CONSTRUCTION REPORT ON
CONCRETE PAVEMENT JOINT REPAIR
WITH PRE-CAST SLABS

MICHIGAN HIGHWAY RESEARCH LABORATORY SECTION

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

CONSTRUCTION REPORT ON CONCRETE PAVEMENT JOINT REPAIR WITH PRE-CAST SLABS

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CONSTRUCTION REPORT ON
CONCRETE PAVEMENT JOINT REPAIR
WITH PRE-CAST SLABS

This report describes the repair of 24 lane joints with pre-cast slabs on I 75 - US 23/10 west of the City of Flint. An earlier report (MDSH Research Report No. R-762) covered the installation of eight pre-cast lane slabs on M 59 about 2-1/2 miles east of I 96.

The M 59 location was selected to determine the feasibility of repairing joints with pre-cast slabs, because of its relatively low traffic volume (1970 ADT 3,000). The Flint location was selected to evaluate the performance of pre-cast slabs subjected to a relatively high volume of traffic (1970 ADT 48,000).

Location and Description

Fifteen slabs were installed on the northbound roadway from north of the Holly interchange to north of M 21. The remaining nine slabs were placed in the southbound roadway between Pierson Rd to just south of Maple Rd. Stationing and general location of each repair are given in Table 1.

All repairs were 10 ft long by 12 ft wide (one lane width) and the pavement to be repaired was 10 in. thick, except at repair Nos. 1 and 2 where the thickness was 9 in. In addition to evaluating the performance of these repairs under traffic, the following features were also incorporated in the project for investigation.

1. Two methods for supporting the pre-cast slabs were used: the first method consisted of placing a thin layer of sand-cement mortar on the existing base; the other utilized a thin layer of sand for supporting the slabs. Twenty slabs were set on the mortar base and the remaining four were set on the sand base.

2. Load transfer utilizing 1-1/4-in. diameter steel dowels was provided at four lane repairs. A 1-in. thick bituminous filler which was slotted from the bottom was inserted in these doweled joints.

3. Eight slab joints were constructed with a 1-in. thick bituminous filler inserted between the new and old slab, but no load transfer was provided.

TABLE 1
REPAIR LOCATIONS AND DETAILS

Repair No.	Station and Roadway	General Location	No. of Lane Slabs	Slab Support	Transverse Joint Details[1]
1[2]	975+40 NB	N. of Holly Interchange	2	Mortar	Bituminous Filler
2[2]	983+20 NB	N. of Holly Interchange	2	Mortar	Dowels and Bituminous Filler
3	725+50 NB	0.3 mi N. of Bristol Rd	1	Mortar	Grouted
4	730+00 NB	0.4 mi N. of Bristol Rd	2	Mortar	Ethafoam and Bituminous Filler
5	736+00 NB	0.5 mi N. of Bristol Rd	1	Mortar	Grouted
6	742+30 NB	200 ft S. of RR Bridge	1	Mortar	Grouted
7	750+00 NB	200 ft N. of RR Bridge	2	Mortar	Ethafoam and Bituminous Filler
8	800+00 NB	0.8 mi N. of M 78	1	Mortar	Grouted
9	823+30 NB	0.3 mi N. of M 21	1	Mortar	Grouted
10	851+50 NB	0.3 mi N. of M 21	2	Sand	Bituminous Filler
11	1057+50 SB	800 ft S. of Pierson Rd	1	Mortar	Grouted
12	1044+60 SB	2100 ft S. of Pierson Rd	2	Mortar	Bituminous Filler
13	895+00 SB	300 ft S. of Beecher Rd	1	Mortar	Grouted
14	850+00 SB	At "OFF" Ramp M 21	2	Sand	Bituminous Filler
15	749+50 SB	200 ft N. of RR Bridge	1	Mortar	Grouted
16	655+50 SB	500 ft S. of Maple Rd	2	Mortar	Dowels and Bituminous Filler

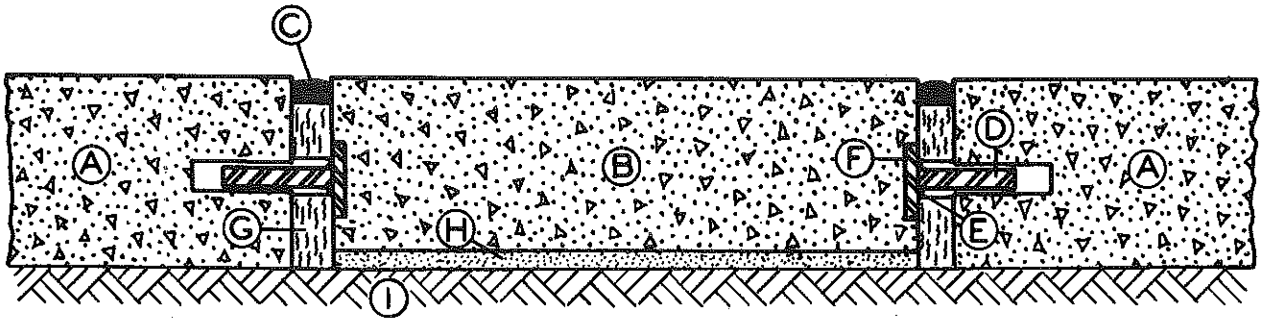
[1] All transverse and longitudinal joints were sealed with hot-poured rubber-asphalt sealant.
[2] These repairs are on I 75 - US 10. The remaining repairs are on I 75 - US 23/10.

4. Four slabs were installed with a 4-in. wide ethafoam filler in one joint and a 1-in. thick bituminous filler in the other. Neither type of joint had load transfer provision.

5. At eight locations one lane of the two-lane pavement had been repaired previously without provision for expansion. At these locations the joints between the pre-cast slab and the old slab were grouted with a sand-cement mortar. Again, these repairs did not provide for load transfer.

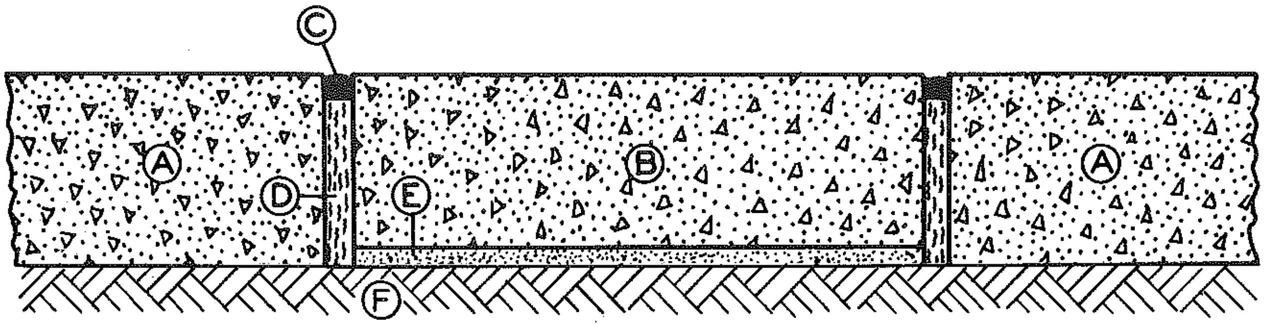
All joints, except the ethafoam joints, were sealed with hot-poured rubber-asphalt sealant. Figure 1 shows the details concerning pre-cast slab support and joint construction; further information is given in Table 1.

In the I 75 - US 23/10 portion of the project, closure of a lane was restricted to the period from 8 a.m. to 3 p.m. with no work permitted on



Ⓐ EXISTING SLAB
Ⓑ PRECAST SLAB
Ⓒ LIQUID JOINT SEALER
Ⓓ STEEL DOWEL
Ⓔ FIELD WELD
Ⓕ STEEL PLATE
Ⓖ BITUMINOUS JOINT FILLER
Ⓗ SAND-CEMENT MORTAR
Ⓘ EXISTING SUBGRADE

JOINT WITH LOAD-TRANSFER



Ⓐ EXISTING SLAB
Ⓑ PRECAST SLAB
Ⓒ LIQUID JOINT SEALER
Ⓓ BITUMINOUS JOINT FILLER OR 4" ETHAFOAM
Ⓔ SAND-CEMENT MORTAR OR SAND BASE
Ⓕ EXISTING SUBGRADE

JOINT WITHOUT LOAD-TRANSFER

Figure 1. Transverse joint details.

Fridays on either roadway, and on Mondays closure on the southbound roadway was not permitted. Traffic control consisted of portable roadside signs and an illuminated target arrow.

The repairs were performed by Genessee County Maintenance personnel in cooperation with Department personnel from the District 6 Maintenance Office and from the Research Laboratory.

The following sections of the report describe the slabs, pavement removal, and installation techniques. A sequence of photographs illustrating these steps appears in the Appendix.

Pre-Cast Slab Details

The pre-cast slabs were 12 ft wide, 10 ft long, and 9 in. thick except for the four slabs installed at Repair Nos. 1 and 2. These four slabs were cast 8 in. thick. The 8- and 9-in. slabs were designed for 9- and 10-in. thick pavements, respectively. By using slabs 1 in. less in thickness than the pavement to be repaired, a 1-in. base of either mortar or sand could be placed, without disturbing the existing base material.

The steel reinforcement was installed in two layers. The bottom layer consisted of No. 4 bars on 12-in. centers in the longitudinal direction and No. 3 bars on 18-in. centers in the transverse direction. The top mat had No. 3 bars longitudinally on 12-in. centers and No. 3 bars transversely on 18-in. centers. Fourteen of the slabs had loops of reinforcement installed at the fifth point in the 12-ft long side for lifting purposes. The remaining ten slabs were cast with a coil type pick-up insert in the slab surface positioned at the fifth points along each of the four sides. The coil type inserts were not available when the slab casting operation began, otherwise all slabs would have been cast with these inserts rather then reinforcement loops.

The four slabs designed for load transfer installation were cast with a 3/8- by 4-in. steel plate in each 12-ft side (see Joint detail in Figure 1).

The slabs were cast during the month of March at the Genessee County maintenance yard on Oakley St in the City of Flint. Four slabs were poured at a time. A high-early-strength concrete mix was used in order to reduce the curing period so that two sets of slabs could be cast in one week using the same space and the same forms. The slabs were stored at the yard until needed at the repair sites.

Sawing

Three full-depth saw cuts were made at each repair site; one cut at each end limit and one 4 to 6 in. inside one of the end cuts. The distance between the end limits was 10 ft 3 in. for slabs having load transfers, 10 ft 2 in. for slabs having grout or bituminous filler installed in the joints, and 10 ft 5 in. for slabs having ethafoam installed in one joint and bituminous in the other. In the longitudinal direction a saw cut was made between lanes and between a lane and a curb. The saw cuts were made with a 60-hp self propelled saw equipped with a 26-in. diameter diamond blade. Under normal working conditions about 2-1/2 hr closing time was needed for sawing on one lane repair. Sawing operations began in February and were continued on an intermittent basis until completed in April.

Pavement Removal

The deteriorated pavement area was removed without disturbing the subbase. The method used involved the following steps:

1. The concrete between the 4 to 6 in. spaced saw cuts was removed by an air hammer to insure that there would be no compressive forces to resist lifting out the concrete.

2. Holes were drilled through the pavement and lift pins were installed.

3. The deteriorated concrete was removed by lifting it out with a front-end loader and the area cleaned up by hand.

Pre-Cast Slab Installation

The procedure developed for installing the pre-cast slabs consisted of eight separate operations when the joints between the slabs were constructed with load transfer. Without load transfer, operations, 1, 3, and 5 of the sequence were eliminated:

1. Holes for 1-1/4-in. diameter dowels were drilled 9 in. deep and on 12-in. centers in the vertical end faces of the existing pavement slab. Alignment and position of the holes were obtained by supporting the drill from a specially made frame.

2. A sand-cement mortar base was placed atop the subbase. A frame was placed across the repair and positioned so that reference lines on the frame would coincide with the top surface of the installed slab. The top of the frame served as a guide for striking off the mortar to the correct elevation.

At the repairs where a sand base was used for supporting the pre-cast slabs, the sand was placed and compacted to the approximate height and struck-off to the desired elevation by using the frame mentioned above.

3. The 1-1/4-in. diameter by 9-in. long steel dowels were placed in the drilled holes. The dowels were machined slightly undersize to insure interference free fit in the holes.

4. The pre-cast slab was placed in the pavement gap by a front-end loader. Slight adjustment in the slab's final position was possibly by use of a ratchet-type load binder in each lifting chain.

5. The dowels were pulled into contact with the steel plate in the edge of the pre-cast slab and welded to the plate.

6. The reinforcement loops used in lifting the slab were cut off with an acetylene torch.

7. A bituminous filler board was inserted into the joint space between the pre-cast and existing slab. Where dowels were used the filler was slotted from the bottom to allow insertion. The 4-in. wide ethafoam filler was installed against the pavement end face prior to installing the pre-cast slab. Transverse joints where expansion space was not desired, and all longitudinal joints, were filled with sand-cement mortar.

8. After a sufficient number of slabs had been placed to warrant the heating of the sealer, the joints were sealed with a hot-poured rubber-asphalt sealant.

The slabs were installed at the rate of two a day with a labor force of seven men. The average time to perform the various operations involved in the removal of the distressed concrete and installation of one pre-cast slab was 2-1/2 hours. The average time required to install a slab with load transfer was 4-1/4 hours.

Repair Cost

The cost of the pre-cast slab repairs amounted to $78.00 per sq yd. This is about 2-1/2 times the cost for a poured-in-place repair. However, the cost of a pre-cast slab repair cannot be compared directly to that of a poured-in-place repair, for the following reasons:

1. The newness of the method and the experimental features tried in this installation naturally would influence the cost adversely. As the procedure becomes more routine a decrease in cost should follow.

2. The full-depth saw cut employed, rather than the 5-in. depth specified for current repair procedures, will increase the cost of pre-cast slab repairs. The benefits from the additional cost consist of elimination of undercutting, cornerbreaks, and cracking of the existing slab when removing the distressed pavement area.

3. The removal of the distressed concrete by lifting it out rather than breaking it up and removing it by use of a front-end loader or backhoe may possibly contribute to the higher cost. However, the advantage of maintaining the subbase intact results in less, if not complete elimination of faulting at the joints between the new and existing slab.

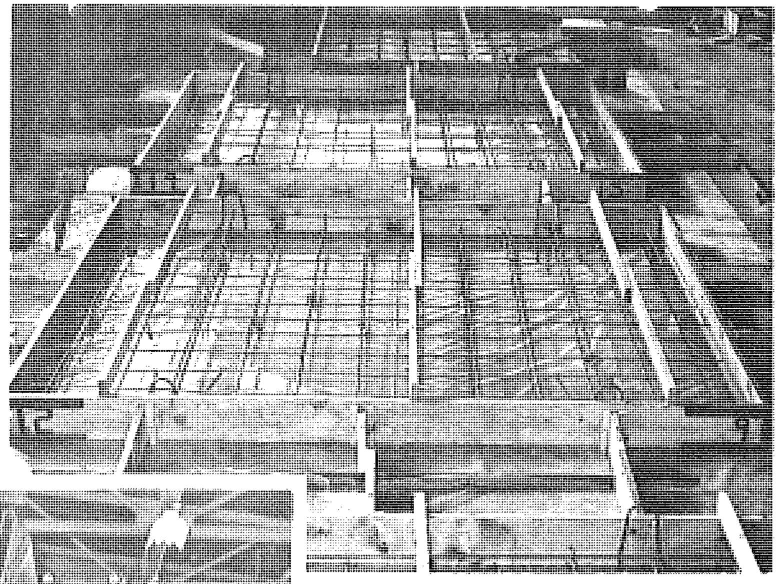
4. The requirement of sealing the joints when repairing with pre-cast slabs as compared to no sealing requirements with most poured-in-place repairs is another factor that causes an increase in the cost of pre-cast slab repairs. The value of sealing these joints is questionable. Observations of unsealed contraction joints at poured-in-place repairs indicate infiltration of incompressible materials and consequently opening of the joints occurs. This results in additional compression in the pavement during expansion periods. If unsealed expansion joints were used the infiltration problem would not be as serious, but the expansion space would be used up sooner. An investigation of the performance of unsealed expansion joints is presently anticipated as a part of a current Highway Planning and Research project (70 F-118: Development of Procedures for Replacing Joints in Concrete Pavement).

Evaluation

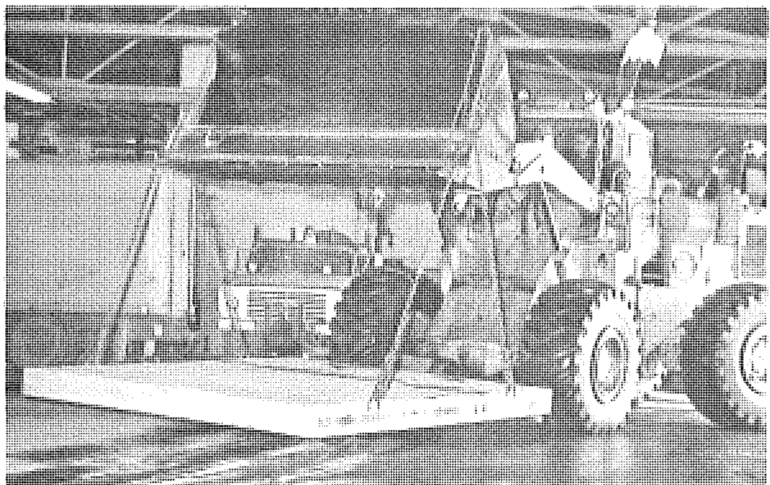
The various experimental features included in this project will be subjected to periodic evaluation surveys. The performance of all 24 pre-cast slab installations has been satisfactory to date. The construction of a sand base compared to a sand-cement mortar base consumed about the same amount of time. If the slabs installed on the sand base continue to perform as well as those on mortar this method could be used for supporting pre-cast slabs on future projects.

APPENDIX

Forms are set up in a maintenance area for casting the slabs. Bottom steel is supported on chairs, the top steel is hung from two-by-fours.

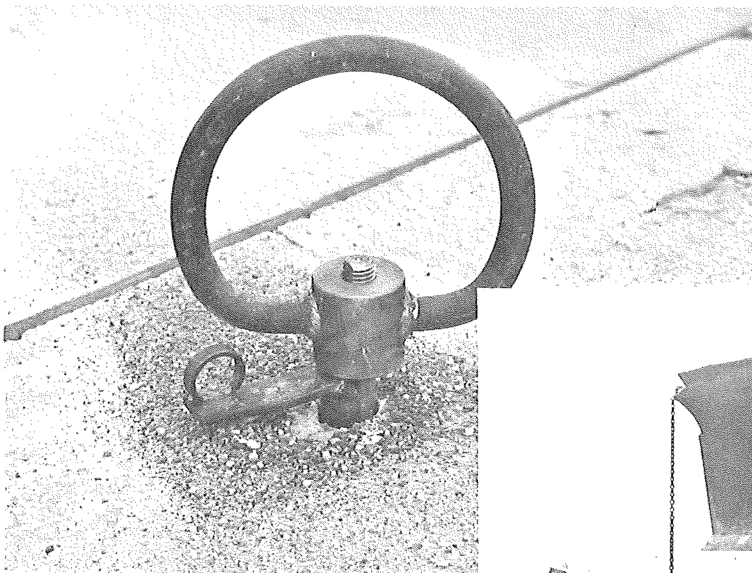


Pre-cast slabs are transported to a storage area after casting.

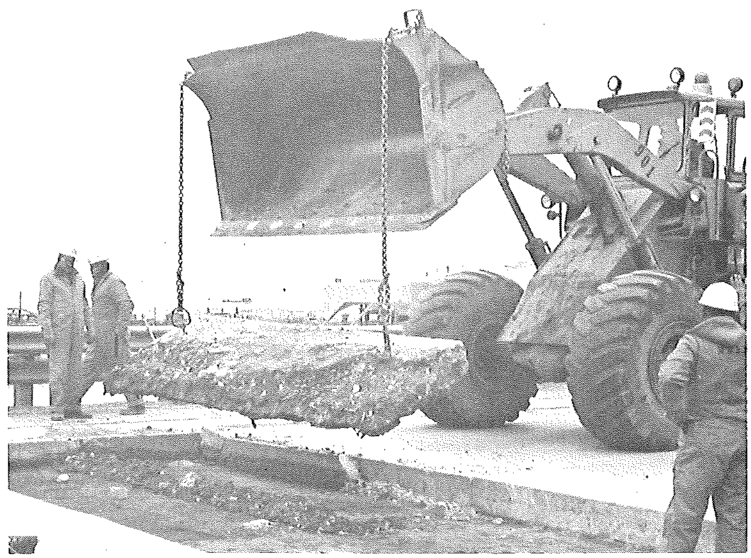


After the full-depth sawing of the pavement, the concrete is removed between the narrowly spaced saw-cuts.

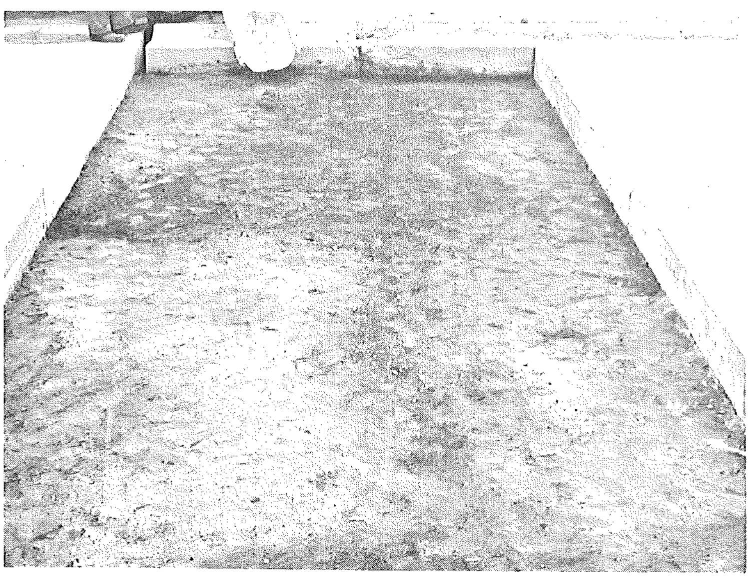
Holes are drilled in the pavement for inserting the lift pins.



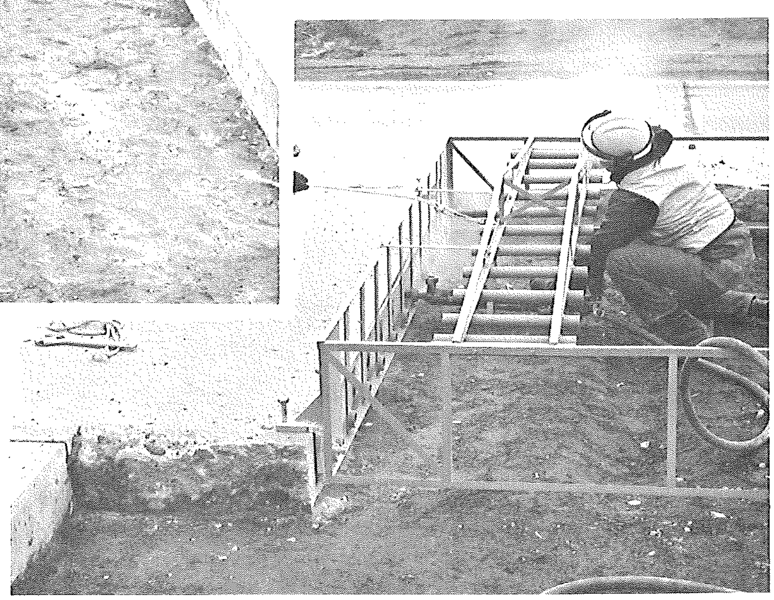
The lift pin, consisting of a handle, pin, and lock key, is inserted in the hole.



Distressed concrete is then lifted from the repair area.



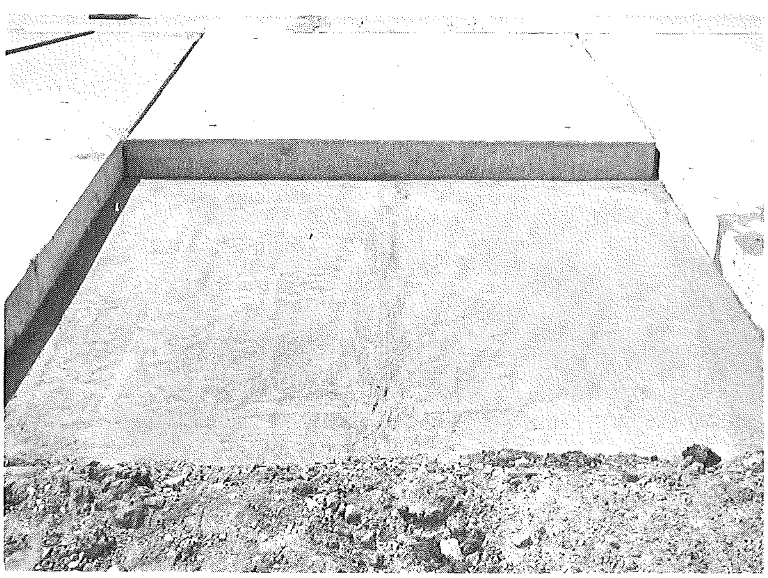
Condition of repair area after final clean-up by hand.



In joints with provision for load-transfer, a specially designed frame is used to align the 1-1/4 by 9-in. holes for insertion of the dowels.

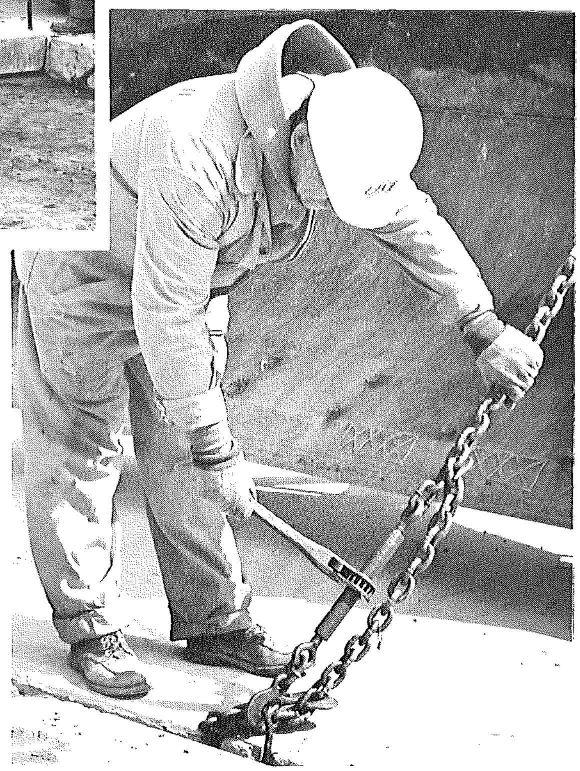
A mortar base is poured and struck-off to the proper elevation.

Mortar base (right), or sand base (below), is now ready for the slab to be placed.



The pre-cast slab is lowered in place.

Adjustment of slab elevation by means of chain binders, prior to final placement.



In joints with provision for load-transfer, dowels are welded to a plate which is cast in the edge of the precast slab.

Lift loops are removed with a cutting torch.

Premolded bituminous impregnated filler board is installed (slotted board used with doweled joints).

Joints are sealed with hot-poured rubber-asphalt sealant.

Completed pre-cast slab repair.