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# Journal

## Preventing Winter Damage

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

Too often, building owners and facility managers find themselves chasing after winter damage, rather than keeping ahead of the storm. What if the toll snow and ice will take were foreseeable, so that something could be done to avert the damage? Although the specific ways in which the winter season will affect a building can be hard to predict, it's worth examining cases of winter damage to turn back the clock and 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 forestall the same fate. Anticipating and managing the potential impact of winter conditions can make 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 needed 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 building envelope deficiencies, deterioration spreads quickly, with one damaged component compromising the integrity of the next.

By investigating examples of typical winter-related building enclosure failures, alongside 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, the melting and re-freezing

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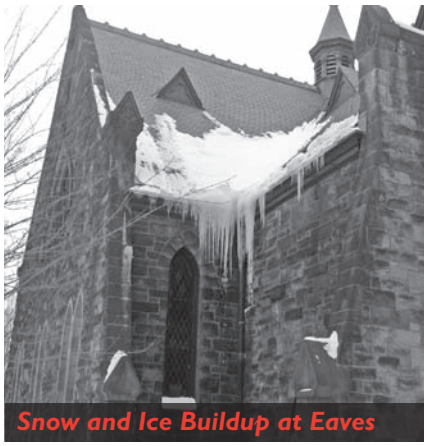
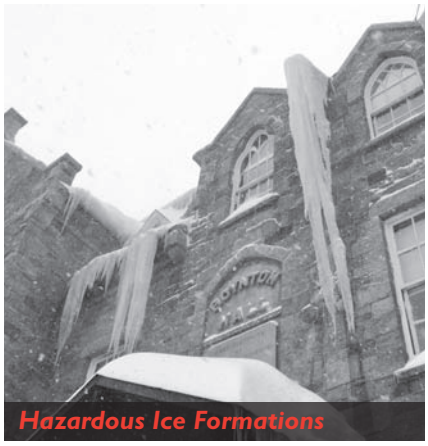
## WINTER PROBLEM #1: Ice Dams


Snow and Ice Buildup at Eaves


PREVENTION: Insulate and Vent the Attic


PREVENTION: Install Heat Tracing

## WINTER PROBLEM #2: Falling Snow and Ice


Hazardous Ice Formations


PREVENTION: Sufficient Snow Guards


PREVENTION: Appropriate Drainage

water 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 collects on the roof will tend to melt, then refreeze as it reaches the colder eaves.

To maintain a cold roof temperature, soffit and ridge attic ventilation should be balanced. Properly sized ventilation area creates a chimney effect, which draws warm, moist air up and out of the attic. An unbalanced system inhibits 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 shield 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.

### *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 an historic military facility in a dense urban environment. 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 the anchorage point 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 the unwitting pedestrians and drivers below.

#### *Prevention: Install Appropriately Sized and Configured Snow Guards*

Evaluating the slope, frictional coefficient, and anticipated snow load of the 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 to 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.

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.

## WINTER PROBLEM #3: Snow Loads on Roofs

*Snow Drifts and Leaks*

*PREVENTION: Remove Snow Correctly*

*PREVENTION: Address Ponding Water*

## WINTER PROBLEM #4: Flooding and Heaving

*Slippery, Uneven Surfaces*

*PREVENTION: Maintain Drains*

*PREVENTION: Establish Adequate Slope*

#### *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 facades began accumulating a lot of ice in the winter, they installed heat tracing and added screens over the gutters to collect debris, which only made matters worse. One action might have prevented the years-long effort to stem the overflowing drainage system and ice-covered facades: 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 resolved 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 snow drifts – on a flat roof. That said, the answer is not to do what one corporate headquarters did on its sprawling campus of low-slung buildings: bring in the snowblowers.

Aiming to protect newly installed roofs from snow damage, the well-intentioned facility 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 a hazardous condition.

#### *Prevention: Remove Snow According to Manufacturer Stipulations*

Rather than react to a snow event, which can lead to impulsive, 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, so it's clear 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.

### 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 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 drains is essential to keeping water from ponding.

#### *Prevention: Create Adequate Slope to Drains*

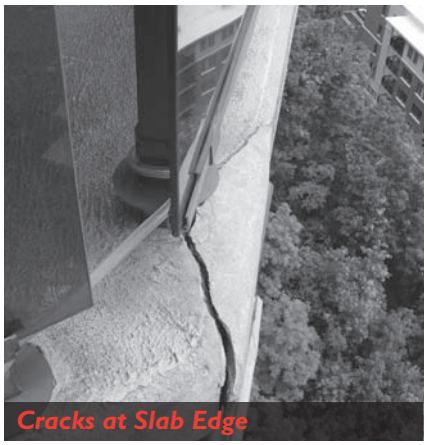
Water runs downhill, which means that the lowest points of a plaza should be at drains. If water is collecting elsewhere, it may mean that the plaza does not have the correct slope. Sometimes, poor drainage can lead to heaving of plaza pavers, which in turn creates a low point on the walking surface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

## WINTER PROBLEM #5: Balcony Concrete Damage



*Cracks at Slab Edge*

*PREVENTION: Install Weeps at Rail Posts*

*PREVENTION: Repair Post-Slab Interfaces*

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 as further protection against water infiltration, although some substrates and situations may contraindicate coating application.

### *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, the surface mount reduces the potential for water infiltration.

## Winter Problem #6: Facade 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, facade 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 facade meets plazas, sidewalks, or roads, deicing chemicals may accelerate damage from exposure and freeze-thaw cycling.

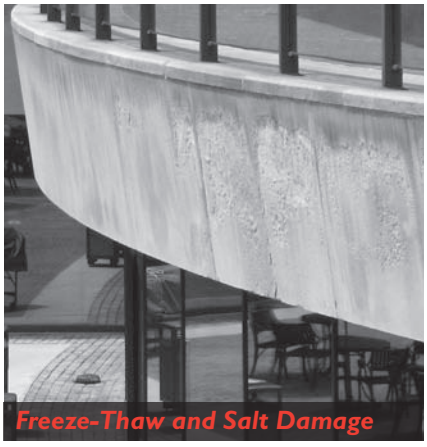
### *Prevention: Maintain Coatings and Seals*

When water can find a way into the facade, it can cause significant damage, especially as it expands when freezing and contracts as it thaws. To protect sensitive facade 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 the other, 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 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 #6: Facade Deterioration**


Freeze-Thaw and Salt Damage


PREVENTION: Consider Adjacent Elements


PREVENTION: Maintain Coatings & Seals

## WINTER PROBLEM #7: Deicing Chemical Damage

*Corrosion and Deterioration*

*PREVENTION: Apply Deicers Judiciously*

*PREVENTION: Choose the Right Chemicals*

## WINTER PROBLEM #8: Garage Snow Removal

*Damage to Expansion Joints and Parking Decks*

*PREVENTION: Protect Surfaces*

*PREVENTION: Use Rubber-Tipped Blades*

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

Facade 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 facade 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.

### Winter Problem #8: Parking Garage Snow Removal

Not only are parking garages subjected to the weather inside and out, they also must endure caustic deicing chemicals, sharp snowplow blades, and snow drifts 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.

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.

*(continued on page 8)*

# representative projects

## Winter Damage

For buildings in cold climates, preventing and treating the ill effects of harsh winter weather is an ongoing process. The facilities that fare the best take proactive measures, tailored to the materials, configuration, and exposure of each building element.

Sometimes, even the best preparation is no match for the severities of frigid conditions. Where the building envelope has been compromised, restoring integrity before the next big storm is crucial to minimizing damage.

As building enclosure specialists, Hoffmann Architects has developed winter weather solutions for a wide range of facilities. Examples include:

**Worcester Polytechnic Institute, Boynton Hall**
Worcester, Massachusetts
*Roof Replacement and Snow Management Improvements*

**Allen-Stevenson School**
New York, New York
*Facade Snow Accumulation Remediation*

**Mount Holyoke College** in South Hadley, Massachusetts. *Exterior Envelope Assessment of 20 Buildings.*

**Lahey Clinic Hospital** in Burlington, Massachusetts. *Parking Garage Investigation and Weather Damage Rehabilitation.*

**Trinity College, Staff Residence**
West Hartford, Connecticut
*Ice Dam and Water Infiltration Investigation and Remediation*

**Montgomery College, Campus Tower**
Rockville, Maryland
*Weather Damage Assessment and Curtain Wall Replacement*

**Lexington Armory**
New York, New York
*Facade Rehabilitation and Roof Snow Management Redesign*

**Farmingdale State College (SUNY), Lupton Hall**
Farmingdale, New York
*Roof Replacement / Ice Dam Mitigation*

**Cornell University, Balch Hall**
Ithaca, New York
*Winter Weather Damage Assessment and Envelope Repair Feasibility Study*

**St. Moritz Apartments**
Edgewater, New Jersey
*Facade Investigation and Repairs*

**Bushnell Tower**
Hartford, Connecticut
*Parking Garage and Plaza Freeze-Thaw Damage Condition Survey*

**Constitution Plaza** in Hartford, Connecticut. *Plaza, Garage, and Exterior Stair Rehabilitation.*

**Pfizer World Headquarters**
New York, New York
*Curtain Wall Snow Load Failure Consultation*

**Domus Apartments**
Philadelphia, Pennsylvania
*Rehabilitation of Plaza Heaving and Settling*

**M&T Bank Headquarters**
Buffalo, New York
*Plaza and Entrance Renovation*

**Worcester Polytechnic Institute, Higgins House**
Worcester, Massachusetts
*Condition Assessment Involving Freeze-Thaw Damage*

**General Electric Headquarters**
Fairfield, Connecticut
*Roof Replacement due to Snowblower Damage*

**Albertus Magnus College, Athletic Center**
New Haven, Connecticut
*Exterior Study Evaluating Snow Damage*

**Phoenix Companies Headquarters**
Hartford, Connecticut
*Plaza Renovation*

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*(continued from page 6)*

### *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 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.

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 to minimize 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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