WABO - SEAW WHITE PAPER
SNOW LOAD REGULATIONS AND ENGINEERING PRACTICES
WASHINGTON STATE
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BACKGROUND

In 1996, the Structural Engineers Association of Washington (SEAW) presented a seminar on snow load design at three locations in the State. The main purpose of the seminar was to introduce a new edition of the SEAW Snow Load Analysis for Washington to engineers and regulators. The first edition was published in 1975.

At the late 1996 seminar in SeaTac, an ad-hoc committee of members of the Seattle Chapter of SEAW conducted a panel discussion of issues related to the seminar, including snow load regulation. Much of the discussion focused on the lower elevation regions of the Puget Sound area. As a result of the panel discussion, it was recommended that SEAW and the Washington Association of Building Officials (WABO) attempt to bring more consistency to the design and review process relating to snow loads. A joint WABO-SEAW Ad Hoc Snow Load Committee (see Appendix III) was subsequently formed to consider snow load issues and to facilitate consistency of design and enforcement.

GOALS OF THE SNOW LOAD AD HOC COMMITTEE

The Goals of the Ad Hoc Committee are to further regional understanding and consistency with respect to snow load design and enforcement practices on low-lying areas of the Puget Sound, and to document the results of the considerations in a White Paper which will be a resource tool available to members of the construction industry. Although the potential exists to use the information generated to consider code changes, the immediate Goals of the Committee do not extend to considering changes to the State Building Code.

CURRENT REGULATIONS

The Uniform Building Code (UBC) is the adopted model code in the State of Washington. In general, the provisions of the UBC (1994 Section 1605.4, 1997 Section 1614) require local jurisdictions to establish snow loads used in the design of structures constructed in the local community. The load that the UBC intends for local determination is a uniform load. In addition the UBC requires consideration of non-uniform accumulation due to potential drifting. This may appear non-specific, but the lack of data and numerous influencing variables, such as moisture, wind, elevation, temperature, geographic location, and proximity to large bodies of water, as well as variations in roof shapes and in the sizes and shapes of adjacent structures, together make state-wide adoption of specific loads and drift methodologies difficult. Lack of specificity of the Code helps cause an inherent lack of consistency from jurisdiction to jurisdiction as compared to more defined regulation. Furthermore, the design practices of private professional engineers vary considerably.

Appendix 1634 of the UBC (Append. Chapter 16 Div. I 1997 UBC) provides methods for calculating loads due to drifting snow. Generally, Appendix Chapters of the UBC are not adopted by the state; rather, they are left available for local jurisdictions to adopt if desired. Appendix Chapters contain regulations that have not been developed sufficiently to gain the standing necessary for incorporation into the main body of the code.

In some cases, individual jurisdictions have adopted ordinances that establish a specific local uniform snow load. In other cases, snow load requirements are developed by the local jurisdiction as written or unwritten policies.

OTHER RELATED ISSUES

For the construction of safe roof structures, other issues can be as important or more important than specificity in regulation. Examples include:
intent of the owner/developer - is the intent construction for a long-term capital investment, or is the focus minimum construction for immediate sale?

technical capabilities of the design engineer, the local plan reviewer and the inspector - is the engineer practicing in an area of expertise? does the jurisdiction have licensed engineers and certified inspectors on staff? does the jurisdiction as well as the design engineer have a continuous education plan?

lack of communication between the design engineer and those responsible for inspection regarding critical concerns - does the design engineer realize an inspector’s time is limited? (10-15 inspections per day are common.) does the contract allow for field involvement by the design engineer?

staffing level of the local regulator- does the jurisdiction have budget to hire engineering staff and sufficient inspection staff?

contractor knowledge and understanding - does the contractor have a good line of communication with the engineer? does the contractor realize a seemingly small change in design or specification may not be equivalent but rather have long term impacts?

financial and economic pressures - are the terms of the construction contract so tight as to drive consideration of less than what was specified? is competition between manufactured products driving designs to be marginalized? are assumptions being made regarding a level of independent inspection that does not exist?

timely mechanisms for resolving conflicts between the regulator and the project designers - does time it takes obstruct getting the right answer and promote further gaps in communication?

perceived relative importance between different sizes and occupancies of structures - is the position of some jurisdictions justified that small car ports and storage buildings, etc. have lower priority for regulatory structural involvement than other larger and more highly occupied buildings?

THE SEAW SNOW LOAD ANALYSIS FOR WASHINGTON

There have been several publications developed over the last 30 years that address the statistical determination of snow loads for the design of buildings. These publications include the 1970 National Building Code of Canada, and manuals by Structural Engineers Associations in Oregon, Colorado, Idaho, and Washington. The latest version of the SEAW Snow Load Analysis for Washington incorporates many concepts from these previous publications.

Precipitation and snow depth data used in the SEAW Snow Load Analysis for Washington are based on measurements from the Soil Conservation Service and the National Weather Service. Density relationships have been developed in the various documents mentioned above. The Snow Load Analysis uses the Rocky Mountain Conversion Density relationship from a 1986 University of Idaho study. Basically, the relationship provides lower density at lesser snow depths and higher density at greater snow depths to account for accumulation effects. Snow depths are based on a Mean Recurrence Interval of 50 years with a Log Pearson Type III distribution.

SEAW’s Snow Load Analysis for Washington provides a method to calculate basic ground snow load throughout the state from mapped information and elevations. Using the ground snow load and formulas found in UBC Appendix Chapter 16, one can then calculate the roof snow load, which for most buildings is less than the ground snow load. The Snow Load Analysis also contains a table in Appendix A of that document that provides a recommended ground snow load for various jurisdictions (see Appendix I this document). These recommended loads are appropriately higher than what one could calculate from known elevations and the isolines.

In the low-lying regions of Puget Sound, these recommended ground snow loads are commonly in the range of 15 to 25 psf. If one calculates roof snow loads by applying the UBC methodology \((P_g \times I \times C_e)\) for common buildings, the associated roof snow loads would calculate to 10.5 to 17.5 psf.

The Analysis also provides examples which calculate drifted snow load based on methods outlined in the UBC Appendix. The methods use the ground snow load as a basis to determine the drift loads.
While it should be recognized that the Snow Load Analysis is the best resource available to help both the designer and the local building official determine local snow load requirements, it is, by itself, not a legally enforceable document. It was written solely to provide information about snow load design.

ISSUES WITH CURRENT REGULATIONS

Because of the lack of specificity in the State adopted code, design engineers can experience difficulties identifying specific local requirements. Because engineers tend to design structures in many different jurisdictions, they must seek this information on a job to job basis. They must maintain contacts, and hope that those contacts can provide information sufficient to prevent costly revisions during the permit application review and inspection of the building. During the preliminary stages of project development, the structural engineer provides information for estimates upon which financial and contractual decisions are based. Subsequent changes made during the permit process not only upset these decisions, but also consume time and money during resolution.

During a panel discussion at the SEAW’s SeaTac seminar, the following issues were discussed, most of which relate to the low lying regions of Puget Sound:

- The confusion surrounding whether specified basic snow loads are ground snow or roof snow loads.
- The perception in some jurisdictions that the Snow Load Analysis is an enforceable document.
- A lack of clarity about which basic ground load source to use (the isoload maps or the various tables) and the limitations of each source as they relate to snow density.
- The variability of snow drift requirements between jurisdictions. At one end of the spectrum, drift considerations are not required by the local regulator, and are left to be determined by the design engineer. At the other end of the spectrum, drift considerations are required, including a multitude of calculations for different roof conditions and load cases.
- The variability of drift calculation assumptions (ground snow vs. roof snow, area of roof that accumulates snow, impact of adjacent structures, complex multiple roof shapes), which can result in widely varying loads and resulting roof structures.
- The discrepancies between the likelihood of significant drift conditions in low lying Puget Sound and the rationale providing the basis for drift recommendations found in the UBC and the Manual. The drift provisions of the UBC appear to be based on climates quite different than the low lying Puget Sound area. The primary difference is the amount of time the snow accumulates and drifts, which can be weeks to months in the central and eastern US and mountainous regions, but only several days in the Puget Sound area.

SURVEY OF CURRENT SNOW LOAD PROVISIONS

Prior to the SeaTac seminar, various building departments were surveyed informally over the phone, which helped generate some of the discussion at the seminar. While the decision to proceed with the WABO-SEAW Ad Hoc Committee occurred before the 1996 December/1997 January storm (the Holiday Storm), the storm caused the Committee to proceed with a more formal survey of all the building officials in the State. In the winter of 1997, this survey was sent to a total of 85 towns, 192 cities, and 39 counties, and response was received from 14 towns, 90 cities, and 27 counties. A copy of the survey results is found in the Appendix II of this paper.

The survey asked jurisdictions questions relating to the uniform load used, drift enforcement practices, local amendments, and use of the SEAW Analysis. It is of note that most jurisdictions reported using at least 20 psf. With the bulk using 25-psf. uniform roof snow load.

FEMA/SEAW STORM DAMAGE EVALUATION RESULTS
The Holiday storm caused much damaged around Puget Sound as well as in regions beyond Puget Sound, particularly on the east side of the Cascade Mountain Range, and in the south central regions of the state. The Holiday storm injected a need for consideration well beyond this White Paper, and indeed, the Seattle Chapter of SEAW joined with the Federal Emergency Management Agency (FEMA) to write a report on the resulting damage in Washington. The report includes a description of the weather event, the general extent of damage, a survey of building departments, as well as case studies of various types of structures, which experienced failure.

The report was published in June of 1998, titled *An Analysis of Building Structural Failures Due to the Holiday Snowstorms*. This document and this White Paper are obviously closely related, and reading SEAW/FEMA’s Analysis is recommended reading.

**REGIONS COVERED BY WHITE PAPER**

The initial purpose of the Snow Load Ad Hoc Committee, was to consider problems relating to snow load regulation and design in King, Pierce, and Snohomish Counties, and to develop a White Paper acceptable to both organizations, that may include recommendations for enforcement and design practices relating to snow loads.

A great deal of Committee discussion occurred about the vertical and lateral boundaries of “low lying Puget Sound”. Greater boundaries provide more information to a larger area and therefore to more future construction projects. On the other hand, effects of local weather conditions such as the Fraser River Valley to the north in B.C., areas immediately east of the Olympic Range, and the Columbia River area to the south are not as well known or understood, particularly with respect to wind and density of the falling snow, and thus argue for limited boundaries. While limiting the boundaries simplifies recommendations, the Committee decided to expand the boundaries to include a wider region of the state west of the Cascades Range.

**SUMMARY OF FINDINGS**

After considering the information provided by the WABO survey, the FEMA/SEAW joint effort, and the experience of committee members, the Committee established the following findings:

- The climates are similar enough in the low-lying areas of western Washington that it is reasonable to establish a consistent specification, and consistency benefits, designers, building officials, as well as the forest product industry...
- The historic approach of uniform snow loads has provided acceptable performance.
- The historic uniform load approach keeps the design and review process straightforward.
- The drift provisions found in the reference documents were developed for significantly different climates and are questionable for the Puget Sound.
- Based on the SEAW/FEMA a joint effort, recent storm damage was not related to drifting.
- Consideration should be given for conditions resulting from a rain storm following a snow storm (rain on snow effect), on flat or near flat roofs- the UBC Appendix chapter suggests 5 psf. For roofs less that $\frac{1}{2}$:12 slope.

**RECOMMENDATIONS**

1. In low lying areas between the Cascades and the coastal mountains of western Washington, it is recommended that all roof structures be designed for a minimum uniform roof snow load of 25 psf. However, this should not preclude certain jurisdictions from adopting a more conservative loading if historical data supports such, due to localized weather phenomenon or particular geographical features.

2. For the purposes of the 25 psf recommendation and the effects of drift, low lying areas are defined areas in jurisdictions that have a recommended ground snow load of 25 psf or less in Appendix A of the 1996 SEAW Snow Load Analysis for Washington. (Note that this is typically conservative in comparison the method outlined in UBC Appendix and the SEAW Analysis where a 30% reduction is commonly applied to the ground snow load to determine roof snow load).
3. In low-lying areas of Puget Sound as described in item 2, there is not a significant enough concern about drift to warrant proactive regulatory enforcement by the local jurisdiction. In some unusual cases (such as buildings with a UBC Importance Factor greater than 1), it may be appropriate for the design engineer to consider the effects of drift and the possibility of snow sliding off steep, upper roofs onto lower ones. However, the method for considering drift (UBC Appendix or *SEAW Snow Load Analysis for Washington*) requires significant judgement which should generally fall within the realm of the design engineer, rather than become part of proactive jurisdiction enforcement.

4. To account for the potential of rain on snow effects in low-lying area, it is recommended that an additional uniform load of 5 psf for roofs with a slope of less than 5 degrees be further studied. (Note: this was a topic where the Ad Hoc Committee did not gain consensus and therefore the “further study” recommendation; this should not be enforced by local jurisdictions based on this Paper unless specifically adopted under ordinance, with consensus on a regional basis with broad industry involvement).

5. It is recommended that those jurisdictions in low-lying regions that do not have a specific written ordinance on snow loads adopt one.