MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

Experimental Concrete Capping on Groesbeck Highway, Project F 50-7,C5 - F-421(1)

Joint Investigation between Construction Division and Testing and Research Division with Approval of Bureau of Public Roads

Research Project 52 F-25
Progress Report No. 1

Research Laboratory
Testing and Research Division
Report No. 194
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EXPERIMENTAL CONCRETE CAPPING ON GROESBECK HIGHWAY
Project F 50-7,C5 26

Introduction 16

For a number of years the Highway Department has noted the early appearance of numerous uncontrolled transverse cracks on concrete capping projects. The cracks usually appear within 24 hours after the concrete surface has been placed, and frequently open to the extent that the mesh reinforcement ruptures. An effort has been made to reduce the cracking by using a bituminous separation coat composed of an application of asphaltic emulsion and sand cover material on the surface of the old pavement. This expedient has appeared to be helpful in some instances in aiding the resurfacing concrete to lengthen or shorten independently of the old pavement, but does not provide sufficient thickness to be of benefit as a leveling course.

In view of the difficulties encountered and the erratic results obtained using current design and construction practices for concrete recapping, the Construction Division proposed a study including several methods of recapping concrete pavement with concrete to determine the relation between method of application and thickness of cap to number of cracks per slab. The data obtained were to be used as a basis for revision of specifications where it was indicated.

On June 7, 1952, C. H. Cash wrote a letter to L. P. Scott, District Engineer, Bureau of Public Roads, outlining the suggested study. The study was to be carried out by the Research Laboratory in cooperation with the Construction Division. W. C. Broughton of the Research Laboratory was assigned to follow the work and report the results.

The investigation was divided into two parts:

1. To determine the location and number of cracks per slab of concrete capping as recorded immediately after removal of curing paper and before pavement was opened to traffic.

2. To determine the number of cracks per slab appearing after opening the pavement to traffic. This will be accomplished by periodic condition surveys over a long period of time.

This report covers part one of the study. It describes in detail the sections recapped and shows what effect the different methods had in controlling cracking which developed before the pavement was opened to traffic.

Description of Project

The pavement on which this study is being made is part of the Groesbeck Highway (M-97) running north from Eight Mile Road to Fourteen Mile Road in Detroit and is referred to as Construction Project F 50-7, C5. The experimental section extends from Station 2+68 to Station 371+88.

The old pavement which is being recapped includes all of Project F 50-7,C2 constructed in 1928 and a short section of Project F 50-7,C3 completed in 1930. Records show that Project 50-7,C2 has a 10-8-10 cross section and was constructed with Oxford coarse aggregate. Project F 50-7,C3 has a 10-9-10 cross section and was constructed with France limestone from Monroe, Michigan.

The original pavement was badly cracked and faulted and there were many bituminous patches. The stretch between stations 250+00 and 319+35 was very badly scaled with considerable disintegration adjacent to joints and cracks, in some instances extending to a depth of four to five inches. See Figure 1 to 4, Plate I, for examples of how pavement looked prior to recapping.

The experimental section of recapped pavement was divided into four sections according to the method of bonding the cap to the original surface.

1. From station 2+68 to 30+32, the concrete capping was bonded directly to the existing pavement.

2. From 30+32 to 249+46, a breaker strip consisting of a single application of asphalt emulsion AE-3 and sand, composed of .25 gallons of emulsion to 40 lbs. of sand per sq. yd., was used.

FIGURE 1. ORIGINAL SURFACE BEFORE CAPPING. LOOKING NORTH FROM STATION 130. JUNE 13, 1952.

FIGURE 2. ORIGINAL SURFACE BEFORE CAPPING. LOOKING SOUTH FROM STATION 218. JUNE 13, 1952.

FIGURE 3. VIEW OF ORIGINAL SURFACE BEFORE CAPPING. STATION 119 IN SECTION WHERE 7" CAPPING WAS PLACED USING REGULAR METHOD OF A E — 3 AND SAND. JUNE 13, 1952.

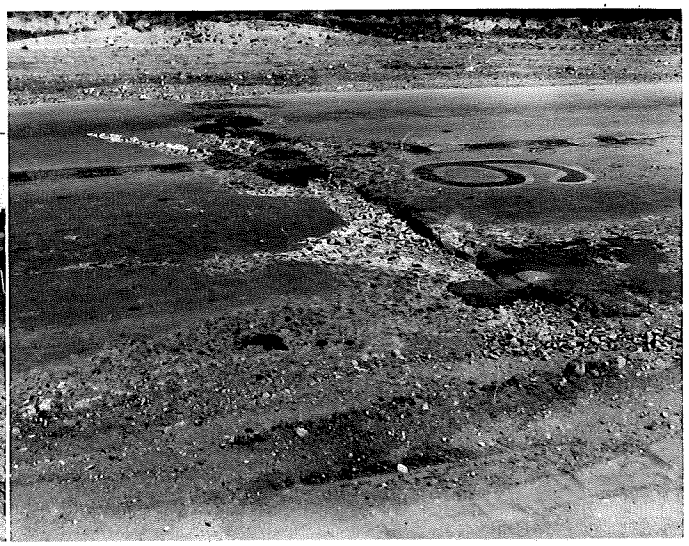


FIGURE 4. CLOSE UP OF BAD JOINT NEAR STATION 130 BEFORE CAPPING WAS PLACED. MARCH 13, 1952.

PLATE I, VIEWS OF OLD SURFACE BEFORE CAPPING

3. From 249+46 to 319+33, a 3/4 inch bituminous concrete leveling course as a breaker strip was used.

4. From station 319+33 to 371+88, the capping was again bonded directly to the old pavement. In this last mentioned section the steel reinforcement was originally carried through the contraction joints by error. As soon as this condition was discovered, an authorization was issued to the contractor to saw the contraction joints to a depth sufficient to cut the steel reinforcing.

The thickness of capping used varies within each of the above sections. The first has thicknesses of 5, 5½, and 6 inches; the second and fourth have thicknesses of 5, 5½, 6, 6½, and 7 inches; while the third has all the above thicknesses plus one stretch of 7½ inch capping. Figure 5 gives the location of the different capping thicknesses within each experimental section according to station.

The recapping was done between June 9 and July 18, 1952. The Contractor was Pierson and Co., of Detroit. The cement used was made by Huron Portland Cement Co., of Detroit, and contained vinsol resin as an air entraining agent. The cement factor was 5.5 sacks per cu. yd. The aggregates, both coarse and fine, were supplied by the American Aggregate Corporation, Oxford. Wire mesh 79.6 lbs. per 100 sq. ft. was used as reinforcement.

Recapping was begun at the north end of the project and proceeded as follows:

1. The section from Station 371+88 to 319+35 was recapped between June 9 and 13, 1952. In this section the concrete capping was bonded directly to the old pavement and the reinforcement was carried through the joints.

2. The section from Station 319+35 to 249+46 was recapped between June 13 and 19, 1952. In this section, a 3/4 inch bituminous breaker strip was used to separate the concrete capping from the old pavement.

3. The section from Station 249+46 to 30+32 was recapped between June 19 and July 9, 1952. In this section, an AE-3 and sand breaker strip was used to separate the concrete capping from the old pavement.

4. The section from Station 30+32 to 2+68 was recapped between July 9 and 10, 1952. In this section the capping was bonded directly to the old pavement but the reinforcement was not carried through the joints.

Test Holes

SUMMARY OF SOIL TEST DATA

Core No.	*Sta.	Field Density	Laboratory Density	Percent Compaction	**Percent Moisture	General Soil Characteristics
14	21/14	98.0	116.8	83.9	16.8	Black to gray Loamy Sand
15	21/33	--	114.8	--	--	Yellow Loamy Sand
16	52/00	109.8	110.8	99.1	13.0	Yellow Loamy Sand
17	124/00	108.0	112.0	96.4	9.0	Medium Sand
18	159/09	103.0	114.8	89.7	18.8	Peat - Clay
19	269/00	93.0	115.6	80.4	20.2	Peat - Loam Clay
20	271/34	68.0	88.0	77.3	39.3	Peat - Clay
21	271/49	84.9	106.2	79.9	26.5	Peat - Clay
22	288/19	102.3	118.7	86.2	15.6	Clay
23	348/49	97.3	104.1	93.5	24.6	Peat - Clay
24	348/63	91.7	101.3	90.5	23.9	Loam - Clay
25	367/21	99.8	108.3	92.2	18.4	Clay Loam - Clay
26	367/43	96.1	105.0	91.5	23.7	Peat - Clay

* All cores taken 6 ft. right of center line.
**In top 5 inches of subgrade.

(3) CIRCLED NUMBERS INDICATE TEST HOLES

21+33
0" - 6" Concrete capping
6" - 15⅜" Original concrete surface
15⅜" - 26" Yellowish loamy, slightly organic sand with roots
26" - 40" Organic grey medium sand
40" - 46" Yellow loamy sand, trace of clay.
44" Free water
46" - 48"+ Sandy clay wet, transitional

124+00
0" - 6-3/4" Concrete capping
6-3/4" - 7-3/4" Old Bit. Patch
7-3/4" - 15-3/4" Original concrete pavement
15⅜" - 48"+ Slightly loamy soft textured medium sand, unconsolidated, somewhat coarser below 36". Dry to slightly moist to 40", moist below 40" saturated at 45".
45" Free water

269+00
0" - 7-3/8" Concrete capping
7-3/8" - 16½" Original concrete pavement
15½" - 20" Peat mixed with some organic black loam
20" - 24" Aquatic peat and organic black loam mix.
24" - 48"+ Greenish plastic mottled clay to clay loam mixed with seams or lenses of aquatic peat.

271+49
0" - 5½" Concrete capping
5½" - 6½" Bit. breaker strip
6½" - 14½" Original Concrete pavement
14½" - 30" Sedimentary muck and peat mixed with a trace of silty clay no pebbles
30" - 48"+ Greenish-gray, firm, mottled, plastic clay, trace of silt, and peat mixed in.

348+49
0" - 6½" Concrete capping
6½" - 6⅝" Bit. breaker strip
6⅝" - 15" Original concrete pavement
15" - 30" Black to dark gray plastic, organic clay top soil, mottled & mixed with some peat & muck
30"-36" Greenish gray firm plastic clay with lenses of peat
36" - 48"+ Rusty brown, greenish gray firm plastic mottled clay

367+21
0" - 4" Concrete capping
4" - 5" Bit. patch
5" - 14⅜" Bit. bound composite patch (concrete stone gravel mixed with bit.
14⅜" - 15⅜" Gravel seam [binder
15⅜" - 20" Organic clay loam top soil
20" - 33" Greenish gray, firm, mottled clay
33" - 48" Greenish-gray to brownish, mottled, more plastic clay, becoming soft plastic below 40"

21+14
0" - 6" Concrete Capping
6" - 15⅜" Original Concrete Surface
15⅜" - 36" Black Organic Loamy Sand (Top Soil & Roots)
36" - 46" Gray medium sand slightly loamy, mottled
42" Free water
46" - 48"+ Gray medium to fine sand, mottled. Trace of clay mixed in.

52+00
0" - 6" Concrete capping
6" - 14" Original concrete surface
14" - 48"+ Yellow loamy sand (Natural soil sand mantel typical of immediate vicinity, loose, unconsolidated all the way) Note this sand was so loose that the inflated volumetric rubber ballon used in measuring the density of the subgrade expanded the test hole at 3 lbs. gauge pressure.

159+09
0" - 6-3/4" Concrete capping
6-3/4" - 8-3/4" 2" filled space sand bit. mix.
8-3/4" - 15⅜" Original concrete pavement
15⅜" - 26" Black organic clay loam, muck and peat, compact
26" - 32" Organic black clay loam, plastic, firm, compact
32" - 48"+ Greenish, gray clay loam, plastic firm.
(originally this was a shallow swale over which the original pavement was laid with no or very little excavation of organic material)

271+34
of subbase
0" - 5⅜" Concrete capping
5⅜" - 6⅝" Bit. breaker strip
6⅝" - 14⅜" Original Concrete pavement
14⅜" - 25" Sedimentary peat trace of organic loam, black plastic to plastic firm
25" - 48"+ Greenish gray plastic clay or silty clay firm, no pebbles

288+19
0" - 7" Concrete capping
7" - 7⅛" Bit. breaker strip
7⅛" - 16-3/4" Original concrete pavement
16-3/4" - 20" Coarse gravel
20" - 26" Greenish gray plastic clay, trace of sedimentary peat gravel, stones, blacktop. Waste (fill)
26" - 36" Greenish gray clay mottled trace of peat
36" - 48"+ Grayish & brown soft plastic & firm clay slightly mottled, no pebbles

348+61
of subbase
0" - 6⅜" Concrete capping
6⅜" - 6-3/4" Bit. breaker strip
6-3/4" - 15⅜" Original concrete pavement
15⅜" - 26" Black organic plastic clay loam top-soil
26" - 48"+ Greenish gray firm plastic clay with rusty brown mottling

367+43
0" - 5" Concrete capping
5" - 14" Original concrete pavement
14" - 20" Highly organic loamy top soil mixed with trace of peat
20" - 33" Greenish gray firm, mottled clay or clay loam. No pebbles
30" - 43" Greenish-gray more plastic and brownish clay or clay loam
Free water 42"
43" - 48"+ Brown clay loam dense plastic (not soft) no pebbles

15 17 19 21 23 25 (circled numbers)

14 16 18 20 22 24 26 (circled numbers)

0 -105 -210 -316 (stations)

8 MILE RD. | 9 MILE RD. | 10 MILE RD. | FRAZHO RD. | 11 MILE RD. | COLE RD. | MARTIN RD. | 12 MILE RD. | COMMON RD. | UTICA RD. | 13 MILE RD. | MASONIC | 14 MILE RD.

CONSTRUCTION METHOD: 2+88 BONDED DIRECT | 30+32 AE 3 & SAND BREAKER STRIP | 249+46 BITUMINOUS CONCRETE BREAKER STRIP | 318+35 BONDED DIRECT WITH STEEL CARRIED THROUGH JOINTS | 371+88

AVERAGE NO. OF CRACKS PER SLABS: 1 | 2.2 | 4.8 | 6.2 | 4.1 | 2.5 | 0.2 | 1.6 | 3.3 | 2.1 | 2.6 | 3.6 | 0.5 | 0.2 | 1.9 | 3.4 | 1.8 | 2 | 1.6 | 1.4 | 1.8 | 0.5 | 2.3 | 0.7 | 2.3 | 0.4 | 1.4 | 0.3 | 0.0 | 0.0 | 0.75 | 0.0 | 2.1 | 3.1 | 0.8 | 0.7 | 2.3 | 1.3 | 6.7 | 6.4 | 6.8 | 6.3 | 7.3 | 7.9 | 6.7 | 5.6

AVERAGE THICKNESS OF CAPPING IN INCHES: 5 | 5 1/2 | 5 | 6 | 5 1/2 | 5 1/2 | 5 | 5 | 5 1/2 | 5 | 5 1/2 | 6 | 5 1/2 | 7 | 6 | 7 | 6 | 6 | 5 1/2 | 7 | 6 | 7 | 6 | 7 | 6 | 6 | 7 | 6 1/2 | 6 1/2 | 7 | 6 | 6 | 7 | 7 1/2 | 5 1/2 | 6 | 6 | 6 | 5 1/2 | 7 | 6 | 6 | 6 1/2 | 6 | 6 1/2 | 5 | 6 | 10" UNIF.

2+88 | 10+44 | 15+42 | 18+38 | 30+32 | 49+22 RAIN 54+73 | 60+10 | 84+70 | 89+14 | 104+17 | 109+15 | 118+11 | 123+13 | 126+63 | 132+57 | 134+07 | 139+01 | 145+92 | 151+80 | 156+75 | 167+87 | 177+97 | 189+90 | 205+83 | 210+76 | 217+68 | 232+15 | 241+91 | 249+46 | 261+91 | 270+48 | 282+15 | 292+93 | 303+66 | 309+14 | 311+36 | 319+35 | 334+48 | 340+53 | 346+96 | 354+92 | 367+43 | 371+88

TOP OF FINISHED PAVEMENT

DIAGRAM OF TEST SECTION AND SOIL DATA

GROESBECK HIGHWAY
PROJECT 50-7, C5
BETWEEN 8 MILE AND 14 MILE RD.

FIGURE 5

5. A few short gaps which marked the intersection of other roads with Groesbeck Highway and which had been skipped during the previous recapping operations were completed between July 10 and 18, 1952.

The average air temperature during the above operations was 79°F, with a low of 64°F on July 9 and a high of 91°F July 8. The average concrete temperature was 81°F, with a low of 74°F on June 14 and a high of 88°F on June 25 and July 8. Recapping operations were halted three times by rain, on June 20 and 26, and July 8. This last rainfall marked the pavement from station 48+95 to 49+22.

Soils Study

Between December 8 and 19, 1952, thirteen cores were removed from the experimental recapped section of the pavement and an examination made of the subsoil by F. J. Hagan. This examination revealed that from station 2+68 to about 124, the subsoil consisted of a gray to yellow slightly loamy sand having a field density of from 98 to 109 lbs., a laboratory density of from 110.8 to 116.8 lbs., a compaction of from 83.9 to 99.1%, and a moisture content of from 9 to 16.8%. The character of the subsoil then began to change, and from about station 159 to about 271 became predominantly peat and muck, with some organic black loam over clay. The field density was lower, ranging from 68 to 103 lbs. The laboratory density and compaction were also lower, ranging from 88 to 115.6 lbs. and from 77.3 to 89%, respectively. The moisture content, on the other hand, was higher, from 18.8 to 39.9%. From station 288 to the end of the experimental recapping the character of the subsoil again changed. In this section the subsoil was predominantly plastic clay, shading into organic loam at about station 367, with traces of peat and muck at the surface. The field density ranged from 91.7 to 102.3 lbs., the laboratory density from 101.3 to 118.7 lbs., the compaction from 86.2 to 93.5%, and the moisture content from 15.6 to 25.7%. Complete results of the subsoil examination at each core location, including

moisture content, field and laboratory densities, and percent compaction are included in Figure 5, with diagram of test sections.

Summary of Observations [34]

Two condition surveys were made. The first, a preliminary survey, was made between May 19 and 23, 1952 prior to recapping operations, by Arthur A. Smith and Arlo Lee of the Research Laboratory. The second was made after recapping operations, between June 18 and July 29, 1952 by William Broughton and Arlo Lee, immediately after the curing paper was removed and before the pavement was opened to traffic. This second survey took longer to make because it was necessary to time it to the paving operations. During the recapping of the experimental sections, construction operations were observed by William Broughton. Figures 6 - 9, Plate II, show the pavement surface ready to be recapped.

In Plates III and IV there are presented eight pictures (Figures 10 - 13 and 14 - 17) illustrating various construction features associated with the recapping work. Each picture tells a story without further words here.

Cracking:

A complete summary of cracking data is presented in Table I. For comparative study, Table II has also been prepared. With reference to Table II, the following conditions can be noted:

(1.) The section bonded directly to the old pavement and with steel originally carried through the joints had a much higher number of cracks per slab than any other section. The number ranged from 6.3 for the 6½" capping to 8.7 for the 5-inch capping, with the weighted average for the entire section being 6.9.

FIGURE 6. SURFACE OF EXISTING PAVEMENT IMMEDIATELY AFTER PLACING OF AE-3 AND SAND (STD. METHOD) NOTE THAT TRAFFIC IS BEING CARRIED. JUNE 27, 1952.

FIGURE 7. VIEW OF THE AE-3 AND SAND TREATMENT AFTER ABOUT A WEEK OF TRAFFIC OVER IT. JUNE 27, 1952.

FIGURE 8. SHOWING POINT OF DIVISION BETWEEN BITUMINOUS BREAKER STRIP AND AE-3 AND SAND. STATION 249+46 LOOKING SOUTH FROM ABOUT STATION 250. JUNE 13, 1952

FIGURE 9. LOOKING NORTH FROM STATION 250 SHOWING 3/4" BITUMINOUS CONCRETE BREAKER STRIP IN PLACE. JUNE 13, 1952.

PLATE II, VIEWS OF PAVEMENT
WITH BITUMINOUS BOND BREAKER TREATMENT

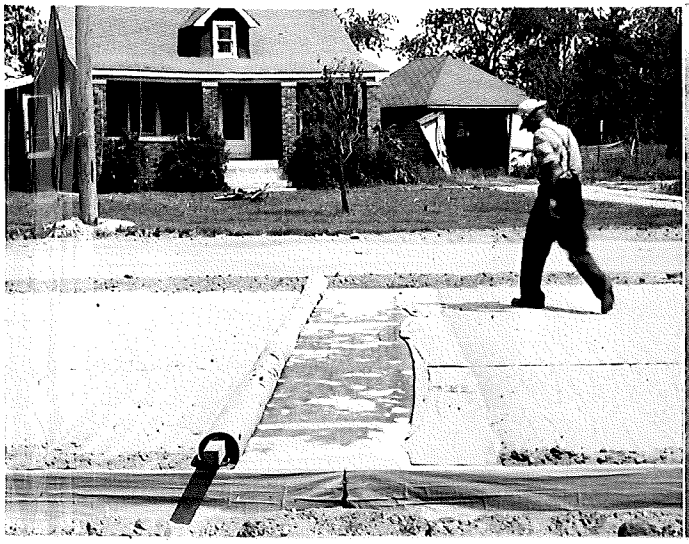


FIGURE 10. VIEW SHOWING PAPER CURING AND MOIST AND DRY PAVEMENT AREAS WHEN PAPER WAS REMOVED AT 7 DAYS. STATION 374. JUNE 17, 1952.

FIGURE 11. VIEW SHOWING METHOD OF DOWELLING THE WIDENING STRIP OUTSIDE OF CAPPING. STATION 311. JUNE 13, 1952.

FIGURE 12. VIEW SHOWING AN EXCEPTIONALLY GOOD METHOD OF INSTALLING TIE BARS.

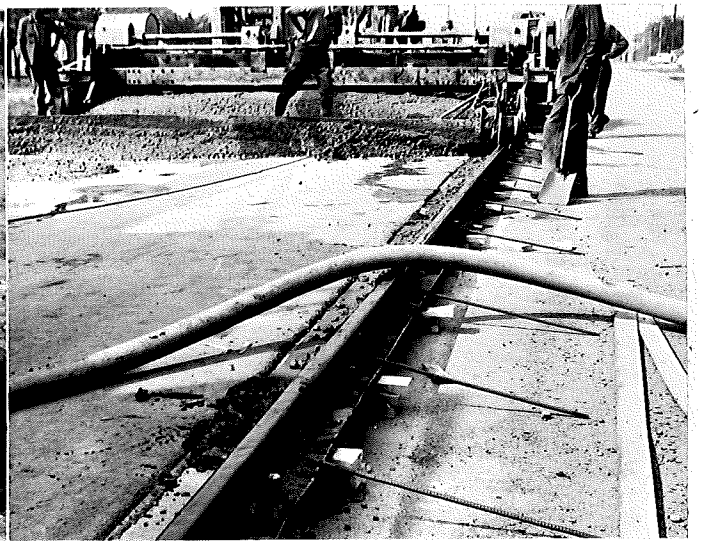


FIGURE 13. METHOD OF BLOCKING FORMS AT INTERSECTION. STATION 312. JUNE 30, 1952.

PLATE III. GENERAL CONSTRUCTION OPERATIONS

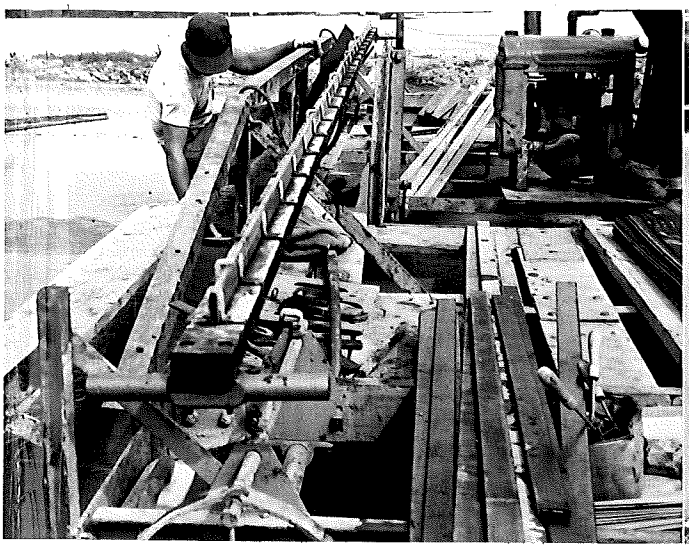


FIGURE 14. TEMPLATE FOR INSTALLING HOLLOW METAL BAR USED IN FORMING GROOVE AT CONTRACTION JOINTS.

FIGURE 15. PLACING TEMPLATES WITH GROOVING BAR IN FRESH CONCRETE.

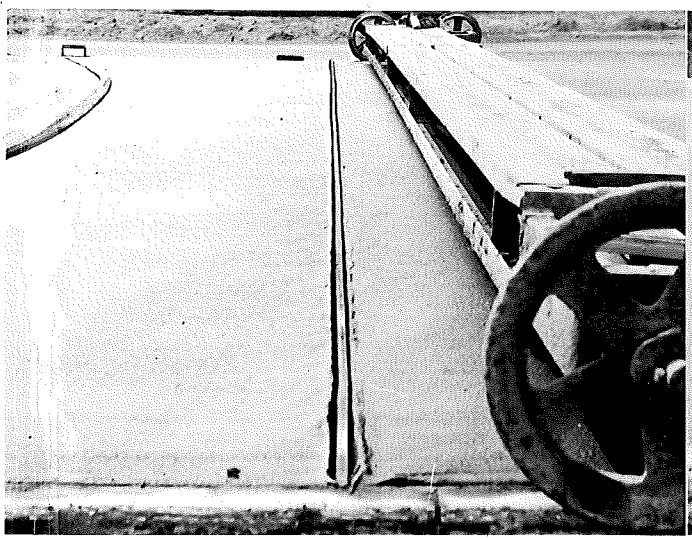


FIGURE 16. VIEW SHOWING METAL GROOVE STRIP IN PLACE WITH TEMPLATES REMOVED.

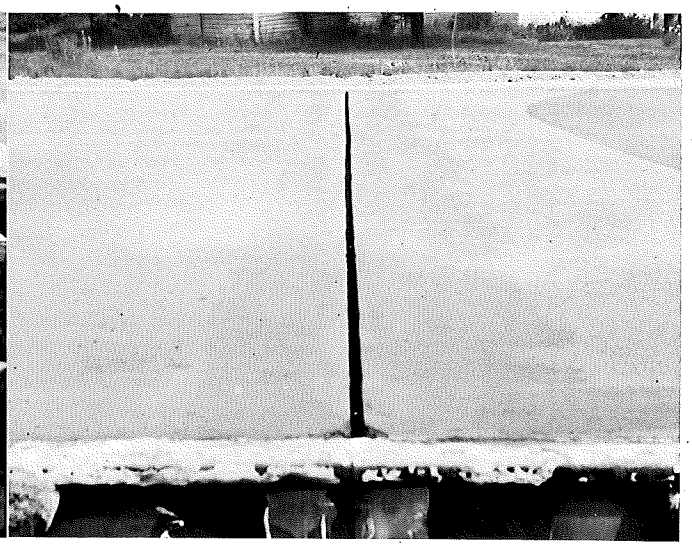


FIGURE 17. VIEW SHOWING FINISHED GROOVE AFTER GROOVING BAR IS REMOVED.

PLATE IV. METHOD USED TO FORM GROOVE FOR CONTRACTION JOINTS

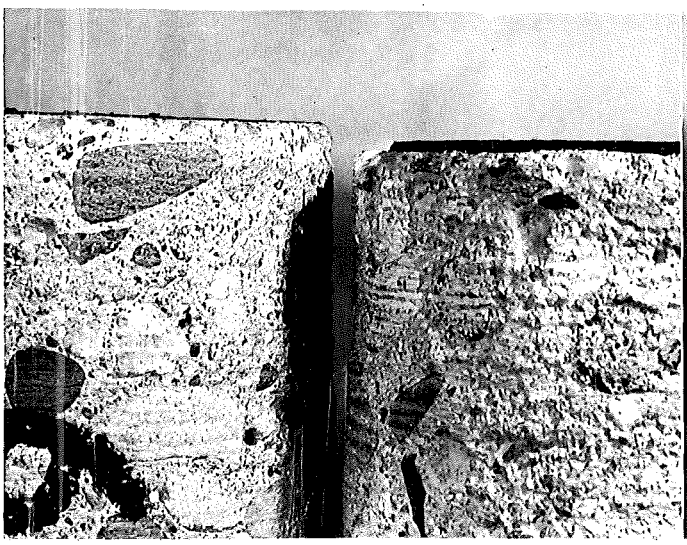


FIGURE 18. TAKEN TO SHOW THICKNESS OF AE-3 AND SAND BREAKER STRIP. CAP ON RIGHT, BASE ON LEFT. STATION 56+06. DECEMBER 18, 1952.

FIGURE 19. ANOTHER VIEW OF SAME CORE SPECIMEN, BASE ON LEFT, CAP ON RIGHT. NOTE THAT BITUMINOUS MATERIAL STICKS TO BOTH OLD AND NEW CONCRETE.

FIGURE 20. CORE SHOWING BITUMINOUS BREAKER STRIP BETWEEN OLD CONCRETE AND CAPPING CONCRETE. STATION 269+00. JANUARY 16, 1953.

FIGURE 21. CORE TAKEN AT STATION 21+14 TO SHOW CRACK IN CAPPING BUT NO CRACK IN BASE COURSE UNDERNEATH THE CAPPING. DECEMBER 18, 1952.

PLATE V. VIEWS OF CORE SPECIMENS

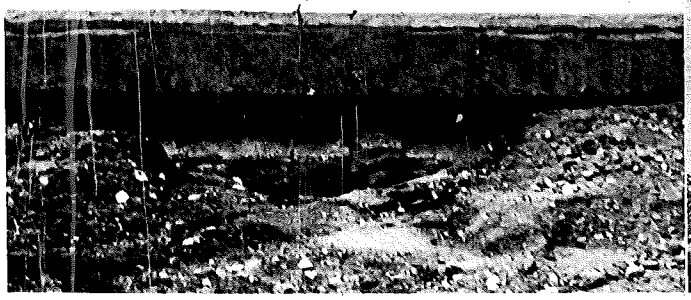


FIGURE 22. STARTING OF PAVEMENT CRACKING STATION 367+21 SHOWING CRACK THROUGH ENTIRE THICKNESS OF SLAB. THIS IS IN AN AREA BONDED DIRECT TO OLD PAVEMENT WHERE STEEL WAS CARRIED THROUGH JOINTS. JUNE 16, 1952.

FIGURE 23. APPEARANCE OF CRACK AFTER RECEIVING ABOUT 3 WEEKS OF TRAFFIC. JULY 16, 1952.

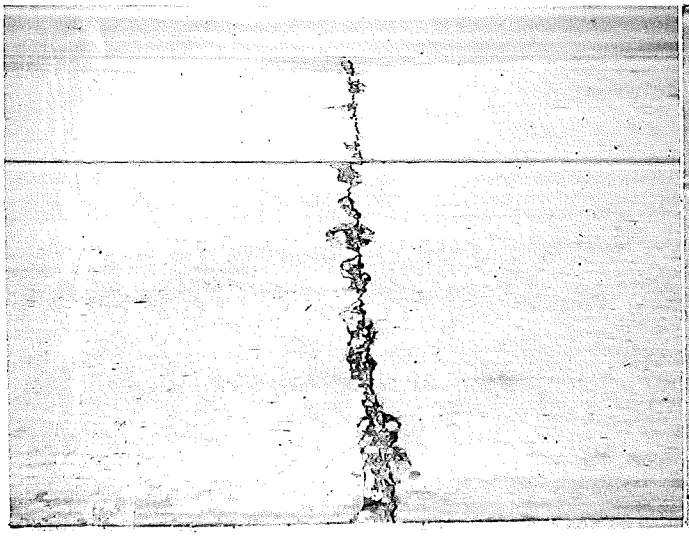


FIGURE 24. APPEARANCE OF CRACK AT STATION 367+21 AT 5 MONTHS. NOVEMBER 18, 1952.

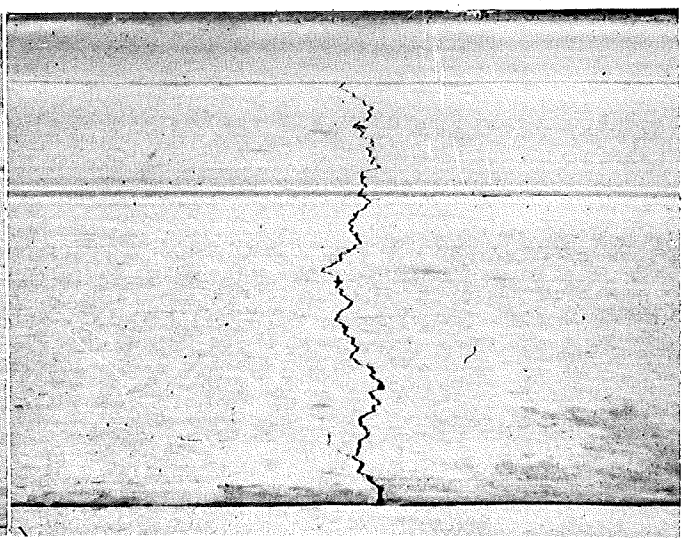


FIGURE 25. BAD CRACK IN CAPPING STATION 348+49 IN AREA WHERE STEEL WAS CARRIED THROUGH JOINTS. NOVEMBER 19, 1952.

PLATE VI. CRACKING OF CONCRETE CAPPING

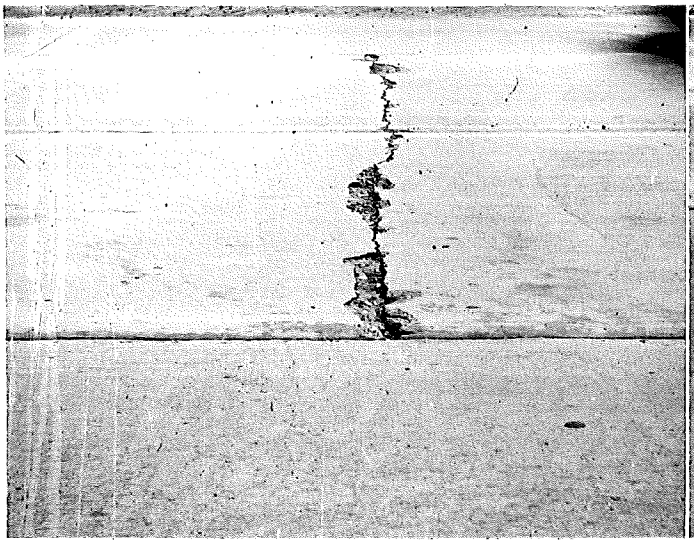


FIGURE 26. SPALLED CRACK AT STATION 344+37 NOVEMBER 19, 1952.

FIGURE 27. JOINT DISINTEGRATION IN AREA WHERE 5 1/2" OF CONCRETE CAPPING WAS PLACED. STATION ~~[illegible]~~ 112+14 NOVEMBER 19, 1952.

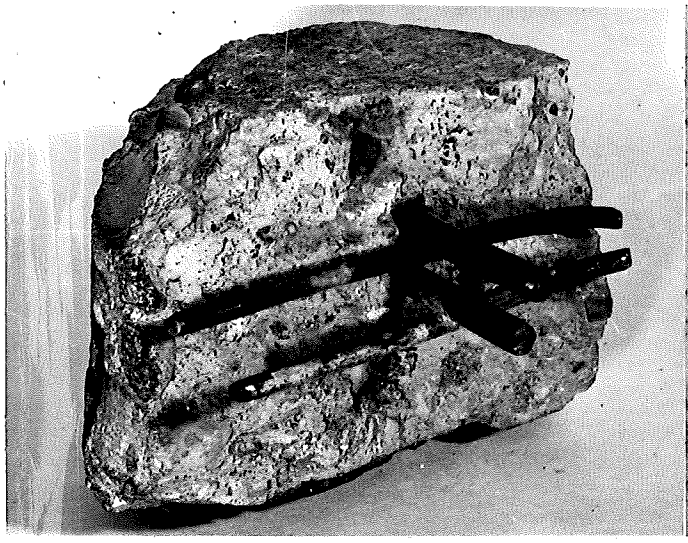


FIGURE 28. CRACK DEVELOPED WHERE TWO TRANSVERSE WIRES COINCIDED. STATION 367+21.

FIGURE 29. VIEW OF CORE HOLE. STATION 159+09 WHERE CORE WAS TAKEN AT CRACK IN CAPPING. DECEMBER 12, 1952.

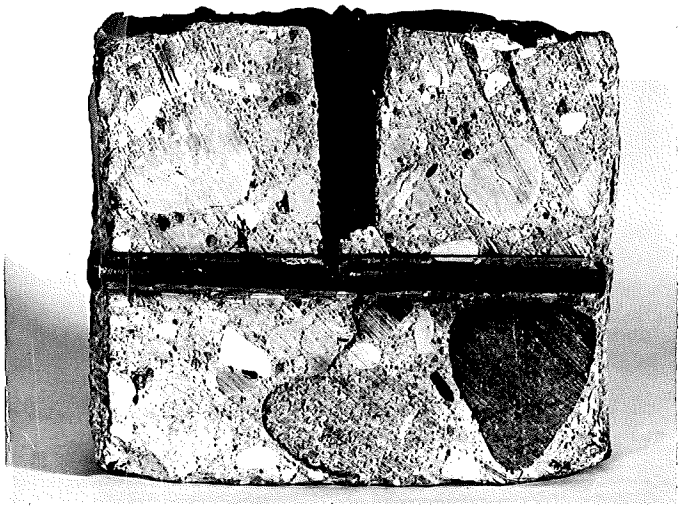


FIGURE 30. VIEW SHOWING STEEL RUNNING THROUGH CONTRACTION JOINT. NOTE STEEL WAS CUT ONLY HALF THROUGH BY SAW. ALSO NOTE HOW WELL JOINT SEAL MATERIAL FILLS JOINT OPENING. STATION 367+43.

PLATE VII. MISCELLANEOUS VIEWS OF PAVEMENT CONDITIONS

TABLE 1

LOCATION AND NUMBER OF CRACKS PER SLAB OF CONCRETE CAPPING AS RECORDED IMMEDIATELY AFTER REMOVAL OF CURING PAPER AND BEFORE THE PAVEMENT WAS OPENED TO TRAFFIC

	No. of Slabs L	No. of Slabs R	Sta. to Sta.	Length, ft.	Thickness of capping, inches: 5" L	5" R	5" Av.	5½" L	5½" R	5½" Av	6" L	6" R	6" Av	6½" L	6½" R	6½" Av	7" L	7" R	7" Av	7½"† L	7½"† R	7½"† Av
BONDED DIRECT TO OLD PAVEMENT	3	3	2/68 – 5/37	269	3	4	1															
	5	5	5/37 – 10/44	507	–	–	–	10	12	2.2												
	5	5	10/44 – 15/42	498	24	23	4.8															
	3	3	15/42 – 18/38	296	–	–	–	–	–	–	16	16	5.3									
	5	5	18/38 – 23/32	494	30	32	6.2															
	8	8	23/32 – 30/32	700	–	–	–	32	33	4.1												
	*15	15	319/58 – 334/48	1490	–	–	–	99	102	6.7												
	* 6	6	334/48 – 340/53	609	–	–	–	–	–	–	–	–	–	–	–	–	38	39	6.4			
	* 5	5	340/53 – 345/56	503	–	–	–	–	–	–	34	34	6.8									
	* 9	9	345/56 – 354/52	896	–	–	–	–	–	–	–	–	–	57	57	6.3						
	* 3	3	354/52 – 357/43	291	–	–	–	–	–	–	22	22	7.3									
	* 5	5	357/43 – 362/44	501	–	–	–	38	41	7.9												
	* 5	5	362/44 – 367/43	499	38	49	8.7															
	* 5	5	367/43 – 371/86	543	–	–	–	–	–	–	25	31	5.6									
CONSTRUCTED USING AE-3 AND SAND	19	19	30/32 – 49/22	1890	–	–	–	47	49	2.5												
	5	5	49/22 – 54/13	491	1	1	.2															
	5	5	54/13 – 60/10	597	8	8	1.6															
	25	25	60/10 – 84/70	2460	–	–	–	82	84	3.3												
	5	5	84/70 – 89/14	444	10	11	2.1															
	15	15	89/14 – 104/17	1503	–	–	–	38	39	2.6												
	5	5	104/17 – 109/15	498	–	–	–	–	–	–	17	19	3.6									
	9	9	109/15 – 118/11	896	–	–	–	8	8	.9												
	5	5	118/11 – 123/13	502	–	–	–	–	–	–	–	–	–	–	–	–	1	1	.2			
	5	5	123/13 – 128/63	550	–	–	–	–	–	–	8	11	1.9									
	4	4	128/63 – 132/56	393	–	–	–	12	15	3.4												
	2	2	132/56 – 134/07	151	–	–	–	–	–	–	–	–	–	3	4	1.8						
	5	5	134/07 – 139/01	494	–	–	–	–	–	–	10	10	2									
	8	8	139/01 – 146/92	791	–	–	–	12	13	1.6												
	5	5	146/92 – 151/90	498	–	–	–	–	–	–	–	–	–	–	–	–	7	7	1.4			
	5	5	151/90 – 156/75	485	–	–	–	–	–	–	9	9	1.8									
	11	11	156/75 – 167/67	1092	–	–	–	–	–	–	–	–	–	–	–	–	6	6	.5			
	10	10	167/67 – 177/67	1000	–	–	–	–	–	–	23	28	2.5									
	20	20	177/67 – 196/90	1923	–	–	–	–	–	–	–	–	–	–	–	–	13	14	.7			
	9	9	196/90 – 205/83	893	–	–	–	–	–	–	18	24	2.3									
	5	5	205/83 – 210/76	493	–	–	–	–	–	–	–	–	–	–	–	–	2	2	.4			
	7	7	210/76 – 217/69	693	–	–	–	–	–	–	–	–	–	10	10	1.4						
	16	16	217/69 – 232/95	1526	–	–	–	–	–	–	–	–	–	4	6	.3						
	9	9	232/95 – 241/51	856	–	–	–	–	–	–	–	–	–	–	–	–	0	0	0			
	8	8	241/51 – 249/46	795	–	–	–	–	–	–	0	0	0									
CONSTRUCTED USING A 3/4 BITUMINOUS BREAKER STRIP	12	12	249/46 – 261/51	1205	–	–	–	–	–	–	9	9	.75									
	9	9	261/51 – 270/48	897	–	–	–	–	–	–	–	–	–	–	–	–	0	0	0			
	12	12	270/48 – 282/15	1167	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	25	26	2.1
	11	11	282/15 – 292/95	1080	–	–	–	33	36	3.1												
	11	11	292/95 – 303/96	1101	–	–	–	–	–	–	9	8	.8									
	3	3	303/96 – 306/94	298	–	–	–	–	–	–	–	–	–	2	2	.7						
	4	4	306/94 – 311/36	442	9	9	2.3															
	8	8	311/36 – 319/28	792	–	–	–	–	–	–	11	10	1.3									

Left slab carries south bound traffic
Right slab carries north bound traffic
*Indicates sections where reinforcing was carried thru joints.

TABLE 2

COMPARATIVE RESULTS OF DIFFERENT METHODS OF BONDING CAPPING TO OLD PAVEMENT

Capping Method		Total Length of Sections in feet	Average Number of Cracks per Slab With Capping Thickness of: 5"	5½"	6"	6½"	7"	7½"
Bonded Direct to old Pavement	Without Reinforcement Carried Thru Joints	1300	4.5					
		1200		3.3				
		300			5.3			
	With Reinforcement Carried Continuous Thru Joints	500	8.7					
		2000		7.9				
		1300			6.5			
		900				6.3		
		600					6.4	
With A.E. 3 and Sand as Breaker (Standard Method)		1500	1.3					
		8000		2.5				
		4700			2.0			
		2500				0.7		
		5500					0.5	
With 3/4" Bituminous Concrete Breaker Strip on Old Pavement		400	2.3					
		1100		3.1				
		3100			1.1			
		300				0.7		
		900					0	
		1200						2.1

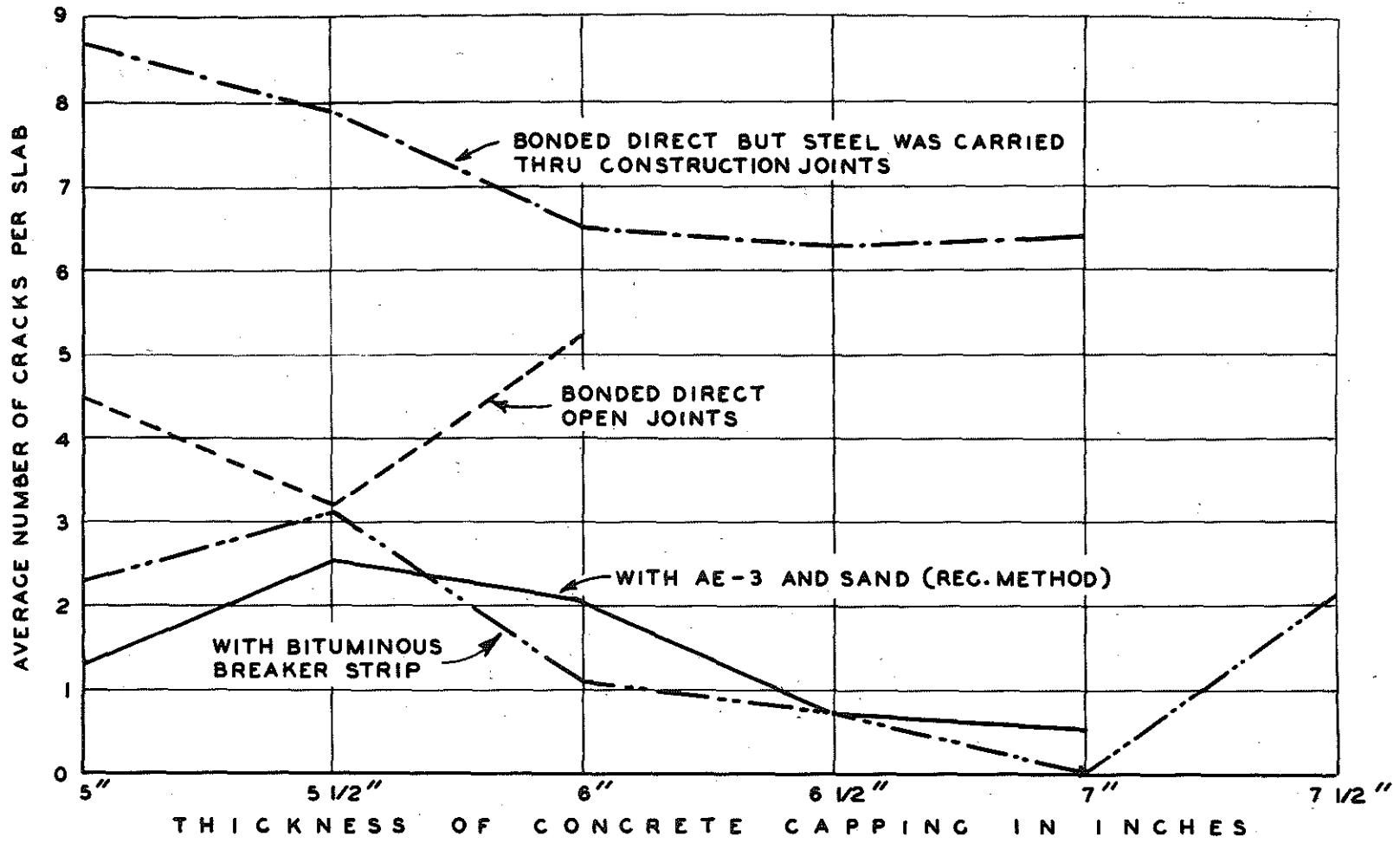
(2.) The section where capping was bonded directly to the pavement but the steel was not carried through the joints had the next highest number of cracks per slab. The number ranged from 3.3 for 5½-inch capping to 5.3 for 6-inch capping, with the weighted average for the entire section being 4.1.

(3.) Both the standard method of recapping using AE-3 and sand between the concrete capping and the old pavement, and the method employing a 3/4-inch bituminous concrete breaker strip gave much better results than bonding directly to existing pavement. The two methods were very nearly equal as to the number of cracks produced. The average number of cracks per slab produced by the first method ranged from 0.5 for the 7-inch capping to 2.5 for the 5½-inch. The weighted average for the entire section was 2.2. The cracks per slab produced by the second method ranged from 0 for the 7-inch capping to 3.1 for the 5½-inch. The weighted average for this section was 1.5.

(4.) Although these preliminary results indicate that the standard method of bonding and the use of a bituminous concrete breaker strip are very nearly equal and are much superior to direct bonding, it is still too early to draw any definite conclusions as to the relative effectiveness of the various methods. In time, the differences between the amounts of cracking in the various sections may become more pronounced. Therefore, only after a period of several years, during which condition surveys are made periodically, will any final evaluation be possible. The above results are presented graphically in Figure 17A.

Core Strengths of Old Pavement:

The core sections of the old concrete pavement were saved and broken in compression to obtain some idea as to the compressive strength of the concrete after 24 years in service. The results of core strengths are shown below in Table III.



GRAPH SHOWING RELATION OF METHOD OF APPLYING CAPPING TO OLD PAVEMENT AND THICKNESS OF CAPPING TO NUMBER OF CRACKS PER SLAB

FIGURE 17a

TABLE III. CORE STRENGTHS OF OLD PAVEMENTS [78]

Project 50-7,C2 - Oxford Coarse Aggregate; constructed 1928 (10-8-10)

listed on P. 5

Core No.				
No. 15	Sta. 21+33	psi	6,340)	
16	52+00		7,790)	
17	124+00		5,880)	
19	269+00		7,800)	Aver. 6,891
21	271+49		8,100)	
22	288+19		5,440)	

Project 50-7,C3 - France Stone (Monroe) C.A.; constructed 1930 (10-9-10)

24	348+61	6,800)	Aver. 7,520
26	367+43	8,240)	

The pictures in Figures 18 to 21, Plate V, show core specimens with and without bond breaking material. Figure 21 shows a core taken at a crack in capping. Note progression of crack downward from top. There is no crack in old pavement underneath. Of all of the cracks that were cored on this project, in no case did the crack in the concrete overlay form over a crack or opening in the old pavement underneath.

Figures 22 to 24, Plate VI, illustrate progressive disintegration of concrete along a crack over a period of several months. The crack is located in bonded section at Station 367+21. Figure 25 in Plate VI also shows a wide crack which developed at Station 348+49.

Plate VII contains several pictures of exceptional interest. Figure 26 is a view of spalling which has taken place at a crack which developed at Station 344+37. Figure 27 shows disintegration starting at joint, Station 114+14. Figure 28 shows positioning of 2 transverse wires at a crack, Station 367+21. Figure 29 was taken to show character of crack which developed at Station 159+09.

Figure 30 shows a cross section of a core taken at contraction joint station. Steel reinforcement is continuous through the joint and it may be observed that saw cut extends only partially through the steel member. Note how well the joint seal material fills the groove section, and partial saw cut in steel wire.