"PARLON"-BASED CURING AND SEALING COMPOUNDS
SECOND PROGRESS REPORT

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

"PARLON"-BASED CURING AND SEALING COMPOUNDS
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The purpose of this project was to test and evaluate--in the laboratory and in the field--a new material that would serve both as a concrete curing compound, and as a sealant to protect concrete bridge decks, poured in the late fall, from ice removal chemicals. This new material contains a chlorinated rubber compound called "Parlon" manufactured by the Hercules Corporation. It is formulated by the Euclid Chemical Company, Cleveland, and the T. K. Products Company of Minneapolis. The particular product used on all subject bridges was either clear or white "Euco Floor Coat," produced by the Euclid Chemical Company. The laboratory evaluation of "Euco Floor Coat" will be included in a separate report.

This report describes the surface condition of five bridges as selected by the Construction Division for field evaluation of this new material. Two of the bridges, S27 of 63174A (Nine Mile Rd over I 75) and S24 of 63174A (John R. over I 75), were initially described in the First Progress Report (Research Report No. R-617, December 7, 1966). The other three were opened to traffic later and are described in this report for the first time. These structures are: S10 of 82252L (Eight Mile Rd over I 75) described in Recommendation No. 55F, October 3, 1966; and S14 and S16 of 50111G (left-turn structures over I 94 at Twelve Mile Rd) described in Recommendation No. 1F, November 15, 1966. The subject sealants were applied to the latter bridges specifically because the decks were poured in late fall and an early open-to-traffic date was anticipated. This would have exposed the green concrete to the effects of ice removal salts. Since the last three structures were not covered in the First Progress Report, they are discussed first.

Eight Mile Road Bridge - White Euco and Clear Euco

The Eight Mile Rd Bridge has eleven spans, concrete deck on steel girders, and six traffic lanes separated in the center by a concrete median strip equipped with steel beam guardrails. The concrete deck was poured in September and October of 1966 and cured as follows: 1) regular white membrane curing compound on spans one through eight of the eastbound roadway; 2) white Euco on nine through eleven of the eastbound roadway; and 3) clear Euco on all spans of the westbound roadway. All three ma-

terials were sprayed on fresh concrete at the rate of 200 sq ft per gal. The sidewalks, upon completion, were also sprayed with the corresponding deck sealants.

When first inspected (November 16, 1966), it was noted that the white membrane curing compound had a yellowish-white color, the white Euco had a brilliant white color, and the clear Euco was colorless. On December 21, 1966, the bridge was opened to traffic and was in service almost one full year before it was inspected again (September 15, 1967). At this time, the appearance of the deck was generally very good. Both the white membrane curing compound and the white Euco were mostly worn off the eastbound traffic areas, but were still visible along the curb lines. The spans protected with clear or white Euco were completely free of scale, but small isolated areas of light scale were starting to develop on the spans cured with white membrane curing compound. This light scale was most prominent in span six of the eastbound roadway. Figure 1 shows the bridge and this scaling.

Left-Turn Structures, Twelve Mile Road Over I 94 - White Euco

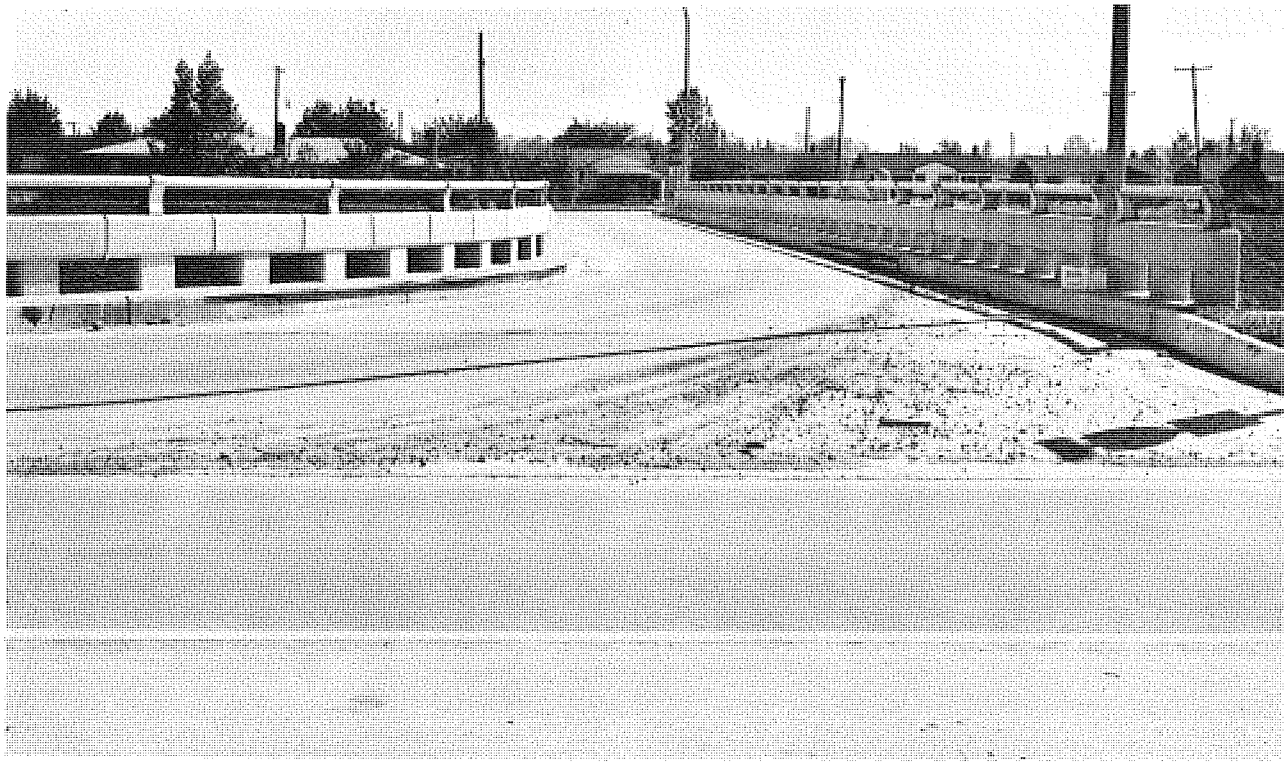
An initial inspection of these two structures was made on January 24, 1967. Bridge S16, the north bridge, was poured on November 22, 1966, when the temperature ranged from a high of 60 to a low of 40 F. S14, the south bridge, was poured on November 25, 1966, when a high of 57 and a low of 53 F was recorded. Both bridge decks were poured late in the afternoon in one operation using a transverse screeding machine. The white Euco curing and sealing compound was then applied the following morning at the rate of 200 sq ft per gal. In both cases, overnight evaporation from the deck was minimized by high atmospheric humidity. In both structures the end span sidewalks, the entire length of parapet railing, and the approach pavements had not been poured. The bridges were completed the following June and were opened to traffic on July 12, 1967.

Our second inspection was made on October 3, 1967. At this time the bridges had been open to traffic for about three months but had not undergone an operational winter. Figure 2 shows the bridge decks of S14 and S16. The white Euco was plainly visible on the entire surface except where it had been darkened or removed by traffic. In general the concrete decks looked very good and were free of scaling and cracks; however, areas of deficient consolidation were noticed on the sidewalks and parapet rails of both bridges.

Scale developing in center lane of span 6.

Figure 1. Eight Mile Rd Bridge over I 75.

Eastbound roadway of Eight Mile Rd Bridge over I 75.



S14 Bridge deck as viewed from west approach.
S16 Bridge deck as viewed from east approach.

Figure 2. Left-turn structures over I 94 at Twelve Mile Rd.

Nine Mile Road - White Euco and Linseed Oil

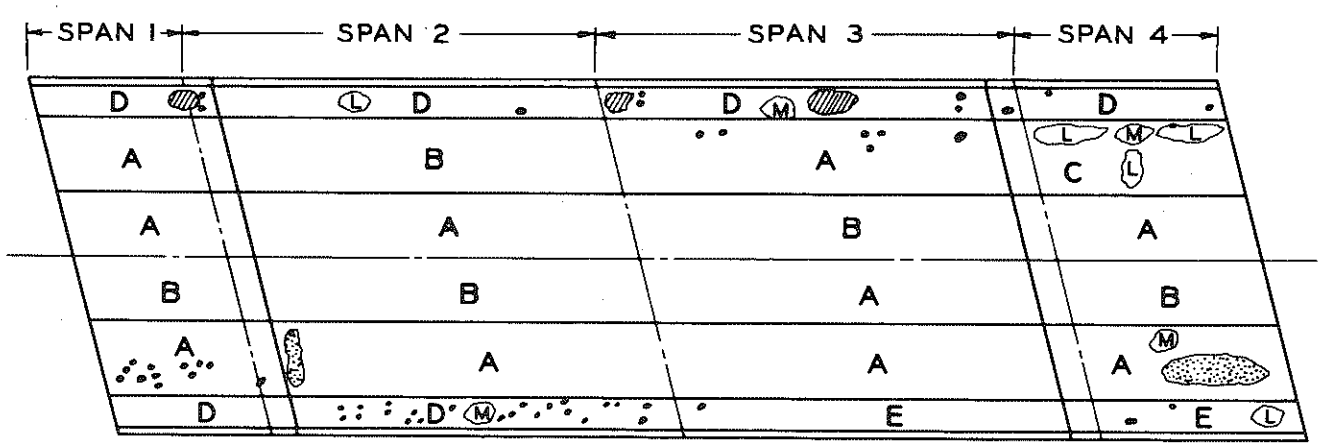
The Nine Mile Rd Bridge has four spans, consisting of a concrete deck on steel stringers and four traffic lanes. The concrete deck was poured in late November 1965. Ten deck pours were sprayed with white Euco the day after they were poured and one was sealed with two coats of a mixture of 40-percent boiled linseed oil and 60-percent naphtha (white gas). The actual coverage was reported to have been excessively heavy (76 sq ft per gal for each coat). Six sidewalk pours were cured and sealed with clear Euco sprayed on fresh concrete, and two sidewalk pours were sprayed with clear Euco the day after they were poured (Fig. 3). The bridge was opened to traffic in January 1966.

The bridge was first inspected on September 9, 1966, and covered in the First Progress Report (R-617). At this time the prominent plastic shrinkage cracks were described, but no significant weathering had occurred. At the time of the second bridge inspection (May 3, 1967), certain portions of the deck had begun to exhibit signs of weathering and traffic damage. Figure 3 shows the location and extent of this damage. This figure shows that the deck pours are still free of significant weathering damage with the exception of the westbound traffic lane of span four which has developed much scale, and the eastbound traffic lane of span one which has developed many pop-outs. The south sidewalk of span two has also developed many pop-outs. On the eastbound traffic lanes of spans two and four, there are large areas of traffic abrasion caused by braking vehicles. The photographs in Figure 4 show some of the traffic and weathering damage diagramed in Figure 3. The westbound traffic lane of span four which was coated with linseed oil-naphtha never showed any signs of puddled linseed oil scum along the curb line.

The plastic shrinkage cracks, described in the first report, were repaired on September 15, 1967; the treatment is described in a separate report entitled, "Repair of Plastic Shrinkage Cracks in the Deck of the Nine Mile Road Bridge Over I 75" Research Report No. R-667.

John R. Avenue Bridge - Clear Euco and Linseed Oil

The John R. Bridge has four spans, consisting of a concrete deck on steel stringers, and four traffic lanes. The concrete deck was poured in late December 1965. The east half (roadway, curb, and walk) was sealed with a linseed oil-naphtha mixture, while the west half was sealed with clear Euco. Both sealants were applied to cured concrete in mid-February before opening to traffic on February 24, 1966. The linseed oil-naphtha mixture

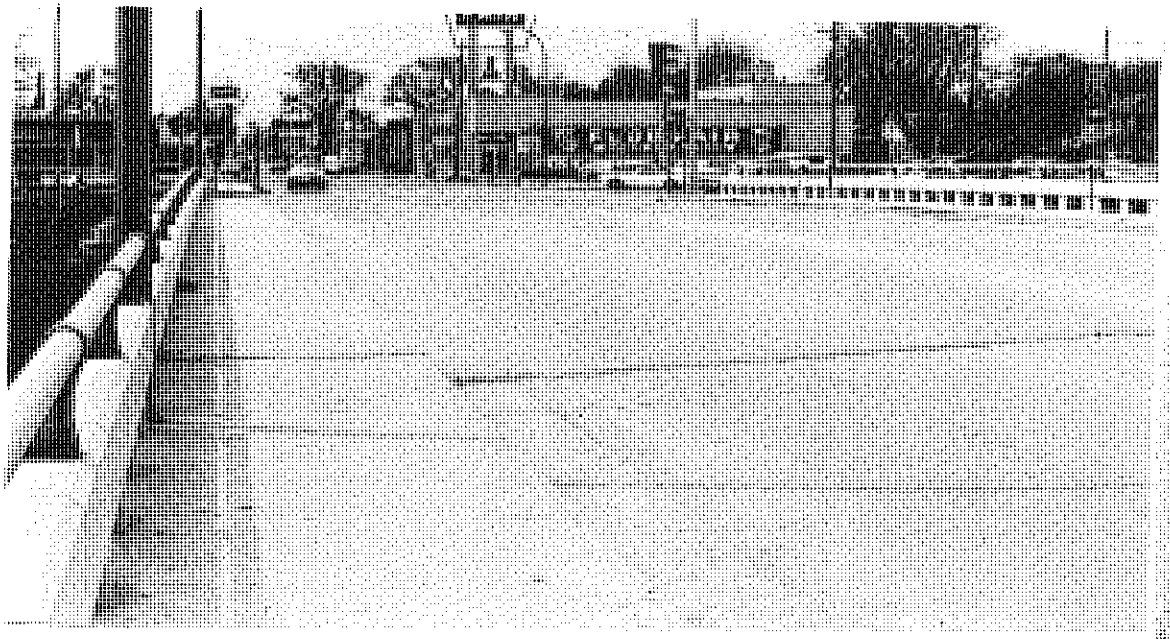


LEGEND:

A - SEALED WITH WHITE EUCO SAME DAY AS POUR.
B - SEALED WITH WHITE EUCO DAY AFTER POUR.
C - SEALED WITH LINSEED OIL AND NAPHTHA.
D - SEALED WITH CLEAR EUCO SAME DAY AS POUR.
E - SEALED WITH CLEAR EUCO DAY AFTER POUR.

- POP OUT
- (L) LIGHT SCALE
- (M) MEDIUM SCALE
- (H) HEAVY SCALE
- TRAFFIC ABRASION
- CRAZE CRACKING

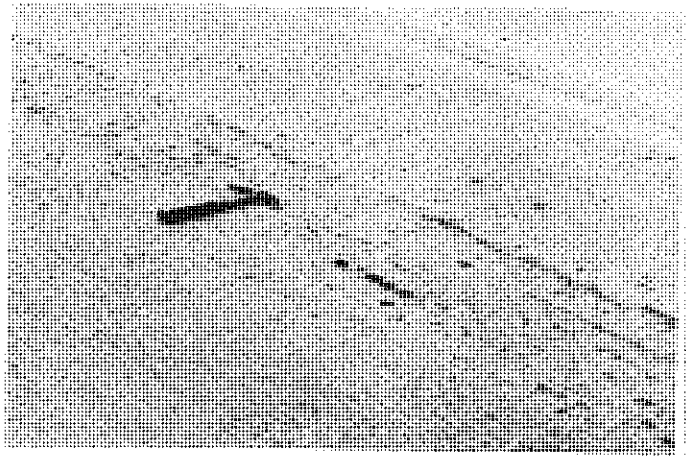
Figure 3. Weathering damage on Nine Mile Rd Bridge over I 75 (May, 1967).



Nine Mile Rd Bridge deck looking west.

Scale along North curb line in span 4.

Heavy abrasion on eastbound traffic lane at south side of span 4.



Scale on south sidewalk of Bridge in center of span 2.

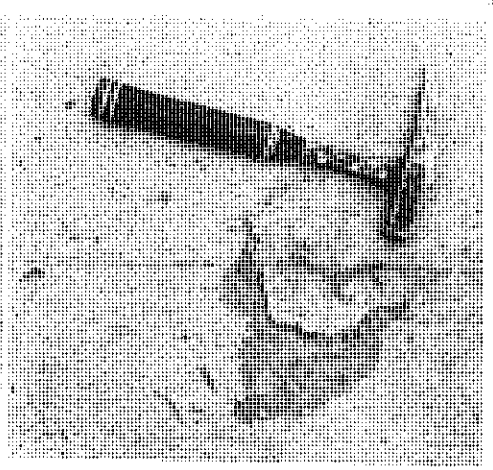


Figure 4. Nine Mile Rd Bridge Over I 75.

was composed of 50-percent boiled linseed oil and 50-percent naphtha and was applied in two coats. The first coat was applied at the rate of 125 sq ft per gal.

The first inspection (September 9, 1966), was covered in the First Progress Report. At that time there was no significant weathering damage.

Figure 5 is a diagram of the bridge deck which indicates the sealant used and the weather damage incurred as of May 3, 1967. At that time it was noted that the linseed oil scum which was so prominent along the east curb line in September 1966, was now almost gone; however, the linseed oil sealant appeared to be doing an excellent job since both northbound lanes were in fine condition except for a few shale or chert pop-outs in each of the first three spans.

On spans one, two, and four of the southbound roadway, the clear Euco afforded equal protection to that of the linseed oil-naphtha mixture; however, the traffic lane of span three did not fare as well. About 2 ft from the curb line throughout the full length of span three, a large number of pop-outs and spots of light scale had developed.

The east and west sidewalks which were sealed with the linseed oil-naphtha mixture and clear Euco, respectively, presented the same general appearance as the bridge deck slab. All the sidewalks seemed to receive excellent protection except the west sidewalk of span two which had developed several pop-outs.

Figure 6 shows various bridge deck features noticed during the May 3rd inspection.

RESULTS

Eight Mile Road Bridge

The Eight Mile Rd Bridge has undergone one complete operational winter and at this time shows negligible weather damage. The clear and white Euco-treated areas are all in good condition and only the first eight eastbound spans cured with conventional white membrane show any signs of beginning scale. Another winter's exposure may produce more obvious differences in the sealant coatings in combination with the slag aggregate concrete.

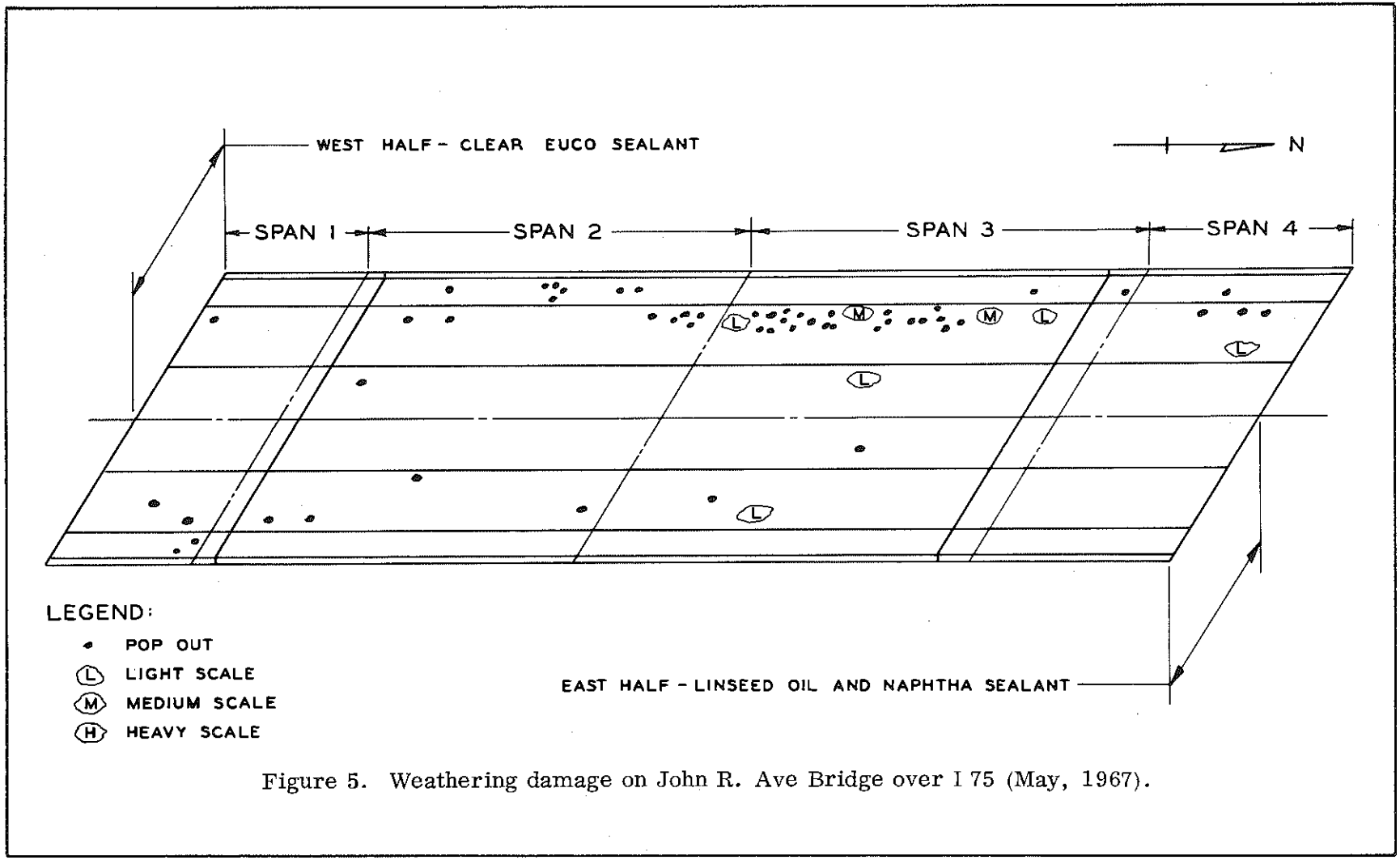
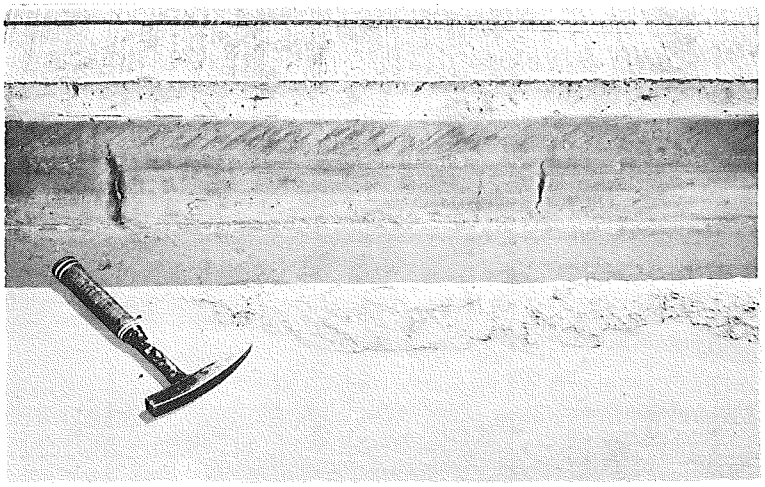


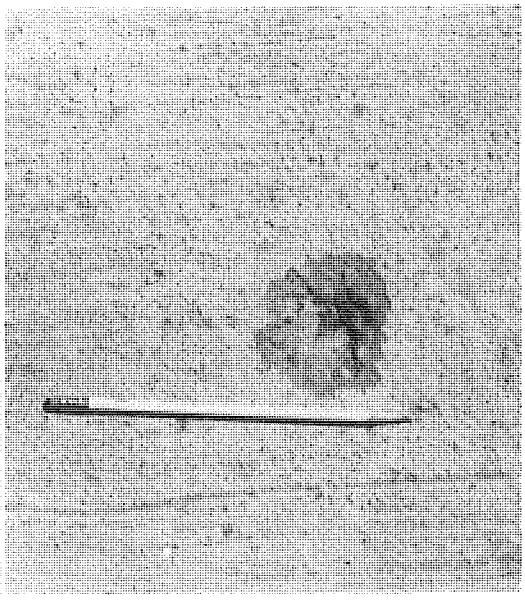
Figure 5. Weathering damage on John R. Ave Bridge over I 75 (May, 1967).

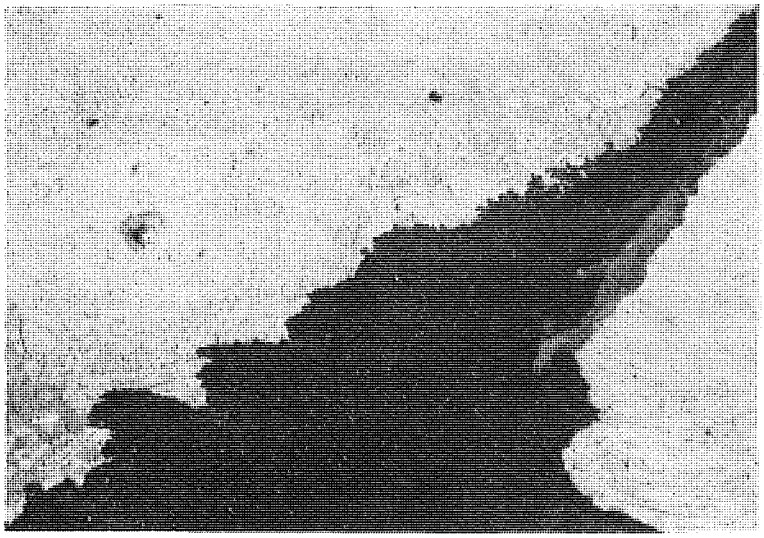
View of Bridge deck looking north.



Typical pop-out and surrounding light scale in span 3 about 2 ft from west curb line.

Remaining linseed oil scum along east curb.





Typical shale aggregate pop-out on east side of deck over pier 2, span 2.

Figure 6. John R. Ave Bridge over I 75.

Left-Turn Structures at Twelve Mile Road

The two left-turn structures at Twelve Mile Rd over I 94 have not undergone an operational winter yet and thus have not been subjected to any destructive weathering action. The original intent on these bridges was never to use them as a part of an experimental testing program, but rather to protect the "green" concrete from ice removal chemicals that were expected in the anticipated early opening date to traffic.

NINE MILE ROAD AND JOHN R. AVENUE BRIDGES

To evaluate the effectiveness of the sealants on the Nine Mile Rd and John R. bridges, it was necessary to devise some means of rating the type and extent of weathering damage. The rating system used assigns numerical values to the different types of weathering damage and is outlined as follows:

Each pop-out	-	1 point
Light scale spot	-	5 points
Medium scale spot	-	10 points
Heavy scale spot	-	15 points
Traffic abrasion	-	0 points
Craze crack spot	-	5 points

Totaling any and all of these defects on a given bridge deck will give an overall number which is used to rate the bridge deck as follows:

Excellent	-	0-5 points
Good	-	6-15 points
Fair	-	16-25 points
Poor	-	26-100 points

The weathering diagrams (Figs. 3 and 5) were inspected and the numerical values for the various types of weathering damage observed were totaled by spans for the sidewalks and for each traffic lane. The results of these ratings are given in Tables 1 and 2.

Nine Mile Road Bridge

On the Nine Mile Rd Bridge, three different sealants were used with three different methods of application, resulting in five different sealant combinations. Thus, on eight traffic lane spans there were six where white Euco was applied to fresh concrete, one where white Euco was applied to day old concrete, and one where linseed oil-naphtha was applied to cured concrete. On eight passing lane spans, four were sealed with white Euco

TABLE 1
DAMAGE RATING COMPARISONS
NINE MILE RD OVER I75 (S27 of 63174A)

	Sealant	Location	Application Time	Damage Rating[1]
TRAFFIC LANE	White Euco	Span 1, EB	same day	Good (12)
	White Euco	Span 1, WB	same day	Excellent (0)
	White Euco	Span 2, EB	same day	Excellent (0)
	White Euco	Span 2, WB	next day	Excellent (0)
	White Euco	Span 3, EB	same day	Excellent (0)
	White Euco	Span 3, WB	same day	Good (6)
	White Euco	Span 4, EB	same day	Good (10)
	Linseed Oil	Span 4, WB	cured	Poor (26)
PASSING LANE	White Euco	Span 1, EB	next day	Excellent (0)
	White Euco	Span 1, WB	same day	Excellent (0)
	White Euco	Span 2, EB	next day	Excellent (0)
	White Euco	Span 2, WB	same day	Excellent (0)
	White Euco	Span 3, EB	same day	Excellent (0)
	White Euco	Span 3, WB	next day	Excellent (0)
	White Euco	Span 4, EB	next day	Excellent (0)
	White Euco	Span 4, WB	same day	Excellent (0)
SIDEWALK	Clear Euco	Span 1, EB	same day	Excellent (0)
	Clear Euco	Span 1, WB	same day	Good (7)
	Clear Euco	Span 2, EB	same day	Poor (32)
	Clear Euco	Span 2, WB	same day	Good (6)
	Clear Euco	Span 3, EB	next day	Excellent (1)
	Clear Euco	Span 3, WB	same day	Fair (24)
	Clear Euco	Span 4, EB	next day	Good (7)
	Clear Euco	Span 4, WB	same day	Excellent (3)

[1] Numerals are the sum of the rating points of the damage observed (Fig. 3).

TABLE 2
DAMAGE RATING COMPARISONS
JOHN R. AVENUE OVER I75 (S24 of 63174A)
ALL SEALANTS WERE APPLIED ON CURED CONCRETE

	Sealant	Location	Damage Rating[1]
TRAFFIC LANE	Linseed Oil	Span 1, NB	Excellent (2)
	Clear Euco	Span 1, SB	Excellent (1)
	Linseed Oil	Span 2, NB	Excellent (4)
	Clear Euco	Span 2, SB	Good (7)
	Linseed Oil	Span 3, NB	Good (6)
	Clear Euco	Span 3, SB	Poor (51)
	Linseed Oil	Span 4, NB	Excellent (0)
	Clear Euco	Span 4, SB	Good (8)
PASSING LANE	Linseed Oil	Span 1, NB	Excellent (0)
	Clear Euco	Span 1, SB	Excellent (0)
	Linseed Oil	Span 2, NB	Excellent (0)
	Clear Euco	Span 2, SB	Excellent (1)
	Linseed Oil	Span 3, NB	Excellent (1)
	Clear Euco	Span 3, SB	Excellent (5)
	Linseed Oil	Span 4, NB	Excellent (0)
	Clear Euco	Span 4, SB	Excellent (0)
SIDEWALK	Linseed Oil	Span 1, NB	Excellent (2)
	Clear Euco	Span 1, SB	Excellent (0)
	Linseed Oil	Span 2, NB	Excellent (0)
	Clear Euco	Span 2, SB	Good (7)
	Linseed Oil	Span 3, NB	Excellent (0)
	Clear Euco	Span 3, SB	Excellent (1)
	Linseed Oil	Span 4, NB	Excellent (0)
	Clear Euco	Span 4, SB	Excellent (2)

[1] Numerals are the sum of the rating points of the damage observed (Fig. 5).

applied to fresh concrete and four were sealed with white Euco applied to day old concrete. On eight sidewalk spans, six were sealed with clear Euco on fresh concrete and two with clear Euco on day old concrete.

Table 1 shows that of the six traffic lane spans that were sealed with white Euco on fresh concrete, sealant performance on three of them was rated excellent, with little or no weathering damage. On the other three, the sealant performance was rated good, with only light damage inflicted to the concrete. The sealant performance on the one traffic lane span which was sealed with white Euco on day old concrete was rated excellent while the performance on the traffic lane sealed with linseed oil-naphtha was rated poor, with extensive weathering damage inflicted to the concrete. Table 1 also shows that the sealant performance on all the passing lane spans was rated excellent. Of the six sidewalk spans sealed with clear Euco on fresh concrete, two gave excellent performance, two were rated good, one fair, and one poor. Of the two sidewalk spans sealed with clear Euco on day old concrete, one gave excellent and the other good performance.

Because of the variety of sealants used, different methods of application, and a lack of an adequate standard or control sealant, the evaluation of sealants on this bridge deck is impossible.

The pour protected with linseed oil presents an enigma. The degree of scaling in this pour is not typical of properly proportioned air entrained concrete after only two winters exposure. In addition, the linseed oil-naphtha sealant, applied at the reported heavy rate, could have been expected to provide a considerable degree of protection; similar to its performance on the John R. Bridge.

John R. Avenue Bridge

On the John R. Bridge deck, the northbound traffic and passing lanes, and sidewalk were all sealed with linseed oil-naphtha applied to cured concrete while the southbound traffic and passing lanes, and sidewalk, were all sealed with clear Euco applied to cured concrete.

On the northbound side sealed with linseed oil-naphtha, the sealant performance on three of the traffic lane spans was rated excellent while the fourth was rated good (Table 2). On all of the passing lane and sidewalk spans, the sealant performance was also rated excellent.

On the southbound side sealed with clear Euco, sealant performance on the traffic lane was rated excellent for one span, good for two other spans, and poor for the fourth span. Sealant performance on all the sidewalk and passing lane spans was rated excellent except for one sidewalk span where it was rated good.

The results here seem to indicate that the linseed oil is a superior sealant to the clear Euco as they were applied to this bridge deck; however, to reliably substantiate this conclusion, at least two other bridge decks should be sealed in the same manner and observed for several years.

REMARKS

When a new material is to be evaluated in actual field applications, it is important that a testing system be employed from which reliable results can be expected. The testing system for this new material should incorporate in its design the following considerations:

1. To measure anything, some basis of comparison must be provided. A basis of comparison for this new material might be afforded by a competitive material whose performance is known through previous evaluation. Thus, the competitive material becomes a standard by which the new material is to be evaluated.

2. In the application or use of the two materials, precautions should be taken to insure that all influencing factors are identical for both. In the case of concrete sealants, it is important that the two materials be used on concrete which was poured from the same mix, on the same day, and finished and cured in the same manner. It is also important that the sealants both be applied the same day by whichever method their respective manufacturers recommend. After the recommended drying time, it is important to insure that the subject concrete receives identical use and weather conditions. In the case of concrete used in highway pavements or bridge decks, both sealed areas should receive the same concentration of de-icing chemicals and the same type of traffic use. In considering traffic, not only must the volume be kept uniform but the action of the vehicles as well; i.e., whether the vehicle is accelerating, braking, moving fast or slow.

3. Multiple comparisons of the material of known performance and a material of unknown performance, will often produce conflicting results. This is because it is impossible to keep all influencing factors identical for the two materials used on each test specimen. Thus, to arrive at a reliable conclusion it is necessary to use as many test specimens as is necessary to establish a consistent trend. In some cases no more than three will be needed and in other cases, where difficulty is experienced in controlling the variables, it might require many more.