PROCEDURES FOR REPAIRING CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

PROCEDURES FOR REPAIRING CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS

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OFFICE MEMORANDUM

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To: L. T. Oehler, Director
Research Laboratory Section

From: J. E. Simonsen

Subject: Procedures for Repairing Continuously Reinforced Concrete Pavements. Research Projects 57 F-46, 61 F-64, and 61 F-64(1). Research Report No. R-668.

Successful repair of continuously reinforced concrete pavements requires that care be exercised in removing and replacing failed areas. In most cases, failures must be temporarily maintained by bituminous patching but, because of the nature of this type of pavement, permanent repairs using this kind of material cannot be effected. However, experience indicates that satisfactory permanent repairs can be obtained. The repair procedures given here deal with permanent repairs only; temporary repairs are similar in nature to routine maintenance patching on standard jointed concrete pavement.

For maintenance purposes, the repairs are divided into minor and major categories. Minor repairs are those in which the steel reinforcement continuity is unimpaired and pavement integrity can be restored by patching with cement or epoxy-type mortars. This type of repair is suitable for failure areas such as isolated spalls or spots occurring as a result of pop-outs, clay balls, foreign material in the concrete, or localized areas of poorly consolidated concrete. Major repairs require full-depth steel and concrete replacement of one or more lanes as a result of steel reinforcement discontinutiy caused by improper laps, insufficient bond due to poor concrete consolidation, or vertical misalignment of the reinforcement.

PROCEDURES

(A) Minor Repairs

1. Inspect the failed area closely to determine if the concrete immediately surrounding it is sound. In the case of spalls it may be necessary to core adjacent to the spall in order to determine if the concrete has been sufficiently consolidated. If poorly consolidated concrete is found and the failure is extensive, it may be necessary to perform a major repair.

2. Remove all foreign material and unsound concrete. To avoid feathered edges, air-chisel to a minimum depth of 1 in. along the perimeter of the patch. Do not use air hammers larger than the 30 lb size.

3. The patching material may be shrink-resistant cement mortar or epoxy mortar. Use Embeco, Groutex, or equivalent as an anti-shrink admixture in the cement mortar, and two-component epoxy binder (Guardkote 250 or Resiweld 7122 MF) in the epoxy mortar. Mix proportions, final cleaning, and filling methods for the two materials are as follows:

Shrink-Resistant Cement Mortar

a. Mix Proportion - (dry weights)

100 lb Embeco, Groutex, or equivalent
188 lb High-Early-Strength cement
300 lb sand
Sufficient water to make a workable mortar for troweling

b. Final Cleaning

Remove all loose material with compressed air. Wet the concrete thoroughly but allow no free water on the surface.

c. Filling Method

Just prior to filling, prime the pre-wetted area with a fluid bond coat consisting of a 1 to 1 mixture of Embeco and High-Early-Strength cement with enough water to produce a creamy consistency. Apply the bond coat by hand with a stiff bristle brush. Place the mortar into the primed area immediately, tamp uniformly, and finish to match the adjoining pavement surface. Spray the finished area with a coat of membrane curing material.

Allow no traffic over patched areas until satisfactory curing has been attained (normally about 24 hrs).

Epoxy Mortar

a. Mix Proportion

Epoxy binder (Guardkote 250 or Resiweld 7122 MF), 1 to 1-1/4 parts by volume.

Sand (at least air dry with no excess moisture) 4 parts by loose volume.

These mix figures are approximate and may vary slightly with gradation of sand. A cubic foot of mixture should contain 2 to 2-1/4 gal of epoxy binder.

The higher epoxy binder content will be needed for areas requiring a more fluid mix. The minimum of 1 part of epoxy binder should give a stiffer mix for compaction by tamping.

Combine the two components of the epoxy binder at the proper ratio by volume or weight as given by the manufacturer, and mix thoroughly in a clean container for 3 to 5 minutes. Add the premixed binder to the sand and blend until a stiff but workable mix is obtained. Small quantities may be hand mixed. Larger quantities (1 to 4 cu ft) may be mixed in a suitable mortar mixer with separate horizontal mixing paddle.

b. Final Cleaning

Remove all loose material by dry sweeping and blowing-out with clean, dry, compressed air.

c. Filling Method

Just prior to filling, prime the dry, clean area with a heavy brush application of the premixed epoxy binder components containing no sand. The two epoxy components used as primer are to be mixed for 3 to 5 minutes as described above. Place the epoxy mortar into the primed area, tamp uniformly, and finish to match the adjoining pavement surface. Cover the fresh patch with a light application of dry sand. Tools used in mixing, placing, and finishing operations will require cleaning between batches to eliminate mortar build-up.

The concrete surface to be patched must have a temperature of at least 60 F and rising.

Allow no traffic over the patched areas until satisfactory curing has been attained (normally about 4 hours).

(B) Major Repairs

1. A typical layout of a lane repair is shown in Figure 1. To determine the limits of the area needing replacement the following steps are required:

a. On the basis of the surface condition in the distressed area, select preliminary end limits of the patch. The minimum width of a repair is one lane. The minimum length is 6 ft.

b. Take cores through each end area where the steel is to remain intact to insure that there are no laps in the reinforcement. Normally, two cores at

each end is sufficient; one about 2 in. and one about 18 in. from the preliminary end limit. If a lap is found, increase the length of the patch as required in order to have 2 ft 6 in. of steel extending intact into the repair area.

c. In case examination of the cores reveals poorly consolidated concrete or unusually low elevation of the steel, it may be necessary to increase the repair length until these conditions are no longer present.

NOTE: All continuously reinforced concrete pavements, except in Ionia County, have staggered steel laps. Therefore, where more than one lane needs repair, it may be necessary to core the end areas of all potential lane patches to avoid stagger in the sawed end limits of the patches.

2. The procedure for removal of the distressed pavement is as follows:

a. Make a 1-1/2-in. deep sawcut at the final end limits of the patch. This saw cut may be made across all lanes to be repaired at one location at one time. When more than one lane at the same location needs repair, make a saw cut of desired depth a sufficient distance from the longitudinal lane joint into the lane to be repaired last to provide room for the paving form. (Fig. 1).

b. Expose and cut the reinforcement at a point 2 ft 6 in. inside the sawed end limits. Also, locate and expose hook bolts and tie bars along the curb and adjacent lane to be left in place. This work is done with air hammers and hand tools.

c. Remove the freed center portion of the slab to be replaced. This portion of the slab may be broken and removed by mechanical equipment. Exerise care to save hook bolts and tie bars in adjacent concrete to be left in place.

d. Remove concrete in the 2 ft 6 in. end areas of the repair by use of air hammers and hand tools. Do not bend reinforcement up to facilitate concrete removal. Transverse reinforcement bars may be cut off at the intersections with the longitudinal bars to make concrete removal easier.

NOTE: Extreme care should be utilized in removing the concrete in this critical area in order that the 2 ft 6 in. extension of the reinforcing steel is maintained straight and intact.

3. Replacement Material

All materials used in the repairs shall conform to the current MDSH Specifications.

a. The subbase material shall be placed and compacted in accordance with MDSH Specifications and density tests made at each repair location to insure that the compaction requirements are met.

b. The concrete shall be High-Early-Strength, air entrained, and have a modulus of rupture of 550 psi, minimum, at the age of three days.

c. All reinforcing bars shall conform to the requirements of ASTM Specification A-432. The longitudinal bars shall span the length of the repair, where possible, in order to avoid intermediate laps. If laps in the longitudinal bars are required they shall be 2 ft 6 in. long. The transverse steel shall be No. 3 deformed bars 11 ft 8 in. long and spaced at approximately 2 ft. The size and number of longitudinal bars per 12-ft lane for continuously reinforced concrete pavements in the following Counties shall be:

Ionia: 46 No. 4 deformed bars in the wire mesh reinforced sections (Sta. 972+20 to 1075+50 WB and Sta. 842+90 to 948+50 EB roadway), and No. 5 deformed bars in bar mat reinforced sections (Sta. 866+90 to 972+20 WB and Sta. 996+40 to 1101+90 EB roadway).

Ingham: 46 No. 4 deformed bars on the eastbound roadway. 22 No. 5 deformed bars on the westbound roadway.

Wayne: Use No. 5 deformed bars on all projects. The number of bars per 12-ft lane shall be equal to the number of longitudinal bars or deformed wires in the existing reinforcement.

NOTE: On projects reinforced with bar mat, 30 bars would be required. On projects reinforced with deformed wire mat of full, half, or third lane width, 31, 32, and 36 bars, respectively, would be required.

4. Replacement Procedure

a. Reconstruct the subbase to proper elevation and set forms (if required). Install hook bolts along longitudinal joints.

b. Place the reinforcing bars. Each bar is to be lapped 2 ft 6 in. at each end with existing reinforcement. If intermediate laps are required they should also be 2 ft 6 in. long. All laps shall be tied. Use chair supports as needed to maintain the steel at the correct elevation. Tie a sufficient

number of intersections between longitudinal and transverse bars to maintain the bars in position during concrete pouring.

NOTE: If the pavement discontinuity extends across the entire roadway the longitudinal reinforcement laps in the lane repaired first must be welded. Use two, 1-in. long fillet welds in each lap, one at each end of the lap. Weld all laps at one repair end and all intermediate laps first. Weld the remaining laps at the other repair end just prior to concrete placement. (See note under c below). The steel continuity in the remaining lane or lanes can be re-established by tied laps as described in b above.

c. Pour the concrete over and through the reinforcement. Use immersion type vibrators to consolidate the concrete. Finish pavement surface in normal manner and spray with membrane curing compound. Edge longitudinal joints, but not transverse joints.

NOTE: If the continuity of the pavement has failed across the entire roadway, concrete pouring in the lane repaired first may need to be postponed until between 8 and 10 p.m. depending on the amount of temperature drop expected the first night after pouring. The anticipated temperature drop should not exceed 10 to 20 F. Concrete pouring in the remaining lane or lanes and in repairs where at least one lane is in satisfactory condition may take place during regular working hours.

General Precautions

To minimize the additional stresses induced in the part of the roadway not under repair, only one lane at a time at each location should be subject to repair. To avoid one or more cycles of expansion-contraction forces each lane repair should be completed in one day or in one continuous operation. Concrete delivery should be scheduled so that each repair can be poured in one continuous operation. Each finished repair should be closed to traffic for 3 days, or until 550 psi modulus of rupture is attained.

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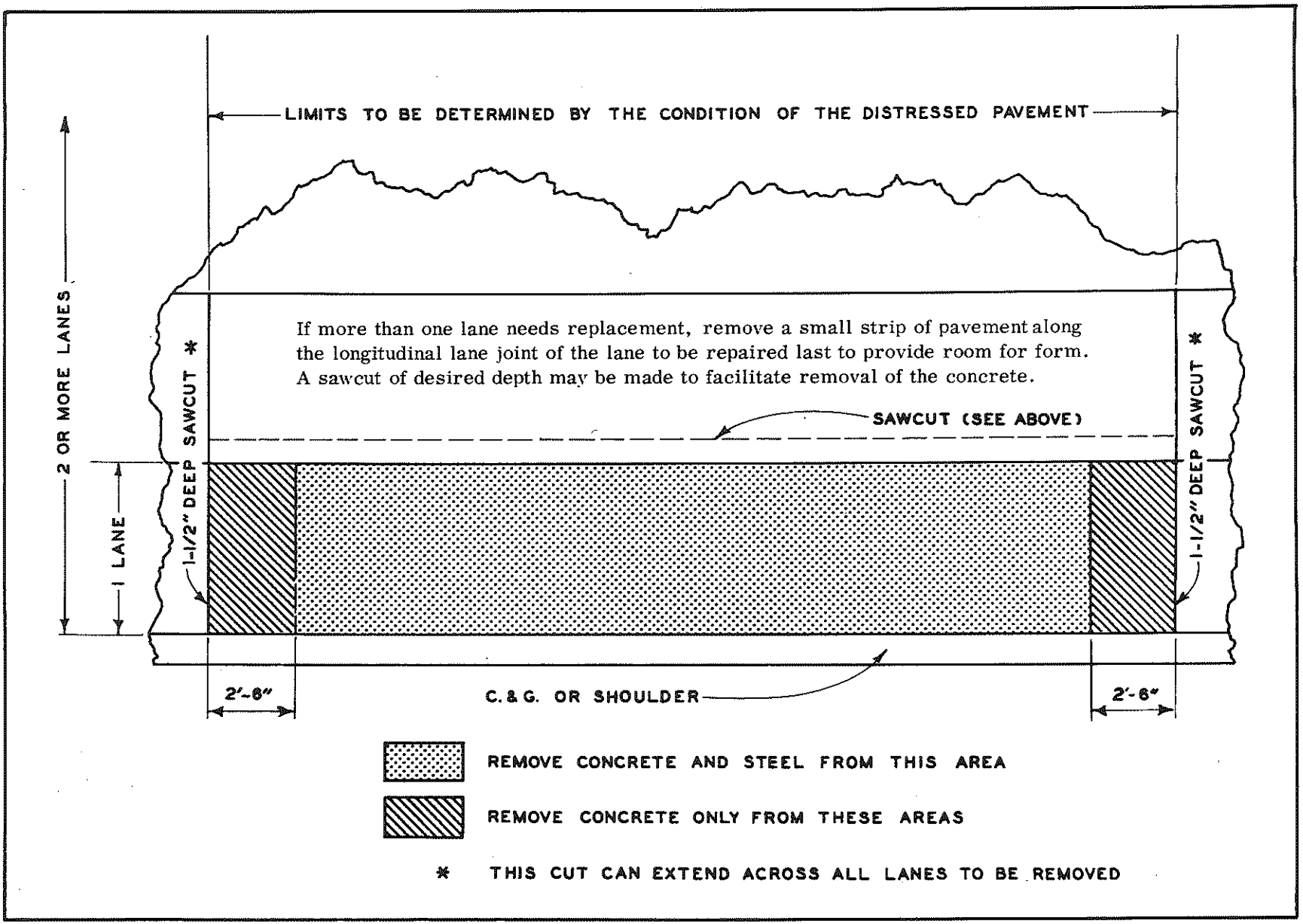

Figure 1. Layout of lane repair.