"CRREL is Developing New Snow Load Design Criteria for the United States"

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ABSTRACT

Current snow load design criteria for the United States[1] does not provide guidance for the Rocky Mountain area or the State of Alaska. All snow load information in the above referenced document was generated from information collected at 140 stations across the country. The presentation of a few snow load isolines on a little map strikes us as being an overgeneralization based on the magnitude of localized differences in snow accumulation that exists just a few miles apart in many regions.

The Office of the Chief, Corps of Engineers has tasked CRREL to develop new snow load criteria. In 1973 we generated interim criteria for Alaska[10]. First, the climatological series of the maximum annual depths of snow on the ground at 137 locations in Alaska were statistically analyzed. Then regionalized "conversion densities" were developed from information available at twenty-five locations. By marrying the statistically-developed depths and the regionalized "conversion densities", ground snow loads for the 137 locations were generated. These were tabulated; not presented as isolines over a map of the state. The accompanying text indicated that significant local variations exist. Factors were presented to convert ground snow loads to roof loads as a function of regional climatology, exposure of the structure and the geometric, aerodynamic and thermal characteristics of the roof.

A similar approach is now underway to develop criteria for the contiguous United States. The USAF Environmental Technical Applications Center provided CRREL with computer listings of monthly maximum depths of snow on the ground at over 9,000 locations. As anyone familiar with weather records knows, there are many gaps in such information. Rather than omit any year having missing monthly records, two techniques (triangulation and patterning) have been developed which allow us to retain, with confidence, much of this information. In both techniques, missing information is concocted. If the concocted value becomes the yearly maximum, the entire year is thrown out. If the concocted value is less than a maximum that existed during some other month of that winter, the existing maximum is used and another valuable year-of-record is added to the statistical analysis. In this fashion the data base has been increased by about 20%. On the average three to four years of record were added to each of the 9,000 locations.

Abstract -- report in progress.

Each Alaskan station was analyzed statistically by plotting the annual depth maxima on log-normal probability paper using the plotting positions of Blom[4]. Several alternative statistical approaches have been evaluated for the comprehensive new work:

1. Log-Normal (Thom)[9]
2. Extreme Value Type I (Gumbel)[6,7]
3. Extreme Value Type I (Gringorten)[5]
4. Extreme Value Type I (Lieblein)[8]
5. Log-Pearson Type III (Beard)[3]
6. Extreme Value Type II (Gumbel)[6,7]

Chi-square goodness-of-fit tests run on 51 stations showed that several of the above statistical alternatives provided acceptable levels of fit. Since the log-normal approach had the best overall fit, it was selected. Rather than determine return period values graphically as was done for Alaska, the more rigorous approach of computing them directly from the distribution parameters was used.

At 176 stations in the contiguous United States where both snow depth and water equivalent measurements are available, "conversion densities" were developed. Two graphical methods similar to that used in Alaska[10] and one statistical approach were tried. The statistical approach which again used a log-normal distribution was selected as the best method since it was consistent with the approach used to develop the snow depth values. Since the graphical approaches generally produced the same conversion densities as were generated by statistics, the "conversion densities" for the contiguous states are compatible with those generated previously for Alaska. Twenty-five year return period "conversion densities" for the 176 stations were placed on a map of the U.S.A. and a single "conversion density" was developed for each state. These values were married to the statistically-developed snow depths at all 9,000 stations across the country to generate ground snow loads for 5, 25, 50, and 100 year return periods.

Ground-to-roof conversion factors were developed in a similar fashion as those developed for Alaska[10]. Additional factors which account for aerodynamic, geometric and thermal differences among roofs were adopted from Alaskan[10] and Canadian[2] criteria.

A report containing state-by-state tabulations of design information for all 9,000 locations in the United States is in preparation. It will include a text and examples which describe how to generate rational design loads for a variety of snow load situations. We expect to publish this report early in 1977.

The factors which convert ground loads to roof loads and those which account for the properties of the roof should be improved. To accomplish this, CRREL has initiated a 3-year case study program. Preliminary snow load case studies were conducted during the 1975-76 winter by Dr. Michael O'Rourke of Rennselaer Polytechnic Institute. During the next three winters, numerous case studies will be conducted from New England to Oregon.

In 1979 the ground snow load tabulation will be updated statistically to include data gathered since 1974 and new snow load factors will be developed based on the case studies conducted from 1975 to 1979. Publication of the updated information is expected in early 1980.

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