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MICHIGAN
STATE HIGHWAY DEPARTMENT
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MICHIGAN'S EXPERIMENT IN SNOW AND ICE REMOVAL ON HIGHWAYS BY RADIANT HEAT

Winter Season 1951-1952
Performance and Cost

Cooperative Research Project between the Michigan State Highway Department and Detroit Public Lighting Commission

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MICHIGAN'S EXPERIMENT IN SNOW AND ICE REMOVAL BY RADIANT HEAT

Performance and Cost Data for Season 1951 - 1952

This is the fifth progress report on the Michigan experiment in snow and ice removal from highways by radiant heat. It is the purpose of this report to present performance and cost information for the winter season of 1951 - 1952. Like the two preceding seasons, the season of 1951 - 1952 was representative of a normal winter in the Detroit area. Temperature records show that the average air temperature under operating conditions for 1951 - 1952 was slightly higher than that for 1950 - 1951 and slightly lower than that for 1949 -1950. This is reflected in an energy consumption that is lower than that of 1950 - 1951 and higher than that of 1949 - 1950.

General Performance

The heating system was put into operation on December 17, 1951 and the last operation period ended March 27, 1952. Total operating hours for the 1951 - 1952 season were 719.77 as compared to 926.35 for 1950 - 1951, 548.70 for 1949 - 1950, and 506.59 for 1948 - 1949. The average air temperature during operation periods for 1951 - 1952 was 28°F. as compared to 25°F, 28°F, and 31°F., respectively, for the previous seasons. The total snowfall for the 1951 - 1952 season was only slightly higher than that for each of the two previous seasons. The operating cost of the system per hour was $1.84 for 1951 - 1952, as compared to $2.02, $1.89, and $1.31, respectively, for the other seasons.

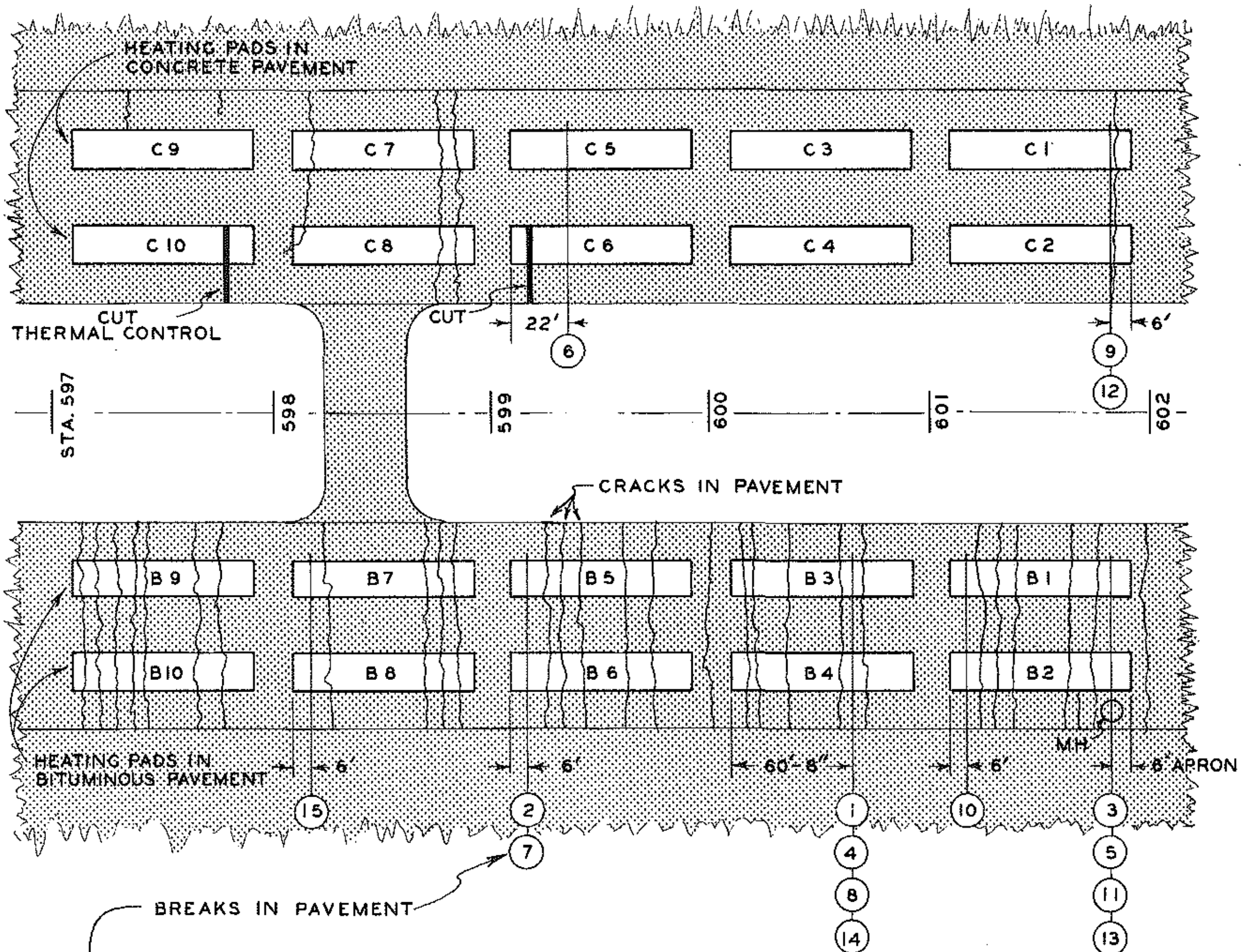
Complete operative cost data for the 1951 - 1952 winter season, furnished by the Detroit Public Lighting Commission, will be found in Table I; Table II contains comparative operative data, by months, for the last four winter seasons; while Table III summarizes additional operative information for these seasons. Wherever service was temporarily interrupted due to breaks in heating elements, energy consumption values in Table F have been corrected to include energy which normally would have been used if heating elements were in continuous service for a particular storm period.

This year, ten breaks occurred in the heating elements, 3 in the concrete section and 7 in the bituminous section. This is the first time that breaks have occured in heating elements located in the concrete pavement. In the asphalt pavement, there were only 2 new breaks, designated Numbers 10 and 15 in Figure I; the other 5 breaks were at the same locations where breaks occurred last year. Figure I also shows the location of all breaks occurring to date.

Several of this years's breaks occurred near the terminal strips of the heating element. When originally installed, these terminal strips were brazed to the heating elements. Because it would require a major repair job that involved tearing out a large section of pavement to replace these terminal strips, Mr. Handleman of the Detroit Public Lighting commission designed a new type of terminal strip, shown in Figure 2, which can be readily installed and which requires less heat because only solder is required and, in addition, its smaller size does not require a major repair job on the pavement.

The method used to locate breaks in the heating element is of interest. Since breaks in the heating grids only occur at breaks in the pavement, testing is simplified. Each branch circuit is tested with a hook-onommeter. Any wire not carrying current obviously has a break in the circuit. One side of a voltmeter is then grounded and the other connected with a probe. The power is turned on and the pavement breaks are probed to see how far the circuit is complete. Sometimes water has to be poured in the cracks in order to get the probe to operate properly. Probing is started at the "hot" side of the branch circuit and proceeds toward the grounded side. A voltage drop at a pavement break indicates that the grid is broken at that point.

Open grids are repaired by cutting away a section of pavement approximately three inches wide across the open grid. A new segment of grid is bent and cut to fit in the trench over the open grid. The purpose of the bending is to allow for further expension of the pavement crack. With the aid of a small acetylene torch,



	'50—'51					'51—'52									
BREAK NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DATE	11-24	12-26	1-14	1-21	1-27	12-3	12-4	12-4	12-5	12-10	12-13	12-18	1-16	1-16	1-30

FIGURE 1

EIGHT MILE ROAD EXPERIMENTAL PAVEMENT HEATING FOR SNOW AND ICE REMOVAL
LOCATION OF BREAKS IN HEATING ELEMENTS

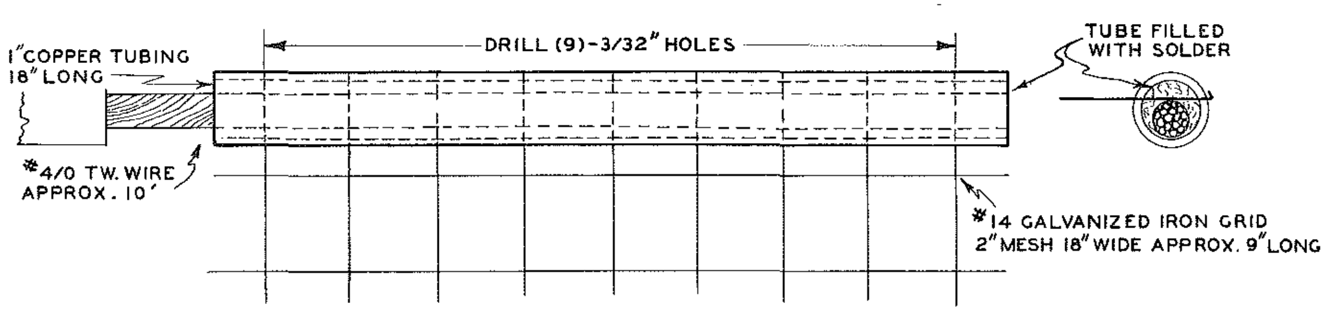


FIGURE 2

TERMINAL BAR FOR HEATING ELEMENTS

The segment is brazed across the open grid. To compensate for the removal of the insulation and to make the joint waterproof, a hot compound is poured over the grid, then the hole is filled with a mixture of gravel and compound.

With reference to Table III, it may be noted that for the first time, the energy consumption for the asphalt section was less than that for the concrete section to the amount of about 12 percent. No explanation can be offered at this time as to why this reversal of power consumption took place during the 1951 - 1952 season.

There follows a brief account of the performance of the system during some major storms of the past season. Operating conditions throughout other storm periods were normal.

December 17 to December 24, 1951

One of the heaviest snowfalls since the beginning of the experiment occured during this period. A total of 11.6 inches of snow fell and the average temperature at the site was 17°F. The storm started on the evening of December 17th and the heated areas were observed the following morning after 5 to 6 inches of snow had fallen. The temperature at 8:00 A.M. December 18th was 22°F. The road had not yet been bladed or salted. Snow on the road was so deep that traffic concentrated on the center portion of the 3-lane surfaces. Only half of the heated lanes were being traveled. The untraveled inside tracks of both the concrete and bituminous sections were clear and had apparently handled all the snow falling on them. The outside tracks of both showed only partial melting due to the quantity of loose snow which was continually being pushed on them by traffic from the center lanes. See Figures 3 and 4.

On December 20th, the heated areas were observed at 10:00 A.M. during a moderate snowfall which began at 6:30 A.M. The temperature was 30°F. The 8-Mile Road in general was covered with 2 inches of loose snow and slush. The less traveled inside tracks on both the concrete and bituminous sections were almost clear except for some splashed slush. The outer tracks of both were being continually covered by loose snow and slush shoved or thrown over by traffic from the unmelted areas. Ice ridges were forming at the edges and ends, especially on the inside track of the concrete section. This has been a common experience throughout the operation of this project, due to the fact that melted water cannot drain off. See Figures 5 and 6.

February 6 to February 7, 1952

A total of 1.4 inches of snow fell during this period, and the average temperature at the site was 26°F. The heating elements melted all snow that fell on the heated lanes.

February 19 to February 22, 1952

Snow began falling at 9:00 P.M. on February 19th and by the following morning the fall totaled 1 inch. The snowfall for the entire period totaled 2.5 inches and the average temperature was 28°F. At 8:00 A.M. on the 20th, the snow was turning to rain and sleet. The heated areas were obviously melting all snow and sleet falling on them plus most of the slush being thrown on them by traffic. The bituminous lanes were not as clear as the concrete - probably because of the heavier eastward moving traffic. Thin ice ridges had built up along the sides and ends of the heated areas, forming a neat outline of the grids. The ice ridges on the concrete were somewhat thicker. Also, on the concrete, the ice ridges were much more pronounced on the high side of the crown - phenomenon which must have been caused by the traffic pattern. See Figures 7 and 8.

Concluding Remarks

The one operational irregularity to appear during the 1951 - 1952 heating season was the complete reversal of energy consumption for the two types of surfaces. The energy consumption for the bituminous section was lower than that of the concrete section by about 12 percent, whereas in the previous seasons, the energy consumption for the bituminous section was always above that of the concrete. This matter is being given special study by the Detroit Public Lighting Commission.

TABLE I

SUMMARY OF OPERATING DATA AND COSTS FOR SEASON 1951-52

DATA FURNISHED BY DETROIT PUBLIC LIGHTING COMMISSION

SYSTEM IN OPERATION		Time "ON"	CONCRETE SECTION		BITUMINOUS SECTION		PRECIPITATION		Average Mean at Site-°F	Average Temperature of Pavement at Control Point	
From	To	Hr. Min.	Energy Consumed KWH	Cost P.L.C. Rate	Energy Consumed KWH	Cost P.L.C. Rate	Snowfall Sleet Inches	Water Equivalent Inches		Concrete °F	Bituminous °F
DECEMBER											
7:00 p.m. 12-17-51	10:35 a.m. 12-24-51	159 : 35	10,160		9,360		11.6	1.7	17	35	45
12:30 a.m. 12-25-51	1:20 p.m. 12-27-51	48 : 50	3,940		4,120		6.2	0.54	21	38	48
4:40 a.m. 12-28-51	1:58 p.m. 12-29-51	33 : 18	1,840		1,200		0.2	0.01	30	38	49
	December Totals	241 : 43	15,940	$299.95	14,680	$278.62	18.0	2.25	23	37	47
JANUARY											
5:55 p.m. 1- 2-52	4:11 p.m. 1- 3-52	22 : 16	1,280		1,080		1.7	0.15	25	36	50
6:21 p.m. 1- 4-52	7:45 a.m. 1- 7-52	61 : 24	2,540		2,000		3.2	0.34	27	39	50
9:06 a.m. 1- 8-52	8:05 a.m. 1- 9-52	22 : 59	920		800		0.6	0.05	32	39	50
7:05 a.m. 1-10-52	4:15 p.m. 1-10-52	9 : 10	120		120		T	T	24	41	50
9:45 a.m. 1-19-52	7:45 a.m. 1-21-52	45 : 51	2,200		1,640		3.8	0.94	31	40	50
2:45 a.m. 1-22-52	1:35 p.m. 1-22-52	10 : 50	460		400		0.9	0.33	31	36	50
12:50 a.m. 1-24-52	2:00 p.m. 1-24-52	13 : 10	600		560		0.5	0.02	18	29	48
	January Totals	185 : 40	8,120	$167.57	6,600	$141.84	10.7	1.83	27	37	50
FEBRUARY											
2:00 p.m. 2- 6-52	3:00 p.m. 2- 7-52	25 : 00	1,160		1,080		1.4	0.10	26	39	50
5:37 p.m. 2- 7-52	1:50 p.m. 2- 8-52	20 : 13	680		520		0.7	0.05	27	38	49
5:50 p.m. 2- 8-52	6:00 p.m. 2- 9-52	24 : 10	940		800		0.3	0.03	30	39	50
9:30 p.m. 2-19-52	9:00 p.m. 2-22-52	71 : 30	2,660		2,280		2.5	0.38	28	40	50
4:00 a.m. 2-28-52	1:50 p.m. 2-29-52	33 : 50	920		800		2.4	0.21	26	40	50
	February Totals	174 : 42	6,360	$137.78	5,480	$122.88	7.3	0.77	27	39	50
MARCH											
5:10 p.m. 3- 2-52	7:45 a.m. 3- 4-52	38 : 35	1,380		1,200		1.6	0.65	30	39	50
6:04 p.m. 3- 4-52	7:30 a.m. 3- 5-52	13 : 26	700		560		T	T	30	40	50
4:05 a.m. 3- 9-52	9:30 p.m. 3- 9-52	17 : 25	460		400		0.8	0.08	31	40	50
7:08 a.m. 3-13-52	1:45 p.m. 3-13-52	6 : 37	120		240		1.6	0.08	30	37	49
4:45 p.m. 3-13-52	11:00 a.m. 3-14-52	18 : 15	800		560		T	T	27	40	50
1:00 p.m. 3-24-52	7:45 p.m. 3-24-52	6 : 45	240		280		T	T	34	40	50
12:07 a.m. 3-26-52	4:45 p.m. 3-26-52	16 : 38	460		400		2.1	0.15	32	41	50
	March Totals	117.41	4,160	$95.85	3640	$84.15	6.1	0.96	31	40	50
	Season Totals	719.46	34,580	$701.15	30,400	$627.49	42.1	5.81	28	38	49

TABLE II
SUMMARY OF OPERATING TIME, ENERGY CONSUMPTION, AND WEATHER CONDITIONS
Winter Seasons 1948-49, 1949-50, 1950-51, 1951-52

Month	Time "ON" - Hours				KWH Consumption							
					1948-49		1949-50		1950-51		1951-52	
	1948-49	1949-50	1950-51	1951-52	Concrete	Asphalt	Concrete	Asphalt	Concrete	Asphalt	Concrete	Asphalt
November	0.00	66.70	101.50	0.00	0	0	1980	2280	5660	7120	0	0
December	79.65	83.55	254.50	241.71	2590	2180	2080	2780	12840	15150	15940	14680
January	190.93	116.50	177.23	185.67	5010	5600	4400	5200	7740	9130	8120	6600
February	142.01	140.01	337.92	174.70	3540	3770	8560	7960	17220	16360	6360	5480
March	94.00	122.69	55.20	129.10	2670	3470	4840	4860	1570	1860	4160	3640
April	0.00	19.25	0.00	0.00	0	0	920	680	0	0	0	0
Total	506.59	548.70	926.35	731.18	13810	15020	22780	23860	45030	49620	34580	30400

WEATHER CONDITIONS DURING OPERATIONS

Month	1948-1949			1949-1950			1950-1951			1951-1952		
	Snow-fall, in.	Water Equivalent	Mean Air Temp. °F	Snow-fall, in.	Water Equivalent	Mean Air Temp. °F	Snow-fall, in.	Water Equivalent	Mean Air Temp. °F	Snow-fall, in.	Water Equivalent	Mean Air Temp. °F
November	----	----	----	4.5	0.76	32	8.4	1.25	18	----	----	----
December	0.50	0.49	38	4.7	0.48	33	6.5	1.91	24	18.0	2.25	23
January	4.60	0.26	35	9.2	0.71	30	12.4	0.79	34	10.7	1.83	27
February	3.10	0.39	25	12.6	2.29	25	7.4	1.38	20	7.3	0.77	27
March	2.1	0.11	25	9.6	0.81	24	5.7	1.41	30	6.7	1.00	31
April	----	----	----	0.4	0.4	26	----	----	----	----	----	----
Total	10.3	1.25		41.0	5.45		40.4	6.74		42.7	5.85	
	Average temperature 31			Average temperature 28			Average temperature 25			Average temperature 28		

TABLE III

SUMMARY OF COMPARATIVE OPERATING DATA FOR FOUR SEASONS

	1948-1949	1949-1950	1950-1951	1951-1952
Total Time "ON"	506.59 hrs.	548.70 hrs.	926.35 hrs.	719.77 hrs.
Total Energy Consumption - KWH				
Concrete Section	13,810	22,780	45,030	34,580
Asphalt Section	15,020	23,860	49,620	30,400
Total KWH Consumption	28,830	46,640	94,650	64,980
Energy Consumption per 500-ft. Section per Hour of Operation - KWH				
Concrete Section	27.3	41.5	48.6	48.06
Asphalt Section	29.7	43.5	53.6	42.24
Percent Difference (Asphalt to Concrete)	+ 8.8%	+ 4.8%	+ 10.3%	- 12.1%
Energy Consumed per 500-ft. Section per Hr. per Sq. Ft. of Heating Surface				
Concrete Section	18.4 watts	27.9 watts	32.7 watts	32.0 watts
Asphalt Section	20.0	29.3	36.1	28.0
Total Cost - (Detroit Public Lighting Commission Rate)				
Concrete Section	$319.66	$507.24	$893.93	$701.15
Asphalt Section	343.76	533.78	973.10	627.49
Total Cost	$663.42	$1,041.02	$1,867.03	$1.328.64
Cost per 500-ft. Section per Hour of Operation				
Concrete Section	$ 0.63	$ 0.92	$ 0.97	$ 0.97
Asphalt Section	0.68	0.97	1.05	0.87
Total Cost	$ 1.31	$ 1.89	$ 2.02	$ 1.84
Total Snowfall, inches	10.3	41.0	40.4	42.1

FIGURE 3. CONCRETE PAVEMENT 12-18-51 LOOKING EAST. INSIDE TRACK CLEAR, OUTSIDE TRACK COVERED WITH SLUSH.

FIGURE 4. BITUMINOUS PAVEMENT 12-18-51 LOOKING EAST. INSIDE TRACK CLEAR OUTSIDE TRACK COVERED WITH SLUSH.

FIGURE 5. CONCRETE PAVEMENT 12-20-51 SHOWING CONDITION OF HEATED SECTIONS.

FIGURE 6. BITUMINOUS PAVEMENT 12-20-51 SHOWING CONDITION OF HEATED SECTIONS.

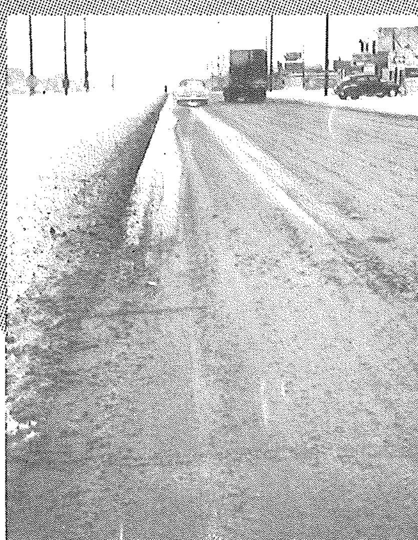


FIGURE 7. CONCRETE PAVEMENT 2-20-52 SHOWING CONDITION OF HEATED SURFACE.

FIGURE 8. BITUMINOUS PAVEMENT 2-20-52 SHOWING CONDITION OF SURFACE.