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EXPERIMENTAL CONCRETE CAPPING
US 127 South of Holt, Project F 33-54, C4
Second Progress Report

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In April 1953, C. H. Cash and C. B. Laird, then Road Engineer and Construction Engineer, respectively, requested a research study to compare the effects of various slab lengths and separation courses on cracking of concrete capping.

That summer, the 27-year-old pavement of Project F 33-27, C3, on US 127 south of Holt, was to be capped and become the southbound roadway of a divided highway, a new northbound roadway being constructed at the same time. The old pavement was not reinforced and had 1-in. expansion joints at 100-ft intervals without load transfer.

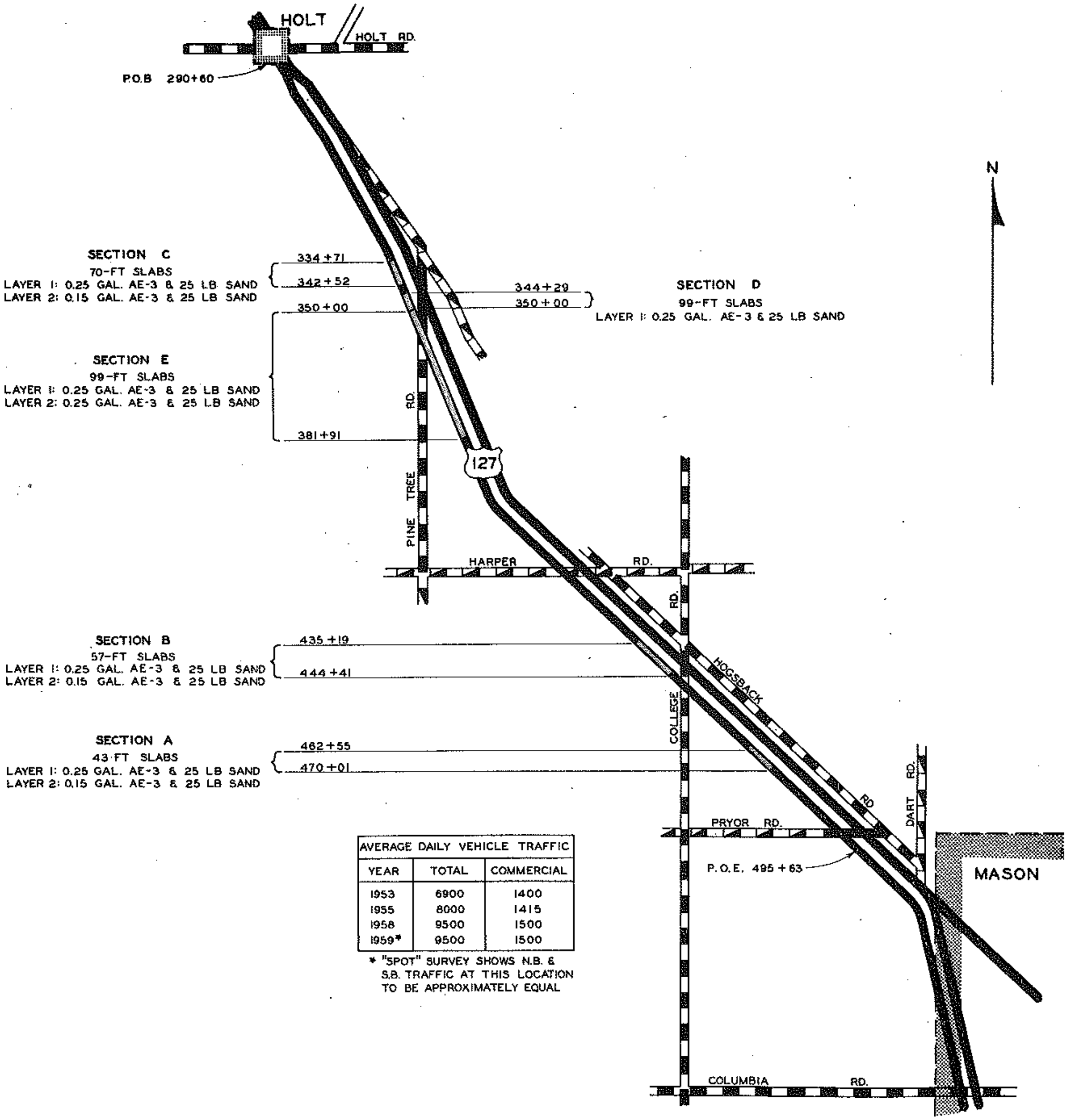
Five capping test sections were constructed during the improvement of the southbound roadway. The sections were reinforced with standard wire mesh. Each section had a single expansion joint at the points of beginning and ending and all joints within the sections were contraction joints without load transfer. Specific characteristics and locations of the individual test sections are summarized in Fig. 1, a plan drawing of the entire project. Construction and early performance of the test sections were described in Research Laboratory Report 215 (1954).

Essentially the five sections, all of 6-in. minimum thickness over old 7-in. uniform pavement, may be classified in two categories:

1. Three sections of increasing slab length--43, 57, and 70 ft--each constructed with the same separation course of a layer containing 0.25 gal AE-3 and 25 lb sand per sq yd, beneath a second layer with 0.15 gal AE-3 and the same amount of sand per sq yd.

2. Two sections of 99-ft slabs with different separation courses--one section with a single layer of 0.25 gal AE-3 and 25 lb sand per sq yd, and the other with a double layer of the same composition.

Typical pavement appearance in each of the five test sections in December 1960 is shown in Fig. 2. Fig. 3 shows the planned cross-section and a photograph taken during joint repair in 1960.



AVERAGE DAILY VEHICLE TRAFFIC		
YEAR	TOTAL	COMMERCIAL
1953	6900	1400
1955	8000	1415
1958	9500	1500
1959*	9500	1500

* "SPOT" SURVEY SHOWS N.B. & S.B. TRAFFIC AT THIS LOCATION TO BE APPROXIMATELY EQUAL

Figure 1. Plan view of capping test areas with traffic volumes.

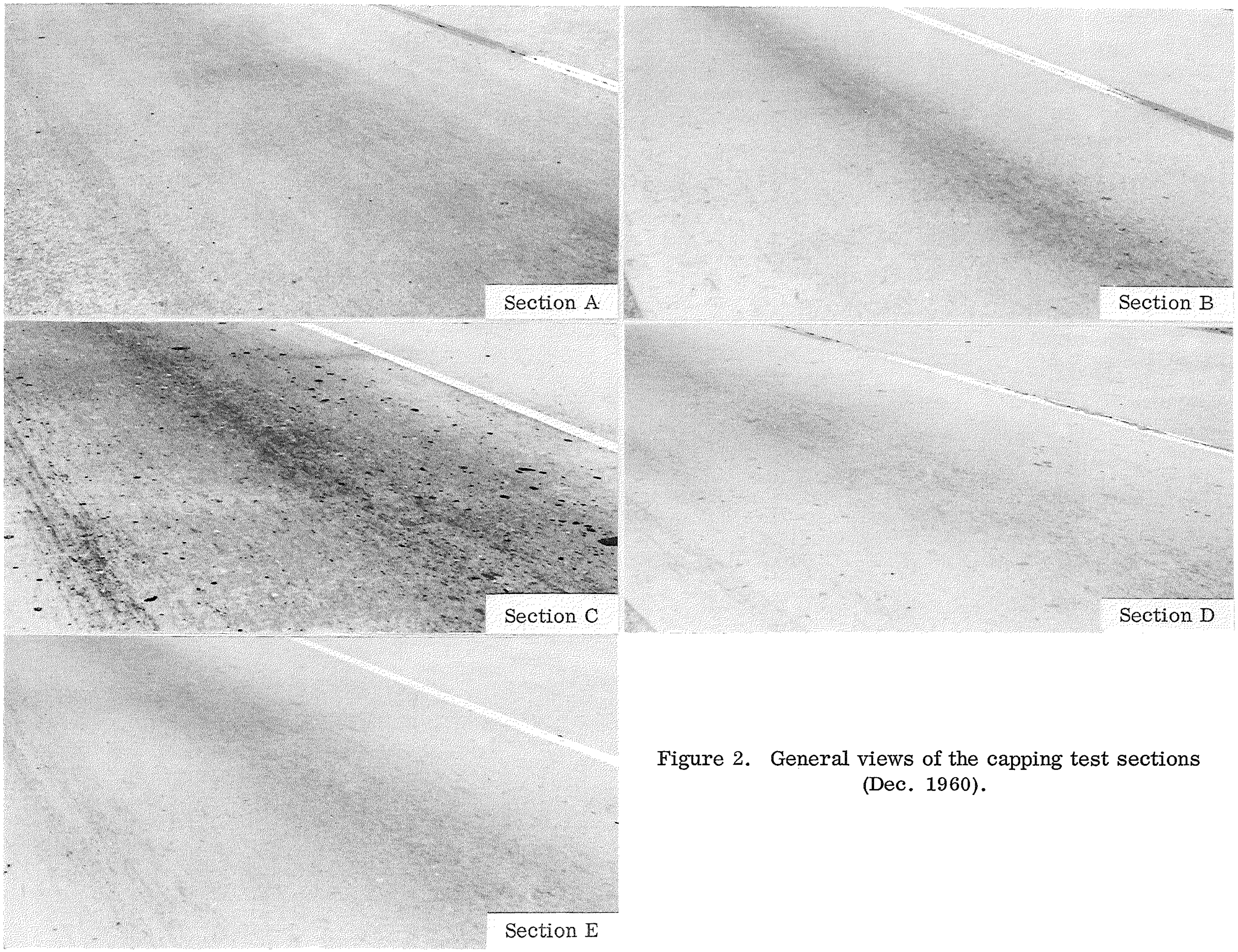
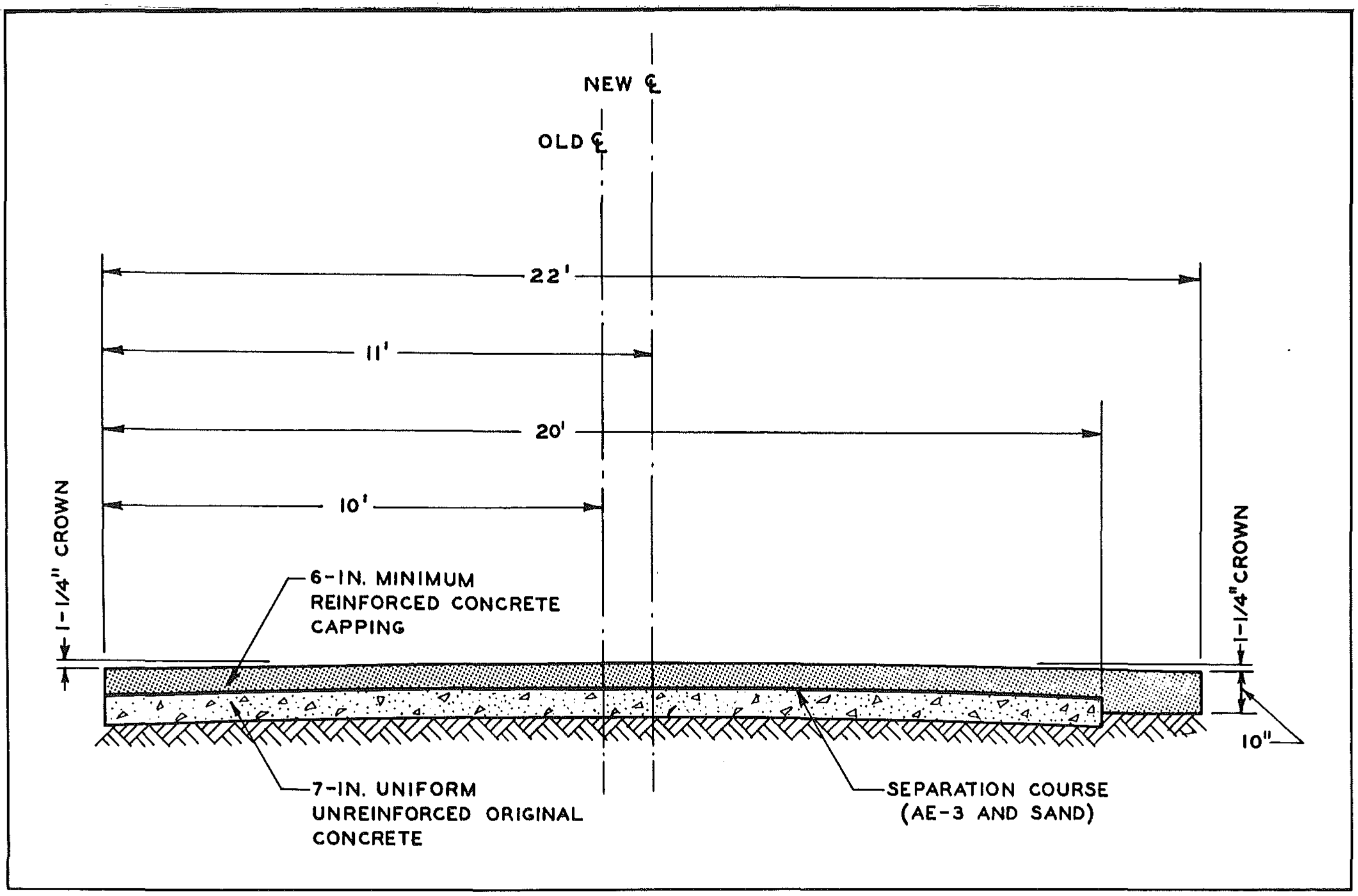

Section A
Section B
Section C
Section D
Section E

Figure 2. General views of the capping test sections (Dec. 1960).



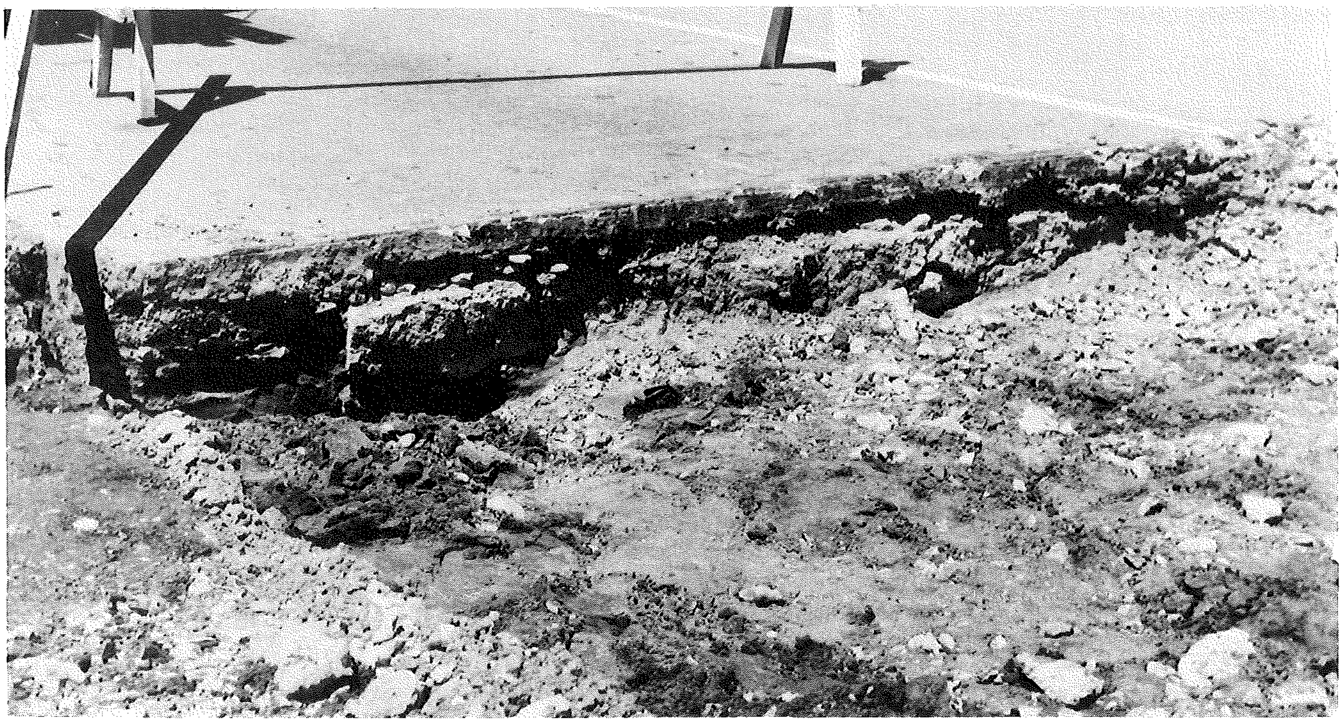


Figure 3. Planned cross-section (top) and pavement appearance during joint repair in 1960 (Section E: 99-ft slabs over two-layer separation course).

Pavement Cracking

Least cracking per mile has occurred where slabs are shortest (43 ft) and most where slabs are longest (99 ft). Cracking is shown in Fig. 4 for the fifth and eighth years, and in Table 1 for the first, fifth, seventh, and eighth years. Cracking increases with slab length in the three short-slab sections with the same separation course. In the two long-slab sections, capping over a single-layer separation course has 2.6 times as many cracks per mile as does capping over a two-layer course.

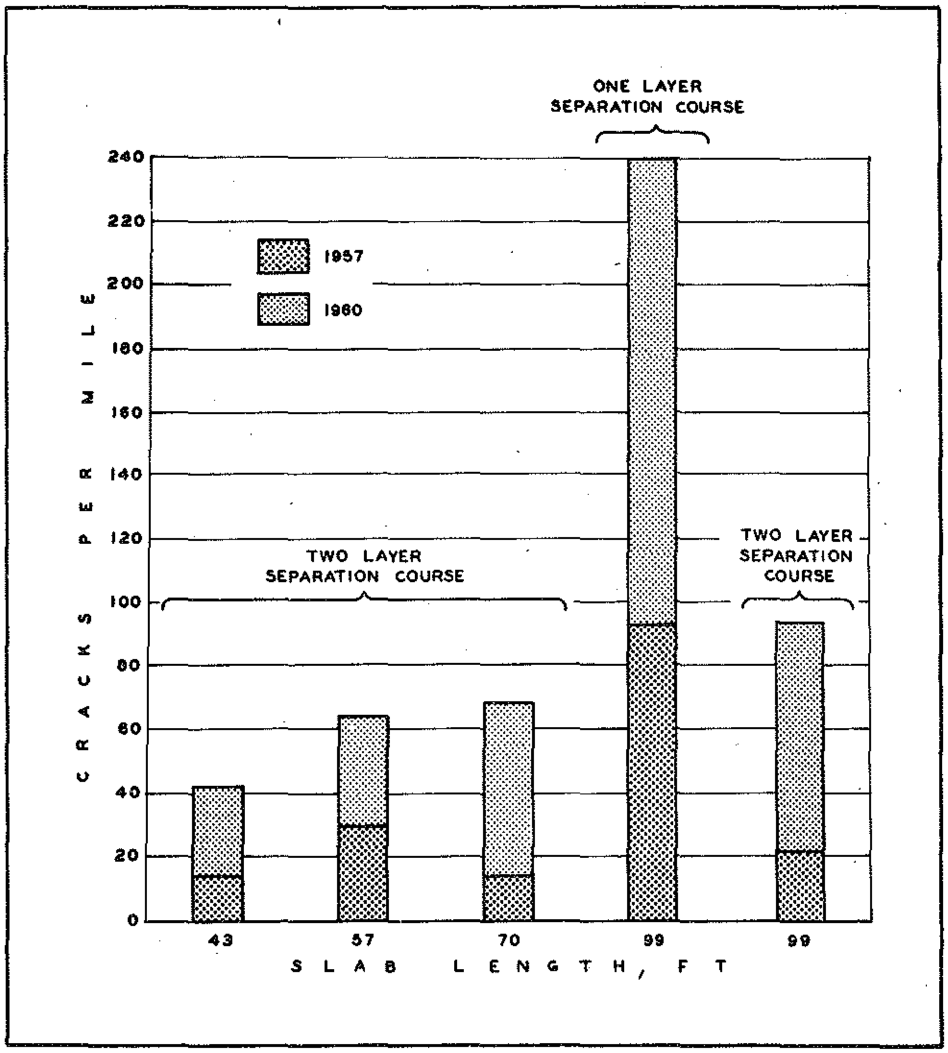


Figure 4. Relationship between cracking and slab length.

These general observations on cracking per lane mile contained in Table 1 and Fig. 4 must be qualified, however. For example, by adding both the 1960 transverse cracks and the transverse joints in the separate sections, the following tabulation of breaks and/or interruptions is obtained:

Section C: 143 per mile
Section E: 146 per mile
Section B: 156 per mile
Section A: 165 per mile
Section D: 293 per mile

From this standpoint, the longest of the short slab sections (70 ft) is best, followed closely by the 99-ft double-course capping. The 43-ft slab section moves from first place to fourth. The 99-ft single-course capping, however, is poorest by either method of performance tabulation.

TABLE 1
SLAB LENGTH AND CRACKING

Construction Data			Cracks per Mile			
Section	Slab Length, ft	Separation Course*	1953	1957	1959	1960
A	43	Method 1	0	14	42	42
B	57	Method 1	0	29	52	63
C	70	Method 1	0	14	68	68
D	99	Method 2	9	92	231	240
E	99	Method 3	0	21	86	93

* Method 1: Layer 1--0.25 gal AE-3 and 25 lb sand per sq yd
Layer 2--0.15 gal AE-3 and 25 lb sand per sq yd
Method 2: Single Layer--0.25 gal AE-3 and 25 lb sand per sq yd
Method 3: Double Layer--0.25 gal AE-3 and 25 lb sand per sq yd

A typical crack is shown for each test section in Fig. 5. Fig. 6 illustrates the appearance of one crack in the section of worst cracking, in 1954 and 1960.

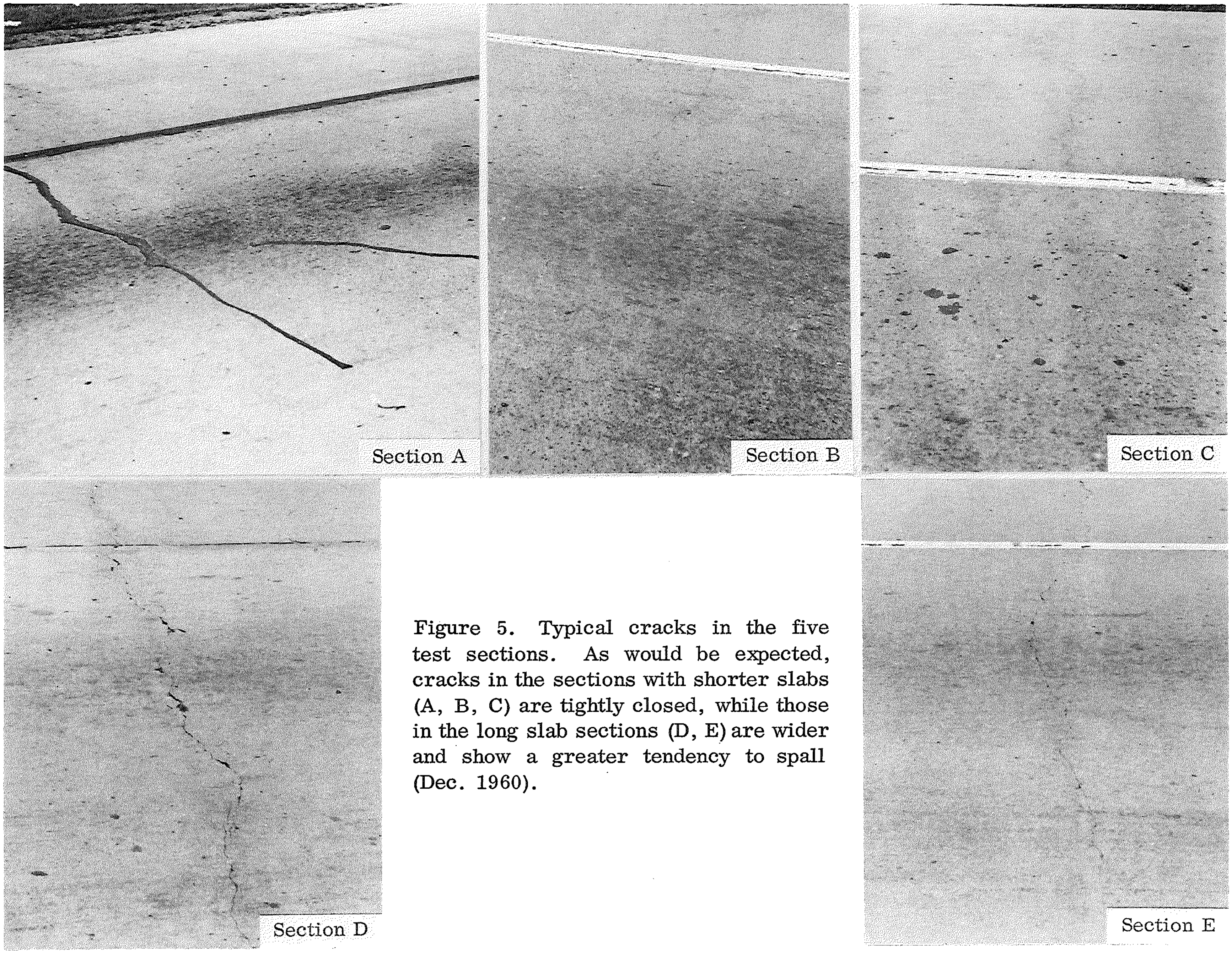


Figure 5. Typical cracks in the five test sections. As would be expected, cracks in the sections with shorter slabs (A, B, C) are tightly closed, while those in the long slab sections (D, E) are wider and show a greater tendency to spall (Dec. 1960).

Figure 6. Appearance of a crack in Section D, the area of worst cracking, in 1954 (top) and 1960, with 99-ft slabs over a single-layer separation course.

Sealer Failure, Joint Faulting, and Roughness

Cracking of capping with various slab lengths and separation courses was the primary performance factor under study on these pavement sections. However, several other performance features have also been under regular survey.

The variety and quantity of joint sealer failures are tabulated in Table 2 as a tentative index of joint movement. The sealer used was standard for 1953 construction, a hot-poured rubber asphalt material. Condition of a typical joint in each section is shown in Fig. 7.

TABLE 2
JOINT SEALER FAILURES
December 1960

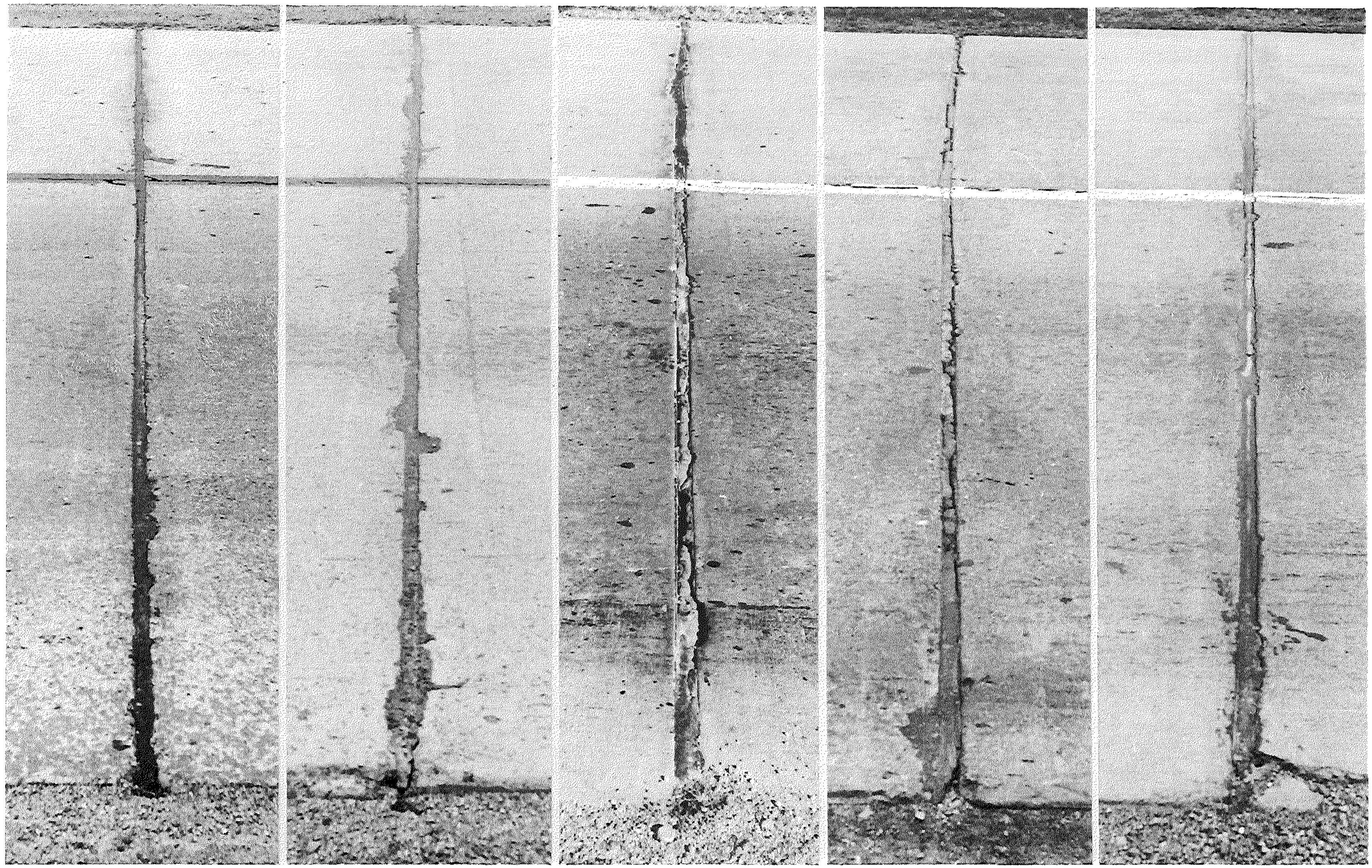
Construction Data				Sealer Not Resilent		Adhesion Failure		Cohesion Failure		Dirt Infiltration	
Section	Slab Length, ft	Separation Course*	Total Joints	No. of Joints	Percent	No. of Joints	Percent	No. of Joints	Percent	No. of Joints	Percent
A	43	Method 1	17	0	0	6	35	0	0	4	24
B	57	Method 1	18	0	0	5	28	0	0	10	56
C	70	Method 1	11**	2	18	11	100	4	36	9	82
D	99	Method 2	6	1	17	0	0	4	67	5	83
E	99	Method 3	33	1	3	0	0	12	36	24	73

* Method 1: Layer 1--0.25 gal AE-3 and 25 lb sand per sq yd
Layer 2--0.15 gal AE-3 and 25 lb sand per sq yd
Method 2: Single Layer--0.25 gal AE-3 and 25 lb sand per sq yd
Method 3: Double Layer--0.25 gal AE-3 and 25 lb sand per sq yd

** One joint resealed after sealer failed.

Fig. 8 shows the distribution and magnitude of joint faulting for each section. Note that faulting is expressed in terms of percentage of joints with maximum faulting equal to or greater than specific displacements in inches.

Finally, Table 3 shows pavement roughness values for the five test sections, as well as a section of standard 1953 pavement in the same construction project--9-in. uniform thickness, reinforced, with load transfer. In 1953, average roughness for the entire project--both standard and special pavements--was 124 accumulated inches per mile, in the "good" category of riding quality.



Section A Section B Section C Section D Section E

Figure 7. Typical joints in each capping section
(Nov. 1960).

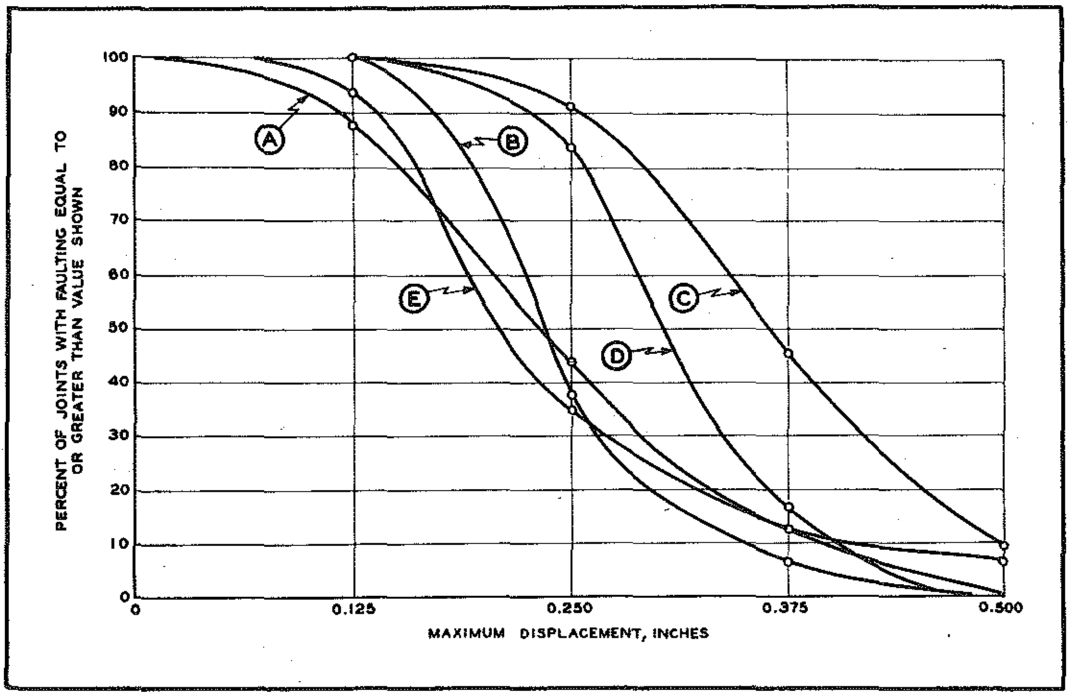


Figure 8. Distribution of faulted joints in capping by magnitude and section.

These illustrations and tabulations indicate that:

1. Sealer performance was best on the two sections with shortest slabs, in every respect but adhesion.

2. Considering all four categories of sealer failure, Section C (70-ft slabs) was poorest in performance.

3. Of the two 99-ft sections, sealer performance was consistently poorer on the one-layer section. The double-layer 99-ft section also was better than the double-layer 70-ft section. It should be noted that both 99-ft sections were better in sealer adhesion than the two shortest slab sections, but poorer in cohesion.

4. Without considering the possible influence of subgrade support variation or the condition of pavement underlying any given section of capping, joint faulting was most severe in Section C (70-ft slabs), with the 99-ft slab section on a single-layer separation course only slightly better.

5. The section with worst faulting, 70-ft slab Section C, was also poorest in pavement riding quality.

6. From the 1953 average roughness of 124 accumulated inches per mile for the entire project, the capping sections have all deteriorated in riding quality, with Section E (99-ft slabs on a two-layer separation course) showing the smallest increase in roughness and actually exceeding the standard pavement section in relative smoothness.

TABLE 3
PAVEMENT ROUGHNESS DATA
March 1961

Section	Slab Length, ft	Separation Course*	Accumulated Inches/Mile**
A	43	Method 1	169
B	57	Method 1	179
C	70	Method 1	182
D	99	Method 2	162
E	99	Method 3	148
Standard Pavement	99	---	162

* Method 1: Layer 1--0.25 gal AE-3 and 25 lb sand per sq yd
Layer 2--0.15 gal AE-3 and 25 lb sand per sq yd
Method 2: Single Layer--0.25 gal AE-3 and 25 lb sand per sq yd
Method 3: Double Layer--0.25 gal AE-3 and 25 lb sand per sq yd

** "Good" = 0-130; "average" = 131-174; "poor" = 175 or more

Joint Movement

Although plugs for joint movement measurements were installed during construction, the resulting data are not presented here. Unfortunately, the plugs were not placed at all joints and as performance observations progressed, it was discovered that the random distribution of plugs was resulting in biased and misleading readings. The expansion joints at the ends of each test section compressed permanently as the years passed, so that exaggerated movement took place at nearby contraction joints. Very few plugs were installed in central areas of the test sections, where more normal movement occurred. Thus, the total number of joints where readings were reliable and representative was statistically insignificant.

Conclusions

After nearly eight years of service, Section E with 99-ft slabs over a two-layer separation course is giving the best overall performance of the five capping test sections, when all performance factors are considered.

By the same performance standards, the poorest capping is the 70-ft slab section (Section C), with the 99-ft slabs over a one-layer separation course (Section D) only slightly better.

In general, overall performance of all sections has been relatively good. This is particularly true in comparison with other experimental concrete capping projects, such as the sections built in 1952 on the Groesbeck Highway (M 97) and most recently reported in Research Report 331 (1960).

The fact that some capped portions of this project have better riding qualities than 9-in. standard concrete pavement built at the same time indicates that capping for improvement of older concrete pavements is feasible and practical in certain situations.