Ice and Snow Accumulations on Roofs

All properly built roofs, whether for animal housing, commercial applications or residences, are built to withstand a “design” snow and ice load. The snow design load is based upon the expected frequency and severity of snowstorms. It also considers such factors as the type of structure, its construction and the risk to human life and safety.

In Connecticut, the design snow load for animal housing is typically about 5 to 10 lbs. per square foot. For residents, commercial buildings and essential services such as hospitals, the design snow loads is 30 pounds per square foot.

It should be remembered that the snow load is only a portion of the total design load, which will include wind and dead loads. Dead loads are loads that account for the weight of the roof structure itself. While the total design load may be 2 to 4 times greater than the design snow load alone, the weight of the snow, if it exceeds the design snow load, may cause structural failure. If the blueprint and construction documents for the structure are available, they should provide the design snow load.

Clearly, poor materials, construction and post-construction maintenance can result in a weaker structure with an actual load capacity significantly lower than the design load. Therefore, proper materials and techniques should be followed for construction. After construction, proper maintenance is vital and any damage should be repaired as soon as possible. Knowledgeable professional assistance should always be sought.

The presence of snow and ice on a roof exerts vertical loads that can cause a roof to sag or bow downward. This loading also transfers horizontal forces that may cause the walls to deflect, or move slightly outward. Depending on the construction design, the deflection may be at the top or bottom of the wall.

When roof loads are below the actual load capacity, any sagging or deflection that occurs is temporary and will disappear after the load is removed. This level of loading and minor sagging or deflection of the roof structure will probably not be noticed. When the loading exceeds the design loads, the sagging and deflections become permanent. In extreme cases the roof collapses.

An assessment of the risk of snow and ice accumulation on roofs, as with any potential disaster, is to:

- Determine what is at risk,
- What is the level of risk,
- What if, anything can be done to avoid or minimize the damage, and
- What are the potential adverse outcomes of the action.

For example, if you leave the ice and snow on a roof, the roof may risk collapse. If you remove the snow, brittle shingles are likely to be damaged, or the person removing snow may get injured. The expense and liability of having someone else remove the snow needs to be considered before taking action.

It is important to ask, is it possible and practical, with the available equipment and labor, to remove the snow and ice? What about the health and safety of the individual who is working on a snow and ice covered roof?

The first step to help answer these types of questions is to determine the design snow load of the structure. If plans and construction documents can be obtained, they should provide this information.
A professional who is knowledgeable in construction practices may be of assistance. Finally, the general rule of thumb above provides some guidance.

It is also important to remember that poor materials and construction combined with poor building maintenance may result in actual load-bearing capacities being lower than the design snow load. So, the building condition must be considered.

The next step is to determine if the current snow load, or the potential snow load, is greater than the load-bearing capacity of the building. The most rapid method to do this is a visual inspection. If there is no detectable sagging of the roof line or no horizontal deflection of the walls, the load-bearing capacity probably has not been exceeded. If visible roof and wall deflections occur, it is very likely that the load-bearing capacity has been exceeded and there is an increased potential for damage.

A difficulty with the visual approach is that one cannot estimate the actual load on the roof for comparison with the design load.

Measuring Weight of Snow and Ice

The weight of accumulated snow/ice, not the depth, is critical in assessing a roof's vulnerability. The water content of snow may range from 3% for very dry snow to 33% for a wet, heavy snow, to nearly 100% for ice. An inch of water depth weighs 5.2 lbs. per square foot. Thus, a roof designed to carry a snow load of 20 lbs. per horizontal square foot is expected to support nearly 12 inches of wet, heavy snow. Table 1 provides information on snow and ice densities and the equivalent inches of water for various snow loads.

Collecting samples of snow/ice is the only practical and accurate way to determine the roof load. The first step is to collect a uniform vertical column of snow from the snow surface to the roof surface. This can be done by thrusting a 3-pound coffee can (6 inches in diameter) repeatedly into the snow until reaching the roof. Empty the snow into a bucket each time the coffee can is filled. After the snow is collected, it is melted and poured back into the coffee can and water depth measured in inches. This depth multiplied by 5.2 provides the snow load in pounds per square foot. For example, if your melted sample measures 4 inches deep, your roof snow load is approximately 21 lbs. per square foot (4 x 5.2 = 20.8). If desired, Table 1 provides a rough estimate snow load.

If there is a layer of ice between the snow and the roof, you don't want to risk damaging the roof. Estimate the average thickness of the ice, then multiply by 5.2 and add this result to the snow moisture weight.

Generally, the most representative samples are taken from the center third of a roof (measured from the ridge to the eave). Loads on these areas are typically the most vital to assess the rafter's strength capabilities or the potential for failure.

In some cases, you should be concerned about the snow/ice loads on:

- Roof overhangs (especially large overhangs projecting several feet beyond the horizontal support), if there is substantial ice buildup

- Multilevel roofs (when the lower roof is subject to an accumulation of sliding or drifting snow or accumulation of snowmelt)

- Valleys (subject to substantial snow or ice accumulation due to drifting, sliding or melting)

Prior to sampling snow loads, safety risks should be weighed against the potential benefits of obtaining a sample to estimate the actual snow load.

Table 1: Equivalent Snow Load Table

Density Information				
	Light/Dry Snow	**Heavy/Wet Snow**	**Ice**	**Water**
Snow density (lb/cu ft)	3.12	20.81	57.25	62.43
% of water weight	5%	33%	92%	100%
Equivalent Inches				
Design Snow Load (lb/sq ft)	**Light/Dry Snow**	**Heavy/Wet Snow**	**Ice**	**Water**
5	19.2	2.9	1.0	1.0
10	38.4	5.8	2.1	1.9
15	57.7	8.6	3.1	2.9
20	76.9	11.5	4.2	3.8
25	96.1	14.4	5.2	4.8
30	115.3	16.2	6.3	5.9

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