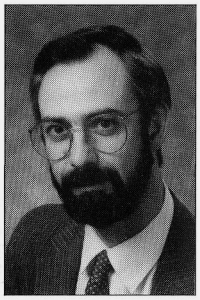
Metal roof systems: Design considerations for snow and ice

by **Thomas L. Smith, AIA, CRC**

Unless taken into consideration during design, sliding snow, falling ice and ice dams can cause roof leakage and present hazards to people entering or leaving the building.



Many of these design considerations are applicable to other types of roof coverings, but because of the low coefficient of friction of the surface, metal systems should be carefully designed in snow country.

Design considerations should begin with the roof's geometry and its relationship to building elements and people passing below. When designing a new building or a conversion from an existing low-slope to a steep-slope system, primary building exits below the eave should be avoided. These exits should be below a rake or a low-slope area, such as a canopy.

Minor egress points below the eaves may be acceptable, but may require extra maintenance to keep them clear of snow or freezing water dripping from the eaves. Also, if people are likely to walk below an eave, landscape features such as retaining walls or shrubs should be used.

Sliding snow

If the exits are not below the eaves and if roof penetrations are not in danger of being harmed, it is usually best to allow the snow to slide off the roof. However, if snow retention is desired, this may be accomplished with snow guards.

When designing guards, calculate their requirements. Calculations should include snow weight (based on the design roof snow load, including drifts), strength and size of the guard, and attachment of the guard to the roof. The calculations, which should assume there will be no friction between the roof and the snow, will allow determination of the spacing between the rows of guards between the eave and the ridge.

For further information, refer to *Canadian Building Digest* 228, "Sliding Snow on Sloping Roofs."

At slopes greater than 3-in-12, retaining snow on metal roofs becomes increasingly difficult. But regardless of the slope, the design should place the weak point in the plane of the snow. Therefore, if the snow *does* slide, it simply shears within itself and will not tear off the guards and cause leakage.

The first row of guards should be placed at least two feet from the eave, so that the guard is not surrounded by the ice dams that develop at the eave. Otherwise, the ice may lift up the guard and cause leakage.

The guards should be screwed or clamped to the top of the panel ribs. If screws are used, sealant tape should be placed between the rib and the guard, and the screws should have a gasketed washer. The guards should be placed so that the screws or clamps do not interfere with concealed clips; otherwise, damage from thermal movement could occur.

If the guard is mounted to the pan of the panel, it should be attached with adhesive rather than a screw. Otherwise, if the guard is sheared off, the screw holes could allow a lot of water to enter the roof.

An extra row of guards should also be placed about two feet above roof penetrations, with the row extending a foot or two beyond the penetration.

If the roof is not equipped with snow guards, special attention should be paid to roof penetrations; otherwise, the penetrations could be sheared off or otherwise damaged. One approach is to place the penetrations near the ridge, where there will be little load pressing against them.

Another approach is to provide a cricket (splitter) above the penetration. Appendix Chapter 23 of the *Uniform Building Code* includes design criteria for splitters. Yet another approach is to provide a shroud over the penetration, which will allow snow to slide over the penetration without causing damage.

Falling ice

If snow falls on the roof, development of icicles should be expected. This occurs during warmer days when the snow melts, but the water freezes at the colder eave or freezes at night and causes an ice dam and formation of icicles. These dams form even when the roof is a "cold roof" (ventilated attic space). While it is possible to prevent snow slides, it is not possible to prevent falling ice.

Electrical de-icing systems are sometimes employed, but these seldom do more than melt a small area adjacent to the heated cable.

Eave ice dams cause a concentrated load that should be considered by the designer. Appendix Chapter 23 of the *Uniform Building Code* gives design criteria for this condition.

When ice is able to fall from an upper roof to a lower roof, damage can occur. Unfortunately, data is lacking on the magnitude of loads due to falling ice. If the lower roof is a protected membrane system, the likelihood for damage is probably minimal (particularly if heavy weight concrete pavers are used). However, if the lower roof is metal, some additional protection measures may be needed if the fall is greater than a few feet. Ice guards and other considerations for valleys and eaves for metal systems will be addressed in a future article. PR

Thomas L. Smith is NRCA director of technology and research.