OFFICE MEMORANDUM

MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

December 1, 1971

To: L. T. Oehler

From: M. G. Brown

Subject: Study of Delayed Set in Bridge Deck Pour (S05 of 63103). Research Project 71 TI-57. Research Report No. R-796.

The following is a brief report on the subject bridge deck, poured on August 9, 1971. The pour in question was designated Pour E of the westbound deck carrying I 696 over I 75 north of Detroit. This study was initiated by D. L. Wickham's letter of August 19, 1971 to J. C. Brehler requesting the drilling of 10 cores.

The deck pour was placed by Jutton-Kelly using central-mixed concrete from Clawson Concrete's Hastings St. and Troy plants. A total of about 220 cu yd was placed from 9:30 a. m. to 6:00 p. m. using pumping equipment and a Gomaco transverse finishing machine. According to project personnel and records, only the first 30 cu yd of concrete came from Clawson's Hastings St. plant which was placed in the first 13 ft at the west end of the pour. The remaining 190 cu yd came from Clawson's Troy plant and was supposed to contain 5 oz of Daratard per sack of cement. Apparently this dosage was highly variable due to erratic dispensing equipment as evidenced in the later setting extremes.

The first 20 ft (45 cu yd) was reported to set up normally, but in the remaining 74.5 ft there were two large full-width areas, plus a smaller one, at the east end that were reported to have taken from 1 to 5 days to completely harden. The attached Figure 1 describes the approximate areas involved and the 4-in. core locations which were drilled on August 20, 1971.

The 11 cores taken on August 20 were kept in water until they were placed in the Research Laboratory moist room on August 23. The cores were examined on August 24 by H. B. LaFrance and D. L. Wickham of the Construction Division, R. L Morris of the FHWA, and M. G. Brown of the Research Laboratory. The full-depth cores appeared to all be in good, sound condition with some scattered 1/8 to 1/4-in. voids. It was decided to select 5 of the cores for air determination and 28-day compressive strength tests. The remaining 6 cores were run through 300 cycles of rapid freeze-thaw in air-water (ASTM C291) and then broken in compression. The results of these core examinations are shown in Table 1 and Figure 2. The strength and durability, in general, proved to be quite good. Core D was found to contain a vertical crack in the top 2 in. which resulted in the low compressive strength after freeze-thaw. The drop in sonic modulus for the freeze-thaw cores shown in Figure 2 appears to be normal for air-entrained concrete deck cores. A similar curve on 7 deck cores previously tested from another project has been included for comparison (from Research Project 71 TI-28, Research Report No. R-774). The 4-in. cores with a full-depth cut surface and exposed aggregate appear to be more vulnerable to the freeze-thaw test than 3 by 4 by 16-in. cast beams with formed faces. The sonic modulus on these standard freeze-thaw beams made from typical deck concrete would be expected to drop to about the 90 percent level in 300 cycles.

The subject deck pour was inspected by D. L. Wickham and M. G. Brown on September 21. The concrete surface appeared to be in good condition except for footprints in the vicinity of Core F toward the south curb line. Also, there was an isolated area at the north curb line where a mortar crust of about 1/2 in. had loosened and was removed, exposing an area about 4 by 24 in. Both of these defects were in the general area that was reported to have taken 5 days to harden (Fig. 1). The strength and durability of the concrete in this particular area would appear to be good, however, as evidenced by the results on cores F, G, and H. Only a very few shrinkage cracks could be found in this area and they appeared to be mostly near the south curb line.

To summarize, the strength and durability of the delayed set concrete would appear to be good. The two isolated areas containing footprints in the east half of the pour will require some grinding to lower the bulged spots between the footprints, down to the original grade. The footprints themselves can be lightly chipped out or sandblasted, primed, and filled with epoxy mortar as described under Sections 4.14.18 and 8.16.06 of the Standard Specifications. The small isolated area of loose mortar crust at the north curb will require some chipping out and sandblasting to repair, using the same methods as the footprints. It is suggested that the few small shrinkage cracks be located by brooming off the pour area and lightly wetting-down with water. The cracks can then be marked for sealing. After the concrete surface has thoroughly dried, the crack areas may be sealed by brushing in a premixed 8.16.06 epoxy binder diluted about 3:1 by volume with toluene. This mixture will have a low viscosity for good crack sealing properties. It is also suggested that the diluted epoxy be applied in mid-afternoon when the concrete has reached a maximum temperature and has started to cool down, to promote better absorption of the sealer. A second sealer application directly over visible cracks would be advisable and this could follow the first application by 1/2 to 1 hour. We understand this structure will not be finished or open to traffic for another year, so the suggested repairs could possibly be done during warmer weather next spring. The repairs must be done before any linseed oil treatment, however.

TESTING AND RESEARCH DIVISION

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TABLE 1

CORE INSPECTION AND TEST DATA

Laboratory No.	Core No.	Core Length, in.	Steel Depth, in.	Air[1] Content, percent	Compressive Strength, psi[2]		Visual Description of Pre-Tested Core
					No Freeze-Thaw Testing[3]	After 300 cycles Freeze-Thaw Testing[4]	
71CC-92	A	9.2	---	---	---	3510	A few 1/8 by 1/4, and 1/4 by 1/2-in. bridging air voids (BAV) in the top 1/3 of the core. A few 1/4-in. trapped air voids (TAV) scattered throughout remainder of core.
71CC-93	B	8.4	No. 6@7	6.9	3130	---	A few 1/4 by 1/2-in. BAV and several 1/8 to 1/4-in. TAV scattered over full depth of core.
71CC-94	C	8.7	---	9.8	4650	---	Same as 71CC-93
71CC-95	D	9.1	---	---	---	2200	Surface appearance of core same as 71CC-92. Subsurface fissures discovered under air slice.
71CC-96	E	9.1	---	---	---	3130	Same as 71CC-93 but with more 1/4 by 1/2-in. BAV.
71CC-97	F	8.9	---	---	---	4890	Same as 71CC-93
71CC-98	G	8.9	No. 4@3	8.8	5050	---	Same as 71CC-93
71CC-99	H	9.0	---	---	---	5250	Same as 71CC-93
71CC-100	I	9.2	---	---	---	4770	Same as 71CC-93
71CC-101	J	8.9	No. 3@3.5 No. 6@7.2	8.1	4840	---	Same as 71CC-93
71CC-102	K	8.4	---	---	5300	---	Same as 71CC-93

1 Linear traverse method on top 1/2 in., ASTM C457-67T.

2 Cores tested in moist condition as per ASTM C42-68.

3 Tested 9-7-71 after 18 days of moist curing (29 day total).

4 Tested 11-4-71 after 300 cycles of freeze-thaw.

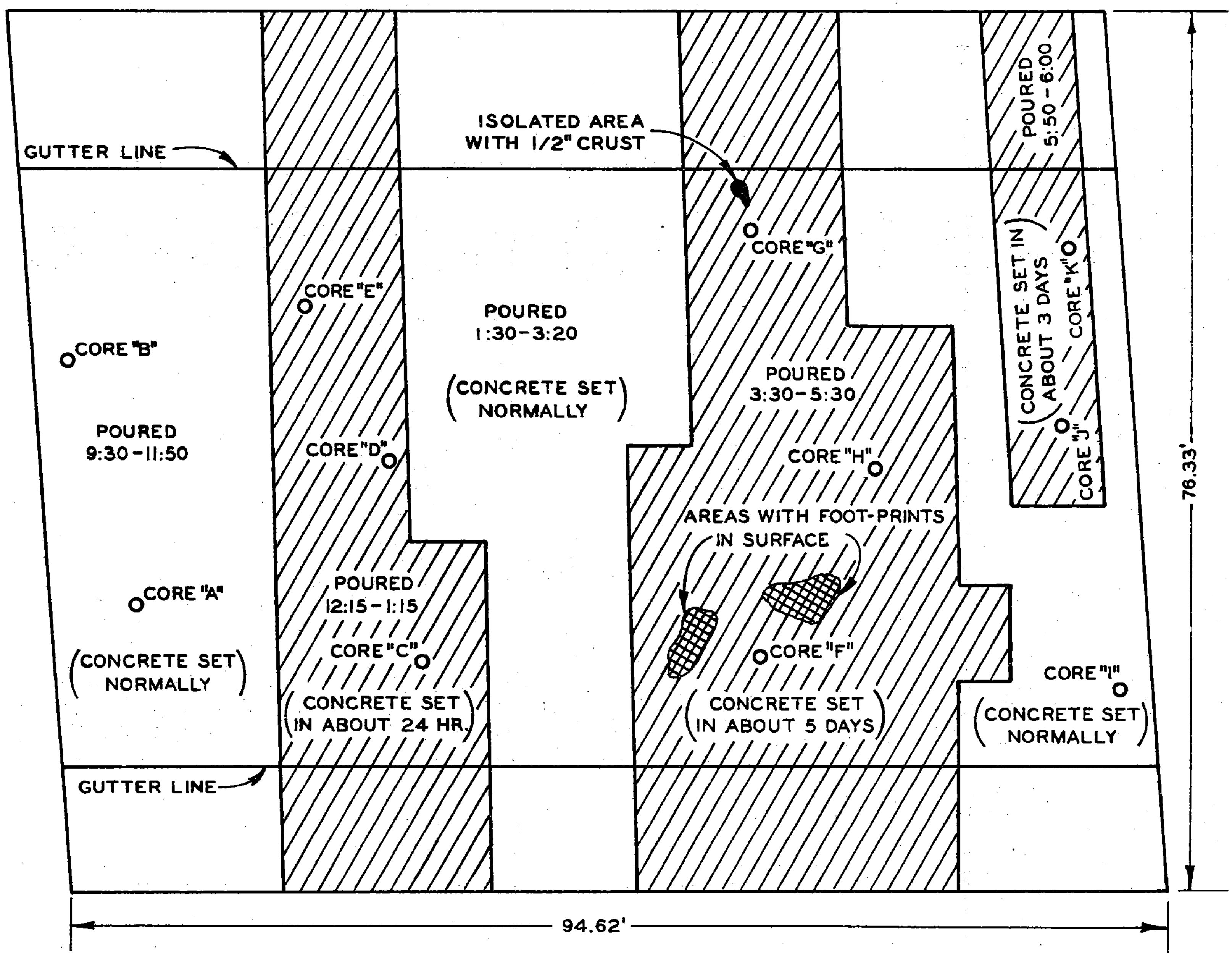

Figure 1. Pour diagram and test core location, S05 of 63103, westbound pour E (8-9-71).

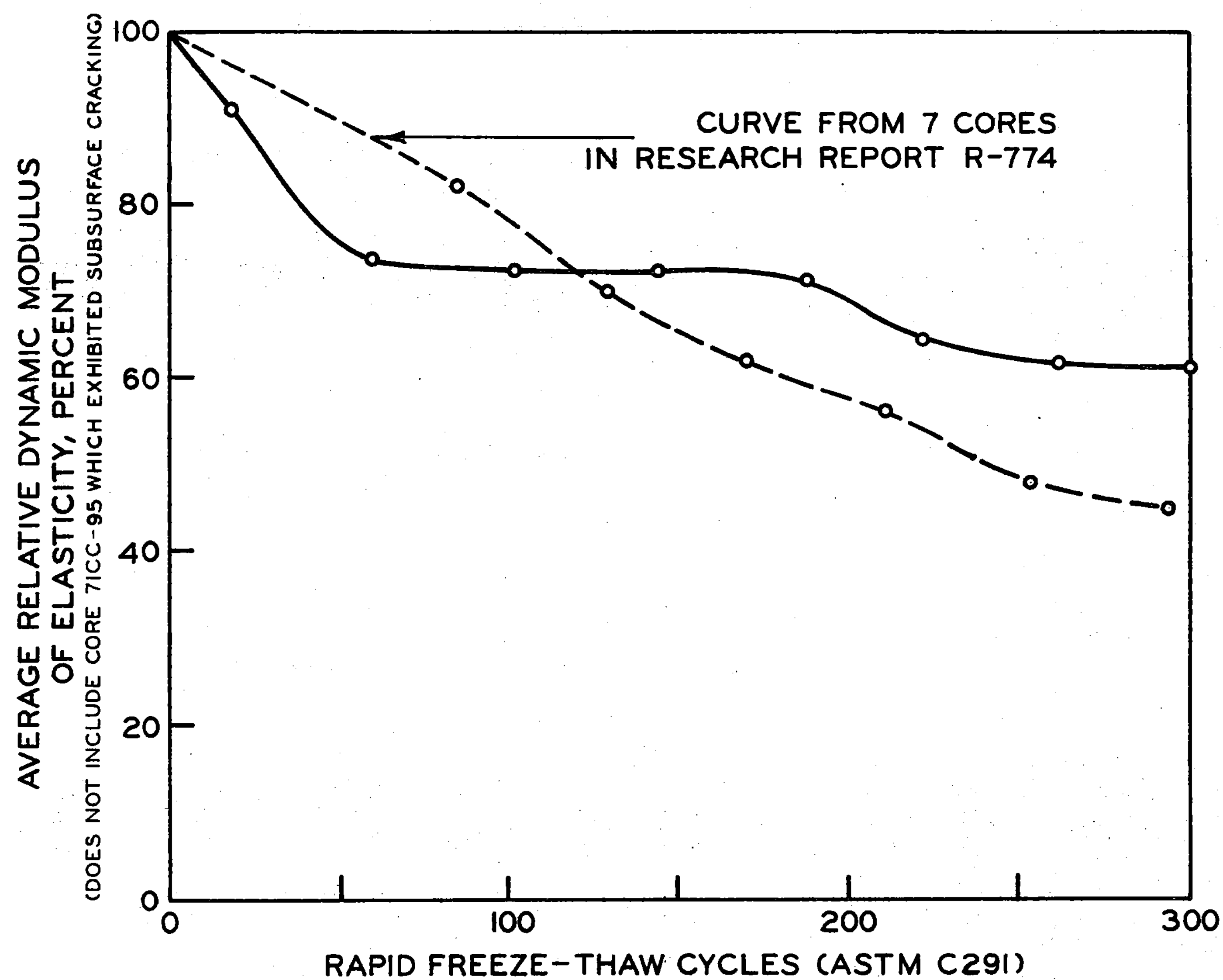

Figure 2. Drop in sonic modulus for five test cores under freeze-thaw in air-water.