

Engineering Matters

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Special Issue: Are You Prepared for Winter?

Falcon Engineering is pleased to announce:

- **The opening of our New York office:**
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Ice Damming Leaks: What Happened?

By William Pyznar, PE

It's that time of year again. That snow that is pretty for some, is scary for others. You may have read or heard about, or even worse, experienced, ice damming. You are likely familiar with the damage that can be caused by this horribly frustrating and damaging condition. Perhaps your Association has spent several hundred thousand—or even over a million—dollars on roofing improvements and/or replacements within the last few years, but this situation was not alleviated by the repairs. Worse, the repairs may have even introduced the situation to buildings where the problem did not previously exist! This leaves the Community and its residents to wonder, “Why do we have leaks from ice damming?” “Wasn't the roof replacement designed or performed correctly?”

In response to these issues, and in anticipation of the upcoming winter, this article reviews the causes of ice damming, and provides guidance to prevent ice-damming-related damage based on a straightforward premise: with a properly designed and installed roof system, the possibility of damage resulting from ice damming should be significantly reduced.

Ice Be Dammed?

There are four (4) main factors that cause ice dams:

1. Snow/ice accumulation on the roof
2. Continuous cycles of warm/cold temperatures
3. An underventilated and poorly insulated attic (heat in attic)
4. Deficient roof installation (lack of ice and water shield, drip edge, insulation baffles, etc.)

A typical ice-damming event is illustrated in **Figure 1**. It occurs when the heat escapes from the living quarters into the attic and eventually warms the roof deck. The heat generated from the sun, and the interior heat, combine to accelerate and exacerbate this “roof warming” process. The melting water runs down the roof deck until it settles in the area over the eaves and the gutter. This area remains cold because it is not over a heated space. This is the area where the water begins to freeze and the ice dam forms. As the ice dam builds, it begins to trap more snowmelt, extending the height of the dam. The melting water begins to pool and backs up under the shingles.

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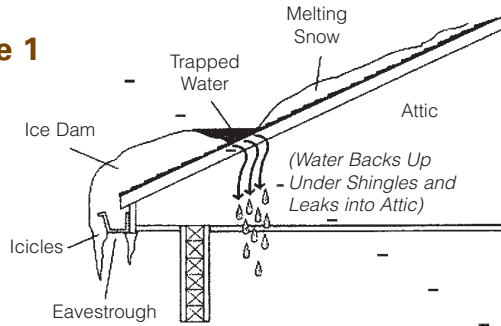
ALSO INSIDE:

De-icers and Concrete—Oil and Water? Page 3
What's New? Page 4

Ice Damming Leaks continued...

Severe problems begin in the absence of a proper ice and water shield, and if no drip edge is located behind the gutters.

Figure 1



Often, the problem is partially attributable to improperly (too tightly) lodged attic insulation against the underside of the roof at the soffits, which prohibits the proper ventilation of the soffit vents. This can be created by the lack of soffit baffles which “hem” the insulation to create an air space for the ventilation, thereby greatly diminishing the performance of a balanced roof ventilation system.

Ice Dam and Water Infiltration Damage Prevention

New roof installations and replacement projects should provide balanced natural draft roof ventilation to equalize temperatures over the entire roof. Heating an entire roof is impractical (and extremely costly), so the most effective solution is to create a cold roof. The most efficient system uses an equal balance of ingress and egress ventilation. Using this approach, cold outside air is drawn into the soffit vents, where it continues up along the underside of the roof decking, and ultimately escapes out through the ridge vent, dome (button) vents or gable vents. This even distribution of airflow minimizes variations in roof temperatures from the peak to the eaves and reduces the possible occurrence of ice damming.

Another line of defense against infiltrating water is the proper installation of an ice and water shield or an equivalent waterproofing membrane with accompanying drip edge installation. Proper ventilation and ice shields at the eave are governed by building code. In order to comply, the ice and water shield must project a minimum twenty-four (24”) inches past the interior face of the exterior wall. Adequate roof ventilation is also a warranty compliance requirement mandated by all shingle manufacturers. In other words, if the Association opts not to install adequate ventilation with a new roof, it in effect, voids the (typically 20 to 30 year) warranty of the new shingles.

An Association or developer can take additional steps at the time of construction or roof replacement that will greatly reduce the possibility of leaks resulting from ice damming. These include installing drip

edges at the eaves and rakes, as well as, installing a continuous run of ice shield along the step walls, low slope roof areas and other vulnerable locations. Properly performed drip edge installation can also help protect the eaves from water infiltration. Additional ice shields will also prevent water from penetrating back into the building envelope even when ice damming does exist.

Your roof replacement project should include, or should have included, these very important considerations to ensure that a quality work product is/was achieved and ice damming potential is minimized. Attention to detail in the installation of all flashings and roofing components also has a significant effect on the performance of the roof system under these extreme conditions.

Completely eliminating any possibility of damage from ice damming while remaining within standard building costs and practices is a challenge. However, if your roof has been engineered and installed with care, detail and in accordance with all applicable building codes, even under severe conditions, the chance of damage should be greatly reduced. Working with the right team of professionals can help you manage the costs, and optimize the protection of your buildings from ice damming and water infiltration-related damage.

For existing roof systems, ice dam and water infiltration prevention is also possible. Several measures can be taken to reduce the chance of ice damming. For example:

- Seal all attic penetrations around bathroom exhaust fans, plumbing vents, electrical wiring and outlets, with caulking or weather stripping—to reduce the heat loss into the attic space
- Vent all exhaust fans (bathroom, etc.) outside through the roof
- Install an appropriate amount of insulation in the attic.

Upgrade to adequate and effective ventilation

so that cold air completely engulfs the underside of the roof above the insulation. This ventilation includes not only soffit and roof vents, but also pre-formed baffles to ensure attic insulation does not block ventilation paths. “Hot spots” need to be addressed.

Summary

The bottom line on ice damming and water infiltration is that no one can be certain of what awaits us in this upcoming, or future, winters. However, Associations which have either experienced ice damming or water infiltration problems, or are concerned that they may be “at risk” for such problems, should consult their engineers and other professional advisors to determine the best course of action to minimize the potential for future problems.

As always, please feel free to contact me, or your Falcon Engineering professional for more information.

De-icers and Concrete— Oil and Water?

By Andrew Amorosi, PE, RS

With winter rapidly approaching, it's not too soon to begin preparing plans and considering the best use of materials for de-icing concrete sidewalks, paths, driveways, etc. While it always appears that the "quick fix" is to apply some form of salt, this approach is really a tradeoff; the salt not only melts the ice, it also slowly degrades the concrete. Associations need to control ice to ensure pedestrian and motorist safety on their property, while being cognizant of the fact that these same ice control measures can be creating a long-term problem requiring surface repair and replacement. This article addresses this issue, and proposes solutions for Associations to achieve an effective balance of safety and surface "preservation."

De-Icing Materials and their Effects— a Primer

Concrete has high strength when it is compressed, or 'squeezed'. However, it is extremely weak when it is subjected to tension, or 'pulled'. De-icing materials, when used in a situation in which this structural "weakness" is present, can cause havoc—that is—the combination of this structurally weakened condition with de-icing materials present can lead to severe degradation of concrete surfaces.

At first glance, concrete may seem like a very dense material. However, in reality, it is like a sponge, in that it can, and does, absorb water. This can be easily observed on a summer day. If you pour water on a sidewalk, you may actually see the water penetrate (be absorbed by) the surface of the concrete. Quality concrete should contain air voids to minimize this absorption potential.

Generally, all ice melters (de-icers) work in the same way. They depress the freezing point of ice or snow and turn the mixture into a liquid or semi-liquid slush. Solid chemical salts bore through ice or snow and form a strong brine solution. This brine spreads under the ice or hard-packed snow and undercuts it, breaking the bond between the ice or snow and the concrete surface. Once loose, the ice or snow is easily removed by mechanical means, such as with a shovel or plow. Alternatively, the material is applied in anticipation of ice or snow. This prevents the bonding of the snow or ice to the concrete surface and melts the snow or ice as it comes in contact with the brine.

The melting action of the material allows water to enter the concrete. If the temperature then drops and the water freezes, the expanding or growing ice crystals can explode the concrete surface. This surface defect in concrete is commonly referred to as **spalling** or **scalling**.



The primary measure of a de-icer's effectiveness is the range of temperatures in which it can provide de-icing action (in a reasonable time period). The "practical" lowest temperature limits for these materials is defined as effective (it melts the ice) within 15-20 minutes of application.

Just Add Salt?

Salts are the most common de-icers, but they are often harmful to concrete surfaces, especially on lower grades of concrete. During the first winter after a new concrete surface is created, de-icers should not be used since the concrete surface may still be curing. (Curing concrete contains excess water and as such, less air voids). The additional absorption of water from the melting ice and a freeze/thaw cycle may be just enough to cause a problem. Because the excess water seeps into the concrete, and crystallizes (as described in the previous section of this article), the concrete can begin deteriorating.

Let's apply the above information in relationship to some commonly available de-icing materials, their specific impacts on concrete—and the surrounding environment. Calcium Chloride works to temperatures to minus -25 degrees F. Sodium Chloride (Rock salt) works only to temperatures of 20 degrees F° resulting in a higher potential for both freeze/thaw to occur and the crystal growth or expansion that can lead to surface deterioration. Even when the concrete has cured, depending upon the mix, a reaction may take place when rock salt is used. Some damage to plants can occur from excessive use of this material, so care should be taken when applying it.

Calcium Chloride is typically sold in small pellets. This material is much more costly than rock salt, however, the concrete damage is less aggressive because it works at much lower temperatures, minimizing the freeze/haw cycle. However, as with Sodium Chloride, some damage to plants can occur from excessive use of this material, and care should be taken when applying it, as well.

Potassium Chloride is much like Calcium Chloride and about the same cost. The difference is it's less damaging to concrete. This material can also harm plants and metals (although less than the other materials) so care should be used when applying it.

It should also be noted that some commercial de-icing compounds contain ammonium nitrite, nitrate or sulfate (fertilizers). You should never use these de-icing compounds, since there is a moderate to rapid chemical reaction between these chemicals and almost all concrete.

Of course, as an alternative sand can be used. The sand will not melt the snow and ice, but it will provide better traction.

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De-icers continued...

Prevention of Concrete Deterioration

Prevention of the spalling and scalling of concrete begins with the proper specifications, composition, installation and finishing of the material.

Concrete for sidewalks should have a minimum compressive strength of 4,000 pounds (higher strength and/or reinforcement is recommended for driveways) per square inch, and have proper air entrainment, as well. Air entrainment allows for voids in the material, and thereby accommodates expansion of water from freezing conditions to occur, without the damaging effects associated with the freezing water. Non-air entrained concrete will lack these voids and as such, can spall or scall much more easily. 6% air entrainment is common in this area of the country. The combination of strength with air is a good defense against de-icing material and salt-related damage. Concrete that is ordered, placed, finished, and cured properly (6 months or more), can resist years of contact with de-icers or rock salt.

In addition to the use of strong, air-entrained concrete, the installation should require a level, stable, and well-compacted sub-base with good drainage under the slab. An allowance for thermal movement, contraction and subsequent expansion can be made by providing joints of required spacing and depth. Sawed or tooled contraction joints should be a minimum of 1/4th the depth of the slab. Grades in the immediate area of the slabs should be set such that surface water is carried away from the slab to assure that the concrete is not continually saturated.

Many times, concrete surface failures such as spalling can be traced to workmanship deficiencies. Guidelines for proper workmanship include:

- **The placement and finishing of the concrete is critical.** The top surface of the concrete can be severely weakened by poor workmanship. Sometimes workers add water to concrete at the jobsite, use it as a finishing aid, or improperly “float” the mix. This approach dilutes the amount of cement at the surface of the concrete and as such, weakens the material. The cement is the element of concrete that binds the concrete materials.

- **All finishing operations must be performed at the proper time.** Any finishing operation should not be performed when free water is present on the surface of the concrete.

- **Provide adequate curing conditions by retaining or supplying moisture (and heat in cold weather)** for a sufficient length of time. Inadequate curing will prevent the concrete from realizing its full potential for strength and durability.

To resist the freeze/thaw action of water, strong concrete at the surface is needed. If concrete spalls or scalls after the winter and de-icers were not used, it must be a mix or a finishing problem. Concrete testing can verify this.

Feeling Like Sealing?

Some older communities seeking to avoid the expense of replacing their concrete walkways use a coating or sealing approach. **Be careful!** Avoid sealing concrete with surface coatings that minimize or eliminate the possibility of water absorption by the concrete. Some of these coatings contain *silanes* and *siloxanes*. These ingredients allow the clear coatings to “breathe”. This is an acceptable coating, but can be effective *only* if applied correctly. **Additionally, avoid using products that contain silicone or paraffin.** These can produce a surface film—which does not allow the concrete to breathe. Concrete typically absorbs water from the adjacent or subsurface soil. The water migrates through the concrete and eventually evaporates. However, if a film is present to trap the water at the surface, spalling may be the result during a freeze.

The Bottom Line

When installing or replacing concrete sidewalks, driveways or patios, always provide the contractor with the proper specifications for the methods and materials for the project. Use qualified concrete contractors with a proven record. Check the work and the concrete truck tickets to be sure the mix is proper. Only resurface concrete using proper materials, proven applications, and surface preparations.

As a rule, or at least as a precaution, new concrete should not be treated with de-icers during a minimum, 6 month period—or during the first winter after installation/repair. Salts may be dangerous to lesser quality concrete at any time if temperatures are, or will be below, 20 degrees F. After the de-icers have done their job, remove the ice and snow to dry out the concrete. Dry concrete will be less likely to be damaged by freeze/thaw cycles. Consider increasing the frequency of snow removal services to minimize potential problems and consider using sand to improve traction.

This combination of approaches can add years of useful life to sidewalks, driveways and patios, while providing the desired safety for pedestrians and motorists.

What's New?

Falcon Engineering congratulates:

Andrew Amorosi—on the birth of a daughter, Gabriella.

David Chesky—on the birth of a daughter, Vivian.

William O'Brien—on joining the firm in our New York office.

We welcome each of these new members of the Falcon Engineering family!