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T E C H N I C A L B U L L E T I N

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Source Document: **19 NYCRR 1220 - *Residential Code of New York State* (RCNYS)**

Topic: **Design Snow Loads**

This document provides information regarding the application of the *Residential Code of New York State* (RCNYS) as it pertains to design snow loads. It discusses two acceptable methods for determining roof design loads while emphasizing the need to consider **unbalanced snow loads** in engineered design.

List of Abbreviations

BCNYS; *Building Code of New York State*
CEO; Code Enforcement Official
GSL; Ground Snow Load
PSF; Pounds Per Square Foot
RCNYS; *Residential Code of New York State*

Introduction

The determination of design snow loads under the *Residential Code of New York State* (RCNYS) is often confused with the requirements of the *Building Code of New York State* (BCNYS). The RCNYS uses a prescriptive approach to meet the design requirements for snow loads whereas the BCNYS uses an analytical approach which includes the use of an equation and considers various roof configurations and design conditions such as exposure, thermal and importance factors, warm roofs vs. cold roofs, partial loading, unbalanced loads and drifting and sliding snow. That which is often misunderstood in the RCNYS is the need to include unbalanced snow loads for common hip and gable roofs.

Snow Loads by Prescriptive Design

The RCNYS requires ground snow loads to be determined from Figure R301.2(5), based on the geographical location of a building. The Ground Snow Load (GSL) and other climatic and geographic design criteria, must be established by the local jurisdiction as set forth in Table R301.2(1). Section R301.5 requires roofs to be designed for the minimum snow load indicated in Table R301.2(1). Since the snow load in Table R301.2(1) is the GSL, it follows that the roof must be designed for the GSL without any adjustments when using the prescriptive method and not a value determined from an engineered approach. One exception is found in section R301.2.3 which requires buildings in regions with GSLs greater than 70 psf to be designed in accordance with accepted engineering practice and ASCE 7-98. Therefore, under the RCNYS a house located in an area where the GSL is 55 pounds per square foot (psf), must have a roof designed as fully loaded for a minimum snow load of 55 psf. In the alternative, section R301.1.2 allows for an engineered design for structural elements not conforming to the RCNYS. Therefore, a roof structure may be designed for either the full GSL by the use of the RCNYS prescriptive provisions or engineered in accordance with the BCNYS.

Snow Loads by Engineered Design

Snow loads for roofs engineered in accordance with the BCNYS is provided for in section 1608. Section 1608.1 of the BCNYS requires design snow loads to be determined in accordance with section 7 of ASCE 7-98, entitled,"Minimum Design Loads for Buildings and Other Structures". This design option allows for adjustments to the GSL but is more complicated than the simplified prescriptive approach offered in the RCNYS. Section 1608 as well as ASCE 7 requires other factors to be applied in the design of a roof. Those most often associated with residential construction include the exposure factor (C_e), thermal factor (C_t), and importance factor (I). These values are used to determine the flat roof snow load (p_f) in equation 7-1 as follows:

$$p_f = 0.7\ C_e\ C_t I p_g$$

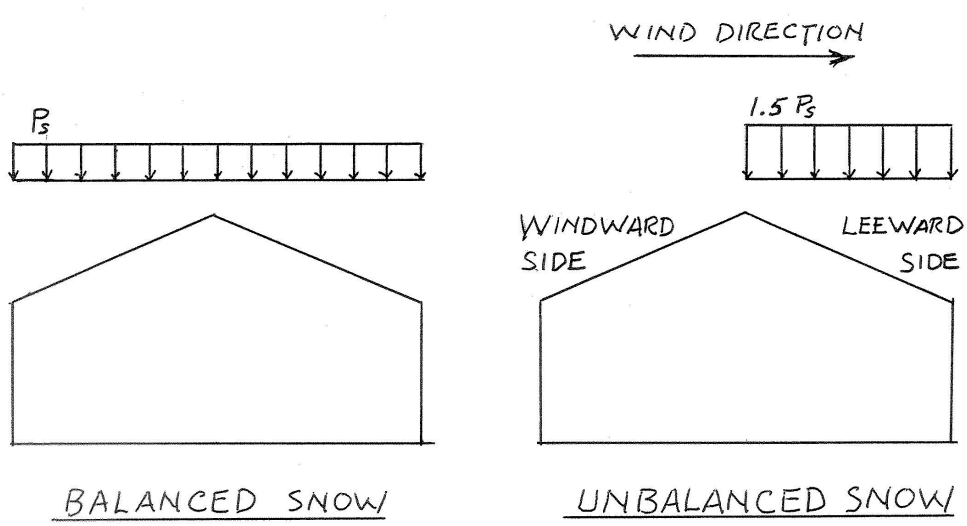
where p_g = is the ground snow load determined from BCNYS Figure 1608.2 or RCNYS Figure R301.2(5).

The values for C_e, C_t, and I are obtained from Tables 1608.3.1, 1608.3.2, and 1604.5 respectively. For residential construction, these values are typically 1.0. Therefore, in most cases the flat roof snow load is the product obtained by multiplying the GSL by 0.7 or 70% of the ground snow load. As an example, the flat roof snow load for a roof located in a 55 psf snow zone is typically 70 % of 55 or 38.5 psf. In some cases this load may be reduced for a sloped roof to account for sliding snow and improved drainage of meltwater. However, for roofs having a non-slippery surface such as conventional asphalt shingles, live load reduction for roof slope is not introduced until the slope exceeds a 7 on 12 pitch pursuant to Figure 7-2 of ASCE 7. Therefore, the sloped-roof snow load (p_s) would most often be equal to the flat-roof snow load (p_f).

In most cases for residential buildings, the design snow load is substantially less than the prescriptive GSL determined from RCNYS Table R301.2(1). However, the engineered roof design is subject to other snow loading conditions identified in ASCE 7-98. One such condition that is most often overlooked and has a substantial impact on a roof design is accounting for unbalanced snow loads.

Unbalanced Snow Loads

Unbalanced roof snow loading occurs as a result of wind. Winds carry snow from the windward side to the leeward side. Section 7.6.1 of ASCE 7-98 requires a roof with an eave to ridge distance of 20 feet or less to be designed to resist an unbalanced uniform snow load on the leeward side equal to 1.5 p_s/C_e. Since the exposure factor C_e is typically 1.0, the leeward side of a sloped roof in most cases must be designed for a uniform load of 1.5p_s or 50 % more than the load determined from equation 7-1. Since it is not possible to determine wind direction, each side of the roof should be considered. It should be noted that the windward side is considered not to be covered with snow. This is illustrated in Figure 7-5 of ASCE 7-98 and in the diagrams below:



Therefore, the roof of a house located in an area where the GSL is 55 psf and the flat or sloped-roof snow load is 38.5 psf, would have to be designed for both balanced and unbalanced conditions with a load of 57.8 psf [1.5x38.5] applied on the leeward side of the roof.

Enforcement Recommendations

Rafters can be checked using the rafter span tables R802.5.1(1) through R802.5.1(8). These tables only list live loads of 20, 50, and 70 psf whereas actual GSLs for New York State include 45, 50, 55, 65, 70 and 85 psf. Where a GSL does not equate to a live load given in the tables, it is necessary to use a table with the next highest load. This may result in a conservative roof design. Rafters for other design loads, spacings, species and grades, and spans not found in the tables, may be designed as fully loaded with the GSL or designed using equation 7-1 and all loading conditions prescribed in ASCE 7-98. Construction drawings should always identify the GSL for the roof. If the design is based on an engineering analysis, the drawings should also reference compliance with the BCNYS and ASCE 7-98 and include the flat-roof snow load (p_f), snow exposure factor (C_e), snow load importance factor (I), and the thermal factor (C_t). The unbalanced snow load should also be identified to ensure that it has been considered in the design.

For wood trusses, section R802.10.1 requires design drawings to be provided to the code enforcement official. Such drawings should be stamped and sealed by a professional engineer or registered architect licensed to practice in New York State and must provide sufficient information to allow a determination by the code enforcement official that the truss has been designed to comply with the RCNYS. It is important to verify whether the design load is for a live load equal to the GSL or determined in accordance with ASCE 7-98. Drawings for trusses designed in accordance with ASCE 7-98 should include the following information:

1. An indication that the design is based on reference standard ASCE 7-98.

2. A statement that the design has been analyzed separately for both balanced and unbalanced load conditions.

3. The flat-roof snow load (p_f), snow exposure factor (C_e), snow load importance factor (I), and the thermal factor (C_t).

4. An indication that the unbalanced snow load factor is 1.5 or $1.5/C_e$.

It should also be noted that RCNYS section R802.10.1 further requires truss design drawings to include at a minimum the following additional information:

1. Slope or depth, span and spacing.

2. Location of all joints.

3. Required bearing widths.

4. Design loads as applicable.

    4.1. Top chord live load (including snow loads).

    4.2. Top chord dead load.

    4.3. Bottom chord live load.

    4.4. Bottom chord dead load.

    4.5. Concentrated loads and their points of application.

4.6. Controlling wind and earthquake loads.

5. Adjustments to lumber and joint connector design values for conditions of use.

6. Each reaction force and direction.

7. Joint connector type and description (e.g., size, thickness or gage) and the dimensioned location of each joint connector except where symmetrically located relative to the joint interface.

8. Lumber size, species and grade for each member.

9. Connection requirements for:

9.1. Truss to truss girder.

9.2. Truss ply to ply.

9.3. Field splices.

10. Calculated deflection ratio and/or maximum deflection for live and total load.

11. Maximum axial compression forces in the truss members to enable the building designer to design the size, connections and anchorage of the permanent continuous lateral bracing. Forces shall be shown on the truss design drawing or on supplemental documents.

12. Required permanent truss member bracing location.

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