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16. ABSTRACT
Weakened plane contraction joints in Portland cement concrete pavements have been constructed under recent California practice by two basic methods. The first involves the formation of a groove in the plastic concrete into which a parting strip is inserted. The inserted material is either premolded "paper" or sheet metal. The second method involves sawing a groove in the hardened concrete. Each of these types has defects and none has consistently provided entirely satisfactory joints. The most common defect in inserted joints is spalling at the pavement surface. Objections to the sawed joints are its higher cost, inability to construct it before random cracks are formed by natural processes, and unsightly raveling at the surface or loosening of the coarser aggregate particles if sawing is performed early enough to forestall the formation of random cracks.

Workmanship and weather conditions are important factors in the successful installation of any of the commonly used joints. Inadequate curing in the immediate vicinity of the joint is believed to be a contributing factor in poor performance. Characteristics of the concrete itself also influence the results obtained in joints. The interplay of these factors probably is responsible for the excellence of results obtained on one job and the poor performance of joints on another job. Not enough is known about the effect of the surrounding conditions to make it possible to select in advance the type of joint that will be most promising in a particular installation. It would be desirable to develop a type of joint that would be affected by variable conditions to the least practicable extent.

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STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

A REPORT ON INSTALLATION OF AN EXPERIMENTAL JOINT SECTION IN PCC PAVEMENT

Contract 57-3TC25-F
III-Sac-4-A,B

MATERIALS & RESEARCH
SAGACITAS · SCIENTIA · STVDIVM
DEPARTMENT

State of California
Department of Public Works
Division of Highways

MATERIALS AND RESEARCH DEPARTMENT
3435 Serra Way
Sacramento 16, California

March 10, 1958

Mr. J. W. Trask
Assistant State Highway Engineer
Division of Highways
Sacramento, California

Dear Sir:

Submitted for your consideration is:

A REPORT

on

INSTALLATION OF AN EXPERIMENTAL

JOINT SECTION

IN PCC PAVEMENT

Contract 57-3TC25-F
III-Sac-4-A,B

Study made by	Technical Section
Under general direction of	Bailey Tremper
Work Supervised by	D. L. Spellman
Report Prepared by	D. L. Spellman

Yours very truly

F. N. Hveem
Materials & Research Engineer

cc:M.Harris
G. Langsner

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INTRODUCTION

Weakened plane contraction joints in portland cement concrete pavements have been constructed under recent California practice by two basic methods. The first involves the formation of a groove in the plastic concrete into which a parting strip is inserted. The inserted material is either premolded "paper" or sheet metal. The second method involves sawing a groove in the hardened concrete. Each of these types has defects and none has consistently provided entirely satisfactory joints. The most common defect in inserted joints is spalling at the pavement surface. Objections to the sawed joint are its higher cost, inability to construct it before random cracks are formed by natural processes, and unsightly raveling at the surface or loosening of the coarser aggregate particles if sawing is performed early enough to forestall the formation of random cracks.

Workmanship and weather conditions are important factors in the successful installation of any of the commonly used joints. Inadequate curing in the immediate vicinity of the joint is believed to be a contributing factor in poor performance. Characteristics of the concrete itself also influence the results obtained in joints. The interplay of these factors probably is responsible for the excellence of results obtained on one job and the poor performance of joints on another job. Not enough is known about the effect of the surrounding conditions to make it possible to select in advance the type of joint that will be most promising in a particular installation. It would be desirable to develop a type of joint that would be affected by variable conditions to the least practicable extent.

A step toward the development of a more successful joint lies in the installation and subsequent observation of a variety of types in a single paving project and this, in brief, was the purpose of the installation described in this report. In considering the types to be installed experimentally, it was not considered necessary to confine the list to those that are primarily of low cost. A costly joint if it proved to be highly successful, might point the way to a less costly joint involving similar principles. Also a more costly joint might prove to be economical in the long run.

The general types of joint selected for this study were the following:

1. Armor the vertical joint faces with sheet metal bonded to the concrete with adhesive.

2. Insert sand mortar in the place of concrete in the immediate zone in which a sawed joint is constructed later.

3. Provide more positive curing for the concrete in the vicinity and on the vertical faces of a constructed joint.

In addition to joints of the above classes, prevailing types of paper, metal and sawed joints were included within the test section. Two other types of joint that have previously been used were also included for study. These are (a) a plane of weakness created by a wood strip 2 inches high secured in place on the subgrade, and (b) a plane of weakness created by the insertion of a T-iron into the surface and its subsequent filling with surface mortar by the action of the float screeds.

This report covers details of an experimental joint installation in the portland cement concrete pavement on Contract 57-3TC25-F, under change order No. 17.

GENERAL

The test section selected covers about two miles of two-lane pavement, part of a four-lane divided highway, about 15 miles south of Sacramento on US 99. Construction was on new alignment, all on a low fill, and on tangent. The structural section was a standard 8-inch portland cement concrete pavement over 4 inches of cement-treated subgrade. The pavement was constructed "lane-at-a-time".

The experiment was to include not only different joint types, but also sections of sawed joints cured in different ways to determine the effects of curing on joint spalling. In this latter category, 226 joints, (113 in each lane) were cured in three different ways. A total of 112 sawed joints was covered with sisalkraft paper strips 12 inches wide and extending the full length of the saw cut. The ends of the strips were brought down over the side of the slab and loose aggregate was used to hold the strips in place. A total of 48 sawed joints was covered with polyethylene sheeting in the same manner. High winds made it difficult to maintain the coverings in place and after three days no further effort was made to restore covering displaced by the wind. A total of 66 sawed joints was sprayed with Hunts curing compound immediately after sawing, completing the curing test series.

TYPES OF JOINT

Seven different types of joint were used in the test section. Description of each type is as follows:

1. Single steel strip, 16 gage, 1-3/4" x 11'-11-1/2". This joint corresponds to metal joints now being used. The purpose of the joint in the test section was to offer some comparison to other types of steel joints. (31 in travel lane, 26 in passing lane.)

2. Double steel strips, 16 gage, 1-3/4" x 11'-11-1/2", nothing between; outer faces coated with epoxy resin type adhesive before being inserted in the fresh concrete. This type of joint would provide an "armor" to both sides of the joint and at the same time help prevent drying out of the concrete at the joint. The epoxy resin type adhesive had the following composition:

Epon 820	2 parts
Thiokol - DMP-30	1 part
Filler (Silica)	2 to 3 parts, depending on temperature

(30 in each lane.)

3. Double steel strips, 16 gage, 1-3/4" x 11'-11-1/2". Thin layer of asphalt-latex emulsion between, metal coated with epoxy resin type adhesive on the outer faces before being inserted in the fresh concrete. The asphalt latex emulsion was the type used to seal joints and cracks and conformed to Section 58

of the California Highway Standard Specifications. In addition to providing an "armor" to the joint edges, it was expected that the filler material would prevent the passage of water and at the same time keep rocks and other foreign matter from entering the joint.
(30 in each lane.)

4. Double steel strips, 16 gage, 1-3/4" x 11'-11-1/2". Two small beads (1/8" to 3/16" wide) of "Pro-Seal" caulking compound near top and bottom edges between the two strips. Epoxy resin type adhesive applied to outer faces before being inserted in the fresh concrete. "Pro-Seal" caulking compound is a polysulfide polymer liquid rubber which is cured to an elastic solid by a lead peroxide curing agent. This joint would be comparable to No. 3 and was intended to accomplish the same purpose.
(30 in each lane.)

5. Redwood strips, 1" x 2" x 11'-11-1/2". Strips nailed to the subgrade in advance of the mixer. This type of joint forms a weakened plane on the bottom of the slab and cracking, when reaching the surface, will be irregular. There is no interference with finishing and the concrete near the crack will not have been "worked" with any hand tools.
(30 in travel lane, 18 in passing lane.)

6. Mortar substitution. To make this type of joint, a portion of the regular concrete was removed in the area of the joint and replaced with a 1:2 mortar. The joint was sawed after the mortar had hardened. By substituting mortar in the vicinity of the joint, it was hoped that some of the usual difficulty of pulling out large rock when sawing should be eliminated. Spalling often occurs at the interface of large rock and the mortar, and should be reduced also.
(25 in travel lane, 15 in passing lane.)

7. T-iron only. In this section, the joints were formed with a T-iron just as would be done when installing paper joints. No insert was made, the surface being finished in the usual way.
(20 in travel lane, 17 in passing lane.)

INSTALLATIONS DETAILS

The general procedure was to install all joints of one type at 30-foot intervals as a section, the intermediate or 15-foot joints being sawed later. Some overlap occurred between the double steel and T-iron sections. Whenever delays occurred, or between sections of a particular type of joint, regular premolded paper joints were used. With a few exceptions, the same type of joint was placed in the companion lane as was used in the first lane. Complete records were kept of the location and type of each joint on survey cards. These records will be used on future surveys. Control sections are standard paper joints placed at 30-foot intervals with 15-foot sawed intermediate joints. One section placed in the afternoon had paper joints placed at 60-foot intervals, all intermediate joints being sawed.

Weather conditions were generally good. The temperatures were cool, the humidity high, and the difference between the minimum and maximum daily temperatures was small. These conditions tended to lessen any effects that might have resulted from the different curing methods. In fact many of the joints did not open for several days, some sections being as long as 60 feet before any cracks appeared along the edge of the slab. In addition, none of the difficulties that usually arise from hot, dry winds, were encountered.

T-iron Section

Forming joints in the T-iron section consisted merely of working the T-iron cutter used to install paper joints down into the fresh concrete, then removing it. The surface was then floated and finished in the usual way.

Steel Strip Sections

In placing the double steel strips, a groove was first made in the fresh concrete with the T-iron cutter. The strips, freshly coated with the adhesive, were placed in the groove, and the concrete surface hand finished. The mechanical floating and finishing operations were then carried out in the usual manner. Though every effort was made to keep the steel strips within 3/16-inch of the surface, finishing operations caused some of them to sink slightly. The single steel strips were inserted in the same way but were not coated with adhesive.

Redwood Strip Section

In this section, 1x2" wood strips were nailed to the subgrade in advance of the mixer and covered with concrete using shovels. The batch of concrete from the dump bucket was then carefully dumped so as not to dislodge the strip. Operations were then carried on in the usual manner.

Mortar Substitution Section

These joints were made by removing a portion of the fresh concrete in the form of a trench and back-filling with a 1:2 mortar made with concrete sand and cement. The mortar was mixed in a small drum-type mixer at the site. The joints were then marked for sawing. The first few trenches were made by shoveling out fresh concrete in the line of the proposed joints. This proved difficult as the fresh concrete "slumped" inward as each shovelful was removed. Later the trench was formed by placing a 2" x 4" board, flat side down, on the concrete and displacing a portion of the mix by two or three men working the board down with their weight, scooping up the excess concrete with shovels. The resulting trench was about 4 inches wide and 2 inches deep, the full width of the lane. Much less mortar was required to fill a trench this size and the mortar could be compacted better.

This report can only cover the preliminary phases of the work as it will probably be months or years before significant results of performance become evident. As pointed out earlier in the report, some of these joints may not be "practical" but results might give answers to some of the questions of why joints act as they do. Since weather conditions were nearly "ideal" because no extreme temperatures were encountered, another section of sawed joints should be tried to study effects of curing methods during the hot summer months.

A schedule showing type of joint, station limits, joint numbers, lane and date installed, is attached. The individual joint numbers that appear on the survey cards will be painted on the pavement to facilitate inspections.

Profiles have been obtained with the 25-foot truck-mounted profilograph to use as a comparison of performance later on.

A series of pictures illustrating joint operations was taken during construction and is on file. Selected views are attached.

The road is scheduled for opening to traffic in the Spring of 1958.

The resident engineer on the job was Lee Spickelmire and the laboratory representative was Douglas Howard.

CONCLUSION

The purpose of this report is to record the types of joint constructed, their location and the conditions surrounding the installation. It is hoped that this record will be of assistance in evaluating the performance of individual joints in succeeding years.

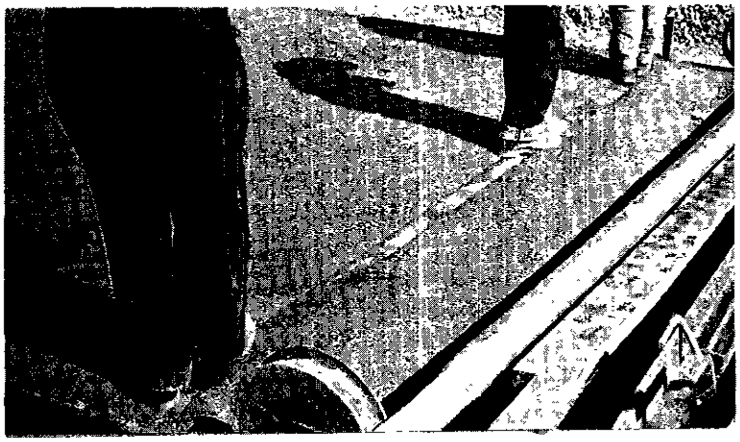
At present no conclusions are justified relative to the merits of any of the experimental joints. It is not anticipated that firm conclusions can be reached for several years although trends may be indicated earlier.

JOINT SCHEDULE

Stationing Increases Northbound

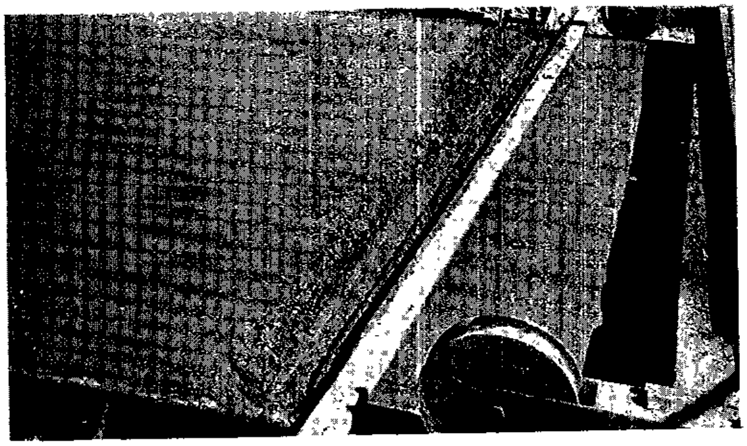
Type of Joint	Stationing of Section	Joint Number	No. Jts. Each Lane	Date Placed
Premolded paper strips (Control)	137+66-128+95	1-59	30 travel 30 passing	10-1-57 10-21-57
Single metal strips	128+65-119+65	61-121	31 travel 26 passing	10-1-57 10-21-57
Double metal strips Adhesive on outer faces	119+35-114+85 and 113+03-109+15	123-153))- 165-191)	30 travel 30 passing	10-1-57 10-21-57
T-iron only	114+55-113+33 and 108+85-103+73	155-163))- 193-228)	20 travel 17 passing	10-1-57 10-21-57
Premolded paper strips (Control)	103+43-100+10	231-253	12 travel 12 passing	10-3-57 10-22-57
Wood strips on subgrade	99+80-91+10	255-313	30 travel 18 passing	10-3-57 10-22-57
Mortar substitution for early sawing	90+50-76+08	317-413	25 travel 15 passing	10-3-57 10-22-57
Double metal strips Asphalt latex between, Adhesive on outer faces	75+48-66+78	417-475	30 travel 30 passing	10-3-57 10-22-57
Premolded paper strips (Control)	66+15-39+70	479-656	77 travel 91 passing	10-3, 10-4-57, 10-22, 11-1-57
Double metal strips Pro-Seal caulking comp. betw., adhesive on outer faces	39+40-30+70	658-716	30 travel 30 passing	10-17-57 10-31-57
Premolded paper strips (Control)	30+40-26+20	718-746	15 travel 15 passing	10-17-57 10-31-57

Paper joint sections are to serve as control



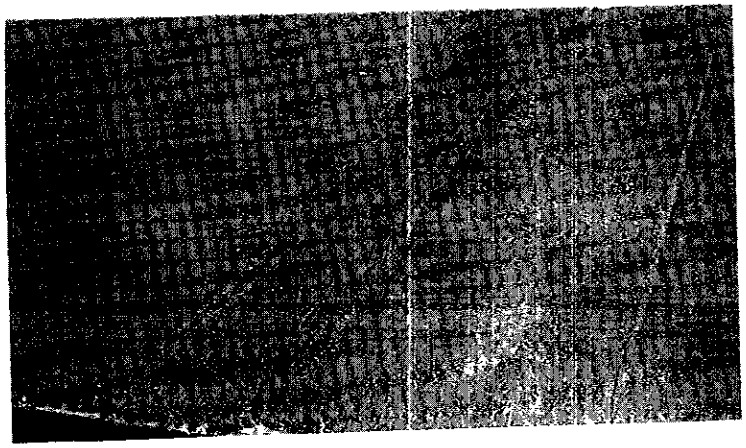
Picture 1

Forming trench for "Mortar Substitution" joint.



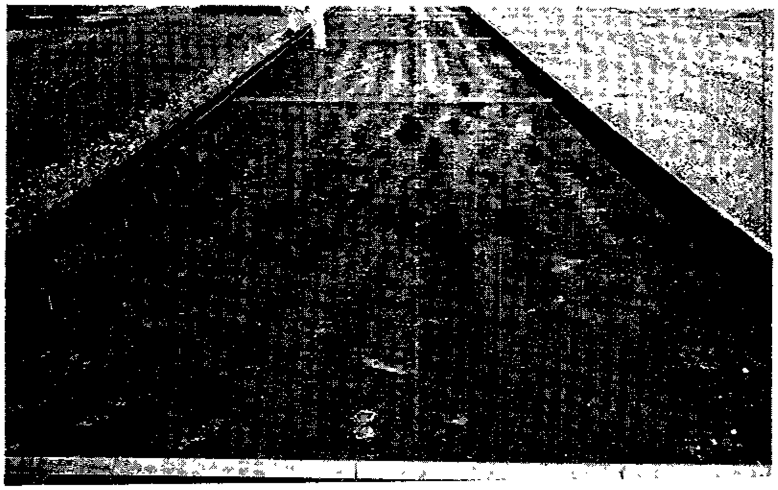
Picture 2

Trench ready for mortar.



Picture 3

Mortar in place, ready for finishing with float. Joint will be sawed later.

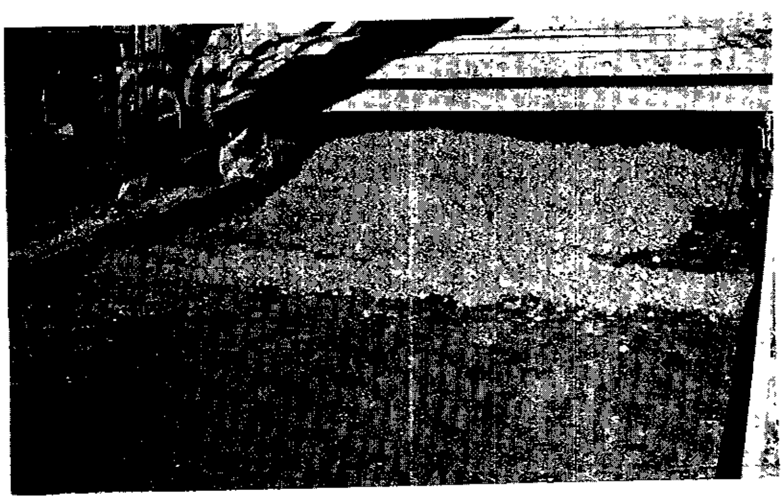


Picture 4

Redwood strips nailed to subgrade in advance of spreader.

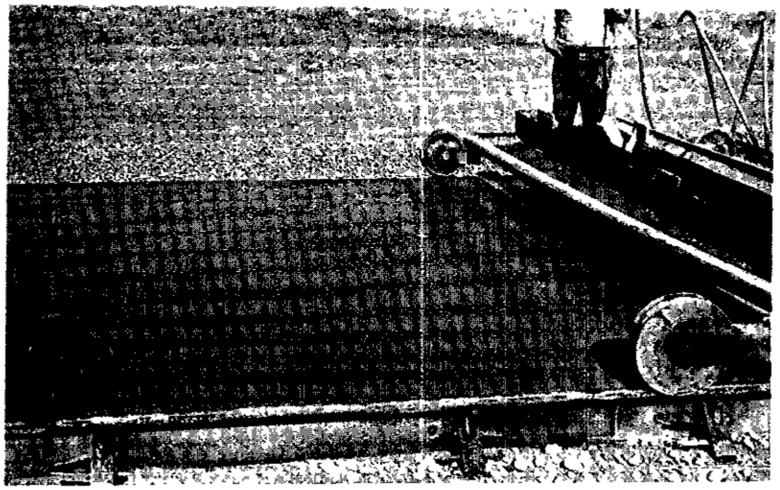
Picture 5

Covering strips with concrete before advance of spreader.



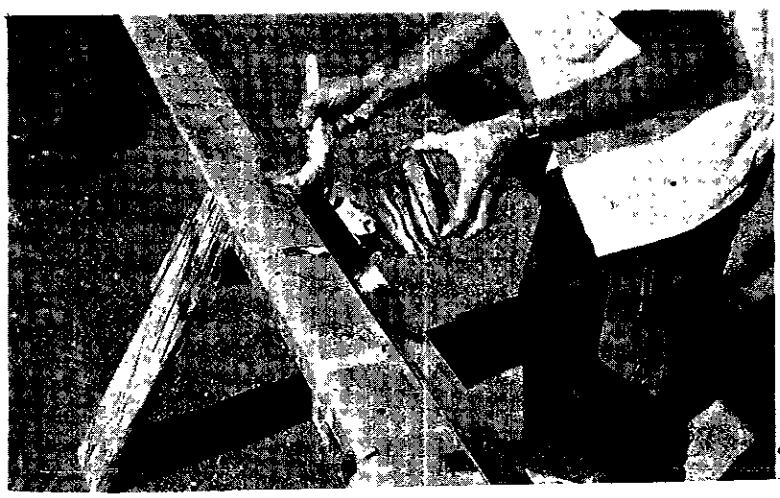
Picture 6

Spread proceeding in usual manner.



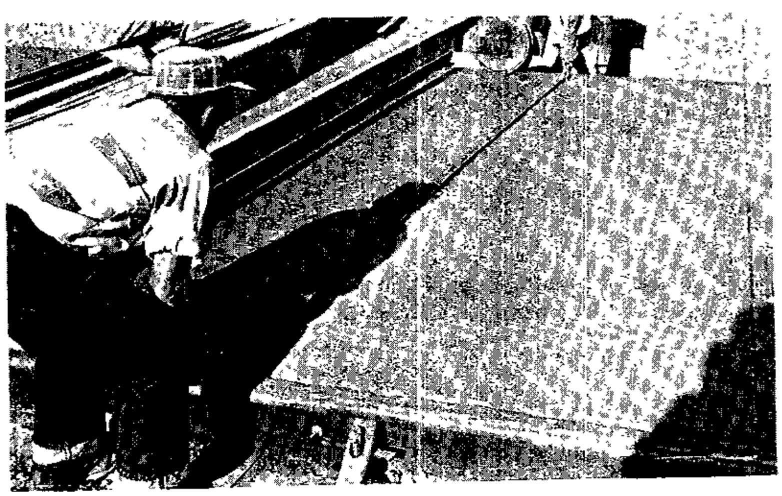
Picture 7

Grocve cut in fresh concrete to receive steel strips.



Picture 8

Coating steel strips with adhesive before being inserted in fresh concrete. (Single steel strips not coated.)



Picture 9

Steel strips being inserted in concrete.