

MICHIGAN  
STATE HIGHWAY DEPARTMENT  
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State Highway Commissioner

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

Winter Season 1954-1955  
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 ON HIGHWAYS BY RADIANT HEAT

## Performance and Cost Data for Season 1954-1955

This is the eighth 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 1954-1955. The data obtained for this season is contrasted with data covering the previous six winter seasons by means of comparative charts. Previous reports on this subject may be referred to by Highway Research numbers 120, 130, 152, 165, 190, 192 and 221.

### Comparison to Previous Seasons

The winter of 1954-1955 was most closely related to the previous season, 1953-1954, with respect to KWH consumption per hour. However, the difference in hourly consumption showed a noticeable increase of 13.8 KWH. The average air temperature difference varied only 1 F, with the average air temperature for 1953-1954 being 25 F as compared to 24 F for 1954-1955.

### General Performance

The heating system went into operation on December 1, 1954 and the last period of operation was on March 27, 1955. Total hours of operation for the 1954 - 1955 were 515.03, as compared to 582.78, 415.17, 719.77, 926.35, 548.70 and 506.59, respectively, for the previous seasons. The snowfall for 1954 - 1955 was considerably lower than the previous season, with a decrease of 13.4 inches. However, the total snowfall of 24.7 for 1954 - 1955 is almost an exact average of the highest and lowest recorded snowfalls for all the previous seasons and only the third heaviest snowfall of the seven recorded seasons.

For the fourth straight season the operating cost per hour for the system increased. For 1954 - 1955 the cost per hour was \$2.47, as compared to \$2.25, \$1.97, \$1.84, \$2.02, \$1.89 and \$1.31, respectively, for the previous six seasons.

#### Related Tables

Complete operative cost data for the 1954 - 1955 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 seven 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.

#### Breaks in Heating Elements

There were numerous breaks in the heating elements this year, many of them occurring at the same locations as in former years. The Detroit Public Lighting Commission concluded that they were caused by the moisture seeping up from the ground into the base and corroding the grids.

Figure 1 shows the location of all breaks occurring to date.

#### Concluding Remarks

It will be noted in Table III that for three consecutive years prior to the 1954 - 1955 season there had been a reversal of energy consumption between the two types of surfaces.

This reversal was believed to have been caused by the close proximity of the temperature control bulb to the heating element in the bituminous section. This assumption seems to have been substantiated by this years experiment, which was carried on after a

new bulb had been installed in the bituminous section. The consumption difference between the two sections is now believed to be in correct relationship, with the asphalt section registering the greater consumption by 8.18 %.

Due to the continued interest in this experiment, it will be continued next season and a subsequent report will be made.

TABLE I

## SUMMARY OF OPERATING DATA AND COSTS FOR SEASON 1954-55

DATA FURNISHED BY DETROIT PUBLIC LIGHTING COMMISSION

SYSTEM IN OPERATION		Time "ON" Hr. Min.	CONCRETE SECTION		BITUMINOUS SECTION		PRECIPITATION		Average Mean at Site-°F (Air)	Average Temperature of Pavement at Control Point	
From	To		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											
11:26 a. m. 12- 1-54	7:30 p. m. 12- 1-54	8 : 04	340		520		1.1	0.09	31	37	38
1:30 p. m. 12- 2-54	6:00 p. m. 12- 2-54	4 : 30	360		400		0.2	0.01	29	33	24
8:08 p. m. 12- 5-54	11:30 p. m. 12- 5-54	3 : 22	1,260		1,680		0.4	0.01	26	35	32
8:45 p. m. 12- 9-54	8:00 a. m. 12-10-54	11 : 15	920		1,240		1.2	0.23	35	39	25
6:43 a. m. 12-15-54	7:50 a. m. 12-16-54	25 : 07	1,400		1,040		1.9	0.17	32	39	40
2:30 p. m. 12-17-54	9:00 a. m. 12-18-54	18 : 30	1,380		1,360		0.4	0.11	31	40	39
7:00 p. m. 12-18-54	12:50 p. m. 12-19-54	17 : 50	920		920		0.2	0.01	24	40	39
8:36 a. m. 12-22-54	10:45 a. m. 12-22-54	2 : 09	920		960		0.1	T	22	37	15
5:30 p. m. 12-29-54	4:30 p. m. 12-30-54	23 : 00	1,620		1,720		0.3	0.12	31	40	38
December Totals		113 : 47	9,120	\$184.50	9,840	\$196.69	5.8	0.75	29	38	32
JANUARY											
9:15 p. m. 1-12-55	6:00 p. m. 1-13-55	20 : 45	920		920		0.4	0.03	26	39	36
9:05 p. m. 1-14-55	6:30 p. m. 1-16-55	45 : 25	1,380		1,680		0.1	0.01	27	39	36
10:44 a. m. 1-19-55	6:30 p. m. 1-19-55	7 : 46	460		680		0.1	T	22	20	34
12:33 p. m. 1-21-55	8:10 a. m. 1-22-55	19 : 37	800		920		0.3	0.03	29	39	36
11:20 p. m. 1-24-55	7:00 p. m. 1-27-55	43 : 40	3,900		3,880		1.8	0.15	20	37	33
7:20 a. m. 1-28-55	7:05 p. m. 1-28-55	11 : 45	600		840		T	T	11	34	32
January Totals		148 : 58	8,060	\$166.56	8,920	\$181.12	2.7	0.22	23	35	35
FEBRUARY											
9:50 a. m. 2- 2-55	4:15 p. m. 2- 3-55	6 : 25	800		800		T	T	17	37	34
5:45 p. m. 2- 2-55	7:45 a. m. 2- 3-55	14 : 00	940		1,080		T	T	16	33	30
6:18 a. m. 2- 4-55	6:50 p. m. 2- 4-55	12 : 32	800		1,100		T	T	21	42	37
7:20 a. m. 2- 5-55	12:15 p. m. 2- 6-55	28 : 55	1,140		1,480		1.1	0.11	24	38	37
5:18 p. m. 2-10-55	9:00 p. m. 2-13-55	75 : 42	3,580		3,760		2.9	0.14	18	37	36
4:37 a. m. 2-14-55	9:35 p. m. 2-14-55	16 : 58	1,260		1,080		2.0	0.13	27	34	36
3:05 a. m. 2-16-55	8:15 p. m. 2-16-55	17 : 10	580		680		2.8	0.31	30	37	37
2:43 a. m. 2-22-55	9:45 p. m. 2-22-55	19 : 02	800		840		2.1	0.19	32	41	38
February Totals		190 : 44	9,900	\$197.71	10,820	\$213.27	10.9	0.88	23	37	36
MARCH											
3:15 a. m. 3- 7-55	5:10 p. m. 3- 7-55	13 : 55	680		800		0.8	0.04	16	36	34
2:06 a. m. 3- 8-55	8:15 p. m. 3- 8-55	6 : 09	240		120		0.7	0.05	24	40	37
8:30 p. m. 3-25-55	2:00 p. m. 3-27-55	41 : 30	1,840		2,000		3.8	0.19	23	41	38
March Totals		61 : 34	2,760	\$ 64.35	2,920	\$ 67.95	5.3	0.28	21	39	36
Season Totals		515 : 03	29,840	\$613.12	32,500	\$659.03	24.7	2.13	24 <sup>a</sup>	37 <sup>a</sup>	35 <sup>a</sup>

<sup>a</sup> Average

TABLE II  
SUMMARY OF OPERATING TIME, ENERGY CONSUMPTION, AND WEATHER CONDITIONS  
Winter Seasons 1948-49 through 1954-55

Month	Time "ON" - Hours							KWH Consumption														
								1948-49		1949-50		1950-51		1951-52 <sup>a</sup>		1952-53 <sup>a</sup>		1953-54 <sup>a</sup>		1954-55		
								Concrete	Asphalt	Concrete	Asphalt	Concrete	Asphalt	Concrete	Asphalt	Concrete	Asphalt	Concrete	Asphalt	Concrete	Asphalt	
November	0.00	66.70	101.50	0.00	25.12	0.00	0.00	0	0	1980	2280	5660	7120	0	0	460	0	0	0	0	0	0
December	79.65	83.55	254.50	241.71	86.24	79.82	113.47	2590	2180	2080	2780	12840	15150	15940	14680	4500	4280	5440	5160	9120	9840	
January	190.93	116.50	177.23	185.67	219.60	214.32	148.58	5010	5600	4400	5200	7740	9130	8120	6600	10360	9820	11700	10760	8060	8920	
February	142.01	140.01	337.92	174.70	49.45	138.36	190.44	3540	3770	8560	7960	17220	16360	6360	5480	2780	2520	8080	7620	9900	10820	
March	94.00	122.69	55.20	129.10	34.76	150.28	61.34	2670	3470	4840	4860	1570	1860	4160	3640	1840	1440	7200	6940	2760	2920	
April	0.00	19.25	0.00	0.00	0.00	0.00	0.00	0	0	920	680	0	0	0	0	0	0	0	0	0	0	
Total	506.59	548.70	926.35	731.18	415.17	582.78	515.03	13810	15020	22780	23760	45030	49620	34580	30400	19940	18060	32420	30480	29840	32500	

<sup>a</sup> Greater KWH consumption in concrete section believed to be due to settling of the temperature bulb on top of the heating mesh; (see page 2 of text).

WEATHER CONDITIONS DURING OPERATIONS

Month	1948-1949			1949-1950			1950-1951			1951-1952			1952-1953			1953-1954			1954-1955		
	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	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	----	----	----	----	----	35	----	----	----	----	----	----
December	0.50	0.49	38	4.7	0.48	33	6.5	1.91	24	18.0	2.25	23	4.02	0.44	30	6.2	0.66	25	5.8	0.75	29
January	4.60	0.26	35	9.2	0.71	30	12.4	0.79	34	10.7	1.83	27	9.56	1.17	28	6.1	1.77	24	2.7	0.22	23
February	3.10	0.39	25	12.6	2.29	25	7.4	1.38	20	7.3	0.77	27	0.60	0.11	28	13.9	1.52	30	10.9	0.88	23
March	2.10	0.11	25	9.6	0.81	24	5.7	1.41	30	6.7	1.00	31	0.60	0.15	26	11.9	1.09	21	5.3	0.28	21
April	----	----	----	0.4	0.40	26	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Total	10.30	1.25		41.0	5.45		40.4	6.74		42.7	5.85		14.78	1.87		38.1	5.04		24.7	2.13	
	Average temperature 31			Average temperature 28			Average temperature 25			Average temperature 28			Average temperature 29			Average temperature 25			Average temperature 24		

TABLE III

## SUMMARY OF COMPARATIVE OPERATING DATA FOR SEVEN SEASONS

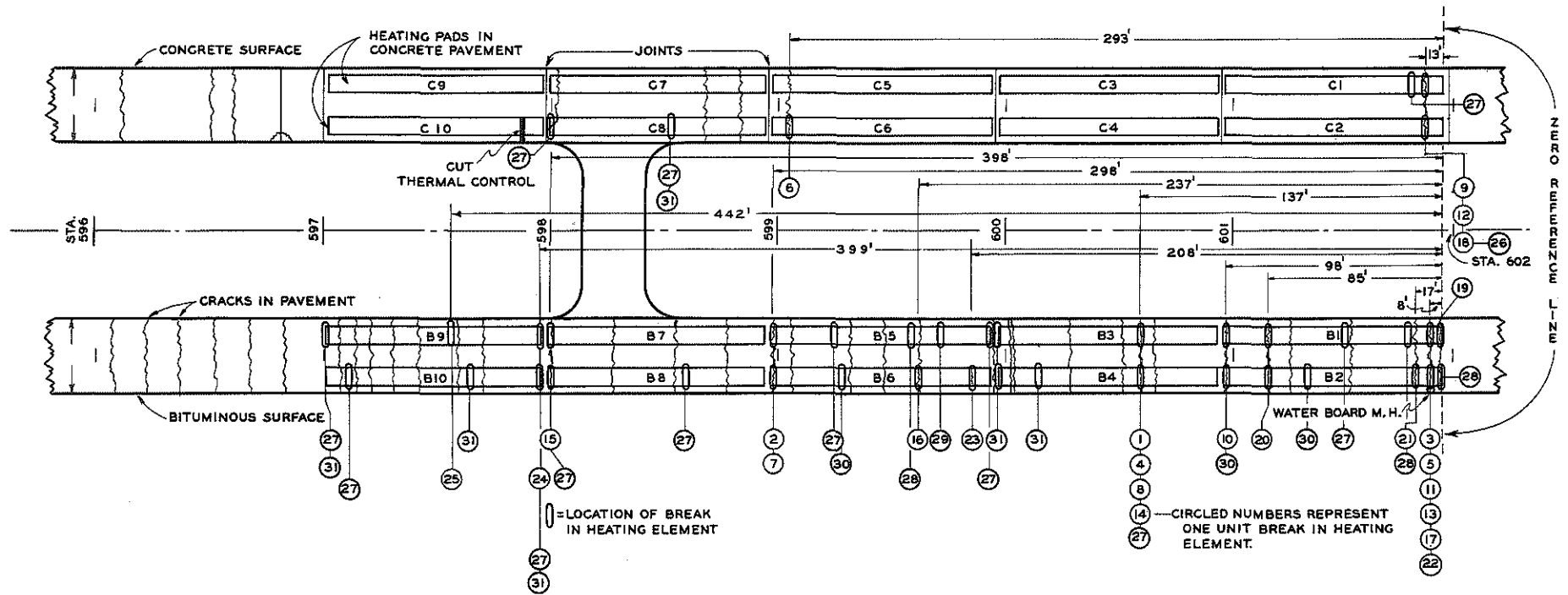
	1948-1949	1949-1950	1950-1951	1951-1952	1952-1953	1953-1954	1954-1955
<u>Total Time "ON"</u>	506.59 hrs.	548.70 hrs.	926.35 hrs.	719.77 hrs.	415.17 hrs.	582.78 hrs.	515.03 hrs.
<u>Total Energy Consumption - KWH</u>							
Concrete Section	13,810	22,780	45,030	34,580	19,940	32,420	29,840
Asphalt Section	<u>15,020</u>	<u>23,860</u>	<u>49,620</u>	<u>30,400</u>	<u>18,060</u>	<u>30,480</u>	<u>32,500</u>
Total KWH Consumption	28,830	46,640	94,650	64,980	38,000	62,900	62,340
<u>Energy Consumption per 500-ft. Section per Hour of Operation - KWH</u>							
Concrete Section	27.3	41.5	48.6	48.06	48.02	55.6	58.3
Asphalt Section	<u>29.7</u>	<u>43.5</u>	<u>53.6</u>	<u>42.24</u>	<u>43.50</u>	<u>52.3</u>	<u>63.4</u>
Total Consumption per 500-ft. Section per Hour	57.0	85.0	102.2	90.30	91.52	107.9	121.7
Percentage difference (Asphalt to Concrete)	+8.8%	+4.8%	+10.3%	-12.1%	-9.4%	-6.36%	+8.18%
<u>Energy Consumed per 500-ft. Section per Hr. per Sq. Ft. of Heating Surface in Watts</u>							
Concrete Section	18.4	27.9	32.7	32.0	31.9	37.0	38.8
Asphalt Section	20.0	29.3	36.1	28.0	28.8	34.8	42.2
<u>Total Cost - (Detroit Public Lighting Commission Rate)</u>							
Concrete Section	\$319.66	\$ 507.24	\$ 893.93	\$ 701.15	\$429.41	\$ 669.25	\$ 613.12
Asphalt Section	<u>343.76</u>	<u>533.78</u>	<u>973.10</u>	<u>627.49</u>	<u>388.49</u>	<u>636.39</u>	<u>659.03</u>
Total Cost	\$663.42	\$1,041.02	\$1,867.03	\$1,238.64	\$817.90	\$1,305.64	\$1,272.15
<u>Cost per 500-ft. Section per Hour of Operation</u>							
Concrete Section	\$0.63	\$0.92	\$0.97	\$0.97	\$1.03	\$ 1.16	\$1.19
Asphalt Section	<u>0.68</u>	<u>0.97</u>	<u>1.05</u>	<u>0.87</u>	<u>0.94</u>	<u>1.09</u>	<u>1.28</u>
Total Cost	\$1.31	\$1.89	\$2.02	\$1.84	\$1.97	\$ 2.25	\$2.47
<u>Total Snowfall</u>							
Total in Inches	10.3	41.0	40.4	42.1	14.78	38.1	24.7

TABLE IV

SUMMARY OF OPERATING DATA AND COSTS  
for years 1948 to 1955

Winter	Snowfall Inches	Water Equiv.	Avg. 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
54 - 55	24.7	2.13	24	515.03	121.70	62,340	1,272.15





BREAK NO.	'50-'51					'51-'52										'52-'53						'53-'54				'54-'55					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
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	11-6	11-6	11-10	11-10	1-30	1-30	11-30	11-30	12-1	12-1	12-2	10 1-31	12-10	10-22	2-18	2-24

**FIGURE 1**  
**LOCATION OF CRACKS AND BREAKS IN HEATING ELEMENTS**  
 EIGHT MILE ROAD EXPERIMENTAL PAVEMENT HEATING FOR SNOW AND ICE REMOVAL