



WILLIAM B. HAZELRIGG
COMMISSIONER

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT, KENTUCKY 40601

August 23, 1968

ADDRESS REPLY TO
DEPARTMENT OF HIGHWAYS
DIVISION OF RESEARCH
533 SOUTH LIMESTONE STREET
LEXINGTON, KENTUCKY 40508
Telephone 606-254-4475

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B-2-2-5

MEMO TO: A. O. Neiser, State Highway Engineer
Chairman, Research Committee

SUBJECT: Final Performance Reports on:
1) A Concrete Pavement without
Transverse Joints
2) Wire Mesh Reinforcement in Bituminous
Concrete Overlays
3) Limestone Sand Blankets to Control
Reflection Cracking in Bituminous Overlays
4) Experimental Joint Installations for Concrete
Pavements

The four reports submitted herewith in one volume are in the nature of "old business". Projects involving experimental design and construction features are considered to remain active until a final report is filed. This is a condition and requirement upon work approved by the Bureau of Public Roads under PPM 60-2 and an implied condition upon all experimental work undertaken by the State on Federal Aid roads. Some projects have lapsed or have otherwise fulfilled their purpose long ago. A list of fifty-six projects of this nature was compiled from memory and records (August 7, 1964) upon request of the Division office of the Bureau of Public Roads, May 15, 1964. Final reports were requested on Items 1, 2, and 4 (hereof). Item 3 has not been listed or reported previously.

Following our recent inspection and preparation of the report on Item 1 (US -31W, Franklin-Tennessee Line), we felt compelled to core the pavement and to investigate further the cracking in the concrete surface--as illustrated in Figure 4 of the report. The cores revealed V-type cracks to a depth of about 1.5 inches. There is a striking similarity between these cracks and those currently being studied on I 65, south of the US 231 interchange (paved in 1965). Both the old and the new pavements were membrane-cured; wire mesh was vibrated into the new pavement; no mesh was used in the old pavement; presumably both were finished with vibrating screeds. No conclusion is implied by this comparison. The pavement was showing distinct indications of pumping at the edge of the slab, and the deflection of the slab at the edge was quite visible when heavy trucks would pass.

It is unfortunate that our report on "Wire Mesh..." (Item 2) was not submitted in time to be of use to the Bureau in their summary of performance (IM CMPB-1, February 1968).

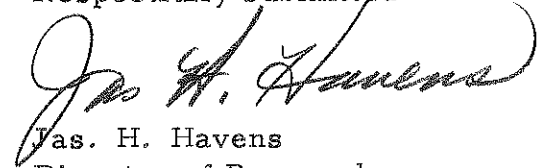
Item 3, of course, is a continuation report on the same (above) problem; dusting or sanding the concrete slabs on each side of a crack or joint--to prevent the asphalt overlay from bonding--seemed to offer considerable promise a few years ago in preventing reflection cracking. Our report relates performance experience with this type of treatment on US 421 west of Lexington. A similar treatment was employed during the reconstruction (4 lanes) of US 41 between US 60, north of Henderson, and a point near the Ohio River. There, reflection cracking was suppressed or delayed noticeably also. Current thinking on this matter seems inclined toward thick overlays and fragmentation of the concrete slabs.

Item 4 includes four subitems. The first three pertain to joint assemblies. The first relates an experimental trial of a preformed Neoprene gasket-type seal that was cast in place over a joint assembly. The second and third pertain to extruded aluminum joint devices. The fourth pertains to poured-type seals for joints. There were antecedent and sequel experiments to the one on US 421 (formerly KY 150); they are listed below:

1. US 68, Lexington-Harrodsburg Road, F-369(4)24(3), 1947 (Fall); eighteen joints were sealed with experimental materials, eight of those were filled with cold-applied mastic.
2. US 31W, Franklin-Tennessee Line, FI 239(4), --this is the same section of road as that covered by Item 4, herein. Cracks were grooved and sealed with cold-applied mastic in November, 1949 (Sta 185+80-311+00) and in October, 1950 (Sta 20+00-40+30). The cracks from Sta 40+30-185+80 were filled with hot-poured, rubberized asphalt; and the remaining cracks were filled with OA-2 blended with MC-3.
3. US 42, Carrollton Bridge Approach, FI 197(6); 1952; this was the first attempt in Kentucky to saw contraction joints in concrete pavements. Preformed (sic, formed with inserts), weakened-plane joints were constructed at 80-foot intervals; and weakened-plane joints were sawed at intervening intervals of 20 feet. Load-transfer assemblies were used at construction joints only. The sealer materials were: 1) OA-2 blended with MC-3, 2) hot-poured, rubberized asphalt, and 3) two-component, cold-applied mastic.

In the near future, we will update the list of experimental projects to indicate their status or final disposition and will provide copies for review or as a matter of record.

Respectfully submitted



Jas. H. Havens
Director of Research

JHH:em

cc's: Research Committee

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- W. B. Drake, Assistant State Highway Engineer
- J. T. Anderson, Projects Management Engineer
- K. B. Johns, Operations Management Engineer
- J. R. Harbison, Program Management Engineer
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- R. E. Johnson, Division Engineer, Bureau of Public Roads
- D. K. Blythe, Chairman, Department of Civil Engineering, Associate
Dean, College of Engineering, U. of Ky.

Attachment

Research Report

FINAL

A CONCRETE PAVEMENT WITHOUT
TRANSVERSE JOINTS
(Experimental)
(US 31W, Simpson County, FI 239(4))

by
Ronald D. Hughes
Chief Research Engineer

Division of Research
DEPARTMENT OF HIGHWAYS
Commonwealth of Kentucky

July 1968

INTRODUCTION

In 1949, a 5.737-mile section of portland cement concrete pavement was constructed without the inclusion of transverse joints. The project, designated as FI 239(4), is a section of US 31W located in Simpson County extending from the Tennessee line (Sta 9+11) to the south city limits of Franklin (Sta 311+40). The pavement is 22 feet wide, 8 inches thick, and is underlain by 1-1/2 inches of compacted No. 10 crushed limestone for insulation and leveling. Air-entraining cement was used and the concrete was placed with approximately 4-1/2 percent entrained air. One-half inch deformed tie bars were used in the longitudinal joint at the center of the slab. Butt-type transverse joints were placed at the ends of pours. The pavement contained no wire mesh reinforcement and was cured by application of liquid membrane-forming compound containing a fugitive dye. The project was completed on June 30, 1949. This final report presents a summary of previous reports and includes results of a recently conducted condition survey.

Several extensive performance surveys were made during construction and within a short period of time after completion of the project. In all, twelve inspections have been made to date -- nine having been made by October 24, 1952, and the most recent on June 6, 1968. The project has been reported periodically, and a listing of these reports is included at the end of this memorandum. Table I contains a summary of cracks noted during the various surveys, and Fig. 1 is a plot of crack intervals vs. inspection date. Forty-one butt-type construction joints were placed at "ends of runs" throughout the length of the project. The joints may be considered as built-in cracks; therefore a listing of number of cracks and joints is included in Table I. Strip maps denoting general conditions of the pavement to date are appended hereto. Additionally, grade lines and elevations throughout the project are included.

PERFORMANCE

Approximately 60.5 percent of the pavement is located within fill sections, 38.8 percent is within cut sections, and the remaining 0.7 percent is at original ground elevation. Cracks noted throughout the project are rather evenly distributed with respect to cut and fill sections. A high percentage of cracks do exist at transitions between cut and fill sections. This condition is often observed in the performance of concrete pavements and such cracking is sometimes attributed to differential settlement or consolidation and in some cases may be a result of hydrostatic pressure. Faulting has not been a major problem; and, in fact, surprisingly few faults have occurred to date. Three faults were reported in December 1952; and those were caused by excessive maintenance in the form of mud-jacking or patching. Twelve additional faults were reported in January 1956

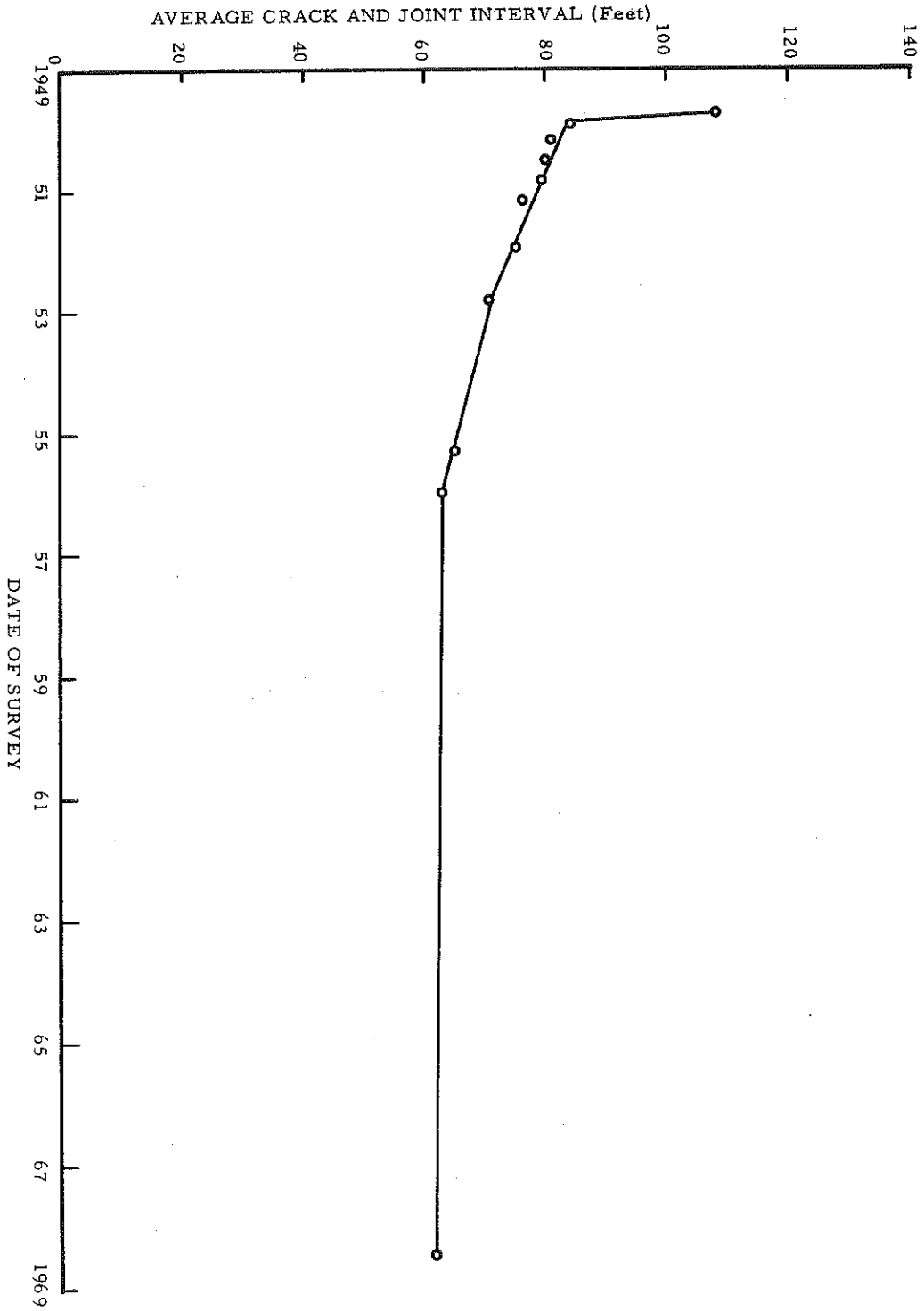


Figure 1. Trend of Average Crack and Joint Interval

TABLE I
Summary of Crack Survey

Survey Date	Cracks	Cracks and Joints**	Average Interval (Feet)	
			Cracks	Cracks and Joints
6-23-49*	77		247.9	
9- 7-49	283	279	127.0	108.3
11-18-49	318	359	95.1	84.2
2-16-50	327	368	92.4	82.1
6- 5-50	337	378	89.7	80.0
10-19-50	341	382	88.6	79.1
2-13-51	354	395	85.4	76.5
11-15-51	361	402	83.7	75.2
10-24-52	386	427	78.3	70.8
4- -55	424	465	71.3	65.0
12- -55	440	481	68.7	62.8
6- 6-68	458	499	66.0	60.6

*Figures for Sta. 9+11 to Sta. 200+00

**41 butt-type joints throughout project

-- none of which were considered as prominent. Nine of the faults reported in 1956 were at construction joints. Two faulted joints and four instances of pumping were noted during the 1968 survey.

Early formation of cracks had been expected from inception of the project; however, cracks that developed were more prominent and severe than had originally been anticipated. Spalling was noted at approximately 20 percent of the cracks. Soon after completion of the project, maintenance forces began sealing all cracks and joints with OA-2 (asphalt cement) filler in accordance with standard maintenance procedures. No grooving or cleaning was done prior to placement of the OA-2 seals. The seals proved unsatisfactory and did not remain intact in the narrower cracks which were predominate at the time sealing was initiated. As a result, the experimental features of the project were extended to include experimental sealing operations which were initiated in November 1949.

Prior to placement of the experimental seals, Tennant machines were used to groove the cracks. After cutting, the cracks were blown with compressed air and flushed with water to remove dust. The majority of cracks grooved late in 1949 were sealed with a cold mastic-type filler then covered by Special Specification No. 46*. Remaining grooved cracks were sealed with

*"Application of Cold-Mastic Asphalt Compounds to the Sealing of Joints and Cracks in Rigid Pavements," Bulletin No. 19, Eng. Exp. Sta., U. of Ky., March 1951.

one of four trial formulations of mastic filler designated as special formulations 332.88 A through D. A detailed description of these grooving and sealing operations is contained in Report No. 2. No particular difficulties were reported for use of the cold mastic-type filler; however, one of the special formulations was too dry and difficult to extrude while another was too viscous and did not bond adequately to the concrete.

At the time of the October 1950 inspection, the cold mastic-type seals were reported as being intact and adequately bonded to the concrete. No comment was made regarding the condition of the special formulations other than the fact that no differences were observed. In the fall of 1950, additional cracks were grooved and sealed with either OA-2 cut back with MC-3, cold mastic-type filler, or hot rubber filler. The original OA-2 seals had been observed as being brittle and the MC-3 was used in an effort to extend pliability to the material. As of December 1952*, all of the OA-2 seals had been replaced while the cold mastic-type and hot rubber fillers were reportedly in excellent condition. The cold mastic-type and hot rubber fillers were again reported in excellent condition in January 1956. In essence, the addition of the experimental sealing feature to the project clearly demonstrated the necessity for early grooving in conjunction with selection of an appropriate sealing material.

As may be noted on the appended strip maps, approximately 15 percent of the roadway has been patched or overlain with bituminous concrete since the 1956 report. More than likely, several unreported cracks may have been covered and therefore were not detected during the 1968 inspection. Disregarding this fact, it is significant to note that the average crack and joint interval decreased by only 2.2 feet during the 12.5-year interval between the eleventh and twelfth surveys. Additionally, it is interesting to note that approximately 70 percent of the cracks occurred within 5 months after completion of the project. Results of this project served to justify use of the 50-foot joint spacing presently required for limestone aggregate portland cement concrete pavements.

Six roughness tests were conducted between 1960 and 1966 in the north-bound lane of the project. Roughness indices obtained from these test data were: 545 for 1960, 460 for 1962, 500 for 1963, 550 for 1964, 630 for 1965, and 525 for 1966. The test values for 1962 and 1965 are suspected as being in error since the riding quality of the pavement did not change appreciably during the test period. The pavement is rated as having good riding qualities for an older concrete surface. Traffic data for the route is presented in Fig. 2 and Tables 2, 3, and 4. A section of I 65, which intersects the project, was opened in 1966; and it is anticipated that US 31W traffic will be reduced considerably.

The April 1962 AASHO Interim Guide for the Design of Rigid Pavement Structures was followed to compute required slab thicknesses for the project in accordance with current practices. Resultant slab thicknesses were 8.7 and 8.9 inches respectively for terminal serviceability indices of 2.0 and 2.5. In the analysis, the following values were used for entering charts

*See Report No. 4; also "The Performance of Coal Mastic Joint-Sealing Compounds and Sawed Joints in Concrete Pavements," D. H. Sawyer, Division of Research, December 1952.

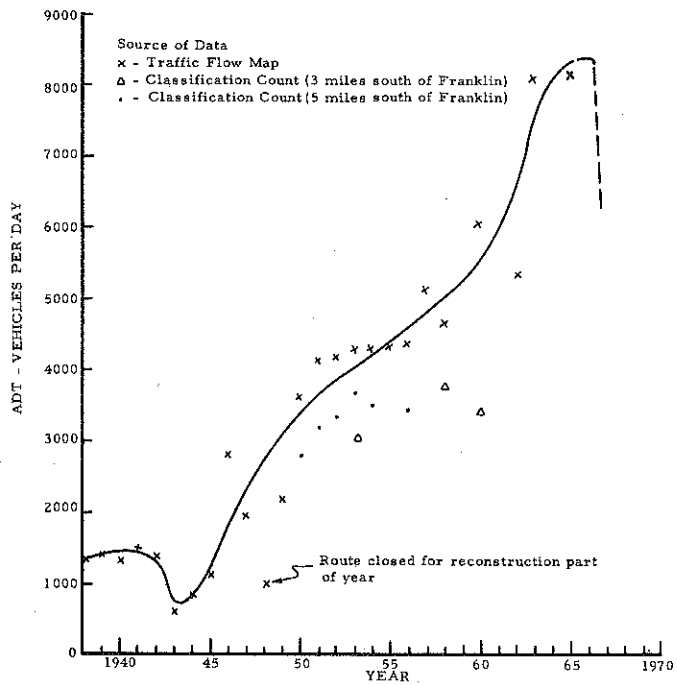


Figure 2. ADT Curve for US 31W South of Franklin

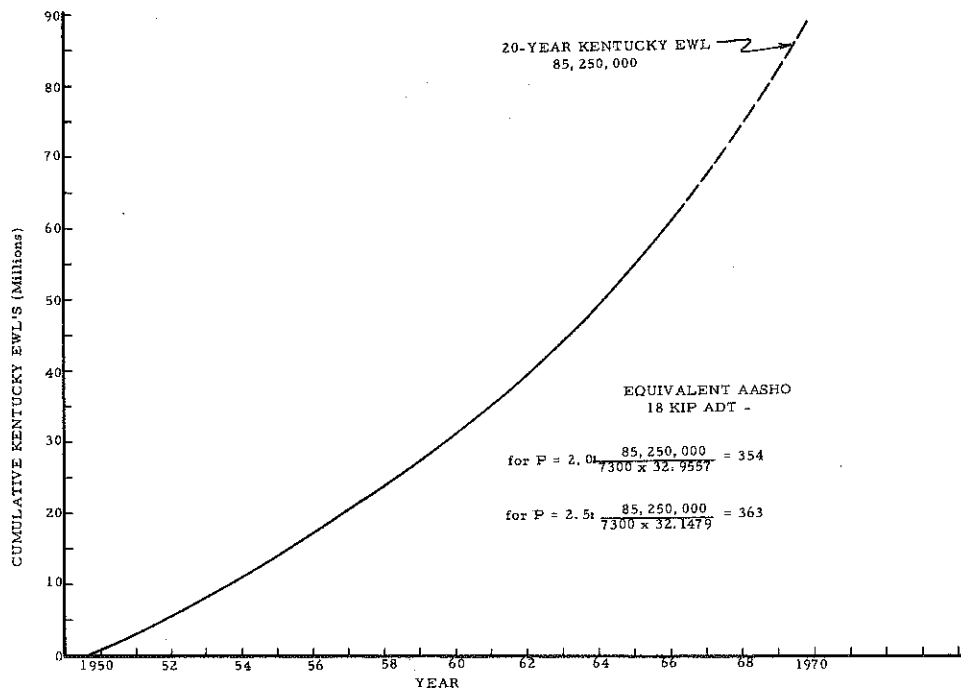


Figure 3. Cumulative EWL Curve

400-1 and 400-2: 100psi for modulus of subgrade reaction, 412psi for working stress, and 354 and 363 equivalent daily 18-kip single axleload applications, respectively. The traffic analysis was extrapolated to July 1, 1969 -- yielding 85.25 million Kentucky EWL's in a 20-year period. These were reduced to daily 18-kip AASHO axles (see Fig. 3). On this basis, it appears that the pavement should have been 9 inches thick if it were to continue to serve as a major route throughout the 20-year period. Failures in the form of pumping and slab deterioration appear imminent now -- especially in the southern portion which has not yet been by-passed by I 65 (see Fig. 4, showing surface cracking). This portion will continue to carry heavy traffic until late 1969. In the meantime, it is anticipated that this section will suffer severe serviceability losses.

TABLE 2

Estimated Equivalent Wheel Loads
(Average EWL per 1000 vehicles = 1922.25)

Year	EWL	Cumulative EWL
1949**	1,087,513	1,087,513
1950	2,385,512	3,473,025
1951	2,525,837	5,998,862
1952	2,683,701	8,682,563
1953	2,806,485	11,489,048
1954	2,911,728	14,400,776
1955	3,052,052	17,452,828
1956	3,192,377	20,645,205
1957	3,332,701	23,977,906
1958	3,508,106	27,486,012
1959	3,683,512	31,169,524
1960	3,858,917	35,028,441
1961	4,139,565	39,168,006
1962	4,560,538	43,728,544
1963	5,262,159	48,990,703
1964	5,683,132	54,673,835
1965	5,858,537	60,532,372

* Based on seven loadometer counts (1950-1956) on US 31W south of Franklin.

**EWL for half of year, since project was completed June 30, 1949.

TABLE 3

Average Vehicle Type Distributions

Year	Cars	Number of Vehicles by Type						Buses	Total
		SU-2A-4T	SU-2A-6T	SU-3A	C-3A	C-4A	C-5A		
1950*	1673	227	309	9	471	33	0	39	2761
1951*	2006	267	342	7	493	20	0	43	3178
1952*	2140	265	347	21	512	21	3	44	3353
1953*	2361	300	373	34	504	38	0	43	3653
1954*	2280	291	296	23	500	67	0	39	3496
1955*	2820	347	348	40	580	136	0	42	4313
1956*	2232	174	348	16	480	205	1	31	3415
1957	1855	268	301	20	495	49	1	50	3039
1958	2513	201	269	39	156	570	1	34	3783
1960	2177	249	230	19	177	475	3	31	3411
Mean %	64.12	7.52	9.34	0.66	12.49	4.69	0.03	1.15	100

*Based on more than one count for year

SU - Single unit
 C - Combination unit
 A - Axle
 T - Tire

TABLE 4

Average Axleload Distribution*
 (Percent of each vehicle type by weight group)

Load Range (Kips)	Percent of Axleloads by Vehicle Type					
	SU-2A-4T	SU-2A-6T	SU-3A	C-3A	C-4A	C-5A
<7	99.70	76.46	63.33	50.70	42.01	10.00
7- 9	0.30	6.85	6.11	7.70	17.60	
9-11		4.26	11.11	4.55	9.29	40.00
11-13		3.32	5.56	7.09	7.24	10.00
13-15		3.79	10.00	11.22	9.72	
15-17		3.39	3.33	11.30	8.85	
17-19		1.60	0.56	5.99	4.43	
19-21		0.33		1.18	0.86	40.00
21-23				0.15		
23-25				0.11		

*Based on seven loadometer counts (1950-1956) on US 31W south of Franklin.

SU - Single unit
 C - Combination unit
 A - Axle
 T - Tire

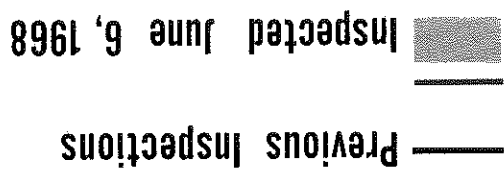


Figure 4. Surface Cracking Prominent in Section South of I 65.
Edge pumping was also noted.

In view of the performance of the pavement to date, consideration might be given to the construction of an experimental pavement containing transverse joints at 50-foot intervals with the exclusion of the transverse dowel assemblies. The absence of any large number of faults within the test pavement seems to indicate that there is generally no real need for load transfer devices at cracks or joints. Additionally, two intermediate cracks per slab have been noted on numerous occasions within various sections of I 64 and I 75. No instances of faulting were noted at any of the cracks. Material and labor costs savings would be sufficient incentive for the establishment of such project.

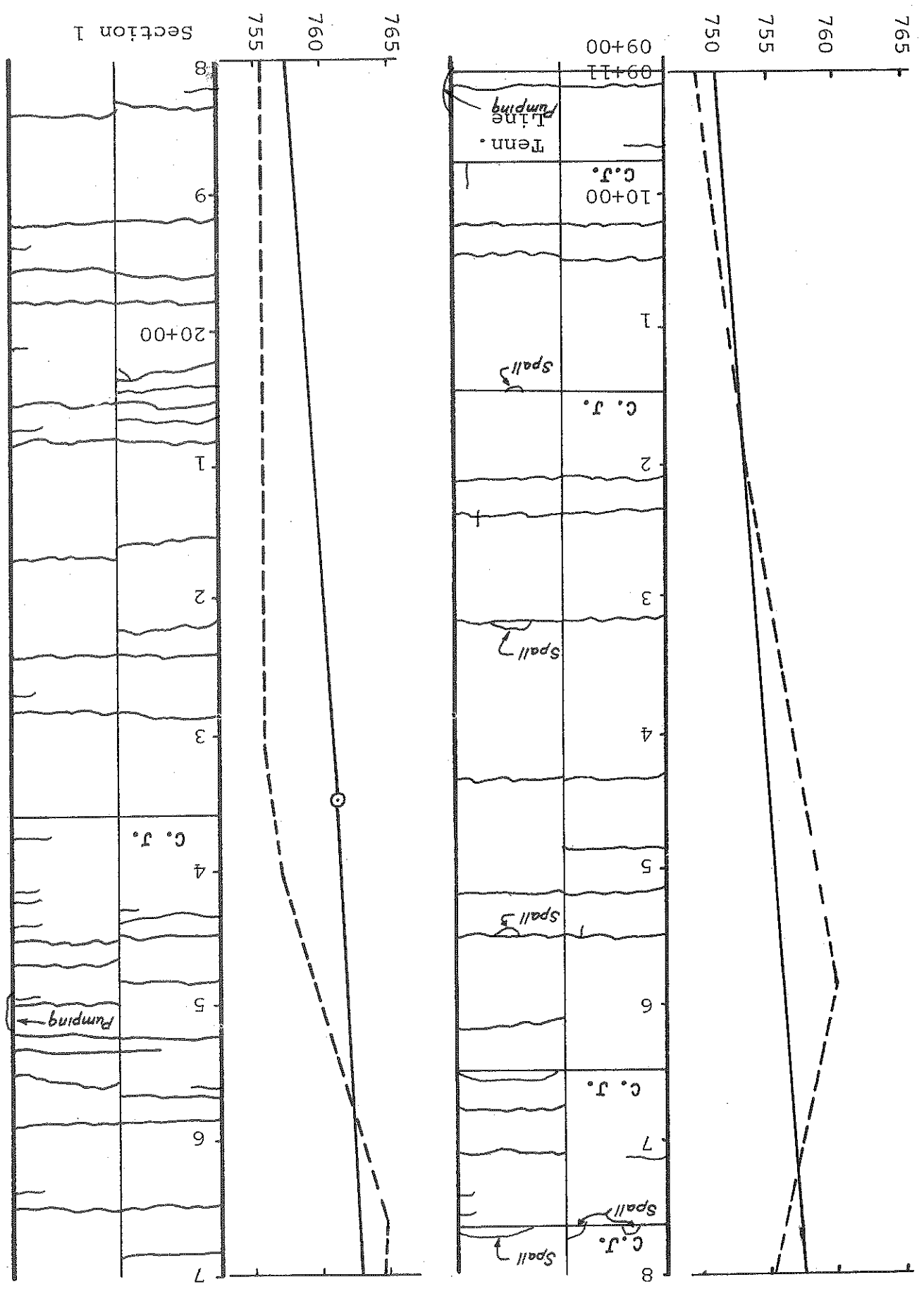
Previous Reports

1. "Concrete Pavement without Transverse Joints, US 31W, Franklin-Tennessee State Line Road," L. E. Gregg, July 11, 1949.
2. "Report No. 2 on A Concrete Pavement without Transverse Joints," W. B. Drake, December 1949.
3. "Report No. 3 on A Concrete Pavement without Transverse Joints," W. B. Drake, January 1951.
4. "Report No. 4 on A Concrete Pavement without Transverse Joints," W. B. Drake, December 1952.
5. "Report No. 5 on A Concrete Pavement without Transverse Joints," D. H. Sawyer, January 1956.

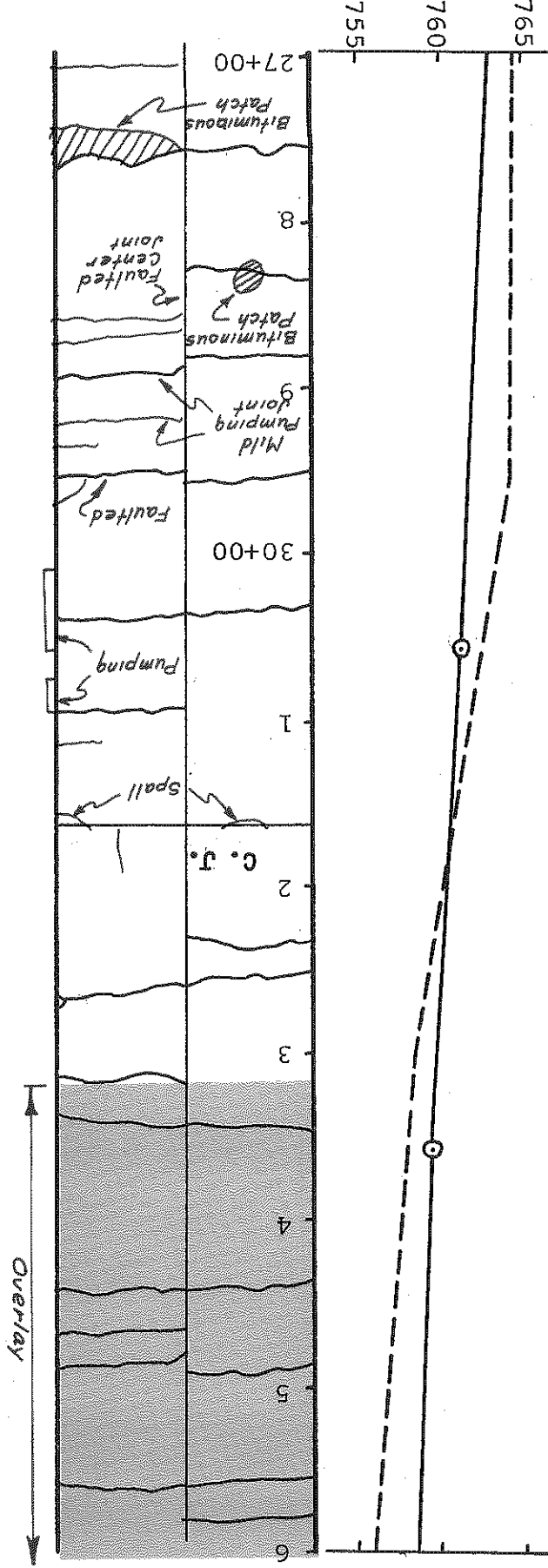
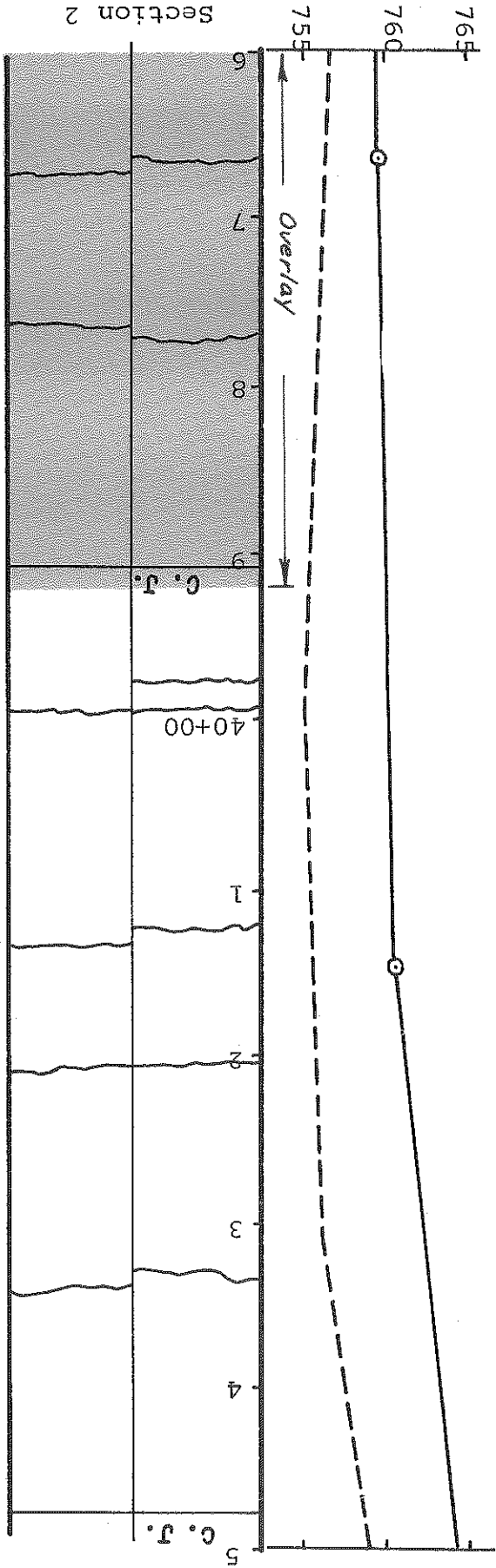
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Previous Inspections

APPENDIX

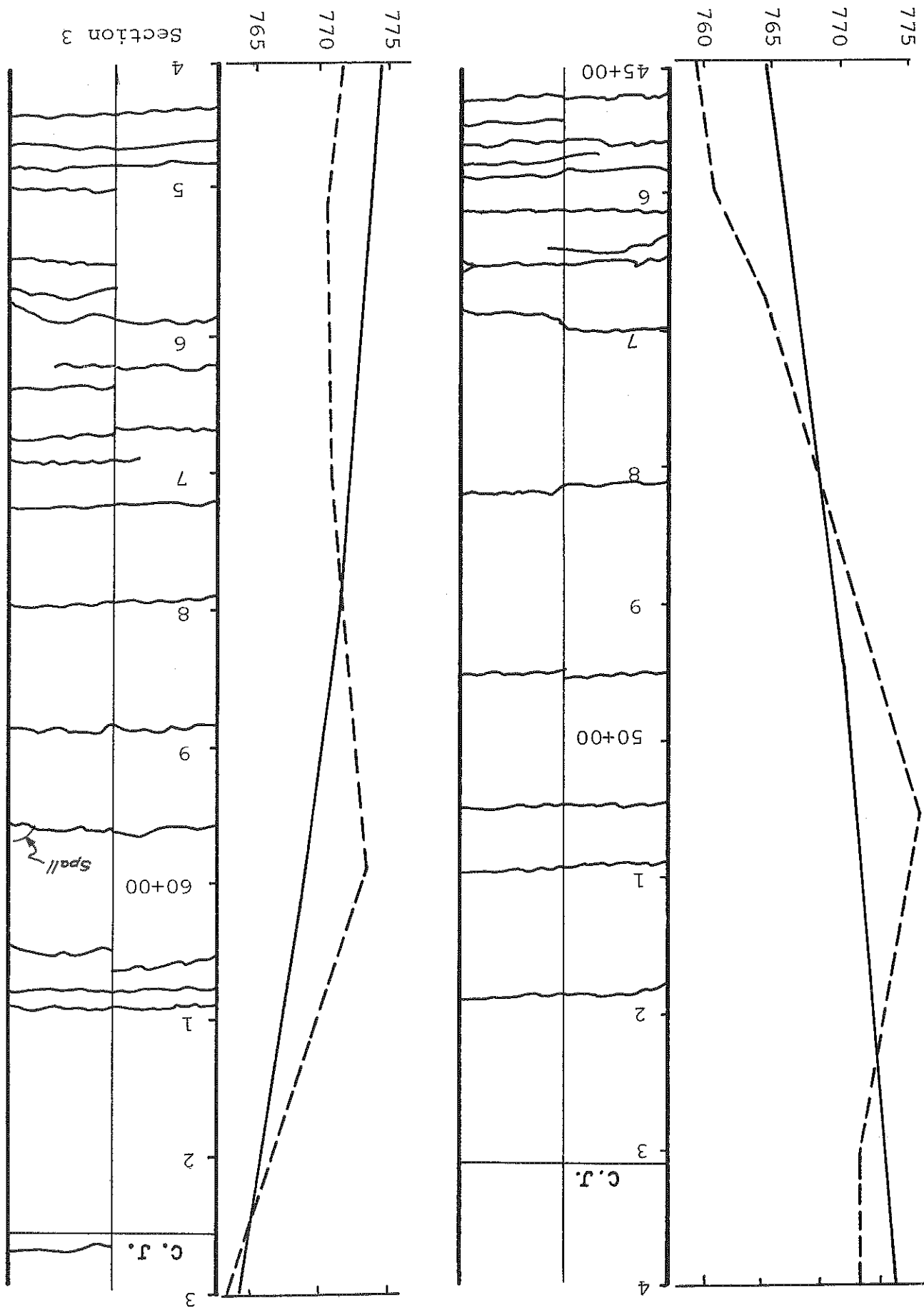
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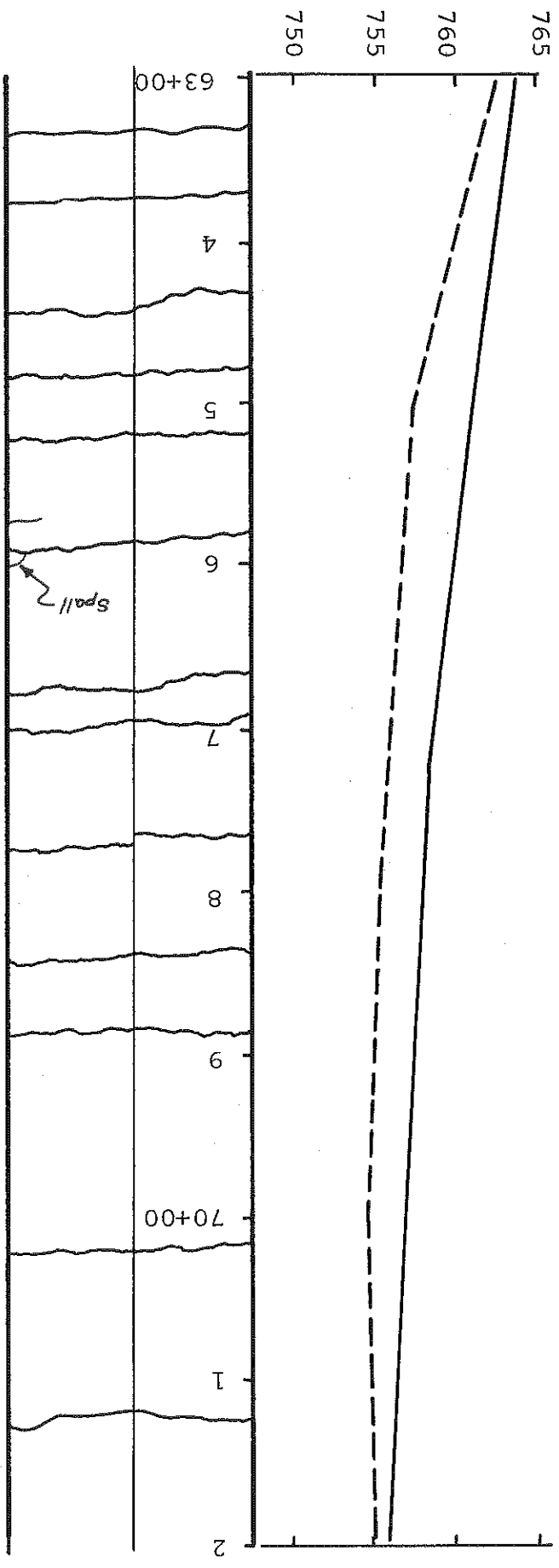
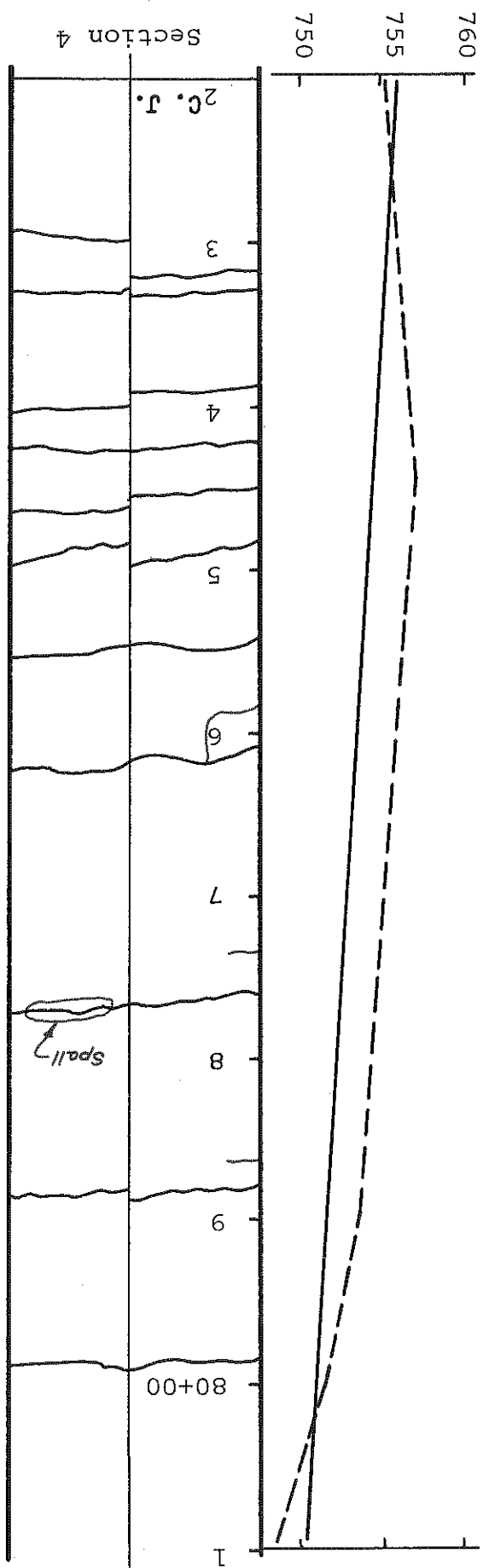


Section 2



12.2





Section 4

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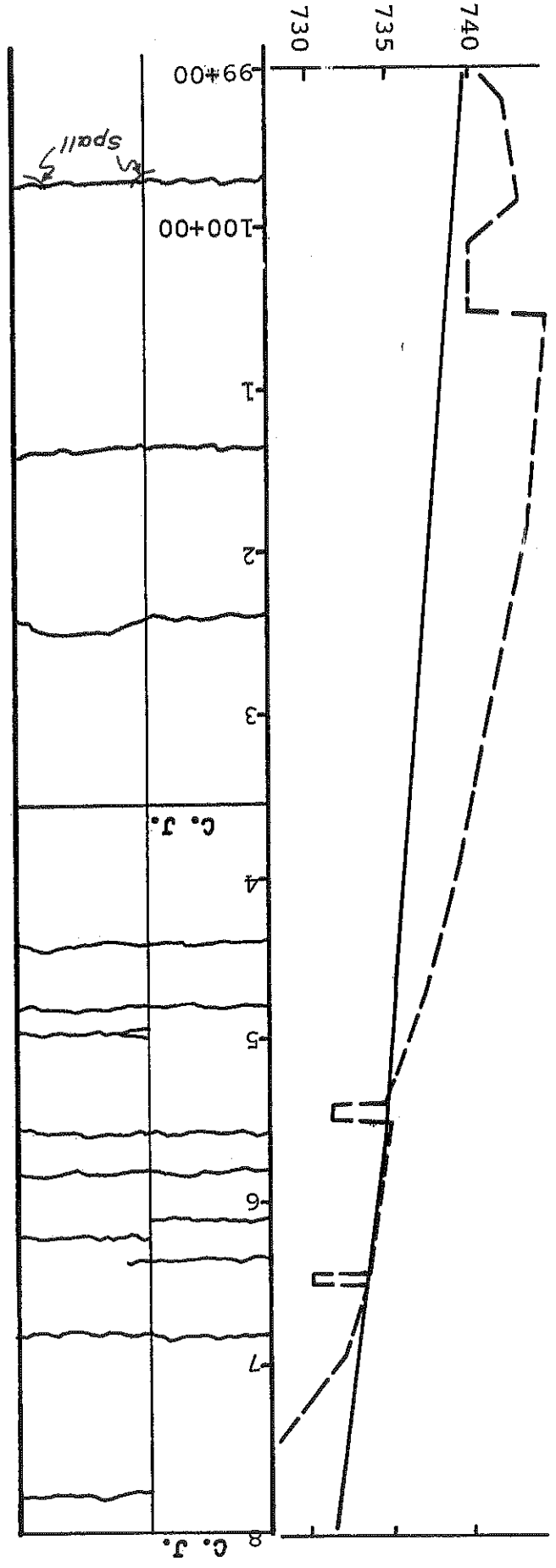
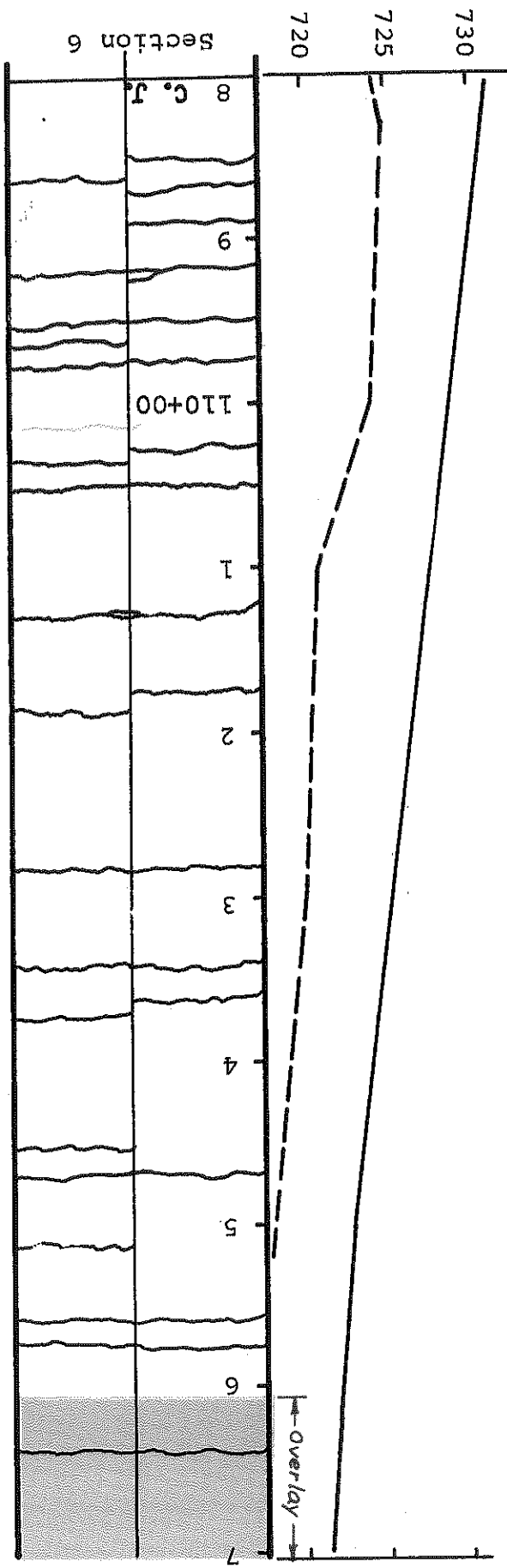
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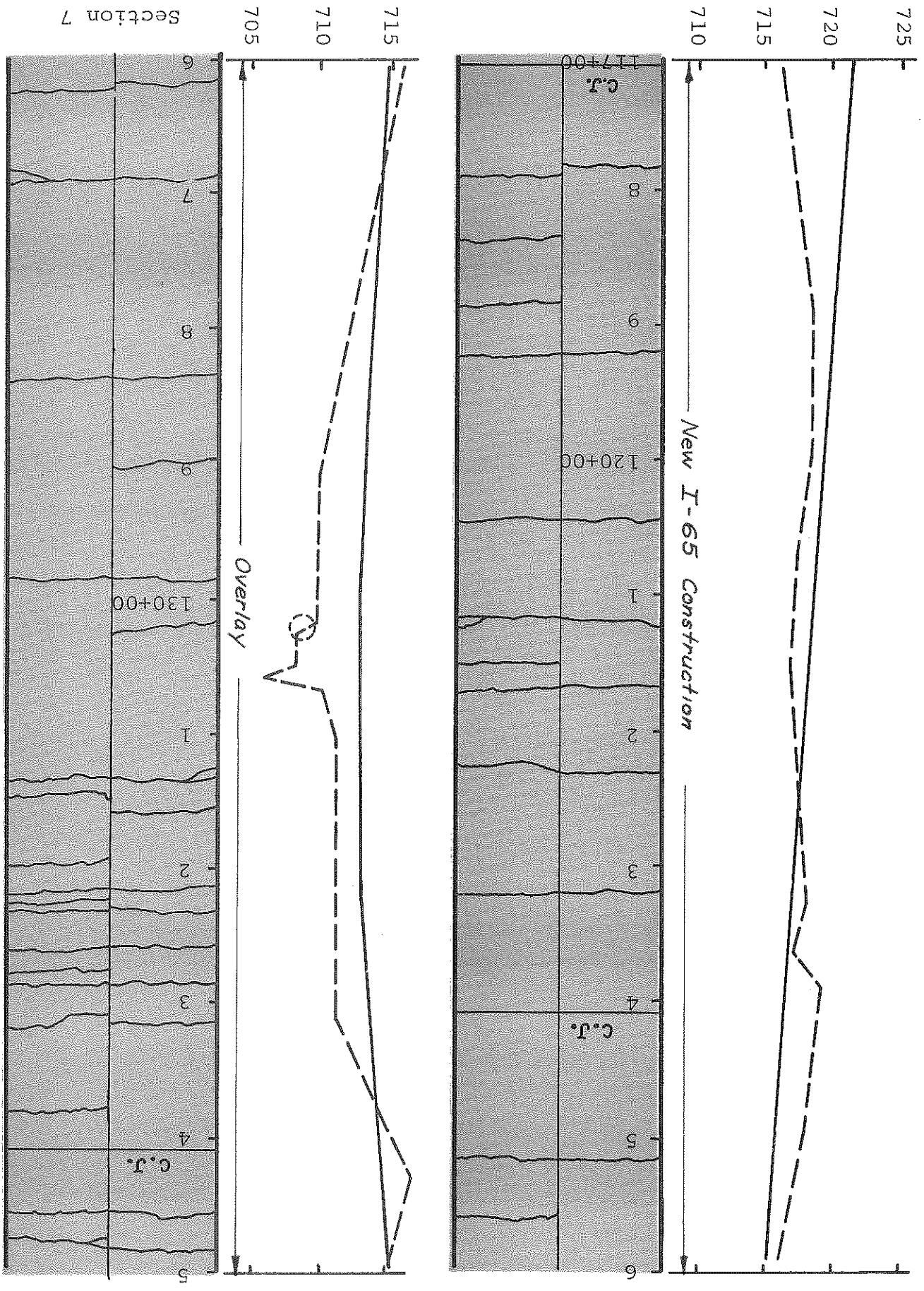
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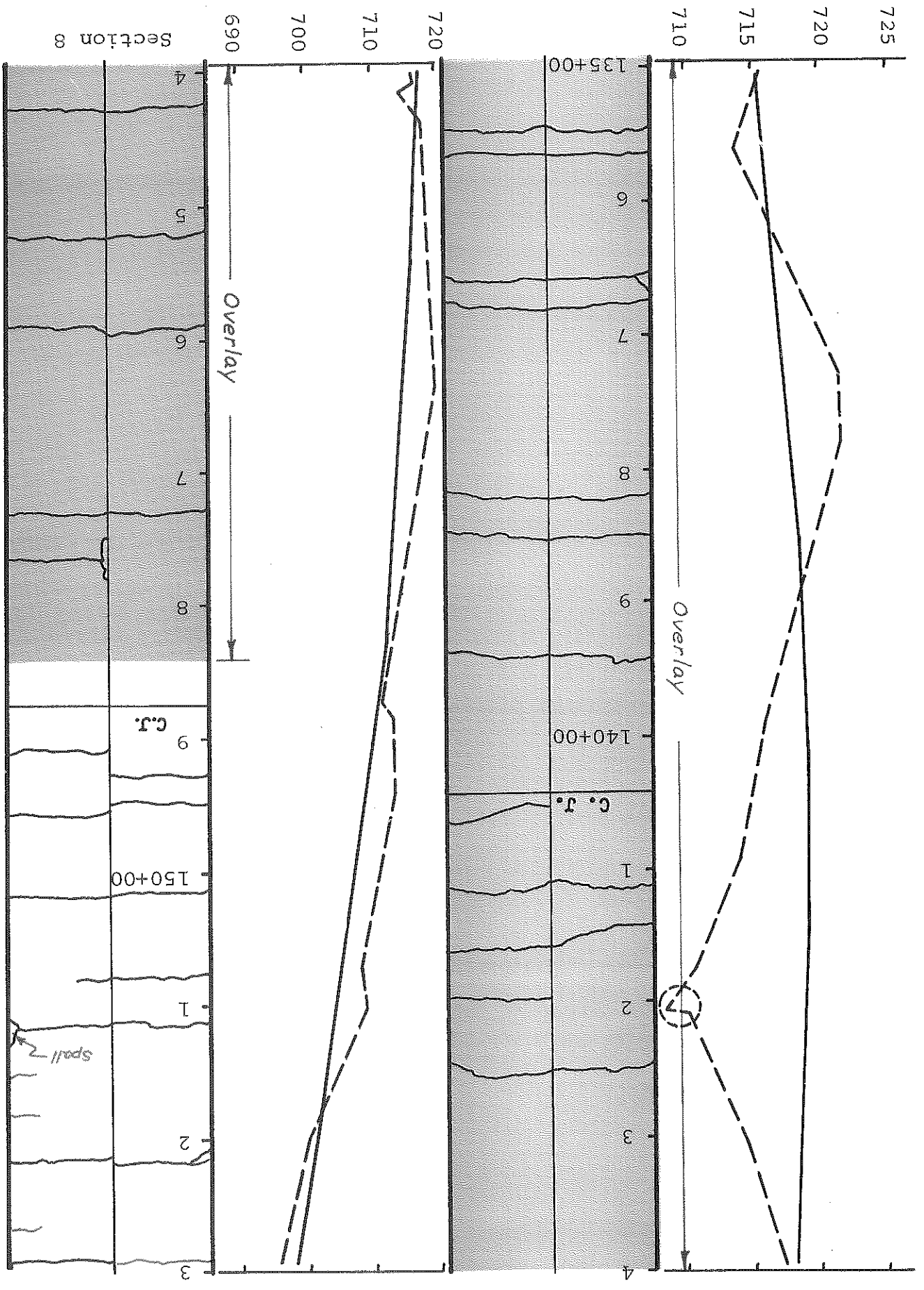
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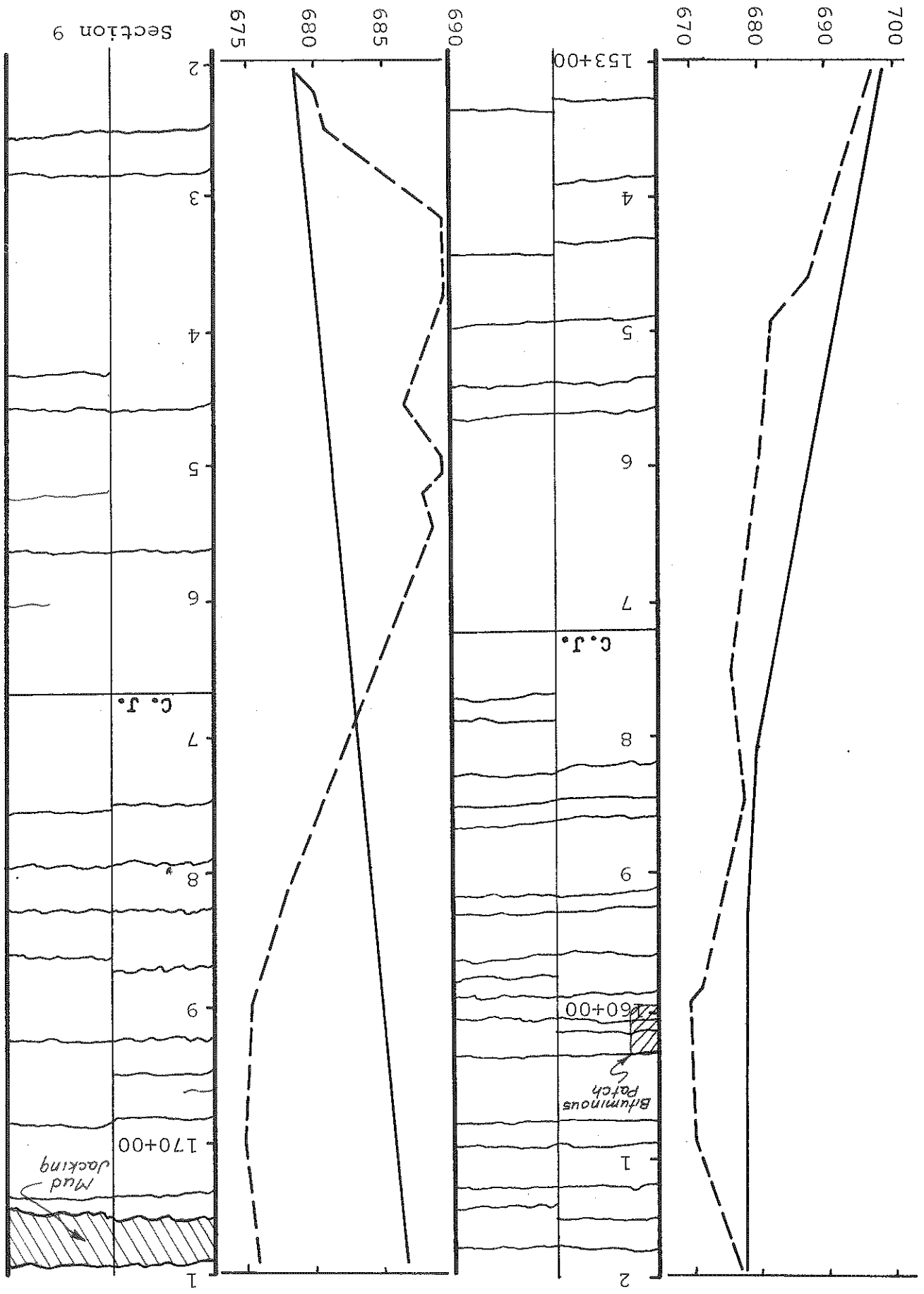
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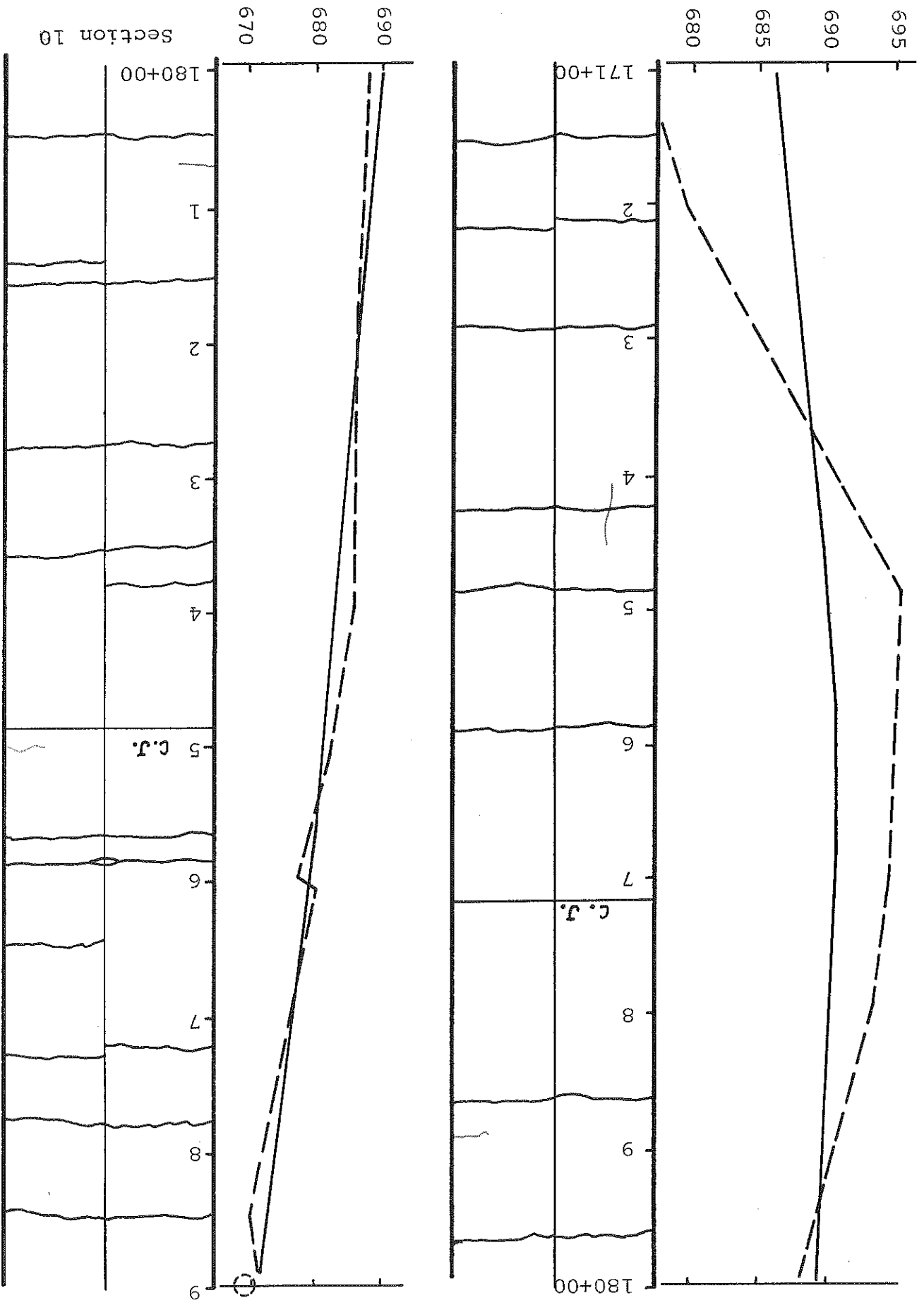




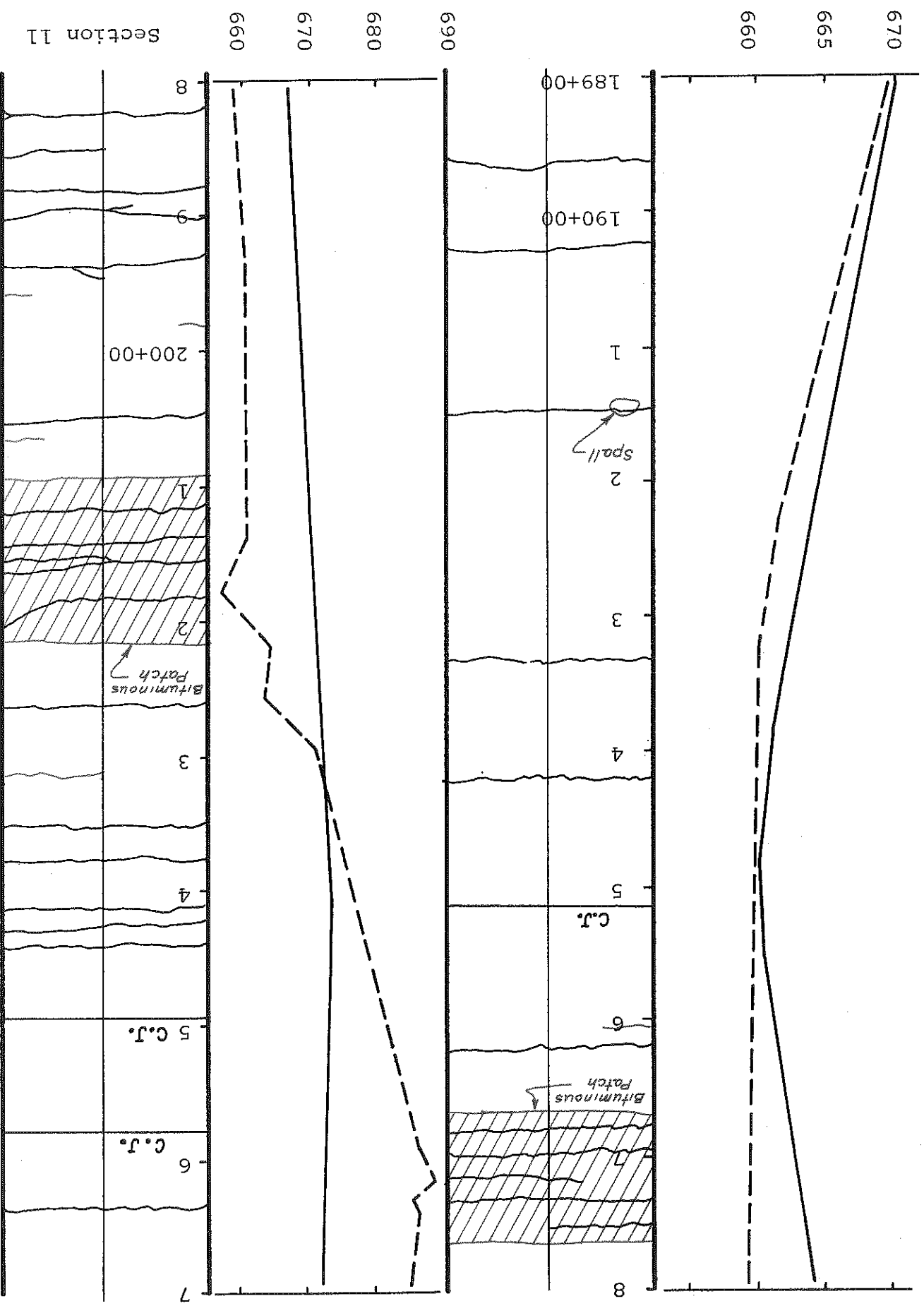




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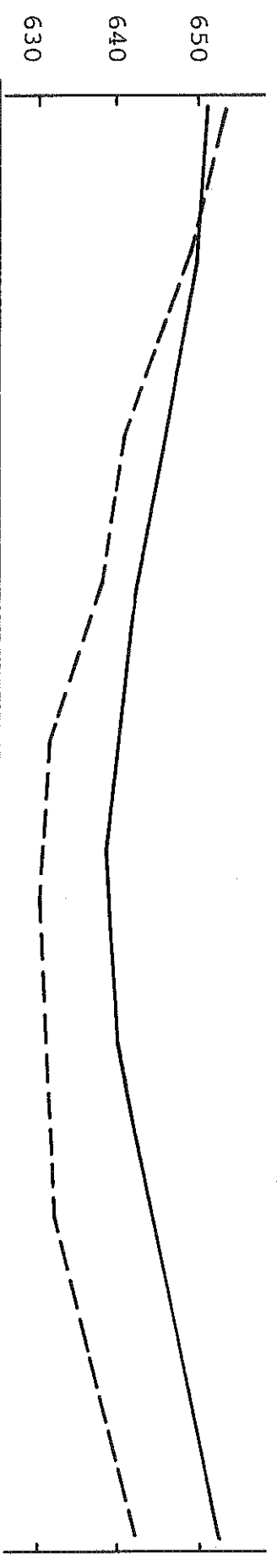
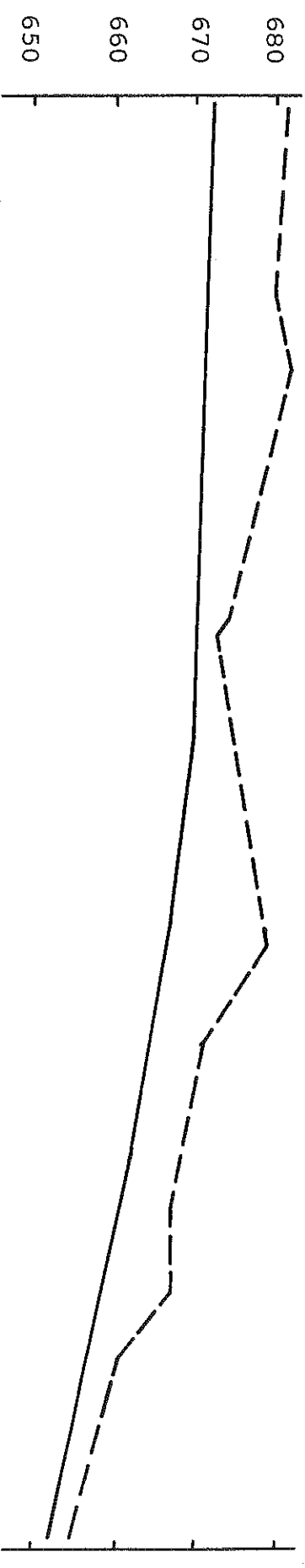


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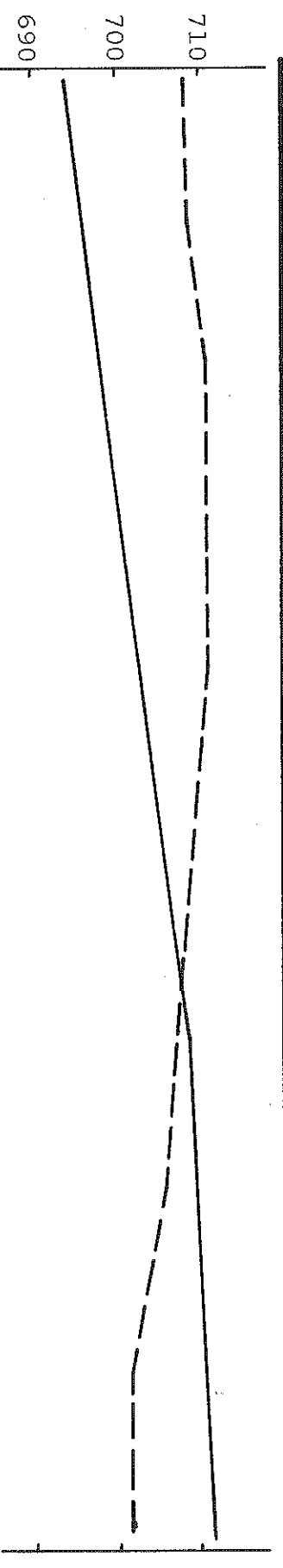
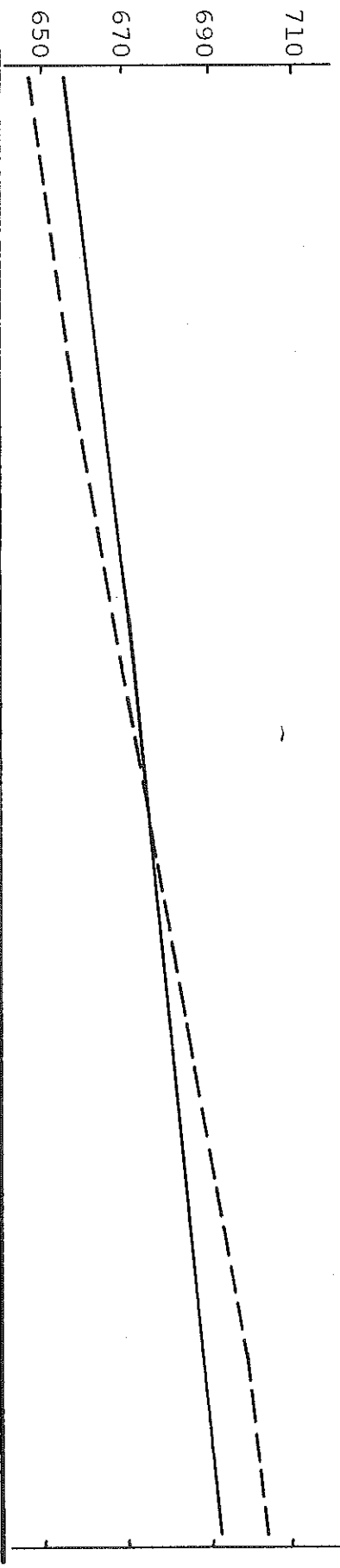
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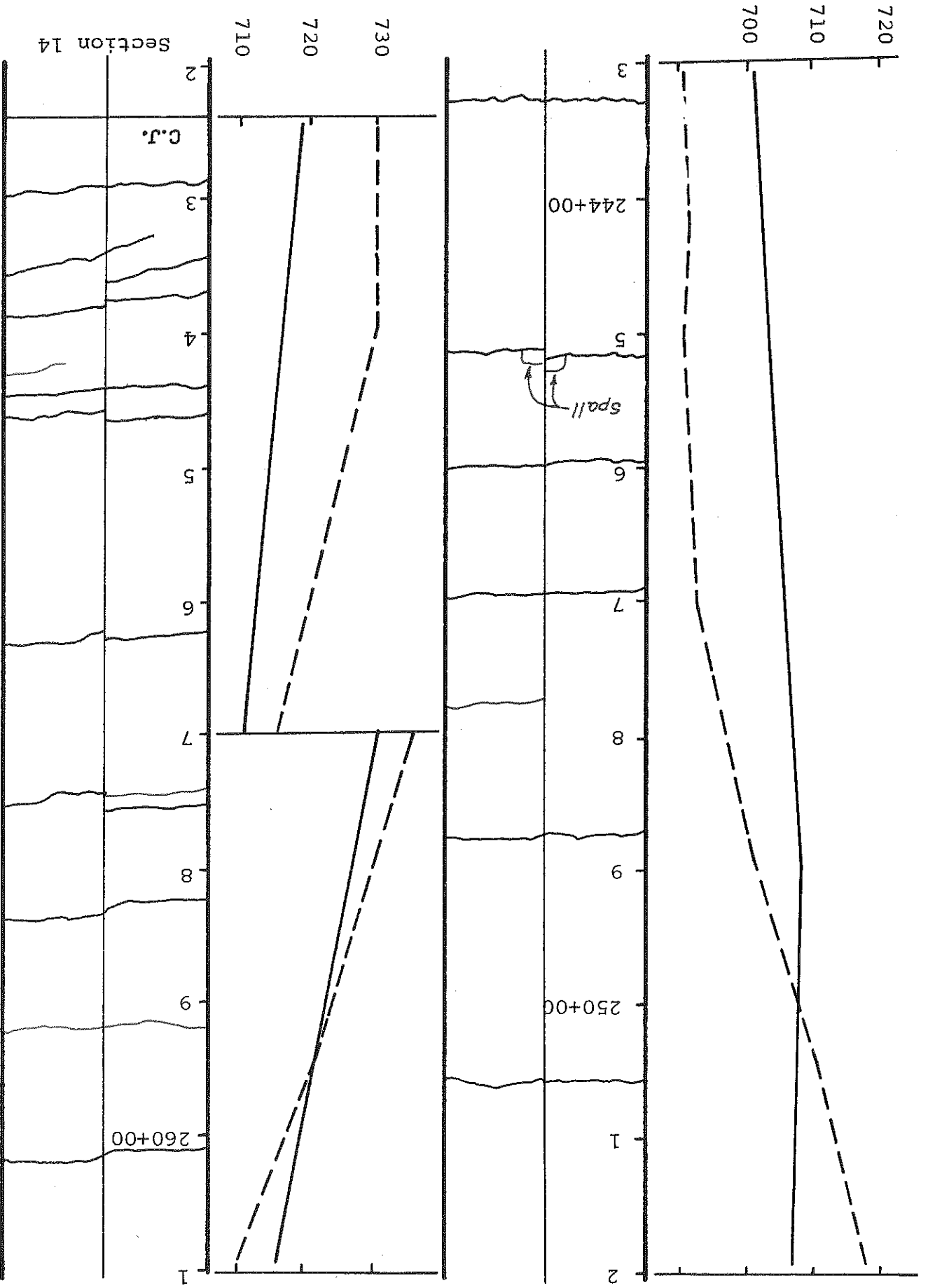


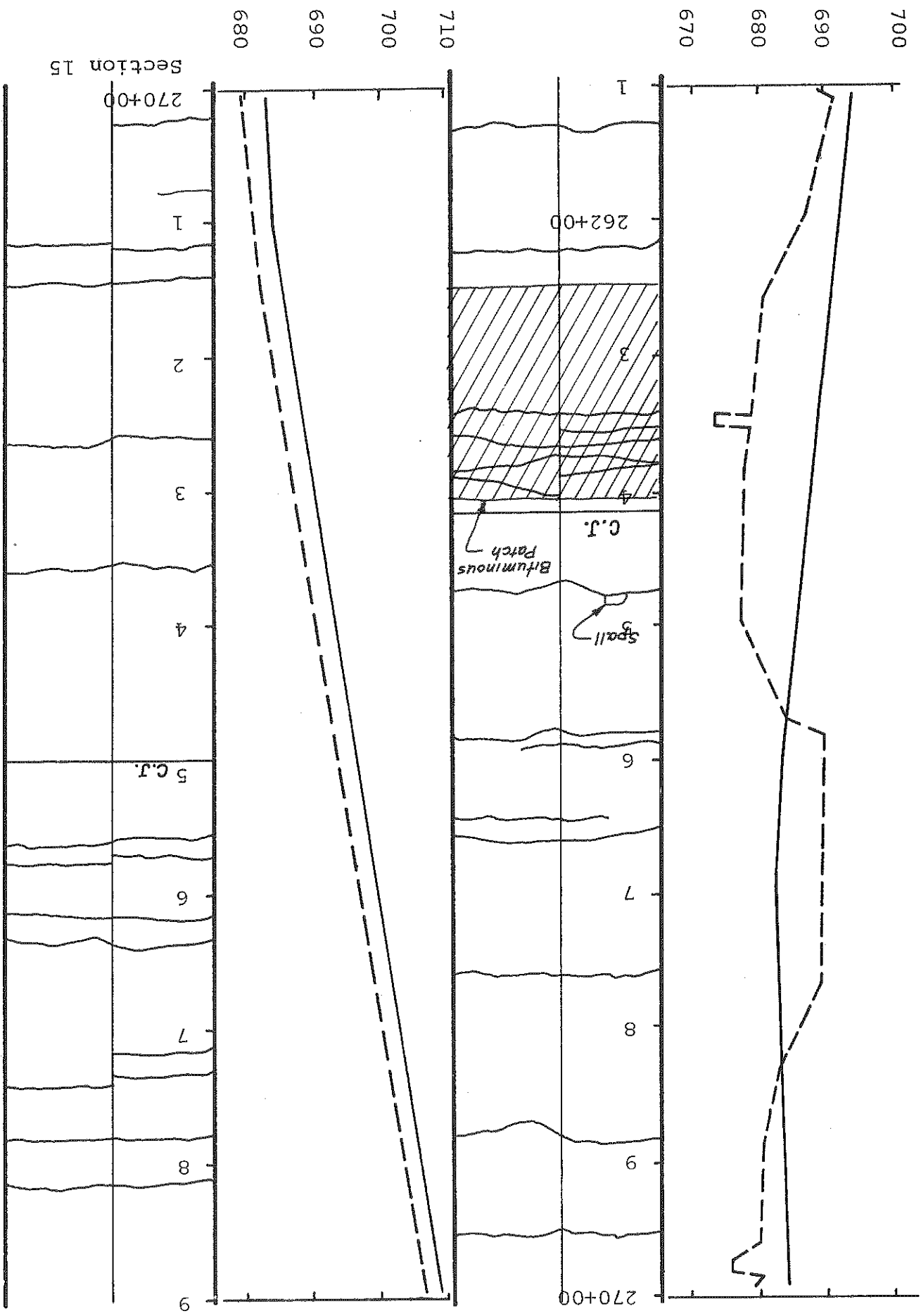
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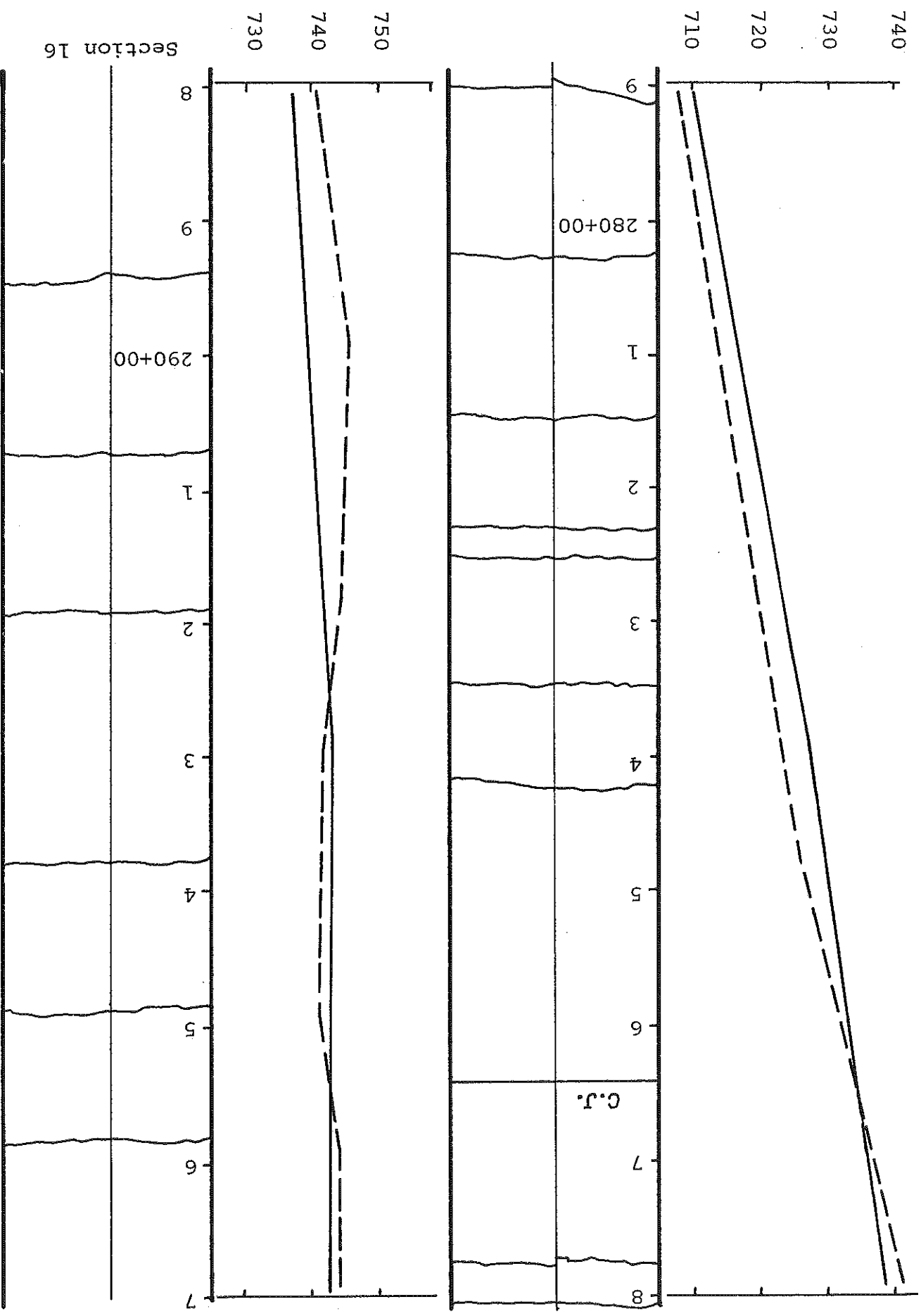


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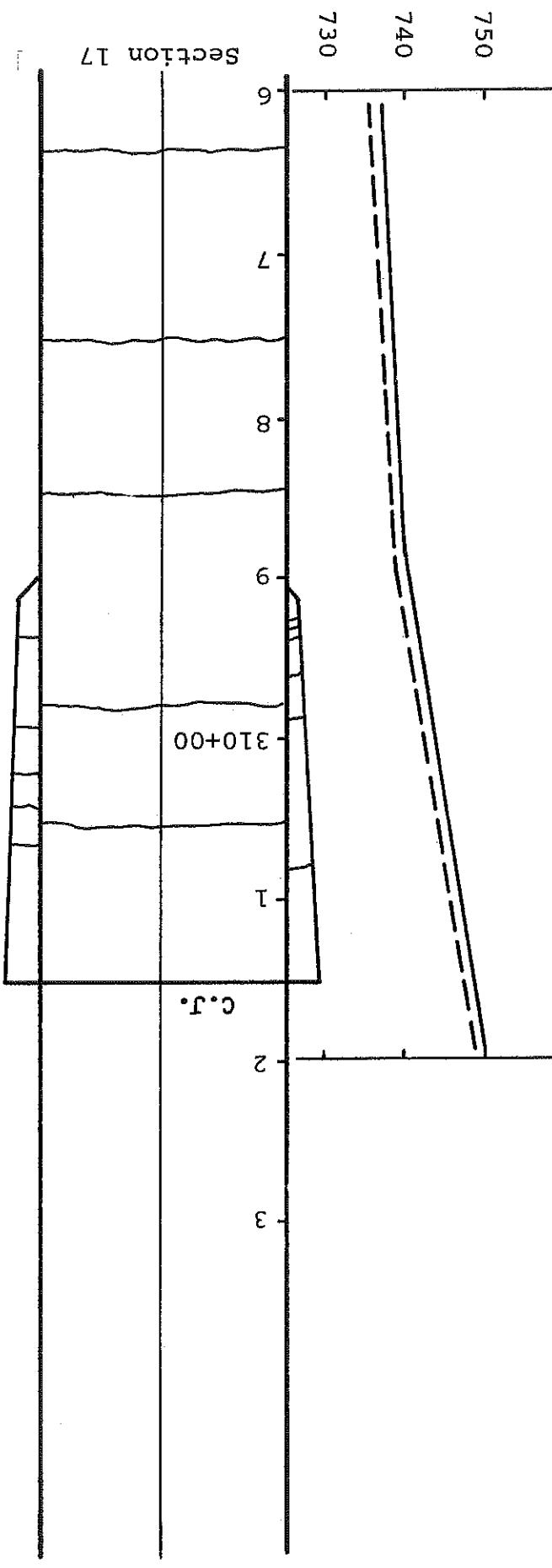
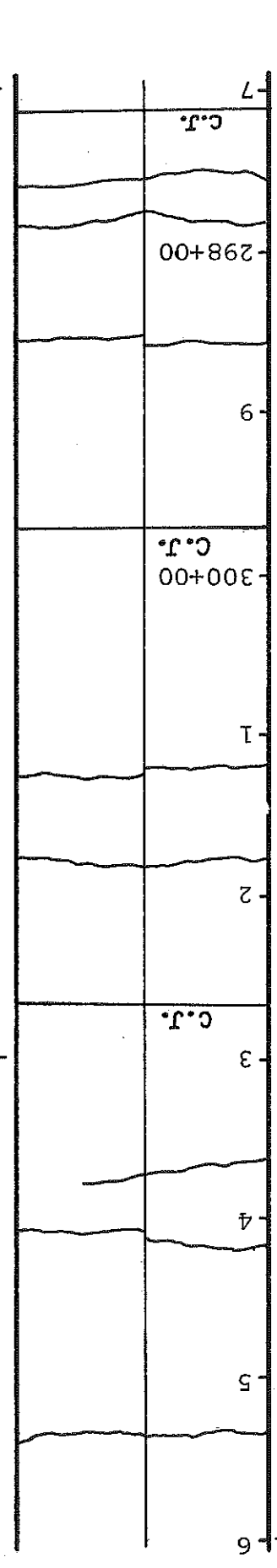
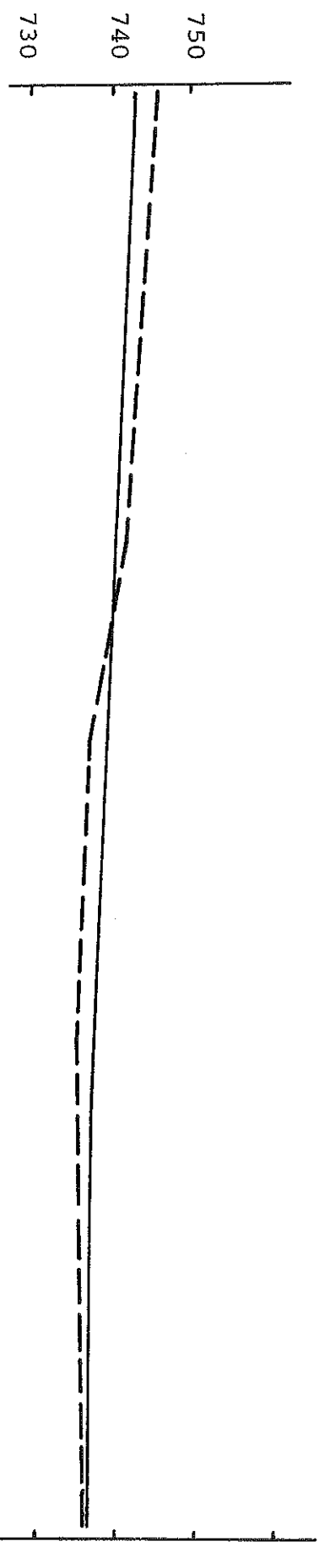




Section 16



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Research Report

FINAL

WIRE MESH REINFORCEMENT IN
BITUMINOUS CONCRETE OVERLAYS
(Experimental)
(Franklin-Shelby Counties, Project FI 172(12))

by
R. L. Musgrave
Research Engineer Assistant

Division of Research
DEPARTMENT OF HIGHWAYS
Commonwealth of Kentucky

July 1968

INTRODUCTION

This is a final performance report on the application of wire mesh reinforcement in asphaltic concrete overlays to control reflection cracking. Previous reports include a construction report (1) prepared in 1954 and a performance report (2) prepared in 1960. The test site is located on US 60 between Frankfort and Shelbyville.

A problem that occurs in bituminous concrete overlays of portland cement concrete pavements is a phenomenon referred to as "reflection cracking," which may appear in the bituminous concrete directly over joints and cracks existing in the underlying concrete slab. It is popularly believed that the primary causes are: "(a) differential vertical movements between adjacent slabs that occur during load transfer causing a shearing action in the bituminous surface, (b) permanent displacement of adjacent slabs due to differential settlement, and (c) the continuous restless movement of the underlying slabs due to temperature changes, causing opening and closing of the joints and a consequent pulling of the resurfacing above" (3).

Initially, reflection cracks do not affect the surface quality of a pavement to any great extent, but these cracks may eventually progress to a stage of distress referred to as "belt cracking" (4). This advanced state of surface deterioration severely impairs the riding quality of the road and shortens its potential service life. Several methods have been proposed to prevent or reduce reflection cracking. One of the more prominent methods is incorporation of welded wire reinforcement into the bituminous overlay. The reinforcement is intended to eliminate or minimize reflection cracking by distributing stresses resulting from movement of the underlying concrete slab. By obtaining a more uniform stress distribution, the stress at any one point will not be sufficient to induce cracking in the overlay.

The main objectives of this study were to evaluate:

1. The use of wire mesh for the prevention of reflection cracking in bituminous concrete overlays.

2. The use of wire mesh for the prevention of lateral displacement of the bituminous concrete overlay when subjected to accelerating and decelerating traffic.
3. The physical condition of the wire mesh with respect to strength and corrosion.

Three test sections were constructed on US 60 between Frankfort and Shelbyville. The primary variable in the test sections was placement of the wire mesh. At Location 1, in Clay Village, the wire mesh was placed continuously and for the full width of the pavement over a leveling course. At Location 2, near Peytona, the wire mesh was placed over transverse joints only and extended a few feet on either side. Location 3, in front of the Half-Way House, was constructed in the same manner as Location 1, except the wire mesh was placed in direct contact with the concrete pavement. For comparative purposes, sections of pavement not containing wire mesh were also studied. A more complete description of test and control sections and methods of construction is included in the construction report.

A summary of findings and conclusions for the 1960 performance survey (2) is as follows:

1. The effectiveness of wire mesh used to prevent reflection cracking was significant.
2. The performance of the 4-inch x 4-inch mesh opening was superior to that of the 3-inch x 6-inch mesh opening.
3. No conclusion was reached in regard to the prevention of lateral displacement of the overlay.
4. At Location 2, where the wire mesh was placed only over the transverse joint, it was postulated that the overlay cracked over the edge of a sheet of wire mesh.

PERFORMANCE

This final survey consisted of visual inspection, charting of cracks in the bituminous overlay, and inspection of the wire mesh beneath the overlay. Results are shown pictorially on strip maps in the appendix and are expressed mathematically in Table 1. Table 2 shows a comparison with the 1960 survey.

Small holes were dug in the bituminous overlay to expose the wire mesh (Figures 1 and 2). The wire mesh was badly corroded and several strands had ruptured. Strands which were intact broke easily and it was concluded that the corroded wire mesh was incapable of distributing any load. A circular memorandum from the U. S. Department of Transportation (5) concludes that placement of the reinforcement



Figure 1. Exploration Hole to Study Condition of Wire Mesh.



Figure 2. Close-up View Showing Deteriorated Condition of Wire Mesh.

Table 1

SUMMARY OF PERFORMANCE DATA

LOCATION	INSTALLATION	NEW CRACKS (FEET)			PERCENT OF CRACKS OR JOINTS REFLECTED				
		ASSOCIATED WITH WIRE MESH	OTHERS	RANDOM CRACKS	CRACKS ALONG CENTERLINE	JOINTS BUILT INTO PCC PAVEMENT	JOINTS DUE TO REFLECTMENT PATCHING	JOINTS BUILT INTO PCC PAVEMENT PLUS JOINTS DUE TO REPLACEMENT PATCHING	ALL JOINTS PLUS NEW CRACKS ASSOCIATED WITH WIRE MESH
1	Control Section	0.0	105.0	0.6	75.5	100.0	26.0	94.0	94.0
	3-inch x 6-inch Mesh	27.0	3.0	0.0	40.6	83.3	0.0	83.0	124.0
	4-inch x 4-inch Mesh	11.0	5.0	13.1	61.6	79.0	33.0	63.6	74.7
2	Control Section	0.0	681.0	7.8	63.4	100.0	26.0	91.3	91.5
	3-inch x 6-inch Mesh	55.0	30.0	1.1	65.0	80.0	0.0	80.0	150.0
	4-inch x 4-inch	218.0	160.0	7.0	77.8	85.6	9.0	77.0	115.8
3	Control Section	0.0	137.0	0.0	65.5	95.0	54.7	86.0	86.0
	3-inch x 6-inch Mesh	31.0	8.0	0.0	83.3	100.0	0.0	100.0	147.0
	4-inch x 4-inch Mesh	24.0	23.0	0.0	100.0	100.0	0.0	100.0	121.8
Overall Performance									
	Control Section	0.0	923.0	2.9	66.2	98.8	41.6	89.6	92.4
	3-inch x 6-inch Mesh	113.0	41.0	0.4	64.0	86.4	0.0	86.4	142.1
	4-inch x 4-inch Mesh	253.0	188.0	7.8	76.9	94.6	14.3	78.6	111.4

TABLE 2

COMPARISON OF PERFORMANCE DATA

LOCATION	INSTALLATION	PERCENT OF CRACKS OR JOINTS REFLECTED			
		6 YEARS AFTER PLACEMENT OF WIRE MESH		14 YEARS AFTER PLACEMENT OF WIRE MESH	
		JOINT BUILT INTO PCC PAVEMENT PLUS JOINTS DUE TO REPLACEMENT	ALL JOINTS PLUS NEW CRACKS ASSOCIATED WITH WIRE MESH	JOINTS BUILT INTO PCC PAVEMENT PLUS JOINTS DUE TO REPLACEMENT PATCHING	ALL JOINTS PLUS NEW CRACKS ASSOCIATED WITH WIRE MESH
1	Control Section	87.4	87.4	94.0	94.0
	3-inch x 6-inch Mesh	50.0	83.3	83.0	124.0
	4-inch x 4-inch Mesh	41.6	41.6	63.6	74.7
2	Control Section	94.9	94.9	91.5	91.5
	3-inch x 6-inch Mesh	48.3	66.7	80.0	150.0
	4-inch x 4-inch Mesh	41.0	44.2	77.0	115.8
3	Control Section	84.3	84.3	86.0	86.0
	3-inch x 6-inch Mesh	100.0	116.4	100.0	147.0
	4-inch x 4-inch Mesh	66.7	83.3	100.0	121.8
	Overall Performance				
	Control Section	91.1	91.1	89.6	92.4
	3-inch x 6-inch Mesh	61.8	83.4	86.4	142.1
	4-inch x 4-inch Mesh	27.2	47.5	78.6	111.4

between overlay layers controlled corrosion over an extended period of time. Wire mesh was placed over a leveling course at Location 1 which was located in a saddle where there was an abundance of water flowing through the pavement. This situation prevented any conclusion being drawn as to the relationship between corrosion and placement of reinforcement.

The summary of performance data, shown in Table 1, is a tabulation of feet of new cracks and percent of cracks or joints reflected through the overlay. Conclusions drawn from these data are:

1. There is no significant difference between performance of the test sections and the control sections in prevention of joint or crack reflection.
2. Cracks resulting from the presence of wire mesh caused the percent of all joints plus new cracks associated with wire mesh to be greater than 100 percent.
3. No conclusion may be presented for the reflection of longitudinal or centerline joints due to the degree of variance (40-100 percent).

By digging near the edge of the pavement at Location 2, it was found that the overlay had cracked over the edge of wire mesh as well as over the joint in the PCC pavement (Figure 3). This confirms the hypothesis put forth in the 1960 report (2).

Results shown in Table 1 do not permit an evaluation or comparison between the different wire mesh openings. The 4-inch x 4-inch mesh performed somewhat better than the 3-inch x 6-inch mesh, but, due to the high percentage of cracks and joints reflected, this is inconclusive.

CONCLUSIONS

Based on data gathered in the final survey (14 years after installation), it is apparent the wire-mesh reinforcement was not effective in the prevention of reflection cracking in the bituminous overlay. However, the 1960 performance survey (6 years after installation) verified that the reinforcement was effective in reducing reflection cracking. It is therefore concluded that wire-mesh reinforcement has a short-term effectiveness in reducing reflection cracking. Conclusions contained in the 1960 survey and the most recent survey are in agreement with the results that have been obtained from other studies of bituminous overlays containing wire-mesh reinforcement. Findings reported in a circular memorandum by the U. S. Department of Transportation (5) show that, "Long term observation of metal



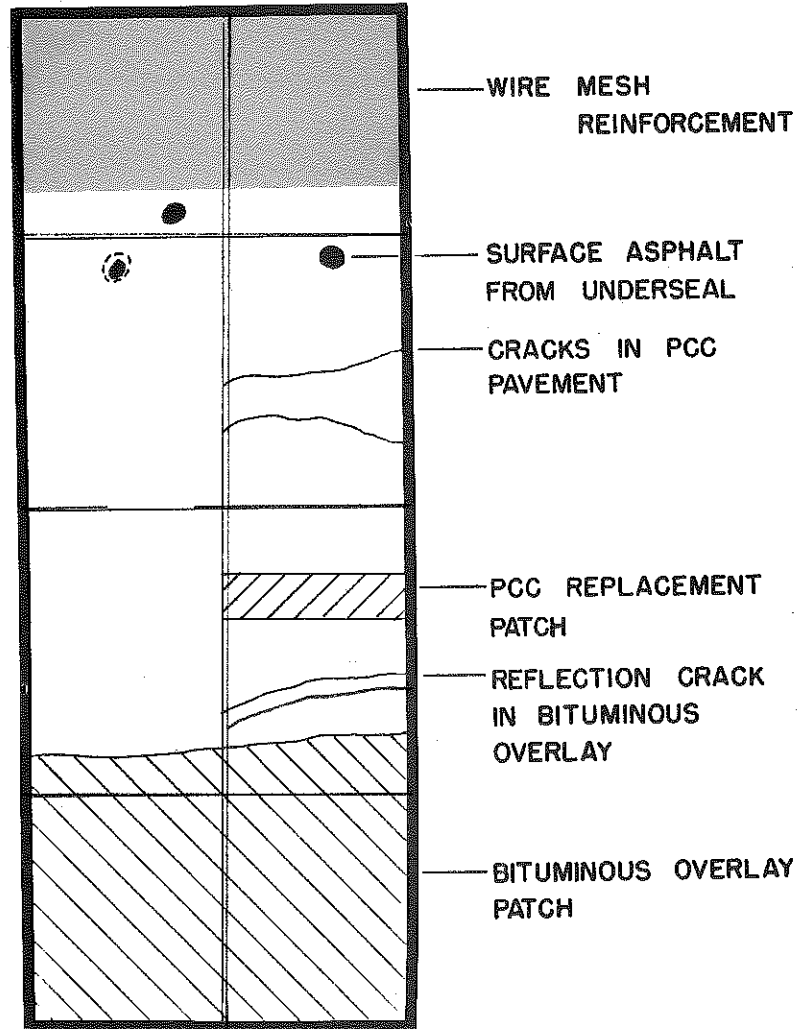
Figure 3. View Showing Reflection Crack over Joint in Rigid Slab and Associated Crack at Edge of Wire Mesh Reinforcement.

reinforcement in bituminous overlays, in range 8 to 10 years, indicates that reflective cracking is controlled in the early life of the overlay (1 to 5 years) compared to nonreinforced sections, but in later years both reinforced and nonreinforced sections may develop the same rate and amount of cracking".

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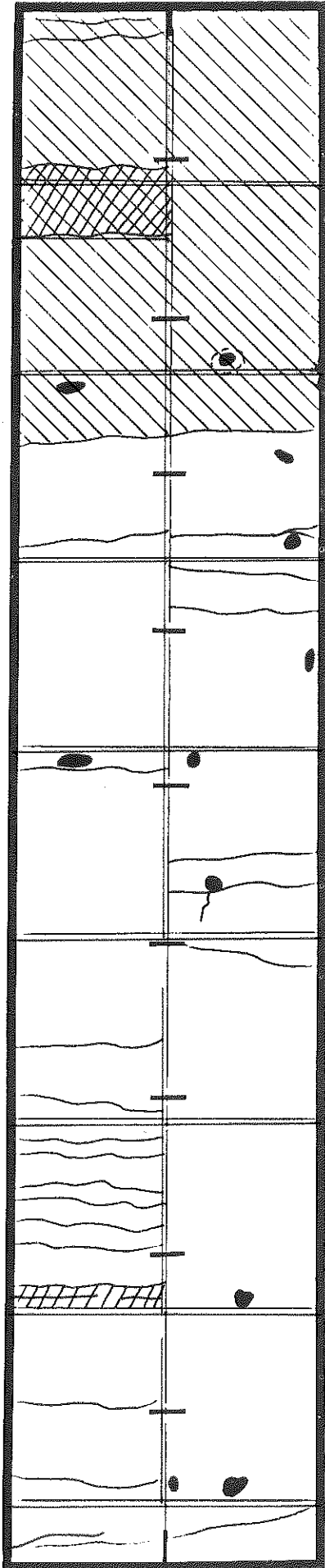
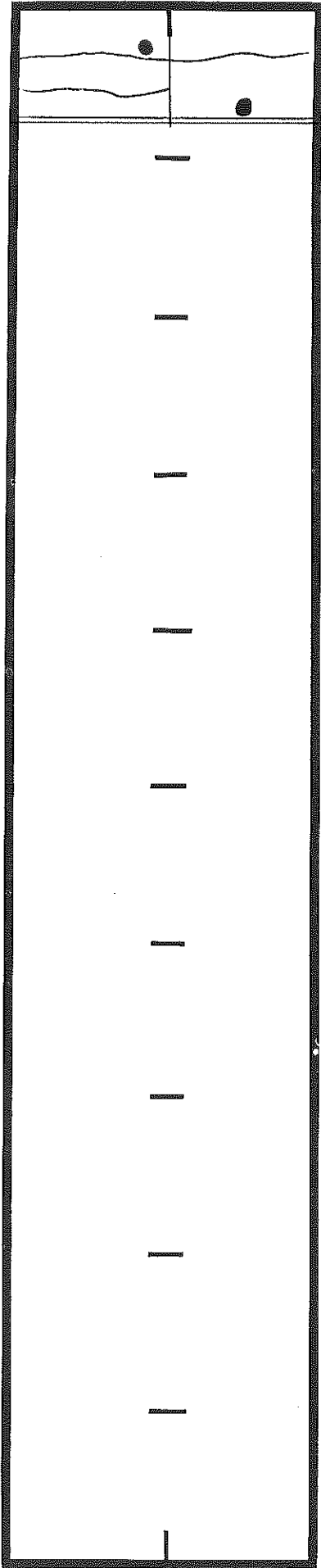
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LEGEND

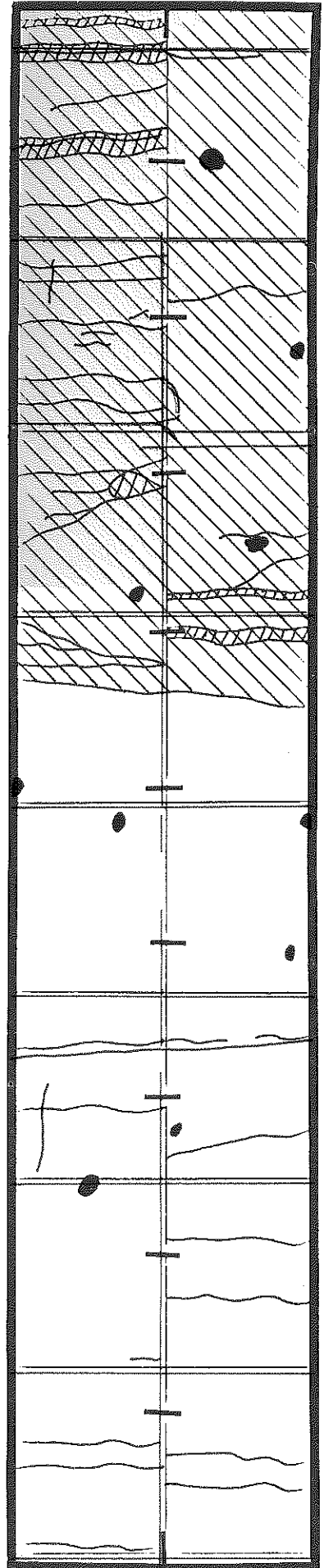


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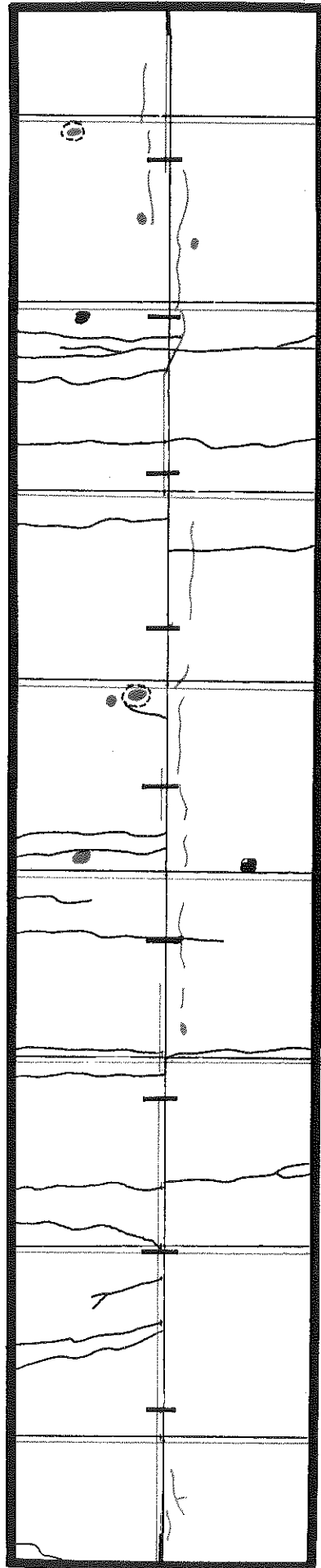
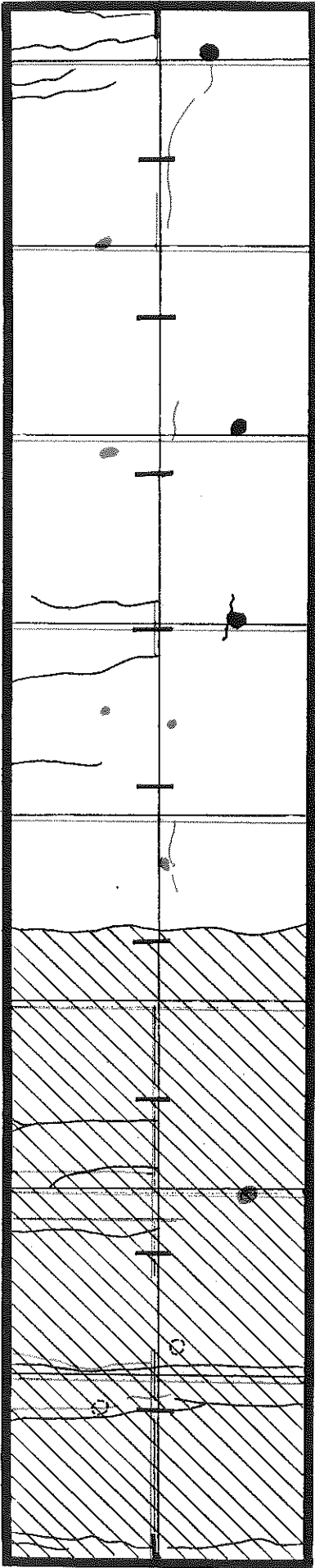
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- PERFORMANCE SURVEY (1968)
- WIRE MESH REINFORCEMENT



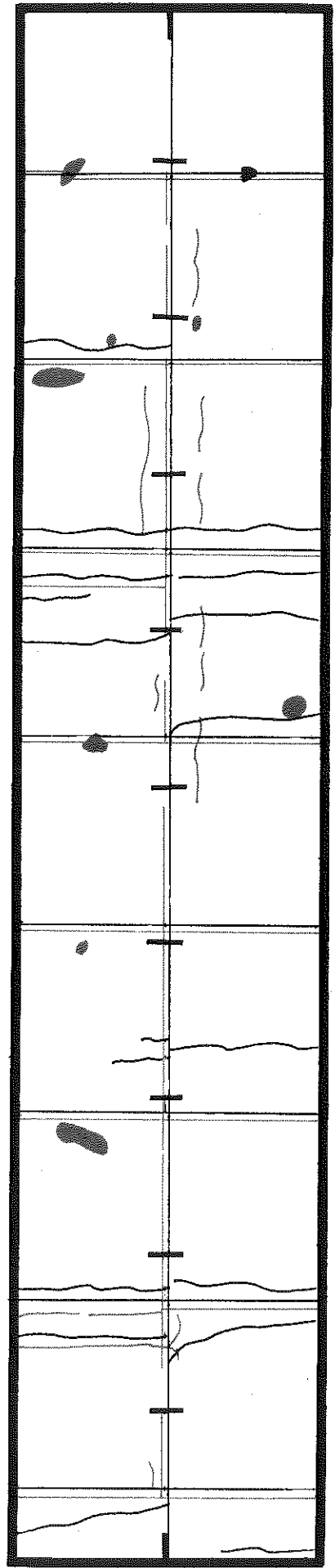
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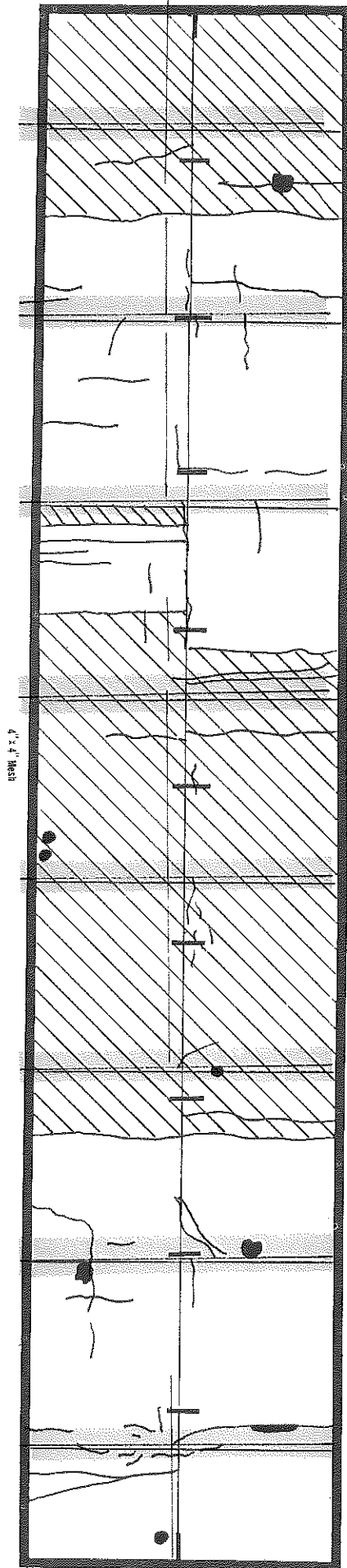
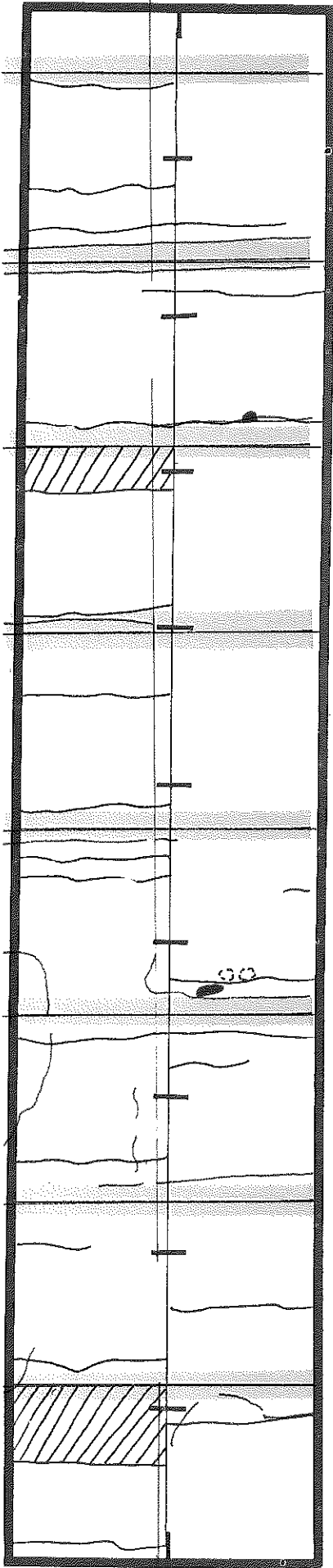
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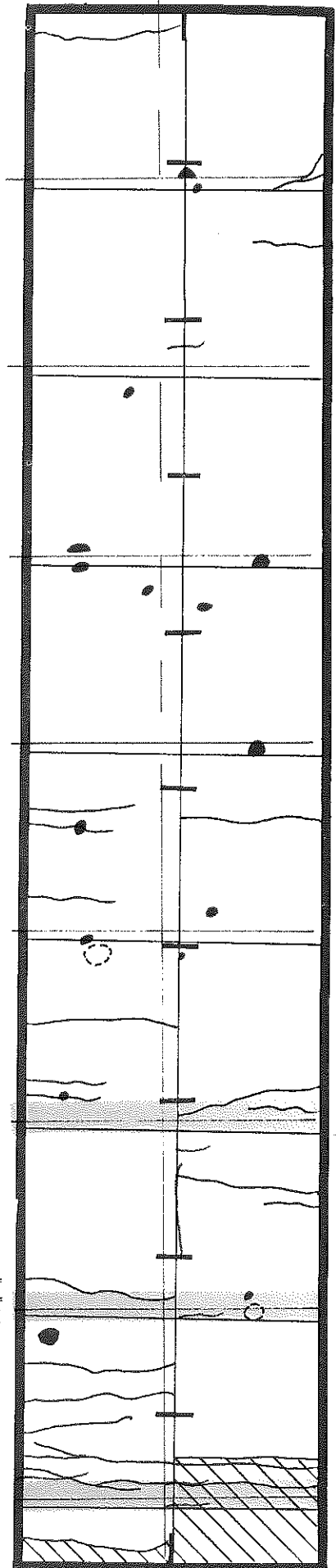
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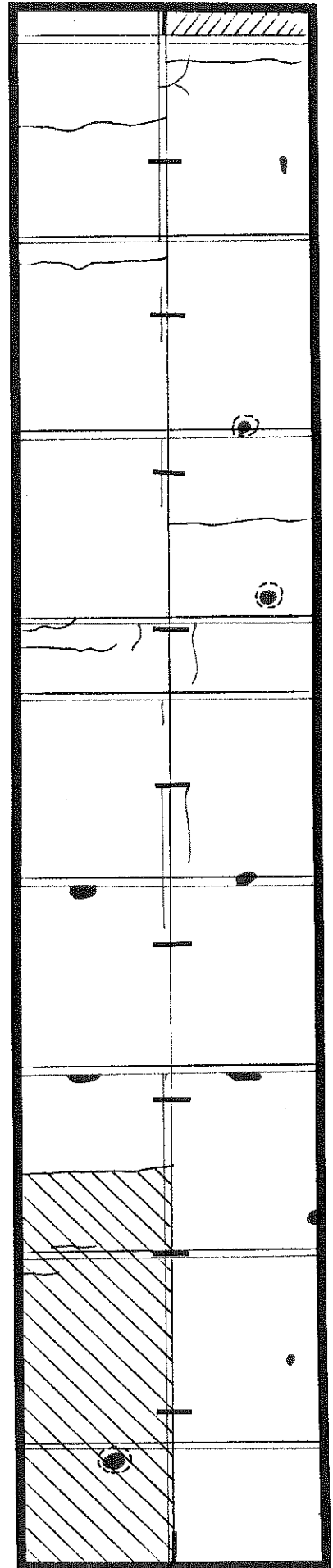
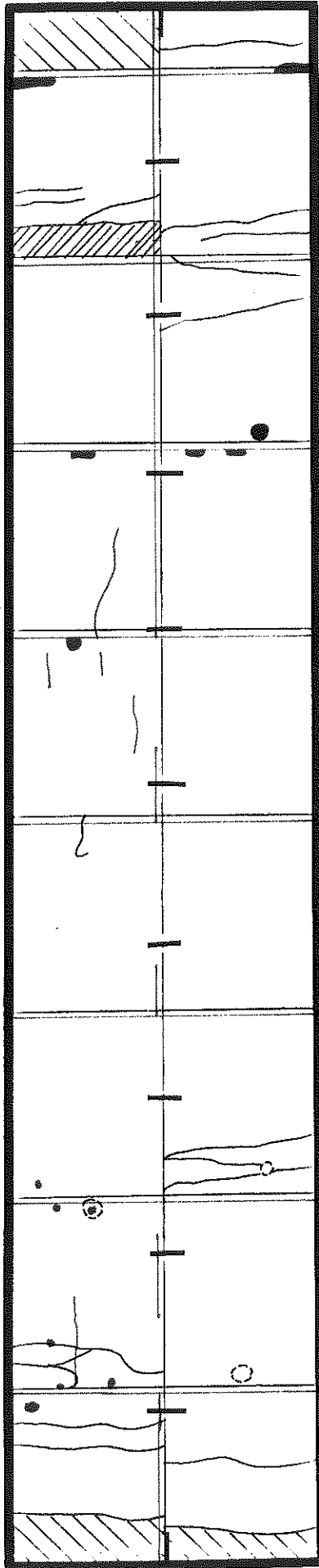
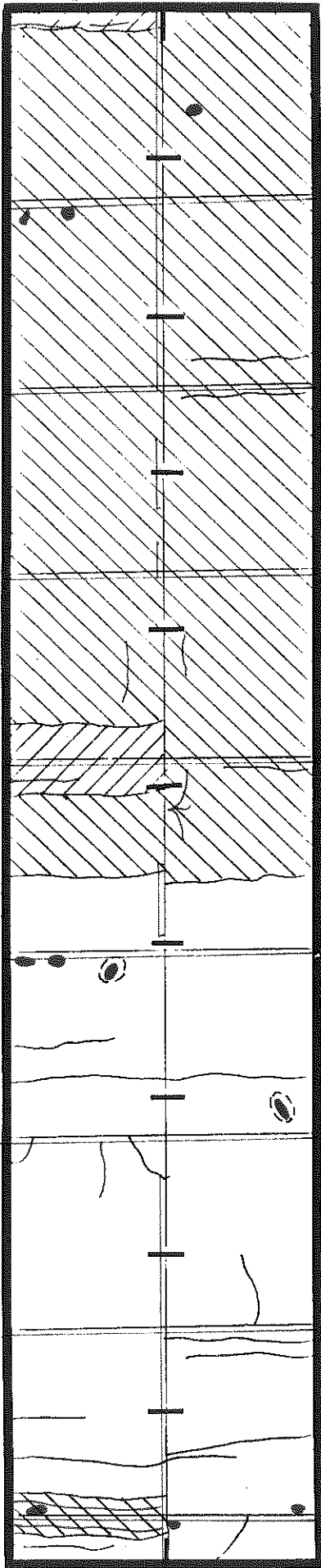


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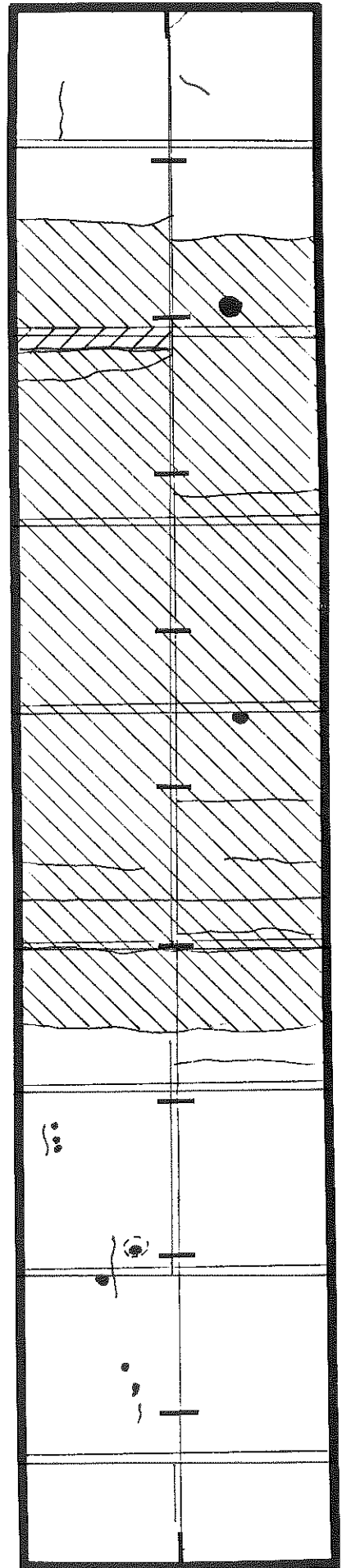
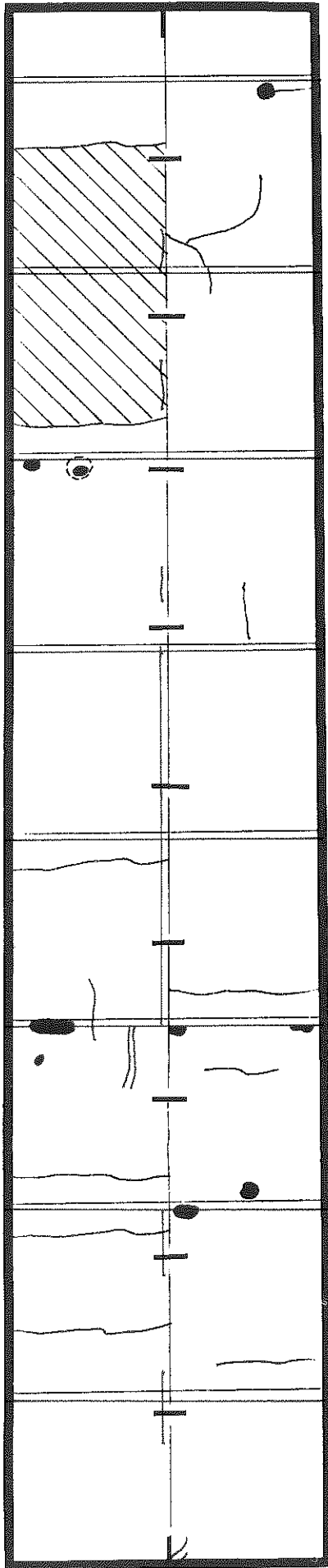
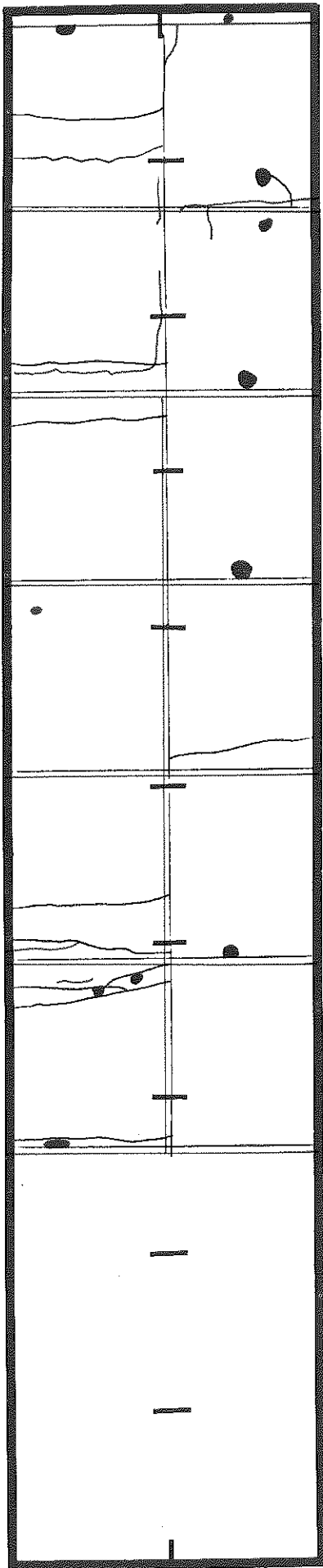


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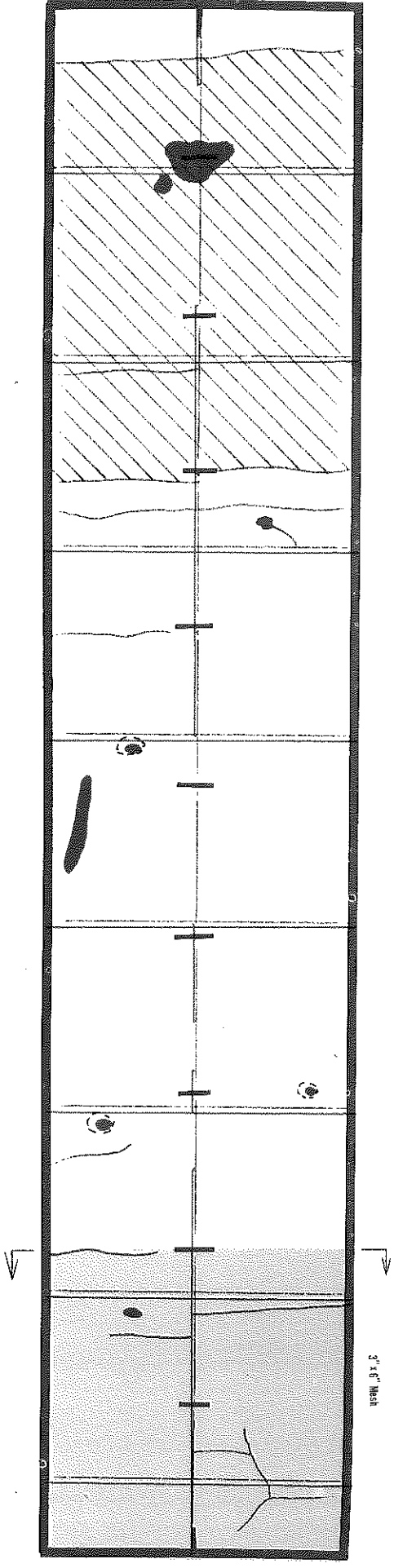
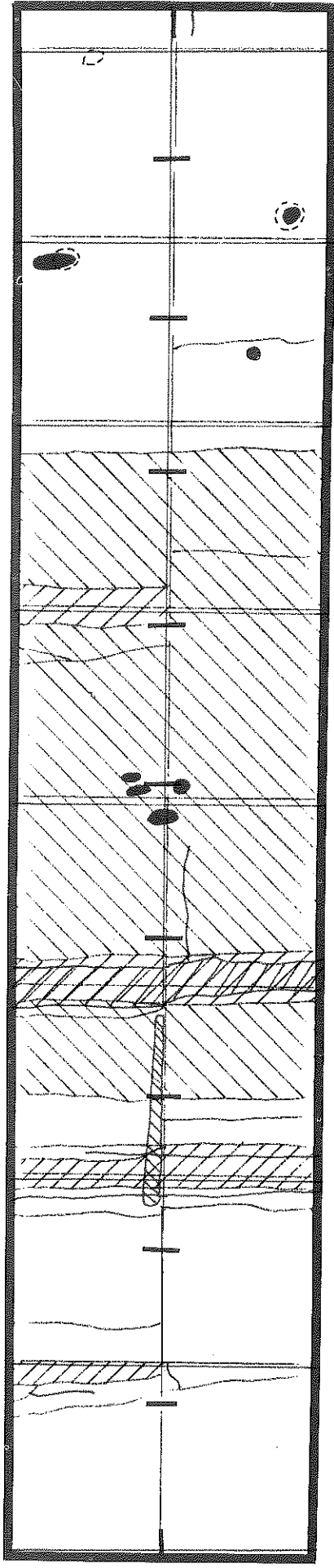
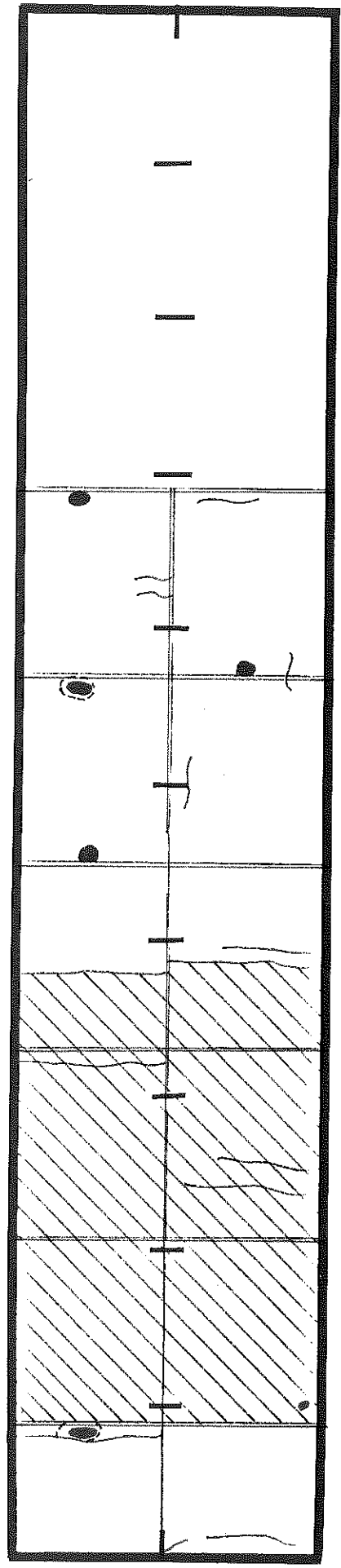


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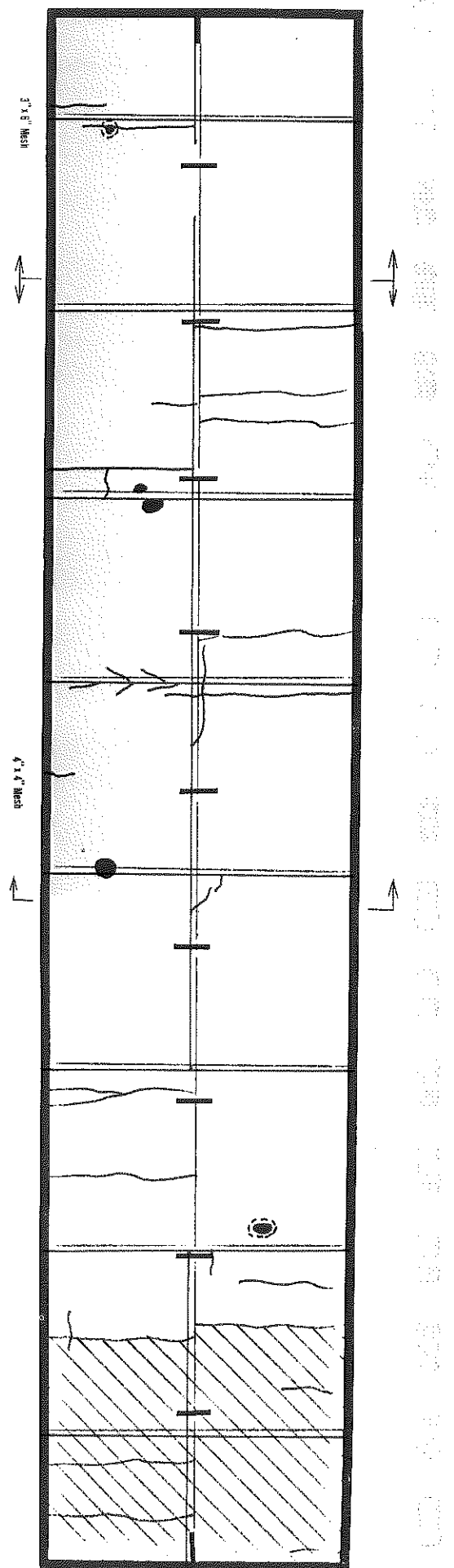
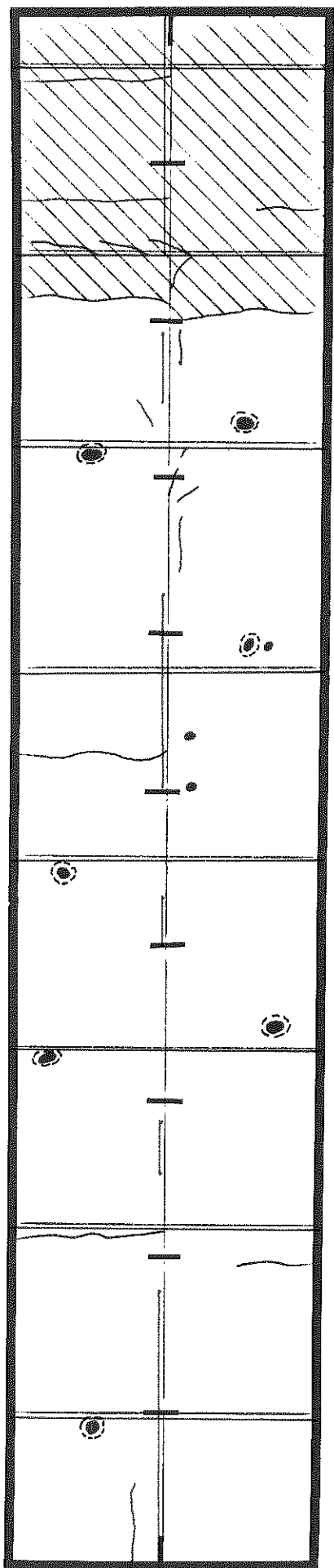
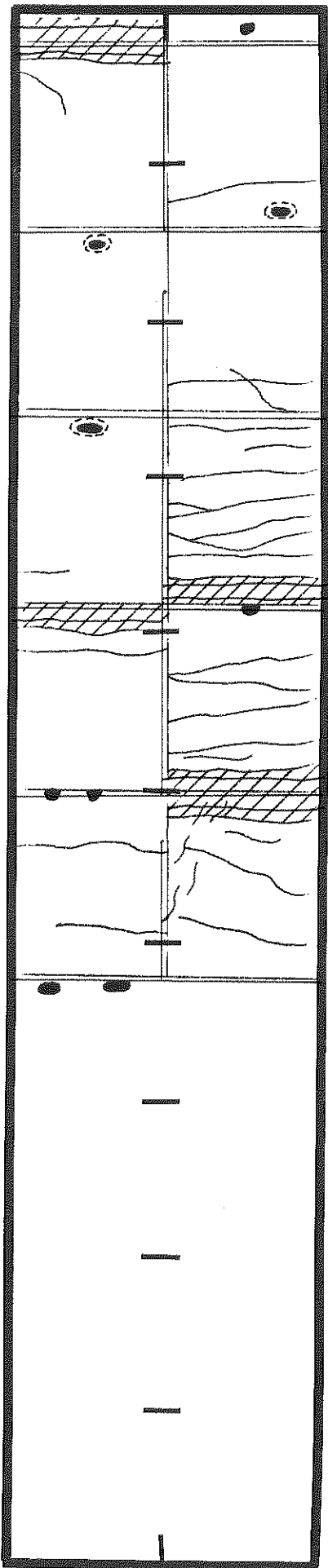


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LOCATION 3



LOCATION 3

Research Report

FINAL

LIMESTONE SAND BLANKETS TO CONTROL
REFLECTION CRACKING IN
BITUMINOUS CONCRETE OVERLAYS
(Experimental)

Division of Research
DEPARTMENT OF HIGHWAYS
Commonwealth of Kentucky

July 1968

INTRODUCTION

In recent years greater use has been made of bituminous concrete overlays on existing portland cement concrete pavements. When employed on the older expansion-joint type construction "reflection cracking" eventually occurs. A reflection crack is one which develops in the bituminous overlay directly above a crack or joint in the slab below(1). It has been observed that reflection cracking may result from either of two causes: 1) differential vertical movement between adjacent portions of the slabs or 2) the repeated differential expansion and contraction of the layers.

This report describes a method of minimizing reflection cracking suggested by Messrs R. C. Deen and R. L. Florence (1). This method of control has been reported on by the Los Angeles County Road Department (2, 3). This method employs the principle of destroying the bond between the rigid pavement and bituminous overlay by placing a mat of fine-graded sand directly over the joint. The zone of unbonded overlay is then more able to withstand movements of the underlying rigid pavement without cracking.

California has reported up to 100 percent reduction of reflection cracking by use of the sanding method. Bond-breaking materials used by California were stone dust and plaster sand--but any fine-graded material free of foreign matter would be acceptable (3). Cost estimates for placing five different materials which were utilized as bond-breaking agents are reproduced in Table I.

TEST INSTALLATIONS

On July 1, 1963, limestone sand was placed in transverse strips on the original portland cement concrete surface of US 421 in Woodford County between Lexington and Midway (see strip map of test site in Appendix A). At the request of the Division of Maintenance, personnel from the Division of Research observed the experimental features of this project.

Personnel from the Division of Maintenance prepared the joints and placed the stone dust. Excess joint-filler material above the pavement surface was removed with a road patrol grader. Joints 9, 10, and

TABLE 1

Summary of Labor and Material Costs*
for California's Reflection Crack Study(3)

Type of Material	Material Costs \$/Sq Ft	Man-Hrs Per Sq Ft	Labor Costs \$/Sq Ft	Total Costs \$/Sq Ft
Sheet Metal	0.118	0.008	0.021	0.139
Expanded Wire Mesh	0.344	0.008	0.021	0.365
Aluminum Foil	0.013	0.003	0.008	0.021
Wax Paper	0.004	0.003	0.008	0.012
Stone Dust	0.004	0.003	0.008	0.012

*Based on 1958 Labor and Material Costs

11 of the northbound lane, however, were cleaned by use of a pick and shovel. Table 2 lists methods of preparation and size of sand mat. The road patrol grader was inefficient in removing completely the excess joint-filler material. After the filler material had been removed, stone dust was spread by repeated passes of a two-wheeled garden fertilizer spreader in transverse strips 18-inches wide and 1/8-1/4 inch thick over each selected joint. All joints were prepared in this manner with the exception of Nos. 1 through 7 in the southbound lane, which received a thickness of less than 1/8 inch and No. 11 which received a strip 30 inches wide in the northbound lane and 48 inches wide in the southbound lane. Stone dust was agriculture limestone obtained from the Central Rock Quarry. No records of gradation were obtained. The size and extent of cracks present in the rigid pavement were not recorded prior to resurfacing.

After placement of the stone dust mats, the roadway was resurfaced with 1-1/2 inches of Type L mix composed of 40 percent natural sand, 40 percent No. 9 limestone, and 20 percent limestone sand. The surface received a tack coat of RS-1 prior to surfacing. Contractor for resurfacing was the Robert L. Carter Contracting Company, Frankfort, Kentucky.

PERFORMANCE SURVEY

Immediately after completion of paving pronounced outlines of all joints were observed where the dust mat was not used and at most joints where it was used.

TABLE 2

Summary of Joint Preparation and
Application of Limestone Sand

Joint Number	Northbound Lane			Southbound Lane		
	Mat Width (Inches)	Sand Mat Thickness (Inch)	Method of Joint Preparation	Mat Width (Inches)	Sand Mat Thickness (Inch)	Method of Joint Preparation
1	18	1/8-1/4	Road Grader	18	< 1/8	Road Grader
2	18	1/8-1/4	Road Grader	18	< 1/8	Road Grader
3	18	1/8-1/4	Road Grader	18	< 1/8	Road Grader
4	18	1/8-1/4	Road Grader	18	< 1/8	Road Grader
5	18	1/8-1/4	Road Grader	18	< 1/8	Road Grader
6	18	1/8-1/4	Road Grader	18	< 1/8	Road Grader
7	18	1/8-1/4	Road Grader	18	< 1/8	Road Grader
8	18	1/8-1/4	Road Grader	18	1/8-1/4	Road Grader
9	18	1/8-1/4	Pick & Shovel	18	1/8-1/4	Road Grader
10	18	1/8-1/4	Pick & Shovel	18	1/8-1/4	Road Grader
11	30	1/8-1/4	Pick & Shovel	48	1/8-1/4	Road Grader

A performance survey was conducted October 28, 1963. At that time, no visual difference in the appearance of treated or non-treated joints was noted. The overlay above joints in both the test section and control section had developed hairline cracks.

On February 11, 1965, an additional performance survey and photographic record of all joints was made (Appendix C). Although cracking had occurred in the test section, it appeared to be less severe than in the control section. In addition a crack survey was conducted in order to determine the size and intensity of cracking within the test section as compared to that within the control section. Results of this survey are listed in Table 3, a summary of detailed tabulations which may be found in Appendix B. These results indicate that application of a stone dust mat reduced the severity of reflection cracking.

Observations of Joint 11 revealed an extensive dendritic crack pattern in the southbound lane; whereas, the northbound lane remained in excellent condition. This joint was the only one in both sections where this type cracking occurred. The width of the stone mat was 30 inches and 48 inches in the northbound and southbound lanes respectively. Indications are that, at some width greater than 30 inches, bonding of the two layers may be broken to such an extent that may encourage cracking.

TABLE 3

Intensity of Types of Cracking Expressed as
a Percentage of Total Joint Lengths

Date	Southbound Lane Size of Cracks				Northbound Lane Size of Cracks			
	Wide ($>1/4''$)	Narrow ($1/16'' - 1/4''$)	Hair- line ($<1/16''$)	No Crack	Wide ($>1/4''$)	Narrow ($1/16'' - 1/4''$)	Hair- line ($<1/16''$)	No Crack
Feb 1968								
Test Section	54	1	1	24	60	20	0	20
Control Section	65	9	8	18	79	7	2	12
May 1968								
Test Section	83	5	2	10	77	7	2	14
Control Section	90	5	3	2	87	4	2	7

On May 21, 1968, a final inspection was made of the test installation. The summary of the data obtained from this inspection is tabulated in Table 3. Comparing the data with that from the 1965 survey indicates that the number of cracks increased significantly. It is also noted that the difference between the test and control sections is less significant. Also it was observed that where the limestone blanket was used, cracks occurred over the underlying joint and at the extremity of the blanket as well. Consequently, there were more cracks in the test section than in the control section.

The method of preparing the joints on this experiment did not prove effective. It was impossible to remove the joint-filler material from the joint void. Cleaning with a patrol grader, at best, only removed excess material from the pavement surface and, as depicted in Figure 1a, the joint void still remains full of material. After placement of an overlay, subsequent expansion of the pavement slabs may force material up and out of the joint voids. Vertical displacement, in turn, introduces a deformation of the overlay resulting in tension cracks on the surface. The obvious solution would be to remove the filler to some depth within the joint void as indicated in Figure 1a.

The sand mat serves as a bond-breaking material and theory dictates that the sand mat must be placed within certain width and depth

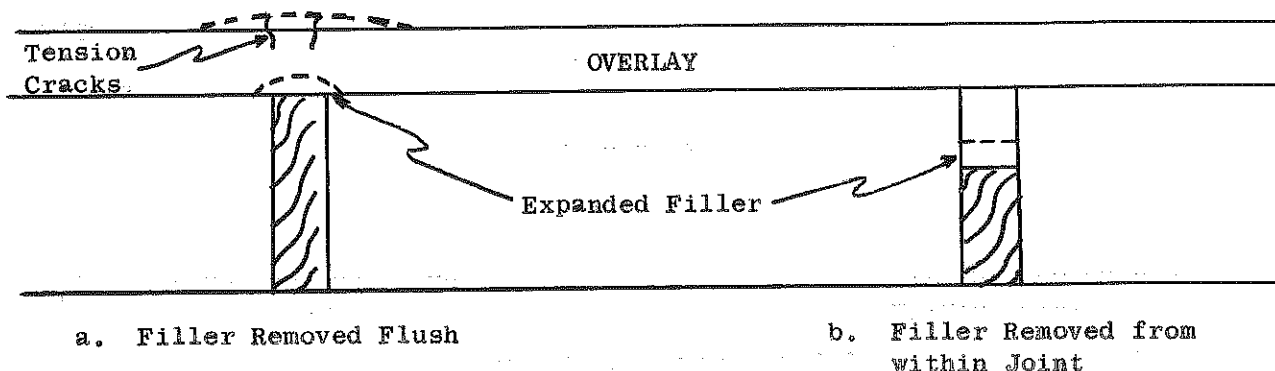


Figure 1. Joint Preparation

limits and be uniform. Ridges or humps within the mat introduce points of stress concentration and provide favorable conditions for cracking when the pavement is subjected to movement. It was difficult to obtain a smooth and uniform band of material by the method used for spreading the mat on this job. A screed type spreader, such as shown in Figure 2, might be used to place the sand mat. This machine could be built from 1/2-inch plywood stock for a cost of approximately \$40.

CONCLUSIONS

Due to the lack of records, no conclusions as to costs and degree of crack reduction may be made. With regard to the information recorded, the following conclusions were made:

1. Difficulty was experienced in obtaining clean, flush removal of excess filler material with the use of a patrol grader.
2. Personnel experienced difficulty in maintaining proper width and depth of sand-mat placement.
3. The severe dendritic cracking of Joint 11, which received a sand layer 30 to 48 inches in width, indicated that too wide a layer of sand might encourage cracking.
4. Use of sand mats did reduce reflection cracking on a short-term basis; but after five years, the effectiveness of the blankets was greatly reduced.

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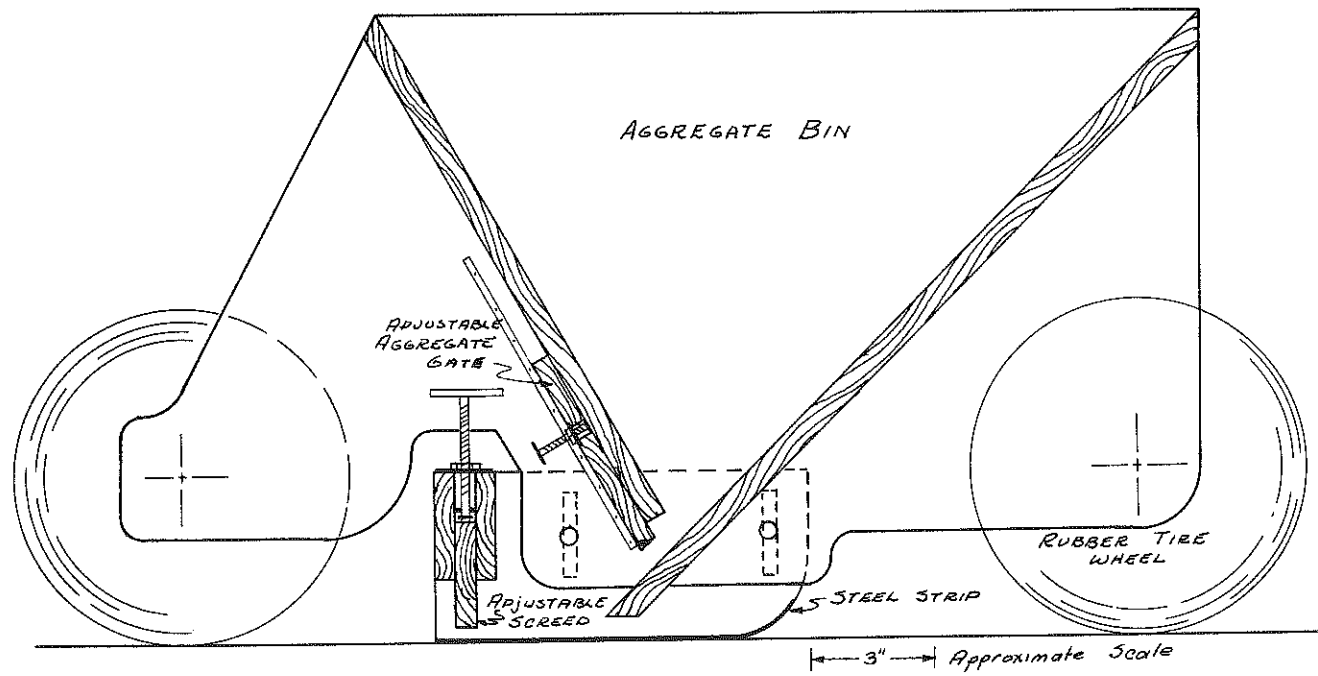


Figure 2. Screed Type Sand Spreader

APPENDIX A

**STRIP MAP OF TEST
AND CONTROL SECTIONS**

LEGEND



**TEST JOINTS TREATED WITH
STONE DUST MATS.**



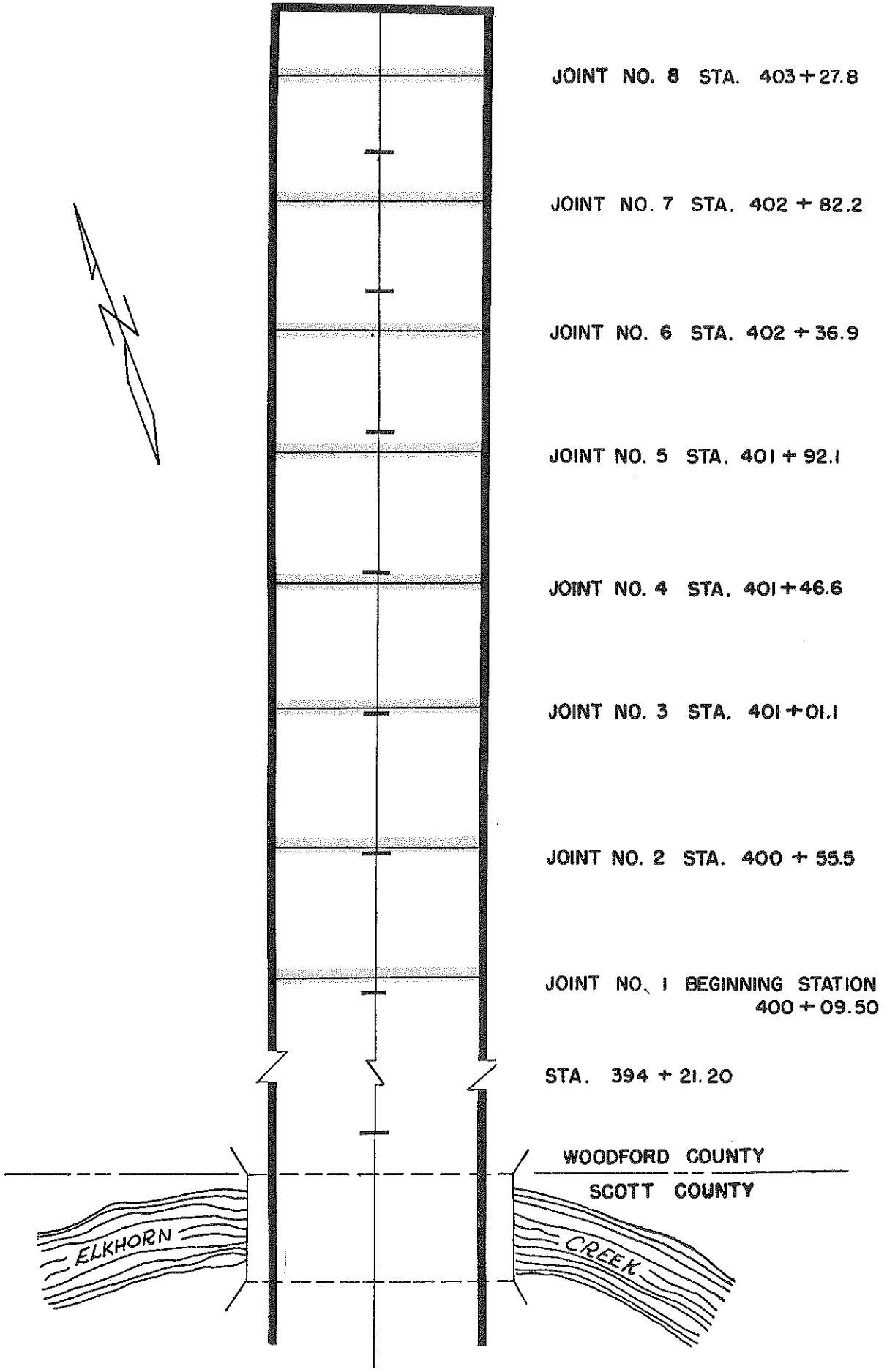
**CONTROL JOINTS NOT TREATED,
BUT INCLUDED IN PERFORMANCE
SURVEY.**



**JOINTS IN PORTLAND CEMENT
CONCRETE PAVEMENT.**



**JOINTS IN PORTLAND CEMENT
CONCRETE PAVEMENT NOT
INCLUDED IN STUDY.**



JOINT NO. 8 STA. 403+27.8

JOINT NO. 7 STA. 402+82.2

JOINT NO. 6 STA. 402+36.9

JOINT NO. 5 STA. 401+92.1

JOINT NO. 4 STA. 401+46.6

JOINT NO. 3 STA. 401+01.1

JOINT NO. 2 STA. 400+55.5

JOINT NO. 1 BEGINNING STATION
400+09.50

STA. 394+21.20

WOODFORD COUNTY

SCOTT COUNTY

ELKHORN

CREEK

STA. 408+00.00

JOINT NO. 18 STA. 407+82.9

JOINT NO. 17 STA. 407+37.4

JOINT NO. 16 STA. 406+92.1

STA. 406+27.0
3'x 2' R.C. BOX CULVERT
@ 15° SKEW LEFT

JOINT NO. 15 STA. 406+46.5

JOINT NO. 14 STA. 406+00.7

JOINT NO. 13 STA. 405+54.7

JOINT NO. 12 STA. 405+09.2

JOINT NO. 11 STA. 404+63.7

JOINT NO. 10 STA. 404+18.5

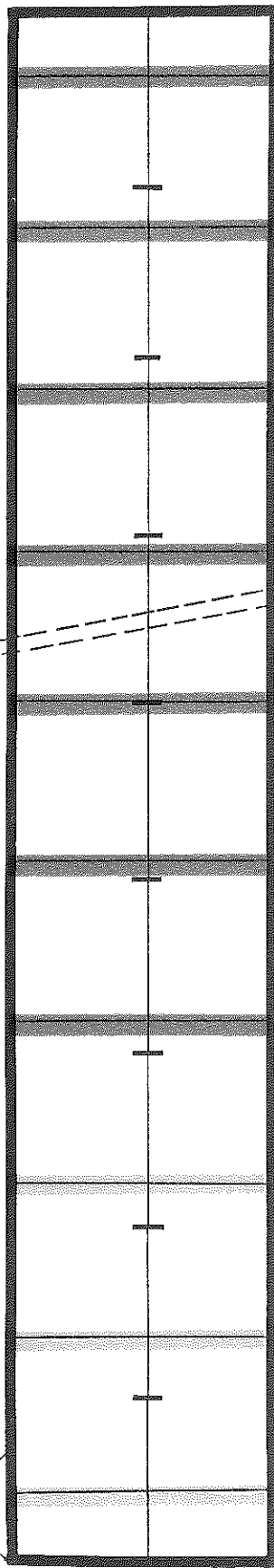
STA. 403+75.00 BEGIN FA 326E
STA. 403+75.00 END FA 326G

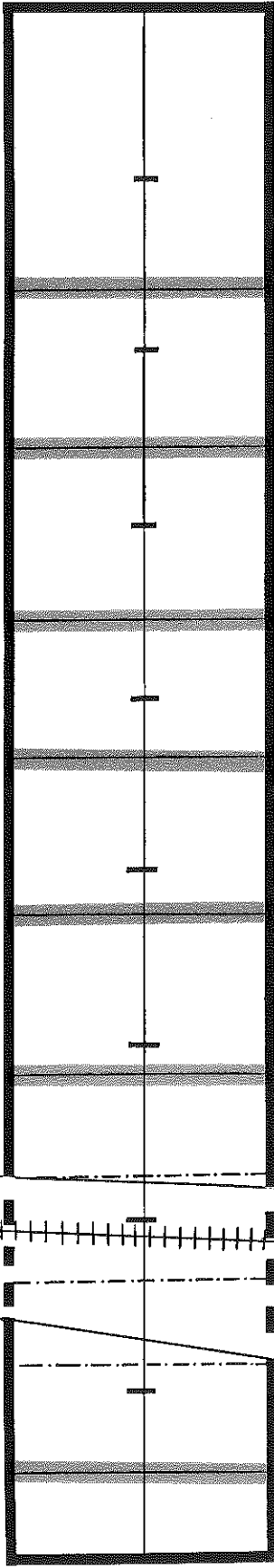
(GRA/EL DRIVEWAY) JOINT NO. 9
STA. 403+73.1

COUNTRY ROAD

(PAVED)

STA. 403+50.00





JOINT NO. 25 ENDING STA. 411+68.00

JOINT NO. 24 STA. 411+22.3

JOINT NO. 23 STA. 410+77.5

JOINT NO. 22 STA. 410+32.4

JOINT NO. 21 STA. 409+87.4

JOINT NO. 20 STA. 409+41.6

LOUISVILLE & NASHVILLE RAILROAD
OVERPASS

JOINT NO. 19 STA. 408+27.6

STA. 408+00.0

APPENDIX B

TABULATION OF CRACK
SIZE AND OCCURRENCE
FOR TEST AND
CONTROL SECTIONS

February 1965

	Joint Number	Southbound Lane				Northbound Lane			
		Wide (1/4")	Narrow (1/16"-1/4")	Hairline (1/16")	No Cracking	Wide (1/4")	Narrow (1/16"-1/4")	Hairline (1/16")	No Cracking
Test Section	1	0.00*	0.20	0.80	0.00	0.60	0.40	0.00	0.00
	2	0.00	0.00	0.00	1.00	0.00	0.80	0.00	0.20
	3	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	4	0.00	0.15	0.00	0.85	0.00	0.00	0.00	1.00
	5	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	6	0.00	0.00	0.20	0.80	0.00	0.00	0.00	1.00
	7	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	8	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	9	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00
	10	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	11	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	Total	6.00	1.35	1.00	2.65	6.60	2.20	0.00	2.20
	Percent of Total	54	1	1	4	60	20	0	20
Control Section	12	0.00	0.00	0.35	0.65	0.00	0.00	0.00	1.00
	13	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00
	14	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	15	0.00	0.00	0.80	0.20	0.00	0.00	0.25	0.75
	16	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	17	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	18	0.00	0.25	0.00	0.75	1.00	0.00	0.00	0.00
	19	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	20	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	21	0.45	0.05	0.00	0.50	1.00	0.00	0.00	0.00
	22	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
23	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	
24	0.80	0.00	0.00	0.20	1.00	0.00	0.00	0.00	
25	0.80	0.00	0.00	0.20	1.00	0.00	0.00	0.00	
	Total	9.05	1.30	1.15	2.50	11.00	1.00	0.25	1.75
	Percent of Total	65	9	8	18	79	7	2	12

*The crack length is expressed as a decimal fraction of the lane width; total lanewidth equal to 1.00.

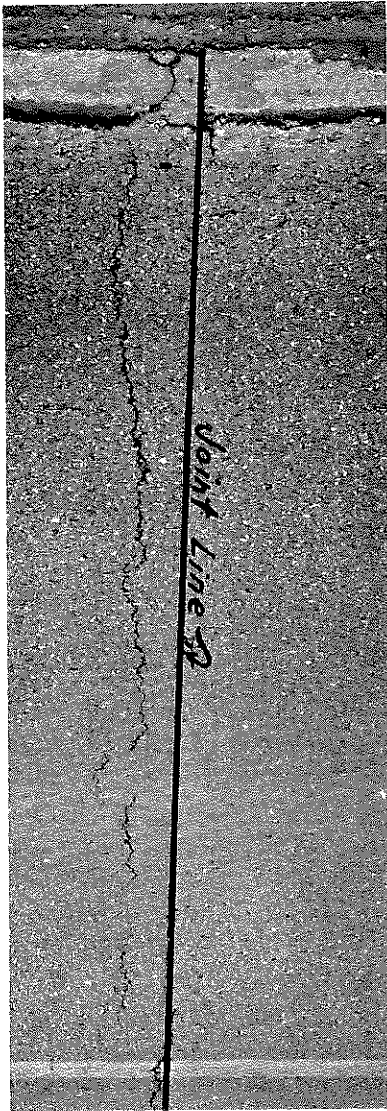
May 1968

	Southbound Lane				Northbound Lane				
	Crack Size	Crack Size	Hairline	No	Crack Size	Crack Size	Hairline	No	
Joint Number	Wide (1/4")	Narrow (1/16"-1/4")	(1/16")	Cracking	Wide (1/4")	Narrow (1/16"-1/4")	(1/16")	Cracking	
Test Section	1	1.00	0.00	0.00	0.00	0.70	0.30	0.00	0.00
	2	0.10	0.10	0.10	0.70	0.30	0.20	0.00	0.50
	3	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	4	0.45	0.00	0.10	0.45	0.20	0.00	0.10	0.70
	5	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	6	0.90	0.10	0.00	0.00	0.30	0.30	0.10	0.30
	7	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	8	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	9	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	10	0.70	0.30	0.00	0.00	1.00	0.00	0.00	0.00
	11	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
Total	9.15	0.50	0.20	1.15	8.50	0.80	0.20	1.50	
Percent of Total	83	5	2	10	77	7	2	14	
Control Section	12	0.35	0.10	0.20	0.35	0.00	0.10	0.10	0.80
	13	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	14	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	15	0.60	0.20	0.20	0.00	0.50	0.20	0.20	0.10
	16	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	17	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	18	1.00	0.00	0.00	0.00	0.80	0.20	0.00	0.00
	19	1.00	0.00	0.00	0.00	0.90	0.10	0.00	0.00
	20	0.90	0.10	0.00	0.00	1.00	0.00	0.00	0.00
	21	0.80	0.20	0.00	0.00	1.00	0.00	0.00	0.00
	22	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	23	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	24	0.90	0.10	0.00	0.00	1.00	0.00	0.00	0.00
	25	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
	Total	12.55	0.70	0.40	0.35	12.20	0.60	0.30	0.90
Percent of Total	90	5	3	2	87	4	2	7	

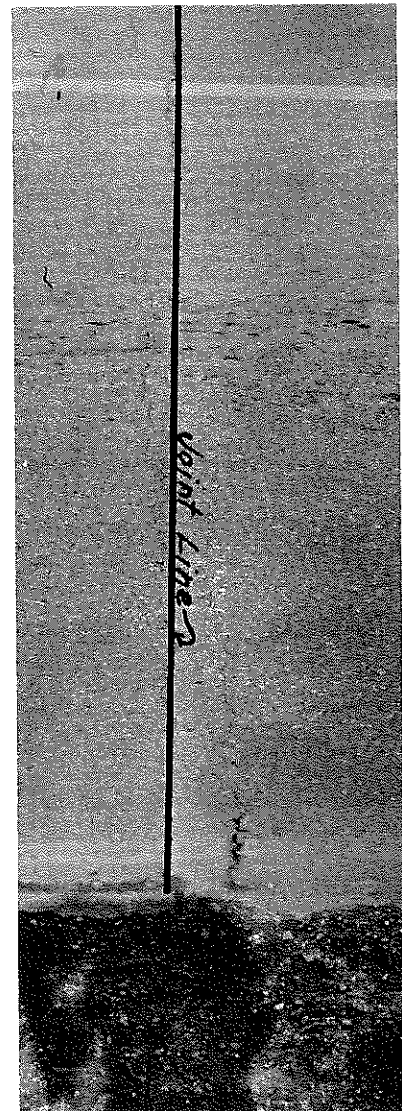
APPENDIX C
PHOTOGRAPHS AND JOINT
DESCRIPTIONS FOR TEST
AND CONTROL SECTIONS

JOINT NUMBER 1

NORTHBOUND LANE



NBL- Ragged crack extending full width of lane parallel to rigid pavement joint indicating crack is along northern edge of sand mat.

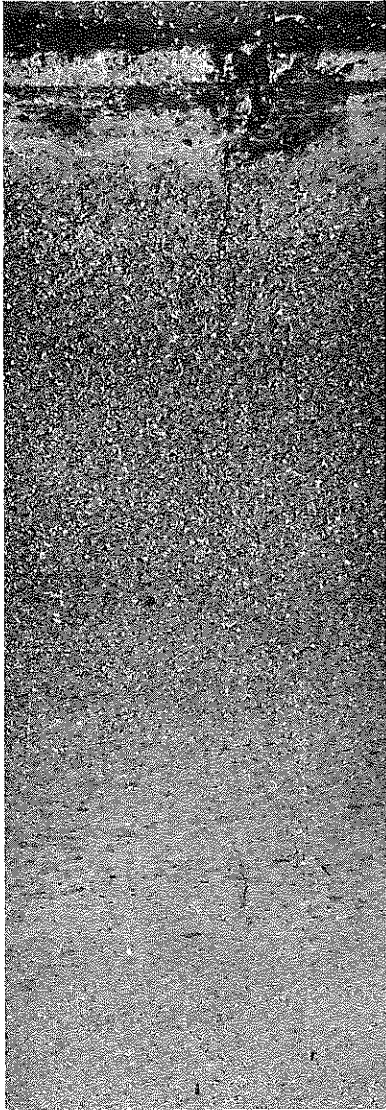


SBL- Hairline crack extending full width of lane with indication of second crack along southern edge of sand mat.

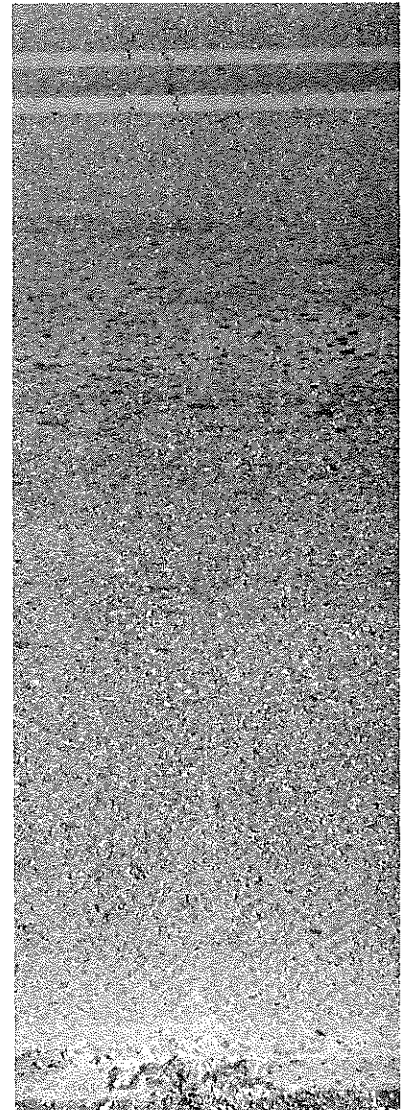
SOUTHBOUND LANE

JOINT NUMBER 2

NORTHBOUND LANE



NBL- Narrow crack from edge of pavement to outside wheel-track. Sixteen-inch long narrow crack across inside wheel track and a 22-inch narrow crack across center stripe.

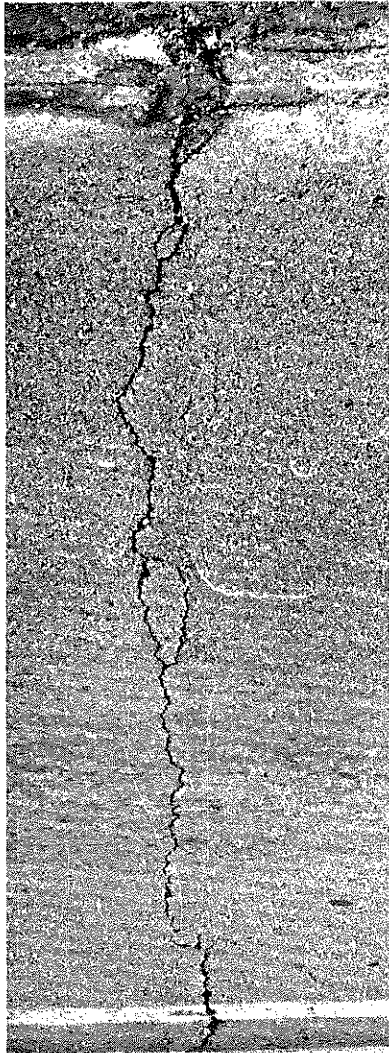


SBL- No cracking evident in bituminous overlay.

SOUTHBOUND LANE

JOINT NUMBER 3

NORTHBOUND LANE



NBL- Crack 1/2 inch wide extending full width of lane. Crack is beginning to ravel. No indication of joint failure in rigid pavement.



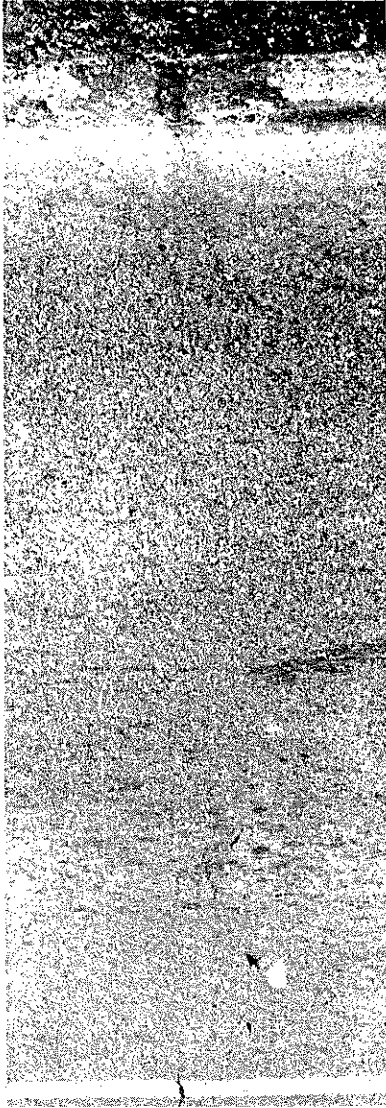
SBL- Progressive dendritic crack pattern. Cracks are 1/2 inch wide and beginning to ravel. No indication of joint failure in rigid pavement

SOUTHBOUND LANE

JOINT NUMBER 4

NORTHBOUND LANE

NBL- No cracking.

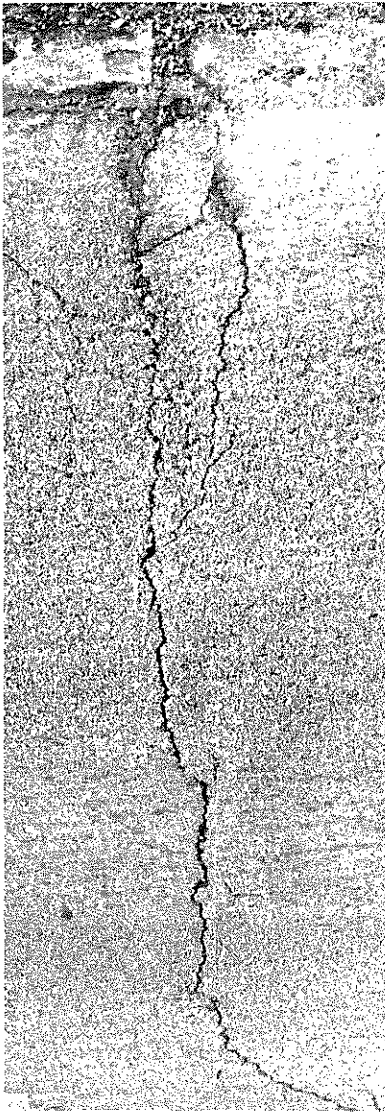


SBL - A crack across the center
stripe 18 inches long by
1/4 inch wide.

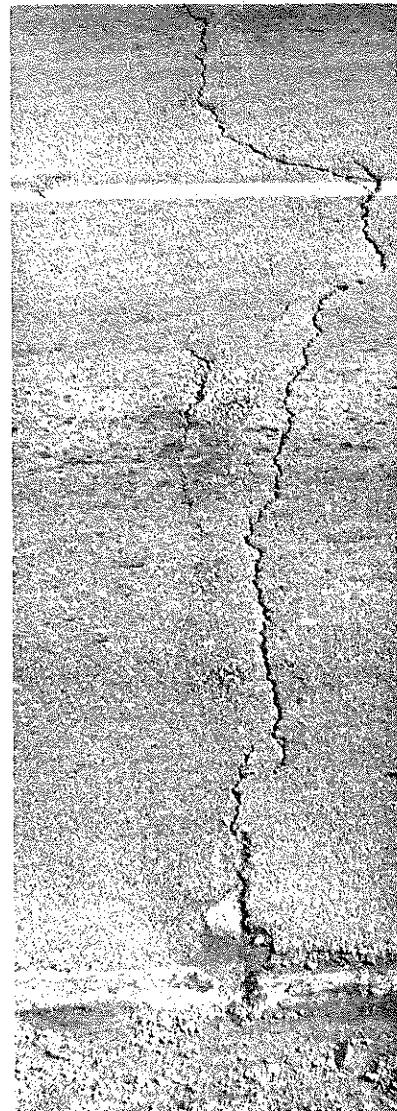
SOUTHBOUND LANE

JOINT NUMBER 5

NORTHBOUND LANE



NBL- A wide, ragged crack extending the full width of lane. Map cracking at curb indicates corner failures of rigid pavement slabs. Joint of lip curb separated 1-1/2 inches.

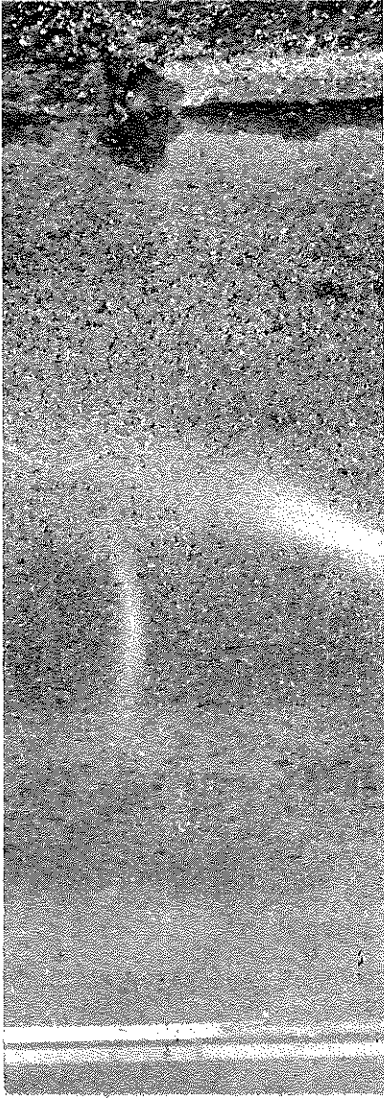


SBL- A wide, ragged crack extending full width of lane. No indication of corner failure. However, joint faulting indicated in relative downward movement of northern slab.

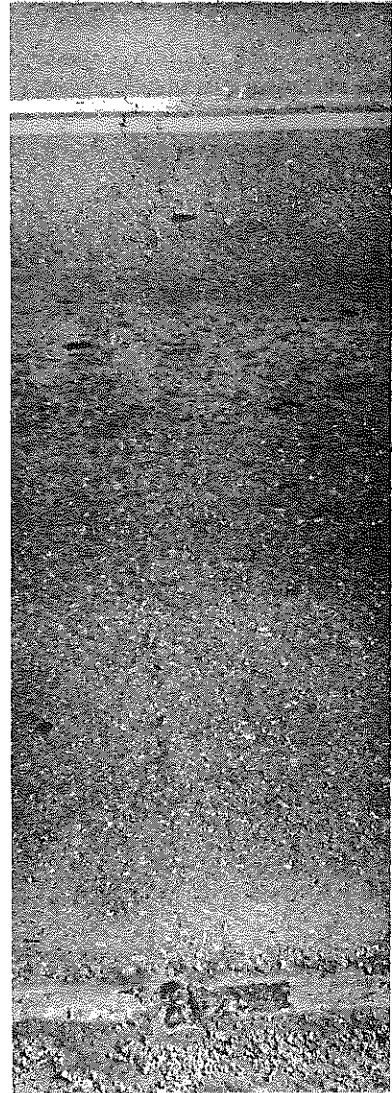
SOUTHBOUND LANE

JOINT NUMBER 6

NORTHBOUND LANE



NBL- Joint shows excellent qualities of smoothness and tightness.

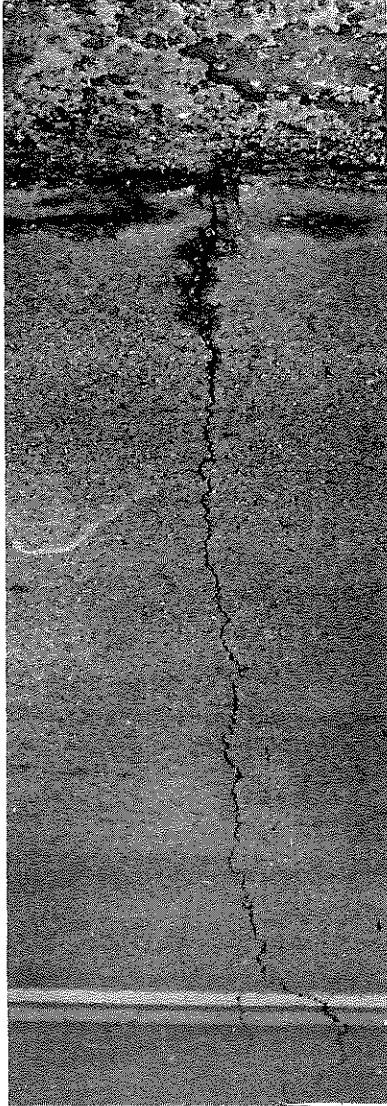


SBL- Hairline crack from inside wheel track across center stripe.

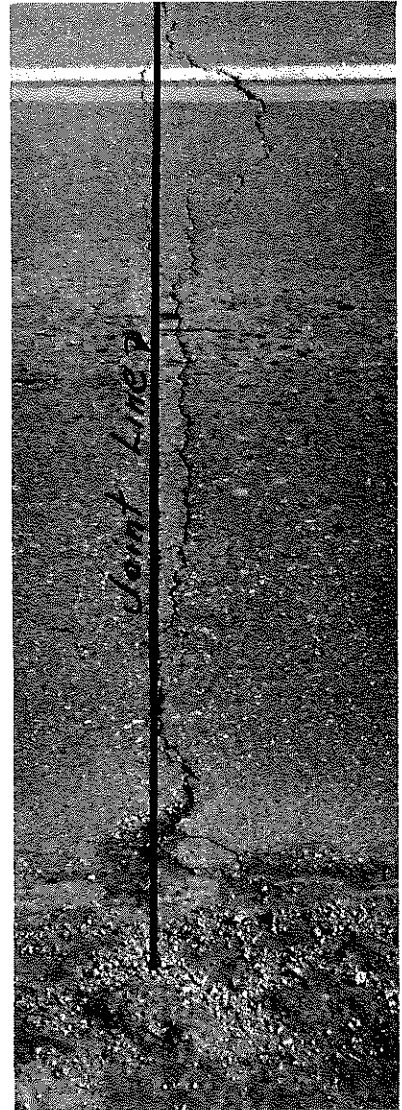
SOUTHBOUND LANE

JOINT NUMBER 7

NORTHBOUND LANE



NBL- Crack extending full width of lane beginning to ravel from edge of pavement to outside wheel track.

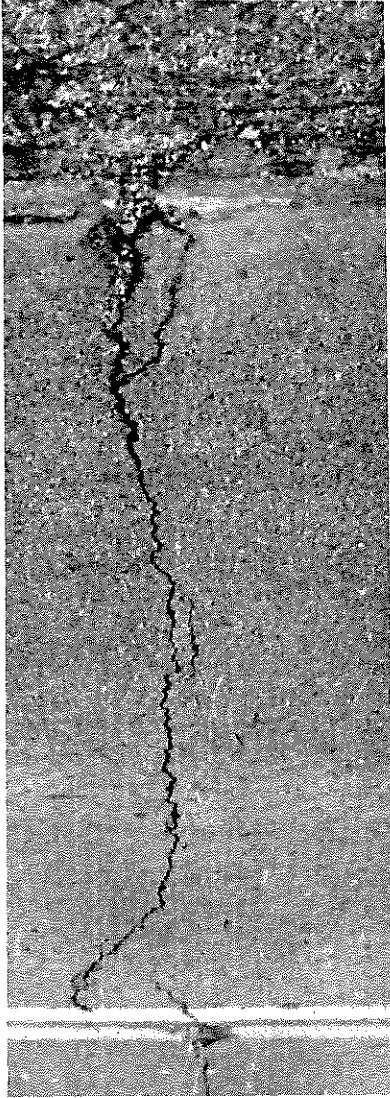


SBL- A crack 1/2 inch wide from edge of pavement to outside wheel track, and a hairline crack from outside wheel track to center stripe. At outside wheel track crack deviates to a parallel crack running along southern edge of sand mat. Indication of slight relative vertical movement of rigid slabs.

SOUTHBOUND LANE

JOINT NUMBER 8

NORTHBOUND LANE



NBL- Wide, ragged crack extending full width of lane. Joint of lip curb indicates joint separation of 2-inches.

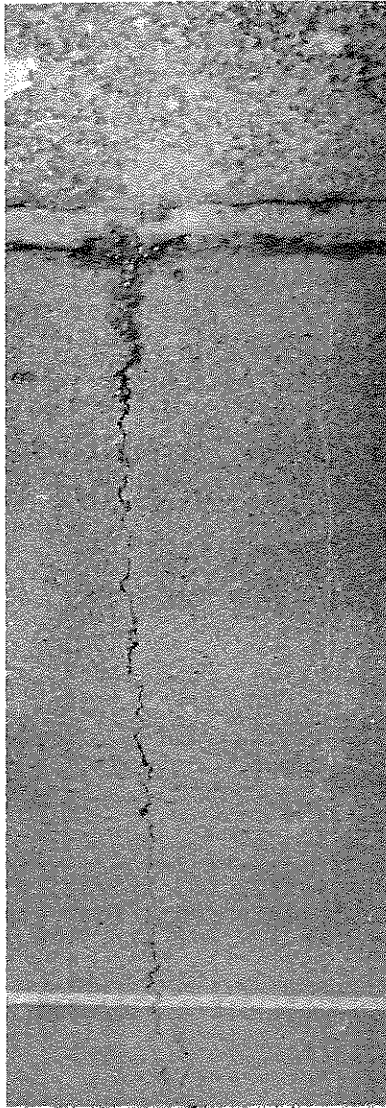


SBL- Wide, ragged crack extending full width of lane. Extensive raveling at center stripe and from outside wheel track to edge of pavement. Joint of lip curb indicates joint separation of 1-1/2 inches.

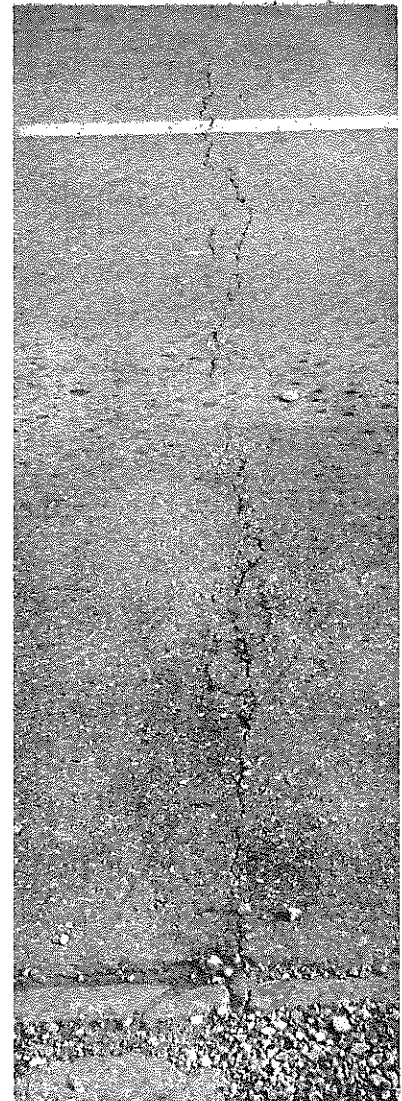
SOUTHBOUND LANE

JOINT NUMBER 9

NORTHBOUND LANE



NBL- A narrow, straight crack extending full width of lane.

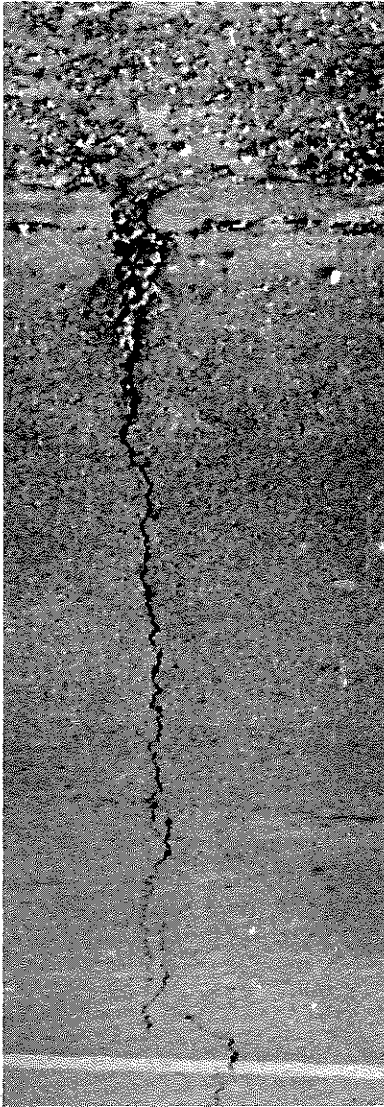


SBL- Narrow crack extending full width of lane.

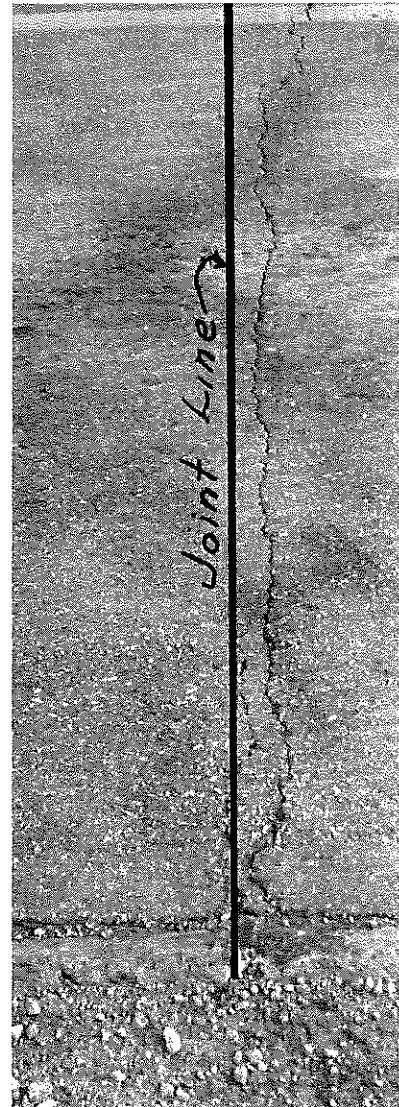
SOUTHBOUND LANE

JOINT NUMBER 10

NORTHBOUND LANE



NBL- Wide, ragged crack extending full width of lane with extensive ravelling from outside wheel track to edge of pavement.



SBL- Crack extends along southern edge of sand mat from center stripe to edge of pavement.

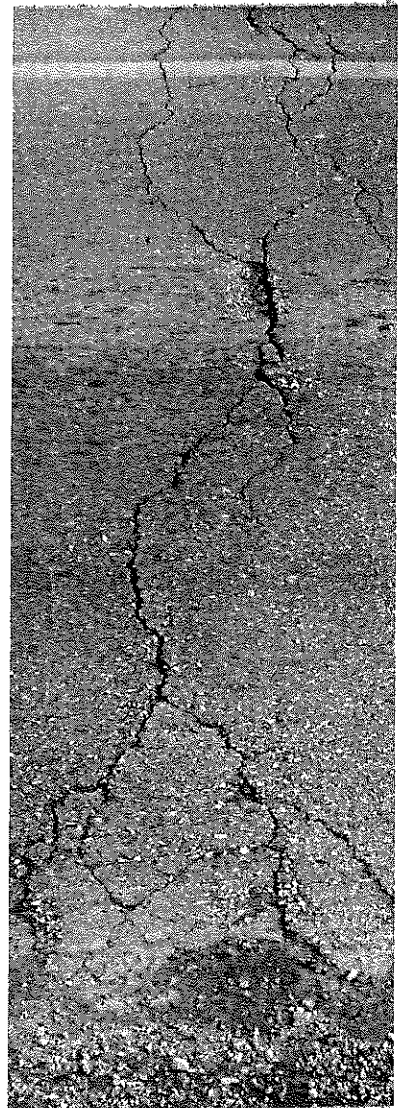
SOUTHBOUND LANE

JOINT NUMBER 11

NORTHBOUND LANE



NBL- Joint shows extensive map cracking with wide, ragged cracks. Relative vertical movement of slabs apparent.



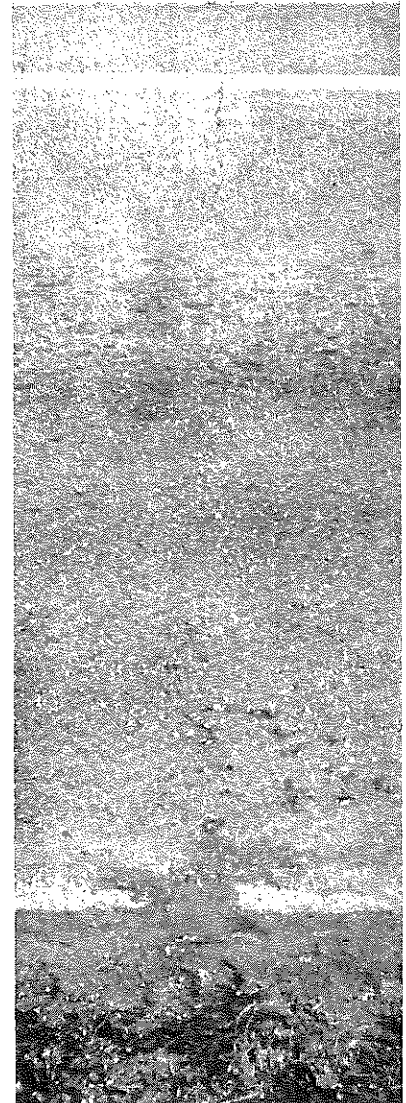
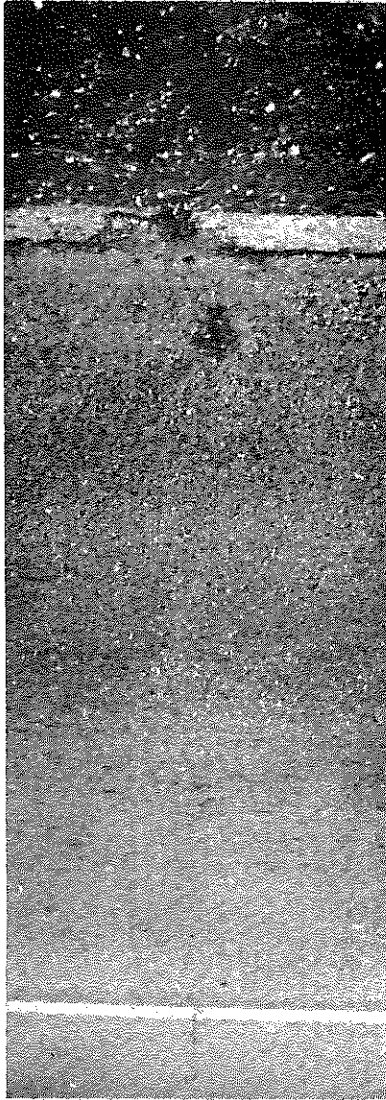
SBL- Extensive dendritic map cracking with ravelling. Indication of corner failure of rigid slabs.

SOUTHBOUND LANE

JOINT NUMBER 12

NORTHBOUND LANE

NBL- No cracking.

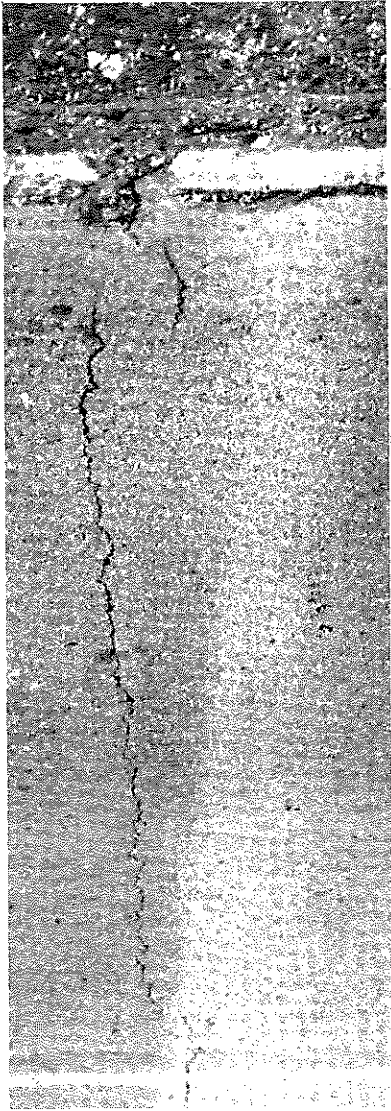


SBL- Hairline crack from inside
wheel track to center stripe.

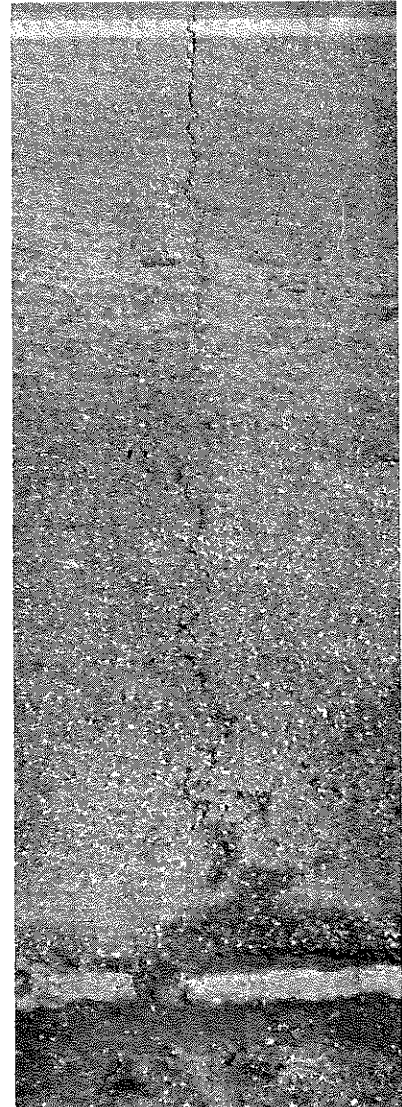
SOUTHBOUND LANE

JOINT NUMBER 13

NORTHBOUND LANE



NBL- Narrow crack extending full width of lane.

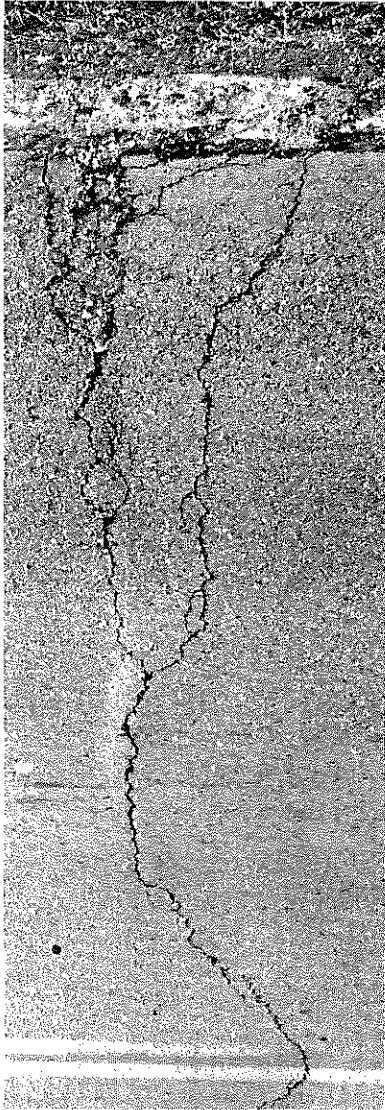


SBL- Crack extending full width of lane.

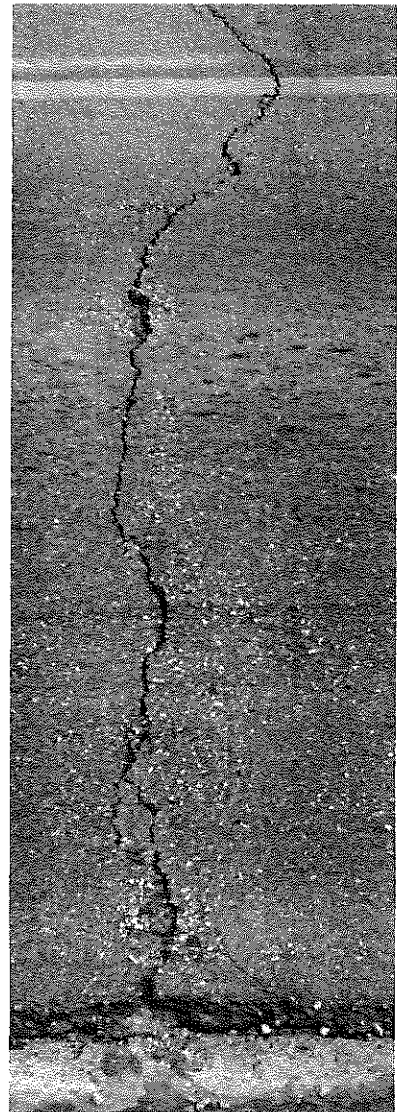
SOUTHBOUND LANE

JOINT NUMBER 14

NORTHBOUND LANE



NBL- Ragged crack extending full width of pavement. Indication of fault cracking and corner failure.

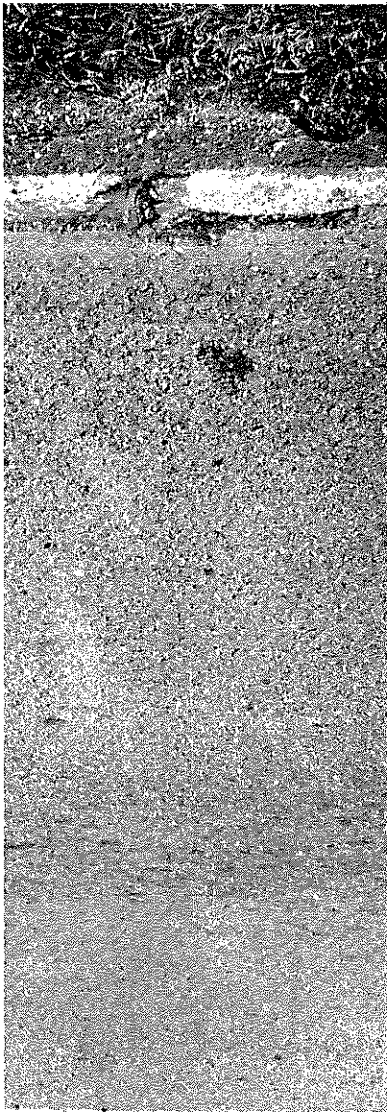


SBL- Ragged crack extending full width of lane. Indication of joint faulting.

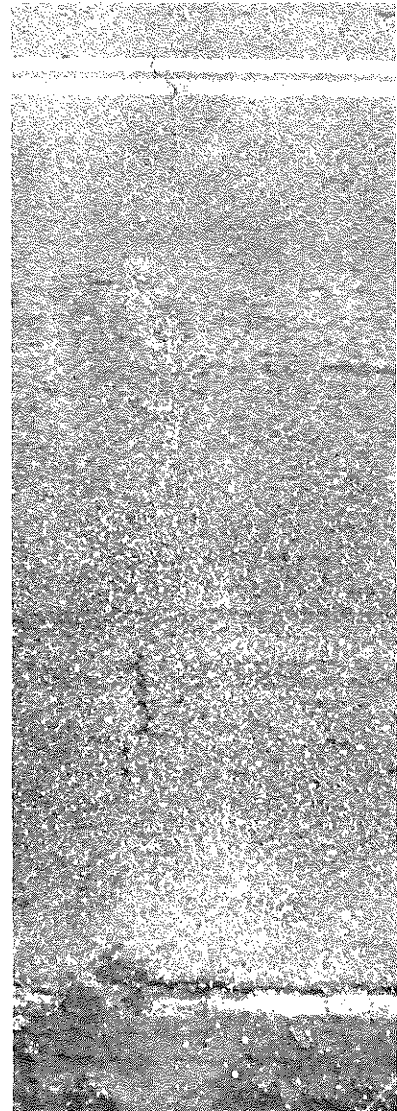
SOUTHBOUND LANE

JOINT NUMBER 15

NORTHBOUND LANE



NBL- Small hairline cracks from inside wheel track to center stripe.

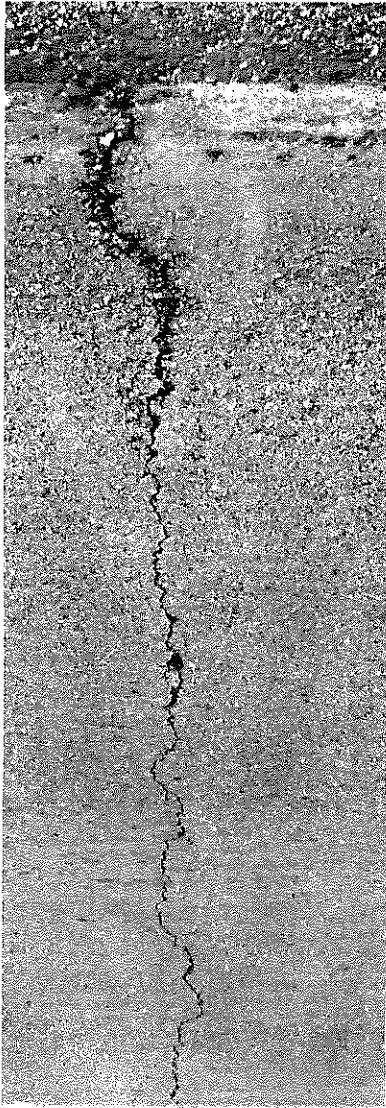


SBL- Hairline crack from outside wheel track to center stripe.

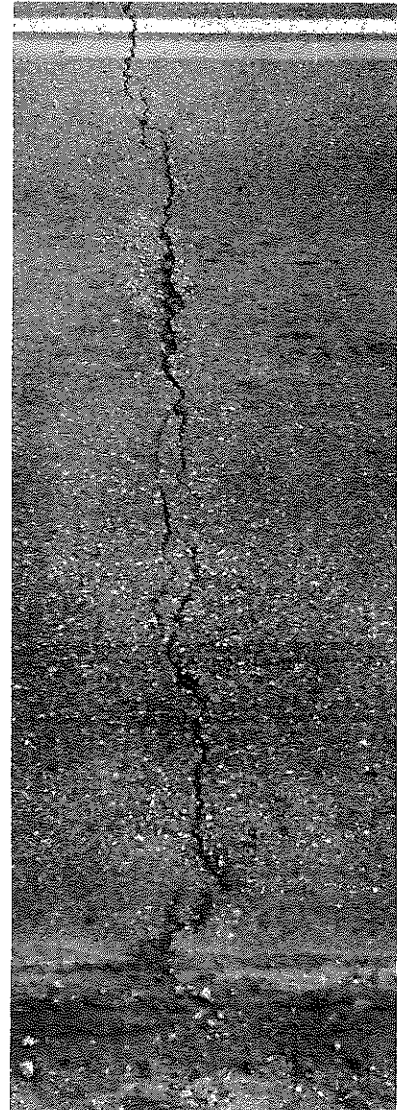
SOUTHBOUND LANE

JOINT NUMBER 16

NORTHBOUND LANE



NBL- Wide, ragged crack extending full width of lane beginning to ravel.

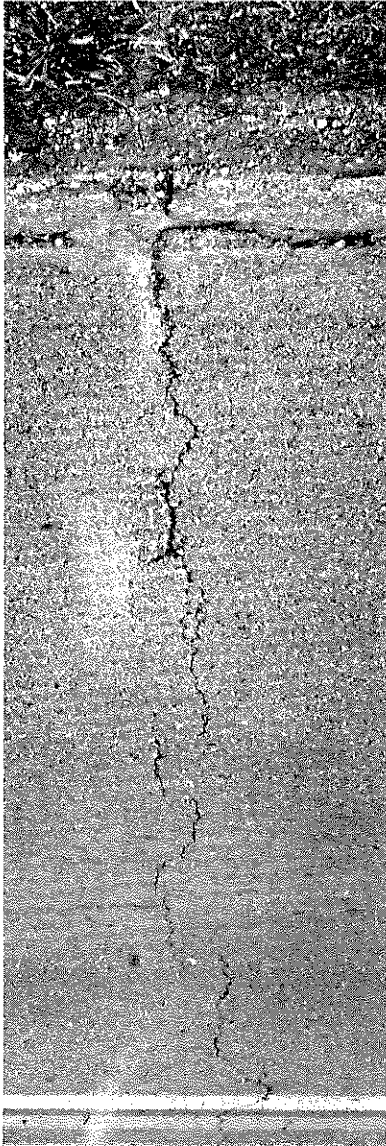


SBL- Wide, ragged crack extending full width of lane beginning to ravel.

SOUTHBOUND LANE

JOINT NUMBER 17

NORTHBOUND LANE



NBL- Ragged crack extending full width of lane beginning to ravel.



SBL- Ragged crack extending full width of lane.

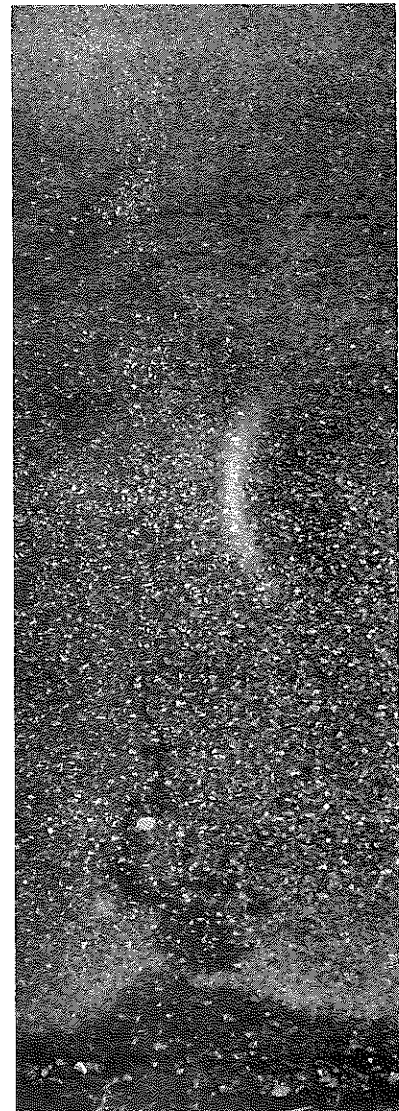
SOUTHBOUND LANE

JOINT NUMBER 18

NORTHBOUND LANE



NBL- Crack extending full width of lane. Some ravelling has occurred toward edge of pavement.

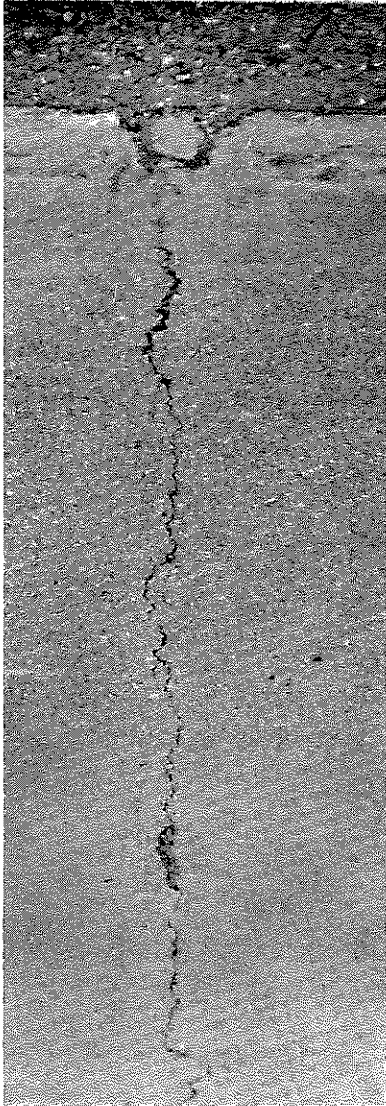


SBL- Narrow crack extending from edge of pavement to outside wheel track.

SOUTHBOUND LANE

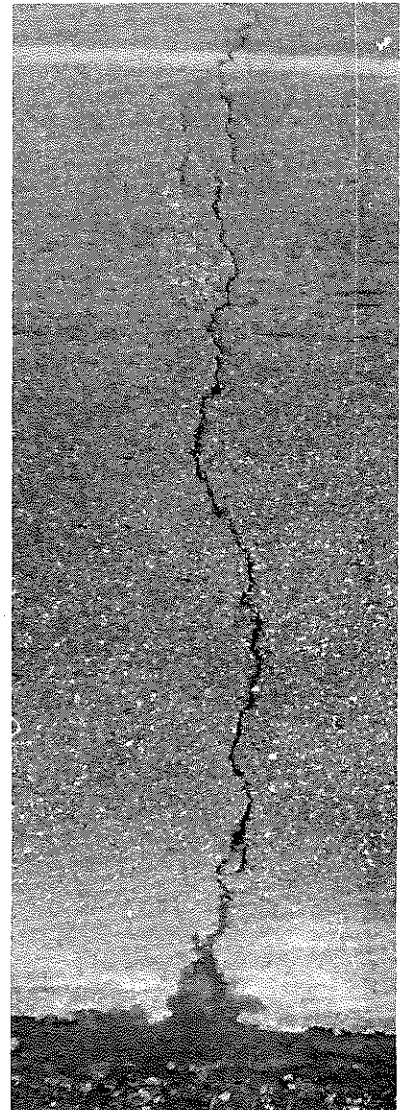
JOINT NUMBER 19

NORTHBOUND LANE



NBL- Ragged crack extending full width of lane. Beginning to ravel in wheel tracks.

SBL- Ragged crack extending full width of lane beginning to ravel at edge of pavement.

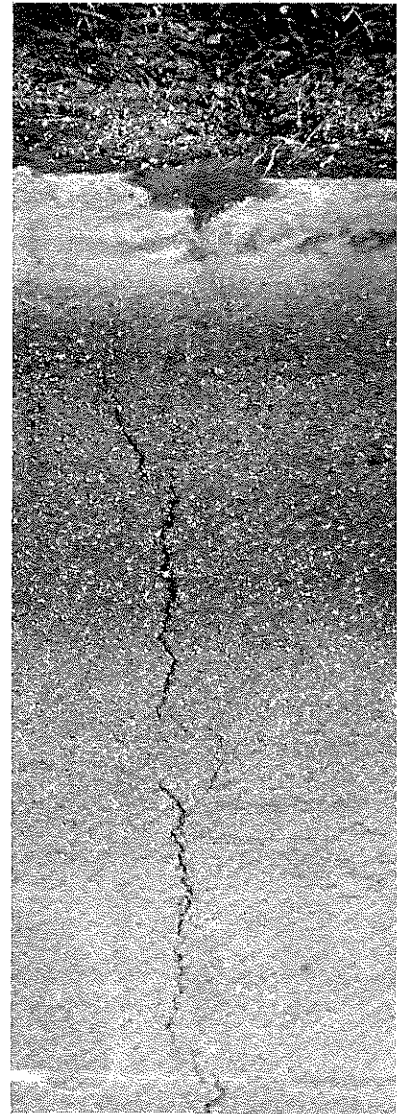
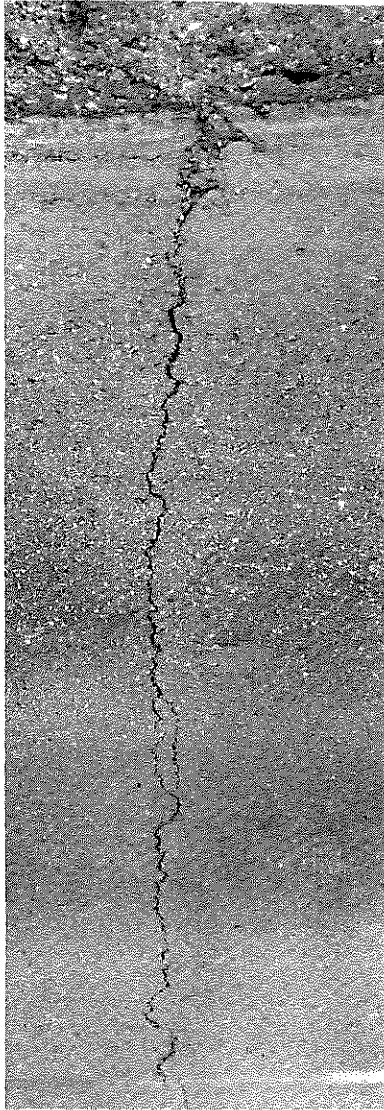


SOUTHBOUND LANE

JOINT NUMBER 20

NORTHBOUND LANE

NBL- Ragged crack extending
full width of lane.

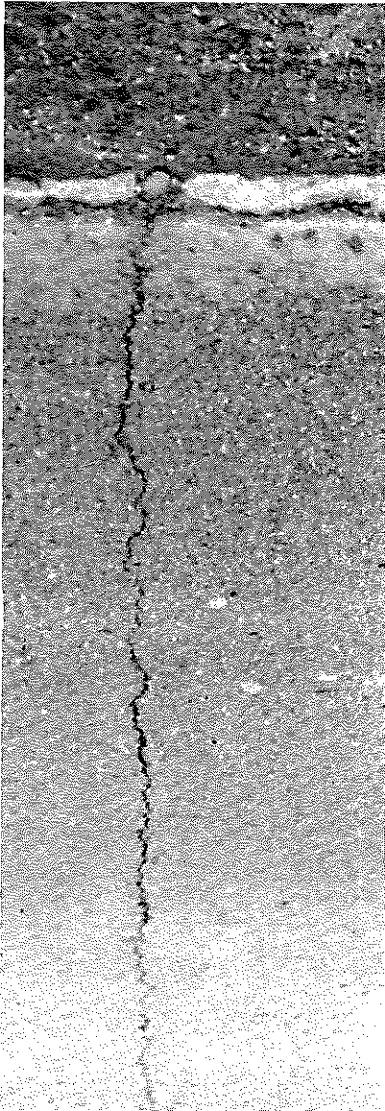


SBL- Ragged crack extending
full width of lane.

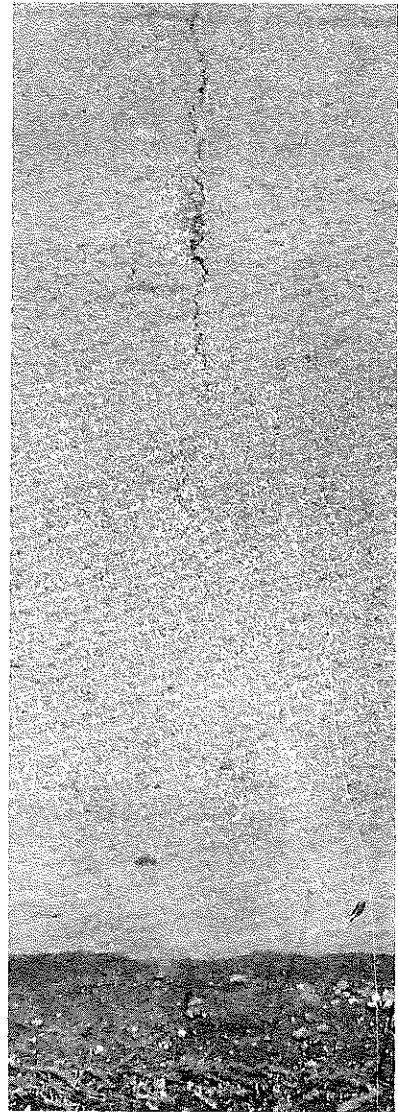
SOUTHBOUND LANE

JOINT NUMBER 21

NORTHBOUND LANE



NBL- Wide, relatively straight crack extending full width of lane.



SBL- Crack extending from center of lane to center stripe. Ravelling has occurred in inside wheel track.

SOUTHBOUND LANE

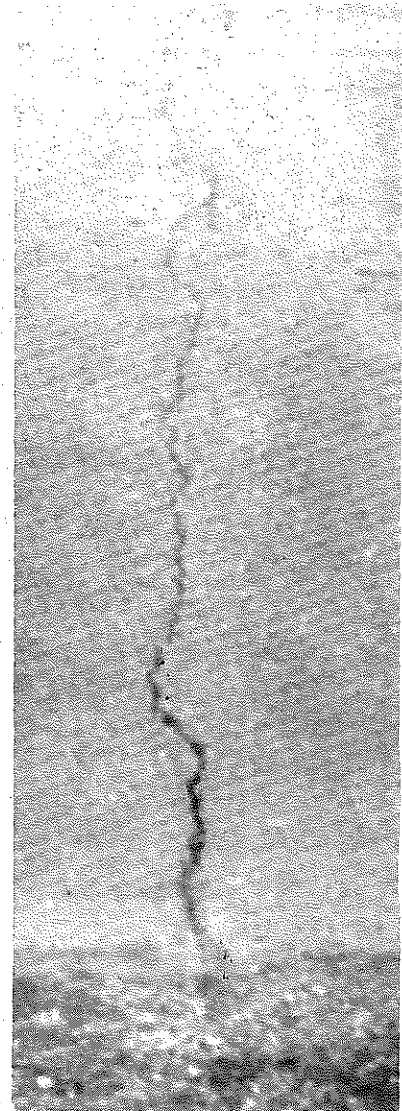
JOINT NUMBER 22

NORTHBOUND LANE



NBL- Wide, ragged crack extending full width of lane and beginning to ravel.

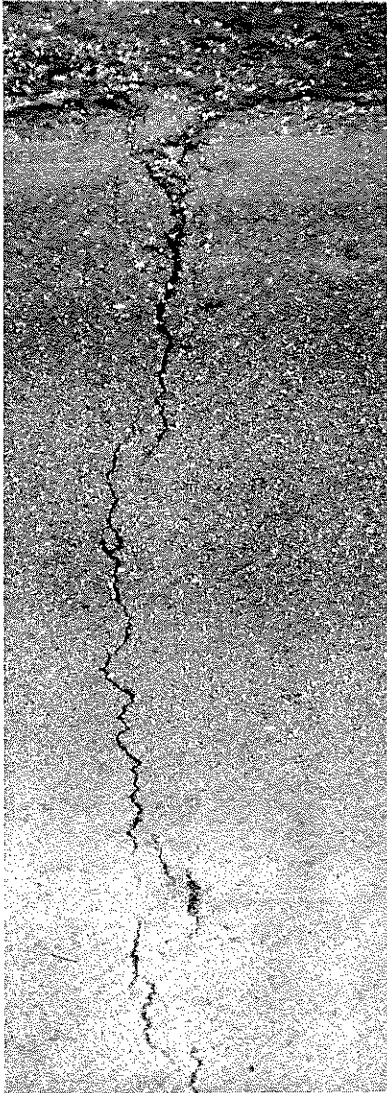
SBL- Wide, ragged crack extending full width of lane.



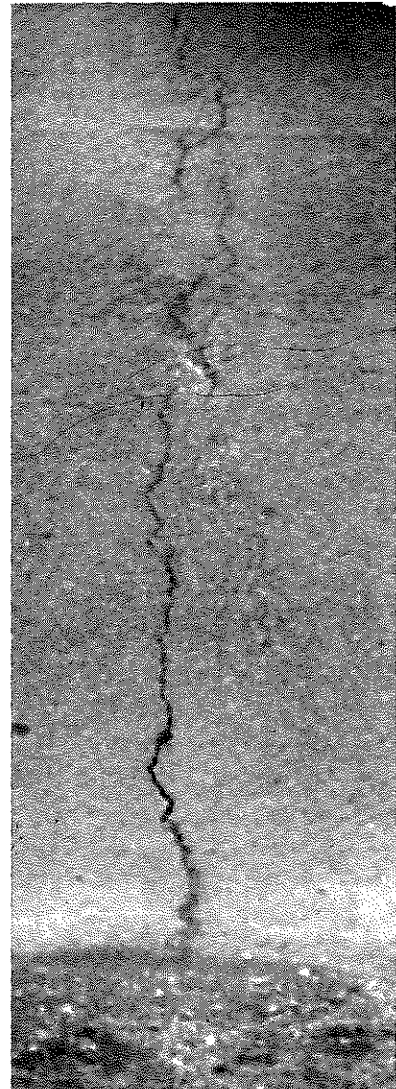
SOUTHBOUND LANE

JOINT NUMBER 23

NORTHBOUND LANE



NBL- Wide, ragged crack extending full width of lane. Beginning to ravel in inside wheel track and from outside wheel track to edge of pavement.

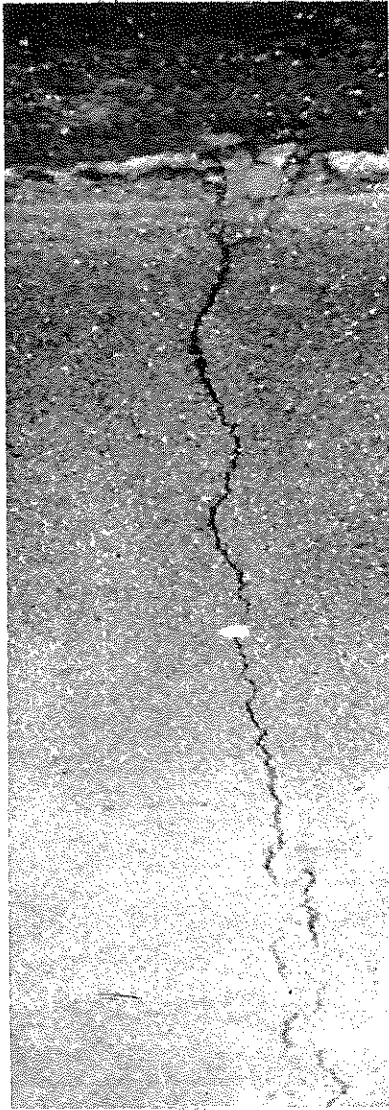


SBL- Wide, ragged crack extending full width of lane.

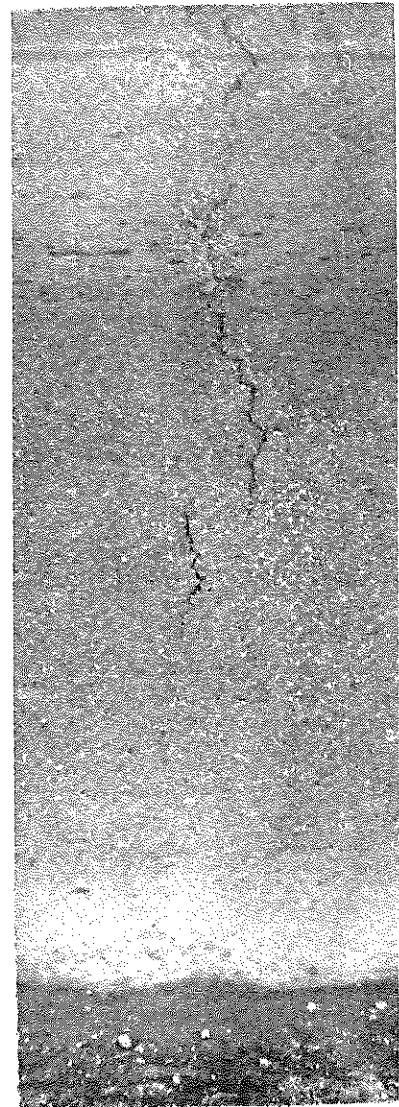
SOUTHBOUND LANE

JOINT NUMBER 24

NORTHBOUND LANE



NBL- Wide, ragged crack extending full width of lane.



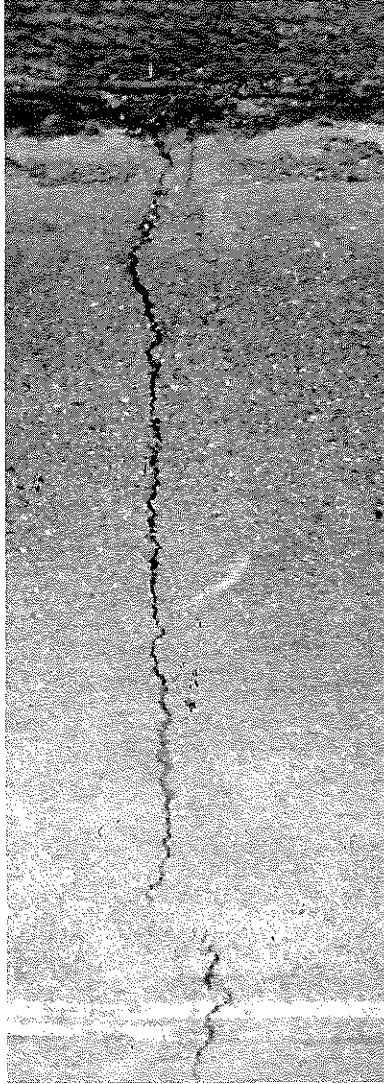
SBL- Crack extending from outside wheel track to center stripe.

SOUTHBOUND LANE

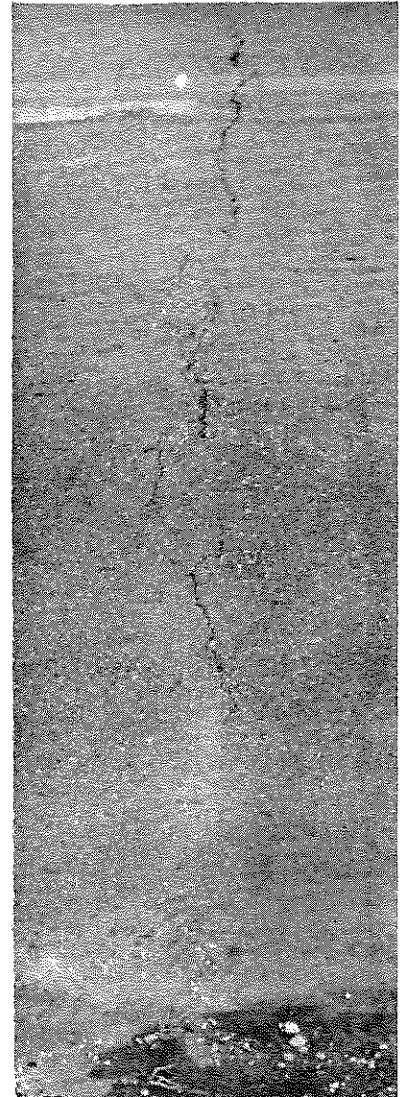
JOINT NUMBER 25

NORTHBOUND LANE

NBL- Wide crack extending full width of lane.



SBL- Crack extending from outside wheel track to center stripe with ravelling at inside wheel track.



SOUTHBOUND LANE

Research Report

FINAL

EXPERIMENTAL JOINT INSTALLATIONS
FOR CONCRETE PAVEMENTS
(Experimental)

by
Ronald D. Hughes
Chief Research Engineer

Division of Research
DEPARTMENT OF HIGHWAYS
Commonwealth of Kentucky

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INTRODUCTION

This report is a final summary of the performance of four experimental joint installations. Each installation included a series of two or more special joint devices or seals in lieu of those conventionally employed throughout the major portions of the projects. These installations were made during 1948 to 1950, at which time OA-2 asphalt or hot-poured rubber asphalts were the conventional seals. The projects covered by this report are:

1. Project F 367(10) - US 27, Campbell County - Prefabricated Neoprene Seal.
2. Project U 58(6) - Paducah Beltline - Aluminum Load Transfer Devices.
3. Project FI-117(22) - Truck Lanes, US 60, Shelby County - Aluminum Load Transfer Devices.
4. US 421, Fayette County - Cold Mastic Seals and Hot-Poured Rubber-Asphalt Seals.

PROJECT F 367(10) US 27, Campbell County

A neoprene sealant produced by the Lastite Joint Company was placed in three joints on the project on November 30, 1948. The experimental seals were placed in joints at Stations 622+22, +42 and +62 located approximately 3.9 miles north of the junction with KY 154. Standard joints used throughout the remaining portion of the project were the weakened-plane type without load-transfer assemblies. All standard joints were sealed with hot-poured rubber asphalt. The experimental joints contained dowel-bar joint assemblies and included rigid pressed-board divider strips for provision of full depth slab separations. The neoprene seals were fitted as a cap to the top of the pressed-board divider strips.

Two of the experimental joints were not properly positioned and consequently were displaced by the finishing machine. The seal at 622+62 remained in position and was considered as being a suitable installation. Spalling near the experimental joints was first observed during an inspection on September 27, 1949. The condition was reportedly more pronounced at 622+22 where the entire face of the seal was exposed for a distance of approximately 7 feet within the southbound lane. Spalling was more evident within the southbound lane and was confined to the south side of all three joints. The condition became more aggravated with time, and eventually the adjoining concrete was patched. Spalling was not observed in the vicinity of the conventional seals, observations on the project were abandoned and the unsatisfactory performance was attributed to improper placement and finishing techniques.

The project was inspected on July 19, 1968. The entire project has been overlain with bituminous concrete; therefore, no general observations as to the condition of joints was forthcoming. Holes were dug in the shoulder at the experimental joints and the seals were noted as being in excellent condition.

The neoprene was intact, tight fitting, and still resilient. No signs of faulting were noted at any of the weakened-plane joints. Holes dug in the shoulder at these joints revealed no faulting and all were functioning adequately. If nothing else, the project serves to illustrate the fact that satisfactory performance cannot be obtained when poor construction practices exist, regardless of the materials employed. The absence of faulting at the undoweled joints is of more significance than the present state of the experimental seals and suggests unnecessary expenditure of funds in our present construction (dowel assemblies) practices.

PROJECT U 58(6)
PADUCAH BELTLINE

Aluminum load transfer devices were installed on an experimental basis on this project in September 1949. The devices were placed in the joints at Stations 60+98.5 and 70+00 on the Beltline (known as Joe Clifton Drive or 28th Street) south of its intersection with Broadway. The devices were developed by the Oxford Manufacturing Company of Oxford, Indiana, and were fabricated by the Reynolds Metal Company of Louisville, Kentucky. The devices were shaped as an inverted cross--the vertical member was 1/16 inch thick and 4 inches high with horizontal members 3/16 inch by 1 inch on each side located 1 inch from the bottom of the vertical member. Installation was accomplished by means of chairs pinned to the subgrade and attached to the devices. Standard joints used throughout the remainder of the project were weakened-plane type with dowel bar load-transfer assemblies.

The devices reportedly lacked stability and were easily dislocated during placement of surrounding concrete. No signs of deterioration or other unusual conditions were observed in late December 1950. These joints were inspected on July 17, 1968, and reportedly were still in excellent condition. No signs of deterioration were observed at the aluminum joints. Apparently, the aluminum has not been affected by the surrounding concrete.

PROJECT FI-117(22)
US 60, SHELBY COUNTY

Seven experimental aluminum load-transfer devices were installed within joints in truck lanes on this project constructed in the fall of 1950. These devices were also a product of the Oxford Manufacturing Company and were a modification of those used on the Paducah Beltline. The sections were designed as equal-armed crosses, 2 inches by 2 inches with a 1/16 inch thick vertical member and 3/16 inch thick horizontal member. Supporting chairs in the shape of an inverted "T" were attached to the lower portions of the vertical members. These aluminum devices were placed at 50-foot intervals from Stations 246+00 to 248+00 and at Stations 305+00 and 305+50. Standard joints placed throughout the remainder of the project were of the weakened-plane type with load-transfer dowel assemblies.

Tongs were also employed to hold the aluminum devices in position during placement of the concrete. The tongs were removed prior to the first pass of the finishing machine; however, the first joints to be placed were displaced and slightly tilted toward the direction of paving. The assemblies were

eventually stabilized by use of hooks placed over the top of the section and secured by a pin driven into the subgrade. The hooks and pins were used in combination with the tongs. The experimental joints were reported as being in satisfactory condition on June 7, 1951. Cores obtained on February 14, 1957, from three of the seven experimental joints, disclosed the presence of diagonal tension cracks in the slab to the rear of the direction of traffic flow. The cracks, apparently caused by excessive shear stresses induced by a bending moment in the horizontal members of the device as loads passed over the joint, extended downward through the pavement from the horizontal member of the device at approximately 45°. The project was again inspected on July 18, 1968, and had been overlain with bituminous concrete in the fall of 1954. Holes were dug in the shoulder at the location of experimental joints at Stations 305+00 and 305+50. The surrounding concrete and aluminum load-transfer devices were observed as being in excellent condition.

A sample of aluminum was cut from the assembly at Station 305+50. No deterioration of metal was noted and no separation of vertical or horizontal members was observed. Reflective cracking was observed within the bituminous overlay throughout the project. The degree of cracking was similar over both the standard and experimental joints and no distinguishable variation in joint performance could be detected in the reflective crack pattern.

US 421
FAYETTE COUNTY

In November 1948, experimental installations of both hot-poured rubber asphalt and cold-applied mastic type sealers were made on that section of US 421 in Fayette County beginning 7.0 miles north of the city limits of Lexington and ending 0.2 miles south of the Scott County line. The joints were grooved for removal of deteriorated OA-2 seals and then refilled with the experimental sealants. Both of the experimental sealants were reported in excellent condition as of December 1952. The project has since been overlain with bituminous concrete and periodic inspections were discontinued. The project was observed on July 18, 1968, at which time samples of the experimental sealants were obtained from portions of the joints near the shoulder. Materials removed from the joints were still pliable and appeared to have been adequately bonded to the concrete. No instances of faulting or pumping were observed on the project.

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3. "Progress Report of Cold Mastic Joint-Sealing Compounds and Sawed Joints in Concrete Pavements", Dave H. Sawyer, December 1952.
4. "Application of Cold-Mastic Asphalt Compounds to the Sealing of Joints and Cracks in Rigid Pavements", Engineering Experiment Station Bulletin, Vol 5, No. 3, March 1951.