OFFICE MEMORANDUM

MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

May 3, 1967

To: L. T. Oehler, Director
Research Laboratory Division

From: H. L. Patterson

Subject: Low Compressive Strength of Concrete Pavement Cores from the Eastbound I 75-Fisher Freeway (Sta. 1101+07 to 1101+70, Construction Project BI 82194H, C21, Part 1). Research Project 66 B-82. Research Report No. R-636.

At the request of J. C. Brehler, on November 29, 1966, Materials Engineer B. A. Ross of the Wayne County Road Commission submitted three special pavement cores from the subject project to the Research Laboratory for analysis. This was subsequent to Mr. Brehler's conversation with E. A. Finney concerning low compressive strengths obtained by Wayne County on certain cores from this project.

Special pavement cores were cut on November 22, 1966, from the south 24 ft of the 48-ft roadway of the Fisher Freeway between Sta. 1101+07 and 1101+70, poured June 24, 1966. The location where each core was cut is given in Table 1. Routine test cores from this area drilled August 17, 1966 and later, indicated that the concrete did not meet minimum strength requirements. The Research Laboratory was requested to analyze the cores for compressive strength, entrained air, and cement content. To serve as a basis for comparison, Mr. Ross sent concrete pavement mix proportions and samples of the cement, sand, and slag coarse aggregate. From these concrete materials samples, four laboratory test cylinders were poured according to the mix proportions used for the pavement.

On November 30, 1966, two of the three pavement cores were checked for air entrainment, and all three were tested in compression, pulverized, and sent to the Spectro-Chemistry Unit for a cement analysis. Two of the four laboratory test cylinders were moist cured 7 days, tested in compression, pulverized, and submitted for cement analysis. The remaining two were moist cured 28 days, checked for air entrainment, and tested in compression.

Test results (Table 1) showed that average compressive strength of the pavement cores was borderline or slightly above the minimum acceptable value of 3500 psi, that entrained air exceeded the maximum limit of 7 percent, and that cement content was in excess of 5.5 sacks of cement per cu yd of concrete. Actual figures received from the cement analysis showed average values of 6.9 sacks per cu yd for both pavement cores and laboratory cylinders. However, since composition of the laboratory cylinders was accurately controlled at 5.5 sacks per cu yd, it was concluded that the cores were also of this same cement content. Values obtained by chemical analysis for both cores and

cylinders were based on duplicate determinations on two different samplings of the thoroughly mixed powder from the ground concrete. The fact that the slag aggregate contained sulfide impurities that may alter to sulfate, possibly injected error into the system. Because of the slag aggregate, the calcium oxide or silica methods of ASTM C 85 could not be used, and an alternate sulfate method was developed for this purpose.

The laboratory cylinders, with the mix accurately controlled, also tested low in compression and slightly high in air, but both figures were within the allowable specification range (Table 1).

For further investigation of the nature of Fisher Freeway concrete, upon request Mr. Ross submitted test results for all the cores and test beams taken. Core data, summarized in Table 2, show substandard compression results for eight of the ten concrete pavement cores taken from the south 24 ft of the eastbound roadway between Sta. 1100+95 and 1101+55 (poured June 24, 1966). The ten cores averaged 3240 psi. All other pours in both the eastbound and westbound roadways had pavement core test results that were acceptable, so the weak concrete was confined to the June 24 morning pour.

All concrete test beams cast in the area exceeded minimum allowable values except those cast for the June 24 pour at Sta. 1100+45 on the eastbound roadway. The concrete exceeded the minimum allowable value for 7 days, but fell slightly short in the 28-day test, with values of 605 and 647 psi, respectively. Corresponding values of 649 and 668 psi were obtained from June 27 beams, and 675 and 751 psi from July 11 beams.

The only obvious factor about this concrete that might contribute to its low compressive strength is its excessively high air content as determined on Cores 735 and 736. However, an air check of 5.5 percent was obtained on the project June 24 indicating air may have varied during the day. Construction records indicated that June 24 air temperatures were quite high, reaching a maximum of 92 F. Concrete temperatures were reported as averaging 87 F. It is uncertain if these higher temperatures could have influenced concrete strength to any great extent.

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TABLE 1
SUMMARY OF TEST CORE* AND CYLINDER DATA

Sample No.	Core No.	Station	Core Height, in.	Longitudinal Steel Depth, in.	Dry Compressive Strength, psi[1]	Air Content, percent[2]
66 CR-79	734	1101+07	9.4	5.5	3650	--
66 CR-30	735	1101+40	9.6	5.0	3400	7.2
66 CR-31	736	1101+70	9.7	4.8	3700	9.3

Cylinder No.	Strength, psi Moist Compressive		Air Content, percent	
	7 Days	28 Days	Fresh Concrete (Roll-O-Meter)	Cured Concrete (Linear Traverse)
1	2940	--	7.0	--
2	2720	--	7.0	--
3	--	3610	7.0	7.3
4	--	3660	7.0	5.4

*Cores taken 8 ft right of eastbound roadway centerline.
(1)Corrected to L/D = 2.0.
(2)Linear Traverse Method on top 1/2 in.

TABLE 2
SUMMARY OF ALL PAVEMENT CORE DATA

	Core No.	Station	Location Relative to Centerline, ft	Pour Date	Compressive Strength, psi	
					Core	Average
Eastbound	670	1100+95	17 right	6-24-66 a.m.	3520	3240
	566	1101+05	17 right		2700	
	734*	1101+07	8 right		3650	
	445	1101+15	17 right		2830	
	353	1101+20	17 right		3390	
	446	1101+25	17 right		3440	
	567	1101+35	17 right		3260	
	735*	1101+40	8 right		3400	
	671	1101+45	17 right		3380	
	686	1101+55	17 right		2830	
	732	1101+65	17 right		3820	3860
	736*	1101+70	8 right		3700	
	733	1101+75	17 right		4010	
	448	1107+96	4 right	6-24-66 p.m.	3700	
	356	1108+01	4 right		3040	
	447	1108+06	4 right		4570	
	357	1113+65	15 right	6-27-66	4180	
	354	1102+02	6 left	7-11-66	4500	4190
	355	1108+08	20 left		4470	
	358	1113+80	3 left		3590	
Westbound	359	1102+20	10 left	6-27-66	4200	4270
	362	1108+18	5 left		4330	
	363	1112+52	18 left		3910	
	360	1102+25	14 right		4510	
	361	1107+96	22 right		4330	
	364	1112+60	4 right		4350	

*Special Cores tested in Research Laboratory and included in Table 1.