Synthesis of Best Practices in Snow and Ice Removal

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ABSTRACT

The removal of ice and snow from pavement surfaces is a critical operation that affects the safety of the traveling public and the timely delivery of goods and services. In fact, major federal and state highways are expected to remain clear of snow and ice during a storm due to the significant safety and economic impacts winter storms have. Secondary roads also are in need to be cleared in a timely manner to prevent excessive accumulations. Federal, state, and local agencies that are involved in snow and ice removal use a variety of tools, techniques, and materials to achieve their own objectives and guidelines to ensure that their operations are safe, efficient, environmentally responsible, and cost effective. A couple of years ago, the Illinois Department of Transportation (IDOT) sponsored a project to develop a synthesis of best practices in snow and ice removal. The Illinois Center for Transportation (ICT) funded project included a thorough review of literature to identify common practices used in clearing roadways from snow and ice and a number of interviews with a variety of professionals in the field.

This paper presents descriptions of pretreatment, plowing, roadway maintenance, and administrative and managerial techniques used in winter road clearing operations. It discusses the conditions of applicability of the various methods and identifies best practices based on safety, practical, economical, and environmental considerations. Finally, the paper examines emerging technologies in snow and ice control operations and presents several recommendations on how technology can be economically integrated into current practice.

Keywords: Snow plowing, best practices, snow control, ice control, synthesis, snow removal, ice removal

INTRODUCTION AND LITERATURE REVIEW

Snow and ice control is a difficult task that is performed in a harsh environment. Moreover, the sheer number of parameters that can affect equipment and operator performance during a snow and ice control operation makes it difficult to establish a viable plan that will capture the effects of all possible parameters. A wealth of information, dealing with the various aspects of snow and ice control, exists, including a few studies that have attempted to investigate plow and blade performance and evaluate plowing techniques (Carney 2008, Conger 2005, Cuelho 2010). However, a lot of work remains to be done to finally obtain a comprehensive synthesis of best practices.

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Snow and ice control is a multifaceted undertaking that relies on a number of techniques that can be used to prevent ice from forming and snow from accumulating, remove already formed ice and accumulated snow to make it safer for drivers to use the road, or allow for better drivability for the traveling public even in the presence of ice and snow. These techniques include pavement pretreatment, roadway maintenance, managerial skills, and the possibility of using emerging technology.

Pretreatment techniques include the application of chemical anti-icing agents or abrasives. Anti-icing is a technique used to prevent the formation or development of a bond between the pavement and snow or ice. Blackburn et al. (2004) stated that anti-icing chemicals should be applied when pavement surface temperatures are above 20°F before a snow event. This is because at temperatures below 20°F the chemicals themselves might freeze and create a thin layer of ice on the pavement, which is contrary to the rationale for applying them in the first place. If properly applied, anti-icing chemicals greatly simplify the snow plowing operation resulting in significant reduction in the time and effort needed to attain desired results.

Abrasives are used to increase the traction on compacted snow and are generally suitable for use in situations where temperatures are so low that chemicals are no longer effective. Vaa (2006) and Norem (2009) state that the improved friction created by abrasives will only last for 50 cars or so on roads with traffic speeds of 80 km/h (50 mph) and a high percentage of trucks. The effectiveness of abrasives may be improved by utilizing heated or chemically warm wetted sand as it is less likely to be dispersed by moving vehicles.

Roadway maintenance techniques include road plowing and deicing. Plowing is generally accepted as the most effective technique for snow and ice control. While a few studies have been conducted on plowing techniques, a significant amount of work still remains to be done to better understand the full effects of the harsh environment on the equipment, including blade, plow, and truck.

Deicing should not be confused with anti-icing. While the first is used to break an existing bond between pavement and packed snow or ice, the latter is used to actually prevent that bond to ever form. Cuelho et al. (2010) notes that through the use of deicing chemicals, it is possible to expect that reduced amounts of abrasives be needed, higher traffic speeds and volumes achieved, and savings on fuel consumption when compared to plowing alone. Although these chemicals can be used in their solid form, Conger (2005) argues that they become more effective when pre-wetting is used, which is an innovative technique in which the solid chemicals are saturated with liquid before they are applied to make them adhere to the road surface.

A less visible component of any snow and ice control operation is the management aspect of it. Plow-truck drivers and other operators in the field must rely on information provided to them by their command centers to run their routes efficiently and use the appropriate snow and ice control technique. Real-time information pertaining to roadway traffic and weather patterns is necessary for a successful snow and ice control operation. Being better informed leads to better planning, which in turn lead to better roads with fewer road closures, fewer delays, fewer accidents, a decrease in the incident response time, and a decrease in the cost of construction (Shi et al., 2007).

In summary, snow and ice control operations play a critical role in ensuring public safety and protecting the economic development and well-being of cold weather regions. The success or failure of any one operation depends on a number of controllable and non-controllable parameters. Controllable parameters include adequate operator training, optimized snow and ice control procedures, a reliable equipment maintenance program, and dependable traffic and weather information systems. A timely inclusion of emerging technologies such as in-place anti-icing systems and GPS can only lead to enhanced and more cost effective performance.

SYNTHESIS OF BEST PRACTICES IN SNOW AND ICE CONTROL

To develop a synthesis of best practices in snow and ice control, a questionnaire was developed to use for interviews with practitioners in the field such as agency personnel, DOT engineers, and consultants actively involved in snow and ice control operations. The questionnaire targeted six categories with a number of questions asked under each category. The interviewees were also
given an opportunity to add other comments or address other issues that were not covered by the questionnaire. The categories and associated questions used were as follows:

1. Interviewee Information: (name, position and affiliation, years of experience in snow and ice control operations, and contact information)

2. General information about best practices
   - What are the characteristics of a successful snow/ice plowing operation?
   - What pitfalls to watch out for in snow/ice plowing operations?
   - What are the most important parameters in snow/ice plowing operations?

3. Standards and guidelines
   - Are there any pre-plowing guidelines that need to be followed?
   - Are there any snow/ice plowing guidelines that need to be followed?
   - Are there any post-plowing guidelines that need to be followed?
   - Are there any safety guidelines that need to be followed?
   - Are there any rules of thumb for best practices in snow/ice plowing operations?
   - Are there specific practices you use when installing plow blades?

4. Equipment
   - Types of trucks (Comment on where and how best to use)
   - Types of plows (Comment on where and how best to use)
   - Types of blades (Comment on where and how best to use)
   - Equipment inspection guidelines and records
   - Equipment maintenance guidelines and records

5. Technology
   - What new technology is available in the field (last 3 years)?
   - Is IDOT using the most recent technology in snow/ice plowing?
   - Are the plowing trucks adequately equipped in terms of technology?
   - How often does IDOT replace its plowing trucks? Is this an adequate truck replacement interval?
   - How often does IDOT replace plows? Is this an adequate plow replacement interval?
   - How often does IDOT replace blades?
   - What criteria are used to determine blade replacement?

6. Personnel and training
   - Are the snow plowing personnel generally competent?
   - What kind of training are snow/ice plow operators usually exposed to?
   - What kind of training do snow/ice plow operators receive specifically related to plows and plow blades?
   - What additional training should snow/ice plowing operators be exposed to?
Interviewees included snow and ice control professionals from the Illinois Department of Transportation and other agencies, including departments of transportation of other states. Some of the most noteworthy findings from these interviews are as follows:

1. A snow and ice plowing operation is successful when it produces the cleanest roads in the quickest time without hampering the traveling public’s convenience. Since public safety is the number one concern, the number of fatalities that are due to road condition can be used as a measure of success.

2. Truck drivers play an important role as they are responsible for determining if roads are clean enough and safe for travel. Consequently, truck drivers need to be adequately trained to be able to identify situations where more plowing passes are necessary and if plowing needs to be combined with other techniques. Proper driver training will result in the safest roads for the most effective cost.

3. The significance of the reliability of the plowing equipment (truck, plow, blades, and accessories) cannot be overstated. Equipment that fails to perform its function or breaks down does not only hamper the plowing operation but it also creates an additional hazard to the traveling public.

4. Changing weather conditions can be hazardous and may interfere with the progress of a successful snow and ice clearing operation. An adequate weather monitoring system that allows managers and operators to make the timely and right decisions with respect to which pretreatment or plowing technique to use is one of the most important items of a successful snow and ice control operation.

5. Drivers need to be adequately familiar with the routes they are responsible for. Taking a driving tour of the route on a clear day to identify possible hazards will go a long way in terms of preventing equipment damage and other possible harm.

6. Drivers need to make sure they stay alert and take appropriate actions when approaching bridge joints and railroad crossings. Some of these actions may involve raising the plow or changing its angle.

7. Fleet and crew management are a significant part of the snow and ice control operation. It is important to have the right number of plows on the road for a given weather and road condition but it is also important to be able to mobilize more people fairly quickly if the conditions worsen. Agencies that are responsible for clearing roadways from snow and ice should have policies and procedures in place that would allow them to optimize the use of their fleets.

8. Adopted road treatment and snow and ice plowing procedures should take into consideration many physical parameters including the type of pavement (asphalt vs. concrete), time of day, pavement temperature, wind condition, and dew point. Some state departments of transportation have specific guidelines for applying specific pretreatment or deicing agents for given specific conditions.

9. The amount of anti-icing or deicing agent to apply is as important as the type of agent to use. Under applying chemical agents will fail to achieve desired results causing the material to just be wasted. Over applying causes a waste of material, will have negative effects on the environment, and may actually cause additional hazard, especially when liquid agents are involved.

CONCLUSIONS

Snow plowing is a generally messy and dangerous operation. This paper is based on the preliminary results of an on-going project that includes a synthesis of best practices in addition to the full instrumentation of a plow-truck to measure stresses on the plow and observe behavior
during the plowing operation. It was found that the instrumentation and data collection system developed for this study is effective in assessing several field factors. Moreover, the Blade-Saver option reduces stresses in the snow plow and the carrier structure, this was true for three different cases: 1) dry runs on asphalt pavement, 2) dry runs on concrete pavement, and 3) soil-dry runs on concrete pavement.

Higher stresses are observed when plowing concrete pavements compared to asphalt pavements. It was found that using the underbody scraper simultaneously with the front body plow during a heavy snow event is an effective way of providing a cleaner driving lane faster.

In addition, using the underbody scraper simultaneously with the front body plow on a ramp is an effective way to ensure that more ice is removed. The ramp can then be made even less slippery by the addition of salt. Finally, snow plow operators should be alert during the operation and need to have an excellent understanding of the equipment they are working with to reduce potential or unexpected hazard to themselves and the public.

ACKNOWLEDGEMENT

This publication is based on the results of ICT-R27-94, Performance Evaluation of Snow and Ice Plows. ICT-R27-94 was conducted in cooperation with the Illinois Center for Transportation (ICT) and the Illinois Department of Transportation (IDOT), Division of Highways. The authors wish to especially acknowledge the effort of the graduate research assistant Drew Dragoo for his valuable contributions to this project.

REFERENCES


