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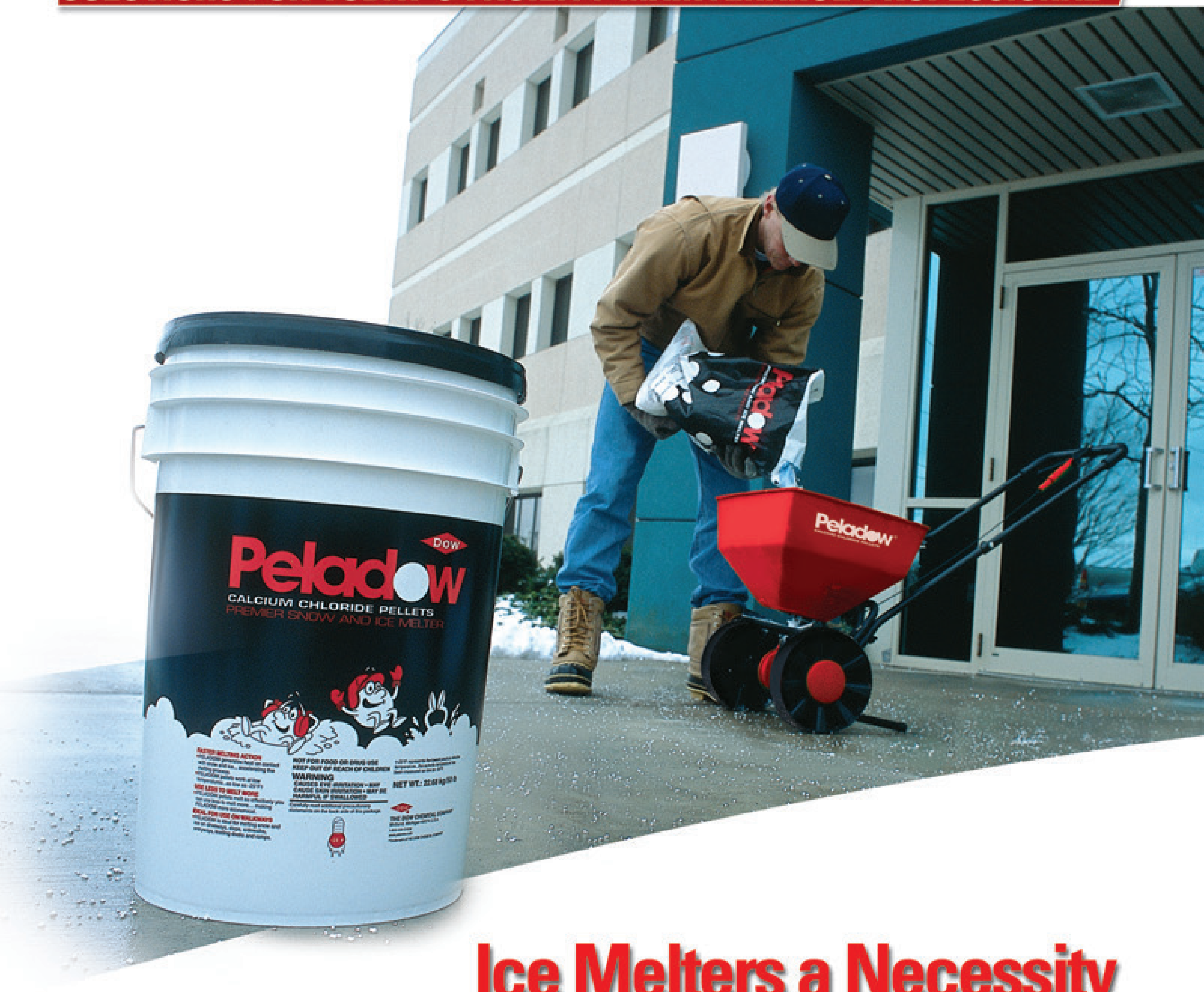

Ice Melters a Necessity

Deicers and Concrete Damage?

Deicers and Concrete Damage
The Straight Scoop

By Joe Althouse

Using ice melting compounds to clear snow and ice from walks, drives, and entries near public buildings is virtually a universal practice today. Facility maintenance personnel learned long ago that to achieve safe surfaces in the shortest time with the least total cost, ice melters are a necessity.

It has also been known for a long time that winter weather and use of deicers can be associated with damage to concrete in the form of surface scaling and flaking.

As far back as 1952, the Research and Development Laboratories of the Portland Cement Association were studying the resistance of concrete to surface scaling associated with the use of salts for ice removal.

Today, there are more than 100 brands of ice melter available. Unfortunately, many of these products make erroneous or misleading claims regarding the issue of concrete damage. The result is considerable confusion on this topic in the marketplace. Therefore, the purpose of this article is to eliminate as much of this confusion as possible by providing a reasonably complete and factual summary of the science behind concrete damage associated with the use of deicers.

"Your Deicer Ate My Concrete!!!"

As a technical service rep for a deicing product, I hear this from time to time.

However, according to the American Concrete Institute, the truth is that the most common deicers do not chemically attack concrete, (see Figure 1).

The fertilizer products, ammonium nitrate and ammonium sulfate, are an exception to this rule, and should not be used for deicing on concrete under any circumstances. There is some evidence that concrete containing dolomite coarse aggregate may be susceptible to chemical attack from magnesium chloride,[2] however it is debatable how applicable this is to most application scenarios.

"So What Caused My Concrete To Flake and Scale?"

To answer this question, we need to know a little bit about the structure of concrete. Obviously, concrete is a rigid material, but perhaps not so obvious is that it is also porous. The porosity allows melt water from the deicing process to soak into the voids and air pockets beneath the concrete surface. This absorbed melt water may re-freeze if the outside temperature drops, as it often does following a winter storm. As the water within the concrete turns into ice, it expands in volume approximately 9 percent, pushing hard on the surrounding rigid structure.

If the pressure exerted by the ice exceeds the strength of the concrete, the concrete will crack and crumble, which eventually appears as surface spalling or flaking. This process is similar to what happens when a water-filled glass container is placed in a freezer. The pressure created by the expanding ice breaks the glass.

This is a physical process, not a chemical one. This was demonstrated nearly 50 years ago by scientists working at the Portland Cement Association (PCA) Research and Development Laboratories. In a 1956 bulletin titled, "Studies of 'Salt' Scaling of Concrete."[3] The PCA scientists found that scaling was not specific to salt-based deicers, but also occurred when organic chemicals such as urea and ethyl alcohol were used as deicers. From this, they concluded, "…the mechanism of surface scaling is primarily physical rather than chemical."

Therefore, if the deicer does what it is supposed to do, (melt snow and ice), it cannot help but create melt water. Because concrete is porous, the melt water cannot help but penetrate beneath the concrete surface. Once this occurs, two factors determine whether damage will result; the structural quality of the concrete and the weather.

"But This Concrete Looked Fine Before Applying Deicer!!!"

The structural quality of concrete cannot be assessed by visual observation. Strength can vary from point to point depending on variability in

Figure 1. Effect of Commonly Used Chemicals on Concrete[1]

Rate of attack at ambient temperature	Salt Solutions
Negligible	Calcium chloride, Sodium Chloride
Slow	Magnesium chloride
Moderate	Ammonium nitrate, Ammonium sulfate

finishing and curing conditions. However, if quality materials and sound construction practices are used, freeze-thaw damage can be largely prevented.

A 1988 PCA article titled, "Winter Weather, Deicers Need Not Damage Concrete,"[4] summarizes the basic requirements for achieving durable, scale-resistant concrete. These requirements include (a) cement content of at least 564 lbs/yd[3]; (b) water-cement ratio less than 0.45 by weight; (c) 6 percent entrained air and (d) proper curing technique. Regarding the use of deicers, the article states, "The safest deicers for concrete are also the most common: sodium chloride - rock salt - and calcium chloride."

"There Was No Damage Last Year -The Deicer Must Have Changed"

Sometimes, damage is reported on concrete that is several years old, having been through previous winter seasons without a visible problem. The first conclusion is often that the deicer must have changed, causing the problem.

However, there are two other explanations that more likely account for this scenario. First, lab testing has shown that the extent of damage is dependent on the number of freeze-thaw cycles experienced by the concrete. In the real world, it may require several years to accumulate the number of freeze-thaw cycles to reach the threshold where visible damage becomes evident.

Second, the potential for freeze-thaw damage depends on the specific weather conditions experienced in any given winter season, such as how cold it gets, how often it snows and how much it snows. Obviously, colder temperatures increase the potential for re-freeze of absorbed water. When it snows a lot, requiring frequent use of deicers, the concrete may become fully saturated with melt water.

The more saturated the concrete, the more stress placed on the concrete if that water re-freezes. Because freeze-thaw cycles and weather conditions can vary dramatically from year to year, they may combine to produce visible damage one year, when no damage was visible in previous years.

"But The Label Of This Product Says 'Safer on Concrete'!!!"

There are a number of different laboratory methods that can be used to test concrete samples for resistance to freeze-thaw damage. Different test methods can lead to different and often conflicting conclusions. It is easy for a vendor to "cherry pick" one favorable test result, and to use that as the basis for a broad, generalized performance claim. Unfortunately, the real world is generally not quite that simple, especially for a relatively complex material like concrete, in which many different factors interact during formulation and fabrication to determine the properties of the finished product. The best tests are the ones that come closest to simulating the real world.

For example, the PCA published results in 2002 from testing outdoor slabs deiced with sodium chloride and calcium chloride through 37 years of actual winter conditions.[5] When recommended concrete construction practices were followed, the findings showed that both deicers received the same visual scaling rating – 1.5 on a scale of 0 to 5, (0 = no scaling; 5 = bad scaling).

"So What Is The Take-Away From All This?"

Be aware that performance claims made by a number of deicing products relative to the issue of concrete damage may be misleading at best. If these claims factor into purchasing decisions, it might be time to re-evaluate whether or not the claims are valid.

The performance of calcium chloride and sodium chloride relative to the concrete damage issue has been studied for over 50 years by the Portland Cement Association. No other deicers can claim a more solid, scientific track record for understanding this element of performance.

The primary factors involved with concrete damage scenarios are the weather and the structural quality of the concrete.

The weather cannot be controlled, and existing concrete cannot be magically modified, but perhaps an improved understanding of the key aspects of making durable, scale-resistant concrete will help prevent potential problems from arising with new installations. ❑

References

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