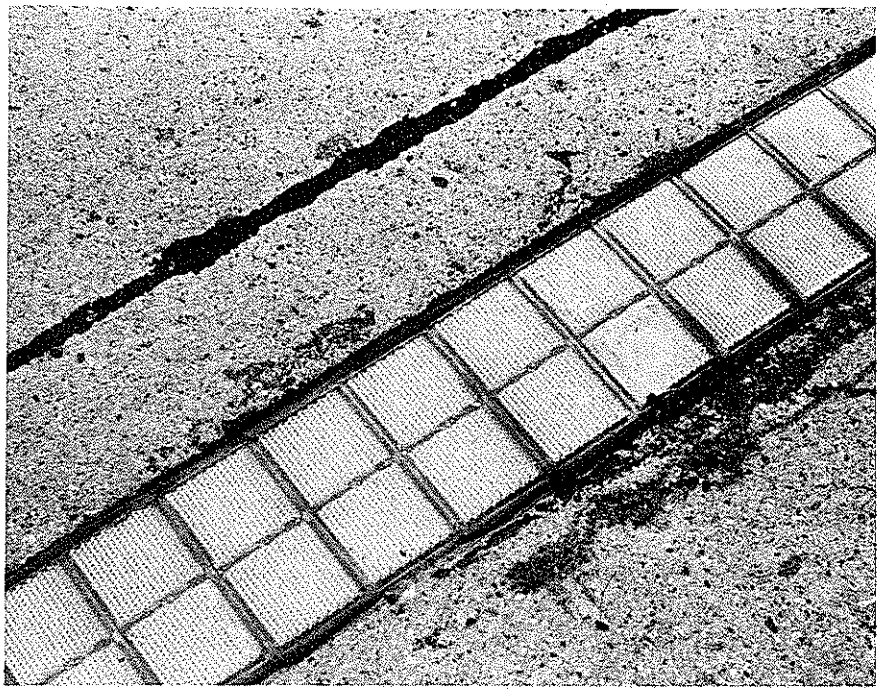
LOW PROFILE MARKER FOR WET/NIGHT VISIBILITY



HR - 1005 Final Report

HIGHWAY DIVISION

April 1977

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LOW PROFILE MARKER

FOR

WET/NIGHT VISIBILITY

HR-1005
Final Report

By

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Adhesives

During the installation of the reflector elements, three (3) different adhesives were tried.

1. The adhesive most extensively used was "Calbar" epoxy. A two (2) component material consisting of two (2) parts of Component "A" and one (1) part of Component "B". This material was supplied by Calbar, Inc., 2620 No. Martha St., Philadelphia, PA. It was packaged in 3-gallon units and at temperatures in the 60 to 70 degree range had a pot-life (for one-half a unit) of about 30 minutes. The pot-life of a full unit was somewhat less than 30 minutes.
2. A second adhesive tried during the reflector installations in this project was "Fast Cure Epoxy 45" produced by Loctite Corporation of Newington, Connecticut. This was a two (2) component material, was mixed half-and-half and was quite viscose and difficult to mix in the short pot-life of about five minutes. Only one (1) small unit of this material was used and the remainder of a 48-unit order was returned to the supplier.
3. A third adhesive used in this project is called an "Adhesive-Sealant Compound" produced specifically for the type of application outlined in the objectives of this project and supplied by Polymeric Systems, Inc., 860 Cross Street, Pottstown, PA. 19464. See Figure 2A.
   This is a two (2) component material packaged as Part "A" (Base Compound) in a one-quart container together with Part "B" (Curing agent) in a small glass jar. The compound

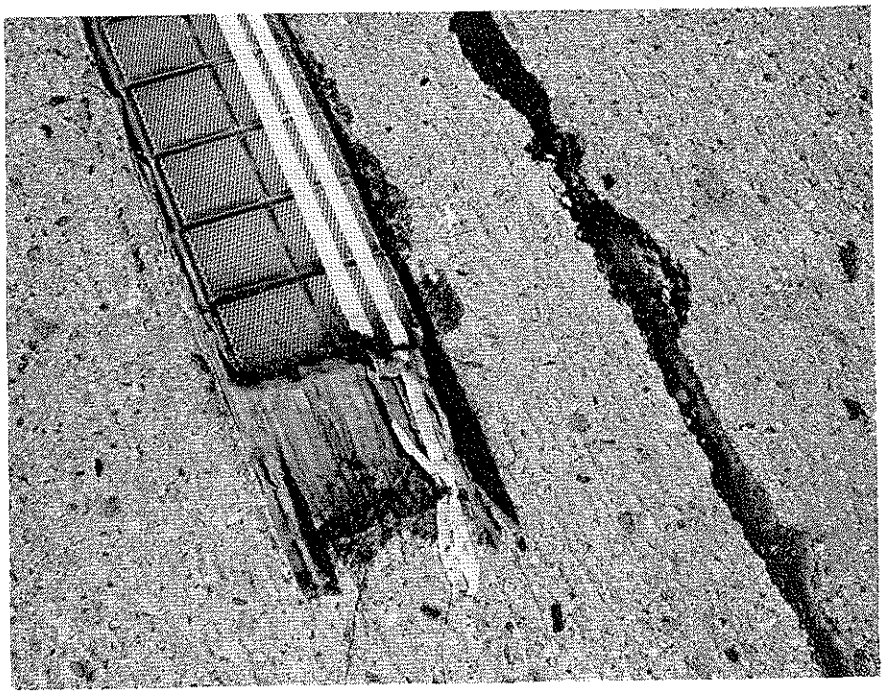

Figure 2A. Illustrates reflector unit installed using Polymeric Systems - Adhesive Sealant

is prepared by mixing Part "B" into Part "A" in the one-quart container. The resulting compound has a pot-life of about 30 minutes and when it has cured, it still retains some resiliency. Both surfaces, that is the concrete and the back of the reflectors were treated with a special primer before the compound was applied.

Installation of Reflectors

Traffic controls were placed and the first batch of epoxy (one-half unit of Calbar) was mixed at about 11:00 A.M. October 8, 1974. The temperature was slightly above 50 degrees at that time. A layout showing type, location and date of installation of markers is shown

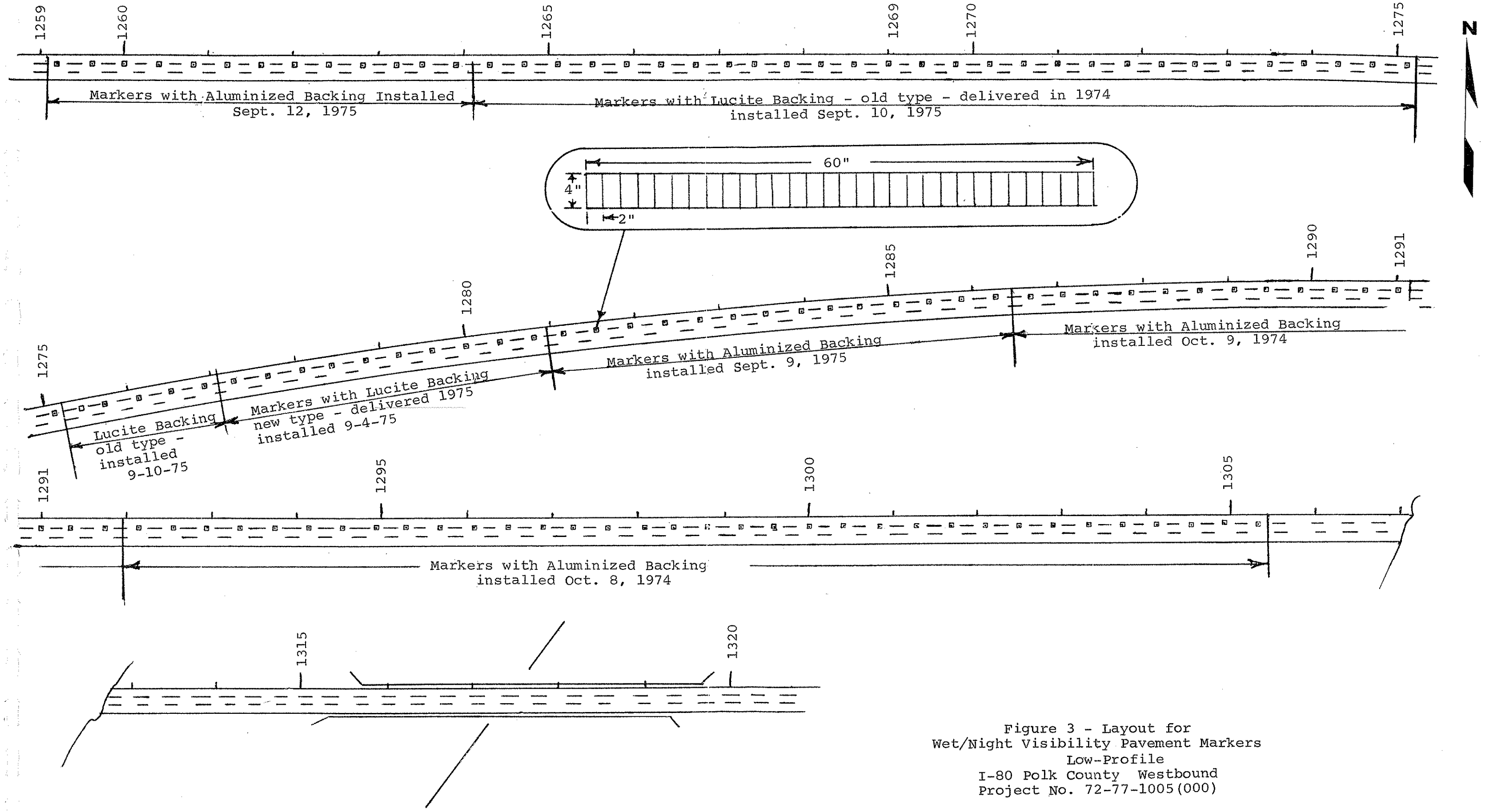

Figure 3 - Layout for
Wet/Night Visibility Pavement Markers
Low-Profile
I-80 Polk County Westbound
Project No. 72-77-1005(000)

in Figure 3.

The "low-profile" markers were placed in an inverted position, on a board to which cleats had been attached forming a recessed area 4 inches wide, 60 inches long and 1/4 inch deep. See Figure 4.

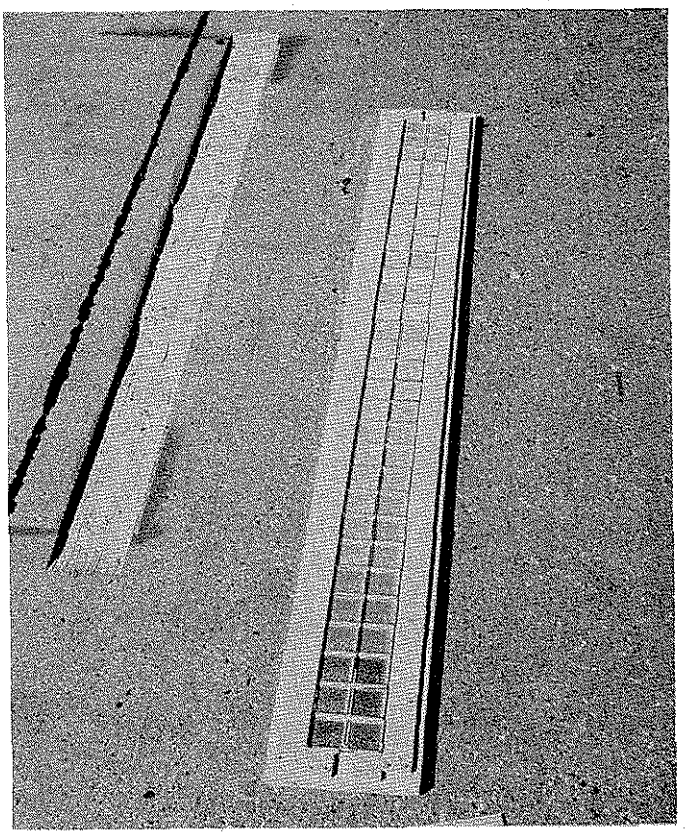

Figure 4. Inverted reflector unit in alignment board

Four (4) such boards were on hand to facilitate preparing more than one marker for installation at one time.

The back or bottom of the reflector unit was filled with epoxy during which time, epoxy was spread onto the bottom of the 4-1/8 - inch x 60 - inch groove in the pavement. Figure 5 shows this procedure. The board was then overturned depositing the reflector unit, right side

up, into the groove and the reflector elements were pressed into the epoxy.

Figure 5. Application of epoxy to reflector unit and to groove in pavement

The first reflector unit was placed just west of the westbound "on" ramp to Interstate 80 from US 65 (Hubbell Avenue-Des Moines) opposite approximately Station 1305+45. Ten (10) reflector units were placed with the first batch (one-half unit) of epoxy.

A full three-gallon unit was mixed early in the afternoon on October 8 and only 13 reflector units were placed with that batch. This was attributed to (1) a larger batch requiring more time to apply with more heat being generated through chemical reaction, and (2) the air temperature being higher at that time of the day. Both of these factors contribute to a shorter pot-life in the epoxy and as a result, it started setting up before it could all be used. Consequently, the

the material for an estimated six to eight reflector units was wasted. Nine (9) reflector units were placed with the half-unit of epoxy left from the morning's operation.

A build-up of epoxy on the board resulted in the problem of not being able to remove the reflector elements from the recess in the board when it was inverted over the groove in the pavement. This resulted in a decision to try installing a few reflector units using the procedure of placing more epoxy in the pavement groove and not filling the recesses in the back or bottom of the reflectors.

No epoxy was placed in the recesses in the back of the reflector units located as follows: Station 1297+25, 1296+90, 1296+50, 1296+10, 1295+70, 1295+30, 1294+95 and 1294+55.

It has been observed that this method of installation is not acceptable inasmuch as the condition of seven of the eight reflectors referred to above was rated "poor" during the final inspection on September 8, 1976.

In order to overcome the problem of not being able to remove the reflector elements from the recess in the alignment board, a saw-cut was made in the board down the center of the recessed area. (See Figure 6). The saw-cut made possible the ejection of the reflector elements with the use of a putty knife while the board was in an inverted position over the groove in the pavement.

On October 9, 1974, the remaining unit (3 gal.) of Calbar epoxy was mixed, one-half unit at a time, and 15 more reflector units were installed. This exhausted all the Calbar epoxy on hand and since the Loctite epoxy (ordered at the same time) had not yet been delivered,

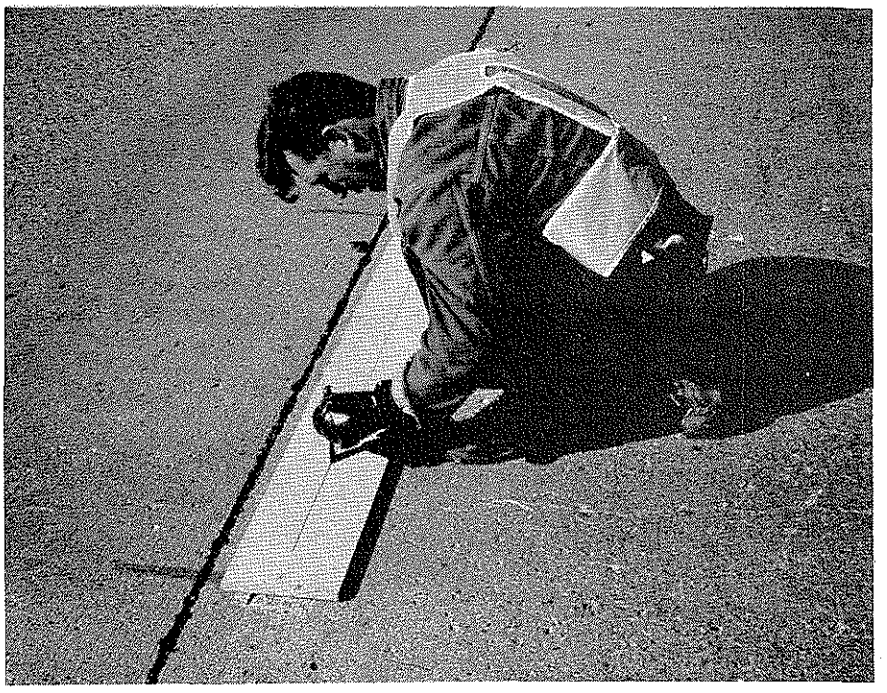

Figure 6. Using a putty knife to eject reflector elements from the alignment board

the operation was discontinued execpt for the installation of one-half a reflector unit at approximately Station 1286+65. This half-unit was installed using a one-pint sample of Loctite epoxy. No more Loctite epoxy was used on the project. That aspect is discussed earlier in this report under "Adhesives".

During the Summer of 1975, contract was made with Polymeric Systems, Inc. of Pottatown, Pa. and some experiments were conducted with an adhesive - sealant compound developed by that company. That product is referred to earlier in this report and is covered in Part 3 under "Adhesives".

The experiments referred to above showed that the Polymeric Systems adhesive compound produced a shadowing effect upon the reflectivity of the reflector elements with aluminized backing, but it appeared not to

have a similar effect upon the elements with lucite backing.

As a result of these findings, it was decided to order enough of the Polymeric Systems material for the installation of the ten (10) lucite backed elements delivered in 1975. The amount estimated was 15 one-quart units and the order also included two (2) quarts of primer for the Polymeric Systems Adhesive - Sealant for application to the surface of the concrete in each recess in the pavement and also to the backs of the lucite backed reflector units. At the same time four (4) more units of Calbar epoxy were ordered for installation of the remainder of the reflector elements delivered in 1974.

Information on the locations, types of reflectors and dates of installation has been illustrated in Figure 3. Calbar epoxy was used in the installation of all reflectors except those from Station 1277+25± to Station 1280+80± (10 reflector units).

Installation of all reflector units including those with aluminized backing, those with lucite backing (delivered in 1974) and those with lucite backing (delivered in 1975) was completed on September 12, 1975. In completing these installations, all the Calbar epoxy that had been ordered was used, thirteen (13) one-quart units of the Polymeric Systems Adhesive - Sealant was used and slightly more than one (1) quart of the primer was used.

Rating Criteria

Four descriptive terms were selected in an attempt to rate the condition of reflector units. The terms chosen were: 1. "Excellent" - No apparent breaking, cracking or loosening of reflector elements. Figure 7 is an example.

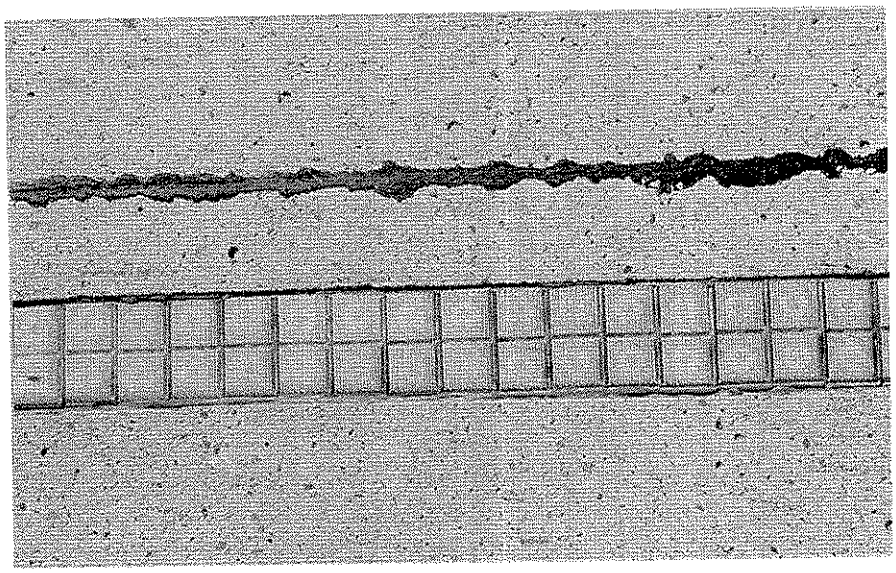

Figure 7. A reflector unit in "excellent" condition

2. "Good" - Up to four (4) cracked elements or some apparent shadowing in up to six (6) of the elements in a unit. See Figure 8.

3. "Fair" - More than four (4) but not more than eight (8) broken or loosened elements; may include shadowing (signs of leaking) in 50% of the elements in a unit. Figure 9 is an illustration.

4. "Poor" - More than eight (8) broken, loosened or missing elements or shadowing (signs of leaking) in more than 50% of the elements in a unit. Figure 10 indicates a reflector unit judged for this condition.

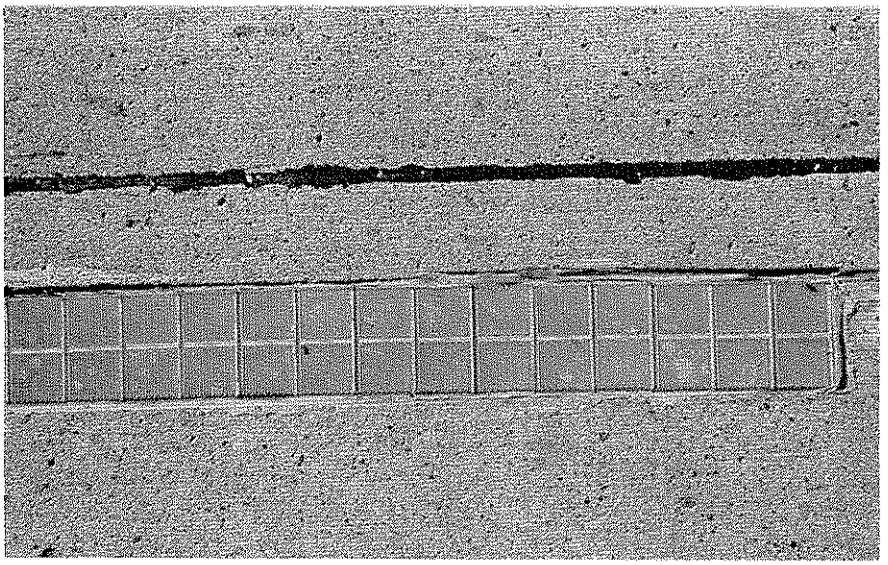

Figure 8. A reflector unit in "good" condition

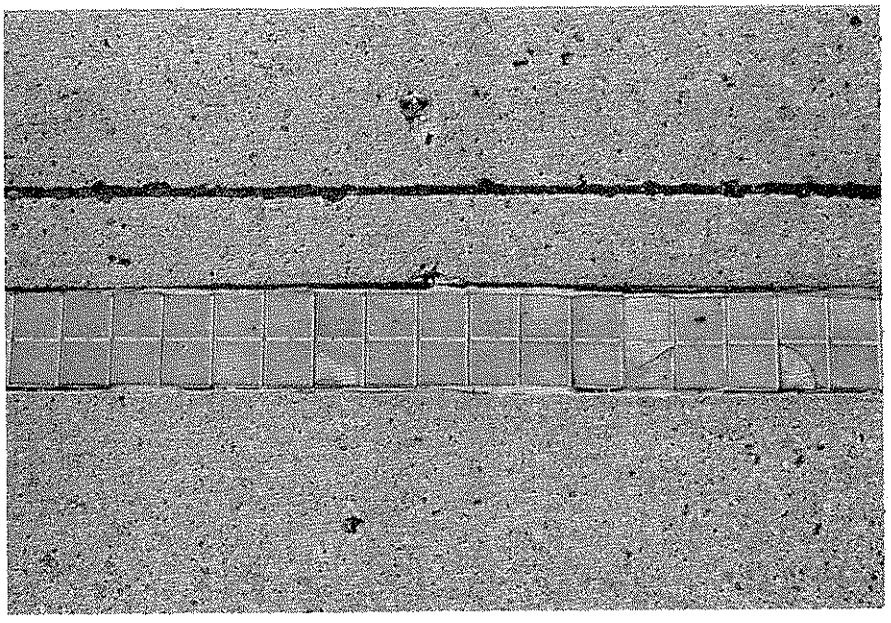

Figure 9. A reflector unit in "fair" condition

Figure 10. A reflector unit in "poor" condition

The data collected during the three inspections referred to above are further tabulated in Tables A & B in Appendix B. A review of these data indicate that the physical failure of the reflector units may be attributable to several factors:

1. Installation - (Table A)

   Most of the reflector units installed on the first day (10-8-74) were rated as being in "poor" condition during the final inspection and a considerable number of these were rated "poor" as early as 9-9-75. It is quite reasonable to believe that the technique used in placement improved as workmen gained experience.

2. Type of Reflector Unit - (Table B)

It appears that the aluminum-backed reflector units are less durable than those with lucite backing. There is more breakage among the aluminum-backed units and some units showed a separation of the aluminum coating from the acrylic material.

3. Traffic

Some reflectors appeared to have been punctured by a small stone or piece of aggregate forced through the surface by a vehicle tire. Some of this damage may have been caused by studded tires. Again, breakage due to traffic appeared to be greater among the aluminum-backed units.

4. Epoxy Failure

Some of the loosening of reflector elements may have been a result of epoxy failure. However, with the exception of the first day's installation, where workmanship may have been a factor, it is believed that most failures were due to a separation of the aluminum coating from the acrylic material. Although the type of epoxy used may have caused the loosening, only one (1) epoxy was applied to the aluminized markers and therefore any conclusions would be only speculative. If some of the breakage experience was due to shock, the use of a more resilient material such as the Polymeric Systems Adhesive - Sealant may well be an improvement. For the most part, it appears that the epoxy used was quite effective, however.

To the date of the final inspection (9-8-76) there were no complete physical losses of markers. However, the condition of some markers was extensively deteriorated as illustrated by Figure 11.

Figure 11. Badly deteriorated units

No formal inspection of the low-profile pavement markers was made while it was raining. As a matter of fact, as a result of the dry weather experienced in this area over the past two summers, there were few opportunities to even observe these markers on an informal basis during wet weather. Reports of observations made by maintenance personnel working in that area indicate a low level reflectivity to the driver of a vehicle unless such vehicle straddles the lane line. This is true during both wet and dry conditions.

CONCLUSIONS

Information gained from informal observations has led to some rather definite opinions with regard to these markers.

The angularity of reflection of light from these markers appears to be very limited and light reflected from then is visible to the driver of a vehicle only when the vehicle is straddling the line in which the reflectors are placed.

These markers offer nothing in the way of delineation during daylight hours and consequently would need to be supplimented with painting or some other type of marking for daylight operation.

The method of installation used in this project is time consuming and costly and since the units have been installed, little if any thought has been given to mechanizing the operation further than that which was used in this project.

While the need for a wet-night visibility marker is very real and still exists, it is not recommended that further trial and study of this type marker be conducted until it can be improved. Improvement would need to be concerned with less difficult and less costly installation and greater angularity of reflection.

APPENDIX A

Rated Condition of
Low Profile Wet Night Visibility Pavement Markers

Backing: "A" - Aluminized "L" - Lucite

Location (East to West) Station	Date of Installation	Condition 9/9/75	Condition 4/7/76	Condition 9/8/76	Backing
1305 + 30	10/8/74	Poor	Poor	Poor	A
1304 + 90		Fair	Poor	Poor	A
1304 + 50		Good	Fair	Fair	A
1304 + 10		Poor	Poor	Poor	A
1303 + 70		Poor	Poor	Poor	A
1303 + 30		Poor	Poor	Poor	A
1302 + 90		Poor	Poor	Poor	A
1302 + 50		Fair	Poor	Poor	A
1302 + 10		Poor	Poor	Poor	A
1301 + 70		Poor	Poor	Poor	A
1301 + 30		Poor	Poor	Poor	A
1300 + 85		Poor	Poor	Poor	A
1300 + 45		Fair	Poor	Poor	A
1300 + 00		Fair	Fair	Poor	A
1299 + 60		Excellent	Excellent	Good	A
1299 + 20		Good	Good	Fair	A
1298 + 80		Good	Good	Fair	A
1298 + 40		Excellent	Good	Fair	A
1298 + 05		Excellent	Excellent	Good	A
1297 + 65		Excellent	Good	Fair	A
1297 + 25		Fair	Fair	Poor	A
1296 + 90		Fair	Fair	Poor	A
1296 + 50		Fair	Fair	Poor	A
1296 + 10		Good	Fair	Fair	A
1295 + 70		Poor	Poor	Poor	A
1295 + 30		Poor	Poor	Poor	A
1294 + 95		Poor	Poor	Poor	A
1294 + 55		Poor	Poor	Poor	A
1294 + 15		Fair	Poor	Poor	A
1293 + 75		Fair	Fair	Poor	A
1293 + 35		Fair	Fair	Poor	A
1292 + 95		Fair	Fair	Poor	A
1292 + 55		Excellent	Good	Good	A
1292 + 15	10/8/74	Excellent	Good	Good	A
1291 + 75	10/9/74	Good	Fair	Fair	A

Rated Condition of
Low Profile Wet Night Visibility Pavement Markers

Backing: "A" - Aluminized "L" - Lucite

Location (East to West) Station	Date of Installation	Condition 9/9/75	Condition 4/7/76	Condition 9/8/76	Backing
1291 + 35	10/9/74	Good	Good	Good	A
1291 + 00		Excellent	Excellent	Good	A
1290 + 60		Good	Fair	Fair	A
1290 + 25		Excellent	Good	Good	A
1289 + 85		Excellent	Good	Fair	A
1289 + 45		Excellent	Excellent	Good	A
1289 + 05		Good	Fair	Fair	A
1288 + 65		Good	Fair	Fair	A
1288 + 25		Good	Fair	Fair	A
1287 + 85		Good	Fair	Fair	A
1287 + 45		Excellent	Good	Fair	A
1287 + 05		Excellent	Fair	Poor	A
1286 + 65	10/9/74	Poor	Poor	Poor	A
1286 + 25	9/9/75		Excellent	Good	A
1285 + 85			Excellent	Excellent	A
1285 + 45			Excellent	Good	A
1285 + 05			Good	Good	A
1284 + 65			Excellent	Excellent	A
1284 + 25			Good	Good	A
1283 + 85			Excellent	Excellent	A
1283 + 45	9/9/75		Excellent	Excellent	A
1283 + 05			Excellent	Excellent	A
1282 + 65			Good	Good	A
1282 + 25			Excellent	Excellent	A
1281 + 85			Excellent	Excellent	A
1281 + 45			Excellent	Excellent	A
1281 + 05			Excellent	Excellent	A
1280 + 80			Excellent	Excellent	L
1280 + 40			Excellent	Excellent	L
1280 + 00			Excellent	Excellent	L
1279 + 60			Excellent	Excellent	L
1279 + 20			Excellent	Excellent	L
1278 + 80			Good	Good	L
1278 + 40			Excellent	Excellent	L
1278 + 00			Excellent	Excellent	L
1277 + 60	9/9/75		Good	Good	L

Rated Condition of
Low Profile Wet Night Visibility Pavement Markers

Backing: "A" - Aluminized "L" - Lucite

Location (East to West) Station	Date of Installation	Condition 9/9/75	Condition 4/7/76	Condition 9/8/76	Backing
1277 + 25	9/9/75		Excellent	Excellent	L
1276 + 85	9/10/75		Good	Good	L
1276 + 45			Good	Good	L
1276 + 05			Excellent	Excellent	L
1275 + 20			Excellent	Excellent	L
1275 + 10			Excellent	Excellent	L
1274 + 70			Excellent	Excellent	L
1274 + 30			Excellent	Excellent	L
1273 + 90			Excellent	Excellent	L
1273 + 50			Excellent	Good	L
1273 + 00			Good	Good	L
1272 + 60			Good	Good	L
1272 + 20	9/10/75		Good	Good	L
1271 + 80			Good	Good	L
1271 + 40			Excellent	Excellent	L
1271 + 00			Excellent	Excellent	L
1270 + 60			Excellent	Excellent	L
1270 + 20			Excellent	Excellent	L
1269 + 80			Excellent	Excellent	L
1269 + 40			Excellent	Excellent	L
1269 + 00			Excellent	Excellent	L
1268 + 60			Excellent	Excellent	L
1268 + 20			Excellent	Excellent	L
1267 + 80			Excellent	Good	L
1267 + 40			Excellent	Good	L
1267 + 10			Good	Good	L
1266 + 70			Good	Good	L
1266 + 30			Good	Good	L
1265 + 90			Fair	Fair	L
1265 + 50			Excellent	Excellent	L
1265 + 10			Excellent	Excellent	L
1264 + 70			Excellent	Excellent	L
1264 + 30	9/10/75		Excellent	Excellent	L
1263 + 90	9/12/75		Good	Fair	A
1263 + 50			Good	Good	A

Rated Condition of
Low Profile Wet Night Visibility Pavement Markers

Backing: "A" - Aluminized "L" - Lucite

Location (East to West) Station	Date of Installation	Condition 9/9/75	Condition 4/7/76	Condition 9/8/76	Backing
1263 + 20	9/12/75		Excellent	Excellent	A
1262 + 80			Excellent	Excellent	A
1262 + 40			Excellent	Excellent	A
1262 + 00			Excellent	Excellent	A
1261 + 60			Excellent	Excellent	A
1261 + 20	9/12/75		Excellent	Excellent	A
1260 + 80			Excellent	Excellent	A
1260 + 40			Excellent	Excellent	A
1260 + 00			Excellent	Excellent	A
1259 + 60			Good	Good	A
1259 + 20	9/12/75		Excellent	Excellent	A

Table B
Inspection by Type and Installation Date
117 Low Profile Pavement Markers

Condition	48 Aluminized						27 Aluminized				32 Lucite				10 Lucite			
	Rec'd 1974						Rec'd 1974				Rec'd 1974				Rec'd 1975			
	Installed 1974						Installed 1975				Installed 1975				Installed 1975			
	Inspection						Inspection				Inspection				Inspection			
	9/9/75		4/7/76		9/8/76		4/7/76		9/8/76		4/7/76		9/8/76		4/7/76		9/8/76	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Excellent	12	25	4	8	0	0	21	78	19	70	22	69	19	59	8	80	8	80
Good	11	23	10	21	8	17	6	22	7	26	9	28	12	38	2	20	2	20
Fair	11	23	16	33	14	29	0	0	1	4	1	3	1	3	0	0	0	0
Poor	14	29	18	38	26	54	0	0	0	0	0	0	0	0	0	0	0	0
Totals	48	100	48	100	48	100	27	100	27	100	32	100	32	100	10	100	10	100