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Roof Snow Loads

Concern about your roof's ability to support tons of ice and snow during a prolonged and especially moist Minnesota winter presents a frustrating dilemma: Should you leave the ice and snow, risking collapse of the roof, or should you remove the snow load, possibly damaging brittle shingles, risking personal injury if the you do the job yourself, and incurring expense and liability if you have someone else do it?

Unfortunately, there is no simple solution to this dilemma. Of course, you should be alert for reports of ground snow depth and moisture content in your locale. However, such information is useful only as a guideline; it is not an adequate reflection of the conditions on your roof because it does not take into account three important variables:

- how much weight your roof is capable of supporting,
- how much dead weight (from roofing materials) your roof is carrying, and
- how heavy the snow/ice accumulation on *your* roof is. (This varies according to drifting, melting, and slide-off conditions.)

Where To Get Help

To measure these variables, especially those related to structural conditions, you will probably need assistance. The following sources may be helpful.

- *Local building and housing inspectors.* See municipal or county telephone listings. (In rural areas where there are no such officials, contact the County Farmers Home Administration supervisor.)
- *Structural engineers.* See "Engineers-Structural" listings in telephone yellow pages.
- *Carpenters and remodeling contractors.* See "Home Builders" in telephone yellow pages for the area home builders association for referrals.
- *Architects.* See listings under "Architects" in telephone yellow pages.
- *Lumberyard owners or managers.* See telephone yellow pages listings under "Lumber-Retailing."

Basic Roof Structural Considerations

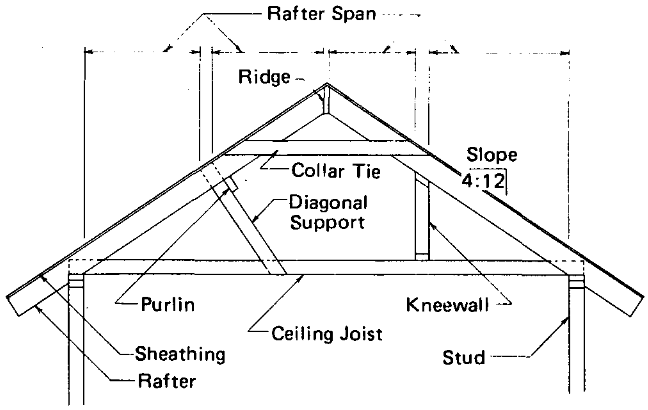
Your roof is subject to the greatest load, temperature, and moisture extremes of any component of your house. A roof in an older home may be the most "underbuilt" portion of the house and thus most vulnerable to structural problems. Additionally, your roof may be subject to several common abuses that increase its vulnerability. Those are:

- insulation without adequate roof deck ventilation,
- reroofing over three or more layers of shingles, and
- employing ineffective "commonsense" practices to correct symptoms of structural problems.[1]

Note: This fact sheet summarizes more in-depth information contained in *Residential Roof Snow Load Concerns,* Special Report 104. This report is available for 40 cents from county extension agents or the Bulletin Room, Coffey Hall, University of Minnesota, St. Paul, MN 55455.

The fact that your roof has endured many winters of heavy snow does not ensure that it will last indefinitely. Roofs of most older homes were built with little or no insulation, so snow melted fairly quickly and roofs carried snow loads for very brief periods. If insulation has been added to your roof, less heat escapes, so snow and ice do not melt as rapidly and snow loads accumulate to new and perhaps excessive weight levels. Furthermore, the roof deck may not have been properly ventilated when insulation was added to your attic. In that case, ice-damming and subsequent backup of snowmelt under shingles, as well as excessive condensation due to moisture transfer from the interior of your home into the attic and rafter cavities may occur. Those occurrences create favorable conditions for deterioration of roof structural members and fastener holding ability.

Figure 1. Common Roof Components



If you are unfamiliar with basic roof structural components, refer to figure one. The rafters and ceiling joist form the basic framework, or truss, of your roof. This joist/rafter combination may also involve a *collar beam* or *collar tie,* which connects the two sides of the rafters, creating tension to stabilize the thrust mechanics of loading; a *vertical support,* known as a "kneewall;" or a *diagonal support* ("purlin") designed to transfer a portion of the roof's load to interior load-bearing partitions. In new construction, an engineered truss of interconnected diagonal members is sometimes found.

An important element in estimating the support capabilities of your roof is the rafter span. Rafter span is the distance between load-bearing supports in your roof. If there are no kneewalls or purlins in your roof, you measure rafter span from the ridge (center point) to the exterior stud wall. Otherwise, you measure distances between ridge, intermediate supports, and the exterior stud wall. (*Note:* Kneewalls and vertical and diagonal supports must be placed over load-bearing walls or joists designed to carry snow loads.)

[1] For example, "kneewalls" or diagonal supports are often installed (to stabilize sagging rafters) over ceiling joists not designed to carry additional loads. Also, rafters are occasionally notched and thus weakened.

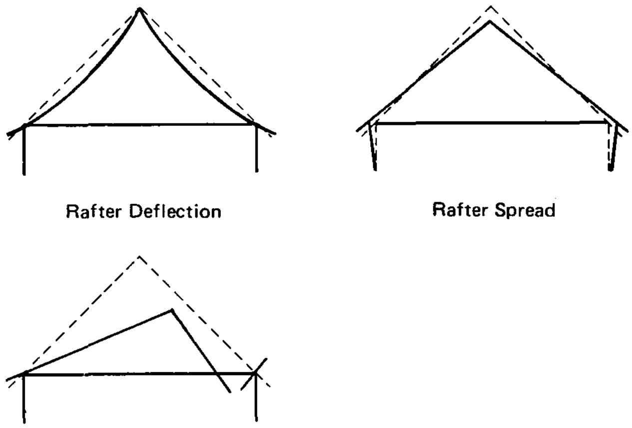


Figure 2. Roof Structural Failure

Roof structural failure generally begins with rafter deflection or rafter spread. Deflection results when horizontal loads (such as snow and ice buildup) cause wood fibers to bend. Eventually, deflection will cause rafters to rupture in the center third of the span or at weak points, such as notches or knots on the top or bottom edge of the rafter. Rafter spread results from the failure of mechanical ties, such as nails, to hold ceiling joists, top plates, and studs together or, occasionally, failure in the ceiling joist itself.

Rafter deflection and spread represent initial stages of structural failure. These problems should be corrected or stabilized with the assistance of a knowledgeable contractor, engineer, or architect.

Estimating Roof Structural Strength

You can use the help of an expert carpenter, contractor, or architect to determine how much weight your roof can support. Characteristics to be considered include the rafter lumber: its size, strength, and stiffness; rafter span (see above); slope of the rafters (see figure one); distance, on center, between rafters; and any strength reduction items, such as notching, rotting, insect attack, grain slope, or knots. With this information, you can refer to span tables, available at lumberyards or through engineers, building inspectors, or carpenters. Those tables enable you to estimate the snow load capacity of your roof, which is measured in pounds per square foot (PSF).

Measuring Roof Dead Weight

Another variable affecting your roof's snow-bearing capacity is roof dead weight, or the weight of all the roofing materials (sheathing, roofing paper, felt, shingles, or built-up membrane). Roof rafters or trusses in new Minnesota homes are assumed to carry 10 pounds of roofing materials per square foot. This assumed weight is well within the realm of reality of new construction practices, but application of additional layers of roofing over the lifetime of a dwelling may exceed dead weight assumptions and thus reduce snow load capabilities. To estimate your roof's dead weight, you must first find out how many layers of materials have been added to the original roof. If the combination of roofing materials on your roof exceeds the assumed 10 pounds of dead load, your roof's snow load capabilities are reduced by an equal number of PSFs.

Measuring Roof Snow and Ice Weight

It is not the depth, but the weight of accumulated snow/ice moisture content that is critical in assessing your roof's vulnerability. Water content of snow may range from 3 percent for a very dry snow to 20 percent for compacted snow, to approximately 100 percent for ice. Water per inch of depth weighs 5.2 pounds per square foot. Thus, a modern roof designed to carry a snow load of 40 pounds per horizontal square foot is designed to support an equivalent of approximately 3½ feet of compacted snow.

The only practical and accurate way to determine the snow/ice weight on your roof is to collect samples of snow/ice from *your* roof. To do this, thrust a 3-pound coffee can (6 inches in diameter) repeatedly into a vertical core of the snow blanket. (See figure three.) Empty the snow into a pail *each time the can fills.* Melt the snow, return it to the coffee can, and measure the depth of the liquid in inches. Multiply that depth by 5.2 to determine weight per square foot. For example, if your melted sample has a depth of 4 inches, your roof snow load is approximately 20 pounds per square foot (PSF). (4x5.2 = 20.8). *Note:* Do not compact snow samples. Bottom may be cut from can.

If there is ice at the bottom of the roof snow blanket and you don't want to risk damaging the shingles, estimate the average thickness of the ice, multiply by 5.2, and add this result to the snow moisture weight.

Snow and ice samples from valleys or other roof areas susceptible to drifting or blow-off should not be assumed to be representative. Generally, the most representative samples can be drawn from the center third of roof planes. These areas are also usually the most important for determination of rafter strength capabilities.

However, in some cases, you should be concerned about snow/ice loads on these specific areas of the roof:

- overhangs, especially large overhangs projecting several feet from horizontal supports that have substantial ice buildup;
- multilevel roofs, where a lower roof is subject to sliding or drifting snow or accumulation of snowmelt; and
- valleys subject to substantial snow or ice accumulation due to drifting, sliding, or melting.

Whether your snow/ice load warrants removal or roof structural modification must be determined by on-site analysis of: roof snow load design capacity, roof dead weight, and amount of seasonal snow/ice accumulation. Owners who desire on-site analysis may wish to retain a knowledgeable carpenter, engineer, or architect.

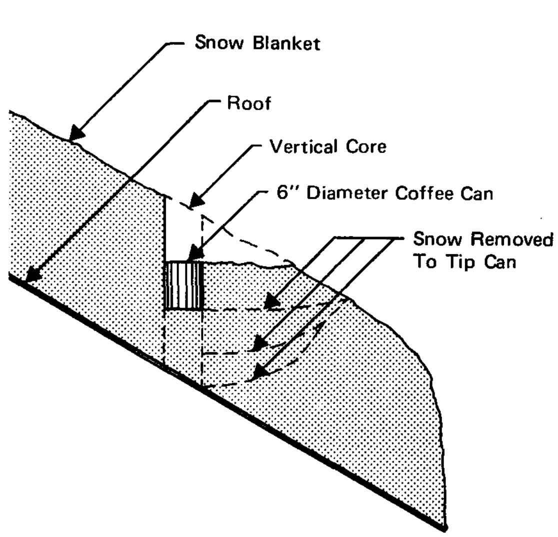


Figure 3. Snow Sampling Technique

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