EFFECT OF COLOR AND TEXTURE ON THE SURFACE TEMPERATURE OF ASPHALT CONCRETE PAVEMENTS

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16. Abstract

From April 1982 through October 1983 surface temperatures were measured on seven asphalt concrete pavement test sections in Fairbanks. The seven test sections included an untreated asphalt concrete pavement, white-painted pavement, yellow-painted pavement, white marble C-chips, B-chips, dark grey C-chips and dark grey E-chips. Air temperatures were also measured throughout the experiment. Incident and reflected shortwave radiation, incoming and emitted longwave radiation, wind speed, wind direction and surface albedo observations with a hand-held radiometer were measured during the 1982 summer. Each of the test sections was approximately 16 ft wide by 50 ft long.

The n-factors varied from 1.53 on the untreated pavement to 1.22 on the white-painted pavement during the 1982 summer. The n-factors on the white- and yellow-painted pavements increased substantially during the 1983 summer because the test areas were not repainted. Values for all of the test sections except the white- and yellow-painted ones were lower than expected due to traffic-induced turbulence.

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PREFACE

This report was prepared by Dr. Richard L. Berg, Research Civil Engineer, Geotechnical Research Branch, Experimental Engineering Division, U.S. Army Cold Regions Research and Engineering Laboratory.

The study was funded by the State of Alaska Department of Transportation and Public Facilities under Project F18221. Mr. David Esch was the Contract Manager for the DOT/PF.

Special recognition is given to the personnel from the U.S. Army Meteorological Detachment stationed at Fort Wainwright, Alaska. They provided, maintained and calibrated the meteorological equipment and conducted the daily albedo measurements over the test sections. Special thanks is also extended to Jerry Bowen of the DOT/PF whose office housed the data collection system and other recorders which were used to monitor the test site.

Several others assisted in the conduction and completion of this study, including Robert Eaton, Bruce Brockett, Richard Guyer, Steven Perkins, Mario Rojas, Blanchard Pratt, Gary DeCoff, Linda Gee and Gregor Fellers of CRREL. David Esch and Billy Conner, ADOT/PF, assisted, as did Dr. Terry McFadden, formerly of CRREL.

CONTENTS

ILLUSTRATIONS

TABLES

Table Page

EFFECT OF COLOR AND TEXTURE ON THE SURFACE TEMPERATURE OF ASPHALT CONCRETE PAVEMENTS

Richard L. Berg

INTRODUCTION

In the discontinuous permafrost regions of Alaska, extremely thick granular embankments (15-20 ft deep) may be necessary to completely contain seasonal thawing. Due to inadequate quantities of materials, costs of material acquisition and placement, or excessively elevated surfaces, the necessary thick embankments are seldom constructed, and considerable differential settlement frequently results beneath roads and airfields. Three passive methods have been used to minimize seasonal thaw depths and thereby minimize embankment thickness requirements: (1) thermal insulating layers (Esch 1973; Berg 1976), (2) high water content layers (Esch and Livingston 1978), and (3) materials that reduce the surface temperature of the embankment (Fulwider and Aitken 1963, Berg and Aitken 1973).

This study evaluated the effects of surface color and texture on the thawing season surface temperatures of an asphaltic concrete roadway pavement in Fairbanks, Alaska. The roadway, Peger Road, carries a substantial volume of automobile and truck traffic each day; therefore, this study differs from most previous surface temperature studies of pavements that were not subjected to significant traffic-generated air turbulence and to the effects of tire wear on the surface treatments.

SITE PREPARATION AND INSTRUMENTATION

The test sections are located on Peger Road between the entrances to the Interior District offices of the State of Alaska Department of Transportation and Public Facilities (DOT/PF) (Fig. 1 and 2). Peger Road was reconstructed during the summer of 1981 to provide a smoother, more heavy-duty pavement than previously existed. Prior to placing the 2-in. (5-cm) thick asphaltic concrete pavement, DOT/PF engineers installed four 1-in. (2.5-cm) diameter plastic pipes across the road near the top of the base course. Each pipe ultimately would contain wires for four thermocouples, two in separate test sections on each side of the roadway centerline (Fig. 1). The pipes extended beyond the pavement on each side by about 2 ft (0.6

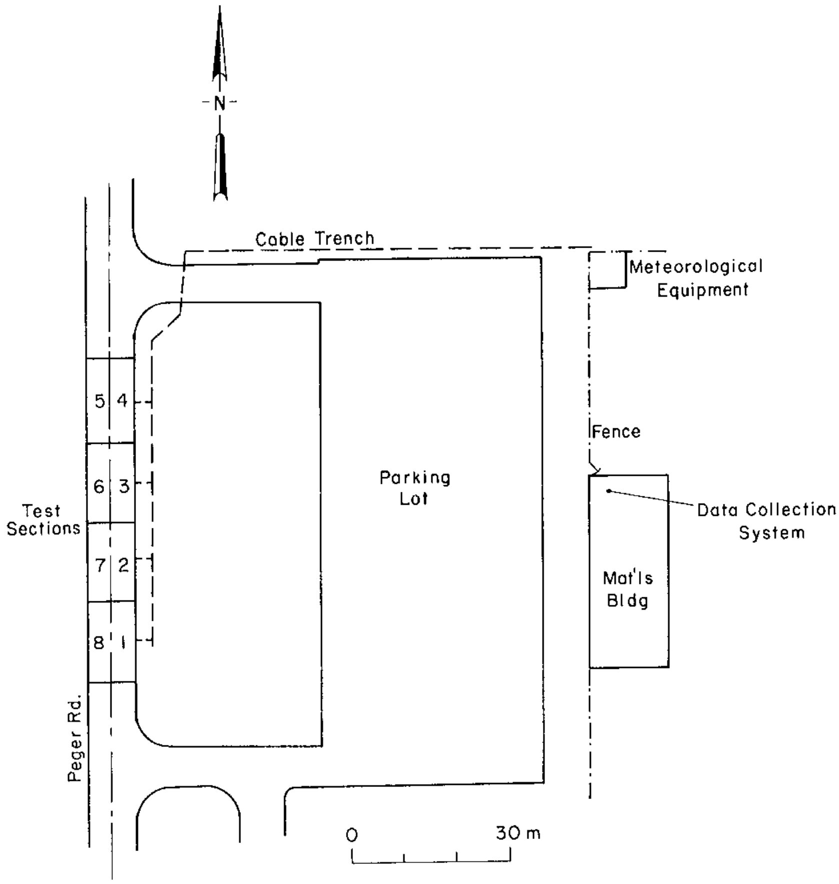


Figure 1. Test sections and instrumentation at the Peger Road test site.

Figure 2. Looking south on Peger Road prior to installation of the surface treatments.

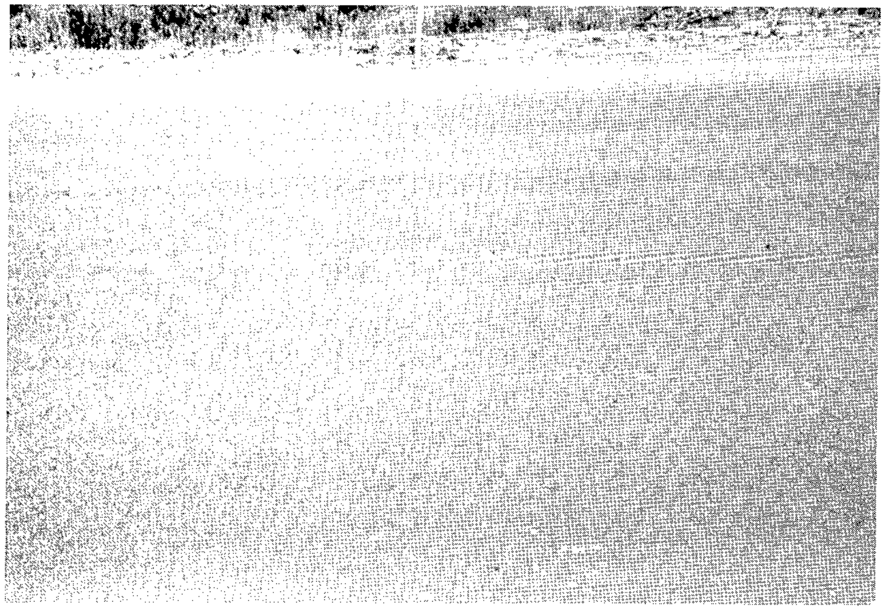


Figure 3. Completed surface temperature installation in one test section.

m). To precisely locate the pipes, a wire was pushed into each and its location determined with a metal detector that was moved slowly over the pavement surface. A coring drill was then positioned over the pipes and a 6-in. (15-cm) diameter core obtained from each test section. The plastic pipes beneath the pavement were also cut during the coring operation. After the pavement cores were removed, two 1/4-in. (6-mm) diameter holes were then drilled through them from the bottom to the top.

Four thermocouple wires were pushed through the pipes from the east edge of the road and wires for two thermocouples were brought to the surface through each hole where the cores were obtained. The thermocouples were epoxied into the pavement cores, with the sensing tip approximately 1/8 in. (3 mm) from the top of the core. Hot asphalt cement was poured on the exposed base course and the core containing the two thermocouples was pushed into the asphalt cement. Additional hot asphalt cement was poured into the annulus between the core and the undisturbed pavement to firmly retain the core (Fig. 3). Wires from the thermocouples were long enough to reach the edge of the road where they were temporarily buried. This portion of the installation was completed in mid-July 1981, well in advance of the application of surface treatments.

In late August 1981, the thermocouple wires were excavated and spliced into one of two cables that were placed in a trench extending along the road and adjacent to the north edge of the DOT/PF parking lot. Figure 1 shows the location of the trench. The trench extended to a fence east of the parking lot. From that point the cables were attached to the fence and extended to the materials building where the data collection system was located.

Surface treatments were applied to the test sections in late August and early September 1981. The chip seals were applied in late August. Figure 4 shows the intersection of Test Section 3, with Browns Hill B-chips, and Test Section 4, with white marble C-chips. Table 1 lists the gradations and other characteristics of the chip seals.

Paint was applied to Test Sections 5 and 6 in September 1981. Test Section 5 was painted white and Test Section 6 was painted yellow. Conventional chlorinated rubber-alkyd traffic marking paints were used and both paints were applied at the rate of approximately 0.075 to 0.10 gal./yd^2 (0.34 to 0.45 L/m^2). Table 2 contains a summary of the test sections. Each test section is approximtely 50 ft (15.2 m) long by 16 ft (5.9 m) wide.

Figure 4. Intersection of test sections 3 and 4 on 27 August 1981.

Table 1. Gradations, colors, and asphalt application rates for Peger Road chip seals.

Test section sieve size	Fairbanks S&G E-chips 1* % passing	Fairbanks S&G C-chips 2* % passing	Browns Hill B-chips 3 % passing	White marble C-chips 4 % passing
0.75"	100	100	100	100
0.50"	100	100	53	100
0.375"	93	51	16	86
#4	25	2	4	2
#8	7	1	4	1
#200	1	0	1	0
80th %tile size	0.35"	0.45"	0.37"	
Color	light gray		dark brown	white
Asphalt				
(gal/yd^2)	0.11*	0.24*	0.43	0.31
(L/m^2)	0.50	1.09	1.95	1.40

* Resealed on 26 August 1982 with asphalt application rate of 0.35 gal/yd^2 (1.58 L/m^2) and Fairbanks Sand and Gravel C-chips.

Table 2. Summary of test items on Peger Road.

Number of test section	Lane	Description
1	NB*	Fairbanks Sand and Gravel E-chips
2	NB	Fairbanks Sand and Gravel C-chips
3	NB	Browns Hill B-chips
4	NB	White marble C-chips
5	SB**	White traffic paint
6	SB	Yellow traffic paint
7	SB	Untreated
8	SB	Untreated

* Northbound lane
** Southbound lane

Engineers from the DOT/PF designed and supervised the application of the chip seals and paints. The DOT/PF also furnished the personnel, equipment and materials for the painting and sealing operations.

Due to abrasion and wear by tires (probably primarily due to tires with chains or studs) during the 1981-1982 winter, the surface treatments were badly worn (Fig. 5) by early March 1982. Test Sections 5 and 6 were

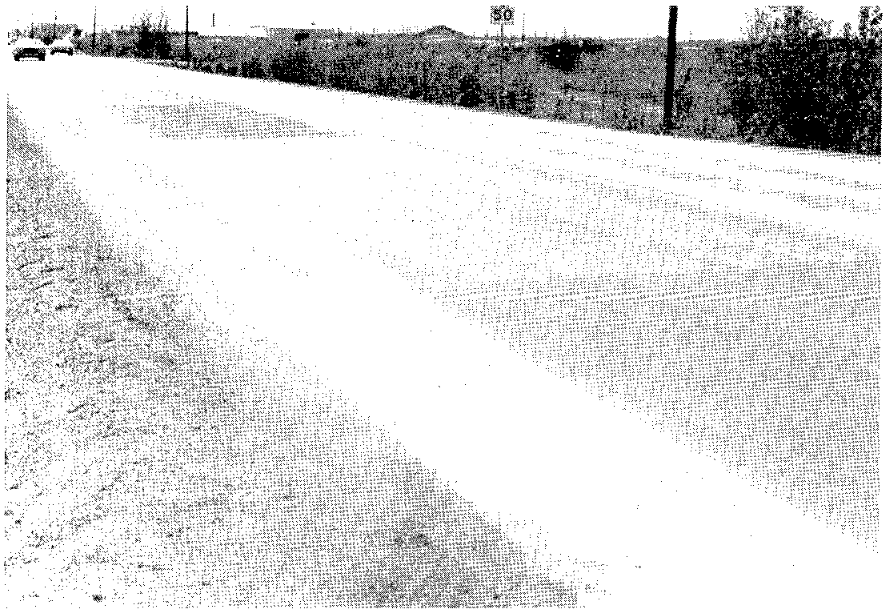


Figure 5. Condition of test sections in early June 1982.

repainted on 8 June 1982 and Test Sections 1 and 2 were treated with Fairbanks Sand and Gravel C-chips on 26 August 1982.

Radiometers for measuring incident and reflected shortwave radiation and incoming and emitted longwave radiation, and equipment for determining wind speed, wind direction, precipitation and air temperature were located within a fenced area to prevent vehicles and vandals from damaging the equipment. The meteorological equipment is located approximately 300 ft (100 m) from the test sections (Fig. 1). Electronic output from the meteorological equipment was carried to the data collection system and other recorders through extension wires mounted on the fence.

Measurements from all of the equipment commenced in March or April 1982 and continued through the summer of 1983. The data collection system recorded the surface temperatures and radiation totals hourly during the 1982 summer. Average wind speeds were also recorded hourly. Between 1100 and 1300 hr each day from April through September 1982, a hand-held radiometer was used to make instantaneous measurements of incident and reflected shortwave radiation over each of the test sections. The albedo of each surface was computed from these measurements. The radiometers were removed for the winter on 25 September 1982. They were reinstalled in early April 1983 and removed in early September 1983.

The cassette tape deck used to record hourly information obtained by the data collection system malfunctioned repeatedly during the 1983 summer but the printer attached to the system operated properly. Problems were also encountered with the radiometers during the 1983 summer. As a result, essentially no valid data were obtained from the radiometers in 1983. Average daily air and surface temperatures were obtained from printed data provided by the data collection system during 1983. These data were tabulated manually (Appendix B) to determine surface and air thawing indexes.

Since the surface treatments were not repaired after the 1982-1983 winter, their condition during the 1983 summer was probably similar to that shown in Figure 5 taken after the 1981-1982 winter.

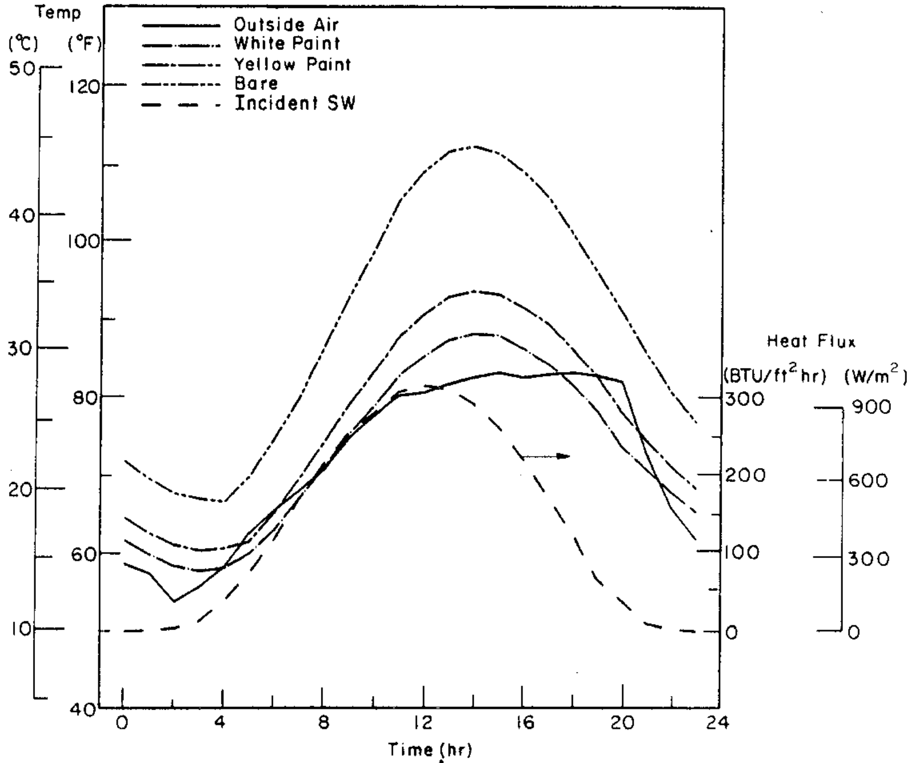
The average daily traffic on Peger Road during the 1982 summer was approximately 2200 vehicles per day in each direction and increased by about 5% in 1983. The speed limit on Peger Road is 50 mph (22 m/s).

DATA PRESENTATION

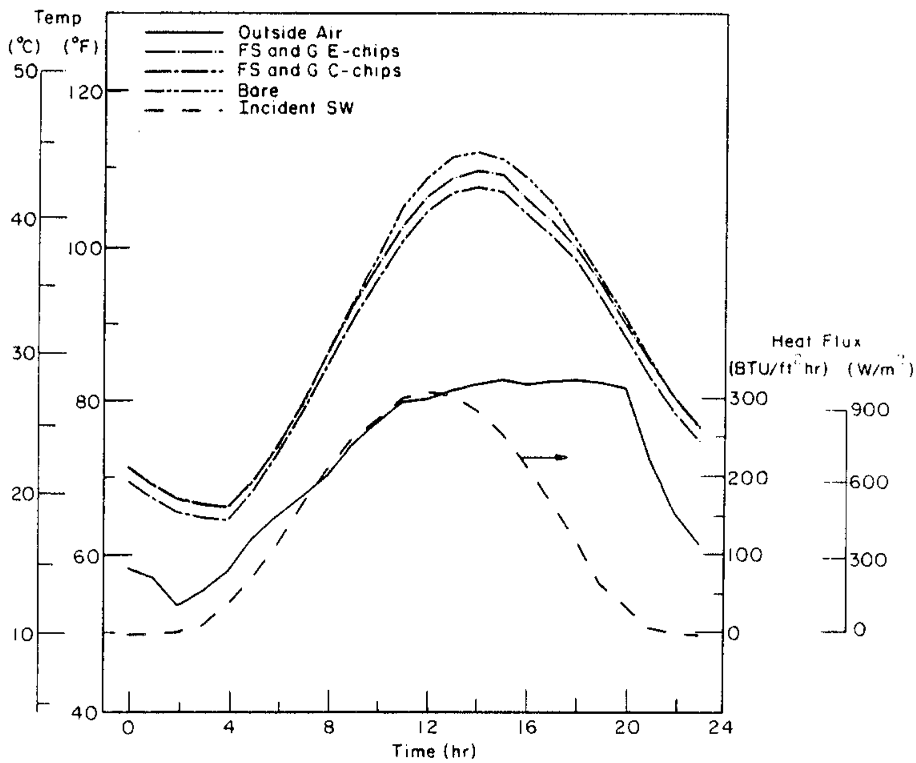
Appendices A and B contain summaries of data from the 1982 and 1983 summers and 1982-1983 winter. Data from the 1982 summer include average daily air and surface temperatures, wind speed, incoming and reflected shortwave radiation over an untreated (bare) asphalt concrete pavement in a parking lot (Fig. 1), incoming and emitted longwave radiation over the untreated asphalt concrete pavement, and approximately daily albedo measurements over each of the test sections. Data from the 1983 summer and 1982-1983 winter include only average daily air and surface temperatures.

Data in Figures 6-8 are typical of all of the days when data were collected. They are shown to illustrate surface temperature fluctuations of asphalt concrete pavements during summers in interior Alaska.

Figure 6 contains incident shortwave radiation totals and air and surface temperatures for each hour on 25 June 1982. Since the average cloud cover for the day, as measured at the Fairbanks International Airport, was relatively low (2/10), the date was near the time of the theoretical maximum incident shortwave radiation (21 June), and the air temperatures were quite high, surface temperatures on this date were also very high. Note that the air temperature reached its maximum value at 2000 hr (8 p.m.) and the surface temperatures reached maximum values at about 1400 hr (2 p.m.). The largest amount of incident shortwave radiation was

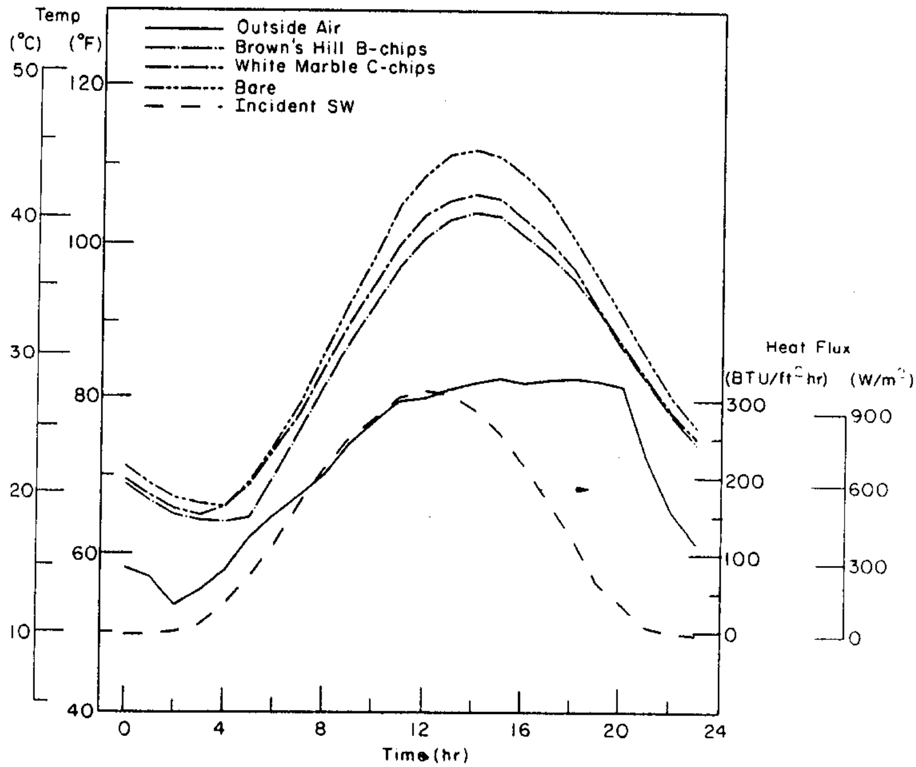


a. Incident shortwave radiation, air temperatures and bare, white-painted and yellow-painted pavement temperatures.



b. Incident shortwave radiation, air temperature and bare, fine-chip and standard-chip pavement temperatures.

Figure 6. Temperature and incident shortwave radiation, 25 June 1984.

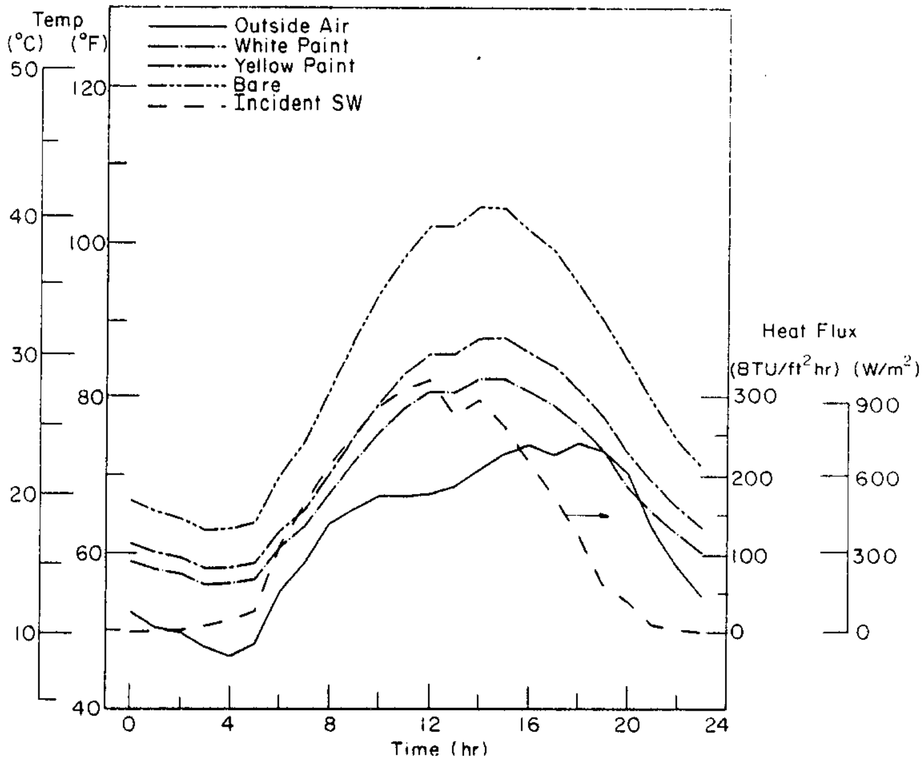


c. Incident shorwave radiation, air temperature and bare, brown-chip and white-chip pavement temperatures.

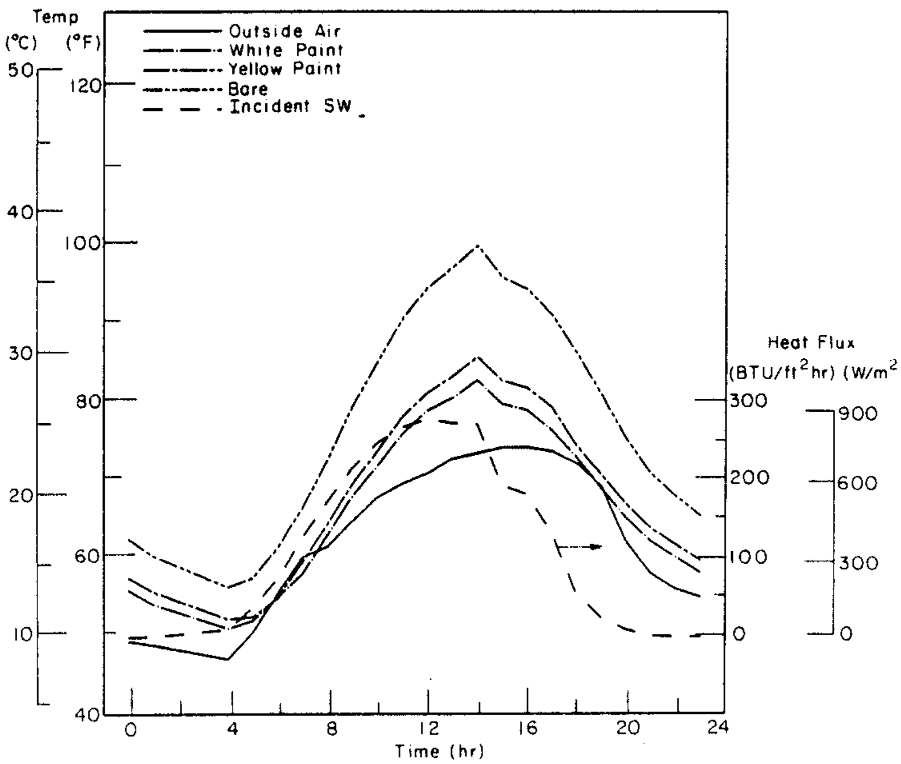
Figure 6 (cont'd). Temperature and incident shortwave radiation, 25 June 1982.

obtained during the hour ending at noontime. Surface temperatures decreased as the amount of incident solar radiation decreased. The air temperature continued to increase until about 2000 hr (8 p.m.) when it decreased rapidly. From 1400 hr (2 p.m.) until 2000 hr (8 p.m.) the temperature of the bare pavement decreased about 20°F while the air temperature increased about 2°F. Since the incident shortwave radiation followed a smooth curve, it appears that the 2/10 cloud cover did not significantly affect the radiation. And since the hourly totals of incident shortwave radiation decreased after noontime, we conclude that the amount of shortwave radiation absorbed by the pavement substantially affects the surface temperatures.

Figure 7 shows temperatures on several days during the 1982 summer. The days were chosen to illustrate the effects of incident shortwave radiation and rain on the measured surface temperatures. The average air temperature on each day was 60°F ± 3°F; therefore, the surface temperature differences from one day to another are due to different amounts of inci-

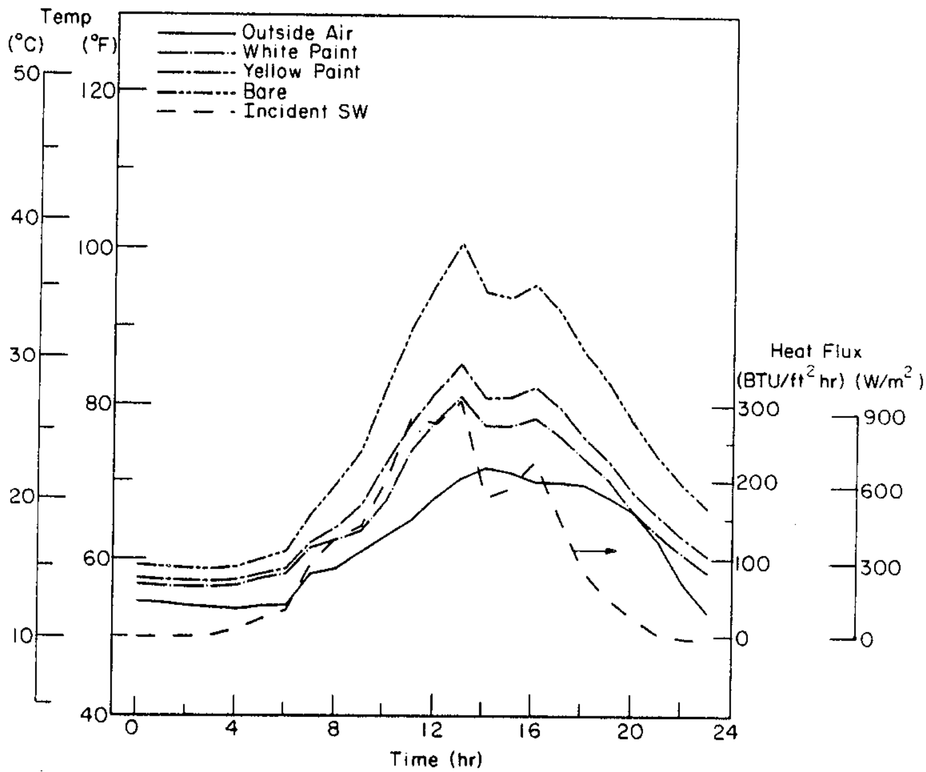


a. 2 July 1982, 3/10 cloud cover, incident SW of 2789 Btu/ft^2-day, average air-temperature 62.2°F.

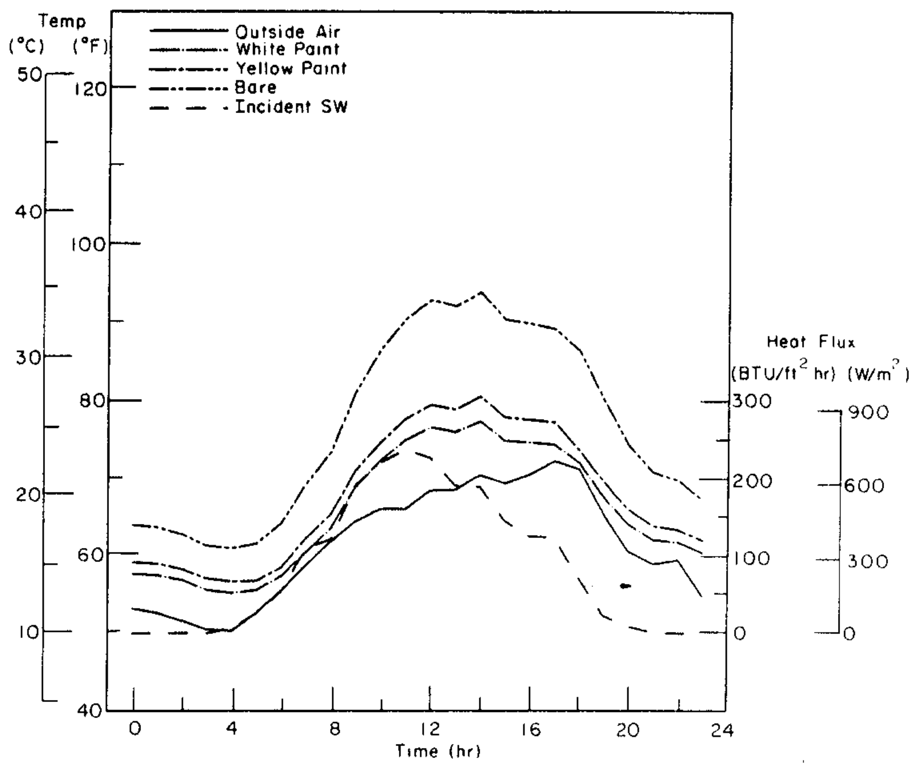


b. 6 August 1982, 0/10 cloud cover, incident SW of 2510 Btu/ft^2-day, average ait temperature 62.9°F.

Figure 7. Effect of incident shortwave radiation on the surface temperatures of the bare and white- and yellow-painted test sections.

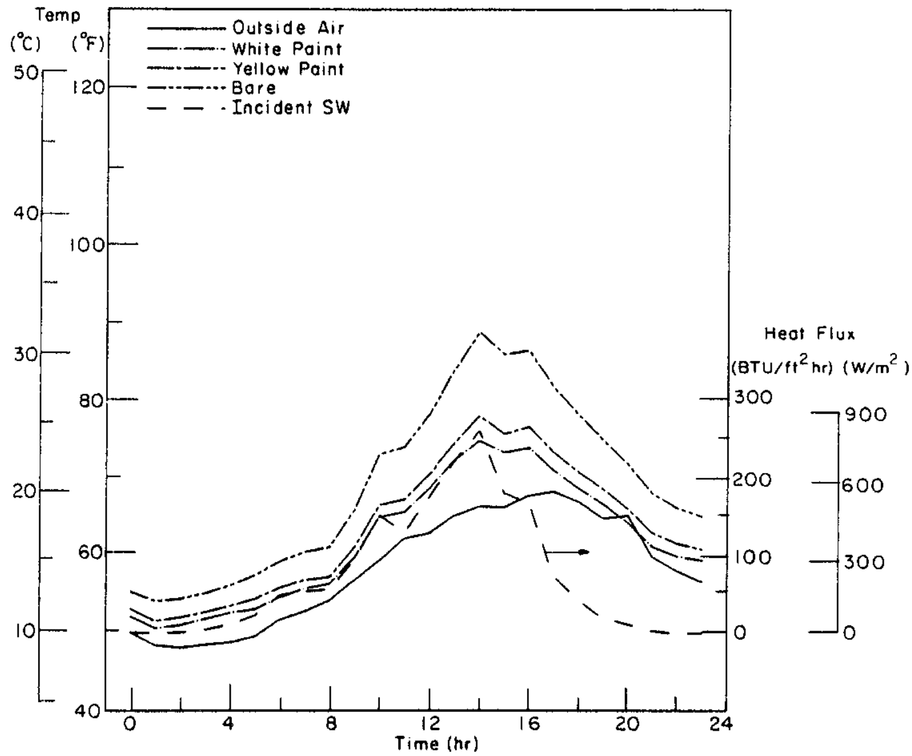


c. 18 July 1982, 6/10 cloud cover, incident SW of 1827 Btu/ft^2-day, average air temperature 61.9°F.

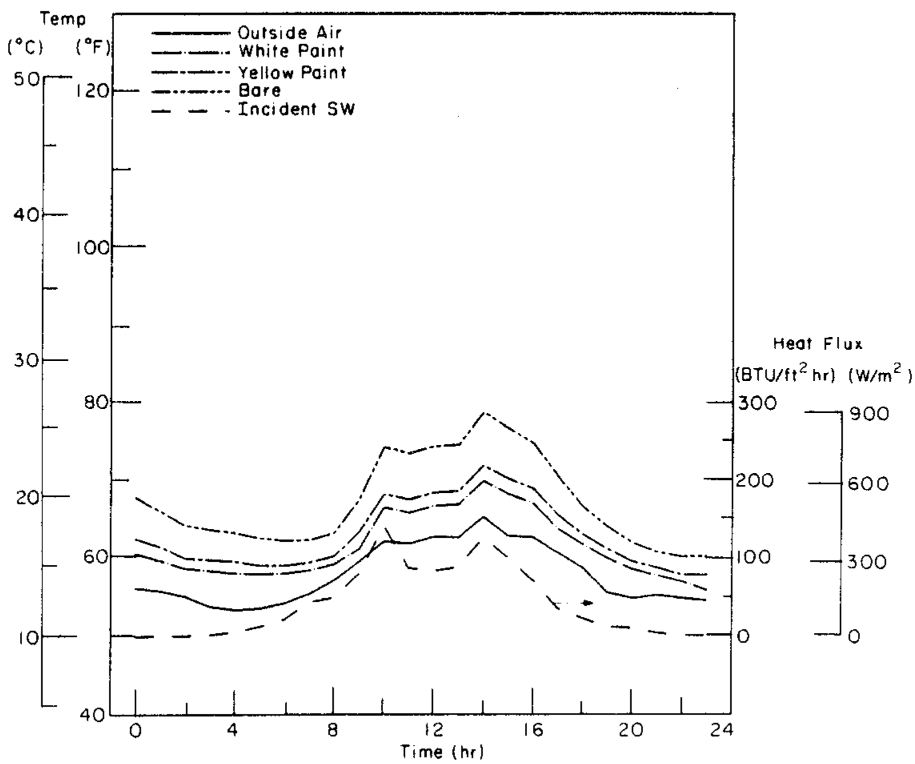


d. 8 August 1982, 8/10 cloud cover, incident SW of 1827 Btu/ft^2-day, average air temperature 61.4°F.

Figure 7 (cont'd).



e. 26 July 1982, 9/10 cloud cover, incident SW of 1508 Btu/ft^2-day, average air temperature 58.2°F.



f. 23 July 1982, 10/10 cloud cover with rain most of the day, incident SW of 880 Btu/ft^2-day, average temperature 57.9°F.

Figure 7 (cont'd).

dent shortwave radiation. On 23 July 1982 (Fig. 7f) rain occurred most of the day. Data from these several days illustrate that the surface temperatures of the pavements decrease as the amount of shortwave radiation decreases. This difference is shown clearly during the middle 12 hours of each day in Figures 7a and 7b. Figures 7a, 7c, 7d and 7e illustrate substantial decreases in surface temperature, or in the rate of change of surface temperature, when significant decreases in incident shortwave radiation occur during the middle few hours of the day. Although the surface temperatures did not vary nearly as much on 23 July (Fig. 7f) as on the other days, the most significant changes coincided with the most substantial changes in incident shortwave radiation. The amount of clouds and rain abated somewhat to cause increases in the amount of incident shortwave radiation, which resulted in the largest changes in measured surface temperature.

Figure 8 contains data from 6, 7 and 8 August 1982. The average daily air temperatures differ by only 1.5°F on these days, but the surface temperatures differ by slightly more. August 6 is listed as a clear day; however, the incident shortwave radiation does not follow a smooth curve, like the data in Figure 7a. Observations at the Fairbanks International Airport did indicate 1/10 cloud cover for a few hours near noontime. These clouds affected the incident shortwave radiation more than the average 2/10 cloud cover on 25 June.

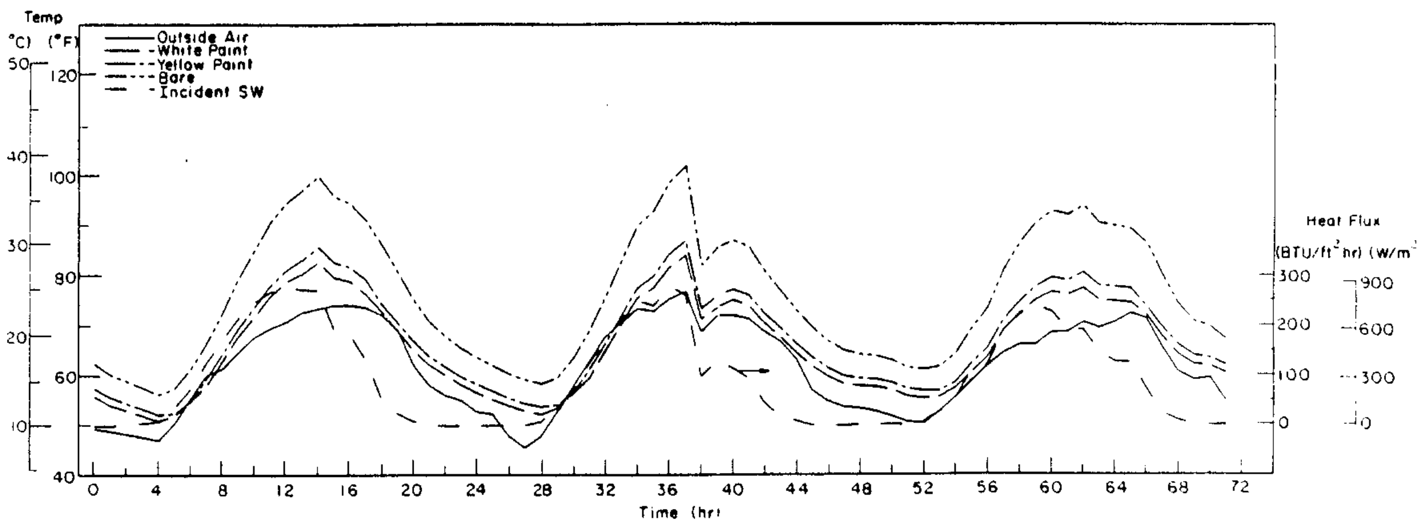


Figure 8. Variations in incident shortwave radiation and temperatures on 6, 7 and 8 August 1982.

DATA ANALYSIS

The mean and design air freezing and thawing indices from observations at the Fairbanks International Airport -- period of record 1950 through 1979 — are:

Mean air freezing index	5760°F-days (3200°C-days)
Design air freezing index	6704°F-days (3724°C-days)
Mean air thawing index	3320°F-days (1844°C-days)
Design air thawing index	3787°F-days (2104°C-days)

Design values were calculated as the average of the three extremes in the 30 years of record.

1982 and 1983 Summers

Air thawing indexes from the Peger Road site and the Fairbanks International Airport for the 1982 and 1983 thawing seasons are shown in Tables 3 and 4. The Fairbanks International Airport is about 2 miles (3 km) west of the Peger Road test site. Air thawing indexes at the Peger Road site and at the Fairbanks International Airport were nearly equivalent during both summers. The 1982 air thawing index was about 7.7% greater than the mean and the 1983 air thawing index was about 8.3% lower.

Monthly surface transfer coefficients and seasonal n-factors, determined from

S = monthly surface thawing index ÷ monthly air thawing index

n = seasonal surface thawing index ÷ seasonal air thawing index

are also shown in Tables 3 and 4.

During the 1982 summer, the n-factor for the bare pavement was 1.63; for the chip seals, n-factors varied from 1.41 to 1.50. For the white-painted and yellow-painted pavements n-factors were 1.22 and 1.30, respectively. During the 1983 summer, the n-factor for the bare pavement was 1.59. For the chip seals, n-factors varied from 1.51 to 1.54. They were 1.46 and 1.48 for the white- and yellow-painted test sections, respectively. As stated previously, the surface treatments were not renewed prior to or during the 1983 thawing season. Wear of the surface treatments due to traffic undoubtedly caused the increased surface transfer coefficients and n-factors on all of the treated test sections during the 1983 summer. The painted surfaces were changed by the largest amounts because paint was almost entirely removed from areas of concentrated traffic, i.e. the wheel tracks.

TABLE 3. 1982 thawing indexes, surface transfer coefficients and n-factors, Peger Road and Fairbanks International Airport.

		Fairbanks S&G				Browns Hill		White Marble	
		E-chips		C-chips		B-chips		C-chips	
Month	Air index (°F-days)	Surface index (°F-days)	S	Surface index (°F-days)	S	Surface index (°F-days)	S	Surface index (°F-days)	S
Apr	59.9	198.1	3.31	165.4	2.76	151.4	2.53	133.6	2.23
May	491.7	850.4	1.73	780.5	1.58	748.8	1.52	755.9	1.54
Jun	851.0	1243.3	1.46	1191.7	1.40	1147.2	1.35	1182.8	1.39
Jul	947.7	1369.3	1.44	1345.7	1.42	1309.4	1.38	1360.5	1.44
Aug	758.9	1062.2	1.40	1048.3	1.38	1033.8	1.36	1077.8	1.42
Sep	464.8	607.5	1.31	599.7	1.29	618.4	1.33	638.3	1.37
Oct	1.4	14.6	10.43	12.6	9.0	15.9	11.36	20.5	14.64
Total	3575.4	5345.4	1.50*	5143.9	1.44*	5024.9	1.41*	5169.4	1.45*
°C-days	1986.3	2969.7		2857.7		2791.6		2791.6	
T_{avg}**	54.1°	62.0		61.1		60.4		61.0	
Start	23 Apr	12 Apr		12 Apr		13 Apr		13 Apr	
End	2 Oct	7 Oct		6 Oct		7 Oct		8 Oct	
Length	162	178		177		177		178	

	White paint		Yellow paint		Bare pavement		Air index, Fairbanks Int'l Airport
Month	Index (°F-days)	S	Index (°F-days)	S	Index (°F-days)	S	(°F-days)
Apr	143.4	2.39	172.6	2.88	219.0	3.66	60.0
May	764.8	1.56	796.5	1.62	859.6	1.75	458.8
Jun	967.6	1.14	1047.5	1.23	1254.0	1.47	795.0
Jul	1080.8	1.14	1152.1	1.22	1378.9	1.46	964.1
Aug	875.5	1.15	914.9	1.21	1092.8	1.44	762.6
Sep	533.3	1.15	547.4	1.18	640.5	1.38	519.0
Oct	9.2	6.57	9.4	6.71	18.9	13.50	9.0
Total	4374.6	1.22*	4640.4	1.30*	5463.7	1.53*	3568.5
°C-days	2430.3		2578.0		3035.4		1982.5
T_{avg}**	57.6		58.7		62.7		53.9
Start	15 Apr		12 Apr		12 Apr		23 Apr
End	3 Oct		3 Oct		7 Oct		3 Oct
Length	171		174		178		163

S = monthly surface index ÷ monthly air index
n = seasonal surface index ÷ seasonal air index

* = n-factor
** = T_{avg} = average temperature during the thawing season.

Table 4. 1983 thawing indexes and n-factors at Peger Road and the Fairbanks International Airport.

		Fairbanks S&G				Browns Hill		White Marble	
Month	Air index (°F-days)	E-chips Surface index (°F-days)	S	C-chips Surface index (°F-days)	S	B-chips Surface index (°F-days)	S	C-chips Surface index (°F-days)	S
April	125.1(15)	224.0	1.79	230.8	1.84	246.4	1.97	242.9	1.94
May	512.2	799.7	1.56	810.2	1.58	831.0	1.62	837.9	1.64
June	581.1	844.3	1.45	855.1	1.47	856.3	1.47	865.3	1.49
July	942.5	1372.0	1.46	1390.9	1.48	1372.4	1.46	1386.6	1.47
August	644.8	932.0	1.45	936.5	1.45	930.8	1.44	930.4	1.44
Sept	226.8	403.3	1.78	403.3	1.78	399.7	1.76	408.3	1.80
Oct	13.0	27.8	2.14	27.1	2.08	27.1	2.08	27.8	2.14
Total	3045.5	4603.1	1.51*	4653.9	1.53*	4663.7	1.53*	4699.2	1.54*
°C-days	1691.9	2557.2		2585.5		2590.9		2610.7	

	White Paint		Yellow Paint		Bare Pavement		Fairbanks International Airport	
Month	index (°F-days)	S	index (°F-days)	S	index (°F-days)	S	index (°F-day)	Number of days
April	220.9	1.77	237.0	1.89	289.5(22)	2.31	197	Varies
May	786.0	1.53	788.1	1.54	880.4	1.72	570	28
June	821.6	1.41	843.3	1.45	887.9	1.53	909	21
July	1309.7	1.39	1327.0	1.41	1397.4	1.48	998	30
Aug	897.2	1.39	909.2	1.41	946.5	1.47	667	31
Sept	382.5	1.69	383.9	1.69	409.4	1.81	276	30
Oct	25.6	1.97	25.6	1.97	27.4	2.11	35	4
Total	4443.5	1.46*	4514.1	1.48*	4838.5	1.59*	3652	
°C-days	2468.6		2507.8		2688.0		2028.9	

Notes.

Thawing indexes at the Fairbanks International Airport for the same days which are missing from Peger Road are:

April	60°F-days
May	56
June	343
July	31
Total	490 °F-days

For the same days as the Peger Road data, the air thawing index at the Fairbanks International Airport was 3162°F-days (1756.7°C-days).

* n-factors

To evaluate differences between the chip seals, we plotted the n-factors and average seasonal surface temperatures against the 80th percentile particle size as determined from the grain size distribution plot for each chip seal. Results are shown in Figure 9.

The color of the chips has a substantial impact on the n-factor and average surface temperature. The size of the chips also appears to be

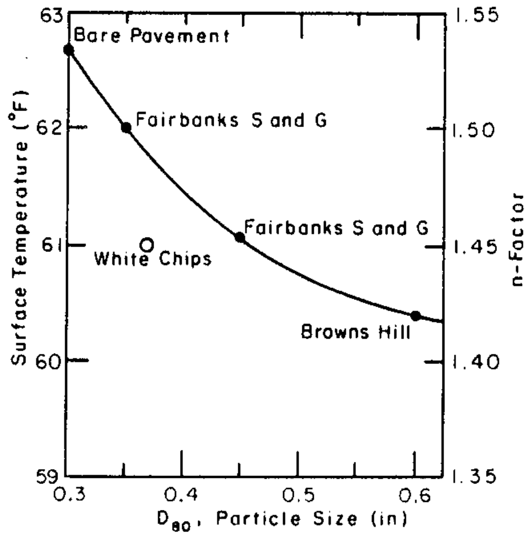


Figure 9. Variation of n-factor with 80th percentile grain size of chip seals.

important. The larger chips have lower n-factors and lower average surface temperatures for the season. Reasons for the decreased n-factors with 80th percentile grain size are not entirely clear. Three possible explanations are: (1) the larger aggregate causes rougher surfaces that are better radiators of long-wave radiation, thereby decreasing the surface temperature; (2) the larger aggregate exposes less of the asphalt, thereby increasing the albedo and reducing the surface temperatures - see Table 5 for albedos; and (3) the surface thermocouple is farther below the surface in the coarser aggregate, thereby causing lower surface temperatures.

On the basis of data from airfield pavement studies in Fairbanks and at Thule, Greenland, the U.S. Departments of the Army and the Air Force (1966) relate summer n-factors to the pavement type and average summer wind speed. The average wind speed measured beyond the zone of traffic-induced turbulence near Peger Road was 0.7 m/s (1.6 mph) for the 1982 summer. For an asphaltic concrete pavement, an n-factor of about 2.8 is obtained from the above reference. This value is nearly two times the n-factor measured at Peger Road.

Air and pavement surface temperatures have recently been measured at several other arctic and subarctic locations. Table 6 contains n-factors that were determined using data gathered from asphaltic concrete pavements. In general, airfield pavements and test sections exhibit the highest n-factors and roadway pavements the lowest. Except for the white painted test section, n-factors measured at Peger Road were significantly lower than those observed at other roadway surfaces.

Table 5. Average monthly measurements of albedo of test sections (albedo values expressed as a percentage of incident shortwave radiation).

Month	Fairbanks E-chips	S&G C-chips	Browns Hill B-chips	White marble C-chips	White paint	Yellow paint	Bare pavement
Apr*	16	17	17	24	24	28	--
May	11	13	13	17	20	19	--
Jun	10	12	14	15	45[1]	41[2]	15
Jul	8	9	9	11	45	38	13
Aug	12[3]	11[4]	12	14	46	44	13
Sep	17	18	19	19	45	42	11[5]
Avg	12	13	14	17	38[6]	35[7]	13

* Days 12-30 only
1 Repainted afternoon 8 June (23 on 1-8 June)
2 Repainted afternoon 8 June (22 on 1-8 June)
3 Additional liquid asphalt and C-chips added on 26 August (13 on 1-26 August)
4 Additional liquid asphalt and C-chips added on 26 August (11 on 1-26 August)
5 Radiometers removed on 24 September
6 45% after 8 June
7 41% after 8 June

Table 6. Summer n-factors for asphalt concrete pavements in arctic and subarctic environments.

Location	Reference	Period of record (yrs)	Type of facility	n-factors Range	n-factors Average
Fairbanks	Berg & Aitken (1973)	1	AT[1]	2.11-2.28	2.19
Fairbanks	Berg & Aitken (1973)	1	RT[2]	1.72-1.96	1.84
Fairbanks	Berg & Aitken (1973)	1	RT	---	0.98[3]
Fairbanks	Lunardini (1978)	1	AT	1.40-2.13	1.92
Inuvik	Johnston (1981)	5	A[4]	1.70-1.89	1.79
Kotzebue	Esch & Rhode (1976)	2	A	1.49-1.72	1.60[5]
Kotzebue	Esch & Rhode (1976)	2	A	1.66-2.00	1.84[6]
Farmers Loop	DOT/PF data	6	R[7]	1.52-1.64	1.62
Parks Hwy	DOT/PF data	7	R	1.59-1.86	1.64
Richardson Hwy	DOT/PF data	2	R	1.58-1.66	1.62

1 Airfield test sections
2 Roadway test sections
3 White-painted pavement
4 Airfield
5 30 cm (12 in.) below pavement surface
6 Insulated pavement
7 Roadway

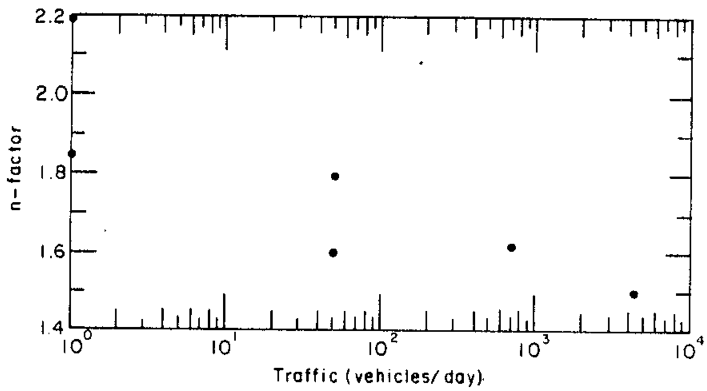


Figure 10. Effect of traffic on n-factors for asphalt concrete pavements.

Airfields and test sections do not receive as much traffic to induce air turbulence as do roadway surfaces. At the location where surface temperatures were measured on the Richardson Highway, approximately 700 vehicles per day use the road. Approximately 4400 vehicles per day use Peger Road. It is unlikely that either the Kotzebue or Inuvik airports have more than 50 aircraft movements per day and probably only one or two vehicles per day use the airfield or roadway test sections. These data imply that turbulence induced by vehicular traffic is an important influence on the n-factor of an asphaltic concrete pavement. In addition, vehicular traffic may indirectly cause the pavement to absorb less solar radiation by wearing the black asphaltic concrete coating off a larger portion of the generally lighter-colored aggregate. Figure 10 illustrates a possible relationship between traffic and n-factor. The n-factor decreases as the amount of traffic, i.e. effective wind speed, increases.

Berg and Aitken (1973) reported that the albedo of the asphaltic concrete test sections was 16%. At Peger Road the albedo averaged 13% (Table 6) on the bare pavement; therefore we conclude that the surface albedo did not cause the lower temperatures observed on Peger Road. Turbulence caused by passing vehicles seems to be the most logical explanation. Since increased turbulence causes increased convective heat loss over the untreated pavement, lower surface temperatures result. Lunardini (1981) also indicates that increased average summer wind speeds cause reduced surface thawing indexes.

Surface temperatures on the white-painted test section on Peger Road resulted in an n-factor of 1.22 for the 1982 season. Berg and Aitken

(1973) reported an n-factor of 0.98 and an albedo of 66% for the white-painted test section in their study. The albedo for the white-painted test section on Peger Road averaged 38% for the entire thawing season and 45% after the test section was repainted on 8 June (Table 3). The most probable cause of the reduced albedo on Peger Road was degradation of the paint coating due to traffic. The reduced albedo is indicative of a larger amount of shortwave radiation absorbed at the pavement surface, which causes higher surface temperatures and larger n-factors.

The yellow-painted test section on Peger Road reflected nearly as much radiation as the white-painted test section. The albedo averaged 35% for the entire summer and 41% after it was repainted on 8 June. The n-factor for the yellow-painted test section was 1.30, only slightly larger than that for the white-painted section. The larger n-factor results from a lower albedo on the yellow-painted section.

None of the chip seals reduced the surface temperatures as much as the white or yellow paint. During the 1982 summer, the Browns Hill B-chips were most effective of the seals. They were also the largest and were applied with the highest application rate of asphalt. The Fairbanks S&G and the white marble C-chips resulted in about the same n-factor. The white marble chips fractured due to traffic loadings. Had they remained intact they probably would have been more effective than the darker colored chips. The Fairbanks S&G E-chips were the least effective chip seal. The application rate of liquid asphalt in 1981 was inadequate to properly bond the Fairbanks S&G E-chips to the pavement; approximately half the chips were quickly dislodged by traffic, exposing the bonding layer of asphalt and lowering the albedo.

White and yellow paints were applied twice to the roadway (the fall of 1981 and early summer 1982); each coat was approximately 0.2 mm (0.01 in.) thick. Annual repainting would be necessary to provide consistent coverage of roadways, especially in the wheel paths. Painting should be completed early in the thawing season to avoid damage by studded tires and to provide the maximum protection during the summer months.

Figure 11 shows two linear relationships between the albedo of the pavement and the surface transfer coefficient. Average monthly data were used to construct the figure. Correlation coefficients from the linear regressions indicate very good correlation at each of the test sites, but different relationships were determined for the Highway Test Sections

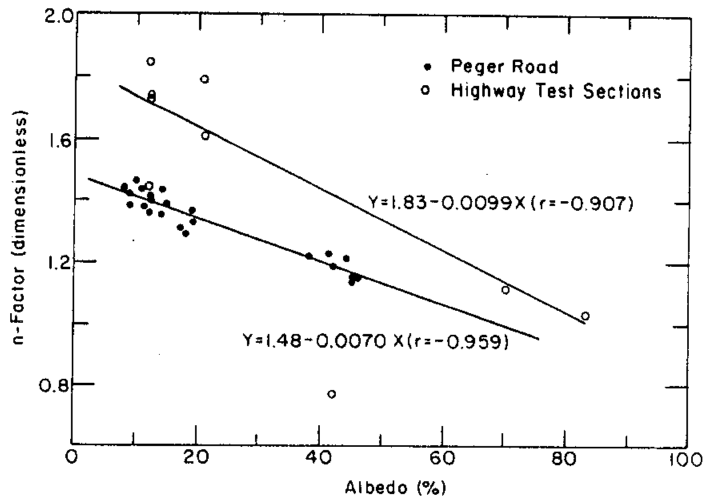


Figure 11. Influence of albedo on the n-factors of pavements at Peger Road and the Highway Test Sections.

(Berg and Aitken 1973) and the Peger Road test site. Since the surface transfer coefficients from the Peger Road site are generally lower than values at similar albedos from the Highway Test Sections, some other influence, probably traffic-induced turbulence, caused the different coefficients.

Prior to further investigation of the influence of traffic on the n-factors, two other possible causes for differences in the n-factors between Peger Road and the Highway Test Sections were investigated. Precipitation and the amount of sky cover are measured by the National Weather Service at the Fairbanks International Airport. A significantly greater number of days having precipitation could reduce the surface temperatures because more thermal energy would be required to dry the pavement. A significant increase in the amount of sky cover could also reduce surface temperatures because a smaller amount of shortwave radiation would be received at the surface. Table 7 lists the average amount of sky cover for the months of April through September during the years 1970 through 1983. Table 8 lists the number of days having more than 0.01 in. of rain for the same period. Data in Table 7 indicate that the average amount of sky cover for both the 1982 and 1971 summers was approximately the same. The amount of sky cover during the months of May, July and August was greater in 1971, but the other three months averaged greater sky cover during the 1982 summer. Data in Table 8 indicate that the number of days with more than 0.01 in. of precipitation was greater than average in 1982 and less than

Table 7. Average amount of sky cover measured by the National Weather Service at the Fairbanks International Airport.

Year	April	May	June	July	August	September	Average
				Month			
1983	6.5	6.1	6.8	7.1	9.0	8.0	7.2
1982	7.8	7.5	7.4	7.5	7.0	8.6	7.6
1981	4.8	6.8	7.0	9.0	7.3	8.4	7.2
1980	6.9	7.5	8.9	7.4	8.1	6.8	7.6
1979	6.4	6.1	8.2	7.2	7.8	6.9	7.1
1978	5.2	6.5	8.3	7.5	6.5	7.9	7.0
1977	7.1	7.5	7.2	5.9	6.8	8.6	7.2
1976	6.0	7.1	6.7	7.0	6.4	7.1	6.7
1975	6.5	6.8	8.1	7.0	8.2	7.7	7.4
1974	5.3	5.1	7.3	7.2	7.2	6.0	6.4
1973	6.9	7.6	7.9	8.1	8.7	7.6	7.8
1972	6.6	7.0	6.9	6.9	7.4	7.0	7.0
1971	7.2	8.2	6.5	8.1	8.1	7.3	7.6
1970	8.0	7.4	8.4	8.4	8.6	8.2	8.2
Average	6.5	6.9	7.5	7.4	7.6	7.6	7.2

Table 8. Number of days having precipitation greater than 0.01 in. Measurements by the National Weather Service at the Fairbanks International Airport.

Year	April	May	June	July	August	September	Total
				Month			
1983	7	7	8	15	21	14	72
1982	8	15	10	17	12	11	73
1981	4	6	13	21	14	12	70
1980	4	4	11	16	19	11	65
1979	10	9	19	15	8	6	67
1978	5	7	16	10	9	10	57
1977	8	13	12	11	6	17	67
1976	2	16	8	12	5	7	50
1975	7	7	11	9	15	11	63
1974	2	2	9	10	11	7	41
1973	2	9	10	14	10	7	52
1972	9	3	10	11	15	12	60
1971	2	8	8	13	14	12	57
1970	8	7	18	16	16	14	79
Average	6	8	12	14	12	11	63

average in 1971. Most of the difference, however, occurred during April and May when the number of thawing degree-days was relatively small. Neither the data in Table 7 nor the data in Table 8 indicate a strong reason for the differences in n-factors between Peger Road and the Highway Test Sections. Turbulence caused by traffic still seems to be the most probable reason for the differences.

Energy Balance Technique. The energy balance at the air/ground interface is determined from:

$$0 = Q_s - Q_r + Q_w - Q_e \pm Q_c \pm Q_l \pm Q_u \pm Q_m \pm Q_g \pm Q_i \ . \tag{1a}$$

Individual heat fluxes are due to:

Q_s = incident shortwave radiation

Q_r = reflected shortwave radiation

Q_w = longwave radiation emitted by the atmosphere

Q_e = longwave radiation emitted by the earth

Q_c = convection

Q^l = evaporation, condensation, sublimation, and evapotranspiration

Q_u = conduction into air

Q_m = mass flow to surface (precipitation)

Q_g = conduction into ground

Q_i = heat flux due to infiltration of moisture into ground.

Units are Btu/ft^2-day. Components carrying heat toward the surface are positive, those carrying heat away from the surface are negative, and those that may flow in either direction are shown with both signs.

The thermal conductivity of air is very small and heat conduction into the air is generally neglected (Sellers 1965). Asphalt concrete is relatively impervious to moisture so that heat flux by infiltration is neglected in this study. Energy flux due to precipitation is also neglected and we assume that the evaporative term is negligible since the surface is paved. Equation 1a can then be rewritten:

$$0 = Q_s - Q_r + Q_w - Q_e \pm Q_c \pm Q_g \ . \tag{1b}$$

The shortwave radiation terms can be combined into one term using the albedo, A, of the surface:

$$0 = Q_s(1-A) + Q_w - Q_e \pm Q_c \pm Q_g \ . \tag{1c}$$

Neglecting the effects of cloud cover, we can approximate the net longwave radiation by the following equation (Berg 1974):

$$Q_w - Q_e = 2.85 \times 10^{-8} \left(T_{aa}^4 - 1.37\ T_{sa}^4\right) \tag{2}$$

where

T_{aa} = average air temperature, °R (°F + 459.7)

T_{sa} = average surface temperature, °R (°F + 459.7).

Equation 1c can then be further simplified to:

$$0 = Q_s\ (1-A) + 2.84 \times 10^{-8} \left(T_{aa}^4 - 1.37\ T_{sa}^4\right) \pm Q_c \pm Q_g\ . \tag{1d}$$

Since we are considering summer temperatures on the surface of an asphaltic concrete pavement, the convective term is negative because the surface temperature is greater than the air temperature and heat is lost from the pavement surface to the surrounding air. Convective heat flux is calculated from

$$Q_c = h\ (T_s - T_a) \tag{3}$$

where h = heat transfer coefficient, Btu/ft^2-day-°F

T_s = average surface temperature, °F

T_a = average air temperature, °F.

The heat transfer coefficient is a function of the wind speed over the surface. The effective wind speed is required for the present situation because traffic causes turbulence, which acts on the surface as a wind of some unknown velocity.

Q_g is negative because the surface temperature is larger than the subsurface temperatures, therefore we can now rewrite eq 1d in the final form to be used in this study:

$$0 = Q_s\ (1-A) + 2.85 \times 10^{-8} \left(T_{aa}^4 - 1.37\ T_{sa}^4\right) - h(T_s - T_a) - Q_g\ . \tag{1e}$$

Sutton (1953) and others have estimated that approximately 10% of the incoming shortwave radiation is conducted into the underlying soil during the summer months. For illustrative purposes, we assume that 10% of the thermal energy from shortwave radiation incident on an untreated pavement surface is lost by heat conduction into the soil underlying the untreated pavement. A value of 6% is used for the white-painted pavement. Equation le may be rewritten for an untreated pavement and for a white-painted pavement. The two equations may then be equated:

$$Q_s(1-A_B) - Q_{gB} + 2.85 \times 10^{-8}\, T^4_{aa} - 3.90 \times 10^{-8}\, T^4_{saB} - hT_{sB} + h\, T_a$$

$$= Q_s(1-A_w) - Q_{gw} + 2.85 \times 10^{-8}\, T^4_{aa} - 3.90 \times 10^{-8}\, T^4_{saw} - hT_{sw} + h\, T_a \;. \qquad (4)$$

By including $Q_{gB} = 0.1\ Q_s$

and $Q_{gw} = 0.06\ Q_s$

and simplifying eq 4 we obtain:

$$h = \left[-3.90\text{x}10^{-8}\ (T^4_{saB} - T^4_{saw}) + Q_s(A_w - A_B - 0.04)\right]/(T_{sB} - T_{sw}). \qquad (4a)$$

At Peger Road average values for A_W and A_B during the 1982 summer were 0.45 and 0.15, respectively. Equation 4a reduces to

$$h_P = \left[-3.90\text{x}10^{-8}\ (T^4_{saB} - T^4_{saw}) + 0.26\ Q_s\right]/(T_{sB} - T_{sw}) \;. \qquad (4b)$$

At the Highway Test Sections on Farmers Loop Road A_W and A_B averaged 0.55 and 0.15, respectively, during the 1971 summer. Substituting these values into eq 4a, we obtain:

$$h_H = \left[-3.90\text{x}10^{-8}\ (T^4_{ssB} - T^4_{saw}) + 0.36\ Q_s\right]/(T_{sB} - T_{sw}) \;. \qquad (4c)$$

Eight days were chosen from the data at Peger Road in 1982 and eight days were chosen from data taken at the Highway Test Sections in 1971. Surface temperatures and the daily totals of incident shortwave radiation are shown in Table 9, as are computed values for the heat transfer coefficient, h. Average daily wind speeds are also shown in Table 9. The calculated heat transfer coefficients from Peger Road are generally much larger than those from the Highway Test Sections. Wind speeds measured near the test site and wind speeds measured at the Fairbanks International Airport are both shown. Wind speeds at the airport are significantly greater than those at the test sites because the airport has no trees to reduce the wind velocities near the ground surface but short trees and shrubs were adjacent to the pavements at both test sites.

The convective heat transfer coefficient is generally considered to increase with increasing wind speeds (Berg 1974, Scott 1970a,b, Sellers 1965). Since the coefficients were greater for the Peger Road site, we can

Table 9. Heat transfer coefficients at Peger Road and at the Highway Test Sections.

Date	T_B (°F)	T_w (°F)	Q_s (Btu/ft^2-day)	W_A (mps)	W_s (mph)	h (Btu/ft^2-°F-day)
			Peger Road 1982			
16 June	57.2	52.8	1002	5.5	1.1	37.9
21 June	74.9	61.4	2780	5.5	0.9	30.6
28 June	86.9	74.1	2546	9.9	3.6	27.1
29 June	86.0	72.2	3049	9.1	2.1	33.0
2 July	83.2	68.7	3205	3.2	0.9	33.5
26 July	68.9	61.7	1733	4.8	1.1	40.0
30 July	68.1	62.7	1357	12.5	3.5	42.8
5 August	74.4	64.9	2194	4.8	0.7	36.9
			Average	6.9	1.7	35.2
			Highway Test Sections 1971			
27 June	92.5	68.5	2551	10.2	3	13.7
8 July	89.0	66.0	1851	6.5	1	4.8
9 July	88.5	64.5	2280	7.1	1	10.1
14 July	88.6	67.5	2090	7.2	2	11.6
1 August	72.5	57.0	981	6.0	0	0.2
2 August	74.5	54.5	1460	10.4	2	3.8
14 August	68.0	51.0	1458	11.5	3	9.0
			Average	8.6	1.6	7.2

T_B = Average surface temperature of untreated pavement
T_w = Average surface temperature of white-painted pavement
Q_s = Total incident shortwave radiation
W_A = Average wind speed, Fairbanks International Airport
W_s = Average wind speed at test site
h = Convective heat transfer coefficient

conclude that the "effective" wind speeds were greater there than at the Highway Test Sections.

Linear Regressions. The most easily applied method for estimating average daily pavement surface temperatures is to relate them to the daily quantity of absorbed shortwave radiation. Berg and Quinn (1976) used this method and developed a family of lines for different wind speeds. Gold (1967) used a similar procedure, but related average monthly temperatures and monthly totals of absorbed shortwave radiation.

During the 1982 summer, surface temperature and radiation data are available for a total of 51 days in June, July and August. Average values

Table 10. Linear regressions relating the difference between measured air and surface temperatures to absorbed shortwave radiation at Peger Road.

Data	a	$bx10^{-2}$	σ	R	V	DF	Regression number
All data	1.010	0.5718	2.98	0.765	28.8	356	1
All weekdays	0.988	0.5653	2.98	0.754	28.7	237	2
All weekends	0.979	0.5905	2.96	0.787	29.1	118	3
Dry days	-1.654	0.6744	3.17	0.746	28.0	195	4
Dry weekdays	-2.124	0.6812	3.02	0.765	27.1	139	5
Dry weekends	-1.038	0.6825	3.40	0.729	29.1	55	6
Dry days, wind speed between 0 and 0.5 mph	-6.787	1.0234	1.13	0.945	11.1	13	7
Dry days, wind speed between 0.5 and 1.5 mph	-0.968	0.6304	3.49	0.707	30.7	118	8
Dry days, wind speed between 1.5 and 2.5 mph	-2.676	0.7352	2.80	0.809	24.4	55	9
Dry days, wind speed greater than 2.5 mph	-13.936	1.3248	1.15	0.972	9.6	6	10

Equation: $Y = a + bx$

σ = standard deviation of Y
R = correlation coefficient
V = coefficient of variation
DF = degrees of freedom

for the albedo for each of the test sections were used with the measured average daily surface and air temperatures and measured daily quantities of incoming shortwave radiation to create an input data file for linear regressions. Table 10 contains results from the regressions.

The first regression was completed using all of the data. The following general equation was used:

$$\Delta T = a + b\, Q_A \qquad (5)$$

where

$\Delta T = T_s - T_a$, °F

T_s = average daily surface temperature, °F

T_a = average daily air temperature, °F

Q_A = total daily absorbed shortwave radiation, Btu/ft^2

and a and b are the regression coefficients.

The standard deviation was 2.98°F and the correlation coefficient was 0.765. Both of these values indicated that the data were reasonably well represented by the linear regression. It was anticipated that fewer vehicles used the road on weekends; therefore, weekdays and weekends and holidays were separated and two more linear regressions, numbers 2 and 3 in Table 10, were completed. Results were not significantly improved because the standard deviations and correlation coefficients were nearly equal to regression number 1.

We thought that using data from only dry days would improve the linear relationships discussed above. Data from regression numbers 4, 5 and 6 in Table 10 are results from these trials. The correlation coefficients were equal to or less than the coefficient for regression number 1 and the standard deviations were all larger than those from the initial regression. At this point no significant improvement was evident using data from only the dry days. However, since the influence of wind speed would not be masked by wet surfaces resulting from rain at different times of the day, it was decided to run additional regressions on data from the dry days. Four intervals of wind speeds were arbitrarily chosen: 0 to 0.5 mph, 0.5 to 1.5 mph, 1.5 to 2.5 mph and greater than 2.5 mph. Results are shown for regressions 7 through 10 in Table 10. Correlation coefficients for the lowest and highest wind speeds were significantly greater than when all of the data were used; unfortunately these data sets contained information from only one or two different days. The standard error for the largest data set, 0.5 to 1.5 mph wind speeds, was larger than that from the initial data set when all wet and dry days were used.

Since placing all of the data in one group, regression number 1, provides standard errors about equivalent to or less than other groups of data, it was concluded that the measured average daily wind speeds did not significantly affect the relationship between temperature difference and absorbed shortwave radiation. The lack of correlation with wind speeds measured near the test site is a further indication that traffic-induced turbulence was more important than naturally occurring wind.

1982-1983 Winter

Air and surface freezing indexes, surface transfer coefficients and n-factors for the 1982-1983 winter are shown in Table 11. Air freezing indexes were calculated for both the Peger Road test site and the Fairbanks

Table 11. 1982-1983 freezing indexes and n-factors at Peger Road and the Fairbanks International Airport.

		Fairbanks S&G				Browns Hill	
		E-chips		C-chips		B-chips	
Month	Air index (°F-days)	Surface index (°F-days)	Surface transfer coefficient	Surface index (°F-days)	Surface transfer coefficient	Surface index (°F-days)	Surface transfer coefficient
Oct	561.1	384.0	0.68	393.0	0.70	378.2	0.67
Nov	885.0	762.0	0.86	774.0	0.87	765.0	0.86
Dec	1035.4	961.0	0.93	970.3	0.94	964.1	0.93
Jan	1463.2	1326.8	0.91	1329.9	0.91	1320.6	0.90
Feb	876.4	817.6	0.93	806.4	0.92	786.8	0.90
Mar[1]	547.8	444.4	0.81	426.8	0.78	413.6	0.76
Apr[2]	136.3						
Total	5505.2	4695.8		4700.4		4628.3	
°C-days	3058.4	2608.8		2611.3		2671.3	
n-factor		0.85		0.85		0.84	
Start	1 Oct 82	3 Oct 82		3 Oct 83		3 Oct 82	
End	13 Apr 83	3 Apr 83[3]		3 Apr 83[3]		3 Apr 83[3]	
Length	195 days	182 days		182 days		182 days	

	White Marble		White Paint		Yellow Paint	
	C-chips		C-chips		B-chips	
Month	Surface index (°F-days)	Surface transfer coefficient	Surface index (°F-days)	Surface transfer coefficient	Surface index (°F-days)	Surface transfer coefficient
Oct	368.3	0.66	397.3	0.71	397.3	0.71
Nov	765.0	0.86	750.0	0.85	765.0	0.86
Dec	982.7	0.95	961.0	0.93	967.2	0.93
Jan	1360.9	0.93	1305.1	0.93	1329.9	0.91
Feb	837.2	0.96	823.2	0.94	806.4	0.92
Mar[1]	457.6	0.84	446.6	0.82	448.8	0.82
Apr[2]						
Total	4771.7		4683.2		4714.6	
°C-days	2650.9		2601.8		2619.2	
n-factor	0.87		0.85		0.86	
Start	3 Oct 82		3 Oct 83		3 Oct 82	
End	3 Apr 83[3]		3 Apr 83[3]		3 Apr 83[3]	
Length	182 days		182 days		182 days	

1 Data missing for 23-31 March, 9 days
2 Data missing for 1-4 April, 4 days
3 Estimated from air temperatures at Fairbanks International Airport
4 Data for entire month of March
5 Data for entire period 1-13 April

Table 11 (cont'd). 1982-1983 freezing indexes and n-factors at Peger Road and the Fairbanks International Airport.

Month	Bare Pavement: Surface index (°F-days)	Bare Pavement: Surface transfer coefficient	Fairbanks International Airport air index (°F-days)
Oct	377.0	0.61	427.6
Nov	753.0	0.85	828.0
Dec	982.7	0.95	923.8
Jan	1326.8	0.91	1333.0
Feb	786.8	0.90	800.8
Mar[1]	393.8	0.72	564.2[4]
Apr[2]			30.0[5]
Total	4620.1		4907.4
°C-days	2566.7		2726.3
n-factor	0.84		--
Start	3 Oct 82		3 Oct 83
End	3 Apr 83[3]		3 Apr 83[3]
Length	182 days		192 days

[1] Data missing for 23-31 March, 9 days
[2] Data missing for 1-4 April, 4 days
[3] Estimated from air temperatures at Fairbanks International Airport
[4] Data for entire month of March
[5] Data for entire period 1-13 April

International Airport. The Peger Road site was significantly colder than the airport because the seasonal freezing index was about 12% larger. The air freezing indexes for both locations for each month are also shown in Table 11. The Peger Road site is colder every month for which complete records are available.

The n-factors for the test sections varied from 0.84 on the Browns Hill B-chips and the bare pavement to 0.87 on the white marble chips. The variation in wintertime n-factors is much less than that observed during the summer, primarily because much less incident shortwave radiation is available at the pavement surface during the winter. The fact that the wintertime n-factors are less than 1.0 indicates that the surface temperatures are higher than the air temperatures during the winter as well as during the summer.

The monthly surface transfer coefficients were greatest during the months having the least amount of incident shortwave radiation.

Table 12. Winter n-factors for asphalt concrete pavements in arctic and subarctic environments.

Location	Reference	Period of record (yr)	Type of Facility	n-factors Range	n-factors Average
Fairbanks	ACFEL (1950)	1	AT[1]	0.65-0.78	0.69
Inuvik	Johnston (1981)	5	A[2]	0.88-0.95	0.92
Chitna	Esch (1973)	1	R[3]	---	1.00
Farmers Loop Road	DOT/PF data	6	R		0.88
Parks Highway	DOT/PF data	7	R		1.03
Richardson Highway	DOT/PF data	2	R		0.97

[1] Airfield test sections

[2] Airfield

[3] Roadway

Values for the wintertime n-factors are slightly lower than the value of 0.90 which the Departments of the Army and Air Force (1966) currently recommend.

Table 12 contains wintertime n-factors observed by other investigators. The table contains only data for pavements in arctic and subarctic environments.

CONCLUSIONS

In this study, white or yellow paint applied to the pavement surface reduced surface temperatures, surface transfer coefficients and n-factors more than any of the chip seals.

The chip seal treatments were only marginally effective in changing the average daily surface temperature of the asphalt concrete pavement. Because of chip losses under traffic, they all lost some of their effectiveness shortly after being exposed to traffic. The data obtained were therefore not representative of the true thermal effects of well-bonded chip seal treatments.

The white- and yellow-painted pavements were effective in 1982. However, the painted surfaces lost considerable effectiveness during the 1983 summer because they were not repainted. If painted surfaces are used on well-traveled highways, the pavements will probably need to be repainted every year.

The unpainted pavement exhibited a lower n-factor, i.e. lower surface temperatures, than similar pavements that did not have vehicular traffic passing over them. The vehicles caused air turbulence that more effectively mixed the air above the pavement with warmer air at the pavement, thereby causing the reduced surface temperatures.

Comparing these results with those reported by Berg and Aitken (1973) indicates that painted treatments may be more effective in remote areas and on airfield pavements where the volume of traffic is inadequate to cause rapid degradation of the paint and wear from studded tires is not a problem. Airfield pavements may require repainting once every 5 years or more, but roadways will probably require repainting every year, due primarily to removal of paint by studded tires.

Asphaltic concrete airfield pavements probably remain "blacker" because less tire abrasion removes the asphalt coating from the aggregate. This may contribute to larger n-factors at airfields than on roads.

The data obtained at Peger Road and at other arctic and subarctic sites indicate that traffic-induced air turbulence reduces thawing season n-factors; i.e. the numerical value of the n-factor decreases with increasing volumes of traffic.

The benefits of different textures of chip seals, resulting from different sizes of rock chips, were found to be significant. The coarse (3/4-in. maximum) rock B-chip section had a 6% lower seasonal n-factor and a 1.6°F lower average thawing season surface temperature than the adjacent fine (3/8-in. maximum) E-chip section. The effects of chip color were not as significant as those of chip size. The largest chips had the lowest surface temperature.

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APPENDIX A

AVERAGE DAILY TEMPERATURES FROM 1982

EFFECT OF COLOR AND TEXTURE ON THE SURFACE TEMPERATURE OF ASPHALT CONCRETE PAVEMENTS

PEGER ROAD SITE
MAR 1982

DAY	AIR	FINE-ST*D	ST*D-CHIPS	GRAY-CHIPS	WHT-CHIPS	WHT-PAINT	YEL-PAINT	BARE-PAVMNT	SW VERT	SW REFL	IR IN	IR OUT	WIND SPEED M/HR
	TEMPERATURE IN DEGREES F								***RADIATION BTU/SQ FT HR***				
1	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
2	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
3	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
4	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
5	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
6	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
7	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
8	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
9	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
10	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
11	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
12	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
13	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
14	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
15	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
16	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
17	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
18	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
19	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
20	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
21	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
22	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
23	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
24	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
25	10.3	20.0	17.6	18.2	17.6	18.8	20.0	20.5	-0.5	-0.2	-0.4	-0.7	2.9
26	8.7	18.5	16.7	16.7	15.6	16.6	17.8	19.4	-1.5	-0.7	-1.4	-2.4	0.5
27	7.4	18.9	17.6	17.4	15.4	16.1	17.5	19.8	-1.4	-0.7	-1.3	-2.3	2.1
28	8.4	20.2	19.2	18.8	16.4	16.6	18.6	21.2	-1.4	-0.7	-1.3	-2.4	0.3
29	9.5	21.0	19.7	19.3	17.3	17.9	19.5	22.1	-1.5	-0.8	-1.4	-2.4	1.0
30	5.1	18.2	16.7	16.5	14.8	15.4	16.9	19.2	-1.5	-0.7	-1.3	-2.5	1.0
31	1.1	15.1	13.5	13.3	11.4	11.9	13.6	16.2	-1.4	-0.7	-1.3	-2.4	0.9
MAX	10.3	21.0	19.7	19.3	17.6	18.8	20.0	22.1	-0.5	-0.2	-0.4	-0.7	2.9
MIN	1.1	15.1	13.5	13.3	11.4	11.9	13.6	16.2	-1.5	-0.8	-1.4	-2.5	0.3
AVG	7.2	18.8	17.3	17.2	15.5	16.2	17.7	19.8					1.2
TOT									-9.0	-4.6	-8.3	-15.2	
INDX	-24.8	-13.2	-14.7	-14.8	-16.5	-15.9	-14.3	-12.2					
-N-	1.0	0.5	0.6	0.6	0.7	0.6	0.6	0.5					

EFFECT OF COLOR AND TEXTURE ON THE SURFACE TEMPERATURE OF ASPHALT CONCRETE PAVEMENTS

PEGER ROAD SITE
APR 1982

DAY	AIR	FINE-ST'D	ST'D-CHIPS	GRAY-CHIPS	WHT-CHIPS	WHT-PAINT	YEL-PAINT	BARE-PAVMNT	SW VERT	SW REFL	IR IN	IR OUT	WIND SPEED M/HR
	---TEMPERATURE IN DEGREES F---								***RADIATION BTU/SQ FT HR***				
1	1.7	14.7	13.1	12.8	11.0	11.5	13.1	15.8	-1.4	-0.7	-1.3	-2.4	0.7
2	3.1	15.8	14.3	13.6	12.0	12.4	14.1	17.0	-1.5	-0.7	-1.3	-2.5	0.5
3	5.6	17.5	16.1	15.5	13.6	14.1	15.8	18.7	-1.6	-0.8	-1.4	-2.6	0.2
4	17.0	24.5	23.6	22.8	20.7	21.1	22.9	25.5	-1.6	-0.8	-1.4	-2.6	0.5
5	31.6	32.2	32.0	31.4	29.9	30.7	31.8	33.4	-1.6	-0.8	-1.3	-2.5	0.3
6	41.4	40.2	40.2	39.1	37.5	38.4	39.1	42.1	-1.6	-0.7	-1.3*	-2.4	0.3
7	35.9	35.2	35.3	34.9	34.5	34.9	35.2	36.0	-0.7	-0.3	-0.6	-1.0	4.5
8	28.4	40.3	37.3	36.3	35.5	36.4	38.1	41.5	-0.9	-0.4	-0.7	-1.4	1.7
9	22.1	33.6	31.8	31.5	30.6	31.2	32.4	34.9	-1.7	-0.8	-1.4	-2.6	2.1
10	15.8	27.3	26.0	26.0	24.9	25.1	26.3	28.5	-0.8	-0.4	-0.7	-1.2	1.1
11	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
12	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
13	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
14	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
15	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
16	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
17	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
18	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
19	30.9	37.6	35.9	35.6	34.6	35.0	36.1	38.5	-0.5	-0.2	-0.4	-0.8	0.9
20	28.2	32.9	32.4	31.9	32.0	32.3	32.6	33.9	-1.8	-0.8	-1.4	-2.7	2.1
21	25.5	36.5	34.3	33.8	33.1	33.7	34.9	37.5	-1.6	-0.8	-1.4	-2.5	1.4
22	30.5	40.6	38.6	37.9	36.7	37.3	38.8	41.8	-1.8	-0.9	-1.4	-2.6	1.5
23	36.4	44.2	42.6	41.7	40.4	41.4	42.9	45.5	-1.8	-0.8	-1.4	-2.6	0.3
24	39.1	49.7	48.0	46.9	45.6	46.5	48.2	51.0	-1.7	-0.8	-1.4	-2.5	1.1
25	40.3	47.2	46.1	45.2	43.5	44.5	46.1	48.5	-1.7	-0.7	-1.4	-2.5	0.5
26	40.6	50.7	49.2	48.0	46.7	48.2	49.7	52.2	-1.7	-0.8	-1.4	-2.5	1.4
27	43.6	51.9	50.3	49.4	48.1	49.2	50.5	52.8	-1.6	-0.7	-1.3	-2.4	1.4
28	43.6	52.2	50.7	49.7	48.9	50.0	51.0	53.1	-1.6	-0.8	-1.4	-2.4	1.6
29	38.9	48.1	46.6	46.0	45.4	46.4	47.5	48.9	-1.2	-0.6	-1.1	-2.1	2.3
30	33.6	42.0	40.7	39.6	39.8	40.6	41.2	42.6	-1.4	-0.7	-1.3	-2.4	1.8
MAX	43.6	52.2	50.7	49.7	48.9	50.0	51.0	53.1	-0.5	-0.2	-0.4	-0.6	4.5
MIN	1.7	14.7	13.1	12.8	11.0	11.5	13.1	15.8	-1.8	-0.9	-1.4	-2.7	0.2
AVG	28.8	37.0	35.7	35.0	33.9	34.6	35.8	38.2					1.3
TOT									-31.5	-15.2	-26.8	-49.0	
INDX	-3.2	5.3	3.7	3.0	1.5	2.6	3.8	6.2					
-N-	1.0	-1.6	-1.2	-0.9	-0.6	-0.8	-1.2	-1.9					

EFFECT OF COLOR AND TEXTURE ON THE SURFACE TEMPERATURE OF ASPHALT CONCRETE PAVEMENTS

PEGER ROAD SITE
MAY 1982

DAY	AIR	FINE-ST'D	ST'D-CHIPS	GRAY-CHIPS	WHT-CHIPS	WHT-PAINT	YEL-PAINT	BARE-PAVMNT	SW VERT	SW REFL	IR IN	IR OUT	WIND SPEED M/HR
	----- TEMPERATURE IN DEGREES F -----								***RADIATION BTU/SQ FT HR***				
1	36.5	46.0	44.1	43.1	43.2	43.9	44.7	46.5	-1.4	-0.7	-1.3	-2.4	2.2
2	33.8	47.4	45.1	44.4	44.0	44.7	45.9	47.9	-1.4	-0.7	-1.3	-2.4	2.7
3	36.5	48.5	46.0	45.2	44.8	46.2	47.4	49.6	-1.4	-0.7	-1.3	-2.4	1.0
4	35.2	51.6	49.1	46.3	47.7	49.1	50.3	52.8	-1.4	-0.8	-1.3	-2.4	0.9
5	43.9	54.4	51.9	51.0	50.3	51.4	52.4	54.9	-1.5	-0.7	-1.3	-2.4	3.9
6	48.6	58.8	56.4	55.4	54.8	55.6	56.7	59.2	-1.4	-0.7	-1.3	-2.4	1.6
7	46.7	60.1	57.5	56.5	55.9	57.1	58.2	60.8	-1.4	-0.7	-1.4	-2.4	0.8
8	47.6	59.2	57.0	56.1	55.5	56.4	57.5	59.8	-1.4	-0.7	-1.4	-2.4	2.1
9	49.2	56.8	55.3	54.5	54.0	54.3	55.4	57.3	-1.5	-0.7	-1.4	-2.4	1.1
10	49.1	57.5	55.9	55.1	54.7	55.4	56.4	58.2	-1.5	-0.7	-1.4	-2.4	1.0
11	43.9	50.6	49.4	48.7	48.8	48.7	49.4	50.6	-1.5	-0.7	-1.4	-2.4	1.5
12	43.5	50.5	49.0	48.1	48.3	48.3	49.0	50.5	-1.6	-0.7	-1.4	-2.4	0.4
13	45.1	54.0	52.1	51.3	51.2	51.0	51.9	53.8	-1.5	-0.7	-1.3	-2.2	1.6
14	45.2	55.0	53.1	52.3	52.3	52.4	53.4	55.4	-1.6	-0.7	-1.4	-2.4	1.2
15*	36.0	43.7	42.6	42.9	42.6	41.5	42.6	44.0	-1.2	-0.5	-0.9	-1.6	1.9
16*	39.1	49.2	47.4	47.3	47.2	46.1	47.5	49.7	-1.8	-0.8	-1.5	-2.6	1.9
17*	42.9	51.2	49.6	49.7	49.6	48.4	49.7	51.5	-1.8	-0.9	-1.5	-2.6	3.6
18*	44.5	53.5	51.4	51.4	41.4	50.5	51.8	53.5	-0.9	-0.5	-0.8	-1.3	2.7
19*	37.8	46.6	47.0	47.2	47.1	45.9	47.2	49.0	-1.5	-0.8	-1.4	-2.5	1.6
20*	42.4	49.7	48.7	48.4	48.6	49.8	49.0	50.0	-1.6	-0.8	-1.4	-2.5	2.6
21*	37.9	46.6	45.4	45.4	45.7	44.7	45.8	57.1	-1.7	-0.8	-1.5	-2.5	2.6
22*	37.1	47.0	45.6	45.7	45.7	44.5	45.6	47.5	-1.7	-0.8	-1.5	-2.5	1.0
23*	44.7	55.0	53.1	53.2	52.9	51.3	53.1	55.4	-1.6	-0.8	-1.2	-2.4	1.3
24*	45.9	52.0	50.7	50.3	50.9	50.3	50.9	52.2	-1.6	-0.8	-1.5	-2.5	1.7
25*	46.5	53.7	52.1	52.1	52.6	51.9	52.7	54.1	-1.6	-0.8	-1.4	-2.5	3.9
26*	48.6	57.8	56.4	56.1	56.4	55.3	56.3	58.2	-1.1	-0.6	-1.0	-1.6	3.0
27*	49.0	56.9	55.4	55.7	56.1	55.0	55.4	57.3	-0.6	-0.3	-0.5	-0.9	7.3
28*	41.2	51.3	50.0	49.8	50.3	49.5	50.5	52.1	-1.5	-0.8	-1.5	-2.5	2.5
29*	47.9	56.2	54.6	55.0	55.2	54.0	55.0	55.9	-1.6	-0.8	-1.5	-2.5	2.5
30*	42.6	53.0	51.4	51.4	51.9	50.6	51.9	53.6	-1.4	-0.9	-1.5	-2.6	3.9
31*	46.9	58.2	56.4	56.4	56.5	55.0	55.0	56.5	-1.5	-0.8	-1.4	-2.5	1.2
MAX	49.2	60.1	57.5	56.5	56.5	57.1	58.2	60.8	-0.6	-0.3	-0.5	-0.9	7.3
MIN	33.8	43.7	42.6	42.9	41.4	41.5	42.6	44.0	-1.8	-0.9	-1.5	-2.6	0.4
AVG	43.3	52.7	51.0	50.6	50.2	50.3	51.2	53.4					2.2
TOT									-45.4	-22.6	-40.6	-71.6	
INDX	11.3	20.7	19.0	18.6	18.2	19.3	19.2	21.4					
-N-	1.[illegible]	1.8	1.7	1.6	1.6	1.6	1.7	1.9					

EFFECT OF COLOR AND TEXTURE ON THE SURFACE TEMPERATURE OF ASPHALT CONCRETE PAVEMENTS

PEGER ROAD SITE
JUN 1982

DAY	AIR	FINE-ST'D	ST'D-CHIPS	GRAY-CHIPS	WHT-CHIPS	WHT-PAINT	YEL-PAINT	BARE-PAVMNT	SW VERT	SW REFL	IR IN	IR OUT	WIND SPEED M/HR
	---TEMPERATURE IN DEGREES F---								***RADIATION BTU/SQ FT HR***				
1	62.6	75.6	73.2	72.4	72.7	71.6	73.0	75.5	-0.6	-0.3	-0.5	-0.9	2.4
2	47.7	54.8	53.4	53.4	54.1	53.7	54.1	54.8	-1.5	-0.7	-1.4	-2.3	4.2
3	44.7	55.5	53.7	53.2	54.1	53.8	55.2	56.0	-1.6	-0.8	-1.4	-2.4	4.4
4*	46.4	56.9	55.2	55.3	55.2	53.6	54.9	57.1	-6.0	-4.0	-5.8	-8.0	3.6
5*	52.9	61.0	59.8	59.6	59.4	58.0	59.3	61.2	-15.0	-8.0	-12.0	-17.0	2.3
6*	53.6	64.3	62.8	62.9	62.9	61.5	62.9	64.2	-14.0	-8.0	-12.0	-17.0	1.5
7*	48.0	56.1	55.0	54.9	55.1	54.0	54.9	56.6	-13.0	-8.0	-12.0	-17.0	1.1
8*	47.2	59.6	58.1	58.1	56.3	56.4	57.9	60.2	-14.0	-6.0	-12.0	-17.0	2.2
9	56.1	66.7	64.6	63.6	64.3	55.7	61.7	66.8	1248.4	54.0	241.4	185.3	2.4
10	64.2	76.3	74.4	72.7	73.7	63.2	66.9	76.3	3399.2	103.2	481.5	436.9	1.9
11	61.4	72.8	71.3	70.0	70.7	62.0	65.4	73.3	2274.7	109.6	344.8	347.0	1.0
12	57.2	72.6	70.4	69.4	70.4	61.1	65.1	72.9	2334.9	376.4	295.4	413.7	2.1
13	56.0	74.0	71.5	69.8	71.3	61.2	65.2	74.1	2516.9	349.5	337.3	397.8	2.1
14	59.5	73.8	71.7	70.1	71.4	62.2	65.6	74.1	2232.4	343.5	301.8	377.7	1.6
15	55.2	63.3	62.1	61.4	62.2	56.7	58.9	63.3	921.9	120.1	108.1	295.5	0.8
16	50.6	57.1	56.5	55.7	56.5	52.8	54.3	57.3	990.6	82.1	-26.5	229.0	1.1
17	52.4	60.8	59.7	58.8	59.8	55.0	56.9	61.2	1519.9	189.2	41.8	236.3	1.3
18	55.3	65.0	63.7	62.4	63.4	56.5	58.9	64.9	1936.3	281.8	188.0	239.7	0.9
19	56.7	66.0	66.6	65.4	66.3	58.9	61.5	68.1	2125.6	336.6	121.6	298.3	1.4
20	55.3	66.3	64.6	63.7	64.8	58.0	60.4	66.4	1832.9	352.3	102.3	270.2	1.6
21	59.8	74.3	72.2	70.4	71.7	61.4	65.1	74.9	2748.6	465.6	423.4	320.8	0.9
22	62.6	78.3	76.0	74.0	75.5	64.1	69.0	79.0	2905.9	454.4	516.8	357.4	0.9
23	66.7	82.1	80.1	78.1	79.3	67.4	71.7	83.2	3136.6	490.3	602.5	398.2	0.7
24	70.1	85.3	83.3	81.5	82.8	70.5	74.6	86.2	2980.4	466.8	568.8	413.8	0.6
25	71.7	88.1	86.4	84.2	65.9	72.7	76.6	88.9	3252.6	503.8	652.3	422.5	0.9
26	75.0	90.1	88.9	86.7	88.3	74.6	78.5	90.9	2902.7	444.5	584.8	378.1	1.7
27	74.6	93.3	92.3	90.0	91.6	76.4	80.4	94.0	3170.9	494.3	648.1	444.2	1.0
28	70.5	86.2	85.0	83.5	85.2	74.1	77.2	87.0	2517.3	400.2	417.1	465.2	3.6
29	65.4	84.6	83.5	81.8	83.6	72.2	75.5	85.9	3015.3	480.5	512.1	505.2	2.1
30	66.2	83.6	82.4	80.9	82.6	71.4	74.4	84.3	2521.6	403.2	346.7	512.6	1.5
MAX	75.0	93.3	92.3	90.0	91.6	76.4	80.4	94.0	3399.2	503.8	652.3	512.6	4.4
MIN	44.7	54.8	53.4	53.2	54.1	52.8	54.1	54.8	-15.0	-8.0	-26.5	-17.0	0.6
AVG	58.9	71.6	69.9	68.8	69.8	62.5	65.2	72.0					1.8
TOT									52420.3	7266.2	7753.2	7863.7	
INDX	26.9	39.6	37.9	36.8	37.8	30.5	33.2	40.0					
-N-	1.0	1.5	1.4	1.4	1.4	1.1	1.2	1.5					

EFFECT OF COLOR AND TEXTURE ON THE SURFACE TEMPERATURE OF ASPHALT CONCRETE PAVEMENTS

PEGER ROAD SITE
JUL 1982

DAY	AIR	FINE-ST'D	ST'D-CHIPS	GRAY-CHIPS	WHT-CHIPS	WHT-PAINT	YEL-PAINT	BARE-PAVMNT	SW VERT	SW REFL	IR IN	IR OUT	WIND SPEED M/HR
	TEMPERATURE IN DEGREES F								***RADIATION BTU/SQ FT HR***				
1	59.5	75.6	74.2	72.9	74.9	65.5	68.0	75.5	2145.9	300.0	270.0	437.5	3.1
2	62.2	82.5	81.4	79.5	81.4	68.8	72.4	83.2	3169.1	508.0	560.3	500.3	0.9
3	66.1	83.3	82.3	80.5	82.4	69.5	72.9	84.0	2673.9	413.5	554.3	366.0	1.4
4	69.3	86.5	85.5	83.6	85.5	72.2	75.5	86.4	2620.9	404.4	447.5	378.0	1.3
5	64.2	81.1	79.8	78.7	80.3	69.4	72.5	81.5	2136.7	322.6	351.2	374.7	1.1
6	55.6	69.4	68.6	67.8	69.3	60.6	62.9	69.8	328.6	53.0	92.2	105.8	0.0
7*	67.7	78.2	77.3	76.7	78.0	69.3	71.3	78.2	2920.0	448.9	519.4	413.5	1.1
8*	64.5	77.6	76.8	76.2	77.7	69.4	71.2	77.2	2658.9	405.2	432.4	419.4	2.2
9*	60.4	69.3	68.8	68.4	69.4	63.4	64.9	69.3	1153.0	128.6	501.0	336.4	1.9
10*	52.5	63.2	62.5	61.9	63.4	56.6	58.9	62.8	685.0	70.2	107.6	131.3	1.2
11*	59.7	71.8	71.0	70.2	71.7	63.7	65.7	71.3	2552.2	357.7	222.3	377.8	0.8
12*	58.2	67.5	67.0	66.5	67.8	61.9	63.2	67.4	1924.2	270.3	166.4	365.1	1.1
13*	55.3	66.8	66.1	65.6	67.1	59.6	61.4	66.5	2000.6	272.1	152.5	362.2	1.1
14*	58.7	67.3	65.7	66.0	66.9	61.4	62.6	66.5	1827.4	249.6	208.5	284.1	0.7
15	66.3	88.2	87.4	65.8	87.7	75.3	78.9	89.7	2169.5	327.7	296.9	298.3	3.1
16	59.2	75.2	74.5	73.4	75.2	65.6	67.9	75.4	2142.6	309.0	263.6	377.9	2.1
17	54.1	61.3	61.0	60.8	61.7	57.9	58.8	61.3	683.6	44.7	-120.8	210.6	3.5
18	61.9	76.0	75.2	73.8	75.5	66.3	68.7	76.4	2443.2	308.0	240.4	314.8	1.8
19	63.3	79.6	78.9	76.9	79.3	67.5	70.2	80.4	2943.1	423.0	524.3	392.8	1.6
20	68.6	84.3	83.7	81.7	83.9	71.9	74.9	85.4	2673.1	423.6	498.3	398.6	1.3
21	64.5	78.1	77.4	76.4	77.8	68.4	70.7	78.0	1769.7	250.0	243.4	362.5	3.1
22	59.2	74.2	73.4	72.5	74.4	65.2	67.5	74.7	2224.9	303.5	222.1	346.4	3.2
23	57.9	67.5	66.9	66.4	67.6	61.6	63.0	67.5	1004.0	97.6	-0.4	226.4	1.8
24	57.7	67.5	67.0	66.2	67.7	61.2	62.8	67.9	1392.9	169.8	141.8	206.8	1.8
25	55.1	62.7	62.5	62.0	63.0	57.9	59.1	62.9	908.6	71.2	37.5	211.3	1.7
26	58.2	68.7	68.0	66.9	68.6	61.7	63.3	68.9	1713.7	208.6	103.6	246.5	1.1
27	66.7	78.6	77.8	76.4	78.2	69.5	71.7	79.3	2379.7	330.7	285.3	322.0	0.8
28	64.8	77.4	76.7	75.6	76.9	68.5	70.6	77.6	1832.3	267.3	321.2	326.3	1.1
29	61.3	71.7	71.1	70.2	71.5	65.3	66.5	71.8	1269.3	172.8	163.3	306.1	1.0
30	57.6	66.1	67.6	66.9	68.2	62.7	64.0	68.1	1342.5	157.7	25.0	279.2	3.5
31	50.9	58.0	57.5	57.3	58.5	54.7	55.6	57.6	707.1	51.0	-83.3	176.9	5.2
MAX	69.3	88.2	87.4	65.8	87.7	75.3	78.9	89.7	3169.1	508.0	560.3	500.3	5.2
MIN	50.9	58.0	57.5	57.3	58.5	54.7	55.6	57.6	328.6	44.7	-120.8	105.8	0.0
AVG	60.7	73.5	72.7	71.7	73.3	64.9	67.0	73.6					1.8
TOT									56596.3	8120.4	7747.9	9855.8	
INDX	28.7	41.5	40.7	39.7	41.3	32.9	35.0	41.6					
-N-	1.0	1.4	1.4	1.4	1.4	1.1	1.2	1.5					

EFFECT OF COLOR AND TEXTURE ON THE SURFACE TEMPERATURE OF ASPHALT CONCRETE PAVEMENTS

PEGER ROAD SITE
AUG 1982

DAY	TEMPERATURE IN DEGREES F AIR	FINE-ST'D	ST'D-CHIPS	GRAY-CHIPS	WHT-CHIPS	WHT-PAINT	YEL-PAINT	BARE-PAVMNT	***RADIATION BTU/SQ FT HR*** SW VERT	SW REFL	IR IN	IR OUT	WIND SPEED M/HR
1	52.9	62.8	62.2	61.8	63.0	57.7	59.1	63.0	1342.0	167.6	125.1	185.6	2.3
2	53.7	64.1	63.4	62.8	64.1	58.7	59.9	64.2	996.9	126.9	122.0	236.1	0.2
3	55.5	67.8	67.1	66.2	67.7	61.1	62.7	68.4	1882.3	267.0	266.5	307.1	1.1
4	57.6	69.6	69.0	67.9	69.4	61.8	63.4	70.3	1982.1	286.3	388.6	277.3	0.5
5	60.6	73.8	72.9	71.7	73.4	64.9	66.7	74.3	2169.2	325.4	384.0	291.9	0.7
6	62.9	77.1	76.5	74.8	76.7	66.7	68.6	77.6	2546.1	390.2	517.8	295.3	1.6
7	62.6	75.2	74.4	73.2	74.9	65.3	67.1	75.3	2129.4	300.2	404.3	217.0	1.7
8	61.4	76.1	75.6	74.3	75.8	65.7	67.8	76.4	2376.6	288.2	398.2	249.5	0.7
9	56.8	66.9	66.5	65.8	67.1	61.2	62.3	66.9	1141.7	125.2	31.9	194.7	1.7
10	56.6	67.3	66.7	65.9	67.3	61.0	62.1	67.0	1545.5	168.7	101.5	200.5	0.9
11	54.5	66.6	66.1	65.2	66.7	60.0	61.3	67.3	1581.1	223.0	246.5	272.2	1.1
12	57.3	70.4	69.9	68.6	70.2	61.7	63.5	71.2	2280.4	329.3	459.6	248.9	0.4
13*	59.6	63.9	63.4	63.0	64.1	55.8	60.5	63.8	913.9	99.8	55.8	206.5	0.0
14/	51.1	56.5	56.2	56.1	57.1	54.1	54.3	56.2	329.4	20.0	-64.3	95.7	1.2
15*	47.5	55.9	55.5	55.1	56.3	51.8	52.4	55.4	1183.8	136.9	84.6	150.4	0.5
16*	48.4	56.3	56.0	55.7	56.6	52.8	53.5	56.1	1325.0	164.6	69.1	225.2	1.4
17*	49.6	54.4	54.1	53.6	54.8	51.5	51.9	54.2	781.3	52.5	-61.0	89.9	3.4
18*	42.8	54.8	54.3	53.9	55.3	50.0	50.9	54.9	2043.5	273.1	330.0	173.0	2.0
19*	51.6	57.9	57.5	57.2	58.3	54.3	54.9	58.0	881.0	102.5	37.2	215.0	0.5
20*	54.3	62.7	62.3	61.9	63.1	58.4	59.2	63.1	1931.3	270.6	189.6	253.1	1.2
21*	48.2	60.8	60.2	59.9	61.1	54.8	55.8	61.1	2087.6	312.2	424.2	226.3	0.4
22*	49.1	61.0	60.5	60.1	61.3	54.3	55.7	61.2	2359.3	309.5	468.9	237.4	0.4
23*	56.8	61.4	61.2	61.0	61.8	57.9	58.6	61.5	164.4	16.9	34.9	64.1	0.0
24*	48.7	60.2	59.7	59.4	60.6	297.5	55.6	60.3	2376.1	297.3	419.2	222.5	0.4
25*	46.4	55.2	54.7	54.1	55.7	50.3	51.0	54.7	1215.3	171.8	224.7	195.5	0.2
26*	42.4	53.8	54.0	54.2	55.4	49.3	50.2	54.8	1954.9	272.5	416.5	128.2	0.7
27*	41.6	52.5	52.4	52.9	54.0	47.5	48.4	53.4	1265.7	196.1	380.5	124.3	1.2
28*	45.2	56.1	56.0	56.5	57.6	51.5	51.9	57.1	599.6	88.4	210.4	86.2	0.9
29*	51.3	56.4	56.3	56.8	57.8	53.1	53.9	57.4	725.9	95.0	150.8	172.8	0.1
30*	50.2	54.0	53.9	54.4	55.2	52.1	52.6	54.8	751.1	60.4	19.6	113.6	0.2
31*	45.6	49.6	49.4	49.9	50.8	48.3	48.6	50.3	542.6	31.4	-5.4	106.2	0.6
MAX	62.9	77.1	76.5	74.8	76.7	297.5	68.6	77.6	2546.1	390.2	517.8	307.1	3.4
MIN	41.6	49.6	49.4	49.9	50.8	47.5	48.4	50.3	164.4	16.9	-64.3	64.1	0.0
AVG	52.3	62.0	61.5	61.1	62.4	64.4	57.6	62.3					0.9
TOT									44505.1	5969.6	6831.4	6364.0	
INDX	20.3	30.0	29.5	29.1	30.4	32.4	25.6	30.3					
-N-	1.0	1.5	1.5	1.4	1.5	1.6	1.3	1.5					

EFFECT OF COLOR AND TEXTURE ON THE SURFACE TEMPERATURE OF ASPHALT CONCRETE PAVEMENTS

PEGER ROAD SITE
SEP 1982

DAY	AIR	FINE-ST'D	ST'D-CHIPS	GRAY-CHIPS	WHT-CHIPS	WHT-PAINT	YEL-PAINT	BARE-PAVMNT	SW VERT	SW REFL	IR IN	IR OUT	WIND SPEED M/HR
	-----------	-----------	-----------	TEMPERATURE IN DEGREES F	-----------	-----------	-----------	-----------	***RADIATION BTU/SQ FT HR***				
1*	41.7	49.8	49.6	49.9	51.2	46.9	47.3	50.7	1350.1	187.4	226.3	144.8	0.2
2*	45.0	51.8	51.6	51.8	52.9	48.6	49.0	52.5	1164.3	157.6	226.5	210.8	0.5
3*	42.7	48.3	46.1	48.3	49.6	45.5	45.9	49.3	915.7	125.0	179.4	199.2	0.7
4*	38.8	47.5	47.2	47.4	48.5	43.4	43.9	48.0	1252.7	180.2	285.1	199.7	0.8
5*	45.3	50.2	50.0	50.2	51.1	46.4	46.9	50.5	899.1	120.2	281.6	75.7	3.7
6*	53.8	56.7	56.4	56.7	57.5	52.9	53.4	57.2	697.1	124.8	187.9	52.6	3.0
7*	48.7	52.1	52.0	52.4	52.9	51.0	51.2	52.6	504.1	29.6	-68.3	99.6	0.5
8*	49.1	51.9	51.7	52.1	52.9	50.7	50.8	52.5	597.7	42.9	-73.4	63.8	0.2
9*	43.1	50.0	49.8	50.1	50.0	47.1	47.3	50.3	1221.8	170.0	211.5	54.2	1.5
10*	42.7	48.5	48.3	48.6	49.4	46.0	46.3	49.0	867.9	108.7	212.5	132.0	0.3
11*	39.6	44.5	44.4	45.1	45.7	43.8	44.0	45.2	484.0	53.2	-52.7	166.1	2.0
12*	47.9	47.3	47.0	47.5	48.4	45.1	45.3	47.9	1064.5	134.1	130.6	62.4	2.3
13	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
14	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
15	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
16	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
17	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
18	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
19	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
20	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
21	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
22	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
23	41.2	47.4	47.0	48.0	48.8	44.1	44.9	48.9	1047.4	35.5	115.0	683.7	0.9
24	39.0	44.2	43.8	44.5	45.3	41.4	42.0	45.1	2371.6	93.5	183.4	1267.2	0.6
25	44.4	47.6	47.2	48.1	48.8	44.3	45.1	48.8	2417.3	94.1	163.4	1144.4	0.9
26	46.0	48.3	48.0	48.6	49.3	45.6	46.3	49.4	2417.2	93.6	159.5	1153.4	1.0
27	42.5	44.9	44.7	45.2	46.0	44.1	44.3	45.8	1612.1	62.6	144.5	992.8	4.1
28	31.3	30.2	29.9	30.2	30.5	29.8	29.9	30.5	2118.7	85.9	211.8	618.8	0.3
29	31.8	31.2	31.0	31.2	31.3	31.1	31.2	31.6	2383.3	97.3	207.6	979.3	1.0
30*	32.1	36.2	36.0	36.4	36.8	35.4	35.5	36.4	1645.0	63.5	207.1	1267.6	0.6
MAX	53.8	56.7	56.4	56.7	57.5	52.9	53.4	57.2	2417.3	187.4	285.1	1267.6	4.1
MIN	31.3	30.2	29.9	30.2	30.5	29.8	29.9	30.5	484.0	29.6	-73.4	52.6	0.2
AVG	42.3	46.4	46.2	46.6	47.3	44.2	44.5	47.1					1.3
TOT									27231.6	2359.7	3141.4	9568.1	
INDX	10.3	14.4	14.2	14.6	15.3	12.2	12.5	15.1					
-N-	1.0	1.4	1.4	1.4	1.5	1.2	1.2	1.5					

EFFECT OF COLOR AND TEXTURE ON THE SURFACE TEMPERATURE OF ASPHALT CONCRETE PAVEMENTS

PEGER ROAD SITE
OCT 1982

DAY	AIR	FINE-ST'D	ST'D-CHIPS	GRAY-CHIPS	WHT-CHIPS	WHT-PAINT	YEL-PAINT	BARE-PAVMNT	SW VERT	SW REFL	IR IN	IR OUT	WIND SPEED M/HR
	TEMPERATURE IN DEGREES F								***RADIATION BTU/SQ FT HR***				
1*	31.1	34.5	34.3	34.7	35.4	33.6	33.5	34.5	2416.4	95.5	250.7	1668.2	0.3
2*	30.5	35.4	35.1	35.4	36.0	34.2	34.1	37.3	2420.2	96.4	106.1	1378.8	0.2
3*	23.2	28.6	29.8	28.3	29.0	27.1	27.0	28.6	2422.1	96.1	139.9	112.9	0.4
4*	27.5	31.7	31.4	31.7	32.3	30.6	30.5	32.0	2419.5	95.4	181.1	1322.7	0.1
5*	29.6	32.4	32.2	32.4	32.9	31.1	31.1	32.5	2417.4	96.7	206.3	871.3	0.2
6*	26.0	30.7	30.4	30.6	31.2	25.5	29.9	30.9	2418.1	96.1	223.8	677.1	0.4
7*	27.1	31.1	30.7	30.9	31.5	30.6	30.5	31.1	2413.1	95.3	178.7	606.0	0.6
8*	25.5	29.6	29.5	29.4	29.8	28.9	28.8	29.7	2419.6	96.5	179.1	584.8	0.7
9*	26.2	30.1	30.1	30.0	30.3	30.0	29.9	30.4	2435.0	96.1	163.6	500.0	2.0
10*	18.6	26.6	26.5	26.3	27.4	25.9	28.9	29.4	2436.0	98.4	142.9	223.7	2.5
11*	24.7	27.0	27.0	27.1	27.4	27.5	26.7	27.1	2428.8	99.1	233.1	-498.1	0.0
12*	22.2	26.7	26.8	27.0	27.3	26.7	26.7	27.0	2422.8	99.7	232.1	-103.8	1.7
13*	-5.2	12.6	12.3	12.7	13.7	11.3	11.6	12.1	2424.1	100.5	254.8	-793.7	2.2
14*	-1.5	11.1	10.8	11.6	12.4	9.4	9.7	10.3	2425.9	99.9	268.2	-43.8	0.0
15*	6.5	12.6	12.2	12.9	13.9	11.5	11.6	12.4	2425.8	99.0	292.4	190.7	0.0
16*	29.1	27.5	27.0	27.4	27.9	26.9	27.0	27.6	2422.2	100.5	212.7	-60.3	0.0
17*	31.5	30.8	30.5	30.5	30.6	30.2	30.3	30.7	2181.0	88.5	219.8	639.3	0.3
18*	31.2	31.2	31.1	31.3	31.4	31.1	31.0	31.4	2422.1	98.9	210.8	1151.6	1.0
19*	27.9	28.4	28.5	28.4	28.5	28.2	28.1	28.4	1937.6	79.0	267.1	2710.1	3.7
20*	9.5	18.5	18.5	18.9	19.4	17.9	17.9	18.0	2409.2	96.5	16.6	3790.7	1.8
21	12.2	17.3	17.1	18.4	18.9	17.0	17.1	18.3	1203.8	48.9	201.6	2202.6	0.9
22	6.5	13.5	13.0	14.0	14.6	13.2	13.1	13.8	2409.2	96.9	257.2	4022.1	0.6
23	0.5	10.4	9.8	10.9	11.3	9.4	9.4	10.5	2411.3	96.8	239.1	2478.6	0.1
24	-0.9	8.0	7.5	8.6	8.8	7.2	7.3	8.2	2412.2	95.8	266.6	2006.6	0.0
25*	-5.0	5.2	4.8	5.6	5.7	4.8	4.7	5.1	2412.2	95.6	267.0	1960.0	0.0
26*	0.2	6.1	5.7	6.8	6.6	6.2	6.3	6.4	2409.4	94.1	286.9	1873.4	0.2
27*	4.1	8.9	8.4	9.2	9.1	9.1	8.9	9.1	2410.4	94.7	282.9	3570.8	0.1
28*	10.6	14.5	14.0	14.6	14.3	14.8	14.6	14.7	2406.0	94.4	282.7	5272.7	0.4
29*	-13.1	0.9	0.5	1.3	1.6	0.7	0.8	1.0	2406.4	93.9	285.3	6457.0	0.6
30*	-17.7	-5.8	-6.4	-5.2	-4.8	-5.4	-5.4	-5.2	2408.6	94.4	266.8	3599.8	0.0
31*	-8.7	-2.1	-2.7	-1.6	-1.5	-1.8	-1.9	-1.7	2402.2	98.2	401.6	4198.2	0.0
MAX	31.5	35.4	35.1	35.4	36.0	34.2	34.1	37.3	2436.0	100.5	401.6	6457.0	3.7
MIN	-17.7	-5.8	-6.4	-5.2	-4.8	-5.4	-5.4	-5.2	1203.8	48.9	16.6	-793.7	0.0
AVG	13.9	19.8	19.5	20.0	20.4	19.3	19.3	20.1					0.7
TOT									73009.0	2929.9	7017.5	52570.0	
INDX	-18.1	-12.2	-12.5	-12.0	-11.6	-12.7	-12.7	-11.9					
-N-	1.[illegible]	0.7	0.7	0.7	0.6	0.7	0.7	0.7					

EFFECT OF COLOR AND TEXTURE ON THE SURFACE TEMPERATURE OF ASPHALT CONCRETE PAVEMENTS

PEGER ROAD SITE
NOV 1982

DAY	TEMPERATURE IN DEGREES F AIR	FINE-ST'D	ST'D-CHIPS	GRAY-CHIPS	WHT-CHIPS	WHT-PAINT	YEL-PAINT	BARE-PAVMNT	***RADIATION BTU/SQ FT HR*** SW VERT	SW REFL	IR IN	IR OUT	WIND SPEED M/HR
1*	17.4	15.1	14.6	15.1	14.9	15.6	15.4	15.6	1790.2	74.2	457.7	999.0	0.0
2*	11.6	14.5	14.0	14.5	14.5	15.3	14.9	15.0	2396.9	99.2	492.7	999.0	0.0
3*	13.5	15.5	15.0	15.6	15.6	16.4	16.2	16.2	2396.1	98.0	466.1	999.0	0.0
4	12.1	15.5	15.3	15.7	15.8	16.4	16.2	16.2	697.8	28.8	154.7	2575.5	0.0
5	8.6	13.6	13.2	13.9	14.1	14.1	14.1	14.3	2351.5	97.4	435.7	7121.3	0.0
6	4.8	11.2	10.8	11.5	11.7	11.5	11.5	11.6	2398.9	100.3	404.4	6766.4	0.0
7	-4.8	5.1	4.7	5.5	5.7	5.2	5.2	5.4	2399.0	98.6	390.3	6673.5	0.0
8	4.9	7.5	7.2	7.8	7.9	8.1	8.1	8.1	2401.0	99.4	449.8	5221.6	0.2
9	4.6	10.1	9.6	10.3	10.6	10.7	10.2	10.3	2401.9	100.5	468.9	695.2	0.7
10	10.5	12.1	11.7	12.2	12.2	13.0	12.7	12.6	1101.9	45.3	147.5	-83.9	0.0
11*	2.6	9.0	8.6	9.2	9.3	9.4	9.3	9.2	2402.4	100.0	438.0	129.3	0.0
12*	22.9	19.1	18.8	19.1	19.1	19.5	19.2	19.4	2401.1	99.8	452.5	2384.6	0.2
13*	12.0	12.9	12.6	13.1	13.2	13.6	13.4	13.4	2401.8	97.9	416.3	808.9	0.0
14*	14.6	15.6	15.3	15.7	15.8	16.2	16.0	16.1	2400.7	98.7	409.2	569.7	0.0
15	8.3	13.5	13.2	13.6	13.6	13.5	13.4	13.6	900.0	37.8	207.9	389.4	0.0
16	-0.9	6.6	6.4	6.9	6.9	6.5	6.5	6.6	2401.5	100.1	436.9	1044.3	0.0
17	-18.3	-6.2	-6.6	-5.8	-5.7	-6.6	-6.6	-6.6	2405.3	102.6	490.6	1540.7	0.0
18	-25.0	-12.9	-13.4	-12.4	-12.3	-13.1	-13.3	-13.5	2403.5	101.5	536.6	1473.4	0.0
19	-26.0	-15.8	-16.4	-15.3	-15.1	-15.8	-16.0	-16.2	2325.2	97.0	558.4	1482.7	0.0
20	1.9	-0.4	-0.8	-0.2	-0.3	0.4	0.1	0.1	2379.8	98.0	492.9	1747.7	0.0
21	7.9	7.3	6.8	7.3	7.2	7.9	7.6	7.8	2400.1	95.3	474.4	2145.6	0.0
22	14.4	12.2	11.9	12.2	12.1	13.0	12.8	13.0	2402.2	94.0	520.8	2252.8	0.0
23	6.8	9.5	9.1	9.5	9.4	9.8	9.7	9.9	2407.2	93.4	528.7	1959.5	0.0
24	14.9	13.5	13.1	13.5	13.5	14.2	14.1	14.2	2433.8	92.1	508.3	1720.9	0.0
25	-0.1	5.7	5.4	5.8	5.8	5.7	5.7	5.8	2400.6	90.9	470.9	1573.7	0.0
26	-5.8	-0.4	-0.7	-0.2	-0.2	-0.4	-0.5	-0.5	2197.1	83.9	520.4	1525.9	0.0
27	-16.1	-6.5	-7.0	-6.3	-6.2	-6.6	-6.8	-6.9	2398.0	90.6	463.6	1453.6	0.0
28	-14.4	-5.9	-6.4	-5.7	-5.6	-5.7	-6.0	-6.0	2397.2	93.0	450.5	1392.4	0.0
29	-2.6	1.0	0.6	1.1	1.0	1.6	1.3	1.4	1798.4	69.4	373.5	1208.2	0.0
30*	-6.1	0.7	0.3	0.7	0.6	1.0	0.7	0.7	2391.6	92.7	557.9	1735.3	0.0
MAX	22.9	19.1	18.8	19.1	19.1	19.5	19.2	19.4	2407.2	102.6	558.4	7121.3	0.7
MIN	-26.0	-15.8	-16.4	-15.3	-15.1	-15.8	-16.0	-16.2	697.8	28.8	147.5	-83.9	0.0
AVG	2.5	6.6	6.2	6.8	6.8	7.0	6.8	6.9					0.0
TOT									65952.8	2670.4	13178.7	60505.1	
INDX	-29.5	-25.4	-25.8	-25.2	-25.2	-25.0	-25.2	-25.1					
-N-	1.0	0.9	0.9	0.9	0.9	0.8	0.9	0.9					

Air and Surface Temperatures - Peger Road (December 1982)
Temperature, °F

Day	Fairbanks S&G E-Chips	Fairbanks S&G E-Chips	Browns Hill B-Chips	White Marble C-Chips	White chips	White paint	Yellow paint	Bare pavement
1	-9.4	-2.0	-2.3	-1.9	-2.0	-1.7	-2.0	-1.9
2	-26.9	-13.1	-13.7	-12.8	-12.7	-13.0	-13.2	-13.5
3	-24.2	-14.8	-15.3	-14.6	-14.6	-14.8	-14.9	-15.1
4	-16.8	-9.8	-10.3	-9.8	-10.2	-10.1	-10.4	-10.3
5	-18.8	-11.8	-12.3	-11.7	-12.1	-11.9	-12.0	-12.0
6	1.5	-2.6	-3.1	-2.7	-3.1	-2.1	-2.4	-2.4
7	6.6	6.8	6.3	6.3	5.7	6.4	6.0	6.4
8	17.0	9.6	9.4	9.4	8.8	9.9	10.0	10.2
9	7.1	9.8	9.5	9.6	9.3	10.0	9.7	10.0
10	-13.0	-1.5	-1.8	-1.5	-1.9	-1.6	-1.8	-1.8
11	6.3	5.7	5.4	5.4	4.9	5.6	5.5	5.6
12	5.7	5.1	4.8	4.9	4.6	5.6	5.3	5.4
13	3.6	5.1	4.8	4.8	4.3	5.1	4.9	5.0
14	-4.3	0.4	0.1	0.2	-0.3	0.2	0.0	0.2
15	3.1	7.6	7.5	7.5	6.9	7.4	7.2	7.4
16	0.0	4.8	4.6	4.7	4.1	4.5	4.4	4.6
17	-8.4	-0.7	-0.9	-0.6	-1.1	-0.6	0.9	-0.8
18	0.2	3.9	3.7	3.9	3.1	3.7	3.5	3.7
19	-6.7	-2.5	-2.8	-2.5	-3.0	-2.6	-2.7	-2.5
20	-15.6	-7.1	-7.4	-7.1	-7.7	-7.4	-7.6	-7.7
21	-21.7	-11.8	-12.2	-11.7	-12.3	-12.1	-12.3	-12.6
22	-23.5	-14.8	-15.2	-14.6	-15.2	-14.8	-15.0	-15.0
23	-8.4	-6.4	-6.8	-6.6	-7.7	-7.1	-7.3	-7.0
24	-20.8	-13.4	-13.8	-13.3	-14.3	-13.7	-13.9	-14.0
25	23.9	-15.9	-16.4	-15.8	-16.8	-16.3	-16.4	-16.3
26	11.9	1.9	1.5	1.7	0.6	2.3	2.0	2.3
27	26.6	14.2	13.8	13.7	12.8	14.3	14.1	14.6
28	36.8	22.5	22.3	22.1	21.4	22.8	22.6	23.0
29	36.5	24.3	24.2	23.6	23.1	24.4	24.2	25.1
30	21.6	21.3	21.3	21.0	20.3	21.2	21.2	21.6
31	13.8	16.4	16.4	16.3	15.6	16.5	16.6	16.8

Measured Daily Albedo - April 1982

Day	Fairbanks S&G E-Chips	Fairbanks S&G E-Chips	Browns Hill B-Chips	White Marble C-Chips	White paint	Yellow paint
1	11	13	12	18	-	-
2	11	14	12	18	-	-
3	9	14	11	20	-	-
4	10	14	12	24	-	-
5	19	14	12	31	-	-
6	11	11	11	16	-	-
7	13	17	16	20	-	-
8	9	10	11	15	-	-
9	-	-	-	-	-	-
10	13	16	17	22	-	-
11	11	16	16	25	-	-
12	-	-	-	-	-	-
13	-	-	-	-	-	-
14	-	-	-	-	-	-
15	-	-	-	-	-	-
16	-	-	-	-	-	-
17	30	22	22	28	33	30
18	29	29	33	45	56	56
19	14	15	15	24	25	22
20	-	-	-	-	-	-
21	12	16	15	23	29	22
22	13	16	15	19	23	22
23	13	15	13	19	24	21
24	11	14	16	22	25	26
25	13	14	15	18	28	24
26	14	16	17	21	22	22
27	15	14	13	18	26	22
28	--	--	--	--	--	--
29	--	--	--	--	--	--
30	--	--	--	--	--	--
Max	30	29	33	45	56	56
Min	9	10	11	15	22	21
Ave	14	16	16	22	29	28

Measured Daily Albedo - May 1982

Day	Fairbanks S&G E-Chips	Fairbanks S&G E-Chips	Browns Hill B-Chips	White Marble C-Chips	White paint	Yellow paint
1	7	5	5	8	10	10
2	4	6	7	8	5	10
3	14	14	14	19	23	20
4	14	15	14	19	24	21
5	14	17	16	22	25	23
6	13	18	13	19	21	21
7	18	27	22	28	30	28
8	14	8	13	11	12	15
9	-	-	-	-	-	-
10	12	14	13	18	24	21
11	-	-	-	-	-	-
12	12	12	14	20	22	28
13	13	18	16	20	25	22
14	-	-	-	-	-	-
15	10	15	12	18	24	20
16	14	18	18	21	24	22
17	-	-	-	-	-	-
18	-	-	-	-	-	-
19	10	12	14	21	22	22
20	-	-	-	-	-	-
21	-	-	-	-	-	-
22	15	18	16	21	25	24
23	14	16	16	20	27	24
24	12	13	13	17	21	18
25	8	14	13	19	21	19
26	-	-	-	-	-	-
27	-	-	-	-	-	-
28	-	-	-	-	-	-
29	2	4	3	3	5	4
30	-	-	-	-	-	-
31	2	2	1	4	4	4
Max	18	27	22	28	30	28
Min	2	2	1	3	4	4
Ave	11	13	13	17	20	19

Measured Daily Albedo - June 1982

Day	Fairbanks S&G E-Chips	Fairbanks S&G E-Chips	Browns Hill B-Chips	White Marble C-Chips	White paint	Yellow paint
1	17	18	14	21	28	23
2	--	--	--	--	--	--
3	--	--	--	--	--	--
4	21	21	21	22	24	25
5	13	11	16	18	32	21
6	15	15	15	18	24	21
7	9	6	14	9	12	22
8	10	14	13	16	20	20
9	11	13	14	17	57	53
10	0	12	12	15	51	45
11	7	8	12	16	50	50
12	11	14	15	17	52	41
13	12	15	15	19	47	39
14	--	--	--	--	--	--
15	--	--	--	--	--	--
16	--	--	--	--	--	--
17	--	--	--	--	--	--
18	11	12	14	16	51	43
19	10	13	16	16	53	46
20	--	--	--	--	--	--
21	13	15	14	16	39	40
22	9	10	11	14	44	38
23	5	10	11	15	43	38
24	10	12	15	14	39	38
25	6	8	11	6	44	42
26	6	9	12	9	44	43
27	9	11	11	12	33	39
28	8	10	12	12	40	35
29	9	9	12	15	39	34
30	9	10	11	11	40	36
Max	21	21	21	22	57	53
Min	5	6	11	6	12	20
Ave	10	12	14	15	39	36

Measured Daily Albedo - July 1982

Day	Fairbanks S&G E-Chips	Fairbanks S&G E-Chips	Browns Hill B-Chips	White Marble C-Chips	White paint	Yellow paint
1	--	--	--	--	--	--
2	7	9	9	10	41	33
3	7	10	11	12	48	36
4	7	7	9	11	45	38
5	8	9	11	11	50	40
6	9	9	10	11	43	34
7	9	10	13	12	50	42
8	9	9	9	11	42	34
9	--	--	--	--	--	--
10	--	--	--	--	--	--
11	4	4	4	12	40	40
12	--	--	--	--	--	--
13	--	--	--	--	--	--
14	11	13	4	13	57	46
15	8	10	11	14	44	34
16	--	--	--	--	--	--
17	--	--	--	--	--	--
18	--	--	--	--	--	--
19	--	--	--	--	--	--
20	--	--	--	--	--	--
21	--	--	--	--	--	--
22	--	--	--	--	--	--
23	--	--	--	--	--	--
24	--	--	--	--	--	--
25	5	4	5	4	38	40
26	--	--	--	--	--	--
27	10	12	10	13	45	38
28	7	12	8	13	47	44
29	--	--	--	--	--	--
30	--	--	--	--	--	--
31	--	--	--	--	--	--
Max	11	13	13	14	57	46
Min	4	4	4	4	38	33
Ave	8	9	9	11	45	38

Measured Daily Albedo - August 1982

Day	Fairbanks S&G E-Chips	Fairbanks S&G E-Chips	Browns Hill B-Chips	White Marble C-Chips	White paint	Yellow paint
1	6	6	6	12	43	33
2	--	--	--	--	--	--
3	10	10	12	11	41	37
4	10	11	13	10	43	35
5	11	11	12	13	41	41
6	23	14	17	17	66	59
7	9	9	10	13	43	38
8	9	7	10	8	40	42
9	--	--	--	--	--	--
10	13	14	15	16	46	35
11	23	13	14	18	68	59
12	--	--	--	--	--	--
13	--	--	--	--	--	--
14	--	--	--	--	--	--
15	8	6	8	20	52	67
16	28	15	15	19	63	60
17	--	--	--	--	--	--
18	15	14	15	13	46	35
19	--	--	--	--	--	--
20	11	12	13	16	45	40
21	9	10	10	10	39	37
22	11	10	9	9	39	42
23	9	10	10	20	37	63
24	--	--	--	--	--	--
25	9	11	11	12	44	37
26	--	--	--	--	--	--
27	11	12	14	11	38	43
28	10	10	12	11	42	39
29	--	--	--	--	--	--
30	--	--	--	--	--	--
31	--	--	--	--	--	--
Max	28	15	17	20	68	63
Min	6	6	6	8	37	33
Ave	12	11	12	14	46	44

Measured Daily Albedo - September 1982

Day	Fairbanks S&G E-Chips	Fairbanks S&G E-Chips	Browns Hill B-Chips	White Marble C-Chips	White paint	Yellow paint
1	--	--	--	--	--	--
2	27	33	33	12	66	70
3	--	--	--	--	--	--
4	14	29	37	34	70	60
5	17	19	15	17	48	41
6	15	16	16	18	50	44
7	17	13	17	17	33	27
8	--	--	--	--	--	--
9	15	13	14	15	45	34
10	14	15	15	17	42	35
11	--	--	--	--	--	--
12	6	13	17	14	39	33
13	--	--	--	--	--	--
14	15	14	15	17	36	36
15	--	--	--	--	--	--
16	27	18	15	20	43	38
17	22	20	23	23	43	33
18	17	17	19	18	29	26
19	25	27	26	25	47	50
20	14	15	14	19	39	43
21	13	23	24	24	43	50
22	16	18	16	18	49	46
23	12	12	13	11	56	56
24	17	18	17	18	40	39
25	--	--	--	--	--	--
26	--	--	--	--	--	--
27	--	--	--	--	--	--
28	21	20	22	32	50	41
29	11	11	9	11	40	33
30	--	--	--	--	--	--
Max	27	33	37	34	70	70
Min	6	11	9	11	29	26
Ave	17	18	19	19	45	42

APPENDIX B

AVERAGE DAILY TEMPERATURES FROM 1983.

Air Temperatures, °F - 1983
Peger Road

Day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct
1	19.5	8.7	3.7	-	43.4	68.4	66.3	61.4	44.0	38.5
2	2.2	13.9	3.2	-	39.9	65.3	61.0	60.9	36.0	38.1
3	-25.3	6.9	4.4	-	34.3	55.8	61.5	59.4	47.4	33.0
4	-30.3	9.1	-4.4	-	38.6	59.3	66.0	57.0	38.7	31.4
5	-41.0	6.5	0.3	37.8	42.1	52.4	71.0	55.9	42.1	
6	-17.5	8.7	6.2	33.4	44.4	48.5	71.5	57.0	41.7	
7	-35.8	12.0	9.8	31.1	45.9	47.9	69.9	62.5	46.4	
8	-39.7	9.9	6.5	33.7	-	50.8	67.6	61.9	46.6	
9	-42.5	9.6	0.9	27.1	-	51.4	65.2	55.4	46.5	
10	-45.3	3.1	1.5	19.0	-	60.0	65.7	55.4	45.5	
11	-47.4	-3.0	1.9	18.7	51.8	57.1	65.1	59.1	46.8	
12	-41.4	-2.7	2.3	26.7	52.4	62.4	63.1	49.8	48.1	
13	-37.3	14.7 -	3.4	24.2	54.1	62.3	58.4	52.5	45.3	
14	-13.7	19.7 -	6.5	36.8	55.6	66.4	54.3	48.5	43.6	
15	-7.8	16.5 -	12.8	40.7	53.9	59.5	58.6	50.6	42.3	
16	-0.6	11.7 -	15.2	36.3	53.2	57.7	60.8	52.5	43.7	
17	-11.3	17.4 -	11.6	37.4	44.5	58.0	58.7	53.6	42.2	
18	0.4	15.0 -	15.6	39.3	41.7	-	54.1	50.8	42.1	
19	-10.2	-2.5	15.7	38.7	47.4	-	58.9	50.8	43.4	
20	-7.3	13.2 -	18.8	43.7	43.9	-	-	48.4	45.9	
21	-11.8	-4.0	20.2	44.2	43.1	-	64.7	53.0	44.3	
22	-10.7	-0.8	21.1	42.6	50.0	-	65.6	50.9	38.2	
23	-	9.3	-	46.1	54.6	-	65.1	45.4	27.6	
24	-5.0	15.0	-	-	54.1	-	64.4	44.1	24.0	
25	-8.4	15.8	-	50.3	55.8	-	65.4	45.0	20.7	
26	-	7.8	-	-	54.5	-	62.6	48.9	19.5	
27	10.0	2.5	-	-	52.1	74.9	63.5	50.6	21.3	
28	9.2	1.4	-	-	57.7	68.0	65.9	52.2	29.9	
29	12.2		-	42.3	66.3	65.5	67.9	50.0	27.9	
30	-5.1		-	42.7	70.7	64.7	60.6	48.8	45.1	
31	1.0				62.2	-	59.1	43.6		

Surface Temperatures, °F - 1983
Peger Road
TS-1, Fairbanks S&G E-Chips

Day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct
1	17.1	6.6	6.8	--	52.1	81.8	81.2	74.0	48.6	40.8
2	7.7	10.8	7.1	--	46.6	75.1	72.8	73.3	48.0	40.7
3	-9.2	7.3	8.0	--	41.4	62.2	72.0	73.8	57.6	37.1
4	-16.9	8.3	2.3	--	44.8	60.8	79.2	64.4	47.0	37.2
5	-24.2	6.2	4.2	38.6	49.6	60.4	84.5	62.8	49.4	
6	-17.2	6.8	7.9	37.6	52.6	59.7	86.9	67.6	49.8	
7	-23.6	10.8	10.8	36.2	55.2	60.0	87.8	73.6	50.4	
8	-26.4	12.1	9.7	39.6	-	61.6	84.3	70.5	49.9	
9	-29.1	10.5	7.3	31.9	-	60.6	83.6	66.4	52.0	
10	-31.9	7.4	7.3	30.8	-	78.8	83.4	69.8	51.3	
11	-34.3	3.0	6.8	30.4	62.0	69.4	78.6	72.8	53.4	
12	-32.1	2.3	6.6	34.0	61.6	76.6	81.4	64.2	54.4	
13	-31.8	-5.2	8.7	32.9	62.2	77.8	75.0	64.9	50.8	
14	-17.5	-10.8	10.1	41.7	65.0	82.7	65.8	62.6	49.9	
15	-14.0	-10.8	15.4	45.2	63.9	72.0	65.8	59.4	47.6	
16	-3.8	-8.4	18.5	42.0	65.0	69.0	73.2	61.3	47.2	
17	-8.4	-11.0	16.6	43.1	59.2	71.4	72.5	64.6	47.4	
18	-1.5	-11.2	18.4	45.0	53.6	-	65.3	62.6	49.4	
19	-5.7	-1.6	19.5	44.4	57.3	-	71.6	62.7	48.0	
20	-7.5	-6.5	21.4	47.8	56.6	-	-	54.8	48.8	
21	-8.1	-1.6	23.0	52.6	58.8	-	81.4	58.8	48.9	
22	-9.6	0.0	24.2	48.2	63.9	-	79.8	55.4	44.0	
23	-	5.6	-	51.8	66.0	-	80.6	53.8	36.2	
24	-4.8	10.8	-	-	65.4	-	83.0	51.2	31.7	
25	-6.6	14.4	-	57.0	67.6	-	82.4	51.5	31.0	
26	-	10.1	-	-	63.6	-	79.4	53.7	29.9	
27	5.8	5.6	-	-	64.8	93.5	77.9	57.4	29.4	
28	6.3	6.0	-	-	70.6	83.1	80.2	59.2	32.2	
29	9.6		-	46.2	76.5	80.2	81.4	54.7	36.1	
30	1.4		-	51.0	79.0	79.6	70.6	52.2	43.0	
31	3.0		-		70.8	-	70.4	50.0		

Surface Temperatures, °F - 1983
Peger Road
TS-2, Fairbanks S&G E-Chips

Day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct
1	17.0	7.1	7.4	—	52.4	82.6	81.7	74.3	48.8	40.6
2	7.7	11.2	7.7	—	47.0	75.6	73.1	73.6	48.0	40.5
3	-9.2	7.9	8.6	—	41.7	62.4	72.2	73.8	57.7	37.0
4	-17.1	8.9	2.8	—	45.1	61.2	79.6	64.6	47.0	37.0
5	-24.6	6.8	4.7	39.0	49.8	60.8	85.2	62.9	49.4	
6	-17.4	7.5	8.4	38.0	52.8	60.4	87.8	67.6	49.8	
7	-24.1	11.4	11.3	36.6	55.6	60.5	88.5	73.6	50.6	
8	-26.8	11.0	10.2	40.0	-	62.0	84.9	70.6	49.8	
9	-29.7	11.1	7.8	32.1	-	61.0	84.2	66.6	52.0	
10	-32.4	8.0	7.8	30.8	-	79.2	84.2	70.1	51.2	
11	-34.8	3.5	7.3	30.7	62.2	69.8	79.2	73.1	53.2	
12	-32.6	2.8	7.2	34.4	62.0	77.2	82.3	64.5	54.4	
13	-32.2	-4.7	9.4	33.2	62.5	78.2	75.8	65.3	50.9	
14	-17.7	-10.4	10.7	42.0	65.4	83.3	66.4	63.0	50.0	
15	-14.3	-10.4	15.9	45.8	64.2	72.5	66.3	59.6	47.6	
16	-3.8	-7.9	19.0	42.4	65.3	69.4	73.8	61.6	47.2	
17	-8.5	-10.6	17.1	43.6	59.6	72.0	73.4	64.8	47.4	
18	-1.5	-10.9	19.0	45.4	54.0	-	66.0	62.8	49.4	
19	-5.5	-1.2	20.1	44.8	57.7	-	72.2	63.1	48.0	
20	-7.4	-6.1	22.0	48.0	57.3	-	-	55.0	48.7	
21	-8.0	-1.2	23.6	52.8	59.3	-	82.2	58.8	48.9	
22	-9.4	0.4	24.8	48.4	64.5	-	80.5	55.5	44.1	
23	-	6.0	—	51.9	66.4	-	81.0	53.8	36.4	
24	-4.5	11.2	—	-	65.8	-	83.8	51.3	31.8	
25	-6.3	14.9	—	57.2	68.0	-	83.4	51.6	31.1	
26	-	10.7	—	-	64.0	-	80.0	53.6	29.9	
27	6.1	6.2	—	-	65.2	94.4	78.4	57.4	29.4	
28	6.7	6.6	—	-	70.8	83.8	80.8	59.1	32.0	
29	9.9		—	46.5	77.0	80.8	82.3	54.6	35.8	
30	2.1		—	51.2	79.4	80.0	70.9	52.3	42.8	
31	3.6		—		71.2		70.8	50.0		

Surface Temperatures, °F - 1983
Peger Road
TS-3, Browns Hill B-Chips

Day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct
1	17.0	7.0	7.9	—	53.6	82.8	81.5	74.0	48.6	40.6
2	7.8	11.2	8.2	—	47.4	75.8	72.9	73.3	47.7	40.4
3	-9.0	7.9	9.2	—	42.4	62.7	72.0	73.7	57.2	37.0
4	-16.5	8.9	3.5	—	45.6	61.4	79.2	64.4	46.7	37.1
5	-23.8	6.9	5.4	39.2	50.4	61.0	84.4	62.9	49.3	
6	-16.8	7.6	9.0	38.4	53.8	60.8	86.7	67.7	49.8	
7	-23.3	11.5	11.8	36.8	56.5	60.8	87.6	73.4	50.4	
8	-26.0	11.1	10.8	40.8	-	62.2	84.1	70.4	49.7	
9	-28.8	11.2	8.6	32.4	-	61.1	83.8	66.4	51.8	
10	-31.5	8.2	8.7	31.1	-	71.3	83.4	70.0	51.0	
11	-33.8	4.0	8.5	31.4	63.2	69.8	78.8	72.7	52.8	
12	31.7	3.3	8.6	35.5	63.0	76.9	81.4	64.1	54.1	
13	-31.5	-4.0	10.5	34.2	63.3	78.3	75.1	65.0	50.8	
14	-17.6	-9.6	11.5	43.0	66.2	83.4	66.0	62.8	50.0	
15	-14.0	-9.7	16.8	46.7	64.8	72.6	65.8	59.5	47.5	
16	-3.8	-7.4	20.0	43.2	66.2	69.8	73.0	61.3	47.0	
17	-8.4	-10.0	18.0	44.4	60.6	72.1	72.8	64.6	47.3	
18	-1.6	-10.2	19.8	46.2	54.6	-	65.5	62.4	49.4	
19	-5.6	-0.5	20.8	45.6	58.4	-	71.6	62.7	48.0	
20	-7.4	-5.2	22.6	48.8	58.8	-	-	54.8	48.7	
21	-8.0	-0.3	24.1	53.8	60.2	-	81.2	58.7	48.8	
22	-9.4	1.0	25.4	49.1	65.2	-	79.6	55.4	44.1	
23	-	6.4	-	52.6	67.0	-	80.4	53.7	36.4	
24	-4.9	11.4	-	-	66.4	-	83.0	51.7	31.7	
25	-6.5	15.3	-	58.2	68.6	-	82.4	51.5	31.0	
26	-	11.2	-	-	64.8	-	79.4	53.5	29.8	
27	6.0	14.0	-	-	66.0	93.8	78.0	57.2	29.4	
28	6.7	7.2	-	-	71.7	83.4	80.4	58.9	32.1	
29	9.9		-	46.8	77.2	80.6	81.4	54.5	35.8	
30	2.0		-	52.2	79.5	79.7	70.6	52.1	42.8	
31	3.5		-		71.6	-	70.4	50.0	-	

Surface Temperatures, °F - 1983
Peger Road
TS-4 White Marble C-Chips

Day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct
1	16.3	5.6	6.4	—	53.4	83.3	82.0	74.5	48.7	40.8
2	7.4	9.8	6.8	—	47.2	76.0	72.8	73.7	48.2	40.5
3	-9.5	6.4	7.5	—	42.4	69.2	72.4	74.1	57.8	37.1
4	-17.1	7.5	1.8	—	45.8	61.8	79.8	64.7	47.0	37.4
5	-24.5	5.4	3.6	38.8	50.7	61.4	84.8	63.2	49.5	
6	-17.7	6.0	7.0	38.0	53.9	61.4	87.4	68.0	50.0	
7	-24.0	10.0	10.0	36.7	56.6	62.1	88.6	73.7	50.7	
8	-26.9	9.8	9.0	40.6	-	62.4	84.9	70.7	50.2	
9	-30.0	9.9	7.0	32.7	-	61.7	84.2	66.6	52.2	
10	-32.6	7.0	7.2	31.6	-	79.3	83.5	70.0	51.4	
11	-34.9	2.8	7.6	31.4	63.3	70.3	78.6	74.0	53.4	
12	-33.0	2.0	7.2	35.3	63.0	77.6	82.1	64.2	54.5	
13	-32.8	-5.4	8.6	34.0	63.2	78.8	75.6	65.4	51.0	
14	-19.3	-11.0	10.0	42.8	66.1	84.0	66.3	63.2	50.1	
15	-15.6	-11.2	15.3	46.2	64.8	73.0	66.2	59.8	47.7	
16	-5.7	-9.0	18.5	42.7	66.2	70.0	73.6	61.6	47.4	
17	-9.9	-11.6	16.6	43.9	60.9	72.5	73.0	65.0	47.6	
18	-3.1	-11.7	18.4	45.8	54.8	-	65.8	62.8	49.6	
19	-7.0	-2.0	19.2	45.3	59.0	-	72.0	63.1	48.3	
20	-8.8	-6.7	20.9	48.5	59.2	-	-	54.8	49.0	
21	-9.6	-2.0	22.6	53.8	60.6	-	82.0	58.9	49.0	
22	-11.2	-0.6	24.1	49.1	65.4	-	80.4	55.4	44.2	
23	-	4.6	-	52.5	67.2	-	81.0	54.0	36.5	
24	-6.7	9.8	-	-	66.7	-	83.6	57.4	31.8	
25	-8.2	13.8	-	58.1	69.3	-	83.1	51.8	31.2	
26	-	9.7	-	-	65.3	-	80.0	51.2	30.0	
27	4.3	5.0	-	-	66.4	94.4	78.4	54.6	29.6	
28	5.2	5.6	-	-	72.4	83.9	80.8	54.9	32.3	
29	8.4		-	46.8	78.2	81.0	82.0	54.7	36.2	
30	0.3		-	52.3	79.9	80.2	70.9	52.2	43.2	
31	1.8		-		72.0	-	70.8	50.2	-	

Surface Temperatures, °F - 1983
Peger Road
TS-5, White Paint

Day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct
1	17.3	6.6	7.0	—	51.4	81.4	79.7	72.8	48.3	40.2
2	7.9	10.8	7.4	—	46.0	74.2	69.6	71.8	47.0	40.0
3	-10.1	7.1	7.8	—	41.7	61.4	70.0	72.2	56.2	36.6
4	-17.5	8.2	1.8	—	49.7	60.8	77.4	63.0	45.7	36.8
5	-25.0	6.0	3.6	38.2	49.4	60.1	82.5	61.9	48.4	
6	-17.1	6.8	7.0	36.8	52.4	60.0	84.3	66.3	48.9	
7	-24.1	10.8	10.2	25.8	54.8	60.0	85.3	71.5	50.0	
8	-27.0	10.6	9.0	29.4	-	61.2	81.4	69.1	49.4	
9	-30.0	10.6	6.8	33.0	-	60.1	80.8	65.3	51.4	
10	-32.6	7.5	7.2	30.8	-	76.4	80.6	68.4	50.6	
11	-34.7	3.0	7.8	30.0	61.1	67.8	75.0	71.0	52.3	
12	-32.6	2.3	6.8	34.0	60.8	75.0	79.2	61.8	53.6	
13	-32.4	-5.8	8.4	32.8	61.6	76.4	72.8	63.5	49.8	
14	-18.2	-11.4	10.4	41.8	64.1	80.4	64.0	61.2	49.2	
15	-14.4	-11.3	15.6	45.0	62.7	70.8	65.0	58.5	47.2	
16	-4.2	-8.9	18.5	42.2	63.8	68.0	71.2	60.4	47.0	
17	-8.9	-11.7	16.4	43.4	58.3	70.5	70.9	63.6	47.0	
18	-2.0	-11.6	18.2	45.0	53.5	-	63.4	61.3	48.4	
19	-6.4	-1.4	18.8	44.4	57.4	-	70.2	61.4	47.2	
20	-8.0	-6.4	20.2	47.6	57.6	-	-	53.8	48.4	
21	-8.8	-1.6	22.0	52.6	58.2	-	79.6	58.0	48.6	
22	-10.4	-0.1	23.4	47.7	63.2	-	77.6	54.8	43.6	
23	-	5.2	—	51.2	65.5	-	78.3	52.8	35.8	
24	-5.9	10.6	—	-	65.4	-	80.6	50.8	31.2	
25	-7.4	14.6	—	56.4	67.4	-	80.2	51.0	30.0	
26	-	10.0	—	-	63.6	-	77.4	53.2	28.8	
27	5.5	5.2	—	-	64.8	91.7	76.2	56.6	28.4	
28	6.4	5.9	—	-	70.0	81.2	78.7	58.2	31.6	
29	9.5		—	46.0	75.5	78.6	79.8	53.8	35.8	
30	1.3		—	50.8	77.4	77.6	69.0	51.8	42.7	
31	2.7		—		69.7	-	69.0	49.4	-	

Surface Temperatures, °F - 1983
Peger Road
TS-6, Yellow Paint

Day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct
1	17.3	7.2	7.7	-	52.2	82.8	81.0	73.2.	48.4	40.3
2	7.6	11.4	8.1	-	46.6	75.2	70.8	72.5	46.8	40.0
3	-10.0	7.8	8.6	-	42.1	62.3	71.2	73.2	56.2	36.6
4	-17.5	8.9	2.6	-	45.2	61.4	78.7	63.6	45.8	36.7
5	-24.9	6.6	4.6	38.8	50.0	61.0	83.6	62.1	48.8	
6	-17.1	7.4	8.0	37.6	53.0	60.8	85.0	66.9	49.0	
7	-24.1	11.4	11.2	36.4	55.5	61.1	86.0	72.4	50.2	
8	-26.8	11.2	10.0	40.2	-	62.4	81.5	69.6	49.4	
9	-29.7	11.2	7.8	33.2	-	60.9	81.4	65.8	51.4	
10	-32.3	8.0	8.0	31.4	-	77.6	81.2	69.0	50.6	
11	-34.5	3.6	8.4	30.8	62.0	68.7	76.0	71.6	52.4	
12	-32.3	2.8	7.8	35.0	61.8	76.3	79.0	62.1	53.6	
13	-32.1	-5.1	9.4	33.6	62.7	77.6	73.2	63.8	50.0	
14	-18.1	-10.8	11.2	42.4	65.1	82.4	64.2	61.4	49.4	
15	-14.1	-10.6	16.6	45.6	63.8	71.8	64.8	58.9	47.4	
16	-3.6	-8.2	19.5	42.8	64.8	68.8	71.2	60.8	46.9	
17	-8.5	-11.0	17.4	43.9	58.9	71.8	71.6	64.0	47.1	
18	-1.5	-11.0	19.2	45.8	54.2	-	63.7	62.0	48.4	
19	-6.0	-0.8	20.0	45.4	58.1	-	70.5	54.1	47.3	
20	-7.5	-5.6	21.5	48.4	59.0	-	-	54.1	48.4	
21	-8.4	-0.8	23.2	53.6	59.2	-	80.2	58.4	48.6	
22	-9.8	0.6	24.5	48.5	64.4	-	78.1	55.0	43.7	
23	-	6.1	—	52.0	66.6	-	79.4	52.9	35.8	
24	-5.4	11.2	—	-	66.4	-	81.4	51.0	31.0	
25	-6.8	15.2	—	57.6	68.4	-	80.6	51.2	29.9	
26	-	10.8	—	-	65.0	-	77.9	53.6	28.8	
27	6.1	6.0	—	-	66.0	92.6	76.8	56.9	28.5	
28	7.1	6.7	—	-	71.1	82.0	79.2	58.4	31.6	
29	10.1		—	46.4	76.6	79.4	80.0	54.2	35.7	
30	2.2		—	51.6	78.5	78.4	69.4	52.2	42.8	
31	3.4		—		70.4	-	69.4	48.4	-	

Surface Temperatures, °F - 1983
Peger Road
TS-7, Bare Pavement

Day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct
1	17.5	7.7	8.4	-	54.8	85.6	82.8	75.1	48.6	40.6
2	7.8	11.8	8.9	-	48.2	77.5	72.2	74.2	48.5	40.7
3	-10.2	8.2	9.9	-	43.3	63.2	72.1	74.9	59.2	36.9
4	-17.6	9.3	4.0	-	46.6	62.5	80.2	64.3	46.9	37.2
5	-25.5	7.0	6.0	41.0	52.1	62.2	85.6	63.0	49.7	
6	-17.2	7.8	9.7	40.3	55.5	62.2	87.7	68.3	50.3	
7	-24.2	11.9	12.7	39.1	58.2	62.4	89.0	74.2	50.7	
8	-27.7	11.6	11.5	43.0	-	63.8	84.6	71.0	50.0	
9	-30.0	11.5	9.4	34.2	-	62.6	84.5	66.9	52.2	
10	-32.7	8.4	9.3	33.6	-	80.8	84.2	70.9	51.5	
11	-34.6	3.9	9.0	33.0	65.3	71.5	78.2	73.6	53.7	
12	-32.4	3.3	9.3	37.2	64.7	79.2	82.7	64.0	54.9	
13	-32.0	-4.5	11.3	36.0	65.0	80.5	75.6	65.6	51.2	
14	-17.7	-10.1	12.5	45.4	67.6	85.6	65.8	63.2	50.4	
15	-13.7	-9.9	18.1	49.2	66.4	74.0	66.6	59.8	47.7	
16	-3.2	-7.5	21.3	45.6	67.9	70.7	74.1	61.9	47.2	
17	-8.1	-10.1	19.3	46.2	61.9	74.0	73.4	65.4	47.7	
18	-1.0	-10.1	21.2	48.2	56.4	-	65.3	63.3	49.8	
19	-5.4	-0.1	22.2	47.8	60.3	-	72.8	63.7	48.4	
20	-7.2	-5.0	24.0	50.5	61.1	-	-	54.6	49.1	
21	-8.1	0.1	25.6	56.4	62.6	-	83.2	59.1	49.1	
22	-9.5	1.7	26.7	50.9	67.7	-	80.9	55.4	43.9	
23	-	7.3	-	54.2	69.2	-	81.5	53.9	36.2	
24	-4.7	12.3	-	-	68.9	-	84.6	51.6	31.3	
25	-6.2	16.2	-	60.3	71.0	-	83.9	51.7	30.9	
26	-	11.7	-	-	66.5	-	80.5	54.0	29.7	
27	6.6	7.0	-	-	68.3	95.8	79.0	58.0	29.3	
28	7.5	7.6	-	-	74.0	84.2	81.8	59.7	32.0	
29	10.6		-	47.8	79.5	81.3	83.0	54.9	36.0	
30	2.7		-	53.6	81.2	80.3	70.8	52.2	43.2	
31	3.9		-		72.2	-	70.8	50.1	-	