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EXPERIMENTAL INSTALLATION OF HYDRON FORM LINING ON BRIDGE WEST OF OVID - B2 of 19-12-4, C2

By

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EXPERIMENTAL INSTALLATION OF HYDRON FORM LINING ON BRIDGE WEST OF OVID

In response to a request from the Bridge Division, Hydron absorptive form lining was tested in the Research Laboratory of the Testing and Research Division to determine the effects of its use on the surface texture and hardness of formed concrete. The results of these tests were given in Report No. 127, dated April 1, 1949, and they were sufficiently encouraging to warrant a recommendation for a full-scale field trial in order to determine the practicability and efficiency of the material in actual construction.

As a result of this recommendation, proposals were issued for the construction of bridge project B2 of 19-12-4, C2 on M-21 west of Ovid, stipulating the use of Hydron Form lining on the abutments and wingwalls, and construction of the bridge was started in the latter part of July, 1949. Specifically, it was desired to accomplish three things: 1) to learn whether rubbing of formed concrete surfaces could be dispensed with by the use of absorptive liner; 2) to determine whether the durability of concrete cast against the liner would be materially increased; and 3) to observe practical details of the use of the liner, such as preparation and removal of forms, placing the concrete, and type of concrete mix best suited for the purpose.

This report contains a description of the progress of the work and the results obtained. It was found that rubbing could not be dispensed with entirely, although the hydron lining definitely improved the texture of the formed surfaces. Surface voids were materially reduced -- practically eliminated in the later pours -- but light rubbing of exposed

surfaces of the entire structure was required to smooth out pointed form tie holes, and slight markings from joints and stapling of the liner. The effect of the liner on durability can be determined only by future performance of the structure in service. A few operational difficulties were encountered during construction, but these presented no serious obstacles to the use of the liner.

Installing the Liner

Hydron absorptive form lining is produced by the United States Rubber Company and is furnished in sheets 4 ft. wide and 4, 5, or 6 ft. long. The contractor had no difficulty in cutting and installing the liner according to the plans. Interior staples were placed about 6 in. apart and edge staples about 2 in. apart in compliance with the manufacturer's instructions. Prepared forms were protected by water-proof tarpaulins at night to prevent possible damage by rain or dew. The liner was installed on the face forms before placing reinforcing steel or setting up back forms in order to facilitate the work of stapling and cutting. Figures 1 and 2 show the first sections of forms in place with the liner installed, and a close-up of the stapled liner.

Concrete Proportioning and Casting

Air-entraining concrete was required and mix data are shown in Tables 1 and 2. Flexural strengths are given in Table 3. The first wall pour was made on August 17, 1949 in the north section of the east abutment (Pour D, Abutment A). Placing was done by crane and bucket and the concrete consolidated with a mechanical vibrator and some hand puddling.

TABLE 1

CONCRETE PROPORTIONING

Type of Concrete	-	Grade A, Non-vibrated
b/b_o	-	0.70
Cement	-	Aetna Air-entraining, Sp. Gr. 3.13
Fine Aggregate	-	J. Post and Son, Durand Sp. Gr. 2.65 Abs. 1.01%
Coarse Aggregate	-	J. Post and Son, Durand Sp. Gr. 2.66 Abs. 1.45%

MIX DATA

Quantities per Sack of Cement

Wt. of C.A. (Bone Dry) p.cf.	5.5 sacks cement per cu.yd. R.W.D. 1.20, Dry Consistency			5.9 sacks cement per cu.yd. R.W.C. 1.25 Medium Consistency		
	C.A. (Dry) lb.	F.A.(Dry) lb.	Water lb.	C.A. (Dry) lb.	F.A.(Dry) lb.	Water lb.
101	347.0	236.0	50.3	323.0	205.0	50.3
104	357.5	227.0	50.0	333.0	196.0	50.0
	Grade A, Vibrated					
	R.W.C. 1.15, Dry Consistency			R.W.C. 1.20, Medium Consistency		
101	366.5	224.5	47.9	342.0	193.5	47.9
104	377.0	214.5	47.6	352.0	184.5	47.6

TABLE 2

CONCRETE MIXING AND POURING DATA

Report	Date	Pour	Quant. cyd.	Chart No*	Consistency	Unit wt. C.A. lb.	Batch size, sacks	F.A. lb.	C.A. lb.	Water, gal. Comp.	Water, gal. Used	Slump in.	Air, percent
1	7-28-49	Subft. A	15.8	280	Med.	104	2	404	693	7.3	7.5	1½	
2	8- 2-49	Ftg. A	54.8	280	Med.	104	2	404	693	7.3	7.5	3	3.8
3	8-10-49	Subft. B	15.8	280	Med.	104	2	404	693	7.3	7.5	3	
4	8-12-49	Ftg. B	54.8	280	Dry	104	3	708	1105	10.9	11.5	2	
5	8-17-49	D of A	20.3	281	Dry	104	3	660	1143	10.0	11.5	3	
6	8-22-49	F of A	21.2	281	Dry	101	3	693	1103	14.4	14.4	5	
						101	3	702	1111	13.6	14.0	3	
7	8-24-49	D of A	20.3	280	Dry	101	3	736	1052	13.5	14.0	3½	
					Med.	101	3	639	980	14.0	14.0	6-7	4.4
8	8-30-49	D of B	20.3	280	Dry	101	3	730	1053	14.0	----	--	
					Med.	101	3	640	988	12.7	11.5	5	
9	9- 6-49	F of B	21.2	280	M-D	101	3	690	1029	11.6	11.2	4½-6	4.5
10	9- 9-49	- - -	20.3	280	M-D	101	3	690	1029	11.6	11.7	4½-6	
11	10-13-49	N ½ Deck	----	281	Med.	101	3	610	1061	9.6	10.2	3-4	
12	10-14-49	S ½ Deck	31	281	Med.	101	3	610	1061	9.6	10.0	3½	
13	10-18-49	Side	8	281	Med.	101	3	601	1052	11.4	11.5	3-5	
14	10-24-49	Butt	2.6	281	Dry	101	3	692	1121	12.6	13.0	3	
15	10-26-49	Butt	2.6	281	Dry	101	3	692	1121	12.6	13.0	3	
16	10-28-49	Pave.	19.75	281	Dry	101	3	703	1117	11.8	11.7	2½	
17	11- 5-49	Curb	7.4	281	Dry	101	3	692	1121	12.6	12.7	2½	

*Chart No. 280 - Non-vibrated
Chart No. 281 - Vibrated

TABLE 3

MODULUS OF RUPTURE

Series	Date Cast	Flexural Strength, psi	
		7 days	28 days
1	8-2-49	650	825
2	8-30-49	592	758
3	9- 6-49	567	791

Considerable trouble was experienced at first in securing a mix of the right proportions and consistency to produce the best surface. A dry, vibrated mix of 3-in. slump was used for the first wall pour, but was too dry and harsh, due in part to an error in the determination of the unit weight of dry, loose coarse aggregate. Consolidation was difficult and honeycombed surfaces were found on both the Hydron and plywood-lined concrete (Figure 3), although surface voids were practically eliminated on the Hydron-lined surface where the concrete was properly consolidated (Figure 4).

A series of modifications of the mix were made on subsequent pours as shown in Table 2. The mix finally adopted was a Grade A medium or medium dry consistency with a slump of from 4-1/2 to 6 in. The remaining pours were somewhat better in surface texture but still were not up to expectations. Photographs at various stages of construction are shown in Figures 5 through 10.

Stripping Forms from Concrete

According to the Hydron literature, the lining was supposed to stick to the concrete when the forms were removed and pull all staples from the wood backing. In the laboratory this was true but on the first two pours of the east abutment the liner pulled off with the forms and had to be plucked loose from them which required considerable time and labor. On the third and remaining pours the liner stuck to the concrete as designed, indicating that the difference was due to the consistency of the concrete. With the wetter mixes the liner was more easily stripped, but the forms

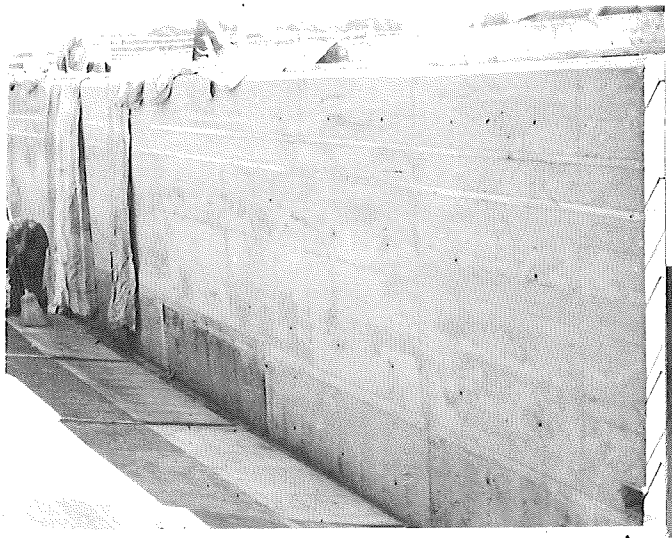


FIGURE 5. SECOND POUR, EAST ABUTMENT.
MIX ADJUSTED TO NEW WEIGHT OF COARSE AGGREGATE.
SURFACE BETTER, BUT STILL UNSATISFACTORY.

FIGURE 6. CLOSEUP OF WALL IN FOREGROUND OF FIGURE 5 SHOWING HORIZONTAL POUR LINE.

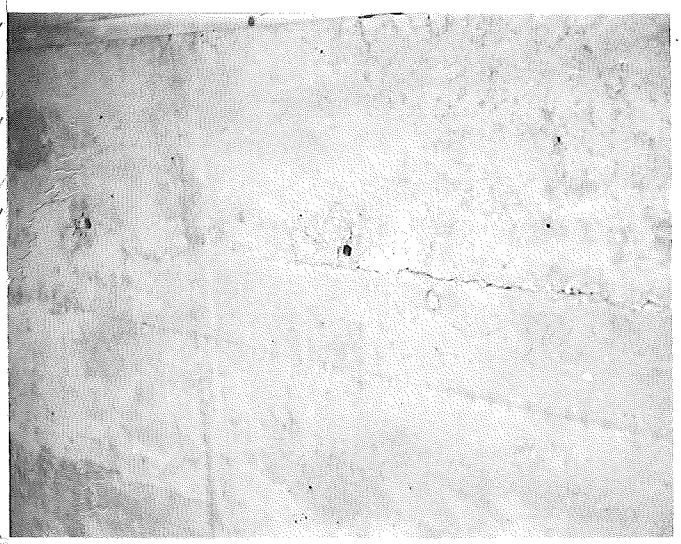
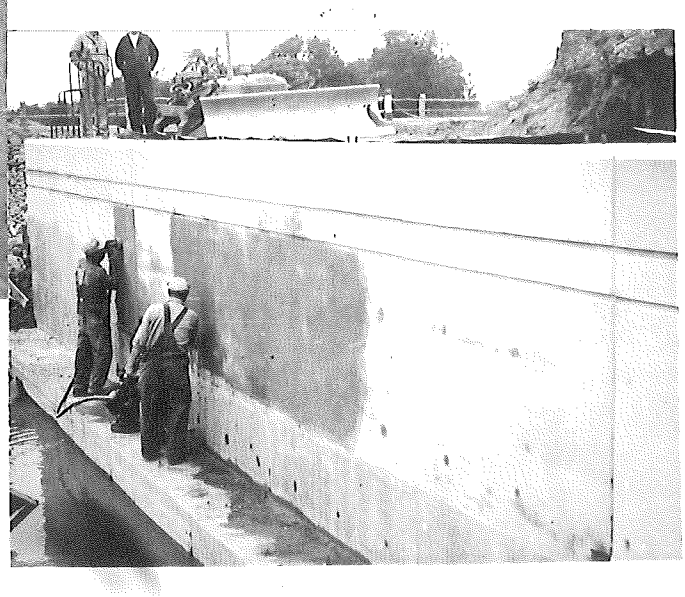


FIGURE 7. SURFACE OF THIRD POUR, BOTTOM 4 FT., DRY CONSISTENCY, SLUMP 3-1/2 IN., TOP, MEDIUM CONSISTENCY WITH SLUMP OF ABOUT 6 TO 7 IN. SAND STREAKING AT FORM TIES AND LINER JOINTS.

FIGURE 8. RUBBING EAST ABUTMENT.



were more difficult to pull away from the concrete. Photographs of the liner in place and during removal are shown in Figures 11 and 12.

As the liner was pulled away from the concrete it was evident that considerable moisture had been retained in the material. If the liner did not have to be removed for rubbing purposes, benefits would be derived from this additional curing.

Benefits to the contractor also are provided through protection of the plywood forms. This was shown in the laboratory tests and discussed in the laboratory report.

As may be seen from the photographs, the liner may be used only once.

Concluding Remarks

Rubbing of the Hydron-formed surfaces cannot be eliminated entirely because of the necessity of pointing up tie rod holes and removing joint and staple marks left by the liner. There are also a certain amount of surface voids that must be filled and rubbed to meet present Department standards. This bridge had to be rubbed in the usual way as shown in Figure 8, although the work was made easier by the use of the liner.

From comments by the workmen during rubbing, the surface of the Hydron-formed concrete apparently was extremely hard. The economic value of Hydron will depend entirely on the comparative durability shown by this structure in service. The texture of surface produced does not in itself justify the added cost.

Acknowledgement

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