# REPAIR OF PLASTIC SHRINKAGE CRACKS IN THE DECK OF THE NINE MILE ROAD BRIDGE OVER I 75




MICHIGAN DEPARTMENT OF STATE HIGHWAYS

# REPAIR OF PLASTIC SHRINKAGE CRACKS IN THE DECK OF THE NINE MILE ROAD BRIDGE OVER I 75

H. L. Patterson

Research Laboratory Section
Testing and Research Division
Research Project 59 F-53(3)
Research Report No. R-667

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Department of State Highways
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# OFFICE MEMORANDUM

MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

April 1, 1968

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

From: H. L. Patterson

Subject: Repair of Plastic Shrinkage Cracks in the Deck of the Nine Mile Road Bridge over I 75 (S27 of 63174). Research Project 59 F-53(3). Research Report No. R-667.

The Nine Mile Rd Bridge was selected by the Construction Division to aid in the evaluation of a new chlorinated rubber material used as a concrete curing sealant. This basic material, called "Parlon," is manufactured by the Hercules Corporation. The material applied to the bridge was a Parlon-based product called "Euco Floor Coat," formulated by the Euclid Chemical Co. The evaluation of this sealant appears in Research Report No. R-662, " 'Parlon' Based Curing and Sealing Compounds: Second Progress Report."

The present report concerns the repair of the plastic shrinkage cracks that were apparent at the time of the Department's condition inspection of the chlorinated rubber-based sealants, and includes a final account of the repair procedure and a laboratory evaluation of the performance of the Colma-Dur LV epoxy patching compound.

The bridge deck was cast in November 1965, and first inspected by Research Laboratory personnel in September 1966. At that time, cracks were noted and described in an earlier 'Parlon' report (R-617). It was suspected that these cracks were of the "plastic shrinkage" type. [1]

Detailed information was obtained concerning the fresh concrete and weather conditions that existed at the time of the pour. From that information it was discovered that when cracks formed for three of the six pours, the temperature differential between concrete and air was greater than 40 F, which would have caused extensive evaporation of mix water from the surface of the concrete. This excessive evaporation from the surface would be one of the main factors contributing to the crack formation. The type of membrane curing compound used would have been immaterial since the cracks would have started forming prior to the application of the membrane. Both the white and the clear Euco curing sealant met standard water retention tests. From the information available, there were no other obvious factors contributing to the formation of the cracks.

[1] Lerch, William, "Plastic Shrinkage," Journal of the American Concrete Institute, February, 1957.

The cracks developed in pours A, C, L, and P, which were sealed with white Euco curing compound the day they were poured, and in pours J and M, sealed with white Euco the day after pouring. It was also noted that some of the cracks traversed partially, and others fully, across the width of the pour. Most of them were full depth and none of them crossed into adjacent pours (Fig. 1).

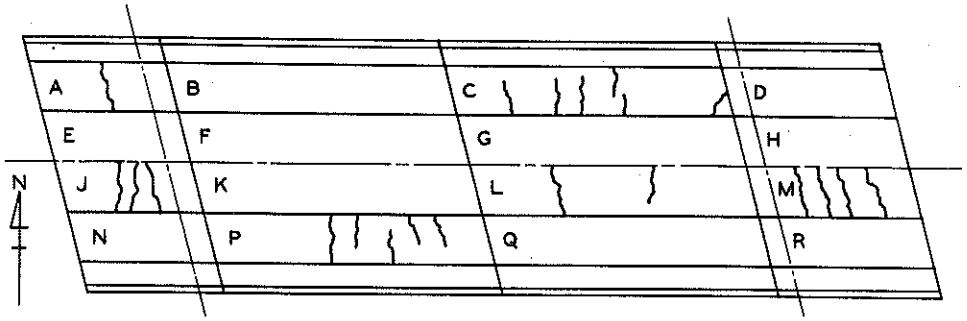


Figure 1. Plastic Shrinkage Cracks in Bridge Deck of Nine Mile Road Over I 75 S27 of 63174A.

On September 15, 1967, maintenance crews were in the process of repairing the most prominent cracks. Research Laboratory personnel visited the bridge to observe the repair procedures and to evaluate the effectiveness of the epoxy material being used.

## Repair Procedure

All the deck cracks were marked with a line of paint such that they could be easily followed by the sand-blast operator. A groove was cut approximately 1/2-in. wide and 1/4-in. deep. The grooves were filled to half-depth with a low viscosity solvent-free epoxy called Colma-Dur LV, manufactured by the Sike Chemical Corp.

After this epoxy had set, the groove was filled to full-depth with the same epoxy in which a silica-flour filler had been added. The filler epoxy was added to the top in order to blend more harmoniously with the surrounding concrete. It was mentioned by the Laboratory personnel present that the filled epoxy should probably be added before the unfilled epoxy had set, since some epoxies will not bond to themselves. Laboratory tests later, however, proved that Colma-Dur LV bonds well to itself, so in future work with this material this precaution is not necessary. Figure 2 shows the routed groove and the procedure for sealing the surface groove above the crack.

Later, in the laboratory, a sample of Colma-Dur LV (Lot No. 631187H) was tested to evaluate its effectiveness as a crack sealant. It was tested in the same manner as epoxy acceptance samples and the physical properties determined are given below.

Part A: Epoxy Resin Base Polymer

| | |
|---|---|
| VISCOSITY (poises, 77 F) (Brookfield No. 4 spindle at 20 rpm) | 3.51 |
| SPECIFIC GRAVITY (77 F) | 1.15 |

Part B: Curing Agent

| | |
|---|---|
| VISCOSITY (poises, 77 F) (Brookfield No. 1 spindle at 50 rpm) | 0.69 |
| SPECIFIC GRAVITY (77 F) | 0.99 |

Mixture of A and B (2:1 by Vol)

| | |
|---|---|
| GEL TIME (60 gm at 77 F), min | 20 |
| TENSILE STRENGTH, psi. | 2580 |
| ELONGATION, percent. | 20.4 |
| SHEAR BOND STRENGTH, psi | 1620 |

The shear bond strength was so high that failure occurred in the concrete at an average strength of 1620 psi. The strength of the tensile specimens were equally impressive, occurring at an average value of 2580 psi and the maximum elongation extended 20 percent at a temperature of 77 F.

To evaluate the depth to which this epoxy will penetrate a fine crack, a broken section was cut from a tested flexure beam; then the broken portions were held together securely while a groove was sandblasted along the crack; finally, the Colma-Dur LV was poured into the routed-out crack. At room temperature (77 F) it had a viscosity similar to that of honey and appeared to penetrate the crack slowly; requiring about 15 minutes for the level, which was poured flush with the top of the concrete, to drop noticeably. It set in about 30 minutes. The following day, sections were cut through the crack and polished such that the depth of epoxy penetration could be visually determined. The portion of the flexure beam used, along with the cut sections, are shown in Figure 3. The figure shows that in Section A-A the epoxy penetrated a crack of an average width of 0.010 to a depth of 2.7 in. In section B-B, a crack of an average width of 0.008 in. was penetrated to a depth of 2.0 in. The arrows show the maximum penetration point.

From the laboratory information it was deduced that this epoxy, Colma-Dur LV, would be an adequate crack sealer. A later inspection of the bridge, conducted on March 19, 1968, found the epoxy sealed cracks still intact and in good condition. From this recent observation and the laboratory information it was concluded that this epoxy has satisfactorily sealed the bridge deck cracks.

TESTING AND RESEARCH DIVISION

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HLP:sjt

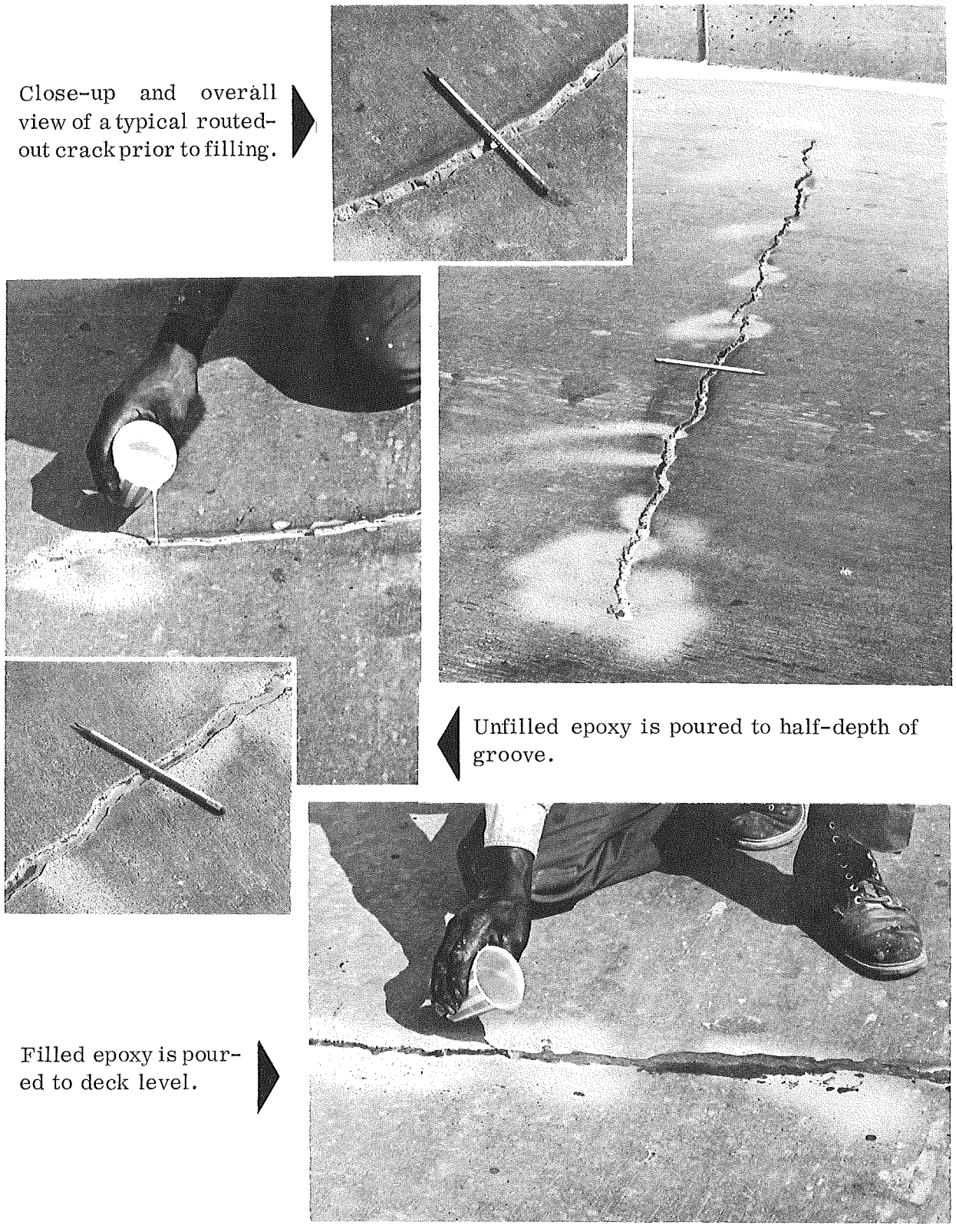


Figure 2. Plastic shrinkage crack repair procedure.

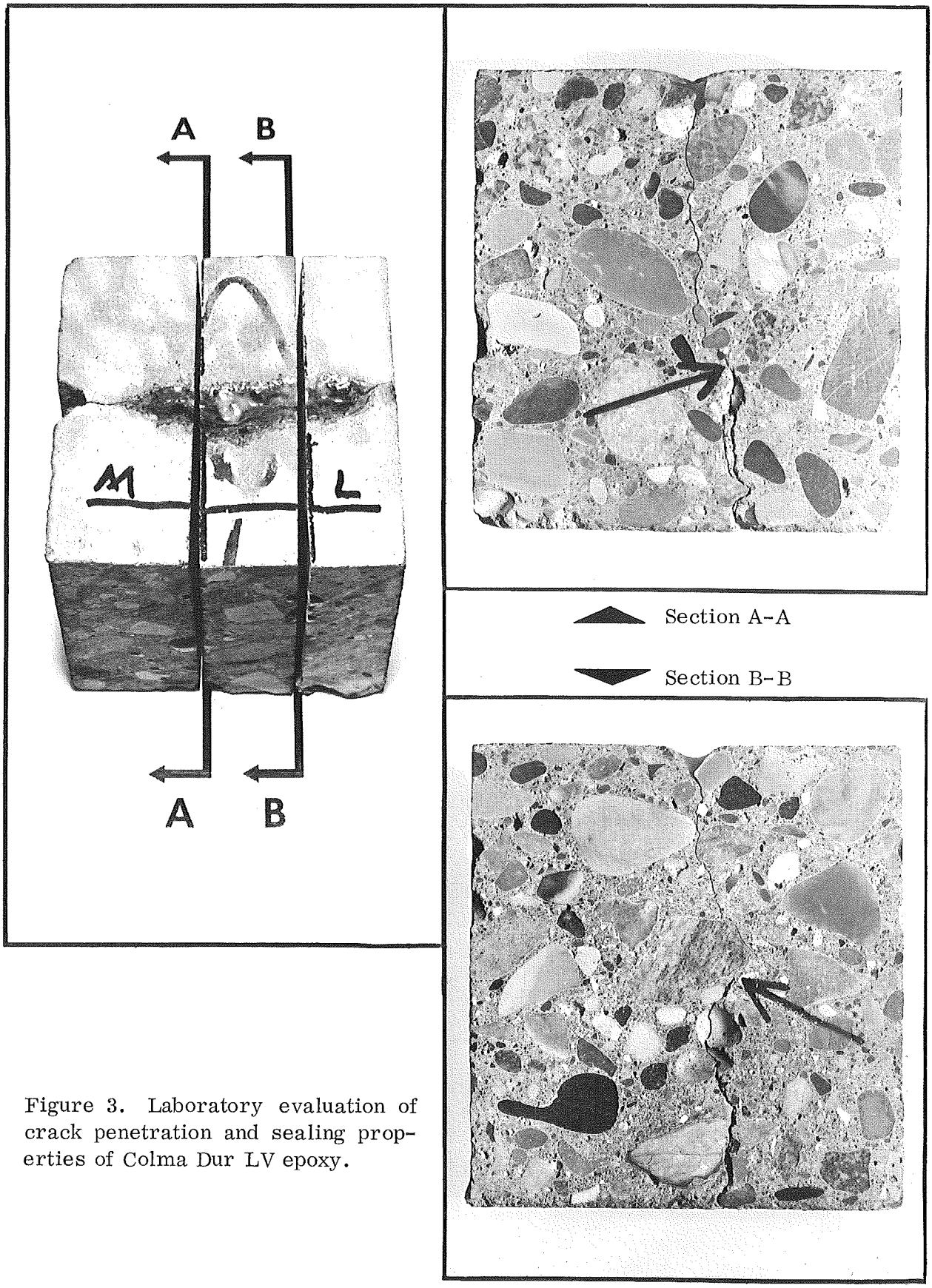


Figure 3. Laboratory evaluation of crack penetration and sealing properties of Colma Dur LV epoxy.