

RESEARCH BRIEF

Snow Removal at Extreme Temperatures

Clearing snow and ice from roadways is critical for public safety. A particular challenge for transportation agencies in northern and mountain states is the regular occurrence of snowstorms at temperatures below 10°F, when granular salt and salt brine are less effective. At these temperatures, agencies have to use abrasives and increased plowing, or larger volumes of salt to achieve satisfactory results, leading to higher costs and increased environmental impacts.

Need for Research

While there is an extensive body of published research on winter maintenance best practices, most was developed for general usage and often doesn't apply to extremely low temperatures. Transportation agencies, therefore, have little guidance in the most effective techniques for clearing snow and ice from roads under these conditions, even though they face extreme cold regularly.

Objectives and Methodology

This research project was aimed at identifying innovative, cost-effective options for snow and ice removal at extremely low temperatures. Researchers' tasks included:

- Performing a comprehensive literature review, with a focus on best practices, emerging technologies and relevant studies in chemical usage, operational strategies, weather forecasting, winter maintenance equipment, and pavement treatments. The review included practices from State and local agencies, other countries, and other fields (including airports).
- Conducting a survey through the SNOW-ICE listserv and a LinkedIn group to learn how transportation professionals maintain roads during extreme cold weather. The 166 respondents were primarily but not exclusively DOT employees at the headquarters or district, region or station level, representing 23 states and four countries.

Results

Based on the literature review and survey, investigators identified several strategies for winter maintenance during extreme cold that have been used by DOTs and other jurisdictions, including the following:

- **Plowing:** Snow at extremely low temperatures tends to be dry and easy to plow, making frequent passes an effective practice. However, hard pack snow or ice at low temperatures can be challenging because of the reduced efficiency of chemicals that can help break them. Survey respondents recommended several types of blades and plows for low-temperature applications, including underbody plows, scarifying blades for front plows, new cutting edges, serrated cutting edges, JOMA blades, rubber-mounted carbide cutting edges, anti-vibration cutting edges, triple-edged plow blades (one of which is a serrated blade to cut ice or hard pack), tow plows and underbody scrapers.
- **Chemicals:** Half of the survey respondents use magnesium chloride in addition to salt or salt brine at cold temperatures, and one-third use calcium chloride. These chemicals are more effective than salt (sodium chloride) at melting snow in extreme cold, but they are more expensive and can be difficult to handle. Both are hygroscopic; after their initial application they attract moisture and can potentially worsen road conditions. Potassium acetate and calcium magnesium acetate can be more effective, less corrosive and less environmentally harmful than chlorides, but their higher cost generally makes them impractical for use on roadways. Agricultural or distillery byproducts have shown some promise as deicing agents or additives, but testing so far has been limited. Many survey respondents warned against using anti-icing chemicals before a storm during severe cold because they can

Principal Investigator

"The most severe 20 percent of storms can cost 80 percent of an agency's winter maintenance budget. If we target these storms, we can save a significant amount of money and labor while reducing our environmental footprint."

—Xianming Shi
Western Transportation
Institute, Montana
State University
xianming_s@
coe.montana.edu

Project Champions



“Two weeks of cold can use up a county’s full-year supply of salt. We needed to see what other jurisdictions do to clear roads at cold temperatures.”

–Mike Sproul
Wisconsin
Department of
Transportation
michael.sproul@
dot.wi.gov

“The value for us was to see if there were options other than what we were already doing to remove ice at cold temperatures.”

–Larry Gangl
North Dakota
Department of
Transportation
lgangl@nd.gov

Brief prepared by
CTC & Associates LLC
ctcandassociates.com



Some transportation agencies use innovations such as the tow plow, which can clear two lanes of a road simultaneously, to improve snow removal operations.

cause snow to stick to road surfaces sooner. Several respondents recommended deicing after a storm or during daylight hours or rising temperatures to return roads to safe conditions.

- **Abrasives:** Sand has a greater negative environmental impact than chloride salts and has limited effectiveness on roads with high vehicle speeds. Abrasives are therefore typically used on roads with low traffic. Heated sand and abrasives pretreated with liquid deicers or hot water may improve performance.
- **Snow storage:** Blowing snow can be a major problem in windy areas. Snow storage options such as ditches, ridges, snow fences and living snow fences may help to address this issue.
- **Pavement heating:** Snowfree, a conductive asphalt pavement runway at O’Hare International Airport, demonstrated effectiveness during a -10°F storm. A geothermal system in Japan’s Abo Pass successfully melted snow and ice at an average minimum temperature of 0°F. Due to the engineering and construction requirements, however, these are not generally practical options for existing roads.
- **Pavement treatments:** Various pavement treatments, including rough surfaces, physical bending pavements, polymer overlays or anti-icing additives, claim to be able to reduce the bond of ice and compacted snow to pavement. Testing has shown mixed results. These treatments generally have higher costs per lane mile than the use of chemicals and are recommended only for problem locations that offer the best return on investment.

Benefits and Further Research

Researchers identified several promising options for snow removal at extreme temperatures. However, these alternatives all have environmental, technical or economic drawbacks that make them somewhat impractical. In view of this, investigators canceled a planned cost-benefit analysis of highly promising best practices. They recommend monitoring developments and periodically revisiting the research to determine when innovations become practical for widespread use. They also recommend field and/or lab validation of the identified best practices.

This brief summarizes project CR11-04, “Snow Removal at Extreme Temperatures—Phase I,” produced through the Clear Roads winter maintenance pooled fund project, TPF-5(218). Clear Roads’ lead state is Minnesota DOT, 395 John Ireland Blvd., St. Paul, MN 55155. Cliff Spoonemore of Wyoming DOT is the Clear Roads Technical Advisory Committee Chair (cliff.spoonemore@dot.state.wy.us).