## Cold Quantities in New Jersey, 1901-1955

ALFREDS R. JUMIKIS, Professor of Civil Engineering Rutgers University

• THE purpose of this study is to provide data for characterizing the severity of winters in New Jersey, to illustrate the distribution, magnitudes and frequencies of cold quantities, and to indicate what can be inferred from the cold quantity chart and map which accompany this report. These show the existence of the frost problem relative to New Jersey highways.

Beyond a certain degree of climatic severity, frost action in highway soils affects adversely the strength of the soil and performance of the road, particularly during thawing seasons.

In order to characterize the severity of a cold winter, climatologic data from the United States Weather Bureau for New Jersey, particularly temperatures, were studied for the past 55 years, beginning with the year 1901-02. There are no complete data available before that date.

The studies were confined to three reporting weather stations, namely, Layton (elevation 480 feet), New Brunswick (elevation 80 feet) and Indian Mills (elevation 100 feet), representing the northern part of New Jersey, central New Jersey and southern New Jersey, respectively. These weather stations were found to be the coldest in each of these three regions during the severe winter of 1947-1948. In some instances Sussex weather station data were substituted for incomplete Layton data, and Moorestown data for incomplete Indian Mills data.

Cumulative cold quantities for each year were computed in the form of degree days, tabulated in Table 1 and represented on a bar chart (Figure 1) for the three weather stations. Cumulative degree days for each winter were computed by adding the differences between the mean temperature and 32 deg F for each day that the mean was lower than 32 deg F.

Observation of this cold quantity chart indicates that: (1) severe winters in New Jersey repeat periodically with a fair degree of accuracy; (2) the recurrence of severe winters varies over a period of from 12 to 16 years, or, on the average, 14 years; (3) the order of magnitude of severe winters for the three regions of New Jersey is from 500 to 1430 degree days; (4) the first order of magnitude of a severe winter for the 55 years studied is characterized by the following cold quantity ranges: (a) in northern New Jersey, between 1000 and 1430 degree days; (b) in central New Jersey, between 500 and 800 degree days; (c) in southern New Jersey, between 500 and 730 degree days.

Everyone still remembers well the severe winter of 1947-48 and the tremendous damage to roads by frost it occasioned in this general area as well as in neighboring states. The subsequent repairs to these roads cost huge sums of money and much time.

Further observation of the chart indicates that there occurs, although in not too pronounced a fashion, a winter of medium severity (that is, of the second order of magnitude) after every four, five or six relatively mild winters. Thus, for example, six years following the severe winter of the first order in 1947-48, a medium-severe winter of the second order, with 285 degree days, occurred in central New Jersey in the freezing season of 1954-55. This caused enough damage to roads to become apparent to the highway user and owner, and to arouse concern.

From the preceding facts there may temporarily be inferred an estimate of the number of degree days at which damage to roads by frost is imminent. For the three sections of New Jersey the approximate numbers of damaging degree days would be: (1) 500 in the northern part; (2) 250 in the central part, and (3) 300 in the southern part.

It is, of course, needless to say that factors other than freezing temperatures may affect the severity of a winter, such as precipitation, elevation, winds and the orientation of mountain ranges.

From the periods or intervals of recurrence of a severe winter of the first or second order it may be inferred that in this general area: (1) there always has been, now is and always will be a frost problem in New Jersey relative to highways; (2) after several "mild winters" a severe winter will occur; (3) highways should be designed for the most

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Year	Degree Days				Degree Days		
	Layton, North, Elev 480	New Brunswick, Central, Elev 80	Indian Mills, South, Elev 100	Year	Layton, North, Elev 480	New Brunswick, Central, Elev 80	Indian Mills South, Elev 100
1901-02	904.0	432.0	433.0	1928-29	564.5	241.0	208.5
1902-03	750.0	356.0	257.5	1929-30	712.5	347.5	284.5
1903-04 <sup>a</sup>	1431.5	760.5	652.0	1930-31	596.0	185.0	193.0
1904-05	1325.5	663.5	578.0	1931-32	300.0	114.5	96.0
1905-06	688.5	208.0	190.5	1932-33	465.5	232.5	175.0
1906-07	1021.0	584.5	363.5	1933-34	996.0	712.5	591.5
1907-08	726.0	334.0	240.0	1934-35	772.5	436.5	338.0
1908-09	481.5	163.0	133.0	1935-36 <sup>a</sup>	1080.0	695.5	596.5
1909-10	835.5	307.5	327.5	1936-37	528.0	125.0	144.0
1910-11	830.0	415.5	341.5	1937-38	535.5	248.5	198.5
1911-12 <sup>b</sup>	932.5	597.5	533.0	1938-39	676.5	309.5	294.0
1912-13	434.0	230.5	173.0	1939-40 <sup>D</sup>	930.5	500.5	482.0
1913-14	745.0	579.0	362.0	1940-41	720.0	279.5	242.5
1914-15	503.0	281.5	265.5	1941-42	621.0	323.5	320.0
1915-16	773.5	475.5	396.0	1942-43	765.0	391.0	390.0
1916-17	692.0	384.5	396.5	1943-44	747.5	297.0	339.0
1917-18 <sup>a</sup>	1253.5	804.5	735.5	1944-45	792.5	400.5	378.5
1918-19	273.5	114.5	133.0	1945-46	650.0	349.5	330.5
1919-20	1086.5	619.5	530.5	1946-47	483.0	236.0	268.0
1920-21	385.0	166.0	166.0	1947-48 <sup>a</sup>	996.0	528.0	507.5
1921-22	664.0	346.0	332.0	1948-49	375.5	167.0	148.5
1922-23	905.5	430.5	317.0	1949-50	516.0	199.5	185.0
1923-24	488.5	275.5	222.5	1950-51	549.0	228.5	239.0
1924-25	686.5	355.5	221.0	1951-52	560.0	139.5	197.5
1925-26	690.0	390. 5	301.5	1952-53	329.5	99.5	120.0
1926-27 <sup>b</sup>	701.0	363.0	283.0	1953-54.	436.5	224.5	220.5
1927-28	580.0	292.0	268.5	1954-55 <sup>b</sup>	543.5	284.5	307.5

TABLE 1 DEGREE DAYS IN NEW JERSEY FROM 1901-1955

dangerous and disadvantageous conditions not only in relation to traffic but also in relation to frost action; (4) the maximum cold quantity on record in New Jersey is 1430 degree days; (5) it is certainly now known that when the 285 degree-days point is reached, frost damage to roads is marked, and (6) the existence of the frost problem in New Jersey, in its turn, poses many problems relative to the performance of soils under freeze-thaw conditions, with the correlative implication that much research should be done in this field.

A map of New Jersey showing degree-days for the severe winter of 1947-1948 was also prepared (Figure 2). It is realized that the degree-day lines are only as representative as the temperature data of each weather station is representative of the surrounding area in which the station is located.

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<sup>&</sup>lt;sup>a</sup> Indicates severe winters. <sup>b</sup> Indicates medium severe winters.