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

Winter Season 1953-1954
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 1953 - 1954

This is the seventh 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 1953 - 1954. The data obtained for the 1953 - 1954 season is also used in conjunction with comparative data charts covering the previous five winter seasons. Previous reports may be referred to by Highway Research numbers 120, 130, 152, 165, 190, and 192. The winter of 1953 - 1954 was closely related to the season of 1950 - 1951 as a representative winter in the Detroit area. The two seasons were indentical with respect to the average air temperature 25°F under operating conditions. Their close relationship is also reflected in the fact that the hourly energy consumption for 1950 - 1951 was 102.20 KWH, while for 1953 - 1954 the hourly energy consumption was 107.98 KWH; a difference of only 5.7 KWH.

General Performance

The heating system was set in operation on December 15, 1953 and the last operation period ended March 30, 1954. Total hours of operation for the 1953 - 1954 season were 582.78, as compared to 415.17 for 1952 - 1953; 719.77 for 1951 - 1952; 926.35 for 1950 - 1951; 548.70 for 1949 - 1950; and 506.59 for 1948 - 1949. The average air temperature during operation periods for 1953 - 1954 was 25°F, as compared to 29°F, 28°F, 25°F, 28°F, and 31°F, respectively, for the previous seasons. The snowfall for 1953 - 1954 was considerably higher than the previous season of 1952 - 1953, with an increase of 23.3 inches. However, it is comparatively equal to the seasons of 1949 - 1950, 1950 - 1951, and 1951 - 1952, with an average variation

of only 3.06 inches.

The operating cost of the system per hour was $2.25, as compared to $1.97, $1.84, $2.02, $1.89, and $1.31, respectively, for the previous five seasons. Complete operative cost data for the 1953 - 1954 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 six seasons; while Table III summarizes additional operative information for these seasons and Table IV further summarizes operating data and costs, by years, for the same period.

Some of the information contained in this report is necessarily inadequate as a result of two contributing factors: (1) It was discovered upon digging into the asphalt pavement that the temperature bulb had settled until it was right on top of the heating mesh. Because of the work involved, the bulb was not raised, therefore, all records are with the temperature bulb on the heating element; (2) Due to conflicting work on another project, it was impossible to make any repairs on pavement breaks after December 25, 1953.

Prior to December 25, 1953, five (5) breaks occurred in the heating elements; four (4) in the bituminous section and one (1) in the concrete section. As designated in Figure 1, two of these breaks, No. 26 in the concrete section and No. 22 in the bituminous section, were in the same place where breaks had occurred in previous years. The other three (3) breaks were at new locations. Figure 1 shows the location of all breaks occurring to date.

Concluding Remarks

For the third straight year, the energy consumption for the bituminous section was less than that for the concrete section. The difference between the two amounts

was 6.36%, as compared to 9.4% for the 1952 - 1953 season and 12.1% for the 1951 - 1952 season. This reversal of energy consumption between the two types of surfaces since the 1950 - 1951 season is now believed to be caused by the close proximity of the temperature control bulb to the heating element in the bituminous section. The bulb will be restored to its correct position in 1954 and the winter readings of 1954 - 1955 should again be in correct relationship.

TABLE 1 - SUMMARY OF OPERATING DATA AND COSTS FOR SEASON 1953-54
DATA FURNISHED BY DETROIT PUBLIC LIGHTING COMMISSION

SYSTEM IN OPERATION		Time "ON"	CONCRETE SECTION		BITUMINOUS SECTION		PRECIPITATION		Average Mean at Site-°F (Air)	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 Equivelant Inches		Concrete °F	Bituminous °F
DECEMBER											
9:50 a. m. 12-14-53	7:50 a. m. 12-15-53	22 : 00	1,520		1,480		3.5	0.44	35	38	50
4:20 p. m. 12-15-53	7:55 a. m. 12-16-53	15 : 35	1,040		920		1.0	0.03	26	39	50
9:10 a. m. 12-18-53	3:25 p. m. 12-18-53	6 : 15	340		400		0.2	0.01	17	34	40
4:21 p. m. 12-18-53	11:00 p. m. 12-18-53	6 : 39	580		400		T	T	17	39	40
12:05 p. m. 12-22-53	8:05 p. m. 12-22-53	8 : 00	800		920		1.5	0.18	30	38	42
5:21 a. m. 12-31-53	8:00 p. m. 12-31-53	2 : 39	340		240		T	T	26	29	20
6:04 p. m. 12-31-53	12:45 a. m. 1- 1-54	18 : 41	820		800		T	T	26	31	24
	December Totals	70 : 49	5,440	$122.20	5,160	$117.46	6.2	0.66	25	35	38
JANUARY											
10:30 p. m. 1- 5-54	8:00 a. m. 1- 6-54	9 : 30	680		640		0.4	0.02	37	40	60
6:03 a. m. 1-11-54	7:45 p. m. 1-11-54	13 : 42	1,160		1,080		0.5	0.04	16	27	50
9:57 a. m. 1-11-54	7:50 p. m. 1-12-54	33 : 53	1,860		1,740		0.7	0.04	17	28	40
8:15 a. m. 1-14-54	12:00 p. m. 1-15-54	27 : 45	1,520		1,400		0.4	0.04	25	32	50
8:20 p. m. 1-16-54	10:00 p. m. 1-17-54	25 : 40	1,860		1,620		T	T	17	29	46
11:58 p. m. 1-20-54	7:45 a. m. 1-21-54	7 : 47	460		400		T	0.73	30	35	40
10:35 p. m. 1-26-54	7:45 a. m. 1-28-54	33 : 12	1,860		1,720		2.6	0.77	27	31	41
6:55 a. m. 1-29-54	9:55 a. m. 1-31-54	62 : 50	2,300		2,160		1.5	0.13	19	33	50
	January Totals	214 : 19	11,700	$228.17	10,760	$212.24	6.1	1.77	24	32	45
FEBRUARY											
7:45 a. m. 2- 1-54	8:10 p. m. 2- 1-54	12 : 25	680		620		1.9	0.16	32	35	43
11:58 p. m. 2- 3-54	6:15 p. m. 2- 4-54	18 : 17	700		720		0.7	0.06	29	36	44
6:48 p. m. 2- 5-54	9:45 p. m. 2- 6-54	26 : 57	1,200		1,080		0.2	0.02	21	35	47
5:45 a. m. 2- 8-54	6:15 p. m. 2- 8-54	12 : 30	580		400		0.8	0.07	34	36	47
4:30 a. m. 2-13-54	5:00 p. m. 2-13-54	12 : 30	580		560		0.7	0.05	27	32	38
7:12 p. m. 2-25-54	3:45 p. m. 2-26-54	20 : 33	1,900		1,880		4.6	0.46	33	37	49
8:50 p. m. 2-28-54	8:00 a. m. 3- 2-54	35 : 10	2,440		2,360		5.0	0.70	32	36	50
	February Totals	138 : 22	8.080	$166.89	7,620	$159.10	13.9	1.52	30	35	45
MARCH											
5:25 a. m. 3- 3-54	4:00 p. m. 3- 5-54	58 : 35	2,820		2,800		5.6	0.45	18	30	47
1:08 a. m. 3-13-54	12:45 p. m. 3-14-54	35 : 37	1,040		960		0.2	0.02	26	44	32
7:35 p. m. 3-14-54	9:15 a. m. 3-15-54	13 : 40	820		720		T	T	22	36	35
3:25 p. m. 3-20-54	10:00 p. m. 3-20-54	6 : 35	340		380		T	0.04	22	39	40
9:10 a. m. 3-29-54	9:00 p. m. 3-30-54	35 : 50	2,180		2,080		6.1	0.58	19	42	35
	March Totals	150 : 17	7,200	$151.99	6,940	$147.59	11.9	1.09	21	38	39
	Season Totals	582 : 47	32,420	$669.25	30,480	$636.39	38.1	5.04	25*	35*	42*

* Average

TABLE III

SUMMARY OF COMPARATIVE OPERATING DATA FOR SIX SEASONS

	1948-1949	1949-1950	1950-1951	1951-1952	1952-1953	1953-1954
Total Time "ON"	506.59 hrs.	548.70 hrs.	926.35 hrs.	719.77	415.17 hrs.	582.78 hrs.
Total Energy Consumption - KWH						
Concrete Section	13,810	22,780	45,030	34,580	19,940	32,420
Asphalt Section	15,020	23,860	49,620	30,400	18,060	30,480
Total KWH Consumption	28,830	46,640	94,650	64,980	38,000	62,900
Energy Consumption per 500-ft. Section per Hour of Operation - KWH						
Concrete Section	27.3	41.5	48.6	48.06	48.02	55.6
Asphalt Section	29.7	43.5	53.6	42.24	43.50	52.3
Total Consumption per 500-ft. per Hour	57.0	85.0	102.2	90.30	91.52	107.9
Percentage Difference (Asphalt to Concrete)	+8.8%	+4.8%	+10.3%	-12.1%	-9.4%	-6.36%
Energy Consumed per 500-ft. Section per Hr. per Sq. Ft. of Heating Surface in Watts						
Concrete Section	18.4	27.9	32.7	32.0	31.9	37.0
Asphalt Section	20.0	29.3	36.1	28.0	28.8	34.8
Total Cost - (Detroit Public Lighting Commission Rate)						
Concrete Section	$319.66	$ 507.24	$ 893.93	$ 701.15	$429.41	$ 669.25
Asphalt Section	343.76	533.78	973.10	627.49	388.49	636.39
Total Cost	$663.42	$1,041.02	$1,867.03	$1,328.64	$817.90	$1,305.64
Cost per 500-ft. Section per Hour of Operation						
Concrete Section	$ 0.63	$ 0.92	$ 0.97	$ 0.97	$ 1.03	$ 1.16
Asphalt Section	0.68	0.97	1.05	0.87	0.94	1.09
Total Cost	$ 1.31	$ 1.89	$ 2.02	$ 1.84	$ 1.97	$ 2.25
Total Snowfall						
Total in inches	10.3	41.0	40.4	42.1	14.78	38.1

TABLE IV

SUMMARY OF OPERATING DATA AND COSTS
for years 1948 to 1954

Winter	Snowfall Inches	Water Equiv.	Ave. Temp.	Hrs. "ON"	Total Hourly KWH	Total KWH	Cost
48 - 49	10.3	1.25	31	506.59	57.00	28,830	$ 663.42
49 - 50	41.0	5.45	28	548.70	85.00	46,000	1,041.02
50 - 51	40.4	6.74	25	926.35	102.20	94,000	1,867.03
51 - 52	42.1	5.81	28	719.77	90.30	64,980	1,328.62
52 - 53	14.8	1.87	29	415.17	91.52	38,000	817.90
53 - 54	38.1	5.04	25	582.78	107.90	62,900	1,305.64