

# SNOW LOADING



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Every year snow loading takes a toll on businesses, homes, and public facilities in northern regions. Most businesses and homeowners start preparation for snowfalls before winter approaches. This typically includes snow removal plans for sidewalks, parking lots, and roadways, contracting snowplows, and winterizing vehicles. However, making a plan for snow removal to prevent a roof collapse may be the most critical. When a record storm occurs, or when a unique combination of moderate snowfall and thawing repeats, structures can be challenged to their design limits. When collapses occur, they are sudden and often catastrophic. These collapses can be very costly in terms of property damage and can interrupt production and operations.

With these repeated stresses and strains, “building to code” is often not a reliable defense against damage or collapse from snow loading. Roof additions, changes to roof mounted equipment, and sustainability upgrades (i.e., “green roofs”) create added opportunities for snow accumulation and drifting that did not exist prior. Further, joists and structural members installed at original construction may have reduced strength due to added interior loads (such as large fans or increased lighting), age, and wear and tear. The thousands of welds in open bar steel joists may not have been thoroughly inspected during construction and the hidden defect(s) never identified.

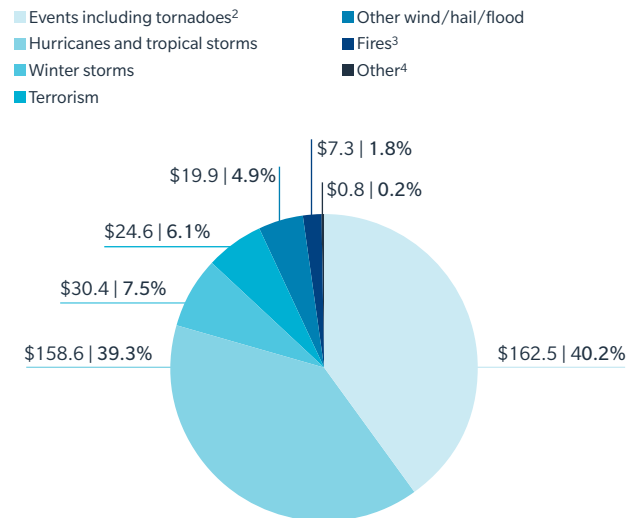
Heavy, repeated snowfall and subsequent melting between storms creates a freeze–thaw cycle that can cause roof overloading. Sloped roofs are subject to ice dams and water penetration to interiors; and once such a flow begins, it only ends when the snow is melted off the roof. Flat or low pitch roofs are subject to bellowing, which exacerbates the condition, followed by further deflection, further accumulation, and can lead to collapse.

If you are concerned about snow loading prevention and mitigation, it is important to understand where problem areas may lie in your facilities and the actions to be taken in advance of and during the winter weather season. Marsh Risk Consulting’s Property Risk Consulting (PRC) team provides insight into this issue below.

Winter storms caused an estimated \$3.5 billion in insured losses in 2015, up from \$2.6 billion in 2014, according to Munich Re. From 1996 to 2015, winter storms resulted in about \$30.4 billion in insured catastrophe losses (in 2015 dollars), or more than \$1 billion a year on average, according to Property Claim Services (PCS).

— Excerpted from “Winter Storms”,  
Insurance Information Institute, 2016

## Inflation-Adjusted US Insured Catastrophe Losses By Cause Of Loss, 1996-2015<sup>(1)</sup> (2015 \$ billions)



(1) Adjusted for inflation through 2015 by ISO using the GDP implicit price deflator. Excludes catastrophes causing direct losses less than \$25 million in 1997 dollars. Excludes flood damage covered by the federally-administered National Flood Insurance Program.

(2) Includes other wind, hail, and/or flood losses associated with catastrophes involving tornadoes.

(3) Includes wildland fires.

(4) Includes losses from civil disorders, water damage, utility service disruptions, and any workers’ compensation catastrophes generating losses in excess of PCS’s threshold after adjusting for inflation.

Source: Property Claim Services (PCS®), a Verisk Analytics® business.





## COMMON PROBLEM AREAS

Building design considerations do account for snow load. However, that load is only part 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 twice or four times greater than the design snow load alone, the weight of the snow and the water it holds may exceed the design snow load, which then may cause structural failure. In addition, building and roof configuration, the qualities and capabilities of roof insulation, wind speed, and drainage can dramatically influence the distribution of weight from snow, drifts, and ice on a roof.

Potential roof design issues include:

- Large flat roof or roofs with slopes of less than 30° such as auditoriums and gymnasiums accumulate snow and drifts easier than sloped roofs.
- Saw tooth or barrel roofs have low points where snow can accumulate.
- Roofs with different elevations allow snow to accumulate and drift where the lower roof meets the higher roof.
- Curved roofs may accumulate snow on the leeward (downwind side) at the eaves.
- “Green” or heavily insulated roofs may slow the melting process.

Issues can also materialize, depending on the maintenance of the facility:

- Identification and response to snow are left to the building owner after the certificate of occupancy is issued; plans often are not updated as occupants and conditions change.
- Roofs and roof equipment may not require service/attention during winter months, delaying “checking” of roof conditions.

Other areas not readily identified include :

- New equipment or piping running across the roof, which pose drifting potentials.
- Changed vent openings, which create freeze-thaw locations.
- Different occupancies below the roof, which result in differential temperatures on the underside of a roof, likewise creating freeze-thaw potentials.
- Changes in roof drain arrangements, obstructions, or discharge, including changes that could result in frozen downspouts.

It should be pointed out that no building is constructed such that it will fail, but a combination of assumptions and circumstances at design can lead to complacency about the integrity of the roof.

Should a collapse occur, or if there is even a threat of a collapse due to excessive snow accumulations, operations may have to cease throughout the building with little warning. Local authorities often require abandonment of all operations pending resolution of threatening snow loads. Depending on what emergency actions can be taken, the building or structure will be impaired until repairs can be completed and/or reinforcement provided. Since the process of shoring-up the roof is subject to oversight by local building authorities, the timing for resumption of operations will be further extended based on their review.

## PREPARATION FOR THE SEASON

Preparations for the season should begin six to ten weeks before the onset of winter. For snow removal planning, the roof should be reviewed to determine a safe maximum snow depth and critical loading areas. You should be prepared to remove snow from critical areas when no more than half this depth is reached. This allows sufficient roof load capacity for personnel and equipment. If contractors are used, arrangements should be made early as demand will increase during winter storms.

You should plan to clear snow starting from interior areas to the edges of the roof. You will need to ensure that proper roof safety procedures are observed, including tying off when working within six feet of any edge. If you will be utilizing contractors, be sure they are aware of your work safety measures with regard to roof operations, ladders, and equipment. Be sure to instruct contractors to protect the roof cover from damage.

Your heating systems should be checked to ensure they are in good working order. If using a finite fuel supply, i.e., fuel propane, tanks should be filled prior to a storm. Many facilities operate their heating systems at lower temperatures during off hours, such as nights and weekends. Heating systems should be run at normal operating temperatures for the duration of any snow loading event.

Interior areas should have specific observation points established to alert plant engineers of roof sagging or other roof/wall movement. Downspouts, scuppers, and other drains should be inspected at least weekly in winter months to assure unobstructed performance.

Any heat tracing should be serviced prior to the freezing season, and should be inspected daily for operational

The insured losses from the winter storms in February 2015 are now the costliest since 1980, totalling over \$2.1 billion. They surpassed the insured losses from the record setting blizzard of 1993 which had insured losses of \$2 billion. In the previous year, 2014, the extreme cold wave will likely continue to rank among the five costliest for winter damage claims.

— Excerpted from “Winter Storms”,  
Insurance Information Institute, 2016

integrity. All heat tracing should be provided with indicator lights or other means to facilitate the daily inspection during freezing periods.

## DURING A SNOWFALL AND ACCUMULATION

Continue the preparation tasks identified above. If your roofs show ice along the perimeters and deep snow pack (12 inches or more), your building may be subject to ice dams and collapse. Seek professional advice immediately. It may be unsafe to go on the roof at this time. 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.

For example, if you leave the ice and snow on a roof, the roof may risk collapse. If you remove the snow, shingles and membranes may be damaged, or the person removing snow may get injured. Once excessive loading and roof deflection is detected, it may be (and usually is) unsafe to attempt removal.

## WHAT YOU CAN DO TODAY

In our broad experience with weather issues, we have seen how best practices and real-life risk mitigation strategies can

come together quickly to successfully minimize areas of increasing risk.

- **Make sure your organization is aware of the risks and your loss prevention plan is up to date:** Assess relative exposures and create tools appropriate to the hazard. Also, factor in the cumulative effect of multiple storms on your property and undertake regular property surveys in advance of storms.
- **Be flexible:** Evaluate each building according to its needs based on importance as well as vulnerability.
- **Expand your vision:** Increase your understanding of the risks associated with winter storms and ice as it threatens not only individual buildings, but supply chains, ingress/ egress, and power sources.

Marsh Risk Consulting's PRC experts can help you perform visual examinations of your suspect building and identify areas susceptible to failure from snow loading and ice accumulations. Our property risk consultants provide value-added solutions in relation to:

- Alignment of planning threshold levels and needed staff capabilities for an effective prevention and response program.
- Consideration of passive protection solutions such as sloped roofs, vulnerable freeze/thaw areas, and design issues.
- Assessment of active protection solutions such as heat tracing systems along eave lines, drains, downspouts, and vulnerable areas to assure melting snow drains away from important areas.
- Manual removal of snow at safe, predetermined levels.
- Review and assessment of overall winter exposures (power, access, employees).

## PUBLIC INFORMATION SOURCES

Information on snow load and snow load potentials is available from multiple sources. Look to weather services for information on accumulations to date; be very aware of warm days followed by several inches of snow fall, repeated over a week or more.

Information sources include:

- NOAA National Climate Data Center.
- Institute for Catastrophic Loss Reduction (Canada).
- Similar national weather services in Europe, Asia.
- A summary review of failure modes is available at <http://www.structuremag.org/?p=5301> (Dr. Michael O'Rourke, PhD, PE: Structural Collapse from Snow Loads, Structure Magazine, Nov. 2008).

# MARSH RISK CONSULTING

For additional information about snow loading exposures and our best practice risk mitigation and management solutions, please contact your local PRC or Marsh representative or:

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