Preventing Winter Damage

By Steven J. Susca

Too often, building owners and facility managers find themselves chasing after winter damage, rather than keeping ahead of the storm. What if we could foresee the toll snow and ice might take, so that something could be done to avert the damage? Although the specific ways in which winter may affect a building can be hard to predict, it's worth examining cases of winter damage, while turning back the clock to see what might have prevented the problem.

For those concerned about how best to prepare for the oncoming harsh weather, learning from others' mistakes can help you avoid the same fate. Anticipating and managing the potential impact of winter conditions can make all the difference, come the spring thaw, between minor repairs and major rehabilitation. Moreover, failure to take proper precautions can create hazardous conditions, whether from falling snow and ice, slippery surfaces, or even dislodged building materials.

Cold-weather building management shouldn't begin and end with the winter season. One of the most crucial components to preparing buildings for the onslaught of ice, freezing rain, and snow, is to conduct proactive building-enclosure assessments, and to perform the necessary maintenance and repairs throughout the year. Warmer weather brings an opportunity to address conditions—from open joints and loose gaskets to insufficient drainage and poor ventilation—that can lead to bigger issues. Once icy moisture and dropping temperatures exploit deficiencies in the building envelope, deterioration spreads quickly, with one damaged component compromising the integrity of the next.

By examining case studies of typical winter-related building-enclosure failures, along with the suggestions of design professionals for preventing such problems, the prudent facility manager or owner can determine what might be done ahead of cold weather to fortify buildings against similar distress.

Winter Problem #1: Ice Dams

When asked for examples of winter-weather problems, the first thing many facility managers and design professionals will bring up is *ice damming*: the frustrating—and potentially dangerous—accumulation of ice and snow at roof eaves. As snow on the roof starts to melt, water flows down to the roof edge, where it collects and re-freezes. Over time, this thawing and freezing creates a build-up of ice at the eave, and causes water to back up under the roofing material, eventually spilling over into the building interior.

In addition, water that melts and re-freezes at the gutter and drip edge begins to extend downward, forming icicles. With water continuing to flow down from the eaves, these pointed shards of ice can grow to many feet in length, posing a tremendous risk to pedestrians and vehicular traffic below.

Prevention: Properly Insulate and Vent the Attic

Buildings are often designed such that the *thermal envelope*—the barrier that encloses the conditioned space of the interior from the unconditioned exterior—terminates at the attic floor. However, in practice, air leakage into the attic from the building interior may be difficult to avoid. Recessed lights, HVAC registers, and other penetrations create sites of thermal transfer, and insufficiently insulated mechanical equipment in the attic warms the surrounding area. Unless the roof deck is kept cold in winter, snow that

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Icicles might seem like charming seasonal decorations, but they mean trouble— both for the building, and for those below.

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Snow and ice buildup at eaves.

collects on the roof will tend to melt, then re-freeze as it reaches the colder eaves.

To maintain a cold roof temperature, soffit and ridge attic ventilation should be balanced. A properly sized ventilation area creates a chimney effect, drawing warm, moist air up and out of the attic. An unbalanced system inhibits the exhaust of warm air, which then collects at the underside of the eaves, where it warms the roof just enough to melt the snow. So begins the cycle of melting and re-freezing that leads to ice dams and icicles.

Calculations may be done to determine the Net Free Ventilation Area (NFVA) and the optimal size of soffit and ridge vents; but for existing buildings, achieving the right balance can be challenging. For some complex roof configurations, adequate venting balance may not be possible.

In those cases, the thermal envelope must be relocated from the attic floor to the underside of the roof. Insulation installed in rafter bays and at eaves shields the roof from the warmer air of the attic. For mechanical equipment, proper temperature and humidity-controlled intake and exhaust ventilation is crucial not only to preventing ice dams in winter, but to preventing mold growth in warmer months.

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Prevention: Insulate and vent the attic.

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Prevention: Install heat tracing.

Prevention: Install Heat Tracing

In some cases, building configuration makes preventing ice dams difficult, as configurations of roof and exterior wall interfaces may prove challenging to drain expeditiously. An electric ice-melt system using radiant heating cable may be installed as part of a roof rehabilitation or replacement project.

Typically, heat tracing is installed at eaves, extending down into gutters and, sometimes, down each leader to prevent ice from clogging drainage pathways. The ice-melting coils should be used in conjunction with *ice and water shield*: a barrier sheet, typically composed of a rubberized bitumen membrane. Installed under the roof covering, ice- and water-shield should extend from the edge of the roof to at least two feet (24 inches) inside the exterior wall line. Manufacturer requirements vary, but ice- and water-shield is typically applied at eaves, valleys, ridges, hips, rake edges, transitions, chimneys, and penetrations.

Winter Problem #2: Falling Snow and Ice

Snow sliding from rooftops in a rural setting is unsettling enough, but adjacent to a city street, it is downright terrifying. Unfortunately, this was exactly the scenario facing one government agency charged with maintaining a historical military facility within a dense urban environment.

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Hazardous ice formations.

Although snow guards were in place along the steep barrel-vaulted roof, many had bent under excess snow loads, and many of the fall-protection line brackets had been ripped out of their anchorage points by the tugging weight of accumulated snow. Dense traffic loomed below, immediately under the struggling snow-protection system, which, if compromised, would deliver a hefty payload of snow and ice to unwitting pedestrians and drivers below.

Prevention: Install Appropriately Sized and Configured Snow Guards

Evaluating the slope, frictional coefficient, and anticipated snow load of a roof is key to providing sufficient snow guards. In the example of the barrel-vaulted roof above a busy street, installing additional snow guards at an intermediate height between existing rows would reduce the amount of snow falling onto lower roof areas, alleviating pressure on the system. More snow guards to share the load means less frequent replacement of rails bent by excessive snow weight.

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Prevention: Sufficient snow guards.

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Prevention: Appropriate drainage.

Accurately identifying the cause of loose snow guards is important to preventing recurrence. Adding fasteners can increase strength, but if the anchorage was incorrectly designed, or fastened to an unstable substrate, redesigning the system might be necessary. Routine inspection of snow guards after each winter season—and replacement of compromised pipe rails or guards—provides reassurance that, come cold weather, the system is ready to weather the storm.

Prevention: Correctly Size Replacement Drainage Elements

Promptly replacing gutters and leaders as they reach the end of their lifespan is important to a well-maintained roof. However, swapping those drainage elements for undersized replacements can do more harm than good.

Case in point: one well-meaning facility retained a contractor to replace aging gutters. When the façades began accumulating a great deal of ice in the winter, the contractor installed heat tracing and added screens over the gutters to collect debris. This only made matters worse. One action might have prevented the years-long effort to stem the overflowing drainage system and ice-covered façades: correctly sizing gutters.

Unfortunately, the replacement gutters were too small for the roof area, so they were overwhelmed with water and snow during storms. Keeping gutters free of debris is important, but the screens and heat-tracing only served to encourage ice-dam formation in the saturated gutters. Replacing the drainage system with an appropriately dimensioned one solved the problem.

Winter Problem #3: Snow Loads on Flat Roofs

News stories about roofs collapsing after a blizzard have justifiably made facility managers jittery when winter weather deposits multiple feet of snow—and sometimes massive snowdrifts—on a flat roof. That said, the answer is not to do what one corporate headquarters did on

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Snowdrifts and leaks.

its sprawling campus of low-slung buildings: bring in the snowblowers.

Aiming to protect newly installed roofs from snow damage, the well-intentioned facilities team quickly responded by blowing snow off the roof and, unfortunately, cutting up the new roof assembly in the process. Furthermore, removal of snow in this manner can result in an unbalanced load on the already overloaded structural roof supports, creating hazardous conditions.

Prevention: Remove Snow According to Manufacturer Stipulations

Rather than react to a snow event, which can lead to impulsive and possibly detrimental actions, the better approach is to plan for winter weather before the season gets underway. Check with roofing manufacturers to identify snow-removal methods that will not void the warranty or risk damaging the roof assembly in the process. A design professional can assist in determining how much snow is too much, making it easier to determine when removing snow from a roof area is necessary.

Prevention: Address Ponding Water

Blockages in roof drains can lead to standing water, the weight of which can cause deflection in the structural system. This low point on the roof then collects more standing water, causing more deflection, and so on. In the winter, ponded water turns to ice, which, combined with snow loads, may pose a structural concern. Clearing blocked drains ahead of the winter season, as well as periodically during the cold weather months, can break the cycle of ponding and deflection. In some cases, inadequate slope to drains may be the issue, which is best addressed well ahead of winter weather.

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Prevention: Remove snow correctly.

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Prevention: Address ponding water.

Winter Problem #4: Flooding and Heaving at Entryways and Plazas

With freezing water leading to displaced pavers and sheets of ice, it's no wonder many plaza owners give up and cordon off outdoor areas for the winter season. At some point, though, people must traverse at least some outdoor path or entrance area to reach the building, and the risk of falls and injury due to slippery and uneven surfaces must be addressed.

Prevention: Install and Maintain Appropriate Drains

The prime suspect in a case of ponding water is the drains. When constructing a plaza, it's crucial to design robust drainage to clear water not only at the paving surface, but at the membrane level below. Water that becomes trapped between the waterproofing layer and the pavers can freeze and expand, pushing pavers out of alignment, which leads

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Slippery, uneven surfaces.

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Prevention: Maintain drains.

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Prevention: Establish adequate slope.

to broken pavers and an irregular walking surface.

Even if drains are designed and installed correctly, they cannot function if they are clogged with debris. Regularly clearing out of drains is essential to keeping water from ponding.

Prevention: Create Adequate Slope to Drains

Water runs downhill, which means that the lowest points of a plaza should be at drains. If water is collecting elsewhere, it may mean that the plaza does not have the correct slope. Sometimes, poor drainage can lead to heaving of plaza pavers, which in turn creates a low point on the walking surface that collects water and ice.

In that case, rehabilitation of the drainage system and re-setting or replacement of pavers may solve the problem. However, it may be that the plaza does not provide adequate slope to drains even with pavers set correctly, in which case rehabilitation and re-grading of the plaza may be the only long-term solution.

Winter Problem #5: Concrete Damage at Balcony Railings

In many instances, lightweight aluminum railing posts at concrete balconies are directly embedded into the concrete at the edge of the slab. If not properly finished and sealed, gaps between railing members will allow the railing stanchions to fill up with water. As the water freezes, it expands, which can cause expansion of the aluminum post where it enters the concrete. This, in turn, results in cracks at the edges of the slab.

Eventually, pieces of concrete may break away, posing a hazard to people below, and compromising the structural integrity of the railing. Deicing salts used on the balcony can accelerate the damage by helping to initiate corrosion of embedded reinforcing steel.

Prevention: Evaluate and Repair Post-Slab Interfaces

Where railing posts are embedded in concrete, cracks and spalls should be repaired promptly to avoid hazardous conditions. Evaluate guardrail components for potential points of water entry into the railing system. At the edges of balcony slabs, applying a waterproofing coating may be considered to ensure further protection against water

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Cracks at slab edge.

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Prevention: Repair post-slab interfaces.

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Prevention: Install weeps at rail posts.

infiltration, although some substrates and situations may contraindicate application of a coating.

Prevention: Install Weeps at the Bottom of Railing Stanchions

Even if all these recommendations are implemented, water will usually find its way in. For this reason, it must be provided with an escape path from the railing stanchion to prevent it from causing damage. Installation of small weep holes at the bottom of the railing stanchion to allow water to drain will help to ensure the integrity of the balcony railing system.

Prevention: Install New Post Anchorage

If railing-post sleeves are deteriorated, poorly installed, or improperly specified, it may be necessary to either replace the railing system entirely or, if the railing is intact, replace just the post anchors. After the concrete has been repaired, a bracket may be fastened to the top of the slab. Not only does this rehabilitation measure spare the expense of replacing the entire assembly, but the surface mount also reduces the potential for water infiltration.

Winter Problem #6: Façade Deterioration from Exposure

Winter weather is hard on vertical building elements, as well as horizontal ones. As wind, rain, and snow batter the building exterior, façade elements eventually succumb to the ravages of winter.

Failed coatings and glazing compound can leave windows and doors exposed to deeper damage from the constant presence of moisture. Curtain-wall mullions may become displaced when subjected to freeze-thaw cycles, and masonry structures may show signs of efflorescence, or migration of salts to the surface. Where the façade meets plazas, sidewalks, or roads, deicing chemicals may accelerate damage from exposure and freeze-thaw cycling.

Prevention: Maintain Coatings and Seals

When water can find a way into the façade, it can cause significant damage, especially as it expands when freezing, and contracts as it thaws. To protect sensitive façade elements, it's important to prepare well ahead of cold weather by replacing worn coatings, repointing open mortar joints, replacing failed sealant and gaskets, and replacing damaged materials.

Prevention: Pay Attention to Adjacent Building Elements

Where different materials intersect, there is potential for damage from differential movement. As each material responds to fluctuating temperatures, one is likely to expand or contract differently from another, which places strain along the plane where they meet.

Even one long span of a single material can undergo movement stress, if that building element is restrained

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Freeze-thaw and salt damage.

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Prevention: Maintain coatings and seals.

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Prevention: Consider adjacent elements.

from moving according to its natural tendency. Providing adequate expansion joints to allow for fluctuating material volume as the seasons change is essential, and other measures may be necessary, depending on the materials and configuration.

Winter Problem #7: Damage to Building Elements from Deicing Chemicals

Façade elements adjacent to walking and driving surfaces need to be protected from caustic deicing chemicals, which can lead to corrosion, scaling, and disintegration. Opting for less damaging ice-management compounds not only protects vulnerable façade materials, it spares exterior stairs, plazas, and garages, too.

Prevention: Choose the Right Deicing Strategy

Rock salt (sodium chloride) may be the most common and least expensive deicing chemical, but that does not mean it is the best choice. When its corrosive and destructive properties are considered, it may prove the more expensive option, given the costs of rehabilitating the damage it does.

Calcium chloride is a better option, although it is still a corrosive compound. Better still is calcium magnesium acetate (CMA), an ice-loosening chemical that does not melt snow, but instead creates a slurry that prevents ice from bonding to the surface. Caveats are that CMA must be applied before snowfall, and that mechanical removal of the loosened ice and snow is required. Addition of grit or sand can improve traction, and reduces the amount of deicing chemical needed.

Proprietary products are also available, combining deicing chemicals like potassium chloride with performance-enhancing additives, such as corrosion inhibitors. Proprietary organic ice-melting chemicals are another option. For any deicing product, it is important to check the operating temperature range, as lowest effective temperatures can range widely, from –20°F for calcium chloride to +20°F for CMA.

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Corrosion and deterioration.

Winter Problem #8: Parking Garage Snow Removal

Not only are parking garages subjected to the weather inside and out, but they also must endure caustic deicing chemicals, sharp snowplow blades, and snowdrifts that can take an entire season to clear. Even if the facility is thoughtful about which deicing chemicals are used, "fenderbergs"—mountains of deicing chemical-laden snow barnacled to car fenders—carry in a mix of harsh compounds.

Prevention: Protect Vulnerable Surfaces

Without benefit of precipitation to clear away accumulated deicing salts, garages are subjected to high concentrations of damaging chemicals. Periodically washing parking decks and clearing drains to remove accumulated salts prevents chemical-laden standing water from causing deterioration.

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Prevention: Choose the right chemicals.

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Prevention: Apply deicers judiciously.

Surface treatments, including traffic-bearing membranes, penetrating sealers, and migrating corrosion inhibitors, require periodic reapplication to remain effective. Areas of wear can open up the concrete to damage from chloride-containing water. Repair of cracks and spalls and replacement of joint sealant are important maintenance efforts that help protect the garage from water and deicing chemicals.

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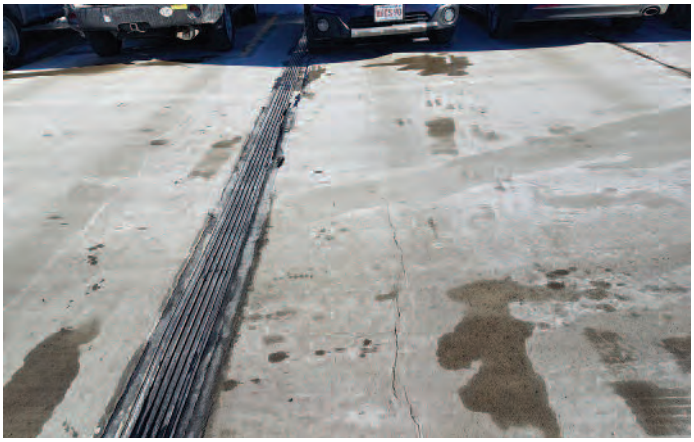

Damage to expansion joints and parking decks.

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Prevention: Protect surfaces.

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Prevention: Use rubber-tipped blades.

Prevention: Use Rubber Plow Blades

Expansion joints, drains, and other uneven surfaces can take a beating from standard steel snowplow blades. Outfitting the plow with rubber-tipped blades can prevent damage to soft joint materials, edges, transitions, and coatings that are often sites of premature deterioration.

Sometimes, plow operators may avow that they are using rubber blades, but rust streaks on the surface of the concrete tell a different story. If the rubber has worn away in places to bare metal, or if metal blades are used on occasion, damage can still occur.

Winter Solutions

While these simplified tips may help in developing a general approach to winter weather management, they are no substitute for a comprehensive building envelope evaluation and customized snow and ice removal program. For a given

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Exterior envelope assessment of the 20 buildings at this facility helped the institution prevent and treat the effects of harsh winter weather.

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At this parking garage, investigation revealed winter weather damage. To repair defects, the facility is undergoing a comprehensive rehabilitation, after which a diligent maintenance program will help prevent further deterioration.

problem, there may be many possible causes, and correctly diagnosing the issue is the key to resolving it. Preventing winter damage does demand some degree of imagination, along with the experience to anticipate likely issues.

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Winter weather and indiscriminate use of deicing chemicals led to widespread damage at this plaza, which was reconstructed to incorporate preventive measures, including heat tracing.

Repairs and protective measures must be appropriately designed and correctly implemented, or they can do more harm than good. Knowing the composition, construction, exposure, and usage of a building allows for winter repair and maintenance programs that are cost-conscious and effective. With the right program, recovery from bad weather can proceed in a pre-determined, systematic fashion, minimizing disruption to operations.

Protection from winter weather doesn't begin with the season; keeping building elements in good repair all year long is the real solution to the annual onslaught of ice and snow. A building that is well-maintained and watertight will fare much better through winter storms than will one that has been compromised by cracks and deterioration. As Ben Franklin's adage counsels, "An ounce of prevention is worth a pound of cure."

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