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FIELD EVALUATION OF CONCRETE CURING MATERIALS

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This field investigation was initiated to compare several new sheet concrete curing materials with the present Michigan State Highway Department approved methods of sprayed white membrane and reinforced curing paper. On June 3, 1958, a meeting was held in the office of H. J. Rathfoot, then Road Construction Engineer, at which a new white-polyethylene-coated burlap curing material was introduced and discussed. It was decided to obtain comparative field temperatures within a regular concrete pavement during the first 72 hr of curing. Four other concrete curing materials, two of which were experimental, were included in this study. Handling characteristics of the white-polyethylene-coated burlap also were to be evaluated.

The project picked was BI 34044, C7RN, on M 66 just south of an interchange with the new US 16 in Ionia County, where pouring began August 13. The northbound portion of the dual 24-ft pavement was chosen as the area for the test sections.

The following materials made up the curing cover for the pavement section where concrete temperatures were measured:

1. White pigmented membrane, the curing method used on the balance of the construction project, applied at the rate of 200 sqft per gal;

2. White polyethylene coated paper;
3. Buff-colored reinforced curing paper;
4. White reinforced curing paper;
5. White opaque polyethylene film, 4-mil thickness;
6. White polyethylene coated burlap, 11 oz per sq yd.

APPLICATION OF MATERIALS

The layout of the experimental curing area is shown in Figure 1. Pouring began at Station 376+00 on the northbound 24-ft pavement at about 9:00 a.m. on August 13. The north end of the test area, near Station 378+00 was not finished until 10:30 a.m. The burlap-polyethylene mats, each 13-1/3 by 28 ft, were placed white polyethylene face up, across the width of the pavement, beginning at Station 376+00 about 11:30 a.m. These mats were used to a point just north of Station 377+00, with the mats overlapping about 1 ft. Beyond the mats, about 15 ft of each of the other four sheet materials was placed across the pavement with all overlaps and edges weighted down with dirt. The application of the white membrane began just south of Station 378+00 and continued for the remainder of the project.

Prior to application of the curing materials, copper-constantan thermocouples were placed at the midpoint of each 15-ft test section and 2 ft in from the east edge of the pavement. Two thermocouples were placed in each section, one at the surface and the other at the bottom of the 9-in.-thick pavement. The leads were run into an automatic temperature recorder for periodic measurement throughout the first 72 hr of curing.

DISCUSSION OF RESULTS

Recorded temperatures are shown in Figure 2. The temperature extremes in each test section for the three 24-hr periods from the time of application of curing material are listed in Table 1. The figures enumerating top-to-bottom temperature differences probably best illustrate the comparative uniformity of temperature control for each curing medium. These figures represent the extreme temperature differences between top and bottom slab surfaces for both day and night and denote the extremes in tensile stress at these surfaces associated with these differences. In comparing temperatures attained under the various materials, it should be kept in mind that small differences in depth of embedment of both the top and bottom thermocouples could affect recorded temperatures appreciably. Under conditions of field installation, variations of 1 or 2 deg, at both top and bottom, may occur from this cause.

It may be seen that during the first 24 hr, the burlap-polyethylene mats and the white polyethylene film had the lowest daytime differentials, and the buff and white papers the highest. The white paper furnished for this test had a low reflectance of only 43 percent, which accounts for its relatively poor showing. The nighttime differentials were quite similar for four of the curing materials, with the highest occurring in the white membrane and white polyethylene sections. Of the six curing media compared, the white-polyethylene-coated burlap maintained the most uniform temperature conditions for the whole 72-hr test period.

The burlap-polyethylene mats were also tried on the concrete bridge deck of a three-span T-beam structure in Calhoun County, Project B1 of 13-2-22, C1. Deck pours of June 12 and 13, July 16 and 17 and August 18 and 19, were covered with the mats for five days. The material performed very well in regard to handling and moisture retention, although no curing temperatures were taken.

The only disadvantage of the white-polyethylene-coated burlap mats placed on the M 66 pavement project was their size. Being only 13-1/3 ft wide and 28 ft long, they had to be placed transversely and required a good deal of labor in placing dirt on all the overlaps. They would be much simpler to use if they were full pavement width plus enough to fold down over the edges, in this case 26 ft, and covered more than 13 lineal ft of pavement. The moisture retention of the burlap-polyethylene material was excellent, as was true of the other sheet curing materials when cured concrete was uncovered and examined after seven days.

SUMMARY AND CONCLUSION

The tests reported here indicate that the five other methods were equal to or better than white membrane from the standpoint of maximum temperature differences generated in the slab. Also, except for the two curing papers, both of which had low reflectance, the various curing materials were approximately equivalent in regulating maximum surface temperatures. All six materials met Departmental requirements for water retention.

The tests show that all six materials are satisfactory curing media, and, with the exception of buff paper, may be permitted as alternates in standard specifications. While buff paper performed fairly well, a white paper with a minimum reflectance of 50 percent would be appreciably better in preventing heat pickup. Polyethylene-coated burlap performed somewhat better than the other materials, from a temperature standpoint, but the difference was not great. Any disadvantages of this latter material with regard to handling and storage are primarily the contractor's concern and probably are no more serious than those of curing paper.

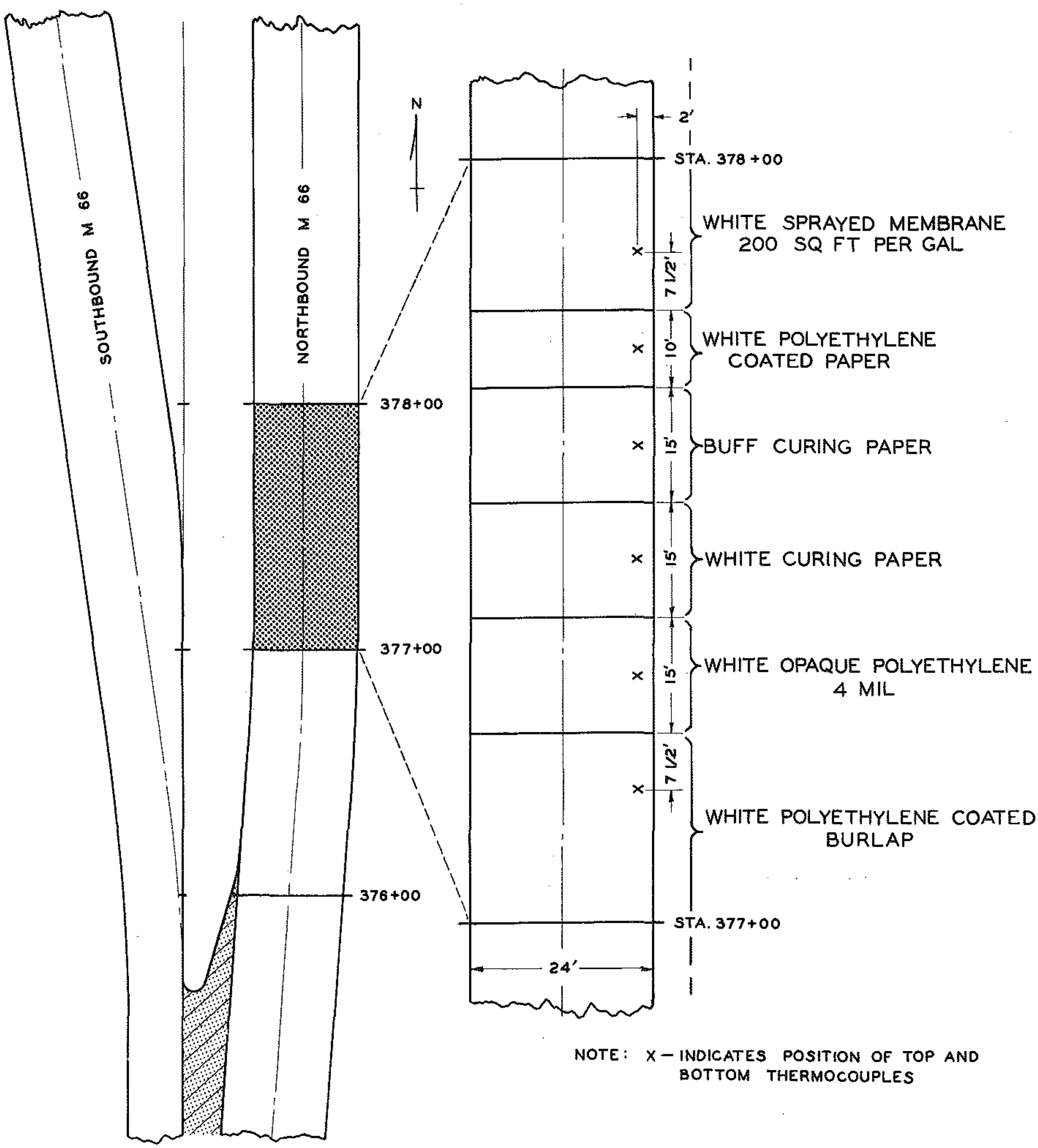

Figure 1. Curing Test Area: Project BI 34044, C7RN
M 66 south of US 16.

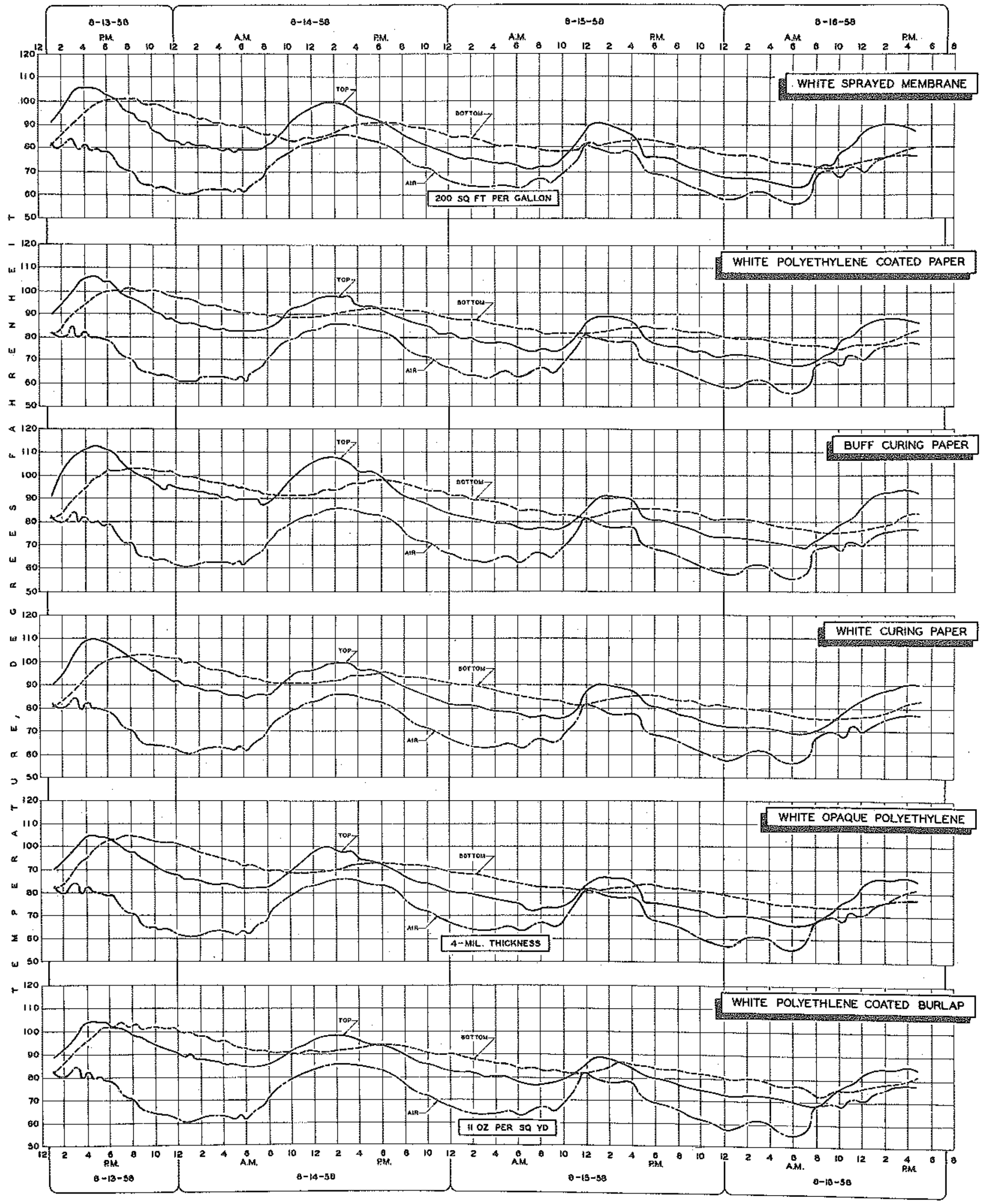

Figure 2. Effect of curing method on pavement temperatures.

TABLE 1

CONCRETE TEMPERATURES DURING FIRST 72 HOURS OF CURING
(DEGREES FAHRENHEIT)
BI 34044, C7RN - M 66 SOUTH OF US 16

Curing Material	Top Surface		Bottom Surface		Maximum Difference, Top-to-Bottom	
	Max.	Min.	Max.	Min.	Day	Night
White Sprayed Membrane	106	79	102	84	12	-14
(200 sq ft/gal)	100	71	92	79	14	-10
	91	64	84	72	10	-10
White Polyethylene	106	83	101	89	12	-11
Coated Paper	98	74	93	82	8	-10
	89	68	85	75	7	-9
Buff Curing	113	88	104	92	18	-8
Paper	108	77	99	82	14	-9
	92	69	86	76	8	-8
White Curing	110	85	103	91	16	-10
Paper	100	76	96	82	8	-9
	91	69	86	75	8	-8
White Opaque	105	82	104	89	10	-14
Polyethylene	100	72	93	80	10	-11
(4 mil)	86	66	84	74	5	-10
White Polyethylene	104	85	103	90	8	-11
Coated Burlap	98	77	94	82	7	-7
(11 oz/sq yd)	89	69	85	75	6	-7

The three lines of figures shown for each material are the pavement temperatures for the three 24-hr periods in the 72-hr test. High and low air temperatures for the three days were 84-61, 86-63, 82-56 deg.