MICHIGAN DEPARTMENT OF TRANSPORTATION
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EVALUATION OF THE URETEK METHOD FOR PAVEMENT UNDERSEALING

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MATERIALS and TECHNOLOGY DIVISION

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EVALUATION OF THE URETEK METHOD FOR PAVEMENT UNDERSEALING

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An Experimental Project by the Michigan Department of Transportation in Cooperation With the U.S. Department of Transportation Federal Highway Administration

Research and Technology Section
Materials and Technology Division
Research Project 93 G-294
Research Report No. R-1340

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This report, authorized by the transportation director, has been prepared to provide technical information and guidance for personnel in the Michigan Department of Transportation, the FHWA, and other reciprocating agencies. The cost of publishing 60 copies of this report at $1.44 per copy is $86.40 and it is printed in accordance with Executive Directive 1991-6.

EXECUTIVE SUMMARY

This project was initiated in 1993 to evaluate the use of URETEK 486 high density polyurethane as a method of raising and undersealing concrete pavement slabs. Three sites were selected on I-75 (truck lane) in Monroe County for test and control sections. The pavement consist of 10 - 11 in. reinforced concrete on an open-graded base.

The URETEK method is a patented process that was originally developed in Europe. In 1975, the URETEK Company developed a special high density polyurethane for its undersealing compound, which distinguishes it from typical grouting mixtures used in mud-jacking operations.

The URETEK method improved the base support where the pavement was severely cracked. However, where the cracks were either hairline or open 1/8 in. or less, there was little improvement in the base support. Where the pavement was severely faulted, the URETEK did raise the pavement and provided a temporary increase in base stability. The URETEK method had some insulating effect on the base that caused differential frost heaving when the adjacent lane was not similarly undersealed. As expected, the depth of the penetration of the URETEK into the open graded drainage course (OGDC) was dependent on the gradation (porosity) of the OGDC. There was no intrusion of the URETEK into any portion of the open-graded underdrain system. While base support was initially improved, the base support decreased somewhat during the one-year trial period. Therefore, more evaluation is needed to determine if URETEK is an effective method of undersealing and raising pavements supported on open-graded drainage courses.

It is recommended that URETEK not be used as a substitute for mud-jacking for pavements with open-graded bases. However, additional limited testing[1] is warranted to gain further experience and knowledge about the material's limitations and capabilities. At this time, URETEK should only be considered as an alternate to mud-jacking on pavements with dense-graded aggregate bases.

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[1] Since the completion of the project trial period the Maintenance Division has entered into a contract with URETEK USA Inc. for undersealing pavements throughout the state.

ACTION PLAN

1. Engineering Operations Committee

   A. No action necessary upon approval of this report.

2. Materials and Technology Division

   A. The Research and Technology Section will close Research Project 93 G-294 with a memo to the project files, after distribution of this report to the Bureau of Planning, Design Division, Maintenance Division and the districts.

This project was initiated in 1993 to evaluate the use of URETEK 486 high density polyurethane as a method of raising and undersealing concrete pavement slabs. Sites were selected on northbound I-75 in Monroe County for test and control sections (Figures 1 and 2). The construction documentation for this project is contained in an October 21, 1993, memorandum from W. H. Opland, District 8 Soil/Materials Engineer, to T. E. Davies, District Engineer for District 8 (Appendix C). The typical design cross-sections for the test and control areas are contained in Appendix C.

Five concrete reconstruction projects were completed on I-75 throughout Monroe County between 1984 and 1990. Recycled concrete coarse aggregate was used in the concrete mix for the first three projects. For the first three projects the open-graded drainage course (8G on the first project and 5G on the second and third projects) was placed directly on the sand subbase, while the latter two projects used geotextile separators.

Excessive transverse cracking was observed in 1992 by district staff for the first three projects (built in 1984, 1987 and 1988). Most likely the poor condition of the transverse cracks was exacerbated by the following:

1. No separator was placed between the open-graded drainage course (8G on the first project, and 5G on the second and third projects) and the very fine sand subbase.

2. Lack of aggregate interlock across the crack from using crushed concrete coarse aggregate in the first three projects (the 1984 project also used 25 percent crushed concrete sand).

3. Poor stability in the open-graded drainage course.

4. Use of 41 ft joint spacing rather than the present 27 ft now required for high truck traffic.

5. Possible movement of fines in the subbase toward the open-graded underdrain causing loss of support under the pavement.

The two northerly projects used a geotextile separator and no excessive cracking was observed by district staff in 1992. The lack of a separator between a fine grained sand subbase and an open-graded stone may allow sand infiltration into the permeable stone base, resulting in a loss of base support and pavement settlement.

The excessive cracking and pavement failure in the right (truck) lane of the 1984 project (northbound I-75, mile point 6 to mile point 12) has resulted in numerous pavement patches by the Monroe County Maintenance. The concrete patches are a relatively expensive maintenance treatment for the

FIGURE 1

I-75
MONROE COUNTY
ERIE & LASALLE TWPS.

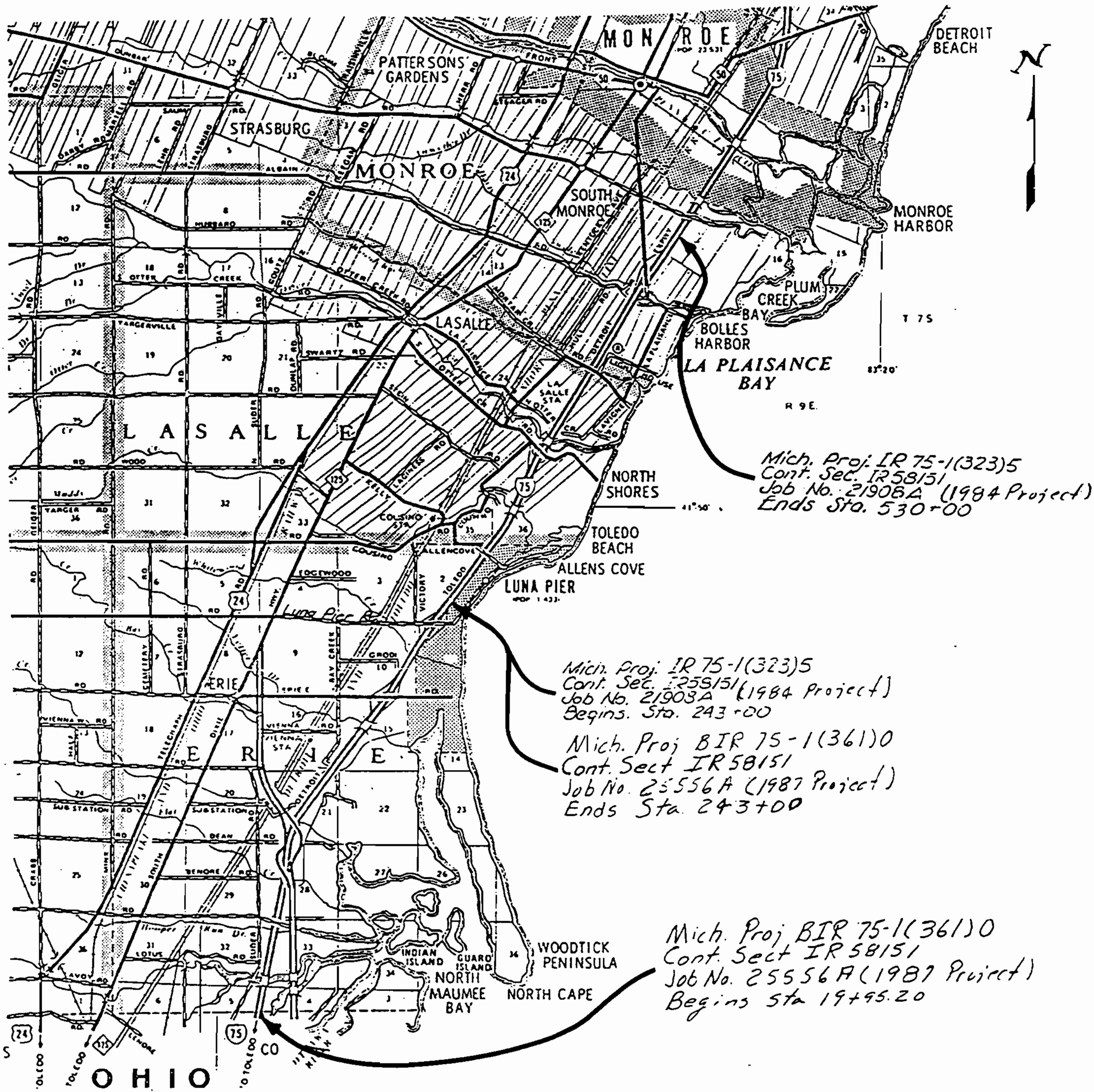
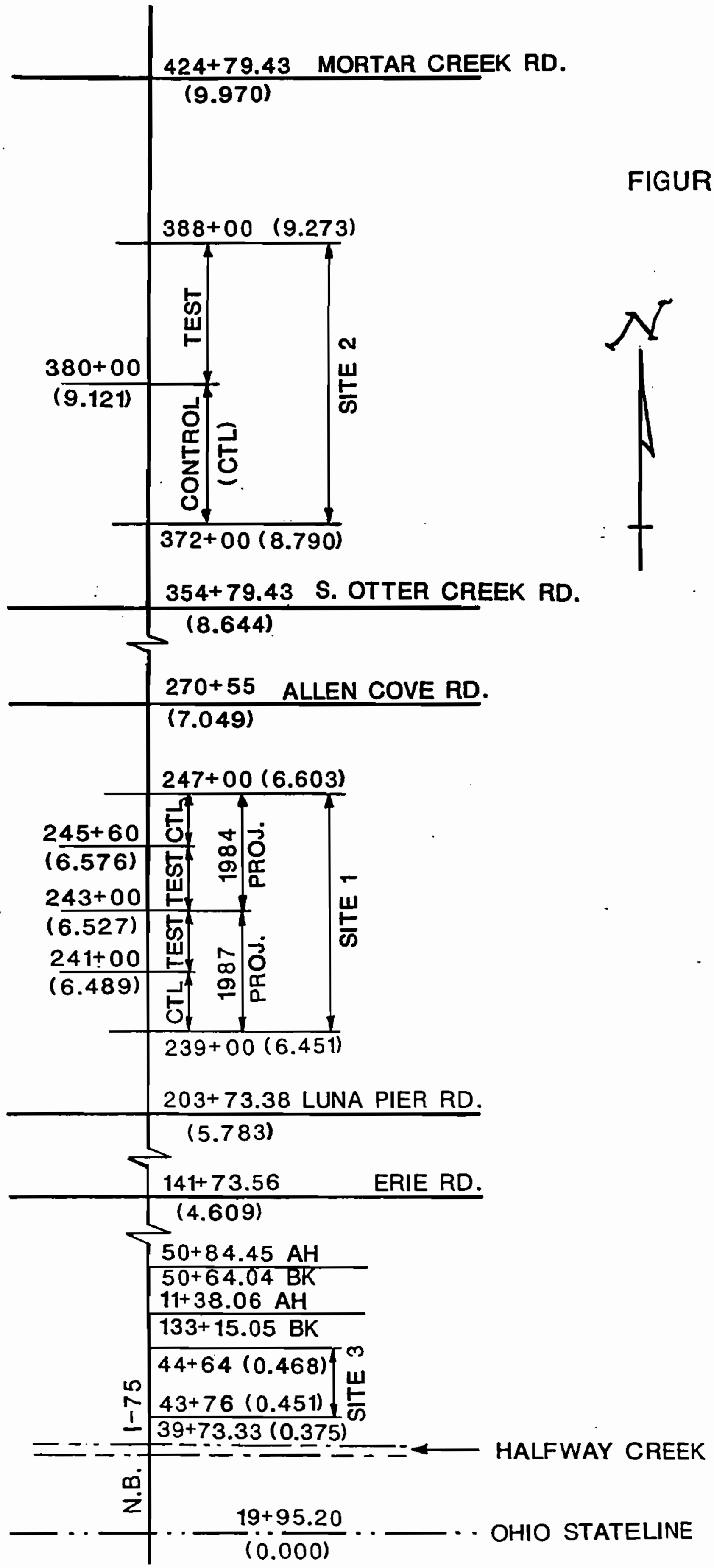


FIGURE 2



424+79.43 MORTAR CREEK RD.
(9.970)
388+00 (9.273)
TEST
SITE 2
380+00
(9.121)
CONTROL
(CTL)
372+00 (8.790)
354+79.43 S. OTTER CREEK RD.
(8.644)
270+55 ALLEN COVE RD.
(7.049)
247+00 (6.603)
245+60
(6.576)
CTL
TEST
1984
PROJ.
243+00
(6.527)
TEST
1987
PROJ.
241+00
(6.489)
CTL
SITE 1
239+00 (6.451)
203+73.38 LUNA PIER RD.
(5.783)
141+73.56 ERIE RD.
(4.609)
50+84.45 AH
50+64.04 BK
11+38.06 AH
133+15.05 BK
44+64 (0.468)
43+76 (0.451)
SITE 3
39+73.33 (0.375)
I-75
HALFWAY CREEK
N.B.
19+95.20
(0.000)
OHIO STATELINE
N

county so a pavement stabilization demonstration project was established to find a more cost-effective preservation technique.

The URETEK method is a patented process that was originally developed in Europe. In 1975, the URETEK company developed a special high density polyurethane for its undersealing compound that distinguishes it from typical grouting mixtures used in mud-jacking operations.

The undersealing material consists of two liquid chemicals that combine under heat to form a strong, foam-like substance. The material is injected under pressure through pre-drilled ⅝-inch diameter holes in the pavement. As it becomes foam, the material then expands to aggressively fill any available void space.

The pavement was undersealed in the right (truck) lane at the following three locations (Figure 2):

Site 1 Test Area: Northbound I-75 at mile point 6.5 (hairline or minor cracks [cracks open ⅛ in. or less]). This 400 ft section includes the northerly 200 ft of the 1987 project, and the southerly 200 ft of the 1984 project.

Site 2 Test Area: Northbound I-75 at mile point 9.2 (severe transverse cracking and faulting). This 812 ft section is in the 1984 project.

Site 3 Test Area: Northbound I-75 at mile point 0.4 (severely cracked and faulting and contains a 4 in. settlement). This area is in the 1987 project.

PROCEDURE

The demonstration project treated three types of pavement distress. The following data were collected to evaluate the URETEK treatment's effectiveness.

1. Before and after falling weight deflectometer (FWD) measurements (maximum deflection values).

2. Before and after pavement elevations.

3. Ride quality measurements.

In addition, cores were taken to determine penetration depths of the undersealing. The underdrain pipe was also checked for any intrusion of the sealant.

RESULTS

Before-and-after data were collected for each test and their corresponding control sites.

FWD (Base Stiffness)

A comparison of before-and-after FWD deflection values is shown in graph form in Figures 3 through 9. The location of the FWD sensors in relation to the joint or crack where the readings were taken is shown in Figure 10.

The graphs show the pavement maximum deflections before the pavement was undersealed in July of 1993, and the three after periods: summer of 1993, winter of 1993/94, and summer of 1994.

Site 1

Mid-Slab Locations - Generally the pavement had the best base support for both the 1984 and 1987 projects in the winter when the subbase was frozen. A slight decrease (from the values before URETEK placement) is shown in Figure 3 for the control and test areas for the 1987 project in the summer of 1994. The deflection values for the 1984 project increased during the summer of 1994 to the 4 to 6 mil range for the pavement.

Joint Locations - Figure 4 shows that the base support rose slightly as expected during the winter. Support decreased during the summer of 1994 for the control area, and the entire length of the test area for Site 1 to below the base support values after URETEK placement. Overall the deflection values varied about 5 to 9 mils between the 1993 and 1994 test periods.

Minor Crack Locations - Figure 5 shows the deflection values typically increased from 3 to 4 mils after placement of the URETEK to 6 to 7 mils during the summer of 1994.

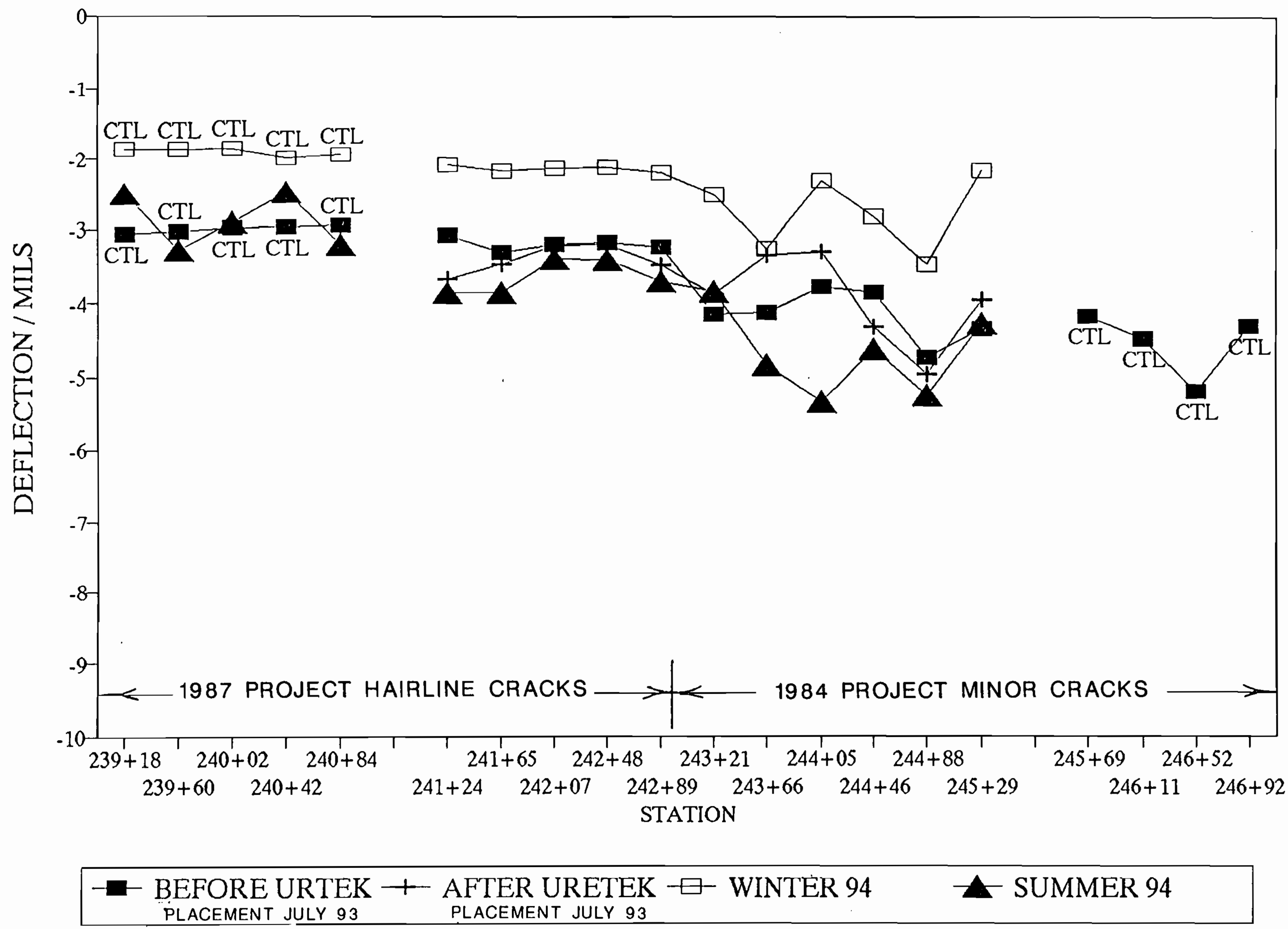
Site 2

In general, Figures 6, 7 and 8 show that the deflection values at the mid-slabs, joints, and cracks after one year increased from the after URETEK values, but remains less than the before URETEK values.

Figure 6 shows that the worst mid-slab values (9 to 12 mils) in the test area before placement of the URETEK were in the 3 to 6 mil range one year after URETEK placement. The deflection values for the control area were generally in the 4 to 14 mil range in the summer of 1994.

FIGURE 3

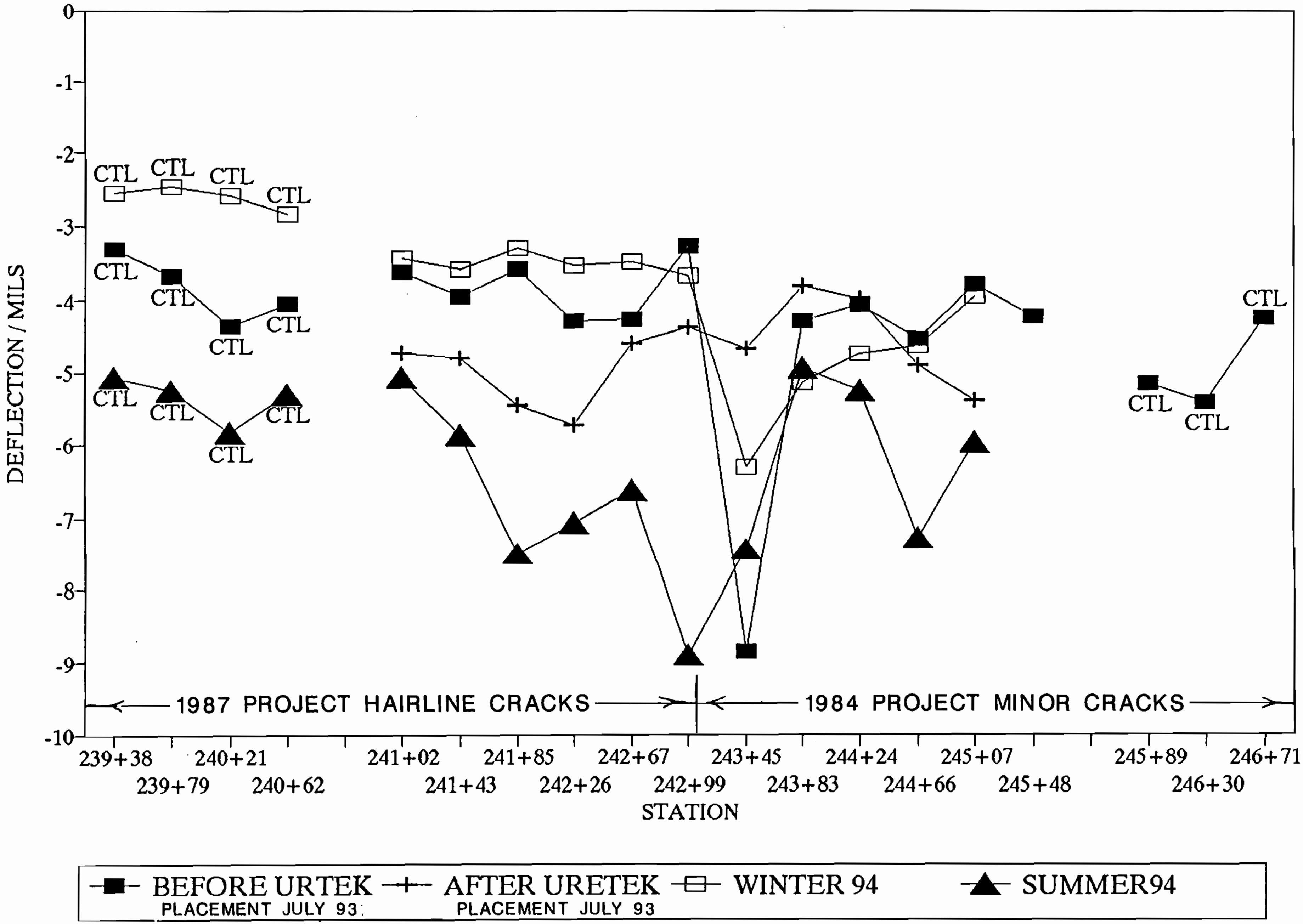
I-75 NBOL URETEK TEST SITE NO. 1
MAXIMUM FWD DEFLECTIONS AT MIDSLAB



NOTE: CTL = CONTROL

FIGURE 4

I-75 NBOL URETEK TEST SITE NO. 1
MAXIMUM FWD DEFLECTIONS AT JOINTS



NOTE: CTL = CONTROL

FIGURE 5

I-75 NBOL URETEK TEST SITE NO. 1
MAXIMUM FWD DEFLECTIONS AT CRACKS

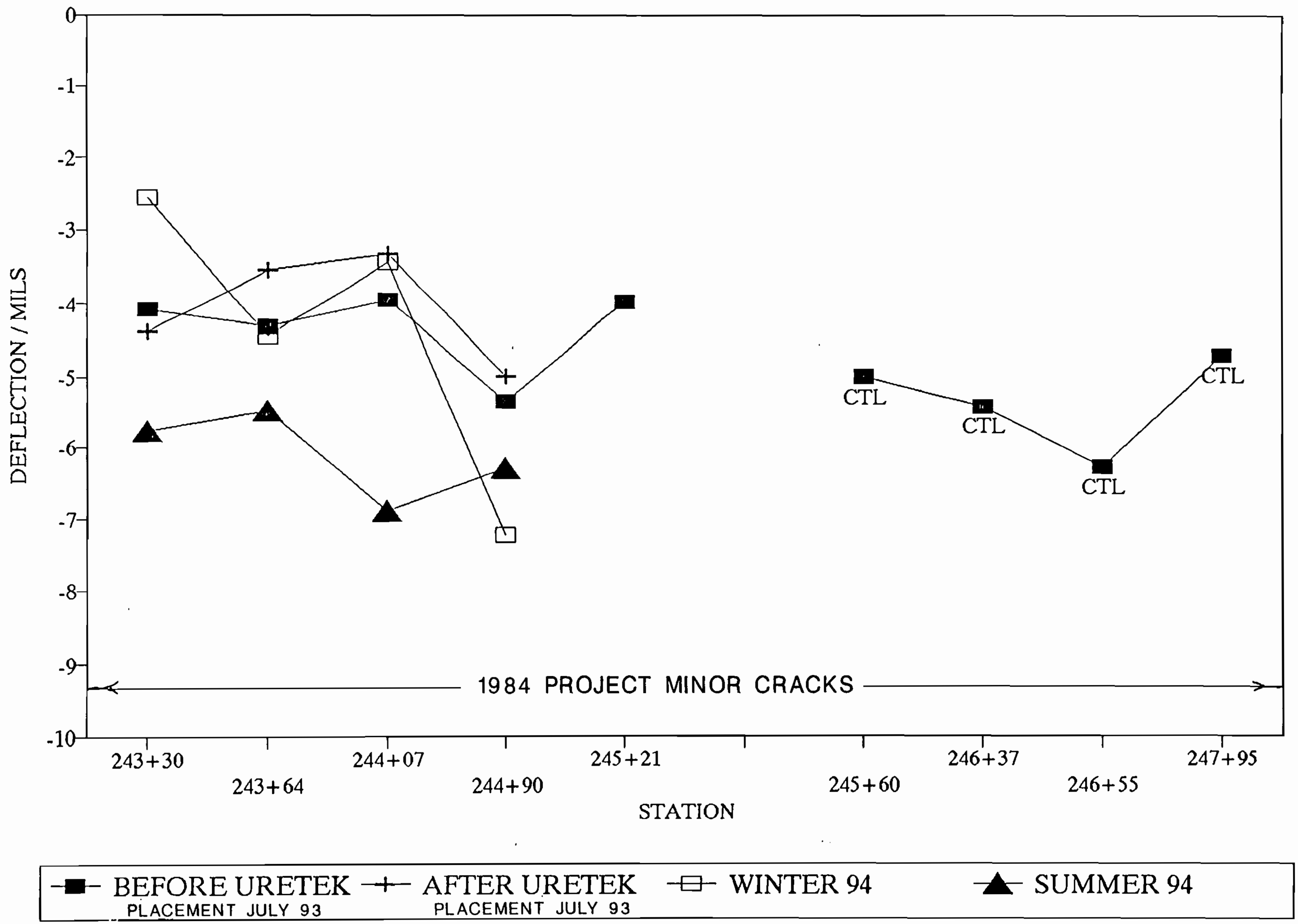


FIGURE 6

I-75NBOL URETEK TEST SITE NO. 2
MAXIMUM FWD DEFLECTIONS AT MIDSLAB

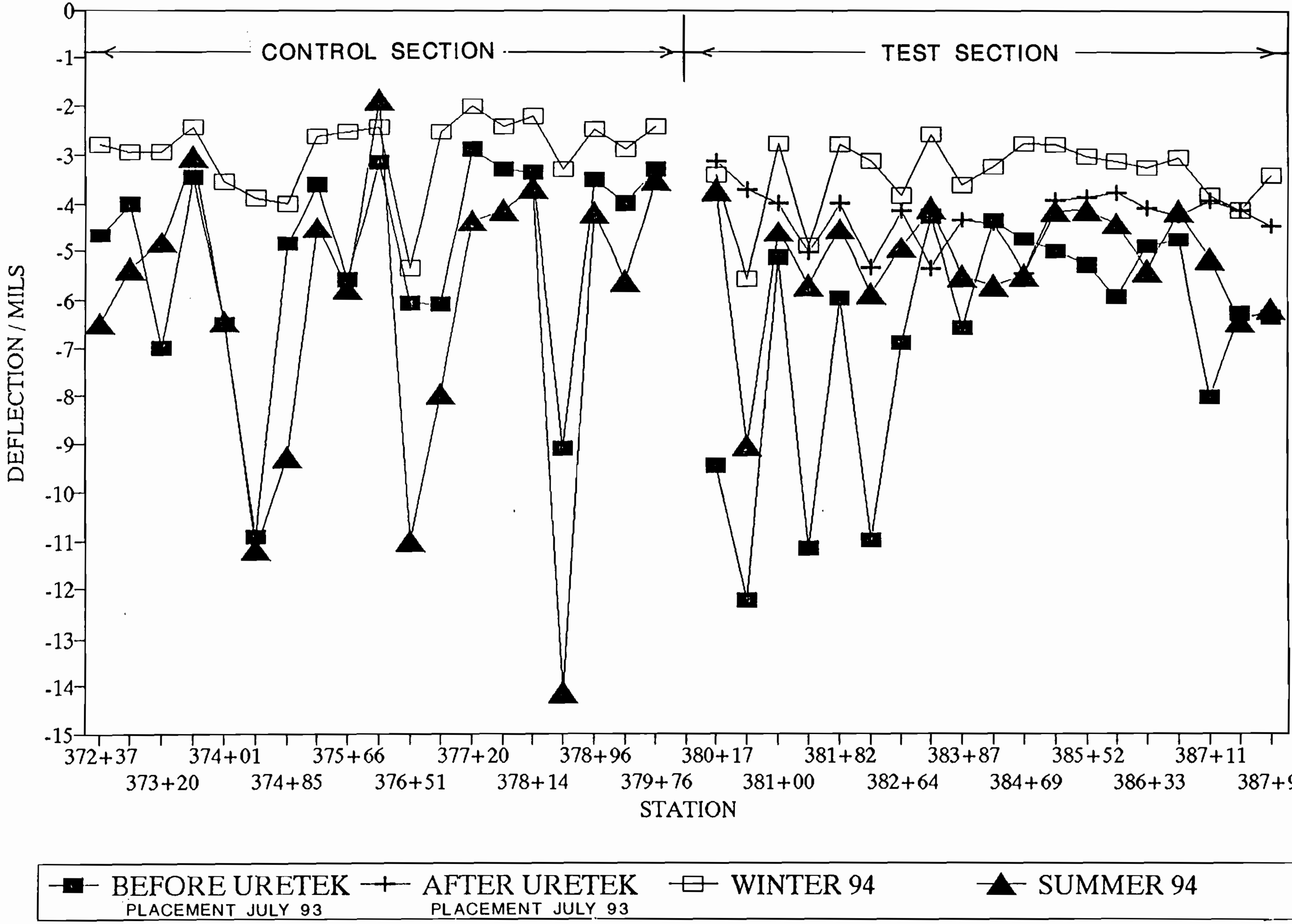


FIGURE 7

I-75NBOL URETEK TEST SITE NO. 2
MAXIMUM FWD DEFLECTIONS AT JOINTS

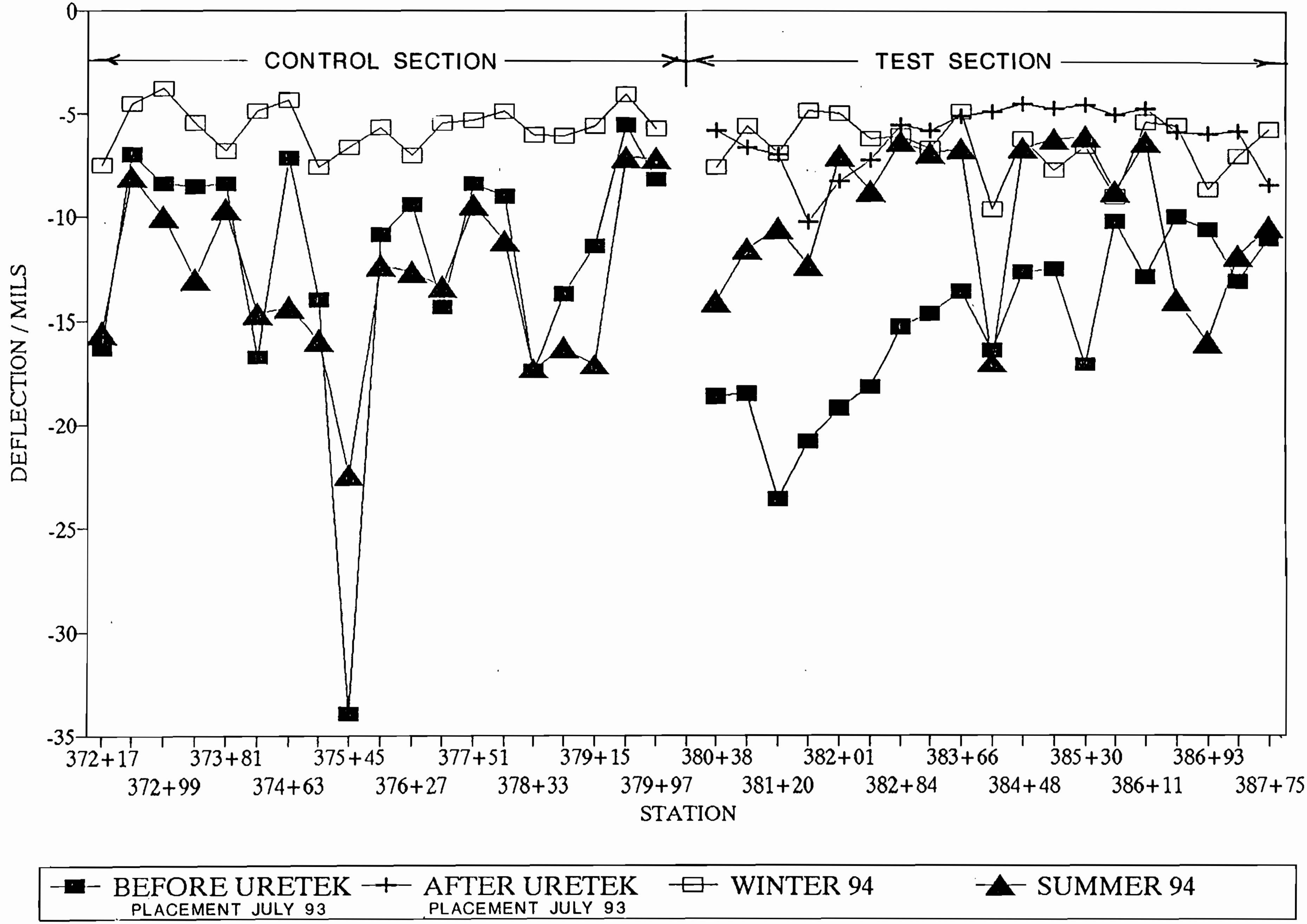
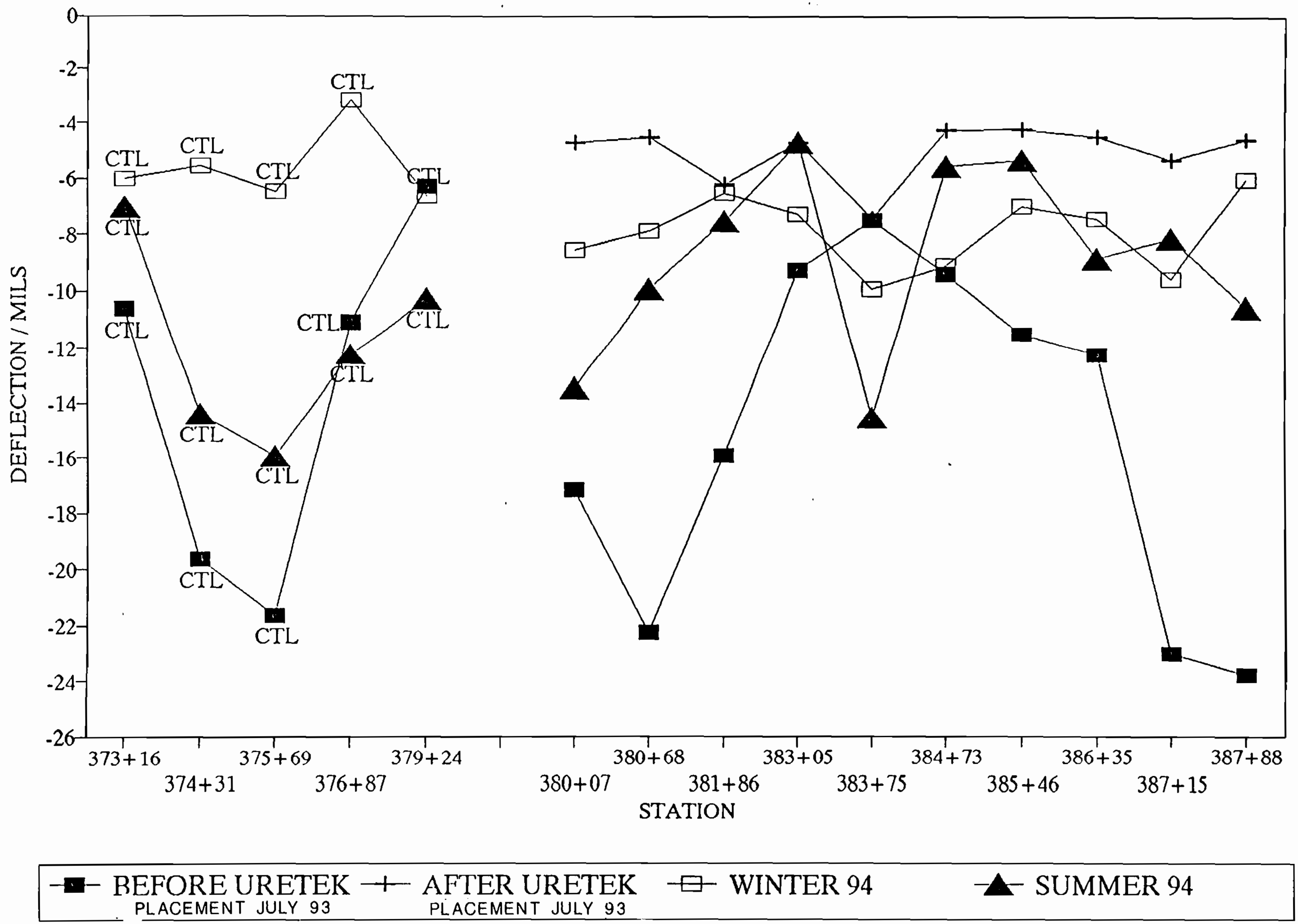


FIGURE 8

I-75NBOL URETEK TEST SITE NO. 2

MAXIMUM FWD DEFLECTIONS AT CRACKS



NOTE: CTL = CONTROL

FIGURE 9

I-75 NBOL URETEK UNDERSEAL TEST SITE #3
MAXIMUM FWD DEFLECTIONS

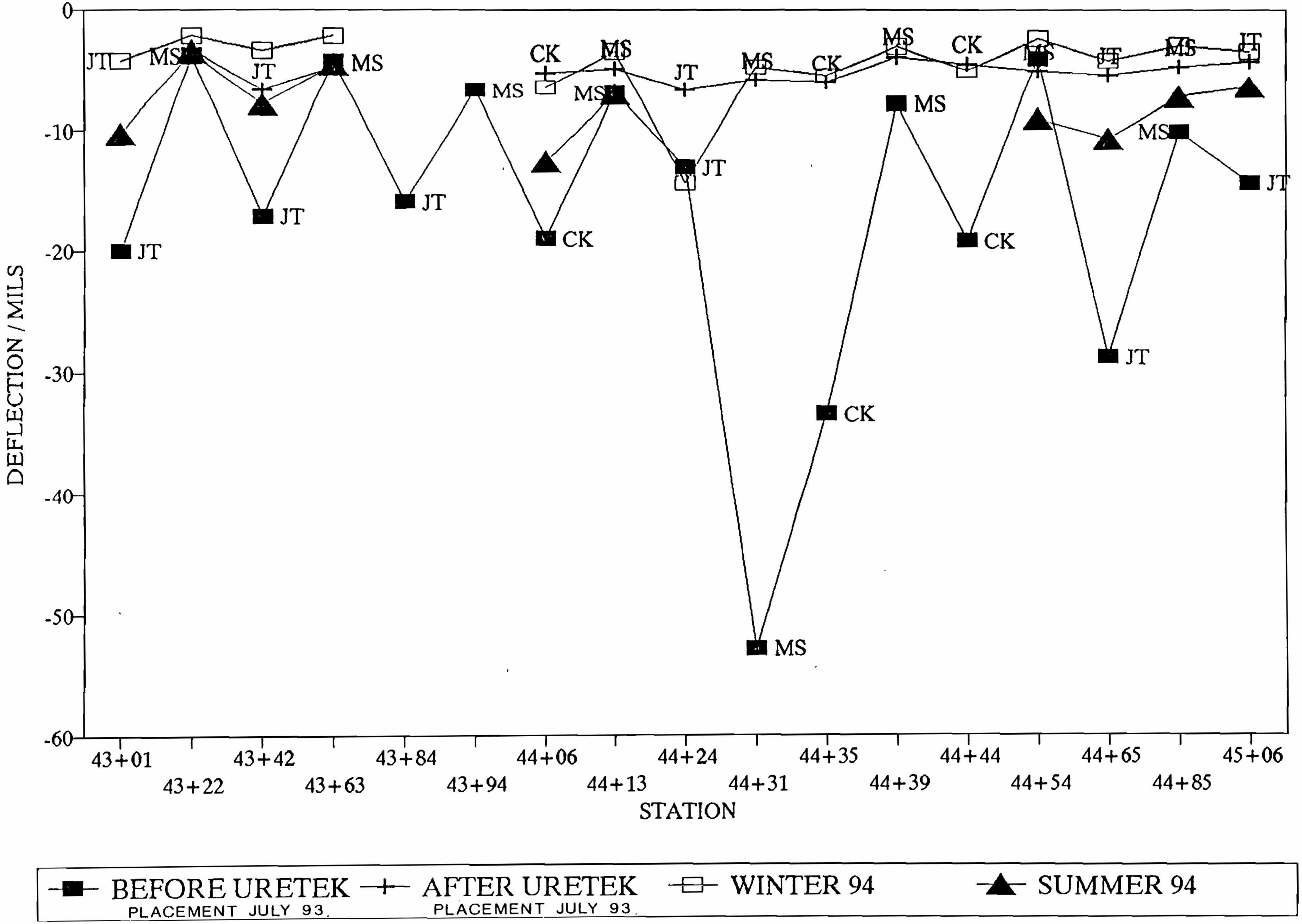
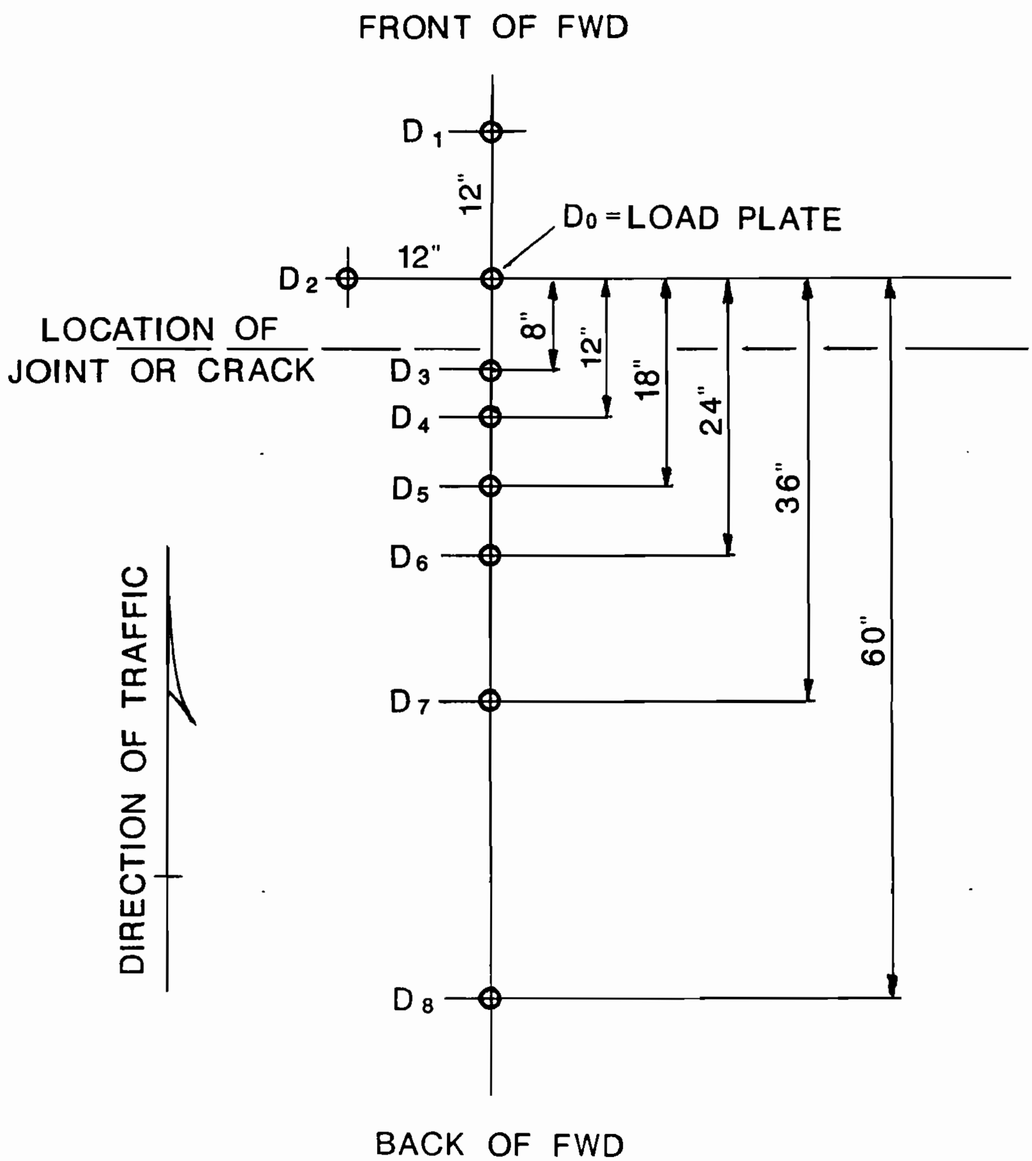


FIGURE 10



D_1 THRU D_8 = SENSOR LOCATIONS

LOAD TRANSFER EFFICENCY = $\frac{D_4}{D_0}$ X 100

For the joint locations, Figure 7 shows test area values before URETEK placement varying between 10 and 24 mils, and one year later the values vary between 5 and 14 mils. The deflection values for the control area in the summer of 1994 were generally between 7 and 17 mils.

For the crack locations, Figure 8 shows test area values before URETEK placement varying between 7 and 24 mils, and one year later the values vary between 5 and 14 mils. The deflection values for the control area in the summer of 1994 vary between 7 and 16 mils.

Site 3

A section of the pavement slab (approximately 25 feet in length) had settled about four inches below the shoulder, indicating the tie bars had failed with no load transfer along the longitudinal joint. The site was stabilized from Sta. 43+01 to 45+06.

The URETEK method raised the slab back to a reasonable grade until the spring of 1994 when the slab resettled. It was later replaced with a concrete patch. The remaining area of Site 3 preformed similarly to the 1987 project portion of Site 1.

Figure 9 shows the very high deflection values at Site 3 (53 mils at Sta. 44+31) before undersealing.

<u>Elevations</u>

Pavement elevations were taken before and after the URETEK treatment in the summer of 1993. Winter readings were taken in January of 1994 to determine if any differential frost heaving occurred from undersealing only the right lane. Summer readings in June of 1994 were taken to determine if any settlement occurred one year after the undersealing treatment.

The relative differences in elevation data are listed in table form in Appendix A. For each station, the relative rise or drop of the pavement for the three after periods is compared to the before period. Positive numbers indicate a net rise above the original pavement, while negative numbers indicate a net drop.

Site 1

In the test section, the pavement surface generally rose about ½ to 1 inch after the undersealing treatment. For the winter readings, the pavement generally stayed the same or settled slightly. For the one-year after period, the pavement had resettled to about ¼ to ½ inch above the original condition.

For the control sections on either end of test section, the pavement rose about ¼ to ½ inch during frost conditions.

Since the test section did not rise during the frost period, the undersealing material apparently has some insulating effect. This would indicate that some differential frost heaving could occur when an adjacent lane is not similarly undersealed.

Site 2

For the 800-foot control section (Sta. 372 to 380), the pavement rose about ½ to ¼ inch during the frost period. During the summer of 1994, the control section dropped about ⅜ inch below the original elevation.

The test section rose about ½ to 1 inch during the undersealing operation. However, the pavement either stayed the same or settled slightly during the frost period. For the one-year after period, the pavement had resettled to about its original elevation.

Similar to the Site 1 test area, this test section did not also rise during the frost period. Again, indicating the undersealing material apparently had some insulating effect that could produce differential frost heaving.

Load Transfer Efficiency

The load transfer data in Appendix B shows the before-and-after load transfer efficiencies. Load transfer efficiency is defined by the ratio of deflection of the unloaded side of a joint or crack to the deflection of the loaded side. Ideally, opposing slabs deflecting equally will have 100 percent load transfer efficiency without any faulting being present.

Table 1 shows a summary of the load transfer data. Actual data are contained in Appendix B. The locations of the respective joints and cracks tested remained the same each time testing was preformed.

Test Area at Site 1 (Hairline and Minor Cracks): The immediate before and after efficiencies of the joints and cracks ranged between 90 and 100 percent. The winter efficiencies ranged between 31 and 91 percent. The load transfer efficiencies for the summer of 1994 ranged between 62 and 100 percent.

Test Area at Site #2 (Severely Cracked): The before efficiencies for the joints varied between 12 and 74 percent, and averaged 43 percent. After undersealing, the efficiencies ranged between 56 and 100 percent, and averaged 87 percent. The winter efficiencies went down (24 to 66 percent), and the one-year after efficiencies went both up and down (15 to 86 percent).

Table 1

Load Transfer Efficency

	Before Uretek '93		After Uretek '93		Winter '94		Summer '94	
	Range (%)	Avg (%)	Range (%)	Avg (%)	Range (%)	Avg (%)	Range (%)	Avg (%)
Test Area Site 1								
Joints (12)	90 - 97	95	94 - 100	97	31 - 75	64	69 - 100	94
Cracks (5)	91 - 95	92	91 - 97	94	39 - 91	72	62 - 100	88
Test Area Site 2								
Joints (19)	12 - 74	43	56 - 100	87	24 - 66	37	15 - 86	47
Cracks (10)	9 - 85	40	50 - 98	84	19 - 41	27	25 - 92	50
Test Area Site 3								
Joints (6)	46 - 97	79	73 - 98	92	46 - 78	35	62 - 98	86
Cracks (3)	11 - 16	13	93 - 96	94	24 - 87	52	NA	NA

Note:

NA = Reading not avaible due to new concrete patch being placed prior to deflection testing

At the crack locations at the test area for Site 2, the before efficiencies varied between 9 and 85 percent, and averaged 40 percent. After undersealing, the efficiencies ranged between 50 and 98 percent, and averaged 84 percent. The winter efficiencies went down (19 to 41 percent), and the one-year after efficiencies were generally low, but still generally higher than the before period (25 to 92 percent, with an average of 50 percent).

Test Area at Site 3: Load transfer improved at both the joints and cracks after undersealing. The efficiency average improved from 79 to 92 percent, and from 13 to 94 percent for the joints and cracks, respectfully. During the winter, the efficiency average reduced to 65 and 52 percent for the joints and cracks, respectfully. The transfer efficiency for the joints after one year was lower than the after readings, but remained higher than the before efficiencies (62 to 98 percent, with an average of 86 percent). Since the area of pavement in Site 3 with the cracks was replaced in the spring of 1994, the summer load transfer efficiency for the cracks is not included.

Ride Quality

Table 2 shows the department's ride quality (RQI) for the test and control sections taken in June 1993, before reading, and in October 1993 and June 1994, after readings.

The rating scale for the RQI is as follows: 0 - 30 Excellent, 31 - 50 Good, 51 - 70 Fair, > 70 Poor.

There was some improvement in the ride quality after the placement of the URETEK. By the summer of 1994, the ride quality was worse than the before readings for all of the areas except the Site 2 control area.

Coring

Cores were taken on July 19 and 20, 1994, to check the thickness of the URETEK and to determine how far the URETEK had penetrated into the OGDC. The thickness of the URETEK ranged for 0 inches where the OGDC gradation was fine, to 2½ inches where the gradation of the OGDC was coarse. The depth of the penetration of the URETEK into the OGDC depended on the gradation of the OGDC.

The possible intrusion of the URETEK into the open-graded underdrain (Prefabricated Drainage System [PDS] [1987 project] or the 4 in. round pipe [1984 project]) was also checked on July 19 & 20, 1994. The PDS had a fine coating of the URETEK on the geotextile core cover, but there was no intrusion of the URETEK into the core interior. No intrusion of the URETEK had occurred into the OGDC backfill, the fabric used to line the trench, or the 4 in. pipe.

TABLE #2

RQI READINGS FOR URETEK PLACEMENT ON I-75 NB IN MONROE COUNTY

SITE NO.	AREA	STA. TO STA.	BEFORE URETEK	AFTER URETEK	
			JUNE 93	OCTOBER 93	JUNE 94
1	CONTROL 1987 PROJECT	239+00 TO 241+00	38	35	41
	TEST 1987 PROJECT	241+00 TO 243+00	61	50	63
	TEST 1984 PROJECT	243+00 TO 245+50	62	67	91
	CONTROL 1984 PROJECT	245+50 TO 247+00	53	54	56
2	CONTROL	372+00 TO 380+00	84	79	77
	TEST	380+00 TO 388+00	70	74	79
3	TEST	43+01 TO 45+06	123	67	NCP

NOTE:
NCP = NEW CONCRETE PATCH PLACED PRIOR TO RQI RUN IN 1994

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The URETEK method improved the base support where the pavement was severely cracked. However, where the cracks were either hairline, or open ⅛ in. or less, there was little improvement in the base support.

Where the pavement was severely faulted, the URETEK did raise the pavement and provided a temporary increase in base stability.

The URETEK method had some insulating effect on the base that caused differential frost heaving when the adjacent lane was not similarly undersealed.

There was some initial improvement in load transfer at joints and cracks, but after one year the load transfer at the joints and cracks had declined to a level approximately the same as before the placement of the URETEK.

After the placement of the URETEK, there was some initial improvement in pavement ride quality, but after one year the ride quality readings were approximately the same as before the URETEK was placed.

As expected, the depth of the penetration of the URETEK into the OGDC was dependent on the gradation of the OGDC. The coarser the gradation (the more voids in the OGDC) of the OGDC, the further the URETEK was able to penetrate into the OGDC.

There was no intrusion of the URETEK into any portion of the open-graded underdrain system. However, it should be noted that the undersealing material had to go through the open-graded drainage course before it reached the PDS or the 4 in. round pipe.

While base support was initially improved, the base support decreased somewhat during the one-year trial period. Therefore, more evaluation is needed to determine if URETEK is an effective method of undersealing and raising pavements supported on open-graded drainage courses.

Recommendations

It is recommended that URETEK not be used as a substitute for mud-jacking for pavements with open-graded bases. However, additional limited testing[2] is warranted to gain further experience and knowledge about the material's limitations and capabilities. At this time, URETEK should only be considered as an alternate to mud-jacking on pavements with dense-graded aggregate bases.

[2] Since the completion of the project trial period, the Maintenance Division has entered into a contract with URETEK USA Inc. for undersealing pavements throughout the state.

APPENDIX A

I-75 NBOL URETEK TEST SITE NO. 1
1987 RECYCLED CONCRETE PROJECT

DATE	STATION	SECTION	READING AFTER URETEK PLACEMENT *	ELEVATION DIFFERANCE * *(ft) DISTANCE RIGHT OF LEFT EDGE OF THE CENTER LANE OF N.B. I-75				
				9	12	18	24	27
07-93	239+00	CONTROL	INITIAL	0.00	0.00	0.00	0.00	0.00
01-94	239+00	CONTROL	WINTER				0.04	0.02
06-94	239+00	CONTROL	SPRING	0.01	0.00	0.02	-0.01	-0.02
07-93	239+50	CONTROL	INITIAL	0.00	0.00	0.00	0.00	0.00
01-94	239+50	CONTROL	WINTER	0.00	0.02	0.03	0.05	-0.01
06-94	239+50	CONTROL	SPRING	-0.01	0.01	0.01	-0.01	-0.06
07-93	240+00	CONTROL	INITIAL	0.00	0.00	0.00	0.00	0.00
01-94	240+00	CONTROL	WINTER	0.02	0.02	0.01	0.02	0.02
06-94	240+00	CONTROL	SPRING	0.01	0.01	-0.01	-0.02	0.00
07-93	240+50	CONTROL	INITIAL	0.00	0.00	0.00	0.00	0.00
01-94	240+50	CONTROL	WINTER	0.01	0.03	0.02	0.02	-0.01
06-94	240+50	CONTROL	SPRING	0.01	0.02	0.01	0.01	-0.03
07-93	241+00	TEST	INITIAL		0.02	0.01	0.03	0.03
01-94	241+00	TEST	WINTER		0.04	0.03	0.04	0.04
06-94	241+00	TEST	SPRING		0.02	0.01	0.00	0.01
07-93	241+50	TEST	INITIAL		0.04	0.04	0.05	0.05
01-94	241+50	TEST	WINTER		0.03	0.03	0.04	0.03
06-94	241+50	TEST	SPRING		0.00	0.02	0.01	0.02
07-93	242+00	TEST	INITIAL		0.05	0.04	0.04	0.03
01-94	242+00	TEST	WINTER		0.04	0.03	0.03	0.03
06-94	242+00	TEST	SPRING		0.02	0.02	0.02	0.01
07-93	242+50	TEST	INITIAL		0.04	0.05	0.05	0.05
01-94	242+50	TEST	WINTER		0.03	0.03	0.04	0.04
06-94	242+50	TEST	SPRING		0.01	0.01	0.01	0.02
07-93	243+00	TEST	INITIAL		0.05	0.05	0.05	0.02
01-94	243+00	TEST	WINTER		0.05	0.05	0.08	0.04
06-94	243+00	TEST	SPRING		0.02	0.02	0.02	-0.02

Note:

* The Uretek Pavement Underseal was placed in July of 1993.

** Elevation difference - for each station, the relative rise or drop of the pavement for the three after periods is compared to the before period. A positive numbers indicate a rise above the original pavement, while negative numbers indicate a drop.

I-75 NBOL URETEK TEST SITE NO. 1
1984 RECYCLED CONCRETE PROJECT

DATE	STATION	SECTION	READING AFTER URETEK PLACE-MENT *	ELEVATION DIFFERANCE * *(ft) DISTANCE RIGHT OF LEFT EDGE OF THE CENTER LANE OF N.B. I-75				
				9	12	18	24	27
07-93	243+50	TEST	INITIAL		0.07	0.07	0.04	0.03
01-94	243+50	TEST	WINTER		0.07	0.05	0.05	0.03
06-94	243+50	TEST	SPRING		0.06	0.04	0.02	0.00
07-93	244+00	TEST	INITIAL		0.06	0.06	0.06	0.07
01-94	244+00	TEST	WINTER		0.05	0.06	0.07	0.06
06-94	244+00	TEST	SPRING		0.03	0.04	0.02	0.01
07-93	244+50	TEST	INITIAL		0.05	0.06	0.05	0.06
01-94	244+50	TEST	WINTER		0.04	0.05	0.06	0.06
06-94	244+50	TEST	SPRING		0.03	0.04	0.02	0.03
07-93	245+00	TEST	INITIAL		0.06	0.08	0.08	0.06
01-94	245+00	TEST	WINTER		0.05	0.04	0.07	0.07
06-94	245+00	TEST	SPRING		0.09	0.05	0.06	0.05
07-93	245+50	TEST	INITIAL		0.03	0.03	0.02	0.07
01-94	245+50	TEST	WINTER		0.04	0.03	0.05	0.11
06-94	245+50	TEST	SPRING		0.02	0.01	0.01	0.06
07-93	246+00	CONTROL	INITIAL	0.00	0.00	0.00	0.00	0.00
01-94	246+00	CONTROL	WINTER	0.04	0.02	0.04	0.04	0.05
06-94	246+00	CONTROL	SPRING	0.03	0.01	0.01	0.02	0.00
07-93	246+50	CONTROL	INITIAL	0.00	0.00	0.00	0.00	0.00
01-94	246+50	CONTROL	WINTER	0.03	0.04	0.03	0.08	0.07
06-94	246+50	CONTROL	SPRING	0.03	0.02	0.00	0.02	0.02
07-93	247+00	CONTROL	INITIAL	0.00	0.00	0.00	0.00	0.00
01-94	247+00	CONTROL	WINTER	0.02	0.03	0.05	0.03	0.06
06-94	247+00	CONTROL	SPRING	0.02	0.02	0.02	0.00	0.01

Note:

* The Uretek Pavement Underseal was placed in July of 1993.

** Elevation difference - for each station, the relative rise or drop of the pavement for the three after periods is compared to the before period. A positive numbers indicate a rise above the original pavement, while negative numbers indicate a drop.

I-75 NBOL URETEK TEST SITE NO. 2
1984 RECYCLED CONCRETE PROJECT

DATE	STATION	SECTION	READING AFTER URETEK PLACEMENT *	ELEVATION DIFFERANCE * *(ft) — DISTANCE RIGHT OF LEFT EDGE OF THE CENTER LANE OF N.B. I-75				
				9	12	18	24	27
07-93	372+00	CONTROL	INITIAL		0.00	0.00	0.00	0.00
01-94	372+00	CONTROL	WINTER		0.05	0.08	0.05	0.07
06-94	372+00	CONTROL	SPRING		-0.02	-0.03	-0.02	-0.03
07-93	372+50	CONTROL	INITIAL		0.00	0.00	0.00	0.00
01-94	372+50	CONTROL	WINTER		0.04	0.06	-0.06	0.06
06-94	372+50	CONTROL	SPRING		-0.04	-0.03	-0.17	-0.04
07-93	373+00	CONTROL	INITIAL		0.00	0.00	0.00	0.00
01-94	373+00	CONTROL	WINTER		-0.02	0.05	0.03	0.04
06-94	373+00	CONTROL	SPRING		-0.05	-0.04	-0.06	-0.03
07-93	373+50	CONTROL	INITIAL		0.00	0.00	0.00	0.00
01-94	373+50	CONTROL	WINTER				0.05	0.07
06-94	373+50	CONTROL	SPRING		-0.06	-0.03	-0.04	-0.03
07-93	374+00	CONTROL	INITIAL		0.00	0.00	0.00	0.00
01-94	374+00	CONTROL	WINTER		0.04		0.07	0.07
06-94	374+00	CONTROL	SPRING		-0.04	-0.03	-0.02	-0.02
07-93	374+50	CONTROL	INITIAL		0.00	0.00	0.00	0.00
01-94	374+50	CONTROL	WINTER		0.05	0.03	0.05	0.07
06-94	374+50	CONTROL	SPRING		-0.04	-0.06	-0.04	-0.03
07-93	375+00	CONTROL	INITIAL		0.00	0.00	0.00	0.00
01-94	375+00	CONTROL	WINTER		0.06	0.06	0.06	0.05
06-94	375+00	CONTROL	SPRING		-0.04	-0.03	-0.03	-0.02
07-93	375+50	CONTROL	INITIAL		0.00	0.00	0.00	0.00
01-94	375+50	CONTROL	WINTER		0.07	0.07	0.07	0.05
06-94	375+50	CONTROL	SPRING		-0.04	-0.03	0.00	-0.02
07-93	376+00	CONTROL	INITIAL		0.00	0.00	0.00	0.00
01-94	376+00	CONTROL	WINTER		0.05	0.05	0.02	0.03
06-94	376+00	CONTROL	SPRING		-0.03	-0.03	-0.03	-0.03
07-93	376+50	CONTROL	INITIAL		0.00	0.00	0.00	0.00
01-94	376+50	CONTROL	WINTER		0.04	0.05	0.07	0.06
06-94	376+50	CONTROL	SPRING		-0.03	-0.04	-0.03	-0.02

Note:

* The Uretek Pavement Underseal was placed in July of 1993.

** Elevation difference - for each station, the relative rise or drop of the pavement for the three after periods is compared to the before period. A positive numbers indicate a rise above the original pavement, while negative numbers indicate a drop.

I-75 NBOL URETEK TEST SITE NO. 2
1984 RECYCLED CONCRETE PROJECT

DATE	STATION	SECTION	READING AFTER URETEK PLACE-MENT *	ELEVATION DIFFERANCE * *(ft) DISTANCE RIGHT OF LEFT EDGE OF THE CENTER LANE OF N.B. I-75				
				9	12	18	24	27
07-93	377+00	CONTROL	INITIAL		0.00	0.00	0.00	0.00
01-94	377+00	CONTROL	WINTER		0.04	0.05	0.07	0.05
06-94	377+00	CONTROL	SPRING		-0.04	-0.01	0.00	-0.04
07-93	377+50	CONTROL	INITIAL		0.00	0.00	0.00	0.00
01-94	377+50	CONTROL	WINTER		0.04	0.06	0.04	0.08
06-94	377+50	CONTROL	SPRING		-0.04	-0.02	-0.03	-0.01
07-93	378+00	CONTROL	INITIAL		0.00	0.00	0.00	0.00
01-94	378+00	CONTROL	WINTER		0.05	0.04	0.04	0.07
06-94	378+00	CONTROL	SPRING		-0.03	-0.04	-0.02	0.00
07-93	378+50	CONTROL	INITIAL		0.00	0.00	0.00	0.00
01-94	378+50	CONTROL	WINTER		0.06	0.05	0.03	0.04
06-94	378+50	CONTROL	SPRING		-0.03	-0.03	-0.03	-0.02
07-93	379+00	CONTROL	INITIAL		0.00	0.00	0.00	0.00
01-94	379+00	CONTROL	WINTER		0.03	0.03	0.04	0.05
06-94	379+00	CONTROL	SPRING		-0.03	-0.04	-0.03	0.01
07-93	379+50	CONTROL	INITIAL		0.00	0.00	0.00	0.00
01-94	379+50	CONTROL	WINTER		0.06	0.04	0.03	0.08
06-94	379+50	CONTROL	SPRING		-0.03	-0.02	-0.04	0.03
07-93	380+00	TEST	INITIAL		0.04	0.06	0.05	0.05
01-94	380+00	TEST	WINTER		0.05	0.05	0.06	0.05
06-94	380+00	TEST	SPRING		-0.01	-0.01	-0.03	0.01
07-93	380+50	TEST	INITIAL		0.05	0.07	0.06	0.04
01-94	380+50	TEST	WINTER		0.06	0.07	0.05	0.02
06-94	380+50	TEST	SPRING		0.00	0.00	-0.03	-0.02
07-93	381+00	TEST	INITIAL		0.06	0.06	0.05	0.05
01-94	381+00	TEST	WINTER		0.05	0.05	0.04	0.04
06-94	381+00	TEST	SPRING		0.00	-0.01	-0.03	-0.01
07-93	381+50	TEST	INITIAL		0.08	0.09	0.07	0.04
01-94	381+50	TEST	WINTER		0.06	0.04	0.03	0.04
06-94	381+50	TEST	SPRING		0.03	-0.03	-0.10	-0.01

Note:

* The Uretek Pavement Underseal was placed in July of 1993.

** Elevation difference - for each station, the relative rise or drop of the pavement for the three after periods is compared to the before period. A positive numbers indicate a rise above the original pavement,

I-75 NBOL URETEK TEST SITE NO. 2
1984 RECYCLED CONCRETE PROJECT

DATE	STATION	SECTION	READING AFTER URETEK PLACE-MENT *	ELEVATION DIFFERANCE **(ft) DISTANCE RIGHT OF LEFT EDGE OF THE CENTER LANE OF N.B. I-75				
				9	12	18	24	27
while negative numbers indicate a drop.								
07-93	382+00	TEST	INITIAL		0.04	0.05	0.03	0.08
01-94	382+00	TEST	WINTER		0.05	0.04	0.04	0.06
06-94	382+00	TEST	SPRING		-0.01	-0.02	-0.03	0.02
07-93	382+50	TEST	INITIAL		0.05	0.07	0.05	0.05
01-94	382+50	TEST	WINTER		0.05	0.08	0.06	0.06
06-94	382+50	TEST	SPRING		0.00	0.01	0.00	-0.01
07-93	383+00	TEST	INITIAL		0.07	0.07	0.05	0.10
01-94	383+00	TEST	WINTER		0.06	0.05	0.05	0.08
06-94	383+00	TEST	SPRING		0.06	0.01	0.00	0.03
07-93	383+50	TEST	INITIAL		0.00	0.06	0.06	0.05
01-94	383+50	TEST	WINTER		0.04	0.07	0.08	0.07
06-94	383+50	TEST	SPRING		-0.01	0.01	0.02	-0.01
07-93	384+00	TEST	INITIAL		0.08	0.06	0.06	0.08
01-94	384+00	TEST	WINTER		0.08	0.04	0.05	0.06
06-94	384+00	TEST	SPRING		0.01	-0.01	-0.01	0.01
07-93	384+50	TEST	INITIAL		0.04	0.07	0.06	0.05
01-94	384+50	TEST	WINTER		0.04	0.08	0.07	0.06
06-94	384+50	TEST	SPRING		-0.01	0.01	0.00	0.00
07-93	385+00	TEST	INITIAL		0.14	0.07	0.05	0.04
01-94	385+00	TEST	WINTER		0.14	0.06	0.06	0.02
06-94	385+00	TEST	SPRING		0.08	0.02	-0.01	-0.03
07-93	385+50	TEST	INITIAL		0.06	0.07	0.06	0.02
01-94	385+50	TEST	WINTER		0.06	0.05	0.05	0.05
06-94	385+50	TEST	SPRING		0.00	0.00	-0.01	-0.03
07-93	386+00	TEST	INITIAL		0.05	0.05	0.06	0.04
01-94	386+00	TEST	WINTER		0.03	0.04	0.05	0.05
06-94	386+00	TEST	SPRING		-0.01	0.00	0.00	-0.02

Note:

* The Uretek Pavement Underseal was placed in July of 1993.

** Elevation difference - for each station, the relative rise or drop of the pavement for the three after periods is compared to the before period. A positive numbers indicate a rise above the original pavement, while negative numbers indicate a drop.

I-75 NBOL URETEK TEST SITE NO. 2
1984 RECYCLED CONCRETE PROJECT

DATE	STATION	SECTION	READING AFTER URETEK PLACE-MENT *	ELEVATION DIFFERANCE * *(ft) DISTANCE RIGHT OF LEFT EDGE OF THE CENTER LANE OF N.B. I-75				
				9	12	18	24	27
07-93	386+50	TEST	INITIAL		0.06	0.07	0.05	0.05
01-94	386+50	TEST	WINTER		0.06	0.06	0.04	0.04
06-94	386+50	TEST	SPRING		0.01	0.00	-0.01	-0.02
07-93	387+00	TEST	INITIAL		0.05	0.06	0.05	0.09
01-94	387+00	TEST	WINTER		0.05	0.02	0.03	0.05
06-94	387+00	TEST	SPRING		-0.01	-0.01	-0.02	0.02
07-93	387+50	TEST	INITIAL		0.05	0.07	0.05	0.04
01-94	387+50	TEST	WINTER		0.04	0.05	0.04	0.04
06-94	387+50	TEST	SPRING		-0.01	0.00	-0.01	-0.03
07-93	388+00	TEST	INITIAL		0.06	0.05	0.03	0.07
01-94	388+00	TEST	WINTER		0.05	0.04	0.04	0.05
06-94	388+00	TEST	SPRING		0.01	0.00	-0.01	0.01

Note:

* The Uretek Pavement Underseal was placed in July of 1993.

** Elevation difference - for each station, the relative rise or drop of the pavement for the three after periods is compared to the before period. A positive numbers indicate a rise above the original pavement, while negative numbers indicate a drop.

I-75 NBOL URETEK TEST SITE NO. 3
1987 RECYCLED CONCRETE PROJECT

DATE	STATION	SECTION	READING AFTER URETEK PLACE-MENT *	ELEVATION DIFFERANCE * *(ft) DISTANCE RIGHT OF LEFT EDGE OF THE CENTER LANE OF N.B. I-75				
				9	12	18	24	27
07-93	43+76	TEST	INITIAL		0.00	-0.01	-0.01	0.01
01-94	43+76	TEST	WINTER		0.04	0.05	0.04	0.07
06-94	43+76	TEST	SPRING		-0.01	-0.01	-0.04	0.00
07-93	44+00	TEST	INITIAL		0.02	0.01	0.02	0.06
01-94	44+00	TEST	WINTER		0.06	0.06	0.07	0.09
06-94	44+00	TEST	SPRING		0.00	0.00	0.00	0.02
07-93	44+20 SOUTH	TEST	INITIAL		0.06	0.05	0.05	0.06
01-94	44+20 SOUTH	TEST	WINTER		0.07	0.07	0.07	0.08
06-94	44+20 SOUTH	TEST	SPRING					
07-93	44+20 NORTH	TEST	INITIAL		0.05	0.07	0.07	0.06
01-94	44+20 NORTH	TEST	WINTER		0.07	0.07	0.07	0.09
06-94	44+20 NORTH	TEST	SPRING					
07-93	44+23 SOUTH	TEST	INITIAL		0.08	0.10	0.07	0.08
01-94	44+23 SOUTH	TEST	WINTER		0.09	0.08	0.10	0.11
06-94	44+23 SOUTH	TEST	SPRING					
07-93	44+23 NORTH	TEST	INITIAL		0.09	0.14	0.15	0.09
01-94	44+23 NORTH	TEST	WINTER		0.06	0.10	0.17	0.11
06-94	44+23 NORTH	TEST	SPRING					
07-93	44+26 SOUTH	TEST	INITIAL		0.14	0.17	0.06	0.07
01-94	44+26 SOUTH	TEST	WINTER		0.08	0.16	0.09	0.11
06-94	44+26 SOUTH	TEST	SPRING					
07-93	44+26 NORTH	TEST	INITIAL		0.10	0.18	0.34	0.08
01-94	44+26 NORTH	TEST	WINTER		0.06	0.17	0.32	0.10
06-94	44+26 NORTH	TEST	SPRING					
07-93	44+33 SOUTH	TEST	INITIAL		0.05	0.07	0.29	0.07
01-94	44+33 SOUTH	TEST	WINTER		0.05	0.07	0.23	0.06
06-94	44+33 SOUTH	TEST	SPRING					
07-93	44+33 NORTH	TEST	INITIAL		0.06	0.09	0.08	0.09
01-94	44+33 NORTH	TEST	WINTER		0.09	0.10	0.12	0.06
06-94	44+33 NORTH	TEST	SPRING					
07-93	44+64	TEST	INITIAL		-0.02	-0.02	0.06	0.04
01-94	44+64	TEST	WINTER		0.02	0.01	0.01	0.07
06-94	44+64	TEST	SPRING		-0.02	-0.03	-0.02	0.02

Note:

* The Uretek Pavement Underseal was placed in July of 1993.

** Elevation difference - for each station, the relative rise or drop of the pavement for the three after periods is compared to the before period. A positive numbers indicate a rise above the original pavement, while negative numbers indicate a drop.

APPENDIX B

SITE	STATION	LOCATION	AREA	LOAD TRANS EFFICENCY BEFORE URETEK	LOAD TRANS EFFICENCY AFTER URETEK	LOAD TRANS EFFICENCY WINTER OF 94	LOAD TRANS EFFICENCY SPRING OF 94	REMARKS
1	23938	JT	CONTROL	94.35		79.97	99.08	1987
1	23979	JT	CONTROL	94.81		86.20	97.85	JOB
1	24021	JT	CONTROL	95.80		78.47	97.20	CONTROL
1	24062	JT	CONTROL	97.11		80.59	98.43	
1	24102	JT	TEST	96.22	94.65	64.92	99.28	
1	24143	JT	TEST	94.08	95.23	64.71	96.66	1987
1	24185	JT	TEST	90.45	94.33	67.51	69.10	JOB
1	24226	JT	TEST	94.31	100.00	65.06	99.25	TEST
1	24267	JT	TEST	95.45	100.00	74.81	100.00	
1	24299	JT	TEST	96.84	100.00	73.38	82.23	
1	24345	JT	TEST	97.21	95.30	30.90	98.88	
1	24383	JT	TEST	95.88	95.88	58.73	96.90	1984
1	24424	JT	TEST	91.37	94.49	57.37	97.59	JOB
1	24466	JT	TEST	94.56	97.36	73.58	96.94	TEST
1	24507	JT	TEST	97.45		68.55	92.31	
1	24548	JT	TEST	94.47				
1	24589	JT	CONTROL	95.74				1984
1	24630	JT	CONTROL	94.71				JOB
1	24671	JT	CONTROL	93.56				CONTROL
1	24330	CK	TEST	91.76	92.87	91.15	93.03	
1	24364	CK	TEST	90.85	93.15	58.77	95.02	1984
1	24407	CK	TEST	91.65	91.30	78.24	62.25	JOB
1	24490	CK	TEST	95.28	96.80	39.12	100.00	TEST
1	24521	CK	TEST	91.60		91.26	88.53	
1	24560	CK	CONTROL	93.96				1984
1	24637	CK	CONTROL	91.44				JOB
1	24655	CK	CONTROL	97.04				CONTROL
1	24795	CK	CONTROL	92.18				

SITE	STATION	LOCATION	AREA	LOAD TRANS EFFICENCY BEFORE URETEK	LOAD TRANS EFFICENCY AFTER URETEK	LOAD TRANS EFFICENCY WINTER OF 94	LOAD TRANS EFFICENCY SPRING OF 94	REMARKS
2	37217	JT	CONTROL	30.47		35.58	23.23	CONTROL
2	37257	JT	CONTROL	59.84		64.17	67.64	CONTROL
2	37299	JT	CONTROL	39.22		78.10	35.62	CONTROL
2	37340	JT	CONTROL	26.75		34.44	20.40	CONTROL
2	37381	JT	CONTROL	71.36		32.12	68.25	CONTROL
2	37422	JT	CONTROL	19.98		49.25	18.49	CONTROL
2	37463	JT	CONTROL	52.68		56.54	26.43	CONTROL
2	37504	JT	CONTROL	23.07		34.30	21.71	CONTROL
2	37545	JT	CONTROL	7.61		28.82	12.19	CONTROL
2	37586	JT	CONTROL	43.01		41.47	25.09	CONTROL
2	37627	JT	CONTROL	49.30		33.60	51.59	CONTROL
2	37668	JT	CONTROL	25.00		41.01	27.91	CONTROL
2	37751	JT	CONTROL	26.07		33.50	28.01	CONTROL
2	37792	JT	CONTROL	28.80		36.73	33.25	CONTROL
2	37833	JT	CONTROL	13.04		29.85	18.26	CONTROL
2	37874	JT	CONTROL	21.04		36.44	21.69	CONTROL
2	37915	JT	CONTROL	24.08		38.16	25.87	CONTROL
2	37957	JT	CONTROL	84.11		73.52	88.17	CONTROL
2	37997	JT	CONTROL	97.06		36.84	47.19	CONTROL
2	38038	JT	TEST	67.49	93.80	29.82	24.37	TEST
2	38079	JT	TEST	11.91	73.53	31.18	14.55	TEST
2	38120	JT	TEST	14.77	95.93	24.41	19.33	TEST
2	38161	JT	TEST	19.41	55.52	53.49	26.26	TEST
2	38201	JT	TEST	26.17	89.00	54.14	53.36	TEST
2	38243	JT	TEST	38.14	66.65	34.32	38.01	TEST
2	28284	JT	TEST	74.29	76.66	34.22	81.48	TEST
2	38325	JT	TEST	32.49	96.18	30.39	66.59	TEST
2	38366	JT	TEST	74.32	97.04	66.21	80.33	TEST
2	38406	JT	TEST	30.94	94.50	27.64	18.37	TEST
2	38448	JT	TEST	70.04	91.28	40.18	69.00	TEST
2	38489	JT	TEST	73.60	90.06	37.74	85.88	TEST
2	38530	JT	TEST	41.78	96.70	32.74	81.27	TEST
2	38571	JT	TEST	44.39	99.14	22.12	62.61	TEST
2	38611	JT	TEST	46.01	96.93	39.95	78.12	TEST
2	38653	JT	TEST	54.56	100.00	42.00	20.75	TEST
2	38693	JT	TEST	30.85	100.00	27.29	21.80	TEST
2	38734	JT	TEST	26.71	77.64	33.32	26.17	TEST
2	38775	JT	TEST	31.36	68.70	40.72	31.47	TEST

SITE	STATION	LOCATION	AREA	LOAD TRANS EFFICENCY BEFORE URETEK	LOAD TRANS EFFICENCY AFTER URETEK	LOAD TRANS EFFICENCY WINTER OF 94	LOAD TRANS EFFICENCY SPRING OF 94	REMARKS
2	37316	CK	CONTROL	44.26		36.85	64.52	CONTROL
2	37431	CK	CONTROL	11.87		44.21	16.82	CONTROL
2	37569	CK	CONTROL	10.97		31.44	16.84	CONTROL
2	37687	CK	CONTROL	16.19		92.00	21.44	CONTROL
2	37924	CK	CONTROL	51.15		31.72	30.98	CONTROL
2	38007	CK	TEST	22.49	94.98	100.00	24.91	TEST
2	38068	CK	TEST	11.66	78.97	22.63	25.60	TEST
2	38186	CK	TEST	18.29	50.27	28.58	36.03	TEST
2	38305	CK	TEST	71.10	86.06	26.74	90.13	TEST
2	38375	CK	TEST	72.00	64.08	25.86	26.59	TEST
2	38473	CK	TEST	85.30	93.31	19.85	88.50	TEST
2	38546	CK	TEST	71.26	94.29	28.67	91.51	TEST
2	38635	CK	TEST	31.65	97.54	33.99	44.63	TEST
2	38715	CK	TEST	11.30	89.42	18.92	37.53	TEST
2	38788	CK	TEST	8.70	94.14	40.57	30.79	TEST

SITE	STATION	LOCATION	AREA	LOAD TRANS EFFICENCY BEFORE URETEK	LOAD TRANS EFFICENCY AFTER URETEK	LOAD TRANS EFFICENCY WINTER OF 94	LOAD TRANS EFFICENCY SPRING OF 94	REMARKS
3	4301	JT	TEST	91.68		68.00	89.24	TEST
3	4342	JT	TEST	96.22	98.37	77.56	97.72	TEST
3	4384	JT	TEST	96.53				TEST
3	4424	JT	TEST	47.14	72.58			TEST
3	4465	JT	TEST	45.70	98.35	46.34	61.85	TEST
3	4506	JT	TEST	95.97	96.82	66.43	95.64	TEST
3	4406	CK	TEST	11.82	96.12	23.60	76.70	TEST
3	4435	CK	TEST	10.95	94.28	87.07		TEST
3	4444	CK	TEST	15.59	92.62	45.46		TEST

APPENDIX C

OFFICE MEMORANDUM

DATE: October 21, 1993

TO: Thomas Davies
District Engineer

FROM: Bill Opland
District 8 Soils & Materials Engineer

SUBJECT: **Initial Evaluation Of The Uretek Method For Pavement Undersealing On I-75, Monroe County, C.S. 58151**

The Initial Evaluation of the Uretek Method for Pavement Undersealing on I-75 is attached for your review.

The initial results of the Uretek method are very favorable. Where major transverse cracks existed, the Uretek treatment significantly improved the base support of the pavement.

The cost of the Uretek treatment is about $95,000 per lane mile. To underseal the deteriorating right truck lane on NB I-75 between mile point 6 and mile point 12 would cost about $570,000.

We will continue to monitor the Uretek test areas during the winter and into next spring. At that time we may be able to determine if the method is an effective undersealing technique to prolong pavement service life. A final evaluation report will be issued next year.

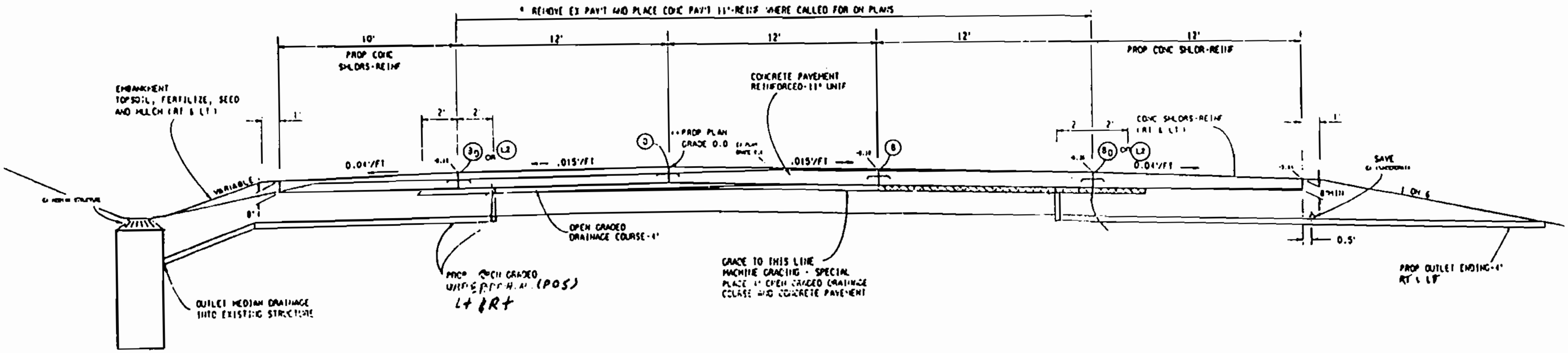
Bill Opland

District Soils & Materials Engineer

BO:sah

cc: M. Frankhouse
T. Anderson
G. Etelamaki
D. Smiley
V. Barnhart

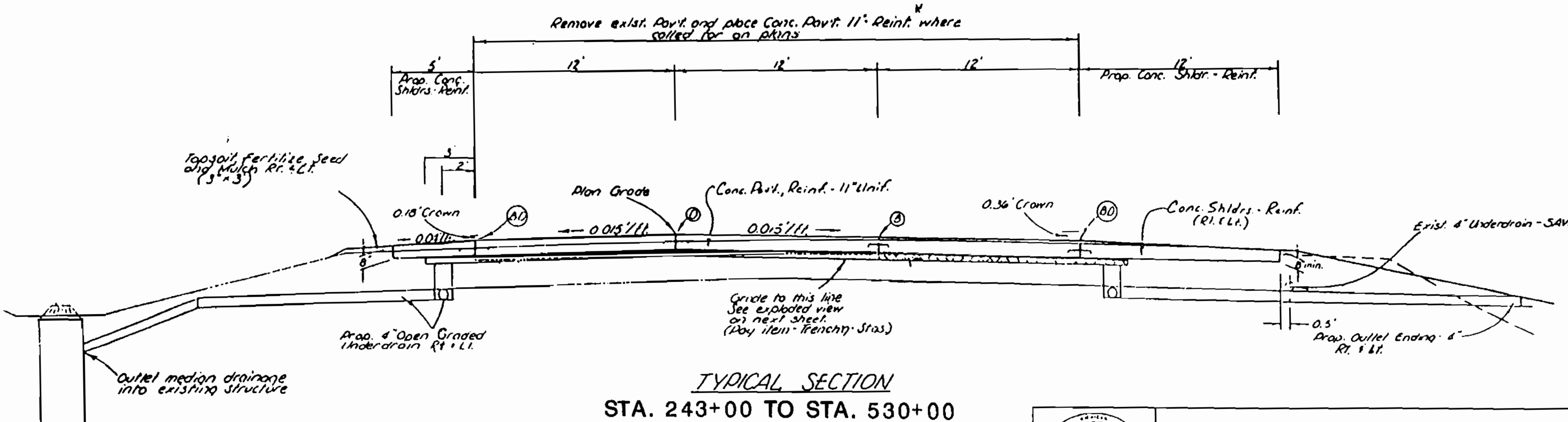
TYPICAL CROSS-SECTIONS



PROPOSED CONC RECYCLED PAV'T NB

STA. 19+95.20 TO STA. 106+00
STA. 121+44 TO STA. 133+15.0 SBK
STA. 11+38.06 AH TO STA. 243+00

TYPICAL TO APPLY RECYCLE CONCRETE					
DATE	SCALE	CONT. SEC.	JOB NO.	DESIGN UNIT	SHEET NO.
2/ 6/87	1"=3'	58151	25556A	J. FALMONCH	2



TYPICAL SECTION

STA. 243+00 TO STA. 530+00

DATE	SCALE	CONT. SEC.	JOB NO.	DESIGN UNIT	SHEET NO.
2-17-84		58151	21908A	CHRISTY	2

INITIAL EVALUATION OF THE URETEK METHOD FOR PAVEMENT UNDERSEALING ON I-75

MICHIGAN DEPARTMENT OF TRANSPORTATION

DISTRICT 8

OCTOBER 1993

BACKGROUND

A series of five concrete reconstruction projects were completed on I-75 in Monroe County between 1984 and 1990. The first four projects used recycled concrete coarse aggregate in the concrete mix. The first three projects did not use a separator between the open-graded drainage coarse and the sand subbase, while the latter two used geotextile separators.

Excessive transverse cracking for the first two projects (build in 1984 and 1987) were noted in 1992. The cracking may be the result of the following:

1. No separator between the open-graded drainage coarse and the sand subbase.

2. Lack of aggregate interlock in concrete due to use of crushed concrete coarse aggregate (and 50% crushed concrete sand in '84 project).

3. Lack of stability in open-graded drainage coarse since no stabilizing agent was used.

4. Use of 41' joint spacing rather than the present 27' required for high truck traffic.

5. Possible movement of fines in the base and subbase toward the pavement underdrain causing voids under the pavement.

The excessive cracking and pavement failure in the right (truck) lane of the 1984 project (NB I-75, M.P. 6 to M.P. 12) has caused numerous pavement patches by the county maintenance crew. The concrete patches have been an expensive maintenance treatment.

To try to find a preservation type solution, a pavement stabilization demonstration project was set up. The Uretek method of stabilization was selected to underseal the pavement.

Using HPR research funds, a $25,000 project was set up with Uretek USA, Inc. Through a purchasing agreement, M•DOT agreed to buy 5,000 pounds of the Uretek product at $5.00 per pound installed. The work for this project was completed between July 28 and August 3, 1993.

DESCRIPTION OF THE URETEK METHOD

The Uretek method is a patented process that was originally developed in Europe. In 1975, the company developed a special high density polyurethane for its sealing compound, which distinguishes it from typical grouting mixtures used in mud jacking operations.

The material consists of two liquid chemicals which combine under heat to form a strong foam-like substance. The material is injected under pressure through pre-drilled ⅝ - inch diameter holes in the pavement. The material then expands as it cures to aggressively fill any available voids.

The Uretek method can be used to underseal cracked pavement slabs and to raise slabs that have settled. Both of these conditions were encountered on the I-75 demonstration project.

Photographs of the Uretek Method are shown in Appendix A.

PROCEDURES

The demonstration project treated three types of pavement distress. These are 1) pavement in good condition but with hairline or minor cracks, 2) pavement with severe transverse cracking and faulting, and 3) a pavement slab with a 4" settlement.

The data collected to evaluate the effectiveness of the treatment was 1) before-and-after pavement elevations, 2) before-and-after falling weight deflectometer (FWD) measurements, and 3) ride quality measurements. In addition, cores will be taken to determine penetration depths of the undersealing. The underdrain pipe will also be checked to determine if intrusion of sealant took place.

Elevation and deflection readings will also be taken next winter to determine if any differential frost heaving occurs.

INITIAL RESULTS

The initial results of the Uretek treatment appear favorable. In general, the FWD tests (which measure base stiffness) showed a significant improvement. Where the pavement was faulted and/or low in spots, the pavement was raised up flush. Where a large (4-inch) settlement existed, the pavement was raised sufficiently to produce a smooth ride.

Figures 1 through 7 show the before-and-after comparisons in graph form. Tests were taken at mid-slabs, joints, and cracks at each of the three test locations.

Test Site 1: NB I-75 at Mile Point 6.5

This 400' section (Sta. 241+00 to 245+00) includes the northerly 200' (Sta. 241 to 243) of the 1987 project, and the southerly 200' (Sta. 243 to 245) of the 1984 project.

The 1987 project (Sta. 241 to 243) had only a few minor hairline cracks. It was treated to determine if early undersealing is effective in preventing future cracking. At the mid-slab locations, Figure 1 shows that no significant changes occurred. At the joint locations, Figure 2 shows that the base support decreased slightly after undersealing.

The 1984 project (Sta. 243 to 245) showed some minor cracking in this section. Figure 2 shows the Uretek treatment was effective in improving the base support at the one poorly supported joint (improved from 9 mils to 4½ mils). Figure 3 shows it also marginally improved the base support at the cracks (4± mils).

Test Site 2: NB I-75 at Mile Point 9.2

This 812' section (Sta. 380+00 to 388+12) is severely cracked and is typical of the pavement condition of the 1984 project. Figures 4, 5, and 6 show the base support at the mid - slabs, joints, and cracks has increased significantly.

At the worst mid-slab location (see Figure 4), base support was increased from 12 mils to 4 mils.

The before data for the joints (see Figure 5) varied between 10 and 24 mils. The after data varied between 4½ and 10 mils. The worst joint improved from 24 mils to 7 mils.

Figure 6 shows the data at the severe transverse cracks. The before data varied between 7 and 24 mils while the after data ranged from 4 to 7 mils.

Test Site 3: NB I-75 at Mile Point 0.4

This sunken slab was part of the 1987 project and is located about 0.4 miles north of the Ohio line. The slab had settled 4" below the shoulder edge, and there was no longer any load transfer at the joints.

The Uretek raising method brought the slab back to a reasonable grade and provided load transfer between the joints.

Figure 7 shows a significant improvement in base support. A worst mid-slab support value of 53 mils improved to 6 mils after undersealing.

Elevations

Survey elevations of the pavement surface were taken before and after the Uretek treatment. Additional elevations will be taken next winter to determine if any differential frost heaving occurs.

At test sites 1 and 2, the pavement surface generally rose about ½ to 1 inch after the undersealing treatment. But since a gradual transition in the cross slope was maintained, good surface drainage is still available.

At the sunken slab (test site 3), the surface was raised 4 inches at the worst spot.

Ride Quality

Although rapid travel profilometer readings were taken before the Uretek treatment, the after readings have not yet been processed. The ride quality data will be analyzed in the final report.

COSTS

For the demonstration project, the Department purchased the installed Uretek product for $5.00 per pound. With a project materials budget of $25,000, a total of 5,000 pounds was purchased.

The following chart shows the material usage rate and cost at each of the three test sections.

Test Site	Type of Distress	Length of Site	Pounds of Material	Pounds Per 100' Sta.	Cost Per 100' Sta.
#1	Hairline & Minor Cracks	400'	1,815	454	$2,270
#2	Severe Transverse Cracks	812'	2,938	362	$1,810
#3	Sunken Slab	90'	525	583	$2,915

Test site #2 is typical of the deteriorated pavement on NB I-75 between mile points 6 and 12. Based on an undersealing cost of $1,810 per 100 - foot station, a lane mile of pavement could be undersealed for about $95,000.

Areas like test site #1 (hairline and minor cracks) would not have to be undersealed prematurely since the cost is higher than that for severe cracks. The reason for this may be because of greater void space of the yet uncontaminated open-graded drainage course. With more void space, a larger volume of material is required to fill the voids.

Where an isolated sunken slab exists (like test site #3), a greater volume of material is required to raise the slab. The amount of material required would probably be dependent on the height to be raised.

Uretek has informed the Department that for larger projects of 20,000 pounds or more, the product can be installed for $5.00 per pound.

CONCLUSIONS

The Uretek method may be a cost-effective method ($95,000 per lane mile) of preserving a distressed concrete pavement. The method should be compared with concrete repair techniques as well as total reconstruction methods.

The Uretek method will be fully evaluated after more data is collected next winter. Only then should a determination be made as to the effectiveness of the treatment.

The initial results of the FWD tests are very favorable. The Uretek treatment significantly increases the base stiffness of a severely cracked pavement. In addition, the method is very effective in raising settled slabs and providing load transfer between joints.

The Uretek method requires only a one-lane closure. At the end of a working day, the treated pavement can be open to traffic within 15 minutes. The lack of overnight lane closures is an advantage that should be considered.

FIGURE 1

I-75NBOL URETEK TEST SITE 1

MAXIMUM FWD DEFLECTIONS AT MIDSLAB

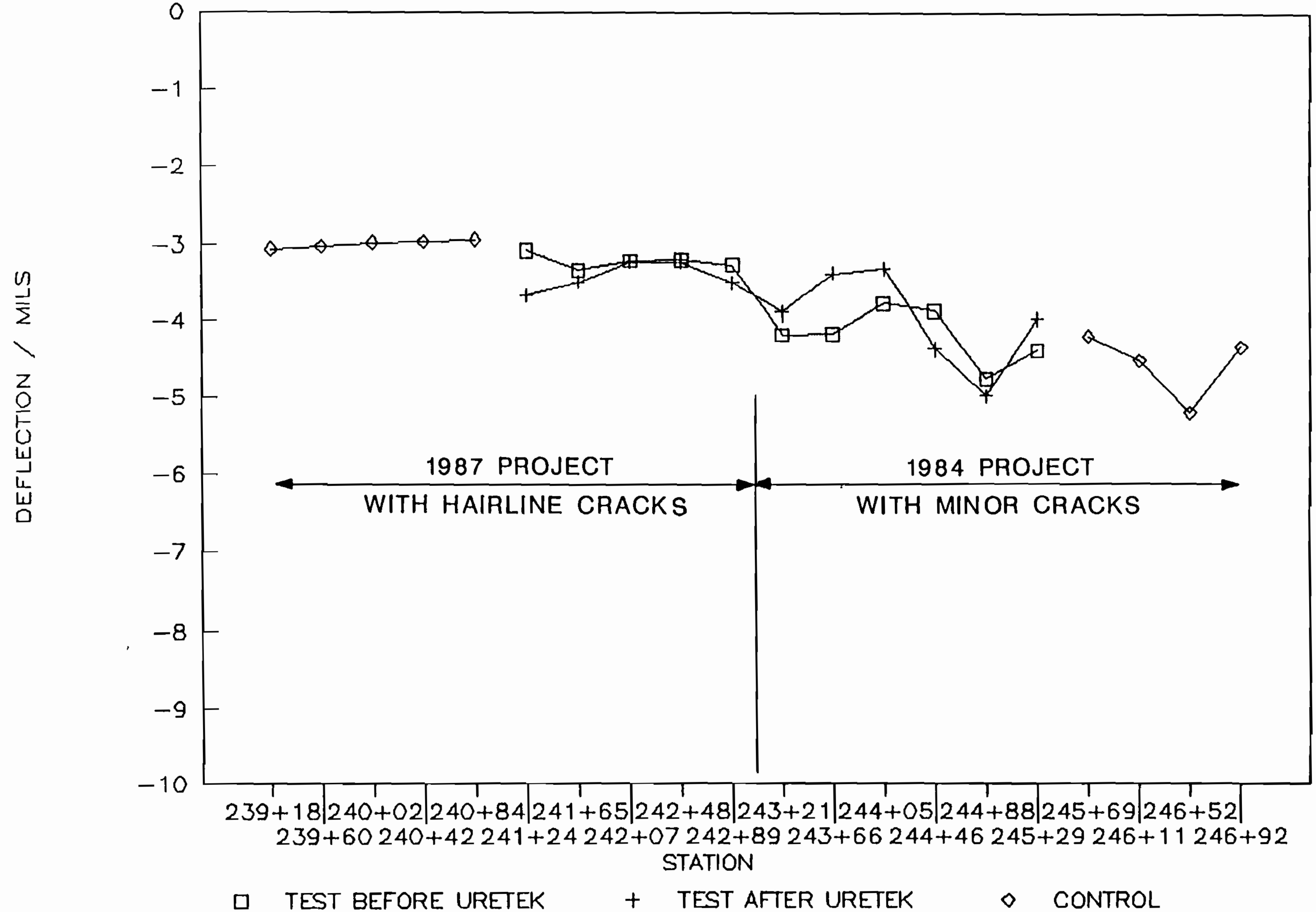


FIGURE 2

I-75 NBOL URETEK TEST SITE 1

MAXIMUM FWD DEFLECTIONS AT JOINTS

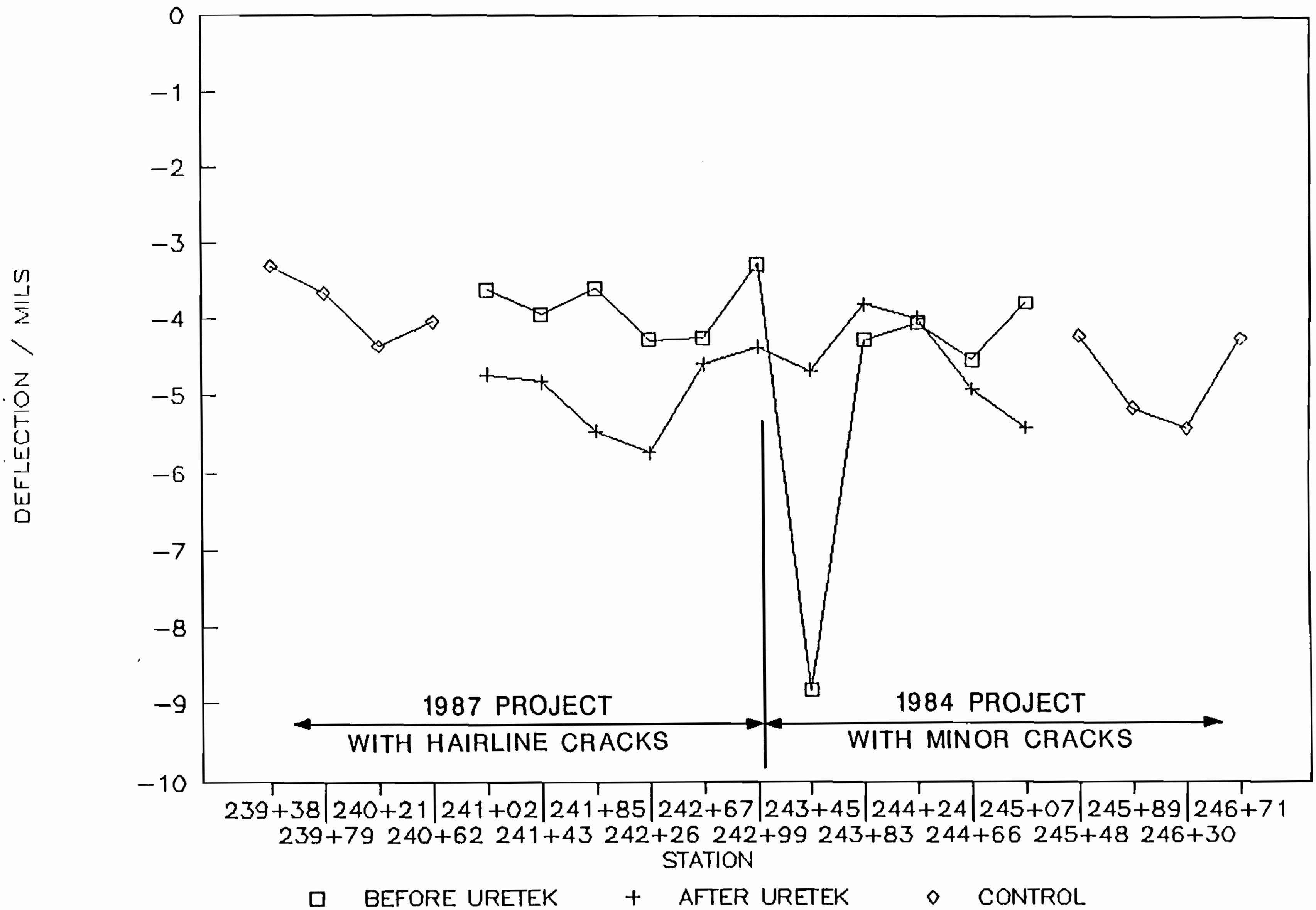


FIGURE 3

I-75 NBOL URETEK TEST SITE 1

MAXIMUM FWD DEFLECTIONS AT CRACKS

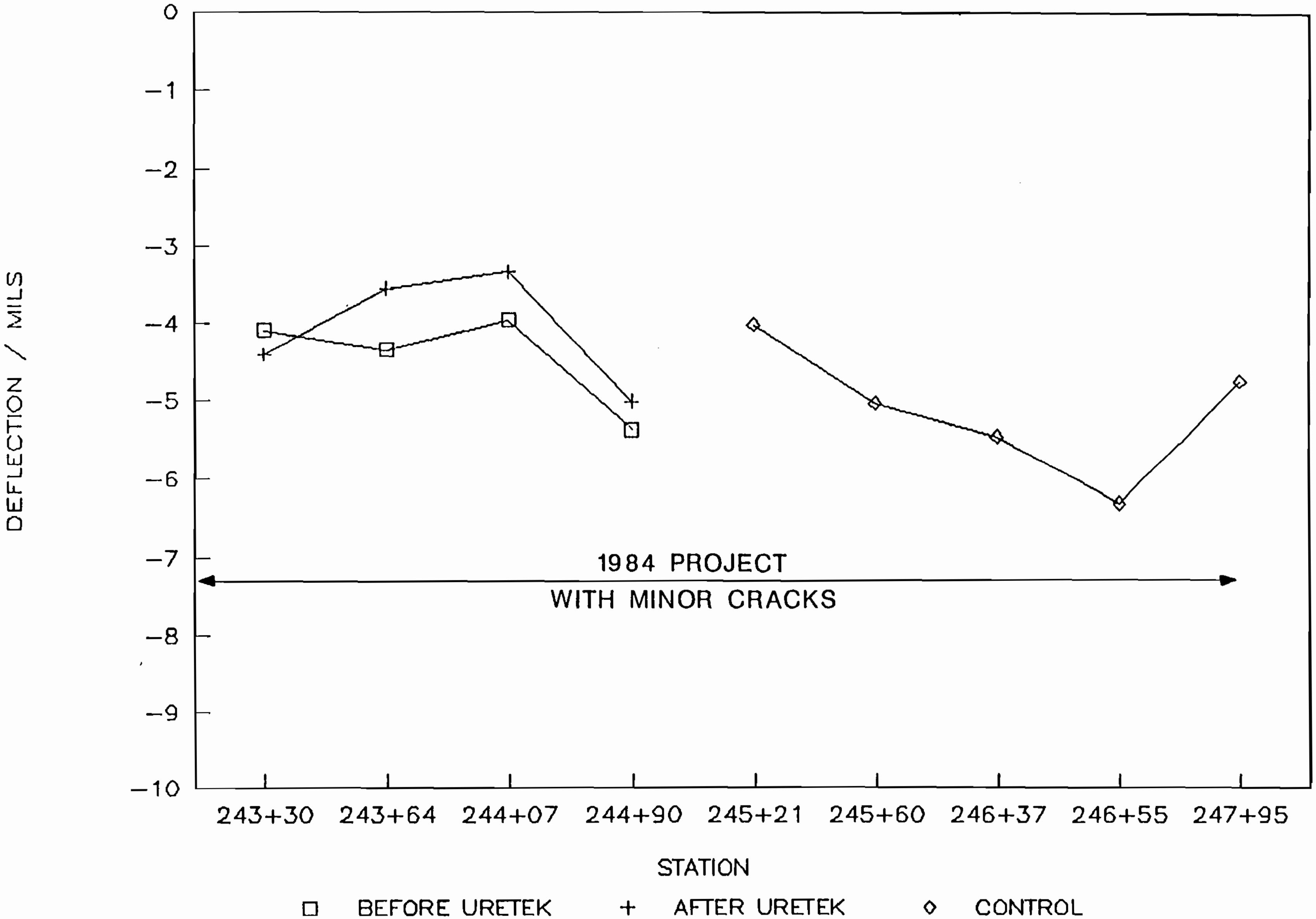


FIGURE 4

I-75 NBOL URETEK TEST SITE 2

MAXIMUM FWD DEFLECTIONS AT MIDSLAB

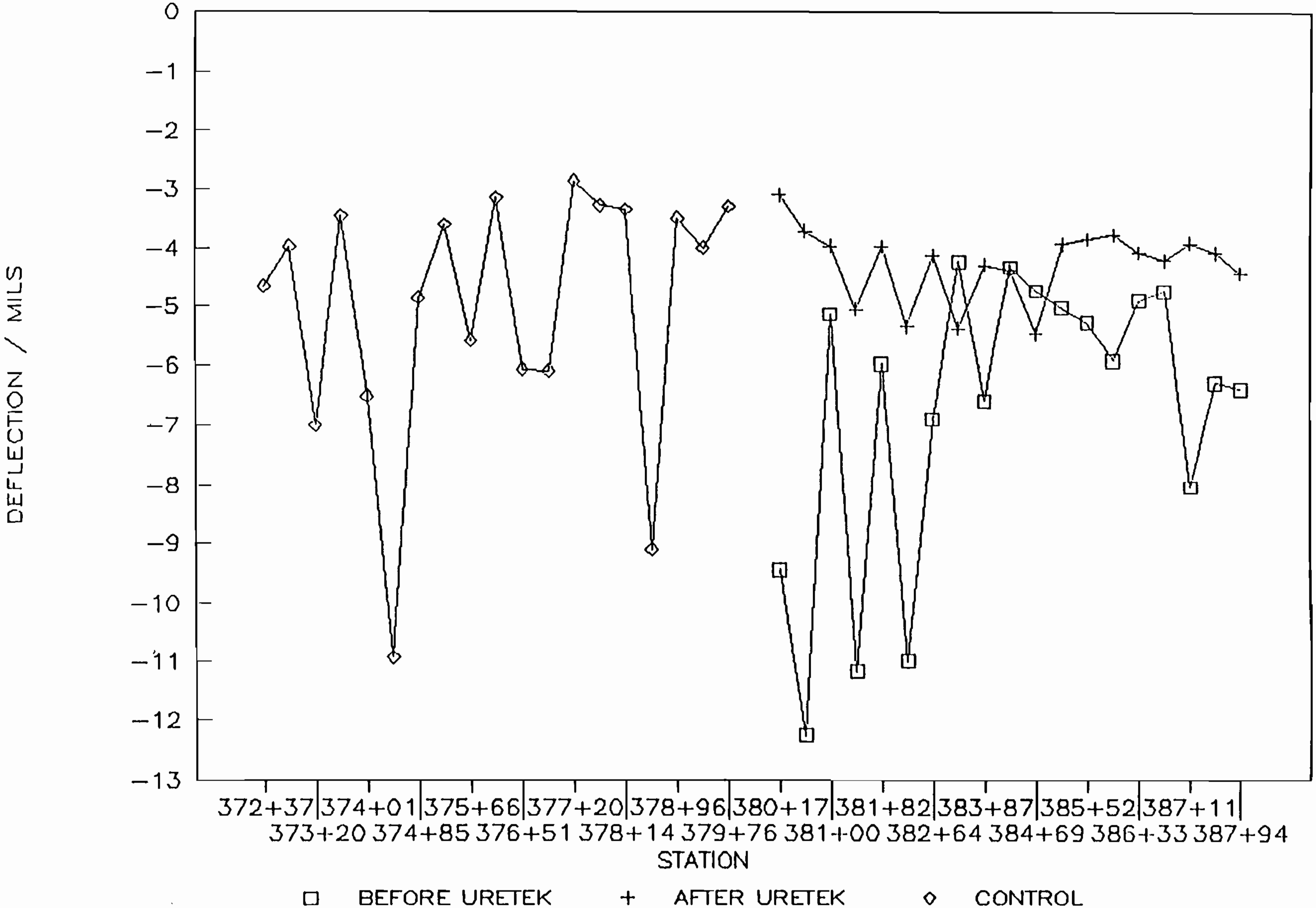


FIGURE 5

I-75 NBOL URETEK TEST SITE 2

MAXIMUM FWD DEFLECTIONS AT JOINTS

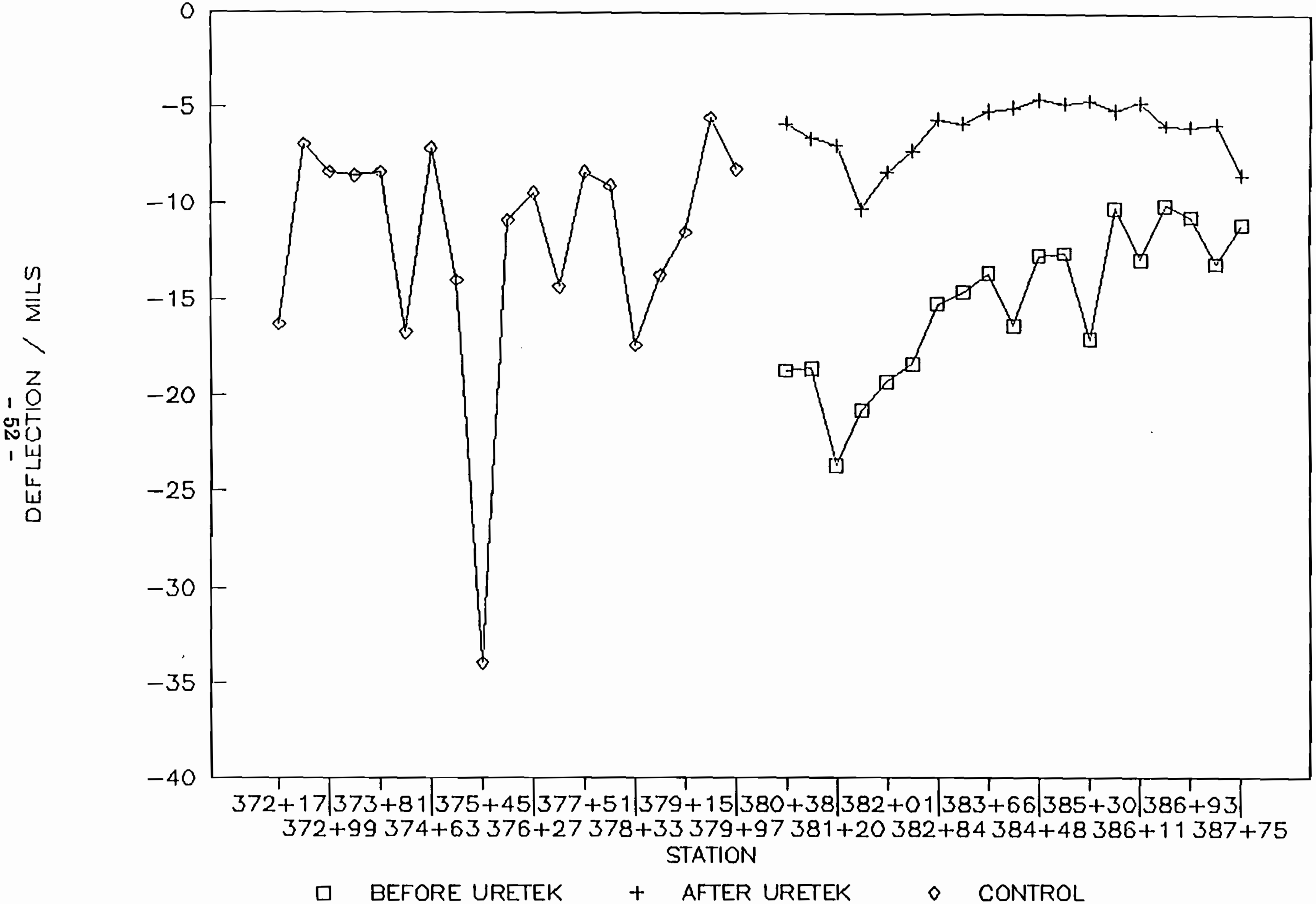


FIGURE 6

I-75 NBOL URETEK TEST SITE 2

MAXIMUM FWD DEFLECTIONS AT CRACKS

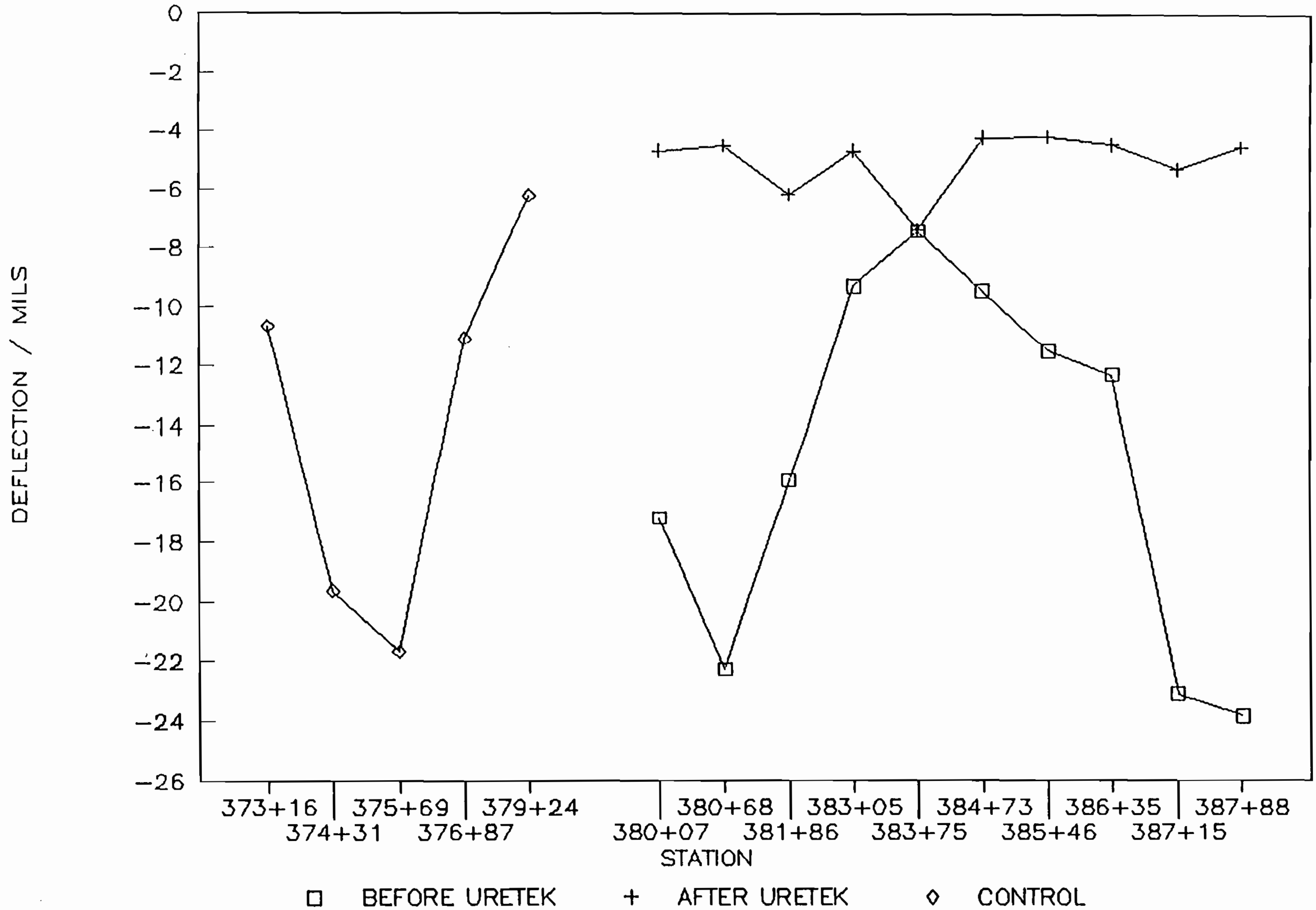
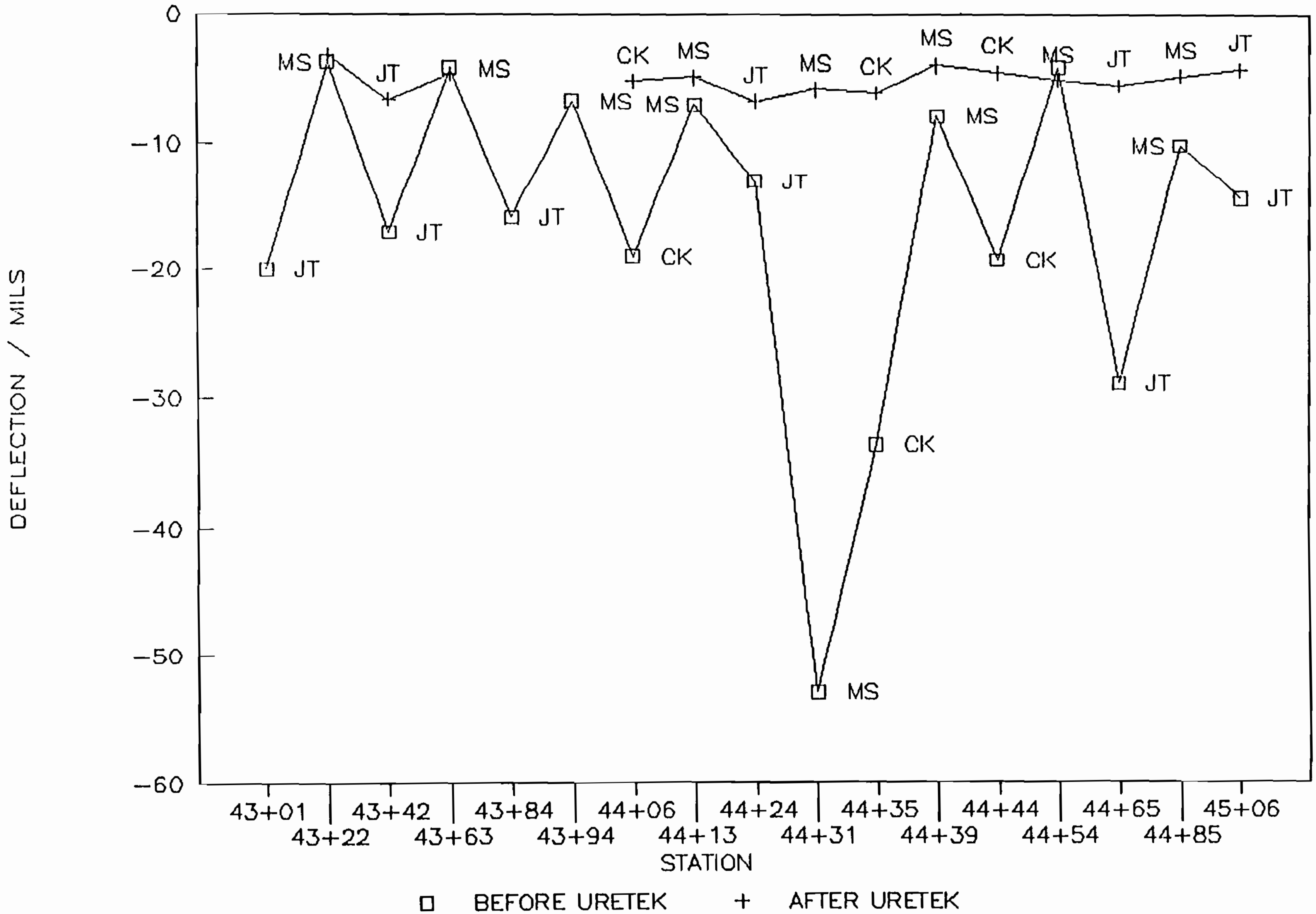


FIGURE 7

I—75 NBOL URETEK UNDERSEAL TEST SITE 3

MAXIMUM FWD DEFLECTIONS



APPENDIX

PHOTOGRAPHS OF THE URETEK METHOD

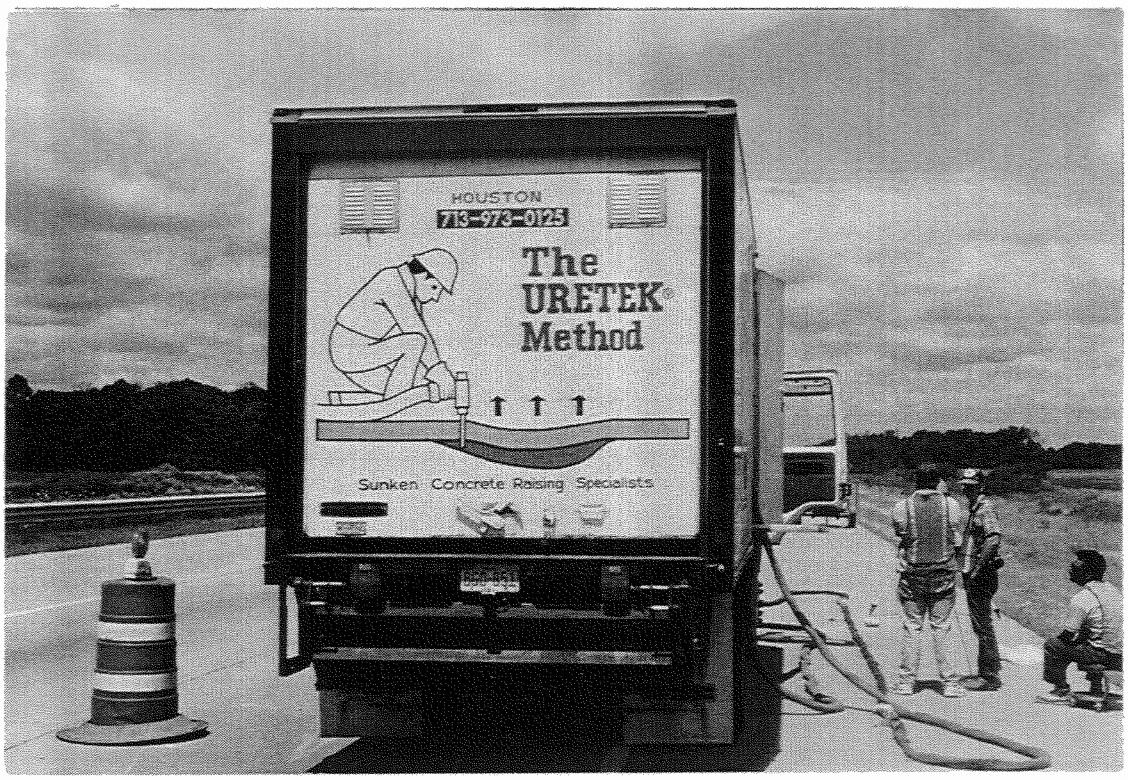


Figure 1. The Uretek truck.

Figure 2. Drilling holes in concrete pavement.

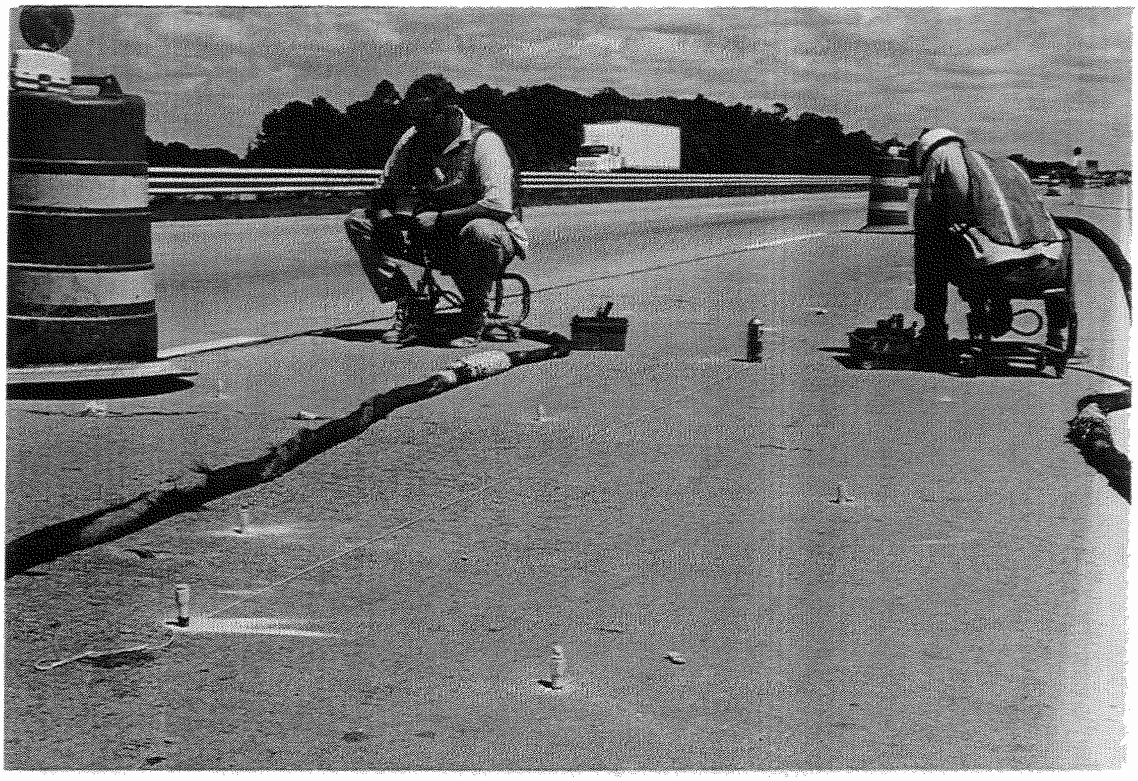


Figure 3. Injecting material through pavement.

Figure 4. Checking slab rise with level rod.

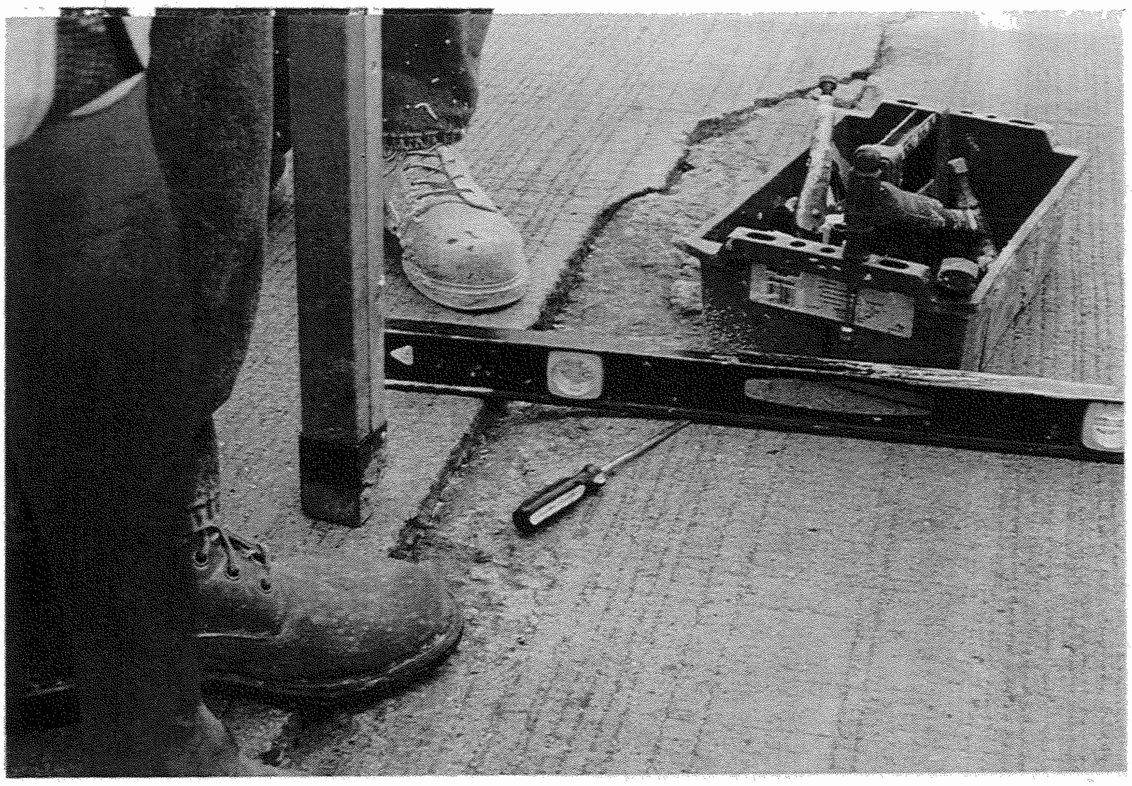


Figure 5. Faulted crack before treatment.

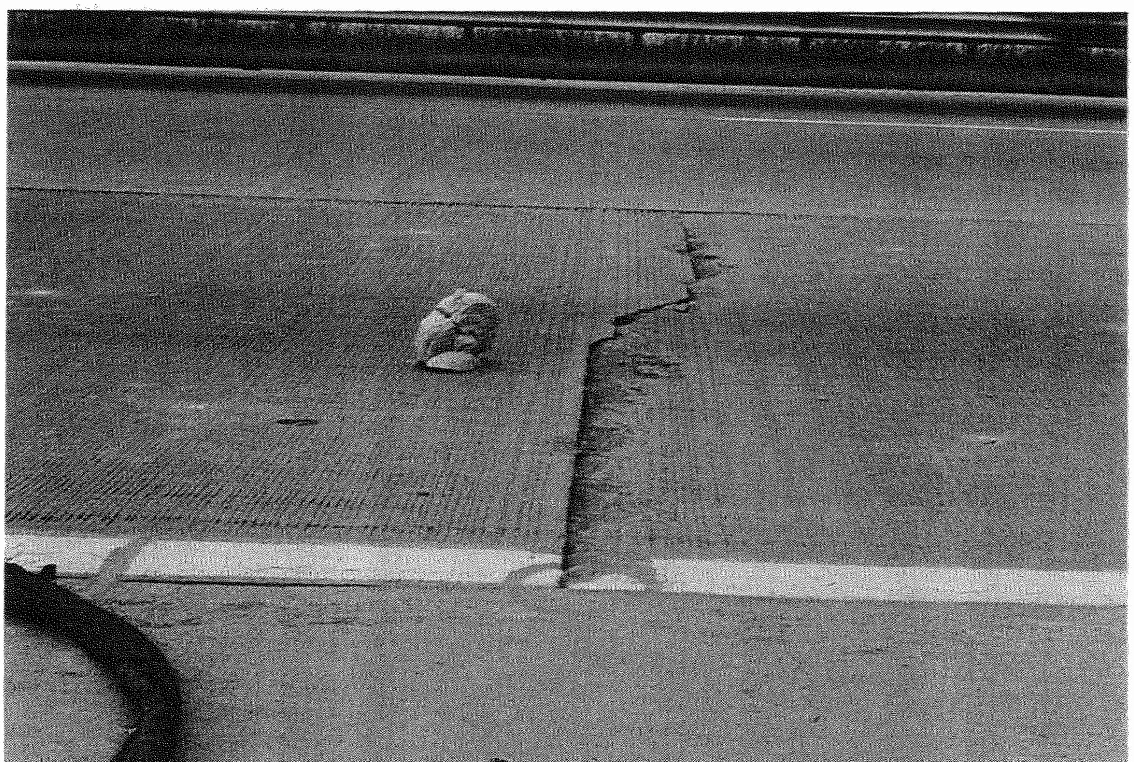


Figure 6. Faulted crack after treatment.

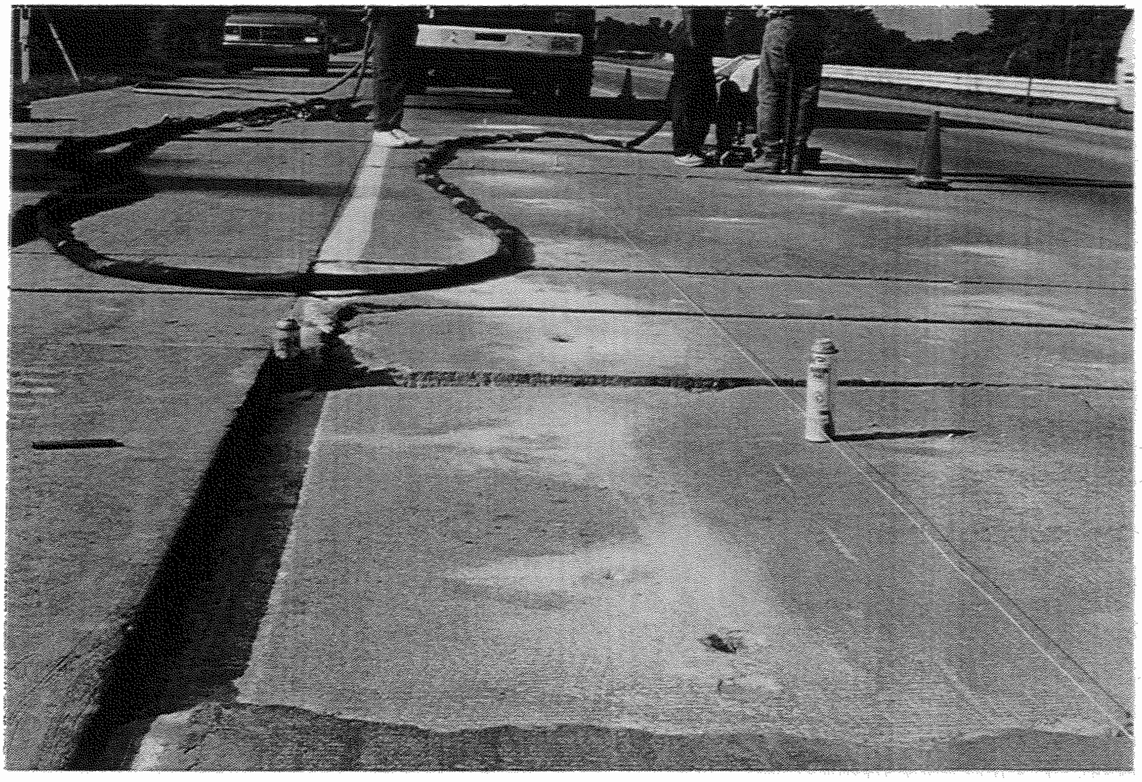


Figure 7. Four-inch settlement before treatment.

Figure 8. Raised slab after treatment.

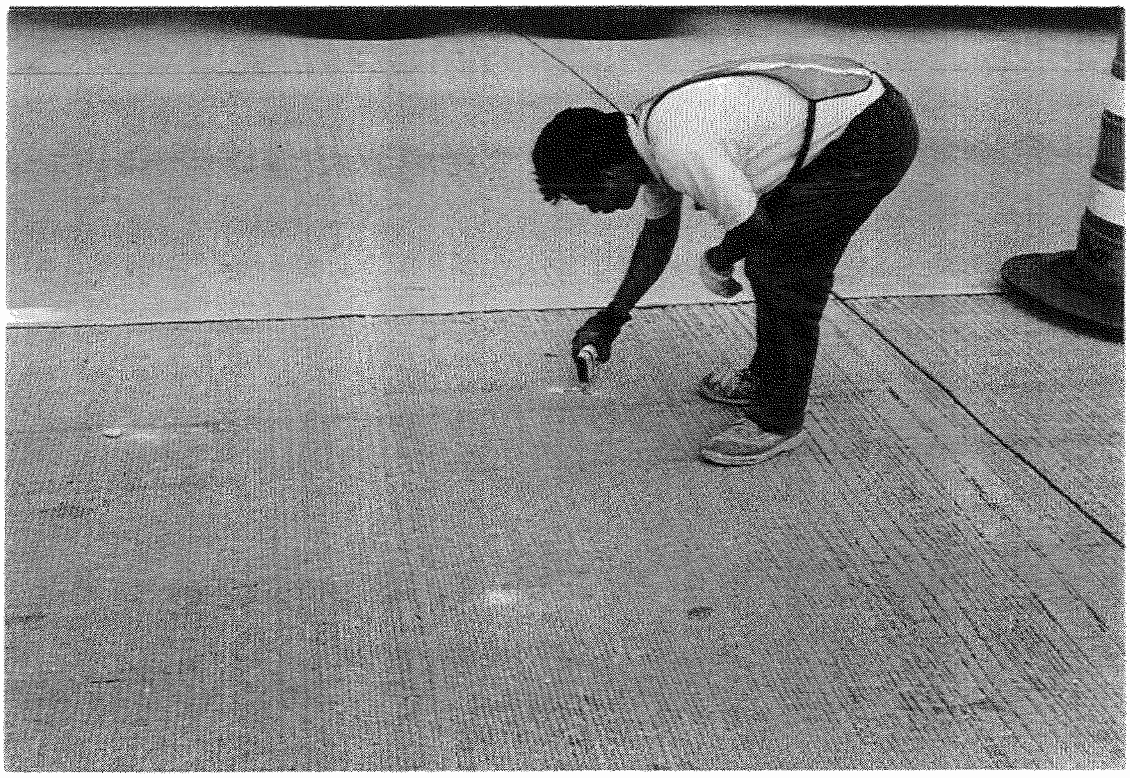


Figure 9. Grouting the drilled holes.

Figure 10. MDOT's Falling Weight Deflectometer.