Deicing, Anti-Icing, and Chemical Alternatives

Emerging Technologies to Consider for Particular Snow or Ice Control Situations

Since the 1930s, state and local road agencies have used rock salt as the primary chemical for fighting ice build up. "Snow fighters" in the NHDOT and in other states have conducted several experiments which indicate that, in certain circumstances,

- An anti-icing approach provides safer roads at less cost than a deicing approach,
- Calcium chloride combined with rock salt melts ice and snowpack more effectively than salt alone, and
- Other chemicals should be considered, especially for bridges and some high volume roads.

Deicing and Anti-icing

Conventional winter operations employ, where necessary, a deicing approach. Operations begin with removal of as much snow as possible during a storm. If snowpack or ice develops, the road agency spreads rock salt to melt its way through the snow/ice layer. When sufficiently softened or loosened from the pavement, crews plow the snow or ice off the roadway.

The initial operation in an anti-icing approach is to spread liquid chemicals to pavement as a pre-storm treatment. Rather than reacting to ice formation, anti-icing methods seek to prevent snow or ice from bonding to the pavement. Snow plows can then remove snow more easily to clear pavement, thereby providing safer roadways sooner. To effectively apply this approach, the road manager must

- Adopt a systematic, anticipatory approach to prevent formation of bonded ice or snow,
- Have accurate weather information in a form which enables forecast of pavement temperatures, and
- Have knowledge of the various chemicals and their applications.

For workshops given this fall, the UNH T² Center staff rewrote a FHWA manual on effective anti-icing practices. (See page 9 to request a copy.) The manual applies to the low volume roads typical in New Hampshire and does not cover some chemicals discussed by salespeople and in the public press. These chemicals are discussed below.

Prewetting

Salt prewetted with a liquid is effective as an anti-icer or deicer because prewetted salt clings to the road rather than bouncing off. Prewetted salt can be applied at a faster rate. This procedure saves money and minimizes environmental affects; 25-65% more prewetted salt remains on the roadway. Highway departments also use less resources because the spreader load covers more area, requiring fewer trips to the garage to reload.

The lowest cost prewetting liquid is a sodium chloride (salt) brine. It lowers the freezing point of salt a few degrees, is very inexpensive and doesn't remain wet on the roadway. "Just wetting down a load of salt with a water hose is preferable to laying down dry salt," says Tom Donahey, Director of Maintenance Programs for the Iowa DOT

Calcium chloride (CaCl₂) increases the effectiveness and efficiency of salt as a deicer or anti-icer. The Merrimack Public Works Department has used calcium chloride since 1985, on average about 5,000 gallons each winter. Master Road Scholar John Starkey speaks highly of CaCl₂. He calls it, "another bullet in the gun" when it comes to fighting snow and ice. "It makes salt work below 20°F, and keeps the salt from bouncing all over the road." John also recognizes its anti-icing potential, noting that the prewetted salt "seems to leave a residue on the streets," which helps if another storm occurs within 4-5 days. "It buys a couple of hours before we need to go out."

The corrosion rate from rock salt treated with 32% liquid CaCl₂ is about the same the as the corrosion rate of rock salt alone. A reformulated grade of liquid CaCl₂ provides lower corrosion levels. It contains a small amount of a corrosion inhibitor which forms a protective barrier between metal surfaces and the deicing chemical. It is a non-toxic, environmentally safe compound with the ability to cut through snow and ice more quickly than salt or magnesium chloride. Also because it doesn't leave sediment in tanks, it allows easy cleanup of vehicles.

Liquid Chemical Alternatives

Several chemicals have been tested as alternatives to conventional road salt. Calcium magnesium acetate (CMA) is considered the most viable alternative because of its low environmental impact and low corrosion level. It is less effective, however, in that CMA melts ice at a slower rate than salt alone. It is also more expensive. CMA is created from limestone and acetic

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acid (a component of vinegar), and is therefore biodegradable. When CMA degrades, the calcium and magnesium elements are said to actually improve the water and air permeability of the soil by restoring sodium-compacted soils.

Since acetate degrades into carbon dioxide and water, and is a natural component of plant decay, CMA is appropriate where roadside vegetation, crops, or ground water are especially vulnerable. Being less corrosive than salt, some agencies prefer CMA for use on bridges, parking structures, side walks, and certain road surfaces (it does cause major scaling).

The cost of CMA is approximately $600/ton whereas salt generally costs $20-40/ton. Some advocates of CMA argue that the initial costs may be misleading because replacement costs for roads and bridges damaged by chloride-related corrosion should be factored into the overall figures.

The pelletized form of CMA is usually preferable to the powdered form, since the powder dust is less controllable. Pelletized CMS does not bounce off the road before melting and its residual action can reduce reallocation frequency.

The Massachusetts District 6 engineer reports that an average of 260 lb. of CMA per lane-mile were used to provide the same level of service as 300 lb. of salt per lane-mile. Frequency of application in CMA treated areas was lower than salt application frequency, more plowable and had better traction. It is best to apply CMA before the snowfall because it is most effective in preventing snow from packing and bonding.

Potassium Acetate, (KAc) is formed through a chemical reaction of acetic acid and potassium carbonate (or potash). On a test section of state road over two winters, the New Hampshire Department of Transportation found that KAc worked effectively, was easy to store and use, and was non-corrosive. It was also very expensive (costing 27 times more than salt and sand).

Other chemicals have been used for deicing or anti-icing under very special conditions. Some products under research, such as sodium formate, can react with car exhaust to form a deadly dormic acid. Uric acid and hydrofluoric acid are effective, but are far more corrosive than other deicing materials. Urea is a corrosion fighter and a fertilizer. It is mostly used on airport ramps and walkways to prevent the ice to pavement bond but since it promotes plant growth, it shouldn’t be used near the water because it could promote aquatic plant growth which can deplete the oxygen in water and cause fish kills.

Charts with recommended rates of application for all these materials are available by calling the T² Center.

Guidelines for Spring Road Use Restrictions

Record Keeping Should Begin in November

Spring thaw, and the need to set load limits, might seem a long way off. Yet, the Guidelines for Spring Road Use Restrictions, distributed at “Load Limits” workshops last spring, rely on average temperatures for the entire winter. These guidelines were prepared by the UNH T² Center staff based on research conducted at Washington State University and confirmed as practical by the Maine DOT. They provide criteria to determine:

- Where to apply load restrictions,
- The amount of the load restriction to apply, and
- When to apply and when to remove load restrictions.

The “when to apply” and “when to remove” criteria depend on average daily temperatures during the freezing as well as thawing periods. One can acquire temperature records from newspapers or other local sources where they are most accurately and conveniently kept throughout the winter period.

The Guidelines were prepared for application by road managers whether or not they attended a workshop. It describes the procedure to make the above determinations, and contains forms for recording temperatures and for performing simple calculations. It is available at no charge from the UNH T² Center. See page 9 to request your copy.