INVESTIGATION OF CONCRETE PAVEMENT CORES FROM THE NORTHBOUND I 75 FREEWAY

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

INVESTIGATION OF CONCRETE PAVEMENT CORES FROM THE NORTHBOUND I 75 FREEWAY

H. L. Patterson

Research Laboratory Section
Testing and Research Division
Research Project 67 B-85
Research Report No. R-657R

State of Michigan
Department of State Highways
Lansing, December 1967

OFFICE MEMORANDUM

MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

December 29, 1967

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

From: H. L. Patterson

Subject: Investigation of Concrete Pavement Cores from the Northbound I 75 Freeway (Sta. 1573+77 to 1574+48 and 1607+60 to 1607+95, Construction Project I 09035D, C009). Research Project 67 B-85. Research Report No. R-657R

On July 13, 1967, at the request of D. L. Wickham, six pavement cores were cut from the two subject areas for testing. This letter reports the laboratory findings for the concrete from these areas.

Due to equipment breakdown on June 5, 1967, difficulty was experienced in finishing the concrete surface between stations 1573+77 to 1574+48. The surface of the concrete was wetted and retempered for over one hour until finishing could be effected. Cores were taken and D. L. Wickham requested that the freeze-thaw resistance and the entrained air content of the top portion of the concrete be determined. The limits of paving on June 5 were from station 1573+77 to 1578+06 or 429 ft.

On June 13, 1967, while pouring between stations 1607+60 and 1607+95, the contractor ran out of concrete, causing a delay in the placement of the pavement's top course. (The concrete pavement was poured in two courses.) The membrane curing compound was not applied until the following afternoon. The limits of paving on this date were from 1595+18 to 1608+01. Fearing that the strength and integrity of the pavement might have been affected, it was requested that cores be taken to determine the compressive strength of the concrete and to note the depth of the reinforcing steel. As a basis for control, an additional core was taken from a section of pavement in an area which was unaffected by the problems described above. This area was poured June 14, and extended from stations 1608+01 to 1615+00 (POE), and the core was taken at station 1612+05.

Mr. Wickham asked that this control core be tested in freeze-thaw along with the cores from the vicinity of station 1574. After the cores from the vicinity of station 1608 tested low in compression, however, he decided to use the control core with the latter cores and test them in compression. When the control core tested lower than the others, he requested that a chemical determination of cement content be made. Later, on December 5, 1961, as requested by J. C. Brehler, two additional control cores (No's. 8 and 9) were drilled five feet on either side of the first control core to check the compressive strength.

See Table 1. We subsequently requested that samples of the cement, sand, and gravel used in this pavement, along with the mix proportions, be forwarded to the laboratory for use in casting six laboratory cylinders. Three of these cylinders were moist cured seven days and tested in compression. Two of the three were pulverized and sent to the Spectro-Chemistry Unit to serve as a basis of control for the cement determination. The other three were moist cured 28 days and then tested in compression.

All physical test data for the cores and laboratory control cylinders are shown in Table 1. The cores from the vicinity of station 1574 were slightly low in entrained air but satisfactorily survived the 200 freeze-thaw cycles. The only visible damage inflicted occurred to sample No. 67 CR-88 when a small portion of a two inch pebble broke bond from the mortar and dropped out. The pebble had been cut in two by the drill bit, and the smaller portion was in the core.

In the chemical determination of the cement content it was found that the gravel aggregate contained considerable soluble calcium oxide so that results based on this constituent were not reliable. The control core (67 CR-93) and laboratory control cylinders had the same amount of soluble calcium oxide. The silica results, however, showed that the core and cylinders had the same cement content. The calculated cement content by the silica method was:

67CR-93 Pavement Core	5.2 sacks/cyd
Laboratory Control Cylinder #1	5.3 sacks/cyd
Laboratory Control Cylinder #2	5.2 sacks/cyd

Since the cement content of the laboratory control cylinders was accurately controlled at 5.5 sacks per cyd, it can be concluded that the control core (67 CR-93) also had the correct cement content.

Visual inspection of all cores revealed several bridging air voids approximately 1/8 by 1/4 in. scattered uniformly along the cylindrical surface. These were probably left by inadequate consolidation and are partly responsible for the low compressive strength developed in the control core and those from the vicinity of station 1608. The late application (after 24 hours) of curing compound may also have caused some slight reduction in the compressive strength of the concrete poured June 13 since the air and concrete temperatures reached maximums of 96 and 84 F, respectively.

In conclusion we feel that despite the watering down and retempering, the concrete pavement in the vicinity of station 1574 appears to be quite resistant to freeze-thaw deterioration and should be relatively free from premature scaling.

The air contents of cores 1 - 3 agree quite closely with a field check of 4.3 percent obtained at station 1576+20.

From the concrete cores taken in the vicinity of station 1608 it was not apparent if a cold joint existed between the top and bottom courses of concrete; however, the compressive strength of the cores averaged 21 percent below the minimum allowable specification strength and this could have been due, in part, to excessive moisture evaporation from the unsealed surface during the morning hours of June 14, 1967, and to the previously mentioned consolidation deficiencies. After sufficient wet weather there is the possibility that this concrete will gain its design strength but this can only be determined by subsequent compression tests.

The additional control cores Nos. 8 and 9 (Table 1) both tested above 3500 psi which would indicate, allowing for age differences, that core No. 7 was probably cut through an isolated section of poorer concrete. The concrete pavement in general would have gained additional strength in the five months since the first cores were cut, but it is doubtful if the strength of core No. 7 would have increased any more than 10 - 15 percent had it been left in place. This is another example of the need for obtaining at least three control cores to more positively measure a particular test variable.

The 3700 psi compressive strengths of cores 8 and 9 are not as high as would normally be expected for 5-1/2 to 6 month old pavement concrete. However, in comparison, the 28 day laboratory control cylinders averaged only 3520 psi using the same materials and mix design of June 14. This lower strength may be the result of a combination of fairly high air contents as indicated by the 5.8 and 6.5 percent test values, and a grind of cement with lower strength gain characteristics. Only 1/2 to 1 ounce of Protex AE agent was used per sack of cement on June 5, but 1-3/4 to 2 ounces was used on June 13 and 1-1/2 ounces on June 14.

TESTING AND RESEARCH DIVISION

Harry L. Patterson

H. L. Patterson, Physical Research Engineer
Concrete and Surface Treatment Unit
Research Laboratory Division

HLP:sjt

TABLE 1

SUMMARY OF TEST CORE AND CYLINDER DATA

CORES

Sample No.	Core No.	Station	Lateral Distance from Center Line, ft	Core Height, in.	Depth to Long. Stl, in.	Compressive Strength psi.[1][2]	Air Content, percent[3]	200 Cycle Freeze-Thaw Performance[4]
67 CR-87	1	1573+81	5.8 Rt.	9.1	2.3	----	3.1	Excellent
67 CR-88	2	1574+11	2.1 Rt.	9.2	4.4	----	4.3	1 percent Wt. Loss[5]
67 CR-89	3	1574+42	5.9 Lt.	9.1	4.1	----	4.0	Excellent
67 CR-90	4	1607+67	8.2 Rt.	8.9	3.0	3050	----	----
67 CR-91	5	1607+78	3.4 Rt.	9.0	3.9	2560	----	----
67 CR-92 (Control)	6	1607+91	6.1 Lt.	9.1	4.5	2660	----	----
67 CR-93	7	1612+05	5.7 Rt.	9.1	4.1	2410	----	----
67 CR-147	8	1612+00	5.7 Rt.	9.0	3.8	3700	5.8	----
67 CR-148	9	1612+10	5.4 Rt.	8.9	3.5	3720	6.5	----

CYLINDERS

Number of Control Cylinders Tested	Acme Air Meter Fresh Concrete Air Measurement, percent	Slump, in.	Age of Concrete, days	Average[1] Compressive Strength, psi
3	5.0	1-3/4	7	2880
3	5.0	1-3/4	28	3520

[1] Cores tested in moist condition as per ASTM C 42-64 at an age of about one and one-half months. Core nos. 8 and 9 were about six months old.

[2] Corrected to L/D = 2.0.

[3] Linear traverse method on the top one-half inch.

[4] Freeze-thaw cycles conducted in accordance with ASTM C 291-61.

[5] Weight loss occurred when the portion of a large pebble 2 in. below the top surface broke bond and dropped out.