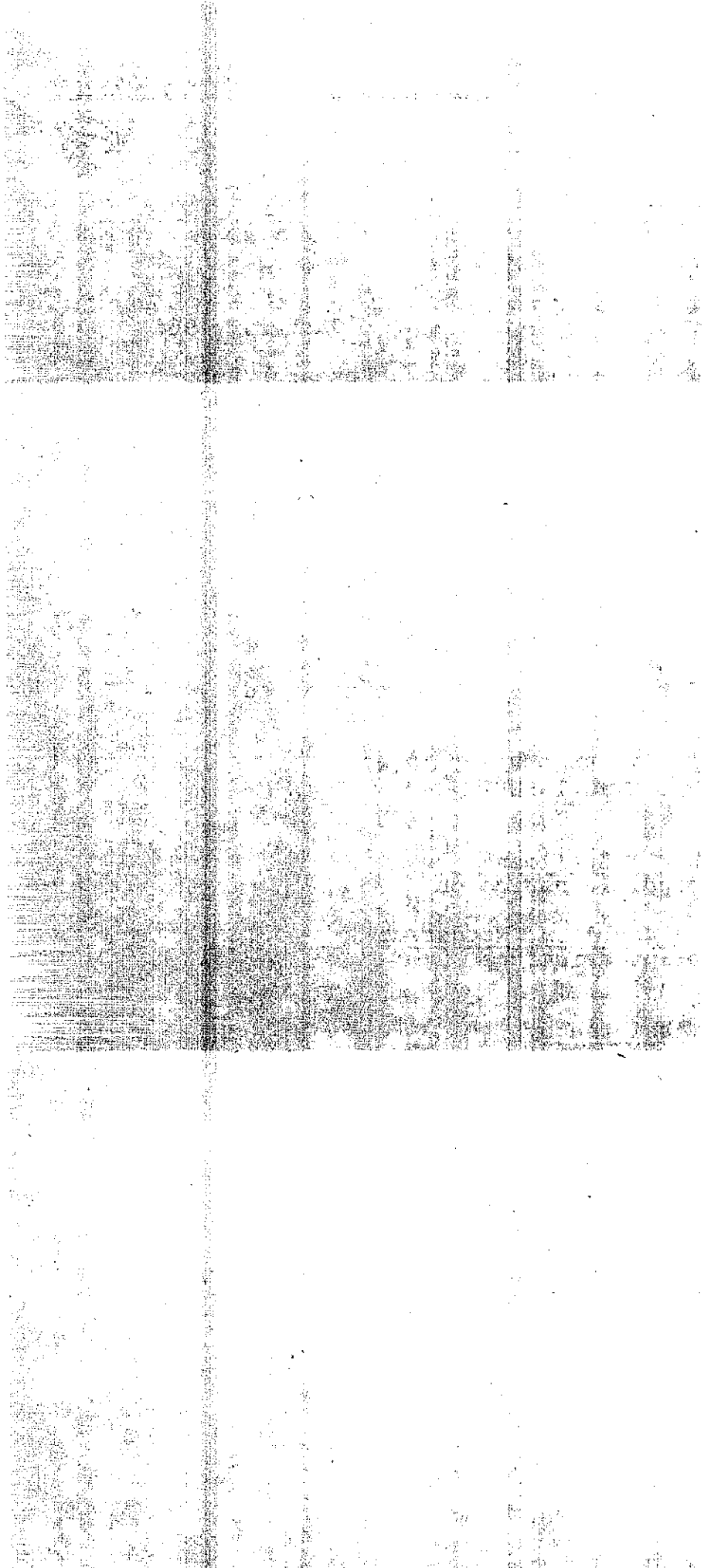
D. L. Spellman
Principal Investigator

J. R. Stoker and J. H. Woodstrom
Co-Investigators

Assisted by
B. F. Neal

Very truly yours,

JOHN L. BEATON
Materials and Research Engineer



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KEY WORDS: Pavement, joints, transverse, weakened plane, plastic

ACKNOWLEDGMENT

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The opinions, findings, and conclusions expressed in this report are those of the authors and are not necessarily those held by the Bureau of Public Roads.

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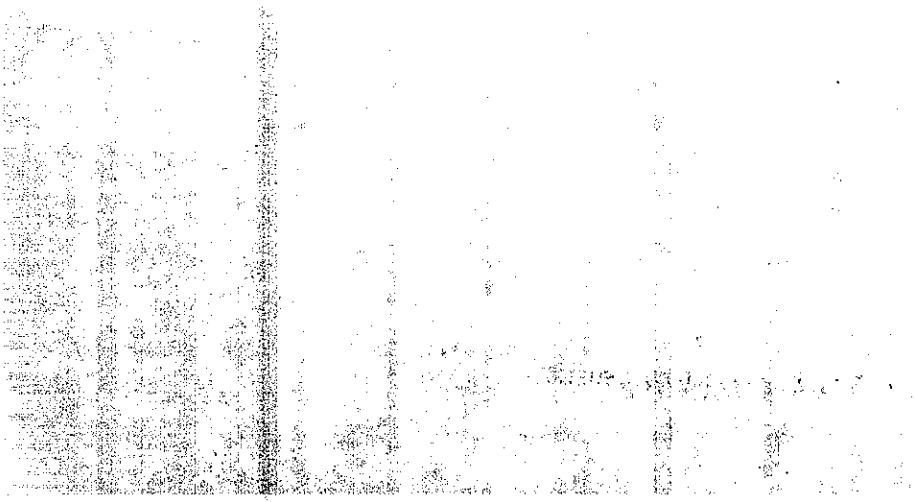

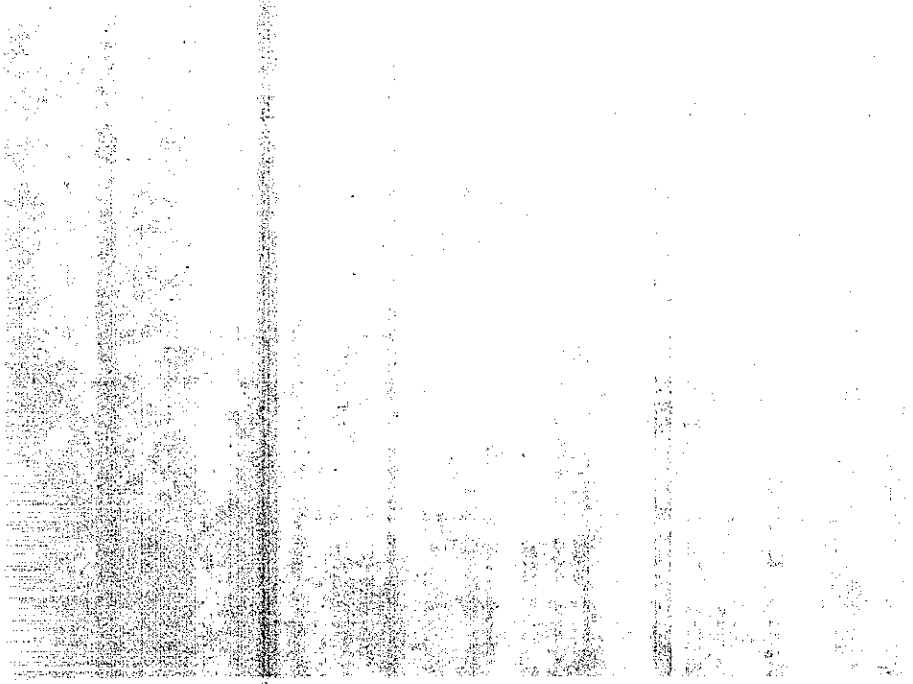

TRANSVERSE WEAKENED PLANE JOINTS BY PLASTIC INSERT

INTRODUCTION

A machine capable of installing a semi-rigid plastic strip into fresh concrete to form a transverse weakened plane joint has recently been developed. This type of joint construction offers many potential advantages over the current method of sawing weakened plane joints. Briefly, the advantages appear to be increased effectiveness in forming a weakened plane, reduced cost of joint construction, and better control of random transverse cracks. Potential application of this type of machine may allow insertion into fresh concrete of new joint materials serving as both a weakened plane and a sealer.

A research project was initiated to determine the acceptability of joints formed by the new device, evaluate the short-term performance of the joints, and establish guidelines to permit or specify general use of the method.

Initially it was planned to examine three paving contracts on which the new device had been used. However, since the information obtained from the first two projects provided positive indications of the potential application of the device, and there would be a long delay before the third project would be completed, it was decided to report findings at this time.

CONCLUSIONS

The machine investigated during this study is capable of satisfactorily forming transverse weakened plane joints in portland cement pavements by the plastic insert method. Its use is considered acceptable in lieu of the sawing method. A proposed specification for weakened plane joints which would permit the use of such a machine is included at the end of this report.

EVALUATION PROCEDURE

To determine the acceptability of the machine in forming weakened plane joints by plastic insert, the following procedure was established:

1. Conduct a visual survey of the pavement noting features that might be related to the new joint construction. This would include effect on smoothness, distorted joint material, final finish, random cracking, and any evidence of spalling at the joint.

2. Randomly select 40 joints to be used as a "sample." Obtain cores through the formed joints at these locations for analyses of joint material position. Obtain a set of photographs of the sampled joints. Obtain a second set of photographs after paving has been subjected to public traffic for approximately three months.

3. Obtain approximately 10 cores at locations where adverse conditions are indicated by visual inspection of pavement surface.

4. Analyze cores for:

   a. Angle of insert material with the vertical
   b. Depth of insert below surface of concrete
   c. Effect of inserting operation on orientation of coarse aggregate around the insert, and
   d. Any other noteworthy features.

The procedure was followed on two portland cement concrete paving contracts; one on Interstate 5 near Oceanside, San Diego County, and another on State Route 152 near Chowchilla, Madera County.

MACHINE DESCRIPTION AND OPERATION

The machine is a self-propelled unit which spans a 24-foot slab. (See photographs.) The joint material, fed from a reel mounted on the machine, is inserted by a vibrating slotted foot as it crosses the pavement. A tapered steel "spear" on the leading edge of the foot cuts the longitudinal weakened plane joint material (polyethylene film 4 mils thick and 2 inches wide). Attached to and following the inserter are small chevron floats and a vibrating pan float to finish the concrete. Temporary side forms are hydraulically placed against the sides of the slab to prevent edge slump during the insertion process.

The machine operates just behind a slipform paver. It is set into place at the joint location; short side forms are positioned against the concrete at each edge, and then the inserting device is activated. The slotted foot is started through an opening in the side form and moves across the slab feeding the plastic material into the fresh concrete as it moves. In the process, the longitudinal joint material is severed. At completion, the inserter passes through an opening in the opposite side of the form and the transverse joint material is automatically cut. The inserter then returns to the opposite side, the side forms are raised vertically, and retracted. The machine is then ready to be moved to the next joint location. A 24-foot joint insertion takes about 15 to 20 seconds to complete. Normal finishing operations satisfactorily eliminate most minor depressions or ridges caused by the process.

DISCUSSION

Considerable effort by private industry went into the development of the plastic joint inserting device. Short trial periods had been permitted on several projects to demonstrate its feasibility. On the first project of this study, the device had been perfected to a degree such that it was considered to be "operational." It then became important to evaluate the type of joint that was being constructed.

Observations made during construction indicate that the machine is capable of installing joint inserts at California's standard spacing (13-19-18 and 12 feet, then repeat), and keeping up with a slipform paver moving at normal operating rates of 600 to 800 lineal feet of 24-foot pavement per hour. There was no difficulty in obtaining the random joint spacing or in installing joints on a skew of 4 feet in 24.

Based on the subjective opinion of several observers, the finished appearance and riding quality of the pavement where the plastic strips were used is entirely satisfactory. Profilograph records of the wheel paths indicate virtually no evidence of this joint construction procedure. There was only minor distortion in the alignment of the joint material in the transverse joints, and no apparent random cracks after six months of use by public traffic.

Observations and a comparison of photographs taken immediately after construction and those taken three months and six months after opening to traffic, indicate that the experimental joints are performing as well as, or superior to, sawed joints. The minimal amount of joint spalling that has occurred is comparable to that associated with conventional sawing operations.

At least forty cores were taken through the plastic strip joints from each paving contract. The core locations were selected on a statistically random basis. Following is a brief summary of the findings from the cores:

Oceanside Project, 11-S.D-5
(4000± Plastic Inserts)

	Depth of Insert Below Surface Nearest 0.01-foot				
Depth	0.00	0.01	0.02	0.03	0.04
Number of Inserts	10	4	11	10	5
Average depth - 0.018-foot					

Angle of Insert with Vertical - Degrees				
Angle	0-1	2-5	6-10	11-15
Number of Inserts	13	18	8	1
Average angle - 3 degrees				

Chowchilla Project, 06-Fre-152
(1000± Plastic Inserts)

	Depth of Insert Below Surface Nearest 0.01-foot				
Depth	0.00	0.01	0.02	0.03	0.04
Number of Inserts	11	9	12	13	1
Average depth - 0.015-foot					

Angle of Insert with Vertical - Degrees				
Angle	0-1	2-5	6-10	11-15
Number of Inserts	1	6	30	9
Average Angle - 8 degrees				

Three inserts tilted in the direction of paving - forty-two in the opposite direction.

Although a considerable number of the plastic inserts are tilted somewhat from the vertical, it is expected that the joints will perform satisfactorily. Modifications to the chevron floats after completion of the Chowchilla project are believed to have corrected the tendency toward tilted strips. Strips should be in an approximately vertical position and at a depth of from 0 to 0.02-foot below the surface to reduce the probability of spalling.

It was also noted during examination of the cores that the plastic inserting operation had no apparent harmful effects on the concrete. There were no significant voids around the plastic and no evidence of segregation was detected, indicating adequate vibration and consolidation of concrete used on these two jobs.

An examination of cores taken at the intersection of the transverse and longitudinal joints shows that at times the thin polyethylene film is displaced laterally and downward rather than being cut. This may be due to the longitudinal joint material having been placed too low. So far there has been no indication of distress in the pavement due to the film displacement. The problem does not appear to be serious and will no doubt be solved.

PROPOSED SPECIFICATIONS

At the option of the Contractor, transverse weakened plane joints may be formed by placing a continuous strip of plastic which will not react adversely with the chemical constituents of the concrete or bond with the concrete. The strip shall have a thickness of not less than 0.013-inch, and a width of 0.17 to 0.18-foot. Final vertical position shall be within 10° of a plane normal to the surface of the pavement. The top of the strip shall not extend above the finished pavement surface, nor be below it more than a distance of 0.02-foot. Final alignment of the strip shall conform to that shown on the plans for transverse weakened plane joints and shall be free of any irregularity of more than 0.1-foot when measured with a 12-foot straightedge.

The strip shall be placed by means of a mechanical installation device which travels transversely across the pavement and vibrates the plastic concrete sufficiently to cause an even flow about the joint material and result in concrete free of segregation and rock pockets or voids. After joint installation, the finished concrete surface on each side of the joint shall be in the same plane.

Splices in the joint material will not be permitted.

Where transverse joint strips cross the longitudinal joint, the transverse joint installation device shall place the strip continuously across the juncture without adversely affecting the alignment of the longitudinal joint material.

During insertion, the sides of the pavement shall be supported by temporary forms, placed and removed in such a manner as to prevent any edge slump of the pavement.

The Contractor shall maintain a standby multiple-bladed power joint saw, in operating condition, on the project at all times while concrete paving operations are under way, regardless of the type of weakened plane joints being constructed.

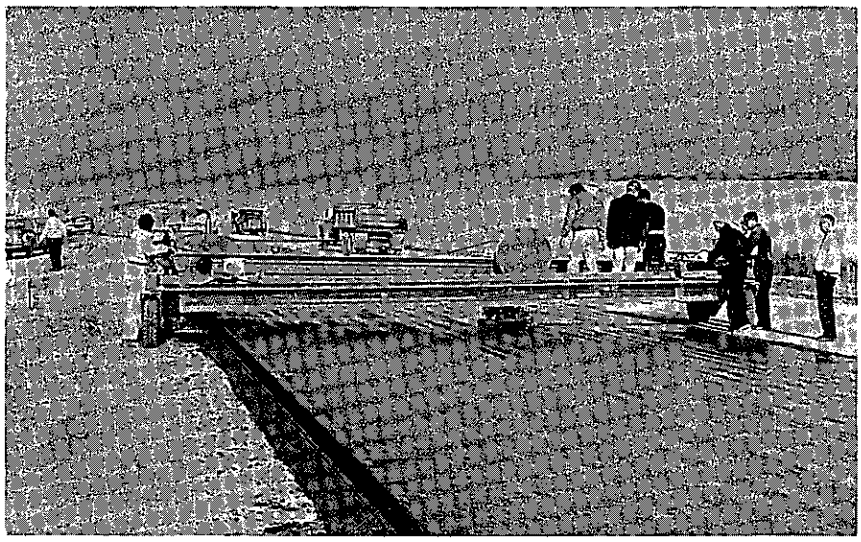

Figure 1 - An overall view of the joint inserting machine.

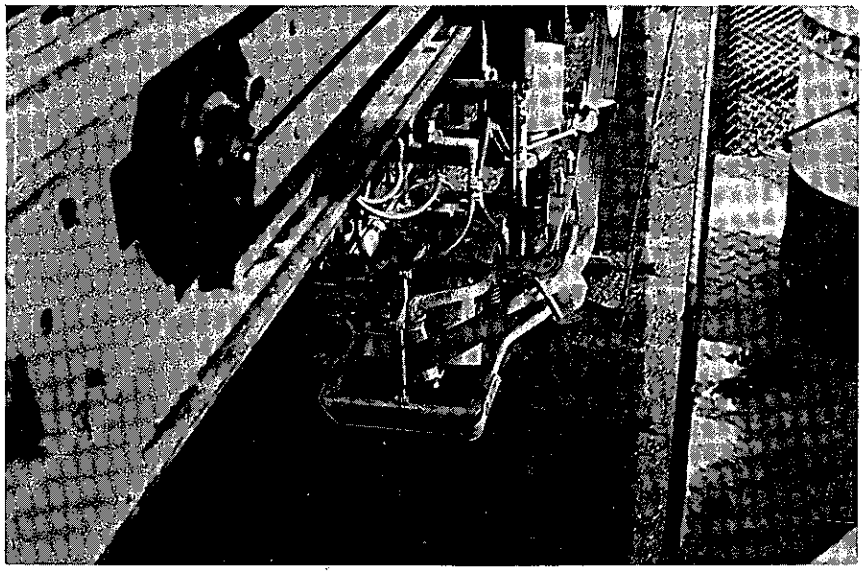

Figure 2 - Joint inserter in operation. Note plastic tape being fed into the concrete at the leading edge, and also the array of lines.

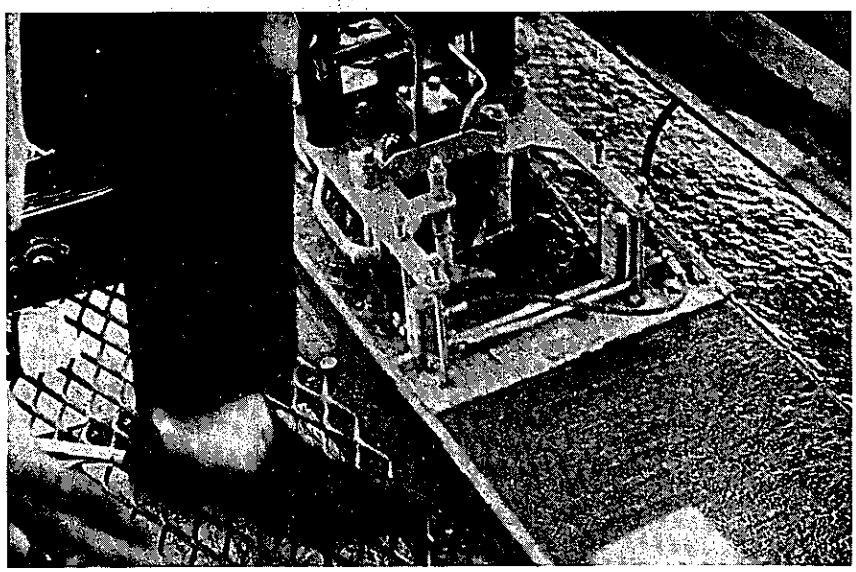

Figure 3 - Top view of the inserter. Note finished concrete surface behind trailing edge.

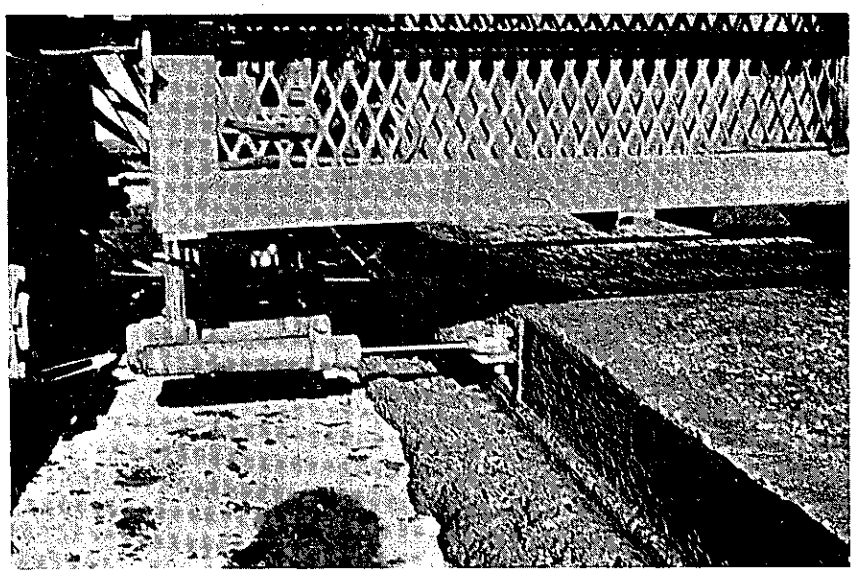

Figure 4 - Completed joint insert. Note temporary side forms.

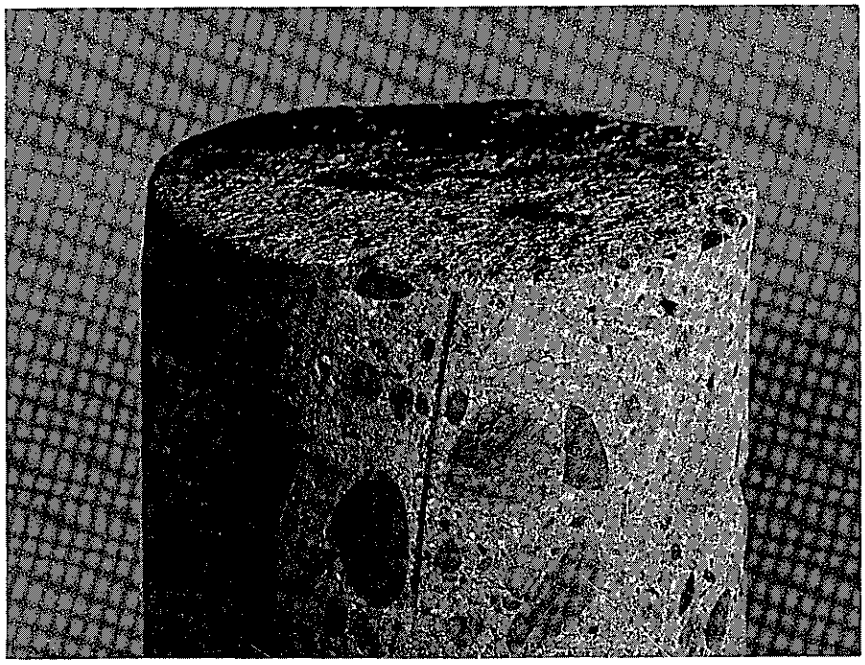

Figure 5 - Picture of core from a joint