

**Hoffmann
Architects**

Journal of architectural
technology published by
Hoffmann Architects, Inc.,
specialists in the rehabilitation
of building exteriors.

Journal

Winterizing Your Building

Steven J. Susca, PE

As spring thaws uncover the ravages winter weather has wreaked on buildings, parking structures, and plazas, owners and managers might scratch their heads and wonder: what might I have done to prevent this? Deicing chemicals, freeze-thaw cycling, snow removal, wind and snow loading, and storm debris can cause significant damage to buildings and structures, in even one season's time.

While properties in colder climates can't escape the yearly onslaught of wind, icy rain, and snow, prudent facility managers can work proactively to shield buildings from winter's deleterious effects. The key is a comprehensive annual winterizing program that prepares building components for freezing temperatures, combined with appropriate, ongoing storm management practices. A design professional experienced in the prevention and treatment of building exterior distress should assist in developing practical strategies specifically suited to a given structure's composition and exposure.

With the right protective and reactive maintenance programs in place, winter need not take a significant toll on building integrity. Anticipating and managing the detrimental impact of snow and ice—and the methods employed for their removal—is one relatively easy way to stretch facility

maintenance dollars. A small investment now in developing and implementing a coordinated seasonal plan can reap big rewards later; by avoiding the expense of rehabilitating damaged materials. A well-sealed building also saves on energy and heating costs.

Roofs

Spring/Summer: Inspect and Repair

Because roofing systems are best repaired or replaced during temperate weather, inspect the entire roof area for tears, punctures, blisters, and other signs of wear. Penetrations for mechanical systems tend to be weak spots, so pay particular attention to the membrane integrity at these areas. Bent or damaged flashings should be repaired or replaced. For high-slope roofs, check for and replace cracked or missing slates or tiles, and repair open seams on metal roofing. Ensure that flashings at peaks and valleys are in good shape, secure loose gutters, and repair bent snow guards or lightning rods. In short, perform a thorough check of the roof for possible points of water entry, which could allow the build-up of ice and the premature breakdown of building components—as well as leaks.

If you do not already keep a maintenance and repair record, establish



▲ Seal doors and windows well ahead of winter weather.

Steven J. Susca, PE, Senior Engineer with Hoffmann Architects, Inc., applies expertise in building system analysis to diverse materials and structures. He is often called upon to lend his structural design and detailing experience to the diagnosis, resolution, and prevention of winter season damage.



A Ponding water on roof setback.



A Reroofing.



A Properly designed roof.

a **Winterizing Program document** that you can use to collect and store information on maintenance evaluations, planning, repairs, and methods. Record your observations about roof conditions, using photographs and sketches, and list needed repairs so that these can be scheduled and completed before the cold weather.

Fall: Plan Snow Removal

During the autumn rains, check low-slope roofs for ponding water; a potential source of leaks. If water collects significantly, the excess weight could cause structural members to deflect, which will form a low point on the roof. This depression will then collect even more water; causing further deflection of roof support members in a self-perpetuating cycle. The cause may be something as simple as a clogged storm drain, which can be easily fixed; or it could be something more serious, such as inadequate slope to drains, which would require more extensive rehabilitation.

For high-slope roofs, clean gutters and downspouts of leaves and debris, and be sure that they are properly secured. This will help prevent ice dams from forming.

If your roof is subject to large accumulations of snow or snow drifting, determine and plan for appropriate snow removal where necessary to prevent excessive or unbalanced loading. Where will you put the snow? Can it safely be removed to street level and then cleared, or will a more sophisticated snow management strategy be necessary? Moreover, how can the snow be removed without causing damage to the roof? Now is the time to consider and plan for these eventualities.

In the Winterizing Program log you have created, outline the snow removal program you plan to use, including any equipment that may need servicing before the oncoming season. Check roof manufacturers' warranties to ensure that the snow removal methods you have selected do not violate any provisions. If any damage to the membrane does occur, detailed record-keeping of your winter repair and maintenance strategies serves to document that you have acted within your warranty rights.

Finally, work with a structural engineer to establish a roof snow management plan that will safely remove or redistribute snow such that no part of the

structure is temporarily overloaded or unbalanced.

Winter: Manage Storm Impact

With the roof area sealed against moisture intrusion, it's time to put the snow removal plan into action. Following a storm or high winds, inspect the roof for debris and remove it promptly. Repair any damage as quickly as weather permits.

Next, check for areas where snow drifting may be creating excessive loads. This generally occurs where a low roof meets a higher roof, or where a roof meets a wall. Following your established snow management plan, distribute the snow as appropriate, or remove it from the roof to the ground level using techniques that won't damage the roof system.

Check storm drains for blockages so that melting snow doesn't lead to ponded water. Ice can block water runoff or damage roof membranes, so be sure that drains remain clear and supplementary drainage systems are in good working order.

On high-slope roofs, ice dams at the eaves indicate drainage problems, and they can be dangerous to passersby

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Deicing Chemicals: Why Not to Just Throw Down Salt

By Lawrence E. Keenan, AIA, PE

It's important to select and order a supply of ice melting and/or loosening chemicals well ahead of the winter season, before supplies dwindle and prices inflate. While **rock salt (sodium chloride)** may serve to get the job done, it is extremely corrosive to steel and destructive to masonry and concrete. Because of its low cost, rock salt has retained its popularity in spite of these damaging properties, but the small savings in up-front product costs is generally insufficient to justify subjecting building materials to this harmful chemical. Ultimately, it may prove the more expensive choice, when the cost of rehabilitating salt-damaged components is taken into account.

So what are the other options? **Calcium chloride**, while somewhat pricier, is generally the most effective deicing chemical. While detrimental effects do tend to be less severe than with rock salt, calcium chloride is nonetheless a corrosive compound that is damaging to concrete. Avoiding these harmful properties altogether, however, may mean using a chemical that is somewhat less effective, particularly at lower temperatures.

A number of **proprietary products** are also available which claim to correct the deficiencies of any one compound. These products usually combine various deicing chemicals, sometimes alongside other performance-improving agents, such as corrosion inhibitors or traction enhancers (e.g. corn starch). While proprietary blends pledge greater effectiveness than their simpler counterparts, they also come at a higher price.



The chemical that is most sympathetic to existing structures—and most highly recommended—is **calcium magnesium acetate (CMA)**; however, CMA does not work at lower temperatures, must be applied before snowfall, and demands expeditious, and, often, continuous snow clearing. An ice loosening chemical, CMA does not melt snow or ice, but rather creates a slurry that interferes with the bond of the ice to the surface, aiding mechanical removal.

Should an ice melting chemical be required, opt for **potassium chloride, magnesium chloride**, or a blend of the two, but not outside their operating temperature range (generally down to 5-15°F). For colder, more severe conditions, it may be necessary to use calcium chloride or a proprietary blended material to maintain safety. In all cases, application of **grit/sand** greatly increases traction and diminishes the amount of deicing chemical required.


With the high liability of slippery surfaces, it's important to consider snow removal options well before the first snowfall forces last-minute decisions. Pilot test proposed materials to verify suitability and performance, and integrate these into a comprehensive snow and ice removal strategy. Detailed record-keeping in your Winterizing Program log will be instrumental in demonstrating your facility's proactive approach to deicing, should a litigation issue arise. ■

Common Deicing Chemicals						
Product	Lowest effective temp.*	Method	Performance	Longevity	Corrosiveness	Concrete freeze/thaw resistance damage
<i>Sodium Chloride (Rock Salt)</i>	12°F	Melting	Very Good	Low	Very High	High
<i>Calcium Chloride</i>	-20°F	Melting	Excellent	Moderate	Moderate to High	Moderate to High
<i>Magnesium Chloride</i>	5°F	Melting	Good	Low	Low	Low
<i>Potassium Chloride</i>	12°F	Melting	Good	Low	Low	Low
<i>Calcium Magnesium Acetate (CMA)</i>	20°F	Loosening	Good (dependent on snow removal frequency)	High	None	None
<i>Urea</i>	15°F	Melting	Used only in special circumstances (e.g. runways)	Low	None	None

*Conditions vary. Test materials to verify suitability and performance.

Be Sure to Inspect Your ...



 Gutters and drains



 Sealants



 Snowmelt systems

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should the ice suddenly slide off. Large amounts of ice can break past snow guards, so these are not failsafe against damage or injury. Furthermore, ice and water backed up at the eaves can penetrate under shingles and leak into the building. Where recurrent ice dams are a problem, such as at valleys where two roof areas intersect, consider installing heat tracing, which warms eaves to melt accumulated snow and ice.

During periods of frequent precipitation, the roof should be checked regularly for adequate drainage and for build-ups of snow, ice, branches, and wind-blown refuse.

Plazas

Spring/Summer: Drain and Maintain

Just as with roofing systems, it's important to stay on top of maintenance and repair issues during the warmer months, so that deterioration conditions are not exacerbated by winter freeze-thaw cycling and snow removal. Check and repair mortar, sealant, and sand joints and replace broken pavers. Pooled water after rains can indicate drainage problems, which are best addressed now, before ice build-up becomes a hazard. Any rusted metal should be repaired.

In consultation with a building envelope professional, select and stock deicing chemicals early in the year, so that limited late-season supplies don't narrow options and increase costs. Determine how chemical deicers will coordinate with mechanical snow removal techniques to avoid excessive damage to plaza or walkway surfaces.

Fall: Prepare Irrigation and Heating Systems

If your plaza or terrace has an irrigation system for plantings, clear out the water according to the manufacturer's instructions so that hoses and pipes

don't freeze and burst. Subsurface heating elements, if present, should be tested before the cold weather, so that repairs can be made where necessary. If you plan to install subsurface heating as a low-maintenance alternative to chemical ice melting, do so well in advance of winter weather, so that construction is completed in time for adequate testing.

“Check for problems and fix them before cold weather makes them worse.”

Winter: Remove Snow and Ice

Following the deicing protocol you have established earlier in the year, apply any ice loosening chemicals, such as CMA, before expected snowfalls, and apply ice melting compounds, like potassium chloride, early and often during periods of snow and icy rain.

As with low-slope roofs, plazas have the potential for ice formation if drainage is inadequate. Regular clearing and testing of storm drains is critical to maintaining safety. Deicing chemicals don't compensate for regular ice formation caused by standing water. Over time, areas subjected to the continuous presence of salt-laden standing water will break down prematurely, leading to leaks, structural damage, and hazardous conditions.

If you plan to use a plow, be sure that your plaza has the load-bearing capacity to sustain the weight of the truck without damage. Request that your snow removal contractor use a plow blade with a rubber edge, as steel blades can cause significant harm to

surface finishes and coatings. A design professional with plaza maintenance experience can assist in developing an integrated snow and ice management strategy that balances safety with building component longevity.

Parking Garages

Spring/Summer: Prepare and Protect

By now, you know the drill: check for problems and fix them before the cold weather makes them worse. However, because parking structures are exposed to harsh winter conditions inside and out, with chemical-covered snowy tires and dripping undercarriages adding a concentrated barrage of corrosive compounds to the mix, garages need extra care and protection to survive the colder months unscathed.

A thorough annual inspection for deteriorated concrete, corroded reinforcing bars, damaged expansion joints, cracks, and areas of poor drainage is critical to preventing winter weather from exacerbating existing problems. These conditions provide sites for water intrusion into the concrete. In turn, trapped moisture accelerates deterioration through a number of mechanisms, including freeze/thaw cycling and corrosion of embedded steel.

Just as water in the ice cube tray swells up as it freezes, so does water in concrete. As it expands, the ice exerts outward pressure. This will eventually cause cracks to form, which act as further points for water entry. Water also acts as an excellent carrier for dissolved salts and other compounds that are deleterious to the overall health of your parking structure. The end result: deterioration occurring at a continually increasing rate.

The best approach, then, is to stop this cycle of damage before it gets



▲ Steel plow blades can cause substantial damage, particularly at drains, joints, and transitions.

rolling. If your parking structure has a surface treatment in place, check for areas of wear and repair or reapply as needed. All surface treatments, from penetrating sealers to traffic-bearing membranes, require maintenance and periodic reapplication. Check manufacturers' recommendations for upkeep schedules. Untreated concrete also demands regular maintenance. Rout and seal small cracks, repair spalls, replace sealant at joints, and check and clear drains. A garage that is sound at the start of the season has a much better chance of staying that way at winter's end than does one that shows even minor signs of deferred maintenance.

Fall: Finalize Deicing Strategies

As with plazas, it's critical to choose and store deicing chemicals early, as low salt supplies in the past few years have driven up prices and sharply reduced availability. Building owners and managers who wait until snow arrives to shop for ice melting materials might find that their approach is severely limited by what's on store shelves, and that they have to settle for something more expensive or more corrosive than they'd intended.

Each facility's climate, usage, location, construction type, budget, and

exposure are unique and dictate the appropriate snow and ice removal strategy. What works on a multi-level freestanding garage in suburban Maryland might not be as effective on a sub-grade parking facility at a high-rise New York hotel.

Winter: Operate Safely and Continuously

The goal with parking structure snow and ice removal is usually to maintain full-capacity operation while protecting against hazardous conditions. Deicing compounds can be an important part of this process, but in areas of the garage not exposed to the diluting effects of precipitation, chemicals can accumulate and cause damage. Optimal drainage is crucial to preventing a stagnating mass of chemically saturated water from penetrating the deck and damaging vehicles below. Regular drain cleaning and deck washing to clear accumulated salts are important steps in minimizing the concentration of chemicals.

For multi-level freestanding parking garages, clearing snow from the top level expeditiously can be a challenge. Where will you put the snow? As with roofs, the decision must be made whether to drop the snow onto ground level and remove it from



▲ Fix drainage problems promptly, before icy patches create liability risks.

there, or to move it to a single area of the parking deck, which would then be closed to use. If the latter is the case, then be sure that the structure can accommodate the load of the mounded snow.

What if emergency repairs are needed?

It is possible to fix dangerous or unstable conditions, even during the winter months. Heating small portions of the garage can permit the safe repair of problem areas, without risk of incurring further damage by attempting to work with frozen building components. Maintaining the Winterizing Program log with regular conditions checks will enable facility managers to identify hazardous conditions quickly, allowing time for correct remediation of the situation in a timely fashion.

Where is that water coming from?

If you have ruled out drainage and water penetration problems, but large concrete members continue to show surface moisture, then you might have a simple case of seasonal condensation. Make observations during different weather conditions; condensation is likely to appear when weather heats up quickly, as during an unseasonably warm winter's day or early spring thaw. There may be little that can be done about the problem, however, as it is simply the nature of a large mass to warm up more slowly than the surrounding air, leading to water



▲ Cracks and eroded mortar compromise resistance to ice, snow, and changing temperatures.

droplet formation on the cool surface (rather like the bathroom mirror after a shower). It is important to be aware of the condition, however, so that maintenance on warmer winter days can include collection and management of the water, to prevent damage to vehicles.

Facades

Spring – Fall: Insulate

Cracks in masonry, deteriorated mortar, failed sealant, and damaged or missing flashings and weather stripping create gaps in the building's shield against winter weather. When water penetrates these small openings, it can cause significant damage through rust, expansive forces, and chemical degradation. But don't make the mistake of slathering the building exterior indiscriminately with surface sealers, as these can actually trap any moisture that does penetrate the surface, accelerating, rather than preventing, deterioration.

Instead, routine maintenance is the best defense against cold weather damage. Inspect and repair mortar and sealant joints; replace cracked, spalled or otherwise degraded masonry; and seal windows and doors. Even insulated glass and thermally efficient doors won't block drafts if weather stripping isn't in place. Pay

particular attention to facade weep holes, if present, when sealing windows or sliding doors; these should remain open and functional to allow water to escape.

Because different building materials have different coefficients of expansion, they respond to changing temperatures in different ways. Recurrent or extensive damage during the winter months may be a sign of incorrect design or incompatible material assembly. All buildings move and change with the seasons and with time. A design professional can help determine the cause and solution to major cracking resulting from uncoordinated building movement.

In the Winterizing Program log, note areas where repairs have been made, so that these spots can be checked again periodically to ensure that the repairs are holding up to winter conditions.

Winter: Manage Thermal Transfer

As with any horizontal building component exposed to the elements, entryways must be cleared and maintained using snow removal and deicing methods similar to those described for roofs and plazas.

Condensation on windows during the winter months should send up a red flag that some component of the thermal management system is not functioning correctly. If the condensation appears between the panes of double-paned windows, then the thermal seal has failed. If, however, the condensation is on the inside of the glass, then the glass may be insufficiently insulating, the seals may have failed, or the HVAC system may need maintenance. To avoid tossing heating dollars out the window (just about literally), attend to the problem quickly. A design professional can pinpoint the source of condensation and recommend a solution.

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representative projects



Winter Maintenance and Repair

Seasonal changes are tough on buildings. Hoffmann Architects specializes in preventing and treating the damage to facades, roofs, parking garages, and plazas that weather cycles can cause. Our project teams have developed maintenance programs and winterizing strategies for facilities that range from a single parking garage to more than 1500 public schools in New York City.

Not all winter management approaches work for all structures. Inappropriate snow removal techniques or incompatible deicing chemicals hurt more than they help. Because we consider each building's condition, situation, and exposure, we develop cost-effective repair and maintenance solutions that let building owners and managers meet each winter season with confidence.

A sampling of Hoffmann Architects' projects that correct or prevent weather-related damage:

Phoenix Life Insurance Company One American Row

Hartford, Connecticut
Addressed freeze/thaw damage at parking garage, plaza, and pedestrian bridge

Crystal Gateway, Crystal Park, and Crystal Square Office Complexes

Arlington, Virginia
Evaluated sealant application and resolved water infiltration problems at eleven buildings

BMW of North America, LLC

Woodcliff Lake, New Jersey
Corrected deicing chemical damage, freeze/thaw degradation, and alkali-silica reaction at parking garage

First Presbyterian Church

Stamford, Connecticut
Remediated weather-related degradation of slate walls, stained glass, roofing, and concrete at iconic landmark structure

Town of Fairfield Public Schools

Fairfield, Connecticut
Created roof, facade, and window maintenance manuals for sixteen schools

NYC School Construction Authority

New York, New York
Developed building exterior manual to coordinate inspection, maintenance, and repair for over 1500 public schools

State of Connecticut Office Building 25 Sigourney Street

Hartford, Connecticut
Designed solutions for damage from water, chlorides, corrosion, impact, and freeze/thaw cycling at parking structure, entry plaza, and building exterior

Severance Hall, Tower Court, and Claflin Hall

Wellesley College
Wellesley, Massachusetts
Improved safety, drainage, watertightness, snow/ice management, and building integrity

Butler Library Columbia University

New York, New York
Addressed differential settlement due to freeze/thaw cycling at plaza; remediated leaks and deterioration at facade



▲ One M&T Plaza in Buffalo, New York. Investigated and resolved chloride-induced corrosion at parking garage and plaza.

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▲ Ice dams pose serious hazards and, over time, lead to roof damage and leaks.

Let It Snow

With a modest expenditure of energy toward planning and prevention, you can stay a step ahead of the weather and avoid shelling out for serious repairs come spring. As the summer wanes, invest a few hours in developing your Winterizing Program checklist and log book, which can act as a quick-reference guide as you prepare each year for the winter months.

Because each structure's situation, climate, usage, and components are different, it might be worthwhile to retain a design professional in the first year to assist with developing your

winter strategy. From deicing chemicals to mechanical snow removal to sealers to insulation, a vast array of winterizing options is available, but not all of them would be suitable for your building. In fact, using a caustic ice melter or permanent surface sealer can do more harm than good if used inappropriately.

The trick is to plan ahead, so that liability concerns and emergency situations don't force hasty decisions. With the right preparation, winter maintenance can be simple, cost-effective, and efficient. All it takes is forethought and diligence. ■

JOURNAL is a publication of Hoffmann Architects, Inc., specialists in the rehabilitation of building exteriors. The firm's work includes investigative and rehabilitative architecture and engineering services for the analysis and resolution of problems within roofs, facades, glazing, and structural systems of existing buildings, plazas, terraces and parking garages.

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Editor: Alison Hoffmann
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Printed on 50% recycled paper. 