Commonwealth of Kentucky
Department of Highways

Report

on

INVESTIGATION OF CONCRETE PAVEMENT US 60 BETWEEN VERSAILLES AND FRANKFORT

by

W. B. Drake
Associate Director of Research

Highway Materials Research Laboratory
Lexington, Kentucky

February, 1960

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT

February 15, 1960

EARLE C. CLEMENTS
COMMISSIONER OF HIGHWAYS

ADDRESS REPLY TO
DEPARTMENT OF HIGHWAYS
MATERIALS RESEARCH LABORATORY
132 GRAHAM AVENUE
LEXINGTON 29, KENTUCKY

P.3.2

MEMO TO: T. H. Baker
Director of Construction

SUBJECT: Franklin-Woodford Counties
S-SG 155 (1)
P. C. Concrete Pavement

REF: Your Phone Conversation and Letter of
November 10, 1959

We have completed a detailed condition survey of the subject pavement. Two of the sections showing the greater numbers of defects were resurveyed at approximately 2-week intervals. Ten 6-inch diameter cores were taken from the pavement and an effort has been made to evaluate the adequacy of the patches placed by the contractor.

There are 2240 50 ft x 24 ft. slabs and 1109 or 49.5% have one or more defects. Fifty-six or 2-1½% of the slabs surveyed have 10 or more defects. The table, SUMMARY OF PAVEMENT DEFECTS, lists the number of slabs for each rating category.

The location of the slabs showing 8 or more defects are tabulated in the table, SUMMARY STRIP PERFORMANCE. It can be noted that some defects were noted throughout the project but by and large the defects observed on the surface were concentrated at two locations in the westbound lanes. These two locations were resurveyed on November 30, 1959, December 15, 1959, January 13, 1960, and February 9, 1960. The condition of the pavement at the time of the surveys is noted in the table entitled, SECTIONS WITH MORE THAN ONE SURVEY. It appears that defects are continuing to show through. These are probably soil and foreign material just under the surface and not deep enough to be protected from water and freezing. Several very cold days were recorded between the first and second surveys with

normal winter weather between the second and third surveys. I believe that the occurrence of new defects in the surface from such foreign material will continue for some time. It is not feasible to estimate the total that will occur in a specific period of time.

I am attaching photographs (Fig. 2 & Fig. 3) of the 10 cores that were taken from the pavement. Cores numbered 1, 3, 7, 8 and 9 were taken at locations where the surface appeared good with no defects in the immediate vicinity. Each of these cores have voids beneath the surface caused by the presence of extraneous materials. Core 10 had a slight cracking at the surface indicating presence of a mud ball. The core was cut to show the extent of the foreign material. Core 5 was cut over a fairly large patch to test the effect of the patch. The patch did not hold and appears to be quite porous. All of the soil was not removed. Core 6 was cut through a patch to check the bond. The patch did not adhere to the concrete pavement. There are indications that the patches are open and porous and that water is collecting behind the patches. The contractor has been painting over some of the patches with a cement paste to try and seal the openings and change the appearance. It is doubtful that this type treatment can be effective for any period of time.

Two tables, SUMMARY COMPRESSIVE STRENGTHS and SUMMARY FLEXURAL STRENGTHS, have been prepared from available construction data on the cylinders and beams made in the field during construction. These can be used to compare the samples made in the sections in question to those made in the other sections. Apparently there is no reflection of the excess of foreign matter in these data for the sections of highest concentration of foreign materials.

Concrete mixes in the laboratory were prepared using two types of mixing equipment. Soil from the Woodford County sand stock pile was added to the mixes. The two photographs (Fig. 4) marked "drum" and "pan" were taken of cylinders after they had been broken. It can be noted that the soil did go through both types of mixing equipment and remain in mud ball form. This side investigation was made to determine if the soil in question would go through the mixing process and remain in lump form. It was thought that much of the soil found in the pavement surface could have been tracked in by laborers in placing the steel, etc. Some of the isolated locations showing mud at

at the surface could have resulted from soil tracked onto the new pavement.

The extent of the total damage to the pavement because of the soil and foreign material is quite difficult to evaluate. I believe that defects will continue to show up for some time. The project will be kept under observation throughout the winter to determine the progress of the deterioration.

W. B. Drake
Associate Director of Research

WBD/va
Enc: Photos
Tables
cc: A. O. Neiser

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT

November 6, 1959

ADDRESS REPLY TO
DEPARTMENT OF HIGHWAYS
MATERIALS RESEARCH LABORATORY
132 GRAHAM AVENUE
LEXINGTON 29, KENTUCKY

Ward J. Oates
COMMISSIONER OF HIGHWAYS

P.3.2

MEMO TO: W. B. Drake
Associate Director of Research

SUBJECT: Investigation of Concrete Pavement on US 60
Between Versailles and Frankfort

A preliminary examination was made of the subject pavement on November 2, 1959, by James H. Havens and the writer, of the Research Division, and J. S. Riley, Construction Division. The discovery of deleterious matter in the pavement was the major reason for the inspection. Foreign objects could be found imbedded in the concrete pavement throughout the project. However, there were a great many more in two sections, each about one quarter of a mile long, than on the rest of the project. The objects observed were wood, cloth, metal and soil. However, there was a decided prevalence of soil. The soil particles seem varied in shape and ranged in size from approximately one half inch in diameter to several inches in diameter.

At the time of this inspection, it was not possible to examine a large number of particles because the contractor had been engaged in chiseling them out and patching the holes with a mixture of his own design containing portland cement, sand and Daraweld. Most of the holes existing in the pavement and particularly the ones in the worst sections have been filled. The only objects which could actually be seen were the ones that were overlooked by the repair crew or the ones in the short section where repairs had not been made. Two photographs are attached (Fig. 1) to show the appearance of a patched area and a close up of a hole after the soil has been removed.

In the worst sections, as many as thirty patches per 50-ft. slab could be seen. Nevertheless, upon closer scrutiny,

additional blemishes were found. These were caused by dirt under as much as one-eighth of an inch of concrete. It was possible to detect the dirt in such cases by very small cracks which had developed in the thin concrete covering and by dampness trapped therein. When such places were tapped with a hammer, the thin covering of concrete would break away exposing the dirt.

In order to estimate the strength of some of the patches observed, a concrete rebound hammer was used. The patches, of unknown age, but estimated to be about six days old, showed compressive strengths of approximately 2000 psi, whereas the surrounding concrete showed strengths in excess of 4000 psi. Probably these strengths will increase with further curing.

It appears that the pavement in question has suffered to some extent from the existence of deleterious matter in it. However, the amount of harm to the concrete is not immediately discernable. At present, the appearance of the pavement is affected by the patches which are visible.

As to the effect of these blemishes on the concrete as it ages and is attacked by weather and heavyloading, there is no immediate answer. The possible injurious effects of these dirt filled voids on the pavement are a weakening of the slab at a point or in a plane, causing subsequent cracking and failure and the openings, allowing the entrance of water into the slab, causing frost wedging, spalling, cracking and further deterioration over a period of time.

In order to better estimate the extent of the damage to the pavement, it would be necessary to know if soil particles are imbedded throughout the depth of the slabs and the frequency of their occurence therein.

Conjecturally there are several explanations for the existence of dirt in this pavement. It may have been dropped into stockpiles off of the tires of trucks hauling aggregate; it may have been picked up from the bottom of stockpiles when they were low; or it may have been tracked into the fresh concrete on the feet of the men placing mesh, etc. In the first two cases above the dirt would have passed through the mixer, whereas, in the third, it would not. There is some question as to whether clods could have passed through the mixer without being pulverized.

In order to satisfactorily evaluate this pavement, the

following procedures are suggested:

1. A complete survey to determine the extent and location of surface faults.

2. A thorough examination of the Resident Engineers and Inspector's diaries and other construction records to determine rainy periods during construction when muddy conditions would have existed and to discover any other pertinent facts.

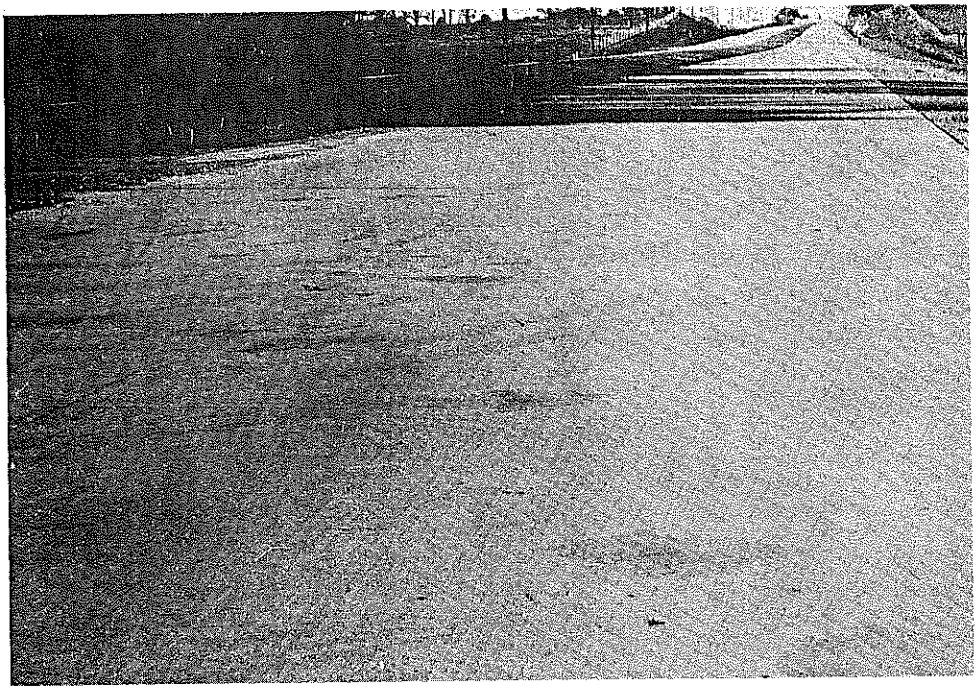
3. The taking of specimens by coring of a representative amount of patched concrete to test the strength and bond of the patches.

4. An analysis of the data obtained by these methods to arrive at valid conclusions about the pavement.

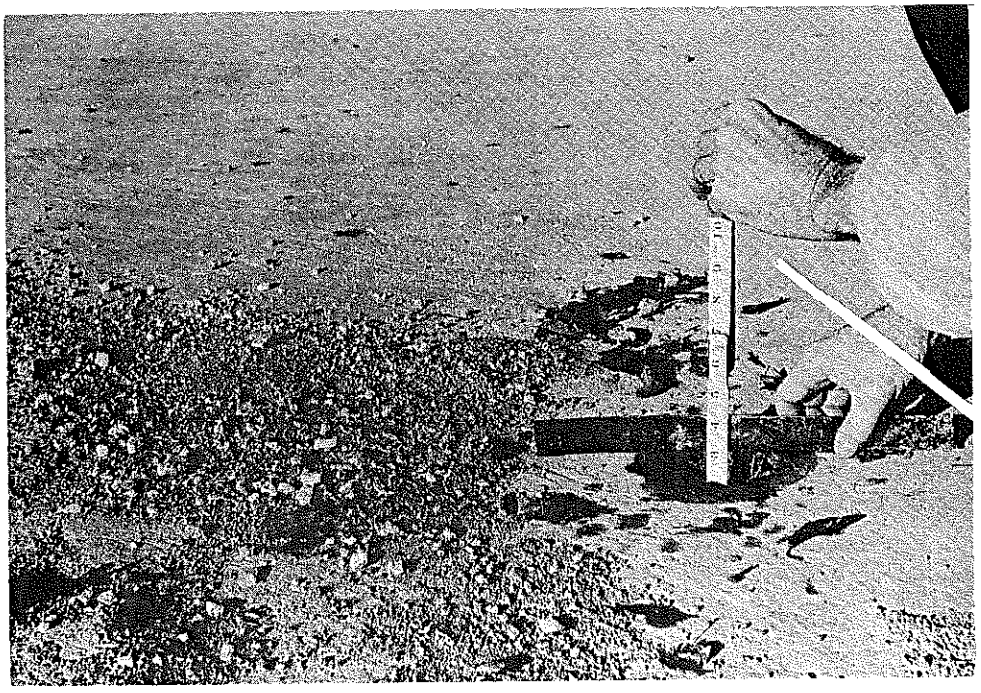
Milton Evans, Jr.

Milton Evans, Jr.
Research Engineer

ME/va
attchs



A Typical Area After Extensive Patching



A Three Inch Deep Hole After the Soil Has Been Removed in Preparation for Patching

Fig. 1:

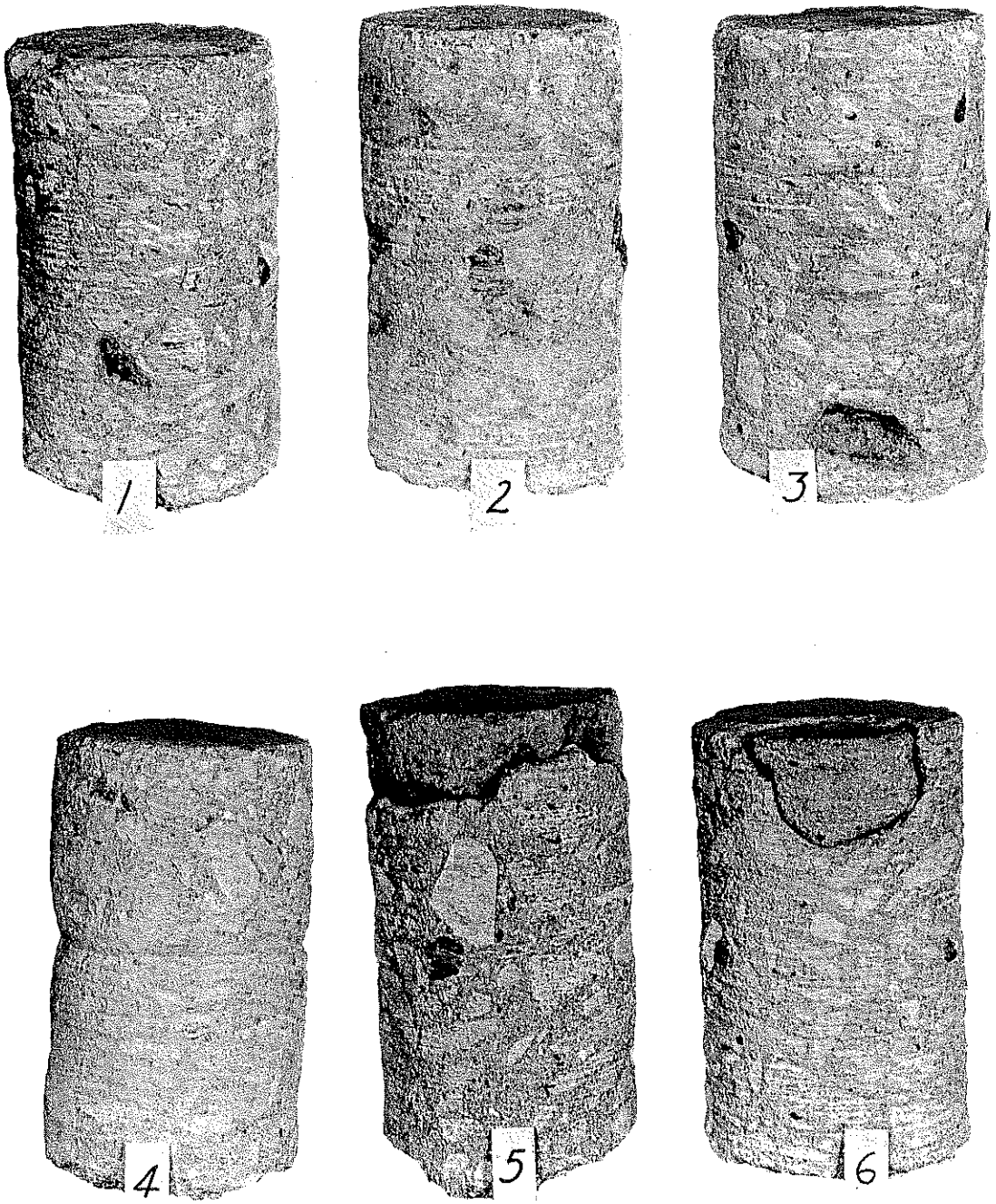


Fig. 2: Cores Taken from the Areas of Distress

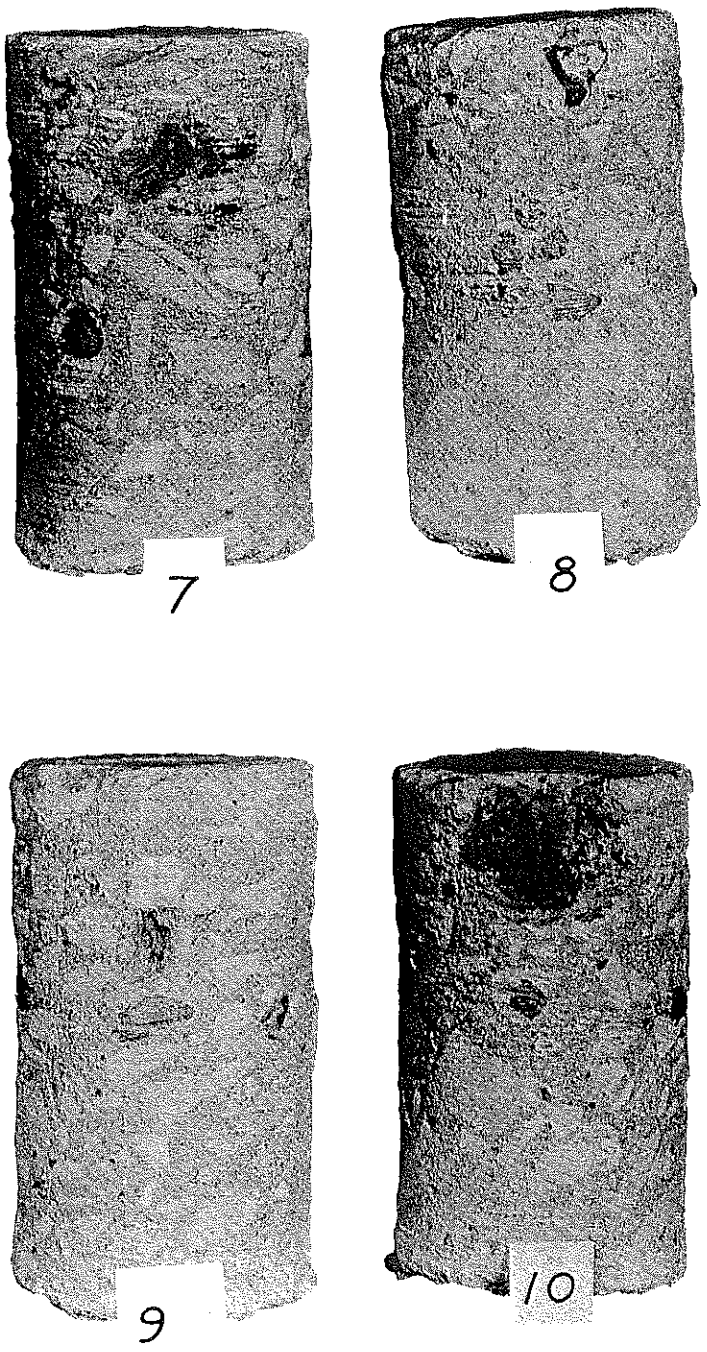
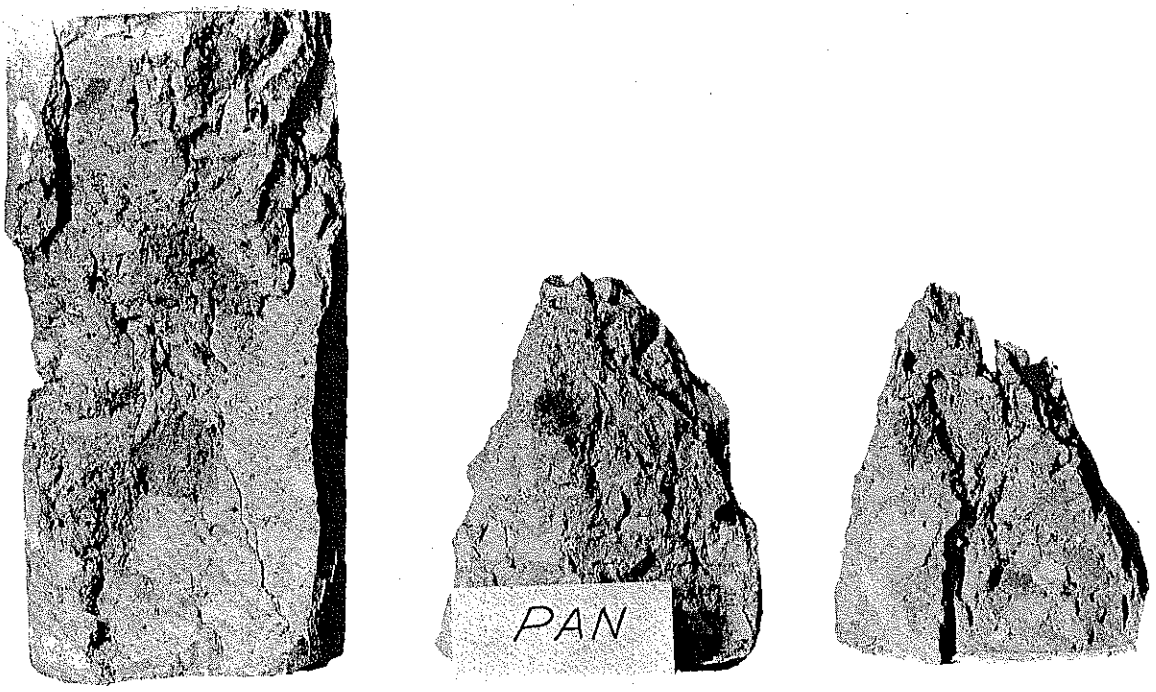
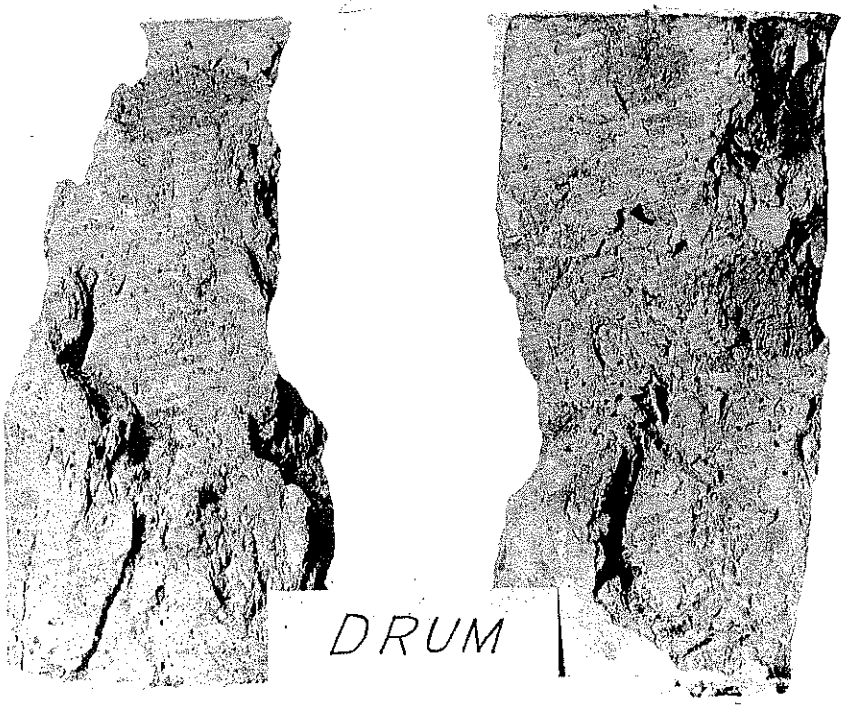


Fig. 3: Cores Taken from the Areas of Distress



Broken Cylinders Containing Soil Particles Which Were Mixed into the Concrete in a Pan Type Mixer



Broken Cylinders Containing Soil Particles Which Were Mixed into the Concrete in a Drum Type Mixer

Fig. 4

SUMMARY OF PAVEMENT DEFECTS
Project: Franklin-Woodford S-SG 155 (1)
Surveyed to Nov. 30, 1959

No. Total Blemishes	No. Slabs				De-Cumulative No. Slabs *			
	Eastbound	Westbound	Total	% Indiv. Total	Eastbound	Westbound	Total	% Decum Total
0	593	538	1131	50.49	1120	1120	2240	100.0
1	245	225	470	20.98	527	582	1109	49.5
2	121	123	244	10.89	282	357	639	28.5
3	76	62	138	6.16	161	234	395	17.6
4	37	37	74	3.30	85	172	257	11.5
5	16	29	45	2.01	48	135	183	8.2
6	12	21	33	1.47	32	106	138	6.2
7	7	22	29	1.29	20	85	105	4.7
8	3	9	12	.54	13	63	76	3.4
9	4	4	8	.35	10	54	64	2.9
10	0	9	9	0.40	6	50	56	2.5
11	2	9	11	0.49	6	41	47	2.1
12	1	2	3	0.13	4	32	36	1.6
13	2	3	5	0.22	3	30	33	1.5
14	0	5	5	0.22	1	27	28	1.3
15	0	1	1	0.05	1	21	22	1.0
16	0	3	3	0.13	1	20	21	0.9
17	1	1	2	0.09	1	17	18	0.8
18	0	2	2	0.08	0	16	16	0.7
19		0	0	0.00		14	14	0.6
20		1	1	0.05		14	14	0.6
21		1	1	0.05		13	13	0.58
22		2	2	0.08		13	13	0.50
23		0	0	0.00		11	11	0.49
24		1	1	0.05		11	11	0.49
25		0	0	0.00		10	10	0.45
26		0	0	0.00		10	10	0.45
27		1	1	0.05		10	10	0.45
28		1	1	0.05		9	9	0.40
29		0	0	0.00		8	8	0.36
30		0	0	0.00		8	8	0.36
31		2	2	0.08		8	8	0.36
32		0	0	0.00		6	6	0.27
33		0	0	0.00		6	6	0.27
34		0	0	0.00		6	6	0.27
35		0	0	0.00		6	6	0.27
36		1	1	0.05		6	6	0.27
37		0	0	0.00		5	5	0.22
46		1	1	0.05		5	5	0.22
47		0	0	0.00		4	4	0.18
49		1	1	0.05		4	4	0.18
50		0	0	0.00		3	3	0.13
59		1	1	0.05		3	3	0.13
60		0	0	0.00		2	2	0.09
68		1	1	0.05		2	2	0.09
69		0	0	0.00		1	1	0.04
77		1	1	0.05		1	1	0.04
78	0	0	0	0.00	0	0	0	0.00

* The De-Cumulative No. of Slabs is the No. of Slabs with at least the No. of Blemishes in left column or more.

SUMMARY STRIP PERFORMANCE

Surveyed to Nov. 30, 1959
Franklin-Woodford Counties, S-SG 155 (1)

EAST BOUND LANES

Station No. of Slabs Begin Frankfort End	Total No. of Defects Per Slab
6 + 00 to 28 + 00	Less than 8
28 + 50	13
29 + 00 to 52 + 00	Less than 8
52 + 50	11
53 + 00 to 98 + 00	Less than 8
98 + 50	13
99 + 00 to 119 + 00	Less than 8
119 + 50	8
120 + 00 to 141 + 00	Less than 8
141 + 50	8
142 + 00 to 278 + 00	Less than 8
278 + 50	15
279 + 00 to 305 + 00	Less than 8
305 + 50	9
306 + 00 to 372 + 00	Less than 8
372 + 50	11
373 + 00 to 473 + 50	Less than 8
474 + 00	17
474 + 50 to 477 + 50	Less than 8
478 + 00	9
Equa. Sta. 478 + 56.2 BK = Sta. 16 + 50 AH	
478 + 50 to 17 + 50	Less than 8
18 + 00	8
18 + 50 to 71 + 00	Less than 8

WEST BOUND LANES

Station No. of Slabs Begin Frankfort End	Total No. of Defects Per Slab
6 + 00 to 52 + 00	Less than 8
52 + 50	13
53 + 00 to 58 + 00	Less than 8
58 + 50	10
59 + 00 to 334 + 00	Less than 8
334 + 50	0
335	2
+ 50	4
336	3
+ 50	6
337	4
+50	14
338	15
+ 50	10
339	22
+ 50	19
340	11
+ 50	16
341	17
+ 50	14
342	27
+ 50	28
343	16
+50	20
344	13
+ 50	12
345	12
+ 50	5
346	29
+ 50	31
347	68
+ 50	49
348	77
+ 50	46
349	59
+ 50	36
350	9
+ 50	5
351	0
+ 50	2

WEST BOUND LANES (Continued)

Station No. of Slabs Begin Frankfort End	Total No. of Defects Per Slab
352	5
353	3
+ 50	2
354	7
+ 50	9
355	2
355 + 50 to 361 + 50	Less than 8
362	14
+ 50	4
363	3
+ 50	4
364	1
+ 50	6
365	9
+ 50	0
366	8
+ 50	6
367	7
+ 50	4
368	1
+ 50	11
369	4
+ 50	8
370	7
+ 50	22
371	21
+ 50	24
372	13
+ 50	14
373	13
+ 50	14
374	8
+ 50	4
375	7
+ 50	10
376	1
+ 50	1
377	1
+ 50	3
378	10
+ 50	5
379	3
+ 50	3
380	3
380 + 50 to 385 + 50	Less than 8
386 + 00	11
+ 50	11

WEST BOUND LANES (Continued)

Station No. of Slabs Begin Frankfort End	Total No. of Defects Per Slab
387	7
+ 50	4
388	2
+ 50 to 389 + 50	Less than 8
390	8
390 + 50 to 399 + 50	Less than 8
400 + 00	9
400 + 50 to 405 + 50	Less than 8
406	9
+ 50	0
407	10
+ 50	3
408	3
+ 50	11
409 + 00 to 410 + 00	Less than 8
410 + 50	10
411 + 00	4
411 + 50	14
412	10
+ 50	11
413	3
+ 50	8
414	1
+ 50	11
415	1
+ 50	4
416	4
416 + 50 to 420 + 50	Less than 8
421	8
+ 50	8
422 + 00 to 431 + 00	Less than 8
431 + 50	12
432 + 00 to 439 + 00	Less than 8
439 + 50	7
440	7
+ 50	11
441	3
+ 50	11
442	6
+ 50	5
443	2
+ 50	6
444 + 00 to 447 + 00	Less than 8
447 + 50	10
Equa. Sta. 478 + 56.2 BK = Sta. 16 + 50 AH	
448 + 00 to 29 + 00	Less than 8
29 + 50	9
30 + 00 to 71 + 00	Less than 8

SECTION WITH MORE THAN ONE SURVEY

STATION	TOTAL DEFECTS					TOTAL CHANGE FROM:				
	1st count	2nd count	3rd count	4th count	5th count	Nov. 12 to Nov. 30	Nov. 12 to Dec. 15	Nov. 12 to Jan. 13	Nov. 12 to Feb. 9	Total % of Original Count
335 ≠ 50	1	4	4	4	4	3	3	3	3	300.00
336 ≠ 00	1	3	3	4	4	2	2	3	3	300.00
336 ≠ 50	5	6	8	11	11	1	3	6	6	120.00
337 ≠ 00	4	4	4	8	9	0	0	4	5	125.00
337 ≠ 50	7	14	14	15	15	7	7	8	8	114.29
338 ≠ 00	5	15	15	17	17	10	10	12	12	240.00
338 ≠ 50	1	10	11	16	17	9	10	15	16	1600.00
339 ≠ 00	14	22	29	38	38	8	15	24	24	171.43
339 ≠ 50	17	19	26	42	54	2	9	25	37	217.65
340 ≠ 00	9	11	11	14	14	2	2	5	5	180.00
340 ≠ 50	15	16	18	20	22	1	3	5	7	46.67
341 ≠ 00	14	17	20	31	31	3	6	17	17	121.43
341 ≠ 50	11	14	14	14	19	3	3	3	8	72.73
342 ≠ 00	19	27	34	46	47	8	15	27	28	147.37
342 ≠ 50	20	28	32	41	43	8	12	21	23	115.
343 ≠ 00	11	16	16	22	23	5	5	11	12	109.09
343 ≠ 50	15	20	23	32	38	5	8	17	23	153.33
344 ≠ 00	10	13	22	25	27	3	12	15	17	170.00
369 ≠ 50	4	8	11	16	14	4	7	12	10	250.00
370 ≠ 00	5	7	9	14	13	2	4	9	8	160.00
370 ≠ 50	10	22	27	33	33	12	17	23	23	230.00
371 ≠ 00	9	21	26	27	27	12	17	18	18	200.00
371 ≠ 50	15	24	27	27	27	9	12	12	12	80.00
372 ≠ 00	6	13	20	20	21	7	14	14	15	250.00
372 ≠ 50	8	14	14	26	26	6	6	18	18	225.00
373 ≠ 00	7	13	13	20	19	6	6	13	12	171.43
373 ≠ 50	5	14	19	24	22	9	14	19	17	340.00
374 ≠ 00	4	8	8	13	13	4	4	9	9	225.00
374 ≠ 50	1	3	3	11	10	2	2	10	9	900.00

SUMMARY COMPRESSIVE STRENGTHS

STATION	Linear Feet	Date Sample Taken	Sample No.	Individual Results (psi)	Average of Individual Results (psi)
70 ≠ 50 to 65 ≠ 50	500	6-22-59	1A	4866	
			1B	5865	
			1C	5646	5459*
65 ≠ 50 to 62 ≠ 88	362	6-24-59	2A	4845	
			2B	4880	4863
66 ≠ 90 to 62 ≠ 22	468	6-25-59	3A	5835	
			3B	5940	
			3C	6155	5976
62 ≠ 22 to 57 ≠ 00	522	6-26-59	4A	4315	
			4B	5020	
			4C	4890	4741
57 ≠ 00 to 44 ≠ 00	1300	6-29-59	5A	4350	
			5B	4525	
			5C	4315	4396
44 ≠ 00 to 31 ≠ 36	1264	6-30-59	6A	4456	
			6B	4740	
			6C	4810	4668
31 ≠ 36 to 478 ≠ 29	1512	7-1-59	7A	5130	
			7B	4670	
			7C	5235	5011
478 ≠ 29 to 461 ≠ 80	1649	7-2-59	8A	4030	
			8B	4260	
			8C	4705	4330
461 ≠ 80 to 447 ≠ 19	1461	7-3-59	9A	5020	
			9B	5130	
			9C	5055	5078
447 ≠ 19 to 427 ≠ 55	1964	7-6-59	10A	4670	
			10B	4175	
			10C	4420	4421
427 ≠ 55 to 407 ≠ 37	2018	7-7-59	11A	4670	
			11B	4490	
			11C	4705	4621
407 ≠ 37 to 388 ≠ 62	1875	7-8-59	12A	4775	
			12B	4390	
			12C	4456	4540
388 ≠ 62 to 373 ≠ 08	1554	7-9-59	13A	4455	
			13B	4245	
			13C	4065	4255
373 ≠ 08 to 354 ≠ 00	1908	7-10-59	14A	4880	
			14B	4460	
			14C	4600	4646*
354 ≠ 00 to 332 ≠ 90	2110	7-13-59	15A	4640	
			15B	4922	
			15C	4852	4804*
332 ≠ 90 to 312 ≠ 22	2068	7-14-59	16A	5116	
			16B	5361	
			16C	4936	5137*
312 ≠ 22 to 293 ≠ 65	1857	7-15-59	17A	4456	
			17B	4530	
			17C	4750	4578
293 ≠ 65 to 277 ≠ 50	1615	7-16-59	18A	2462	
			18B	3417	
			18C	3240	3039*
62 ≠ 88 to 66 ≠ 90	402	7-17-59	19A	2279	
			19B	2524	
			19C	2419	2407*
58 ≠ 24 to 42 ≠ 40	1584	7-21-59	20A	3360	
			20B	3040	
			20C	3465	3288
28 ≠ 80 to 478 ≠ 27	1259	7-27-59	21A	4175	
			21B	4065	
			21C	4595	4278
478 ≠ 27 to 459 ≠ 09	1918	7-30-59	22A	4705	
			22B	5130	
			22C	5020	4951
459 ≠ 09 to 438 ≠ 93	2016	7-31-59	23A	5020	
			23B	5200	
			23C	5130	5116
438 ≠ 93 to 421 ≠ 32	1761	8-1-59	24A	5055	
			24B	5200	
			24C	4950	5068
421 ≠ 32 to 393 ≠ 60	2772	8-3-59	25A	4880	
			25B	4670	
			25C	4350	4633
393 ≠ 60 to 370 ≠ 40	2320	8-4-59	26A	4530	
			26B	5022	
			26C	4880	4810

SUMMARY COMPRESSIVE STRENGTHS (Continued)

STATION	Linear Feet	Date Sample Taken	Sample No.	Individual Results (psi)	Average of Individual Results (psi)
370 ≠ 40 to 349 ≠ 71	2069	8-5-59	27A	5163	
			27B	5305	
			27C	5280	5249
349 ≠ 71 to 335 ≠ 58	1413	8-6-59	28A	3220	
			28B	4140	
			28C	4350	3903
335 ≠ 59 to 313 ≠ 83	2175	8-8-56	29A	4950	
			29B	5234	
			29C	----	5092
16 ≠ 47 to 33 ≠ 46	1698	8-14-59	31A	3890	
			31B	3360	3625
33 ≠ 46 to 52 ≠ 12	1866	8-15-59	32A	4315	
			32B	4430	
			32C	4350	4365
52 ≠ 12 to 70 ≠ 28	1816	8-18-59	33A	4775	
			33B	4915	
			33C	5130	4940
70 ≠ 28 to 91 ≠ 45	2117	8-19-59	34A	4958	
			34B	4575	
			34C	4915	4816
91 ≠ 45 to 107 ≠ 04	1559	8-20-59	35A	3995	
			35B	3960	
			35C	3890	3948
107 ≠ 04 to 130 ≠ 04	2300	8-21-59	36A	4525	
			36B	4030	
			36C	4595	4383
130 ≠ 18 to 144 ≠ 77	1459	8-22-59	37A	5020	
			37B	4775	
			37C	3995	4596
144 ≠ 77 to 157 ≠ 85	1308	8-24-59	38A	4525	
			38B	4775	
			38C	3785	4361
157 ≠ 85 to 179 ≠ 60	2175	8-25-59	39A	4845	
			39B	3925	
			39C	4100	4290
179 ≠ 60 to 204 ≠ 72	2512	8-26-59	40A	4670	
			40B	5130	
			40C	5305	5034
204 ≠ 72 to 225 ≠ 92	2120	8-27-59	41A	4880	
			41B	4490	
			41C	4525	4631
234 ≠ 73 to 257 ≠ 84	2311	9-1-59	42A	4020	
			42B	4350	
			42C	4600	4326
257 ≠ 84 to 277 ≠ 50	1966	9-3-59	43A	----	
			43B	----	
			43C	----	----
28 ≠ 44 to 47 ≠ 12	1868	9-8-59	44A	4280	
			44B	4350	
			44C	4245	4291
47 ≠ 12 to 69 ≠ 18	2206	9-9-59	45A	5055	
			45B	4810	4933
69 ≠ 18 to 92 ≠ 47	2329	9-10-59	46A	4490	
			46B	----	
			46C	----	4490
92 ≠ 47 to 119 ≠ 24	2677	9-11-59	47A	5137	
			47B	5032	
			47C	4427	4865*
119 ≠ 24 to 137 ≠ 06	1782	9-12-59	48A	5076	
			48B	4906	
			48C	5081	5021*
137 ≠ 06 to 159 ≠ 29	2223	9-14-59	49A	4434	
			49B	4189	
			49C	----	4312*
159 ≠ 29 to 171 ≠ 44	1215	9-15-59	50A	4908	
			50B	5088	
			50C	5018	5004*
171 ≠ 44 to 196 ≠ 22	2478	9-16-59	51A	5207	
			51B	4677	
			51C	5277	5053*
196 ≠ 22 to 216 ≠ 29	2007	9-17-59	52A	4866	
			52B	5046	
			52C	5151	5021*
216 ≠ 29 to 236 ≠ 52	2023	9-18-59	53A	4245	
			53B	4565	
			53C	4105	4305*
236 ≠ 52 to 261 ≠ 81	2529	9-21-59	54A	4427	
			54B	4677	
			54C	4642	4582*

* Concrete Manual, Control of Concrete Construction, Bureau of Reclamation, Dept. of Interior, Denver, Colorado, 1951, Chart: Standard curing, p. 49. Strength reduced to 28 day compressive strength.

SUMMARY FLEXUAL STRENGTH

Date of Sample	Sample Number	Stations of Placement	Linear Feet	14 Day Flexural Strength (psi)
6-25-59	3-D	66 ≠ 90 to 62 ≠ 22	488	750
6-29-59	5-D	57 ≠ 00 to 44 ≠ 00	1300	700
6-30-59	6-D	44 ≠ 00 to 31 ≠ 36	1264	666
7-1-59	7-D	31 ≠ 36 to 478 ≠ 29	1512	816
7-2-59	8-D	478 ≠ 29 to 461 ≠ 80	1649	700
7-3-59	9-D	461 ≠ 80 to 447 ≠ 19	1461	700
7-6-59	10-D	447 ≠ 19 to 427 ≠ 55	1964	658
7-7-59	11-D	427 ≠ 55 to 407 ≠ 37	2018	700
7-8-59	12-D	407 ≠ 37 to 388 ≠ 62	1875	650
7-9-59	13-D	388 ≠ 62 to 373 ≠ 08	1554	666
7-10-59	14-D	373 ≠ 08 to 354 ≠ 00	1908	750
7-13-59	15-D	354 ≠ 00 to 332 ≠ 90	2110	633
7-14-59	16-D	332 ≠ 90 to 312 ≠ 22	2068	691
7-15-59	17-D	312 ≠ 22 to 293 ≠ 65	1857	816
7-16-59	18-D	293 ≠ 65 to 277 ≠ 50	1615	666
7-17-59	19-D	62 ≠ 88 to 66 ≠ 90	402	650
7-21-59	20-D	58 ≠ 24 to 42 ≠ 40	1584	633
7-27-59	21-D	28 ≠ 80 to 478 ≠ 27	1259	608
7-30-59	22-D	478 ≠ 27 to 459 ≠ 09	1918	616
7-31-59	23-D	459 ≠ 09 to 438 ≠ 93	2016	716
8-1-59	24-D	438 ≠ 93 to 421 ≠ 32	1761	666
8-3-59	25-D	421 ≠ 32 to 393 ≠ 60	2772	700
8-4-59	26-D	393 ≠ 60 to 370 ≠ 40	2320	700
8-5-59	27-D	370 ≠ 40 to 349 ≠ 71	2069	700
8-6-59	28-D	349 ≠ 71 to 335 ≠ 58	1413	650
8-8-59	29-D	335 ≠ 58 to 313 ≠ 83	2175	616
8-13-59	30-D	6 ≠ 14 to 14 ≠ 28	814	591
8-14-59	31-D	16 ≠ 47 to 33 ≠ 46	1699	650
8-15-59	32-D	33 ≠ 46 to 52 ≠ 12	583	583
8-18-59	33-D	52 ≠ 12 to 33 ≠ 46	1816	616
8-19-59	34-D	70 ≠ 28 to 91 ≠ 45	2117	625
8-20-59	35-D	91 ≠ 45 to 107 ≠ 04	1559	600
8-21-59	36-D	107 ≠ 04 to 130 ≠ 04	2300	633
8-22-59	37-D	130 ≠ 18 to 144 ≠ 77	1459	650
8-24-59	38-D	144 ≠ 77 to 157 ≠ 85	1308	650
8-26-59	40-D	179 ≠ 60 to 204 ≠ 72	2512	633