Snow Provisions in ASCE 7-05

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Recently changes have been made to the snow load provisions of ASCE 7 *Minimum Design Loads for Buildings and Other Structures*. Sliding snow loads, the rain-on-snow surcharge, and provisions for calculating unbalanced snow loads on gable roofs, and particularly simplified provisions for residential roof rafter systems are some of the provisions affected by the updates.

Unbalanced Snow Loads on Gable Roof

Over the past decade or so, there have been more changes to the unbalanced load provisions than any other snow load in the ASCE standard. The unbalanced load for a gable roof has been prescribed to be a uniform load from ridge to eave, or a load which increases from ridge to eave. The magnitude of the load has been prescribed, at various times, to be a function of the ground snow load or the roof aspect ratio.

The difficulty in establishing an appropriate unbalanced load was due, in part, to the fact that it is actually a drift load. That is, the windward side of the gable serves as the snow source area for the drift which accumulates downwind of the ridge on the leeward side. The top surface of the actual drift is nominally flat and, except for very narrow, low sloped roofs in particularly windy locations, the drift does not extend all the way to the eave. The unbalanced gable roof load in ASCE 7-05 is intended to mimic the expected triangular drift surcharge near the ridge. Based on water flume studies, the size or cross-sectional area of the gable roof drift is taken as that for a roof step drift with the same upwind fetch. The horizontal extent of the gable roof drift is related to the size of the drift (size of the windward snow source area), and the space available for drift formation as quantified by the roof slope. In an attempt to make the provisions user friendly, the triangular surcharge is replaced with an equivalent rectangular surcharge. The centroids of the triangle and rectangle match. The intensity of the uniform rectangular surcharge equals the average of that for the triangular surcharge.

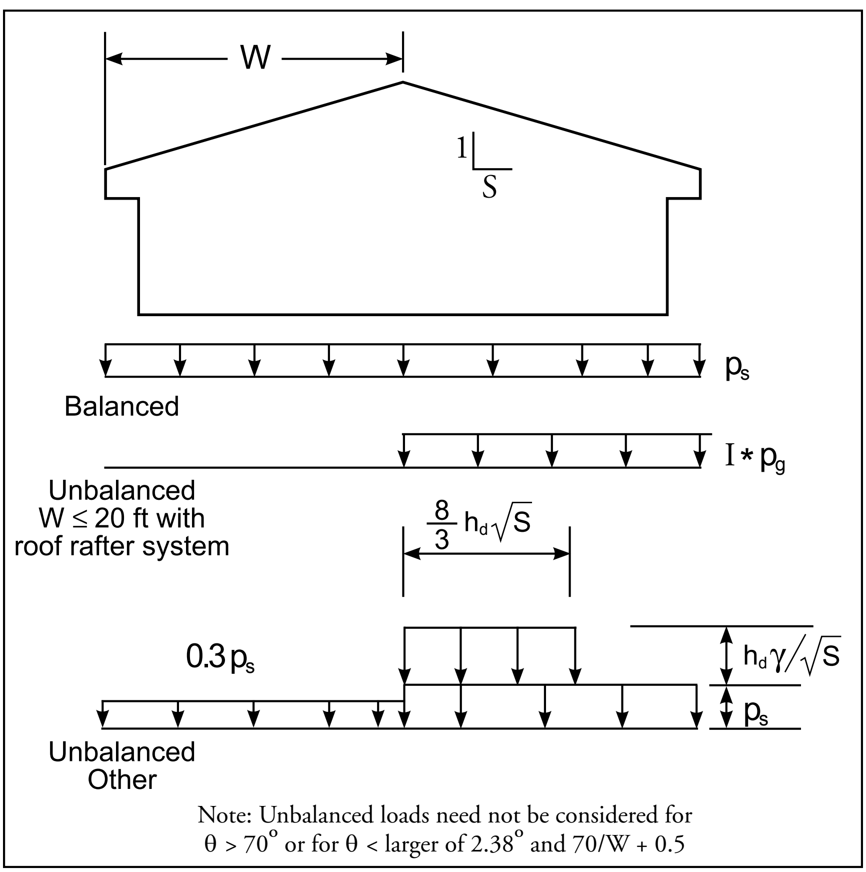

Figure 1: Balanced and unbalanced snow loads for hip and gable roofs per ASCE 7-05 (reprinted with permission of ASCE)

As in the past, gable roof drift loads are not required for very steep roofs (slopes of 70 degrees or more), where not even the balanced load is expected to stick. At the other extreme, gable roof drifts are not required for near flat roofs where there is no area of areodynamic shade at which the drift can form. Specifically, gable roof drifts are not required when the roof slope is less than the larger of 2.38 degrees (½ on 12) and 70/W + 0.5 (*Figure 1*).

Simpler provisions have been incorporated in ASCE 7-05 for residential roof rafter systems with W ≤ 20 feet. Residential roof rafter systems are those with simply supported prismatic joists spanning from eave to ridge, supported by either a ridge board or a ridge beam. For such systems, the prescribed unbalanced condition is a uniform snow load on the leeward side equal to the importance factor, I, times the ground snow load, p_g. Since rafters in such systems are typically selected from span tables, the prescribed unbalanced loading was established to correspond to a uniform load from eave to ridge. The intensity of the load is such that the peak moment and shear for the prescribed uniform load are larger than the corresponding values for the expected triangular load. Since the locations of the maximum shear and moment are different, the so-called residential roof rafter system must utilize prismatic joists so that the specific location of the actual maximums is of no consequence.

By their nature, roof trusses are not prismatic in this sense; their bending moment and shear force capacity vary along the span, although their components may well be prismatic. As such, roof trusses are not eligible for the uniform Ip_g load from eave to ridge.

Table 1 shows balanced and unbalanced snow loads (in pounds per linear foot) on exterior load bearing walls for symmetric gable roofs with various spans (eave to eave distances). The table lists unbalanced loads from both the 1998 and 2005 versions of ASCE 7. The darkened value is the controlling load condition in ASCE 7-05 for each ground snow load and roof span. Note that unbalanced snow is the controlling bearing wall load for short spans, while the balanced snow controls for longer spans.

Table 1: Comparison of Balanced and Unbalanced Snow Loads on Single Story Exterior Loadbearing Walls Using ASCE 7-05 vs. ASCE 7-98[a]

Roof Span (ft)	Ground Snow Load (psf) 30: Balanced	30: Unbalanced ASCE 7-98[b]	30: Unbalanced ASCE 7-05	30: Unbalanced 7-05 / 7-98	50: Balanced	50: Unbalanced ASCE 7-98[b]	50: Unbalanced ASCE 7-05	50: Unbalanced 7-05 / 7-98	70: Balanced	70: Unbalanced ASCE 7-98[b]	70: Unbalanced ASCE 7-05	70: Unbalanced 7-05 / 7-98
	Unit Load on Exterior Loadbearing Wall/Header/Girder (plf)											
12	185	231	**200**	0.87	308	385	**333**	0.87	431	539	**467**	0.87
24	323	384	**333**	0.87	539	640	**554**	0.87	755	896	**776**	0.87
36	462	539	**467**	0.87	770	898	**778**	0.87	1078	1258	**1089**	0.87
48	**601**	875	578	0.66	**1001**	1458	966	0.66	**1401**	2041	1360	0.66
60	**739**	1072	710	0.66	**1232**	1786	1183	0.66	**1725**	2501	1663	0.66

a. Assumes 2 foot overhangs, no dead load, roof slope of 7 on 12, C_e = 1.0, C_t = 1.1, C_s = 1.0, I = 1.0
b. The gable roof drift parameter, beta, used for W>20 is conservatively assumed to be unity for this example.

The comparison with ASCE 7-98 provisions shows that the current unbalanced snow load is significantly less than in ASCE 7-98. For smaller spans the current unbalanced load is 87% of the ASCE 7-98 value. For larger spans, the current values are 66% of the ASCE 7-98 values. This highlights the significant changes in the gable roof drift load provisions over the past decade or so.

Sliding Snow Load

In earlier versions of the ASCE 7 load standard, for example in ASCE 7-98, the sliding snow load was taken to be all of the sloped roof snow load on the upper roof. A strict interpretation of this provision would require a sliding load check for upper level roofs of <u>any</u> slope. In addition, the older provisions resulted in a smaller sliding load from a steeply sloped upper roof, and a larger sliding load from a mildly sloped upper roof, which is counterintuitive. Finally, the provision was a bit vague in relation to the spatial extent of the sliding load surcharge atop the lower "receiving" roof. In the new approach, which first appeared in ASCE 7-02, the sliding load is 40% of the flat roof snow load, p_f, over the horizontal distance from the ridge to the eave of the upper roof, or 0.4 p_f W. The sliding snow is to be uniformly distributed over 15 feet from the upper roof eave. This load is superimposed on the lower roof balanced snow load, p_s. This provision applies to upper roofs with slippery surfaces and slopes > ¼ in 12 and to non-slippery roof surfaces with slopes > 2 in 12. Although the thermal characteristics of the upper roof (heated, unheated, south facing, etc.) likely influence the potential for sliding, these parameters are not currently considered.

Rain-on-Snow Surcharge

It is not unusual for it to rain while the roof has a significant snowpack. This rain can refreeze in the snowpack, or it can percolate through the snowpack. If the rain refreezes, it becomes more or less a permanent part of the snowpack and its weight would presumably be included in any daily, weekly, or monthly measurement of the ground snowpack. On the other hand, rain which percolates through the roof snowpack and then flows in a saturated layer towards the eaves results in a transitory increase in the total roof load. The ASCE rain-on-snow provisions are directed at this second case, since it is unlikely that the transitory weight increase due to rain would be captured during a ground snow load measurement program.

In prior versions of the ASCE standard, a 5 psf surcharge was required for shallow roofs (slope < ½ on 12) in low ground snow load areas (p_g ≤ 20 psf). High ground snow load areas (> 20 psf) were excluded because it was assumed that rain would refreeze in deeper snowpacks. Recent analysis shows that the transitory increase in weight (i.e. the thickness of the saturated layer at the base of the roof snowpack) is significant for roofs that are wide and shallow. In ASCE 7-05, only roofs with a slope < W/50, where W is the eave to ridge distance, (i.e. roofs that are both wide and shallow) potentially require the 5 psf surcharge.

Summary

This article describes recent changes to snow load provisions of ASCE 7. Specifically, changes to the sliding snow load, rain-on-snow surcharge, and gable roof unbalanced snow load criteria are discussed. Of particular interest are simplified unbalanced load provisions for residential roof rafter systems with ridge to eave spans of 20 feet or less, and simply supported prismatic joists with either a ridge board or a supporting ridge beam.

A more complete description of the ASCE 7-05 snow load provision; with examples for various types of construction will soon be available in *Snow Loads: Guide to the Snow Load Provisions of ASCE 7-05*, published by ASCE Press.

Example problems for determining sliding snow loads and gable roof unbalanced snow loads are included in a more comprehensive version of this paper at **<u>www.awc.org</u>**.▪

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