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The Climate Part of the National Building Code of Canada

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Canada recently published a new National Building Code [1], to assist small municipalities and to promote more uniform building regulations across the Dominion. It is an advisory document only and has no legal standing until and unless it is adopted by a provincial government or a municipal administration.

Any building code is essentially a set of minimum requirements issued in the interest of public safety. A number of these regulations depend on the severity of certain weather elements, such as temperature, wind speed, and rainfall intensity, whose wide ranges in Canada must be taken into consideration when preparing a code for national use.

The new arrangement of the Code brought all the weather data together in one part. "Part 2: Climate," contains twelve maps of Canada on each of which are shown the variations in one weather element. Each regulation in the Code which depends on the value of some weather element contains a reference to the map from which a value can be obtained for any location. The charts are listed below:

1. Winter Design Temperature, 2½% Basis
2. Winter Design Temperature, 5% Basis
3. Mean Annual Total Degree-days, 65°F Basis
4. Mean January Daily Minimum Temperature
5. Mean July Daily Maximum Temperature
6. Fifteen-minute Rainfall Expected Once in Ten Years
7. Mean Annual Total Precipitation
8. Computed Maximum Snow Load on a Horizontal Surface
9. Computed Maximum Gust Speed
10. Direction Frequencies of Winter Winds
11. Earthquake Probability
12. Approximate Southern Limit of Permafrost.

Charts 3, 4, 5, 7 and 10 were prepared from readily available data. Charts 11 and 12 are not really climate maps but were inserted in this section for convenience. The computations that were necessary for the preparation of the maps of design temperatures, snow loads, and gust speeds are discussed below. The data for the chart of maximum fifteen-minute rainfall expected once in ten years were not obtained directly from rainfall records because there were too few stations in Canada with recording rain gauges. The data were computed from the average rainfall per rainy summer day, using the few actual values as controls.

Over eighty maps were originally prepared by Mr. M. K. Thomas for this project. Only ten of these were used in the Climate Part of the Code, but most of them have now been published in the Climatological Atlas of Canada [2].

DESIGN TEMPERATURES [3]

Roughly speaking a winter design temperature is the coldest temperature which occurs with sufficient frequency during the average winter to justify its use in the design of heating systems. There are a number of ways of choosing design temperatures, but the definition agreed on for the National Building Code of Canada is: "The winter design temperature on a 2½ percent basis is the temperature expressed in degrees Fahrenheit at or below which 2½ percent of the January hourly outdoor temperatures occur." Other percentages can be substituted for 2½, but this is the one ordinarily used.

The ten Januaries from 1941 to 1950 inclusive were used to obtain these design temperatures. The hourly temperatures for the ten Januaries (that is 7440 values) at each station were arranged in order of temperature and the 2½ percent value or the 186th temperature from the coldest was read off. In this way design temperatures were obtained for 35 stations in Canada.

In order to obtain a more complete coverage without the time consuming process of counting hourly temperatures, Mr. H. C. S. Thom of the United States Weather Bureau suggested the use of a linear relationship which he had noticed between (a) the standard deviation of the monthly mean temperatures, and (b) the difference between the normal mean temperature and the design temperature. The constants in the equation are somewhat different in different parts of the country and three graphs were drawn for three different areas. The 2½ percent design temperatures for an additional seventy stations were obtained from these graphs, and used to draw the first map in the Building Code.

The second map in the Code shows the five percent design temperature. The one and ten percent maps are in the Climatological Atlas of Canada.

The American Society of Heating and Air-Conditioning Engineers has been publishing winter design temperatures in its Heating Ventilating Air Conditioning Guide since 1948 [4]. Their design temperature is defined as "the outdoor temperature which is equalled or exceeded 97½ percent of the hours in December, January and February." This definition gives a slightly higher value than the Canadian 2½ percent value since it is based on the three winter months, which, on the average, would be

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milder than the single month of January. At Toronto, for example, the ASHAE 97½ percent design temperature is 3 degrees while the Canadian 2½ percent value is zero.

In a few years, when both countries have more hourly reports on punched cards we may be able to use the same definition for design temperatures.

SNOW LOAD [5]

In both Canada and the United States the data on the weight or water equivalent of the snow on the ground are very scarce. The depth of newly fallen snow and the depth of the accumulated snow on the ground are, of course, measured regularly at most stations. These latter observations must be used to estimate the weight of snow which a roof may have to bear.

In Canada the maximum reported depth of snow on the ground during the ten years 1941 to 1950 was tabulated for all the stations with such records. The average density of this snow was assumed to be 0.2 although rather wide variations from this value do occur.

In some parts of Canada, many of the structural failures due to snow loads have been reported after a winter or early spring rain falls into a heavy snow cover. To take this rain into account the weight of the maximum 24-hour rainfall in the appropriate season was added to the computed weight of the maximum snow cover. This sum is the maximum snow load on a horizontal surface which is used in the National Building Code of Canada. The values vary from 25 pounds per square foot in Alberta to 90 pounds in Labrador.

A study of snow loads in the United States by the Weather Bureau under the sponsorship of the Housing and Home Finance Agency was completed in 1952 [6]. These snow loads do not include any rain. However, they agree quite well with the Canadian values near the Great Lakes. Further east and west the snow loads on the Canadian basis are greater than the USWB values by 5 to 15 pounds per square foot.

WIND GUST SPEEDS [7]

For many years the standard wind measuring instrument in Canada has been a rotating cup anemometer which records the passage of each mile of wind. The number of miles of wind in each hour are read from the charts and these records are the only readily available data on strong winds from most stations.

A few stations also have Dines pressure-tube anemometers which record gust speeds. To compute the maximum gust speeds for all the wind stations in Canada it was necessary to find a relation between the gust speed and the corresponding hourly speed. These values were plotted for the stations equipped with both types of anemometers, and the best straight line for gusts over 65 mph was obtained. This line represents the average of all the strong gusts, but to get the strongest gust which might occur the line must be shifted upwards by 6 mph, and we get another line with the equation:

$$\text{Maximum Gust Speed} = 25 + 1.22 \text{ Mean Speed.}$$

With winds of less than 35 mph there are occasionally very strong gusts and the maximum gust speed for these lighter hourly winds is about 68 mph. Maximum gust speeds computed from the equation above were used to prepare the map of gust speeds for the Code.

In the United States the design wind pressures are based on the maximum five-minute wind instead of the maximum hourly wind, and hence the calculations are quite different [8]. The final design wind pressures, however, agree quite well along the international boundary from the Atlantic to Lake Superior. Further west the Canadian values are higher. In southern Saskatchewan and Albert the gust speeds of over 100 mph correspond to design pressures of 30 pounds per square foot, whereas in northern Montana the design value is only 20 pounds.

It is hoped that all the climate charts in the National Building Code of Canada and the more complete collection in the Climatological Atlas of Canada will prove useful, not only to builders, but to many people interested in Canadian climate.

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