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EVALUATION OF PAVEMENT BLEEDING PROBLEM ON 1-55 IN ILLINOIS

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Paper presented at the 1991 Meeting of the Transportation Research Board

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ABSTRACT

Evaluation of Pavement Bleeding Problem on 1-55 in Illinois

Shortly after construction fat spots began to appear throughout the project on a 3 inch hot mix asphalt (HMA) overlay of an existing PCC pavement. The fat spots appeared to occur at end of truck loads. After time the fat spots developed into potholes and the asphalt appeared to be stripped from the aggregate at the bottom of the potholes. Some rutting and shoving also developed at these fat spots. The objective of this study was to evaluate the HMA and to determine potential causes of these fat spots.

The test plan included a visual inspection of the pavement and obtaining core samples from fat spots, adjacent to fat spots and from random locations throughout the project. Rut depth measurements were also obtained. The cores were tested for asphalt content, gradation, void content and slag content. Several of the asphalt mix layers were split in half (resulting in top and bottom halves) and the asphalt content and gradation of each half compared. The asphalt cement from several cores were recovered and the viscosity and penetration determined. The results of this study indicated that the most likely cause of the fat spots was contamination of the HMA with some solvent (likely diesel) during the placement operation.

Evaluation of Pavement Bleeding Problem on 1-55 in Illinois

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Introduction

The existing pavement surface on 1-55 near Collinsville, Illinois was overlaid in 1985-1987 with 3 inches of asphalt mix. This work was performed under two contracts and was finished in 1987. The asphalt mix that experienced problems was placed in 1987.

Shortly after construction, personnel within the Illinois DOT began to notice fat spots at locations throughout the project. After some investigation it was noticed that there was some pattern to the fat spots. Most of them appeared to occur at the end of truck loads. It was also noticed that after a period of time these spots developed into potholes and the asphalt appeared to be stripped from the aggregates at the bottom of the potholes. Some rutting and shoving also developed at these fat spots.

The objective of this study was to evaluate the asphalt mix placed on 1-55 and to determine potential causes of the fat spots.

This study included an inspection of the roadway to develop a detailed test plan. A test plan was developed that included cutting a trench through one of the fat spots, taking cores in and adjacent to these spots and taking random cores throughout the project. These asphalt samples were evaluated to determine aggregate gradation, asphalt content and properties, and mix properties. The test data was analyzed to identify possible causes of the localized bleeding problems.

Field Inspection

The inspection of the pavement on 1-55 in May 1989 verified that a number of fat spots existed throughout the project. The distance between these fat spots varied over the pavement but it did appear that the problem was generally associated with some segregation that typically occurs at the end of truck loads. In some places it appeared that the asphalt in these fat spots had migrated to the pavement surface. In these places it appeared that the asphalt had been stripped from the underlying aggregates. The test plan was set up to evaluate if stripping had occurred or if some other problem had caused the fat spots. The area of pavement adjacent to these fat spots had become rough in some cases and it appeared that the roughness would increase with time.

Test Plan

A test plan was developed for 1-55 to determine the cause of localized bleeding. Samples of asphalt mix were taken in the fat spots, adjacent to the fat spots, and at random from station 916+25 to station 937+50 (Figure 1). A total of 30-4 inch cores were taken for testing. A trench approximately 2 ft. wide and approximately full width was excavated at station 934+70. The trench was selected at a location that had bleeding spots to determine if the problem could be identified by viewing the side of the trench.

Typical cores were taken at 300 ft. intervals to evaluate the average asphalt mix properties. Additional cores were taken in bleeding areas at stations 923+47, 936+10, and 936+93. One core was taken inside the bleeding area and one core was taken immediately adjacent to the bleeding area. The asphalt content and aggregate gradation of the samples in the bleeding areas were compared to that from adjacent areas and to that from the typical cores.

The cores in the bleeding areas and adjacent to the bleeding areas were sawed into to obtain atop half and bottom half. The asphalt content and aggregate gradation was determined for the top half and bottom half. The purpose of this effort was to determine if the asphalt cement and maybe some fines had migrated from the bottom of the top layer to the surface.

Rut measurements were taken at the trench and the results plotted in Figure 2. The rut depth at this location was approximately 0.6 inches. Atypical localized bleeding area is shown in Figure 3.

There was some concern about the amount of slag that was used *in* the asphalt mixture. Since slag has a high absorption, a high variability in slag content would adversely affect the optimum asphalt content. The amount of slag was measured by visually separating the slag particles from the limestone particles on individual sieve sizes during the aggregate gradation tests. The slag particles were weighed for each sieve size and compared to the weight of the non-slag particles. The percentage of slag larger than the No. 16 sieve was determined in this way. This is not a standard test and the accuracy is questionable but this was one method of estimating the slag content. The material smaller than a No. 16 sieve could not be separated visually and hence this material was not considered in the slag content.

Test Results and Discussion

The pavement section (Figure 2) shows that there were 2 layers of asphalt mixture placed over an existing layer of concrete. The total thickness of asphalt mixture was approximately 3 inches. Figure 2 shows that rutting had occurred in the surface and binder course. The rutting was more severe at the locations that had localized bleeding than in the other areas. The major concerns at the time of inspection was the rutting problem in general and the ravening and potholes being developed at the localized fat spots.

An inspection of the pavement adjacent to the trench cut through a bleeding spot did not indicate causes of the problem. This inspection did show that the problem was confined to the top layer of asphalt mixture and that the lower half of the layer had less asphalt cement than the top half.

The results of slag content tests are shown in Table 1. The measured slag content ranged from a low of 28.4 to a high of 31.6. The JMF required 39.3 percent slag between the No. 4 and No. 16 sieves. The test used to measure slag is not a standard test therefore the accuracy of the test is unknown. Since the measured amount of slag is consistent at each of the stations it is doubtful that variation in slag content caused the bleeding problem.

The aggregate gradation of the surface course is reasonably consistent at the various sampling locations. The average gradation of the surface course does deviate from the JMF on the No. 4 and No. 8 sieves (Table 1). After evaluating the individual gradation it is believed that the gradation has had no affect on rutting or the localized bleeding problems. It is possible that segregation of the mix at particular points could be a problem but that is discussed later.

Table 1 shows that the measured in-place asphalt content is approximately 1 percent lower than the designed asphalt content. This lower asphalt content could be the result of testing error, mix modifications made during construction, or failure of the contractor to meet the job mix formula. The relatively low in-place voids (4.6% average) shows that the asphalt content actually used is not too low. Regardless of the reasons for an asphalt content lower than design, the asphalt content actually measured on the final product appears to be acceptable based on the in-place voids.

Samples of the asphalt mix in layers 1 and 2 were recompacted with a Marshall hammer and with a Gyratory Testing Machine. The compaction results (Table 2) shows that the voids were low in layer 1 and satisfactory in layer 2. The low voids in layer 1 are likely one cause for rutting. (1, 2,.3) The Gyratory Shear Index (GSI) value in layers 1 and 2 are 1.2 and 1.3 respectively. A mix with a GSI over 1.1 may have a tendency to rut and one with a GSI over 1.3 is almost certainly going to rut based on past evaluation of rutting projects.[7] The low voids and high GSI do help explain the rutting problem but do not explain the bleeding problem at localized areas.

Test results from mix obtained from localized bleeding areas are shown in Table 3. The average asphalt content is 5.4 percent higher in the top half of the asphalt cores than in the bottom half (8.8% in top half and 3.4% in bottom half). The average aggregate gradation is approximately 3 percent finer in the top of the cores than that in the bottom. This indicates that the asphalt and fines likely migrated from the bottom of the top layer to the surface.

Test results on material taken adjacent to the bleeding areas are shown in Table 4. These results show that the average gradations for the top half and bottom half are essentially the same. The average asphalt content is actually slightly higher in the bottom half of the cores which is opposite of that shown in the bleeding area. A slightly higher asphalt content in the bottom half of the core could be the result of normal variability in test results or there could be some scientific reason for it being lower (for example the bottom half of the layer could include some tack coat material which would increase the asphalt content). It is obvious however that little or no migration has occurred outside the bleeding areas but significant migration has occurred inside these areas.

A summary of the test results obtained from samples taken at random, inside bleeding areas, and adjacent to bleeding areas is shown in Table 5. This data shows that the overall gradation and asphalt content on random samples, samples from bleeding areas, and samples adjacent to bleeding area are approximately the same. The major difference is the higher amount of material passing the No. 200 sieve in the bleeding areas. This indicates that the mixture initially placed contained the correct gradation and asphalt content but after compaction and/or traffic the asphalt cement and fines migrated from the bottom of the top layer to the surface.

The asphalt was recovered from the bleeding area and adjacent to the bleeding area to determine if there were differences in asphalt properties between the two areas. It is obvious from Table 6 that there are significant differences. The properties of the asphalt from bleeding areas is considerably softer than the properties of asphalt adjacent to bleeding areas. In fact the asphalt binder from bleeding areas is softer than the original asphalt would have been. For instance the viscosity of 956 is close to that for an AC-1O, 460 is close to that for AC-5, and 322 is close to that required for an AC-2.5. The original asphalt cement on this project was an AC-20, hence, the viscosity of the asphalt recovered from the in-place mix should be significantly higher than the results indicated.

This low viscosity of the recovered asphalt cement indicates some type of contamination. Since the viscosity of the asphalt cement recovered from samples taken adjacent to bleeding areas is reasonable the contamination must have occurred after mixing. It is suspected that the contamination either came from the use of diesel or some other unacceptable release agent to coat truck beds or from some spillage of one of these materials on the binder course prior to overlaying. Diesel fuel is the most likely contaminant since it evaporates slowly and thus would keep the viscosity of the asphalt low for a long period of time. The specific cause of the contamination problem was not identified.

Summary

Small localized bleeding areas were identified on 1-55 a short time after placement. The bleeding areas developed into potholes in some cases and increased rutting. A test pattern was developed to determine causes of the bleeding problem. After completion of tests it was obvious that the resultant bleeding was due to migration of the asphalt cement and filler from the bottom of the surface course to the top of the course. Tests also showed that the asphalt cement recovered from the bleeding areas had much lower viscosities than expected, even lower than the original viscosity. It was concluded from this that the bleeding was caused by contamination with some solvent, likely diesel fuel. Further investigation, which included conversations with contractor and state DOT personnel and a review of the constructlon records, did not identify exact cause(s) of contamination.

References

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2. Huber, G.A. and Herman, G. H., 'Effect of Asphalt Concrete Parameters on Rutting Performance: A Field Investigation', Proceedings, Association of Asphalt Paving Technologists, Volume 56, 1987, pp. 33-61.

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Table 1. Properties of Random Samples of Asphalt Mix (Top Layer)

Property	JMF	916+25	919+50	922+50	925 +50	928 +50	931+50	934+50	937+50	Average
Rice Gravity	–	2.376	2.376	2.380	2.406	2.442	2.397	2.413	2.402	2.399
Bulk Gravity	–	2.271	2.304	2.292	2.278	2.298	2.298	2.257	2.305	2.288
Voids in Total Mix	—	4.4	3.0	3.7	5.3	5.9	4.1	6.5	4.0	4.6
Slag Content	39.3	29.3	29.8	28.4	31.2	30.5	30.8	30.7	31.6	30.3
Asphalt Content	7.3	6.7	6.5	6.2	6.3	5.6	6.5	6.1	6.4	6.3
Aggregate Gradation Sieve Size										
1/2 inch	100	100	100	l a)	100	100	100	100	100	100
3/8 inch	98	98	98	97	97	96	97	94	98	97
No. 4	52	60	64	59	63	50	56	54	54	58
No. 8	30	37	41	38	40	30	36	34	33	36
No. 16	20	25	28	26	27	22	25	24	24	25
No. 30	13	17	18	18	18	15	18	17	16	17
No. 50	9	11	12	11	11	11	12	11	11	11
No. 100	7	7	8	8	8	7	9	8	8	8
No. 200	5.3	4.8	6.4	5.8	5.8	5.4	6.3	5.8	5.5	5.7

Table 2. Properties of Recompacted Mix

Compactive Effort	'Layer No.	Voids in Total Mix	Marshall Stability	Marshall Flow	Gyratory Shear index
Marshall 75 Blows	1	2.2	3688	12	---
GTM (120 psi, 1 degree angle, 300 revolutions)	1	2.1	3165	14	1.2
Marshall 75 Blows	2	3.6	3194	12	---
GTM (120 psi, 1 degree angle, 300 revolutions)	2	3.1	3033	13	1.3

Table 3. Properties of Top Half and Bottom Half of Samples Taken from Bleeding Areas (Top Layer)

Property	Top Half				Bottom Half			
	936+93	936+10	923 +47	Average	936+ 93	936+10	923 +47	Average
Asphalt Content	8.8	9.4	8.3	8.8	3.0	2.3	4.9	3.4
Aggregate Gradation Sieve Size								
1/2 inch	100	100	100	100	100	100	99	100
3/8 inch	96	97	100	98	98	99	97	98
No. 4	52	62	70	61	46	58	71	58
No. 8	31	39	44	38	26	33	45	35
No. 16	23	28	30	27	19	22	31	24
No. 30	17	22	20	20	14	15	21	17
No. 50	12	17	13	14	9	10	14	11
No. 100	9	14	10	11	6	6	10	7
No. 200	6.8	11.6	7.3	8.6	4.2	4.6	7.3	5.4

Table 4. **Properties of Top Half and Bottom Half of Samples Taken Adjacent to Bleeding Areas (Top Layer)**

Property	Top Half				Bottom Half			
	936+93	936+10	923+47	Average	936+93	936+10	923+47	Average
Asphalt Content	5.6	6.2	6.1	6.0	6.1	6.7	6.5	6.4
Aggregate Gradation Sieve Size								
1/2 inch	100	100	100	100	100	100	100	100
3/8 inch	96	98	100	98	98	100	98	99
No. 4	51	59	64	58	53	56	64	58
No. 8	30	35	39	35	32	34	39	35
No. 16	21	24	26	24	23	24	27	25
No. 30	15	16	17	16	16	16	18	17
No. 50	11	12	11	11	11	11	12	11
No. 100	8	8	8	8	8	8	8	8
No. 200	5.8	6.4	5.8	6.0	6.0	5.9	5.9	5.9

Table 5. Summary of Asphalt Contents and Gradation at Various Locations in Top Layer

Property	JMF	Average of Random Samples	Bleeding Areas			Adjacent to Bleeding Areas		
			Top Half	Bottom Half	Combined	Top Half	Bottom Half	Combined
Asphalt Content	7.3	6.3	8.8	3.4	6.1	6.0	6.4	6.2
Aggregate Gradation Sieve Size								
1/2 inch	100	100	100	100	100	100	100	100
3/8 inch	98	97	98	98	98	98	99	98
No. 4	52	58	61	58	60	58	58	58
No. 8	30	36	38	35	36	35	35	35
No. 16	20	25	27	24	26	24	25	24
No. 30	13	17	20	17	18	16	17	16
No. 50	9	11	14	11	12	11	11	11
No. 100	7	8	11	7	9	8	8	8
No. 200	5.3	5.7	8.6	5.4	7.0	6.0	5.9	6.0

Table 6. Summary of Asphalt Properties in Bleeding Areas and Adjacent to Bleeding Areas

Property	Bleeding Areas			Adjacent to Bleeding Areas		
	936+93	936+10	923+47	936 +93	936+10	923 +47
Viscosity (140°F, Poises)	956	460	322	10003	5430	2575
Penetration (0.1 mm)	290+	169+	350+	30	36	151

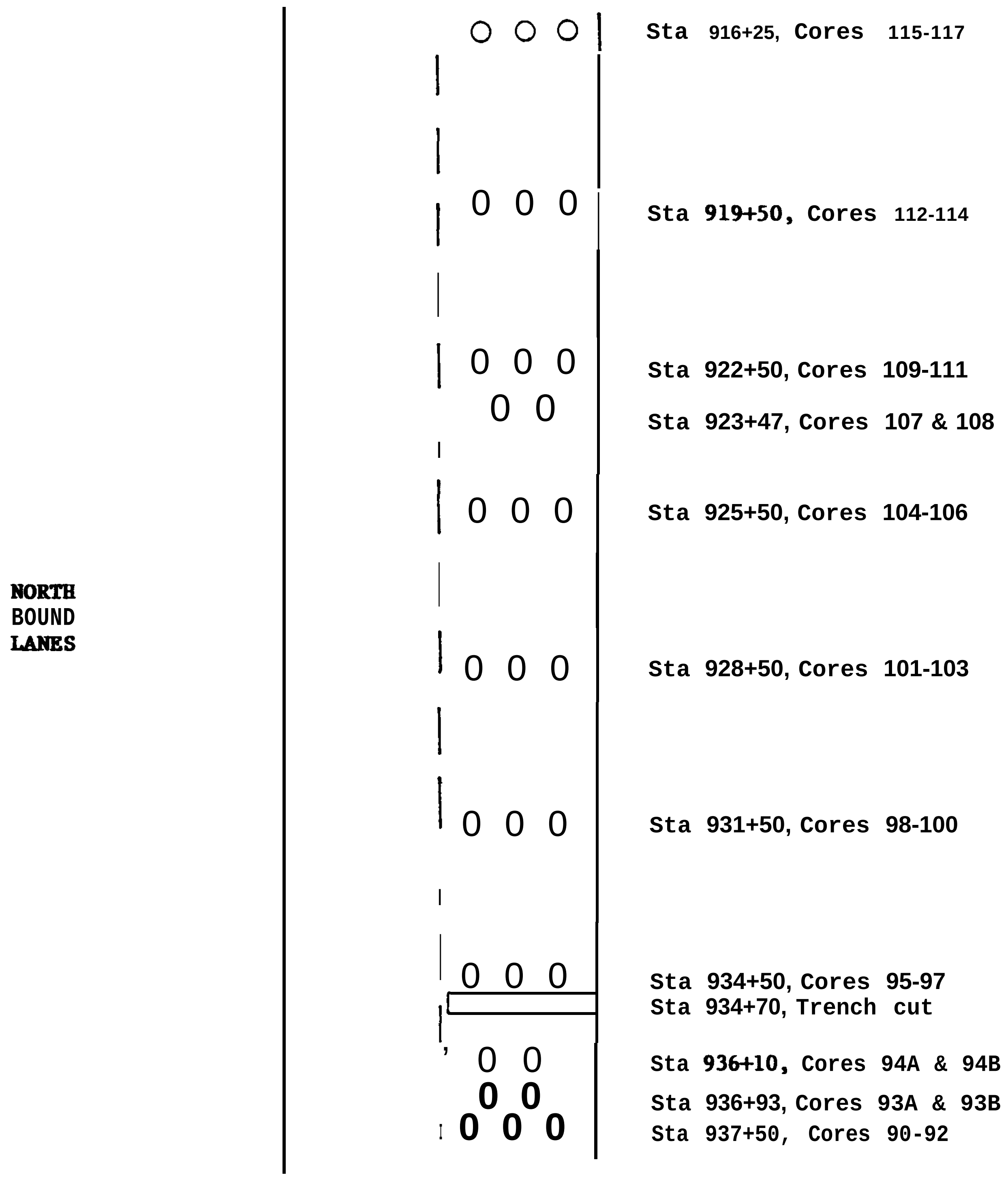

Figure 1. Layout of Test Section North Bound Lanes, 1-55, Near Collinsville, IL.

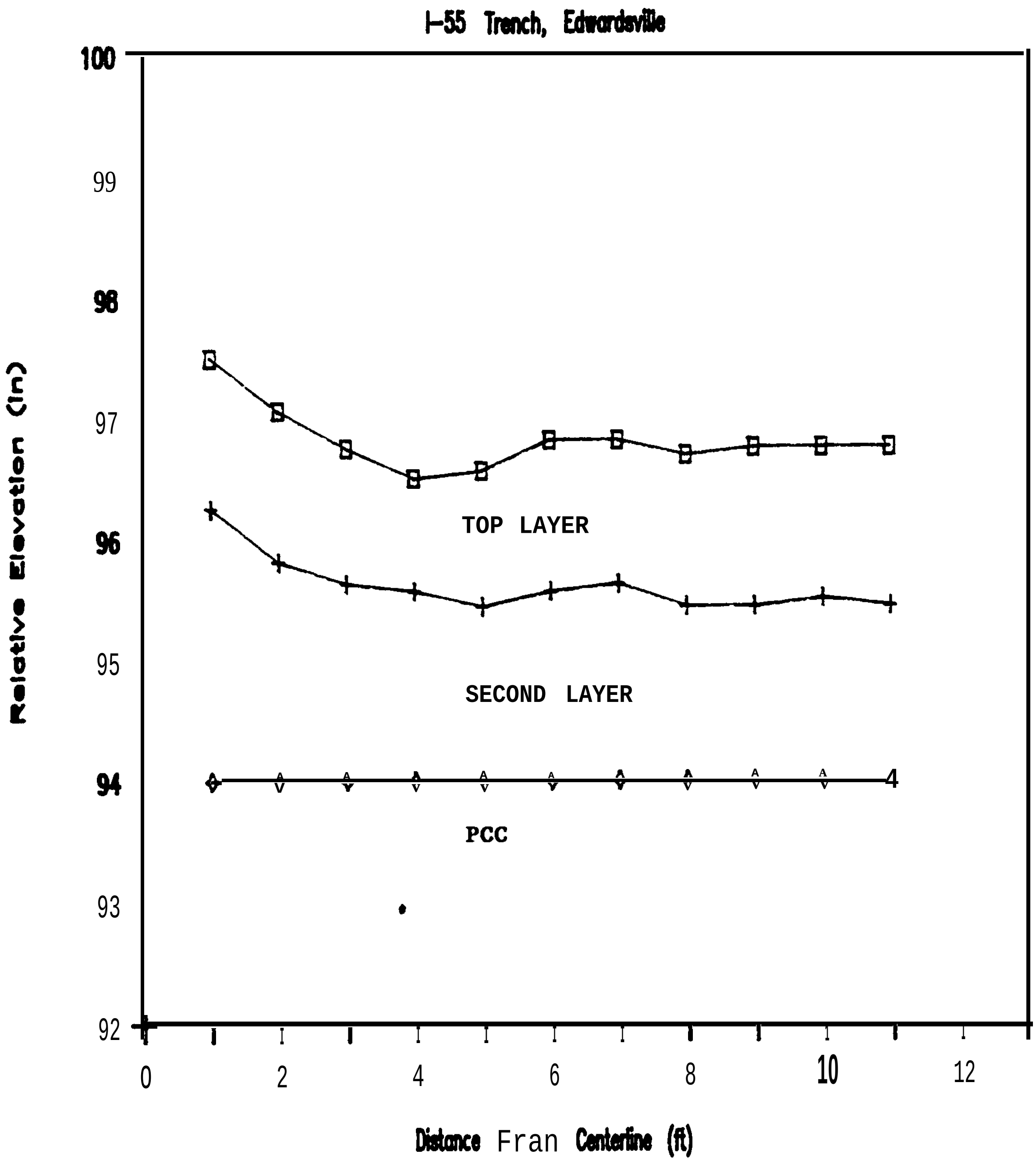

Figure 2. **Trench Cut at Sta. 934+70, North Bound Lane, 1-55, Near Collinsville, IL.**

Figure 3. Typical Localized Bleeding Area, North Bound Lanes, 1-55, Near Collinsville, IL.