

PROGRESS REPORT
CONCRETE PAVEMENT JOINT REPAIR
WITH PRE-CAST SLABS

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MICHIGAN DEPARTMENT OF STATE HIGHWAYS

PROGRESS REPORT
CONCRETE PAVEMENT JOINT REPAIR
WITH PRE-CAST SLABS

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Research Laboratory Section
Testing and Research Division
In Cooperation with the Maintenance Division
Research Project 68 F-102
Research Report No. R-762

Michigan State Highway Commission
Charles H. Hewitt, Chairman; Wallace D. Nunn, Vice-Chairman;
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PROGRESS REPORT
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At the January 8, 1969 meeting of the Pavement Selection Committee the proposed use of pre-cast slabs in repairing joints in concrete pavement was discussed. It was agreed that the Research Laboratory and Maintenance Division prepare requirements for a project utilizing this type of repair. A proposal suggesting a two-part study was approved by the Committee on July 2, 1969. Part I would consist of replacing four failed joints on a highway having a relatively low traffic volume. The objectives of this part of the project were: to speed the removal of the failed area, develop the technique for installing the pre-cast slabs, and to test their performance under load. If the results of Part I were satisfactory, Part II would be carried out to obtain information on the time and expense involved when several joints were replaced with pre-cast slabs. The joints to be replaced would be on a major highway to test the performance of the pre-cast slabs when subjected to heavy traffic.

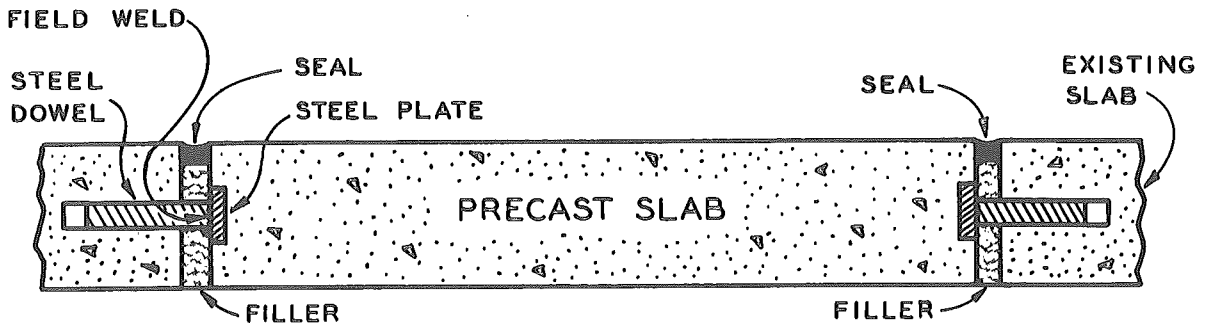
The Department's Research Policy Committee, on November 20, 1970 approved submittal of a HPR proposal for rapid repair procedures for concrete pavements. The pre-cast slab method will be included in this study for further evaluation.

The installation of eight pre-cast lane-slabs as proposed in Part I is now completed and described in this report.

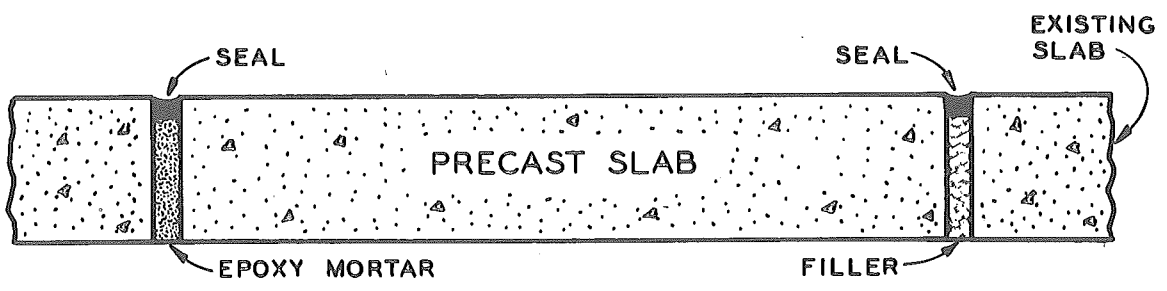
Site Location

The four distressed joints selected for replacement with pre-cast slabs were on M 59 in Livingston County, about two miles east of Grand River Avenue. The roadway consists of two 11-ft lanes of reinforced concrete, 8 in. thick. The joints are spaced at 99 ft and contain 1-in. diameter by 18-in. long dowel bars on 12-in. centers. The pavement, constructed in 1957, was placed on 3 in. of selected subbase material overlaying a 6-in. layer of sand.

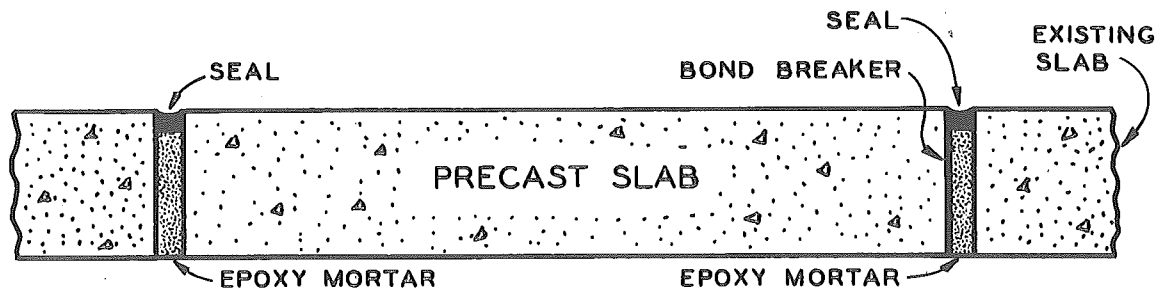
The stationing of the four failed joints were: 131+45, 136+42, 138+41, and 143+47.



A. Doweled joints with expansion - contraction provision at both joints.



B. Non-doweled joints with expansion - contraction provision at one joint.



C. Non-doweled joints with contraction provision at one joint.

Figure 1. Methods of joining precast slab with existing slab.

Pre-Cast Slab Details

The pre-cast slabs were 11 ft long, 6 ft wide, and 8 in. thick. The reinforcement paralleling the traffic direction consisted of two layers of No. 5 bars. The bottom layer was spaced at 6-in. centers and the top layer at 12-in. centers. In the other direction two layers of No. 3 bars, both spaced at 12 in., were used. Four lift holes, approximately 5 by 5 in. were cast in each slab. The holes were positioned in such manner that a No. 5 bar from the bottom layer of reinforcement passed through the center of each hole. The slabs for use with doweled joints had a 3/8- by 4-in. steel plate anchored into the vertical faces of the long sides of the slabs.

The slabs were poured at the Brighton Maintenance garage during the winter and stored outside until installed this fall.

Joint Between Slab and Existing Pavement

One of the problems in using pre-cast slabs for concrete pavement repair is to obtain a satisfactory joint between the pre-cast slab and the existing slab. Several methods of joining the two slabs were considered to determine the joint type to be used. Actually, two types of joint were selected, one with provision for load transfer and one without this provision. Figure 1 shows the two joint types.

Two distressed joints were replaced with pre-cast slabs utilizing doweled joints as shown in Figure 1A. One joint was replaced with slabs joined to the existing slab in the manner shown in Figure 1B, and at the remaining joint the two slabs were joined as shown in Figure 1C.

Repair Procedure

The various operations involved in replacing a failed joint with a pre-cast slab are shown pictorially in Appendix A. A description of each separate operation follows:

Sawing - The sawing was accomplished by using a self-propelled, 60 hp saw equipped with a 26-in. diameter diamond blade. A full-depth saw cut in the 8-in. reinforced concrete slab could be made at a speed of 0.6 ft per min. At each repair, three saw cuts were made transversely across the pavement; one at each end limit and one about 8 in. inside one end limit. This additional transverse saw cut was made to facilitate opening a trench across the slab with air hammers which would relieve pressure in the slab before lifting out the distressed pavement. In the longitudinal direction, a saw cut was made in the center of the roadway and in the center of each

lane. This permitted removal of the failed area in four sections at each repair location.

Because of pressure present in the slab in the afternoon as a result of rising temperature the full depth saw cut would snap shut just before completing the cut. This sudden release of pressure caused the blade to seize up. To prevent this from occurring the saw cut was made in two passes. In the afternoon the top half of the slab would be sawed and in the morning the cut was completed without difficulty.

Removing Failed Pavement - The first step in removing the failed joint area involved the removal of the concrete between the narrowly spaced saw cuts with an air hammer. While this was being done, 1-1/4-in. diameter holes were drilled through the slab for inserting lift pins. Three holes were drilled in each half-lane slab to be removed. This allowed the slab to be lifted out in a horizontal position and minimized breaking of the failed slab. The lift pins were inserted in the holes and a crane used to load the concrete pieces on a truck. A small amount of broken or deteriorated concrete was removed by hand. Each repair area (6 by 11 ft) was cleaned out in 30 to 40 min.

Installing Pre-Cast Slab - The installation of the pre-cast slabs required the following operations:

1. The drill frame was positioned in the repair and 1-1/4-in. diameter by 9-in. deep holes, spaced at 12 in. were drilled in the vertical end faces of the existing slabs. Using an air drill with carbide tipped bit, a hole could be drilled in about 2 min.
2. The top elevation of the pre-cast slab was set by positioning a 2 by 8 plank against each vertical end face. Because the pavement had a parabolic crown and the pre-cast slabs were straight the planks were adjusted until the best transition from old to new slab was obtained.
3. The elevation of the subbase was established 9 in. below the top of the planks by use of a template. Any excess subbase material was removed by hand tools and care was taken to insure that the subbase below the required elevation was not disturbed.
4. A sand-cement mortar slurry was mixed and poured atop the subbase. A template was used to strike off the mortar at an elevation of 8 in. below the plank's top edge.

5. The 9-in. by 1-1/4-in. diameter dowels were inserted in the drilled holes. (The dowels were machined slightly undersize to insure interference free fit in the holes.)

6. The pre-cast slab was lifted into place and held in position a few inches above the mortar by suspending it from two pipes resting on four screw jacks.

7. The pre-cast slab was lowered by the jacks until final elevation was obtained. The slab was supported from the pipes until the mortar had set sufficiently to carry the slab weight.

8. The dowels were pulled into contact with the steel plate in the slab edge and welded to the plate.

9. The repair was completed by inserting slotted bituminous filler strips over the dowels and sealing with a liquid sealer. The lift holes were filled with cement mortar in the bottom two-thirds and the remaining portion was filled with epoxy mortar.

For the two repairs where no load transfer was provided, steps 1, 5, and 8 were omitted. A repair of the load transfer type could be completed and opened to traffic in 3 to 3-1/2 hr. A repair without load transfer took about 2 to 2-1/2 hr to complete.

Conclusions

Although no direct comparison was made of the time required to remove a deteriorated joint by our standard procedure and the procedure described here, it appears that full-depth sawing and lifting the slab out intact would be a satisfactory method of removing a distressed pavement area. Partial-depth sawing and breaking up the slab with a pavement breaker often results in undercutting and cracking of the existing slab. These undesirable effects are eliminated when the slab is sawed full depth. By lifting out the failed pavement the subbase is undisturbed which eliminates backfilling and the problem of obtaining satisfactory and lasting compaction in a small area.

The proposed technique for installing the pre-cast slabs worked very well. A satisfactory transition between the old and new slab was obtained by setting the pre-cast slab in a cement mortar slurry. The welding of dowels to the steel plate embedded in the pre-cast slab edge was done without difficulty.

Because of the onset of winter, load-deflection tests on the pre-cast slabs have not been conducted. However, on the basis of visual observations of the slabs they appear to be performing very well.

Future Work

On the basis of the performance of the slabs installed on M 59, Part II of study was begun early this spring. I 75 - US 23 near Flint, in Genesee County has been selected for installations of pre-cast slabs at failed joints.

APPENDIX A

Figure 1. Sawing full-depth saw cut in 8-in. reinforced concrete slab with 60 hp self-propelled saw equipped with 26-in. diameter diamond blade. (Sawing speed 0.6 ft/min)

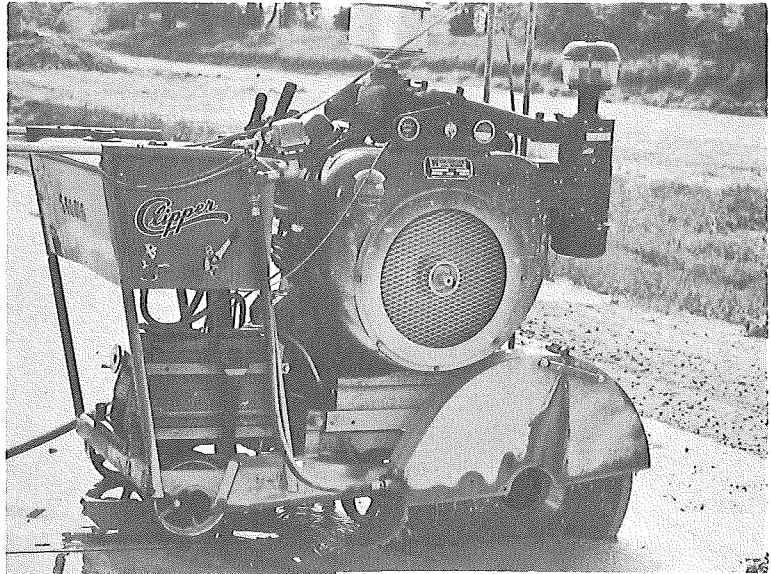


Figure 2. Transverse saw limits. The second saw cut, about 8 in. inside the repair limits at one end, was made to facilitate removal of the distressed pavement.



Figure 3. Longitudinal saw cuts. A full-depth saw cut was made in the center of the roadway and also in the center of each lane.

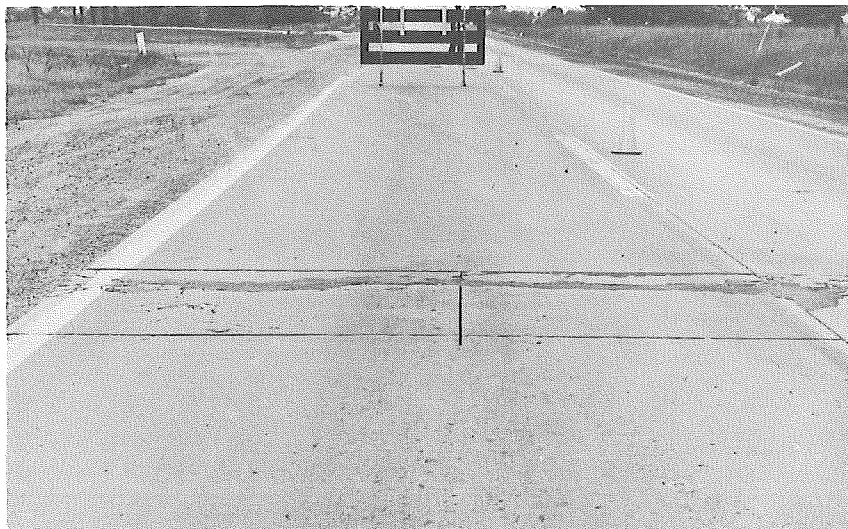


Figure 4. Removing concrete between narrowly spaced saw cuts with air hammer.



Figure 5. Drilling 1-1/4-in. diameter holes, full-depth, for insertion of lift pins. Three holes were drilled in each half-lane slab to be removed.

Figure 6. Lift pin, consisting of handle, pin, and lock key, inserted in a drilled hole. Three pins were used in each half-lane slab.

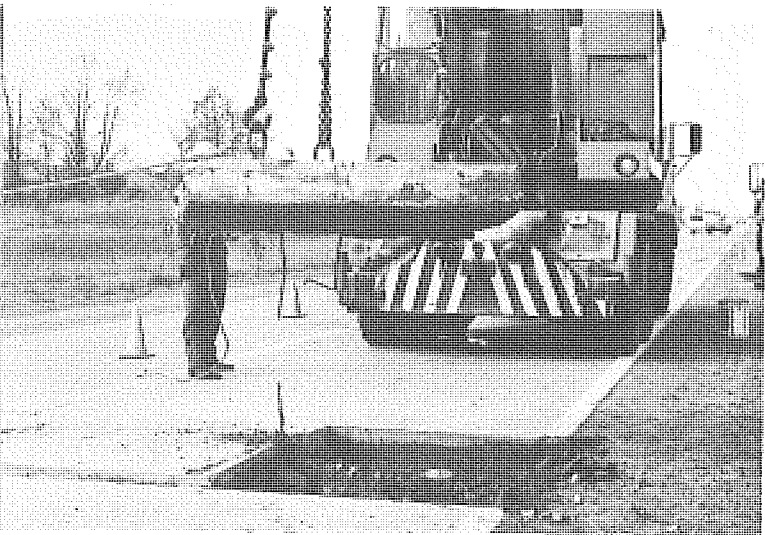
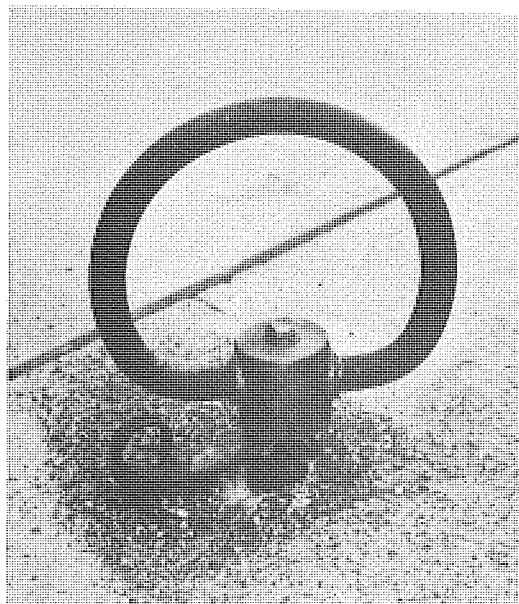


Figure 7. Removing the first half-lane slab.

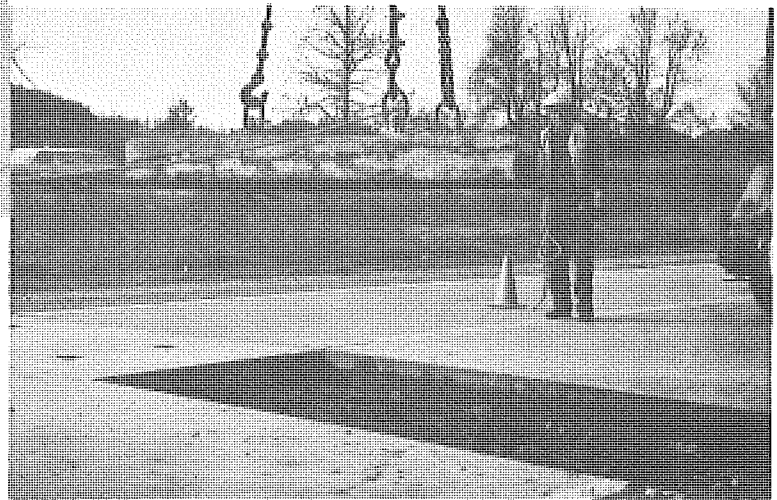


Figure 8. Removing the second half-lane slab.

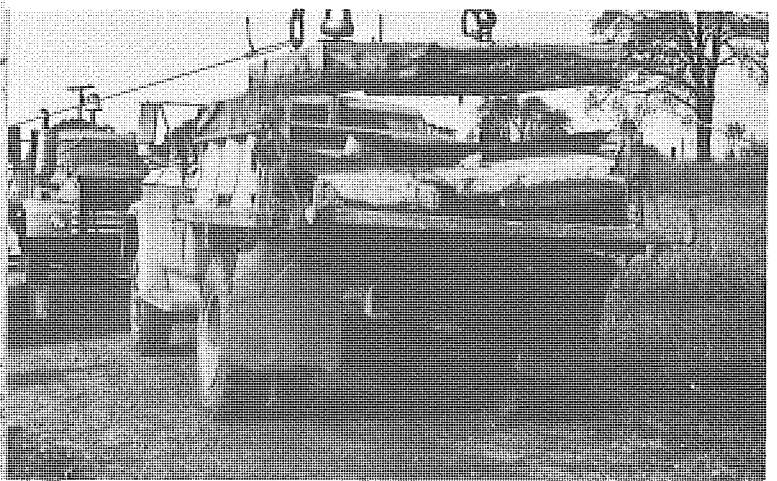


Figure 9. Loading the distressed slab onto truck.

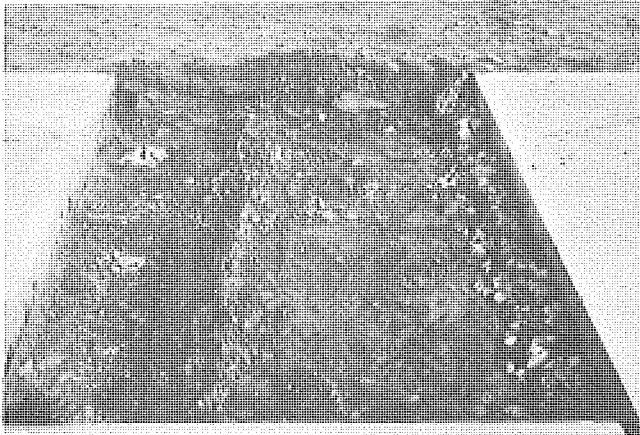


Figure 10. A typical repair after the old slab was removed. A few shovels full of deteriorated or broken concrete remain to be removed by hand. Note the subbase has not been disturbed during removal operations. By using the procedure shown above, a lane repair could be cleaned of the old concrete in 30 to 40 minutes.

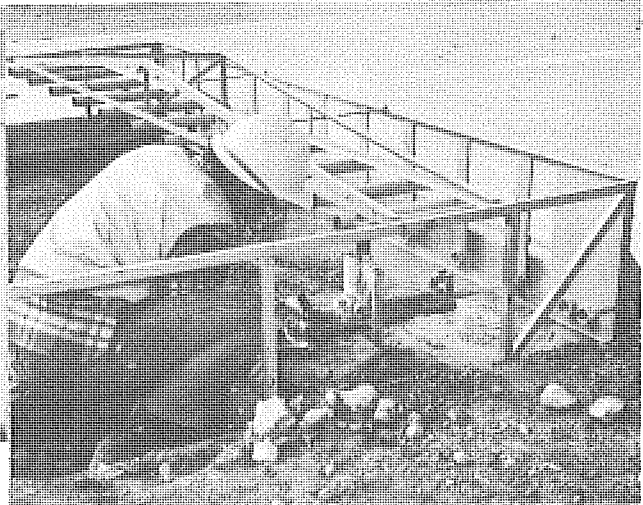


Figure 11. Drilling 9-in. deep by 1-1/4-in. diameter holes on 12-in. centers for dowels, using a guide frame and air drill with carbide bit. The time required to drill one hole was approximately 2 minutes.

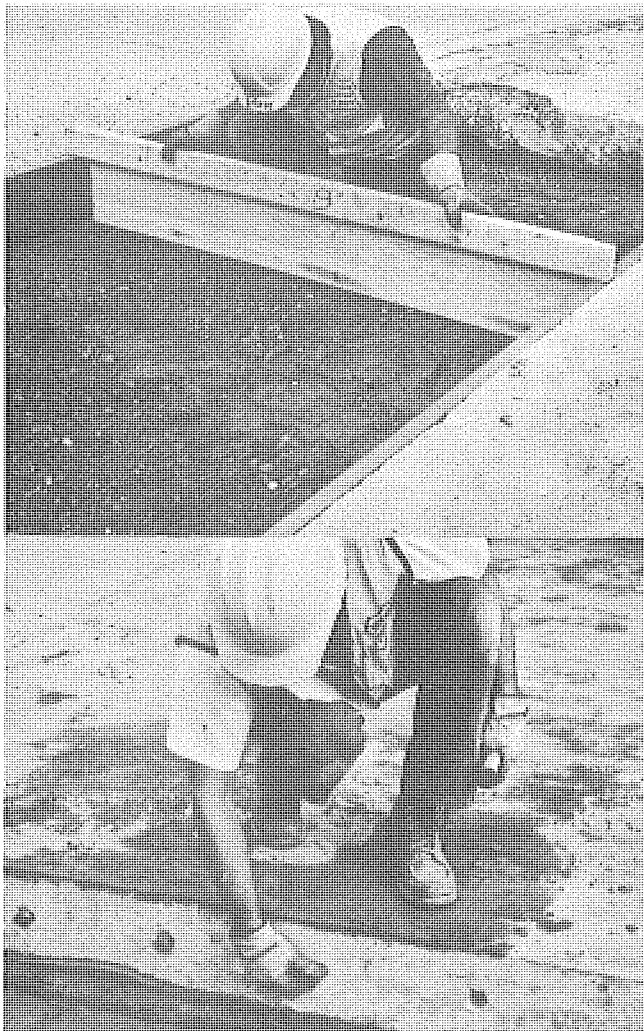


Figure 12. The elevation of the pre-cast slab was established with planks set at each repair end. The elevation of the subbase was established by sliding a template across the planks.



Figure 13. The elevation of the cement mortar was established by a template in a manner similar to that used for subbase elevation.

Figure 14. Inserting 9-in. by 1-1/4-in. diameter steel dowels in the drilled holes.

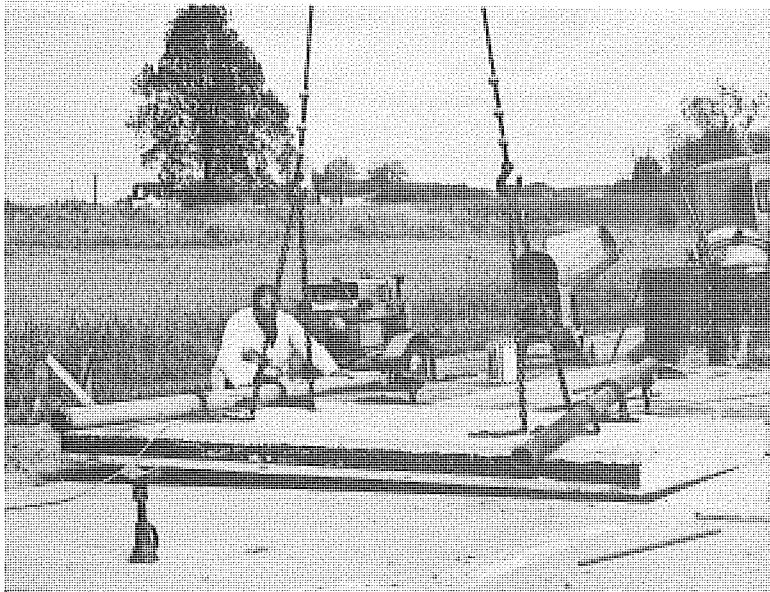


Figure 15. Positioning pre-cast slab by crane.

Figure 16. Pre-cast slab positioned on building jacks for final lowering to correct elevation.

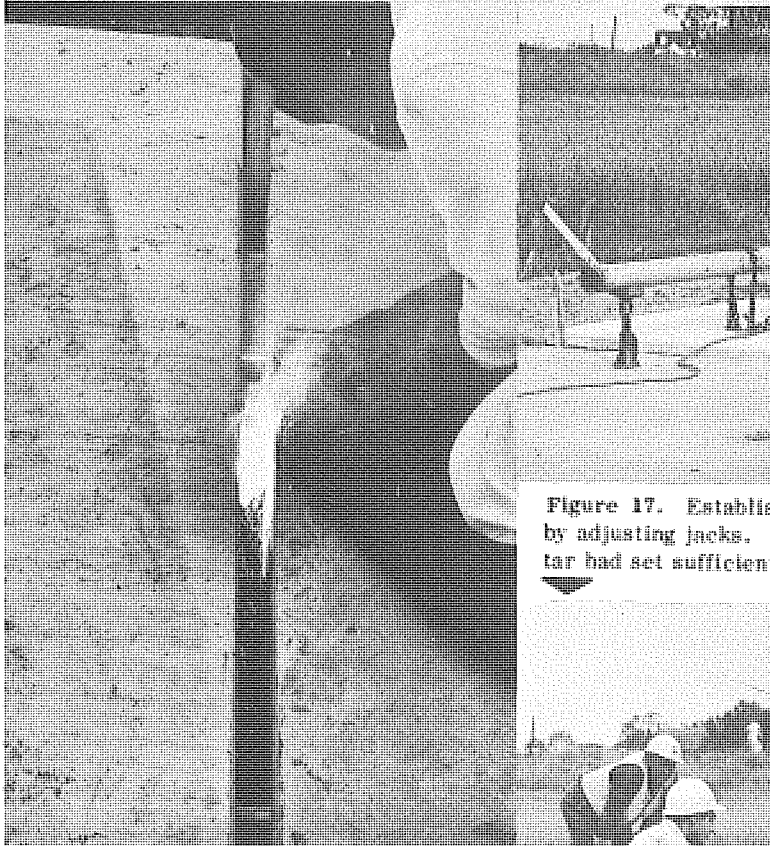


Figure 17. Establishing final elevation of pre-cast slab by adjusting jacks. The jacks were left in place until mortar had set sufficiently to carry the slab.

Figure 18. After the slab was in correct position the dowels were pulled into contact with the steel plate cast into the side of the pre-cast slab and welded to the plate. The time required for one man to weld the dowels varied from 30 to 45 minutes.



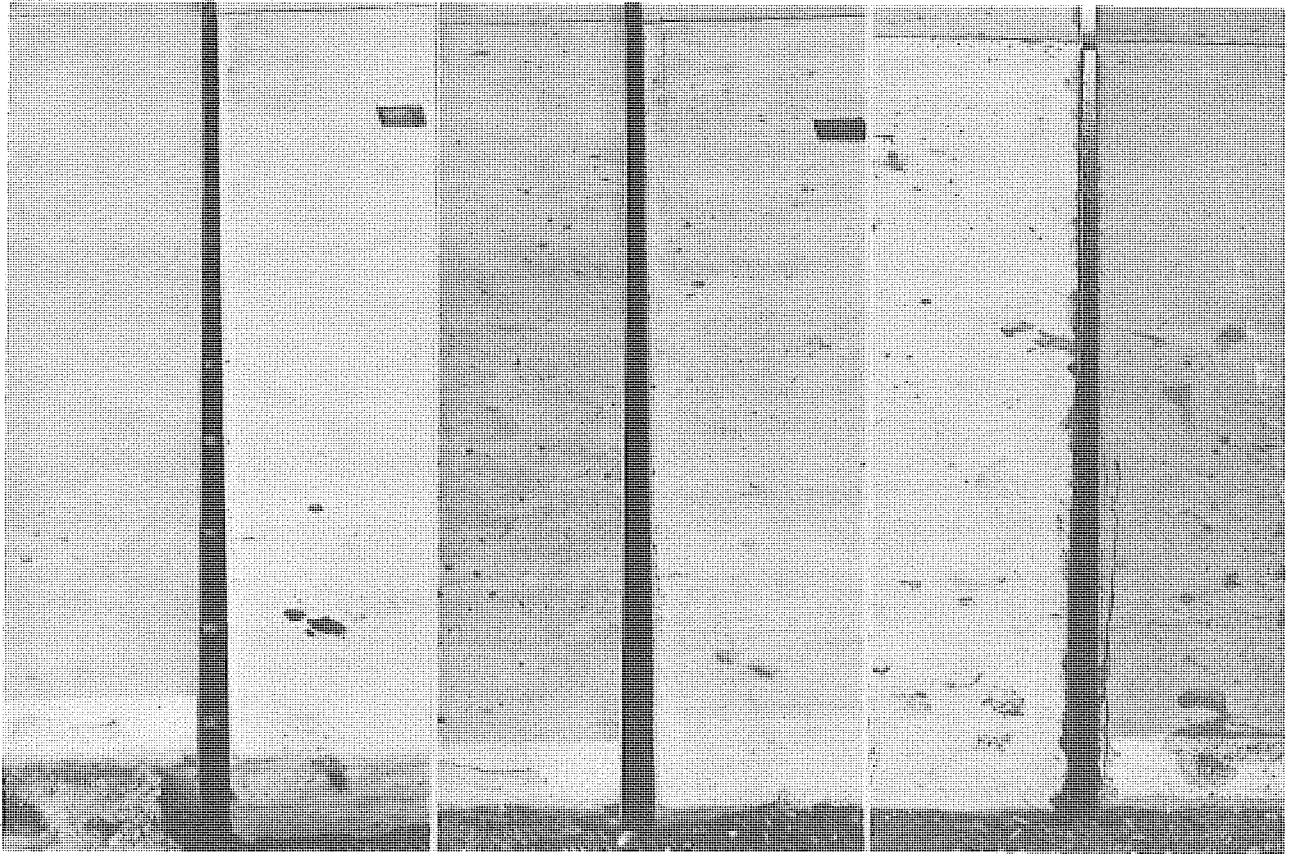


Figure 19. Typical joint after completion of welding operation.

Figure 20. Typical joint after bituminous filler was installed.

Figure 21. Typical joint after two-component cold pour seal was installed.

Figure 22. Appearance of repair after completion. Lift holes were filled with mortar in the bottom two-thirds and the top one-third was filled with epoxy mortar. A lane repair with load transfer, including removal of the distressed pavement, can be accomplished and opened to traffic in about 3 to 3-1/2 hours. A repair without load transfer can be completed and opened to traffic in about 2 to 2-1/2 hours.

