OFFICE MEMORANDUM
MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

August 30, 1967 388

To: R. L. Greenman
Acting Testing and Research Engineer

From: L. T. Oehler

Subject: Investigation of Foreign Material Embedded in the Continuously Reinforced Concrete Pavement of the Seaway Freeway (I 75); Construction Project I 82194A. Research Project 61 F-64 (1). Research Report No. R-651.

The following is a report by H. L. Patterson on a special trip made July 19, 1967 to inspect the subject pavement condition. At your request, he accompanied the following personnel in making the inspection:

D. L. Wickham
W. J. MacCreery
A. Sinelli
P. Daavettila
N. A. Totzke
N. Stark } B. P. R. Representatives
D. Harker }

In a letter dated July 20, 1967, to D. L. Wickham, Mr. Totzke, Project Engineer, supplied the information given in Table 1, which covered both the NB and SB I 75 Freeway. At many places, the subject popouts resembled holes that would be produced from embedded sandstone aggregate that subsequently disintegrated. Closer examination, however, showed the popouts to contain a variety of foreign materials such as cohesive soil, tree bark, wood and fibrous material resembling paper. Often, the holes exposed subsurface pockets containing cohesive soil ranging in size up to about 4-in. in diameter with the cavity larger than the opening. Some examples of the above are shown in Figures 1 and 2. At other locations, peculiar crack patterns were noticed as shown in Figures 3 and 4. Tapping with a hammer around the questionable areas indicated a hollowness with subsequent probing revealing concealed clay pockets which apparently were responsible for causing the unique crack pattern.

At NB Sta. 888+51, a night header placed on August 30, 1966 adjoined a 2-ft strip of pavement between transverse cracks that had faulted about 1/4 inch (Fig. 5). Cores taken subsequently revealed that the reinforcing steel was within 1-1/2 in. of the bottom of the pavement.

At NB Stations 925+00 to 925+15, a series of transverse cracks, spaced about a foot apart had formed in the center and right hand lanes with only two extending into the left hand lane. Cores taken subsequently revealed a stratum of soil that had become sandwiched between the two concrete courses. Figure 6 shows the most prominent crack and others adjacent to it.

After noting the various defects that are scattered along both the NB and SB roadways, it must be concluded that the visible defects represent only a portion of the total amount of foreign material present. As time goes by, it can be expected that more and more of this foreign matter will cause deterioration in the concrete. It was suggested by Mr. Wickham that much of the cohesive soil that is being found in the roadway was probably brought into the slag stockpiles by dump trucks which picked up mud and clay on their tires as they brought in loads of slag during the winter and spring months of the year.

Repair Recommendations:

1. Clay Pocket Repair

Previous experience covering "clay ball" repairs was presented in Research Laboratory Report No. R-462. The following recommendations were made in that report for effecting this repair.

The cavities and pockets of cohesive soil and other material should be repaired one lane at a time in the following manner: Remove all clay and foreign material from the pockets and clean thoroughly with a stream of water under pressure. Examine the edge of the hole and break back to sound concrete of 3/4 in. minimum thickness. Remove all the loose concrete either with another water flushing or an air blast. Blow all standing water from the pocket, leaving the surface wet. Fill with a stiff portland cement-Embeco shrink-resistant mortar, tamped and finished to match the adjoining pavement surface. Mix the mortar in the following proportions (as prescribed in Specifications for Shrink-Resistant Mortar for Patching Concrete, dated July 8, 1963):

100 lb Embeco, Groutex, or equal
188 lb portland cement (High Early Strength w/Air Entrainer)
300 lb sand
water for stiff mix

Then cover the filled and finished holes with a spray coat of membrane curing material.

2. Continuously Reinforced Pavement Repair

It was decided that the defective areas in the north bound roadway near stations 888+50 and 925+00 would have to be replaced.

The repair procedure should be as follows:

1. The limits of the area to be replaced at each location should be determined by taking cores through the distressed pavement.

2. At each end of a repair area the existing reinforcement shall extend intact for 3 ft into the area to be replaced. To insure this, these areas should be cored

to determine that there are no laps in the existing reinforcement at these locations (Fig. 7) and the reinforcement is at the design depth. If laps are encountered or the steel depth is not correct, the length of area to be replaced must be increased until 3 ft of the existing reinforcement will be intact and in the correct position when exposed.

3. Make a 1-1/2-in. deep saw cut at the final end limit locations.

4. Expose and cut the reinforcement at a point 3 ft inside the sawed end limits. Also locate and expose hook bolts or tie bars along curb and adjacent lane. This work is to be done by using air hammers and hand tools, being careful not to damage the existing reinforcement.

5. Remove the freed center portion of the slab to be replaced. This portion of the slab may be broken and removed by mechanical equipment. Excercise care to save part of the hook bolt assembly embedded in the adjacent concrete to be left in place.

6. Remove the concrete in the 3-ft end areas of the repair by using air hammers and hand tools. Do not bend the reinforcement bars up to facilitate concrete removal.

7. The replacement steel shall conform to the requirements of ASTM Specification A-432. The longitudinal steel shall be No. 5 deformed bars and the transverse steel, No. 3 deformed bars. It may consist of individual bars or of a preassembled mat of the same design as the existing reinforcement. If individual bars are used, the transverse steel spacing shall be approximately 2 ft.

A tied lap with both bars in the same horizontal plane and 3-ft long shall be maintained at each end of a repair. For repairs less than 30 ft in length the replacement steel should span the length of the repair. In cases where it is necessary to lap the steel in the interior portion of a repair, a tied lap of 3 ft length should be used. If a preassembled mat is used and the transverse bars of the existing mats are on top of the longitudinal bars, correct placement can be facilitated by removing the existing transverse bars in the lap area at the ends of the repair area.

Chair supports shall be used to maintain the steel at the design elevation throughout the length of repair zone. In lieu of chair supports where mats are used, the concrete may be poured in two layers and the mats placed on top of the first layer which shall be struck-off at the proper elevation. However, it appears that proper laps and alignment of the steel would be easier to obtain by installing the reinforcement prior to concrete pouring, and it is suggested that this method be used whether or not the reinforcement consists of individual bars or prefabricated mats.

8. The replacement concrete shall be High-Early Strength (Type IIIA), air entrained, and have a modulus of rupture of 550 psi, minimum, at the age of 3 days. Concrete delivery should be scheduled so that each repair zone can be poured in one continuous operation.

In order to minimize the additional stresses induced in the roadway width not under repair, it is suggested that only one lane at a time be subject to repair. It is also suggested that each lane repair be completed in one continuous operation to avoid one or more cycles of expansion-contraction forces, and that the repaired lane not be opened to traffic for 3 days.

All materials used in the repairs should be tested for conformance to MDSH Specifications, and subgrade density tests should be made of each repair zone to insure that the necessary compaction requirements are met.

OFFICE OF TESTING AND RESEARCH

L. T. Oehler

L. T. Oehler, Director
Research Laboratory Division

LTO/HLP:sjt

TABLE 1
POP-OUT LOCATION AND AIR CONTENT, I 75

	Pour Date	Length of Pour	Location of Pop-outs	Air Content, percent	
				Rolla-meter	Chace
Northbound	8-27-66	943+98 to 928+29	941+60	5.6	6.5
	8-27-66	943+98 to 928+29	940+30	5.6	6.5
	8-27-66	943+98 to 928+29	933+80	5.6	6.5
	8-27-66	943+98 to 928+29	933+10 to +30	5.6	6.5
	8-29-66	928+29 to 918+50	925+00	— —	8.5
	8-29-66	928+29 to 918+50	921+20	— —	8.5
	8-29-66	918+50 to 910+13	912+50	5.2	6.8
	8-29-66	918+50 to 910+13	910+50	5.2	6.8
	8-30-66	903+08 to 888+51	899+60	7.1	8.7
	8-30-66	903+08 to 888+51	897+00	7.1	8.7
	8-30-66	903+08 to 888+51	888+51	7.1	8.7
	8-31-66	888+51 to 869+95	886+60	6.5	6.0
	8-31-66	888+51 to 869+95	876+05	6.5	6.0
	8-31-66	888+51 to 869+95	874+10	6.5	6.0
	8-31-66	888+51 to 869+95	873+50	6.5	6.0
	8-31-66	888+51 to 869+95	871+50	6.5	6.0
	9-1-66	869+95 to 856+62	867+90	6.8	7.4
	9-1-66	869+95 to 856+62	865+50	6.8	7.4
Southbound	9-2-66	858+09 to 887+00	867+00 to 869+00	7.1	6.1
	9-2-66	858+09 to 887+00	870+97	7.1	6.1
	9-2-66	858+09 to 887+00	876+40	7.1	6.1
	9-2-66	858+09 to 887+00	878+80	7.1	6.1
	9-2-66	858+09 to 887+00	879+40	7.1	6.1
	9-2-66	858+09 to 887+00	883+10	7.1	6.1
	9-2-66	858+09 to 887+00	885+50	7.1	6.1
	9-6-66	887+00 to 902+43	892+50	6.3	8.5
	9-6-66	887+00 to 902+43	893+90	6.3	8.5
	9-6-66	887+00 to 902+43	896+15	6.3	8.5
	9-6-66	887+00 to 902+43	897+50	6.3	8.5
	9-6-66	887+00 to 902+43	891+90	6.3	8.5
	9-6-66	887+00 to 902+43	899+30	6.3	8.5
	9-6-66	887+00 to 902+43	900+00	6.3	8.5
	9-6-66	887+00 to 902+43	901+10	6.3	8.5
	9-6-66	887+00 to 902+43	902+00	6.3	8.5
	9-7-66	909+49 to 918+50	914+30 to 914+80	7.3	7.5
	9-7-66	909+49 to 918+50	915+00+10+75	7.3	7.5
	9-7-66	909+49 to 918+50	918+05	7.3	7.5
	9-7-66	918+50 to 927+45	918+60	— —	7.1
	9-7-66	918+50 to 927+45	924+50	— —	7.1
	9-8-66	927+45 to 949+08	929+50	7.0	9.8

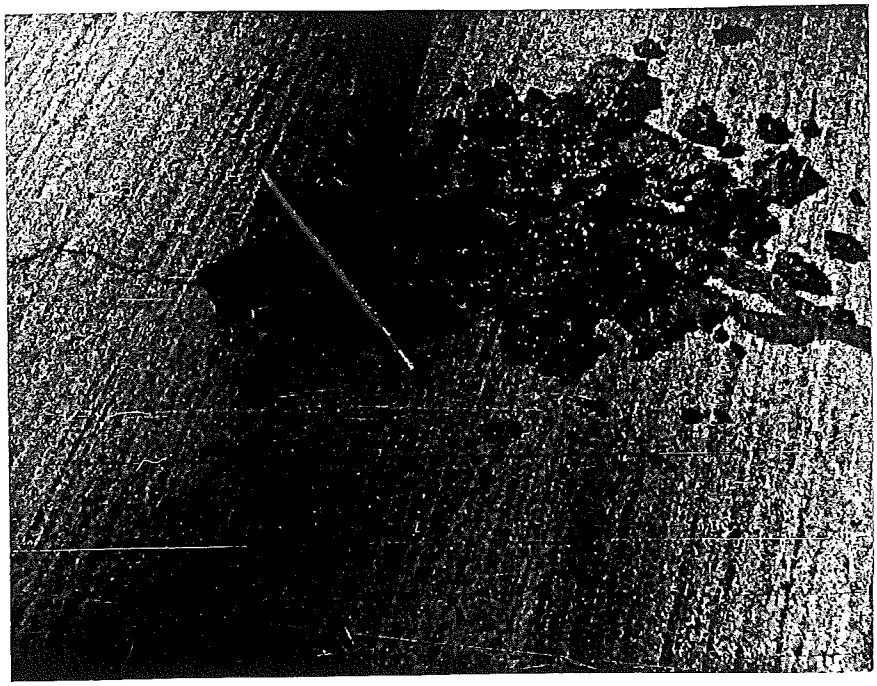

Figure 1. Several clay pockets in area of Sta. 914+70 in center lane of SB roadway. Note hammer protruding from the largest hole that was dug out and close-up (below).

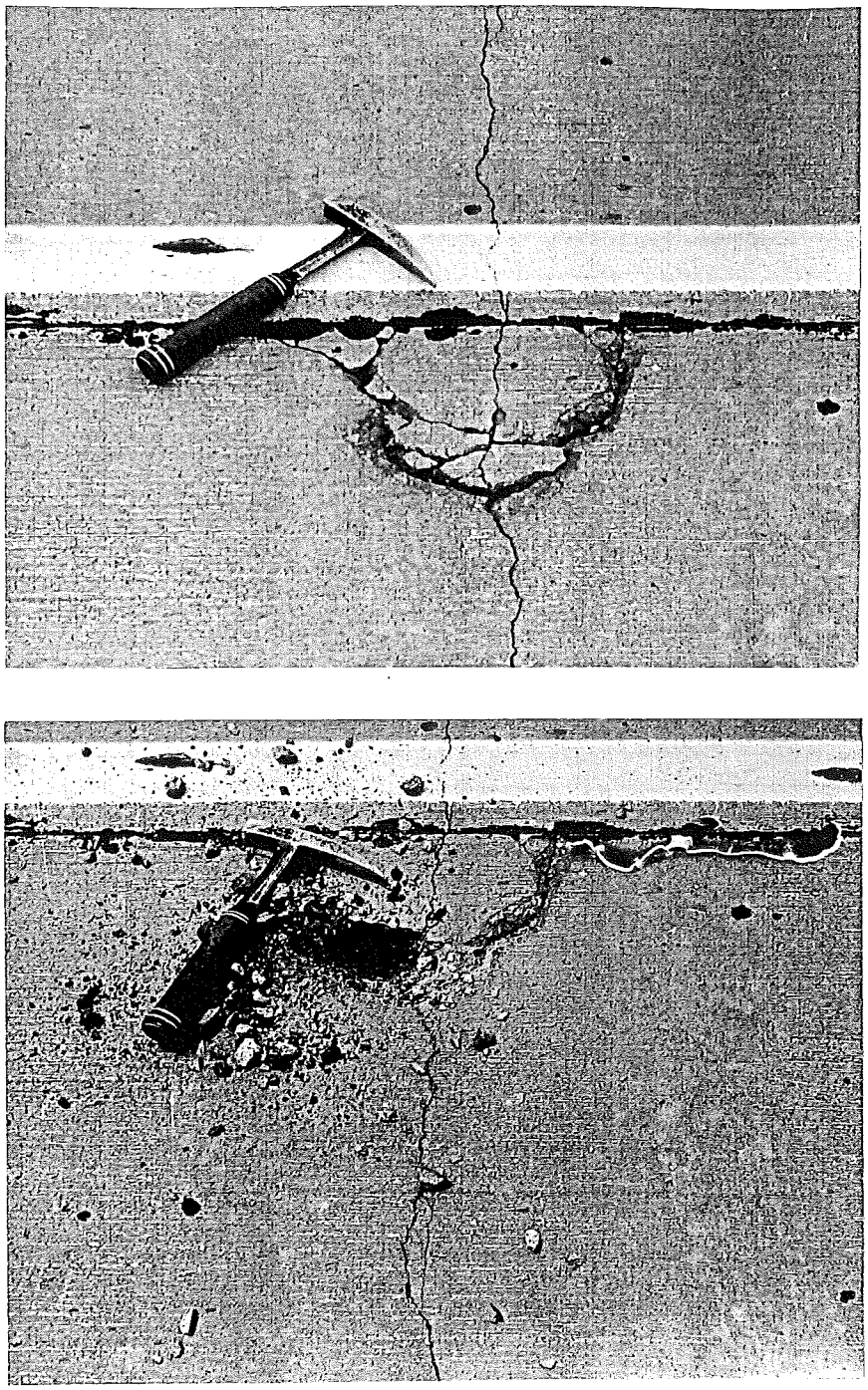

Figure 3. Pavement condition at suspected clay pocket (Sta. 940+20) in NB roadway. Lower photograph reveals clay pocket after partial opening.

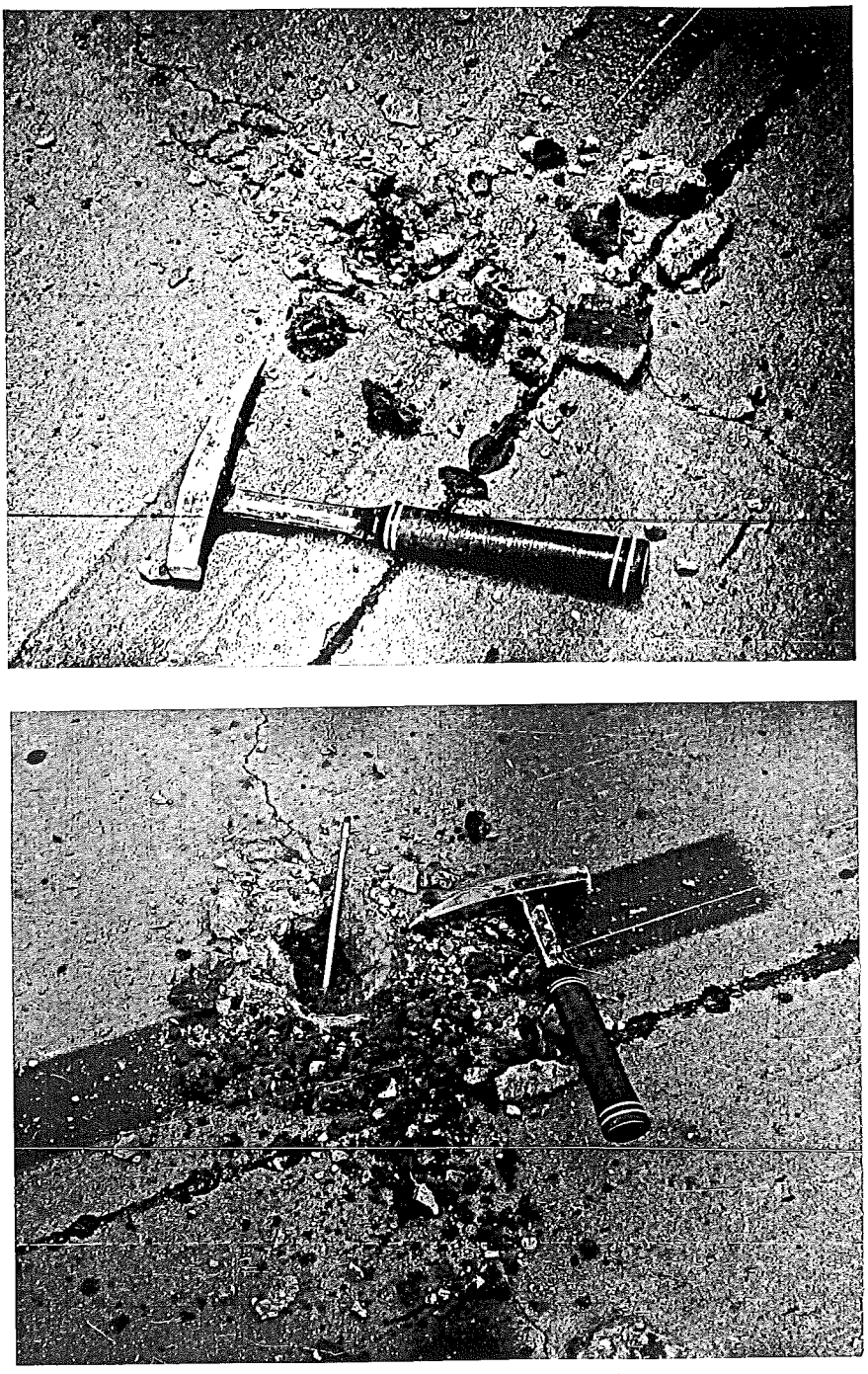

Figure 4. Close-up of unusual crack pattern (Sta. 872+15) of the SB roadway before and after exposing clay pocket.

Figure 5. General view of faulted cracks on NB roadway near night header at Sta. 888+49.

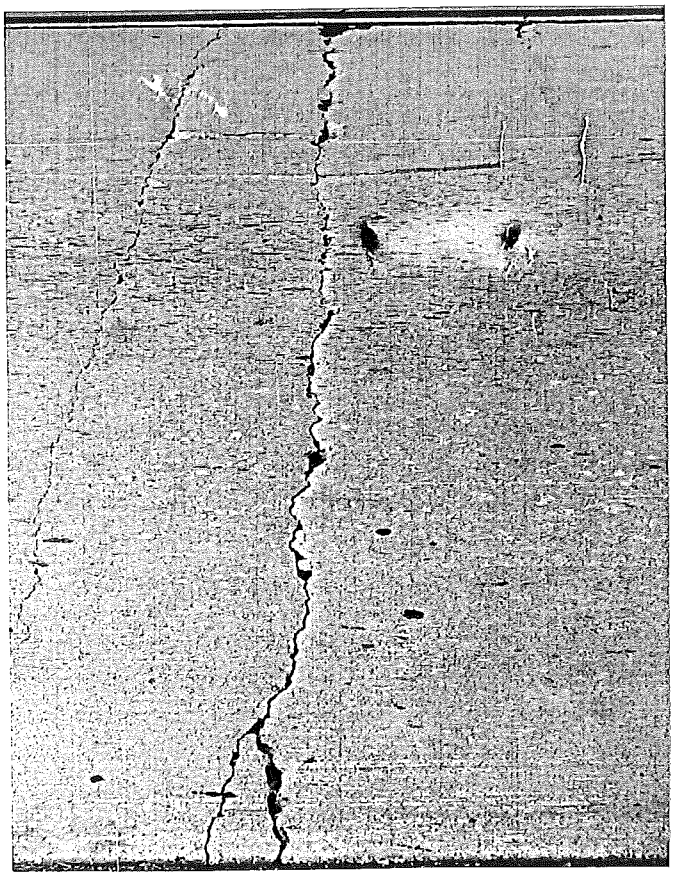

Figure 6. General view of distressed area (Sta. 925+00) of the NB roadway.

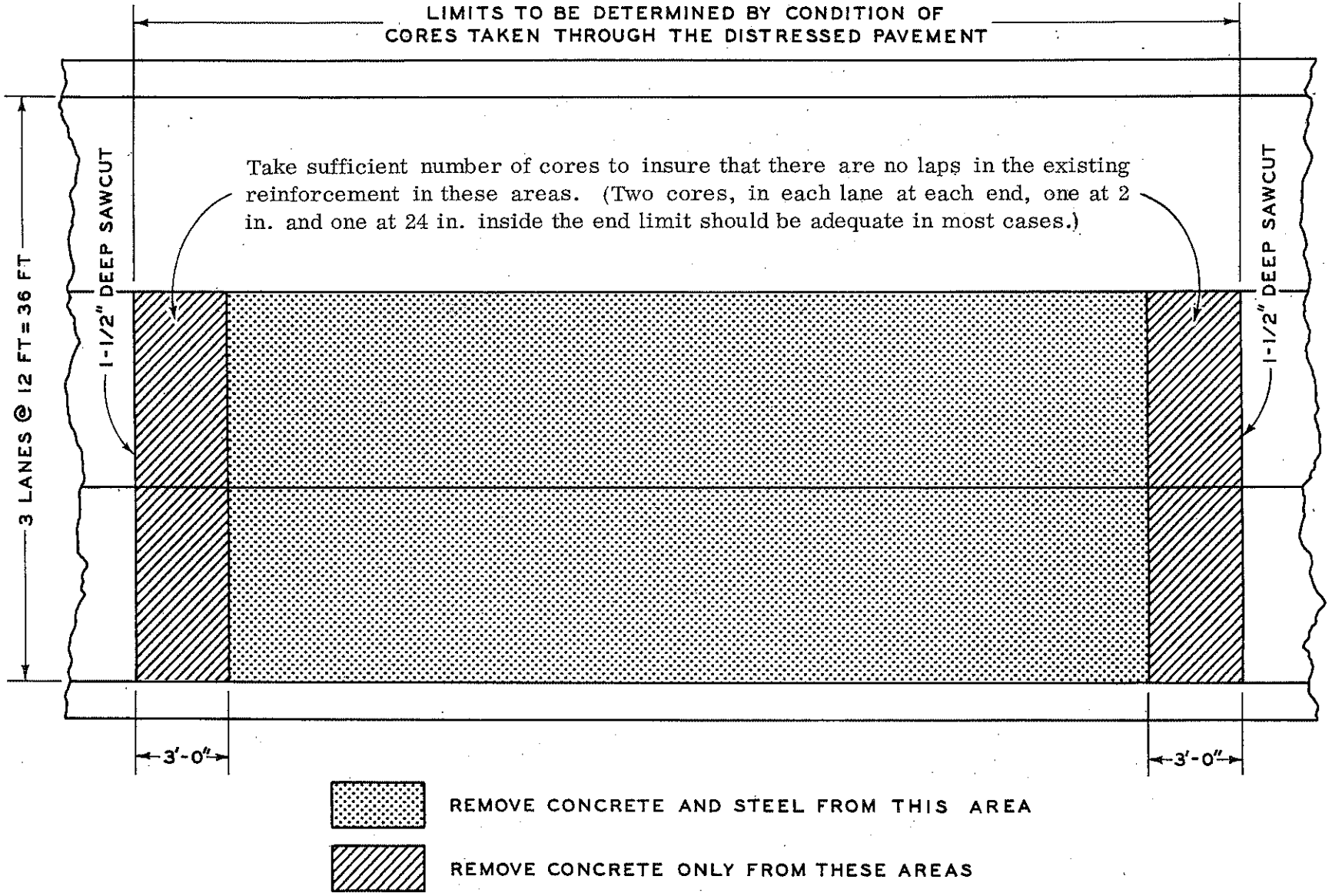

Figure 7. Layout of repair area.