Best Practices in Snow and Ice Removal

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ABSTRACT

The success of snow and ice control operations is crucial for ensuring safe road conditions for the traveling public in many US states and Canada. Moreover, failure to clear highways and roads from snow and ice in an efficient and expedient way can hinder the ability to distribute goods and services and consequently hamper economic growth. This paper presents a collection of best practices in snow and ice control that were developed based on a research project sponsored by the Illinois Department of Transportation (IDOT). As part of the project, a survey of best practices in snow and ice control was developed and administered to a number of snow and ice control professionals from around the country. The interviews generated a number of final recommendations with respect to effective snow and ice control operations, and the recommendations are being presented herein.

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

INTRODUCTION AND LITERATURE REVIEW

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 as it may have significant safety and economic impacts. Secondary roads are also 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. This project was proposed by the Illinois Department of Transportation (IDOT) to better understand the behavior of snow and ice plows, shed some light on the effectiveness of common types of blades, and produce a synthesis of best practices in snow and ice control operations. In the recent past, efforts have been made to study and evaluate plowing techniques (Carney 2008, Conger 2005, Cuelho et al 2010, Nixon 1993) and the use of anti-icing and de-icing agents to control the formation of ice and snow on roadway surfaces (Conger 2005, Cuelho et al. 2010, Ketcham and Minsk 1996). This paper is intending to add a synthesis of best practices in snow and ice plowing and control to the body of knowledge.

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SYNTHESIS OF BEST PRACTICES IN SNOW AND ICE CONTROL

To develop a synthesis of best practices in snow and ice control, a survey 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. The answers from the interviewees were collected and reorganized to produce a set of recommended best practices as follows:

1. A successful snow and ice control operation results in the cleanest road in the quickest time without hampering the public’s convenience and safety. Measures of success are the absence of fatalities, maintaining a passable roadway surface during the storm event, and returning to normal road surface conditions and flow in less than 24 hours after the storm ends.

2. A successful snow and ice control operation is cost effective and uses as little salt as necessary to reduce the effect on the environment.

3. Management and field operators need to be flexible in terms of adopting the changing technology and procedures of operations.

4. Management and field operators need to make sure equipment is ready and drivers are prepared to respond in a timely manner when the weather condition warrants it.

5. Management and field operators must watch for changing weather conditions. Sometimes a storm may start with 100% snow but a sudden change in temperature and dew point creates favorable conditions for the sudden formation of black ice, necessitating a change in the treatment approach.

6. Snow and ice control operations may be severely hampered by shortages in material, equipment, and personnel. Failure to plan ahead will put the safety of the public at risk.

7. Larger counties may need to have different operations running in different parts (such as one for snow and one for sleet). Such counties need to have the proper equipment and materials ready to be deployed where they are needed in a timely manner.

8. Some of the challenges that may interfere with a successful snow and ice control operation include equipment reliability, physical road condition, and drivers’ lack of experience.

9. It is extremely important for drivers to be familiar with the routes they are assigned to clear snow and ice from. Drivers need to be aware of obstacles on the roadway surface, such as manhole covers, curbs, and joints at railroad crossings and bridges. Driver training programs should include route scouting missions before the snow season, and drivers should be assigned to clear the same route throughout the season.

10. The efficiency of ice and snow control operations diminishes when managers focus on reducing hours of operation and use of materials. Operators should be instructed to focus on ensuring the safety of the traveling public first.

11. Over-applying or under-applying salt and other chemicals may create unsafe conditions. Plow operators need to be provided with instructions on when and how much anti-icing or deicing material to apply and also be properly trained to make sure they follow the guidelines.

12. In connection with knowing when and how much anti-icing or deicing material to apply, trucks should be equipped with sensors to measure road temperature.
13. Blowing snow and freezing rain represent challenges that operators need to be well trained and prepared for. For example, anti-icing with liquid chemicals is not recommended during freezing rain or sleet events (NCHRP Report 526).

14. Night operations present additional challenges because visibility is greatly reduced, temperatures are typically lower, and traffic is not as heavy—allowing more snow to accumulate on the pavement. Shifts should be planned in such a way to ensure that drivers remain alert during the operation.

15. The following parameters are the ones that might affect an ice and snow control operation the most:
   a. Pavement temperature: Critical in determining the type of anti-icing or deicing material to use, if any.
   b. Temperature: The warmer it is, the faster and easier it is to get snow off the pavement.
   c. Dew point: The higher the dew point, the quicker and more likely ice is to form on the pavement.
   d. Wind speed and direction: Wind can completely change the operation because it can cause snow drifts and possibly blow the dry chemicals away from the pavement.
   e. Type of pavement: The dark color of asphalt makes it absorb solar radiation and radiate heat better than concrete, which means that concrete is quicker than asphalt to freeze. Moreover, the permeability of asphalt allows the liquids to dissipate faster and not freeze.
   f. Topography and trees: It affects snow distribution and the amount of snow accumulated.
   g. Bridge vs. roadway: Bridges are more likely than roadways to have ice on them as bridges cool much faster because of the air passing under them. The soil underneath provides thermal mass to roads.
   h. Time of day: Night operations are more challenging and require increased alertness. Also, temperature is typically lower during the night, which increases the probability of ice formation.
   i. ADT: Affects the priority and timing of snow-clearing operations.
   j. Availability of equipment and parts.
   k. Manpower and management logistics.
   l. Operator training and familiarity with assigned routes.
   m. Plowing speed affects safety and equipment—specifically, blade durability.

16. Pre-plowing guidelines: Perform a quick inspection of the equipment (truck and plow) and ensure adequate quantities of anti-icing and deicing materials. Make sure there is enough of the blade left to avoid having to change it during the storm. It may also be worthwhile to mention here that a more thorough inspection of the equipment is necessary after the current operation is completed to make sure the equipment is ready for the next storm.

17. Make procedure manuals and guidelines for application of chemicals and plowing available to operators to ensure they are familiar with the procedures and guidelines and are able to follow the instructions as required and applicable. These guidelines usually include what chemicals to apply under what conditions, how much to use, and how to plow.

18. When plowing on an interstate highway using the front plow, speed may be as high as 30 to 40 mph. A lower speed should be used on secondary roads. The operator must consider weather and traffic conditions and use an appropriate and safe speed.
19. The underbody scraper is harder on the pavement, so a lower speed of 20 to 30 mph should be used.

20. Monitor temperature and general weather conditions on a regular basis.

21. Keep communications open with the foreman and report any incidents immediately.

22. Plow drivers are first on the road; therefore, they are the best positioned to evaluate the situation and adjust the snow-clearing operation as necessary to ensure successful results.

23. Some general rules to observe while plowing:
   a. If conditions are favorable, pretreat the roadway before the snow starts to fall. It could take up to four times the amount of salt to remove ice and snow than it does to prevent it from bonding in the first place.
   b. When wind is blowing above 10 mph, do not use solid pretreatment on a dry pavement.
   c. When there is blowing snow, do not get pavement wet because it will build snow packs.
   d. Pre-wetting rock salt before spreading it on a dry roadway will prevent it from bouncing. A sodium chloride brine solution will help salt stick to roadway.
   e. Look out for reflectors (“cat eyes”) because hitting them will tear up the carbide, cause vibrations in the plow, and may cause bolts that are holding the blade to come loose. Raised pavement markers can also be knocked loose and become a dangerous projectile. They tear up the carbide by acting as a ramp and causing the blade to bounce. This is a problem for blades with trapezoidal carbide. The material used to hold the carbide in the blade fractures and the carbide is lost in chunks.
   f. Change blades when less than the width of two fingers is left on them.

24. Completely clean and adequately inspect trucks and plows after the plowing event. Inspect tires, bolts, lights, springs, spreaders, curb guards, liquid tanks, truck fluids, etc. All maintenance must be performed if due.

25. Best practices for installing plow blades:
   a. Make safety your number one concern. Immediately replace cracked or otherwise broken blade.
   b. Blades should be replaced by at least two people—and preferably three. Always use jack stands or a hoist.
   c. It is usually safer and more efficient to torch off old bolts.
   d. Always use new bolts with each blade replacement.
   e. Use an impact wrench to tighten bolts and secure blade in place. The impact wrench should be such that it does not over torque the bolts. An inexpensive ½ inch drive unit is better in this application than a ¾-inch air impact wrench. Torque sticks or torque wrenches are ideal.
   f. Replace the carbide bits and the blade at the same time. Set the carbide and then install the steel blade.
   g. Shops should develop carriers to hold the blades in place and allow for a safer installation operation. Two or three piece blades reduce the weight that staff has to deal with. The smaller size of two or three piece blade segments may also be necessary if blades are heat treated. This is because the segments can grow; the longer they are the greater the variability and the harder it is to maintain tolerance for holes.

26. Supervisors should be provided with pickup trucks that are safe to use in snow. Supervisors sometimes have to go out to check road conditions and assist operators or check on snow-
clearing progress. Rear-wheel-drive pick-up trucks are not adequate for performing these tasks, and supervisors often end up having to be driven around in a snow plow-truck to be able to do their work.

27. Plow trucks should have the adequate capacity to carry the required amount of material, both solid and liquid, for treating their assigned route.

28. High-output plows, such as the Alaskan plow, should be used in rural areas only. In urban areas, 12-ft-long flush plows are best.

29. Steel blades cut ice better than carbide blades, but also they wear out faster. The best setup is to use a steel blade in front of a carbide-reinforced plate. The steel blade ensures cutting adequacy, while the carbide ensures durability.

30. High performance blade systems that use multiple materials, such as Joma or PolarFlex, provide improved performance. Some materials may wear out quicker but they are also less expensive.

31. Use a hydraulic system that limits the down force on the blade when available. It does make a difference.

32. One-way plows can handle more snow and may be more efficient in clearing large areas such as parking lots and interstate highways. Reversible blades are more efficient for clearing roadways because they can be used to push the snow away to the left or right of the road.

33. Some plows, such as the Alaskan plow, cause uneven wear on the blades. It is common practice to replace the whole blade set—not just sections of it.

34. A safety inspection should be conducted on trucks every six months.

35. Drivers must perform a walk-around inspection of their trucks every time before they head out. They must also be trained on how to look for problems such as loose bolts and cracked blades.

36. Keep adequate truck maintenance and inspection records.

37. Keep adequate blade replacement records.

38. Technology is improving and can be integrated to make snow and ice control operations more efficient. This includes GPS, weather-monitoring systems, road temperature sensors, computerized salt control and slurry technology, automatic vehicle location (AVL), a maintenance decision support system (MDSS), and mobile apps to keep the public informed about road conditions.

39. Guidelines for truck replacement must be developed. These guidelines must take into consideration any value added by new technology in addition to comparing maintenance to replacement costs. Plows do not need to be replaced as long as they are still structurally adequate and safe to use.

40. Initial and continual training must be required of all truck operators. Hands-on training is necessary, and job shadowing or riding along during an actual snow- and ice-clearing operation is highly recommended. The Clear Roads Project and AASHTO offer a number of training manuals and videos that can be incorporated in a comprehensive training program.

41. Training programs must be updated on a regular basis to incorporate new information and the use of new technology.
CONCLUSIONS

Adequate control of snow and ice in Illinois and other states with similar weather conditions is vital for the safety of the public and economic development. It is widely known that many of the operations that must be performed are dangerous and costly. In an effort to address these issues, one of the purposes of the study reported herein was to produce a synthesis of best practices in snow and ice control to help local and state agencies run safer and more effective, efficient, and economical operations. The forty one best practices presented in this paper can be used as a starting point for developing a comprehensive set of snow and ice control policies and procedures for interested agencies. However, as technology evolves, new tools and techniques may be developed and implemented. The authors recommend that the effort of identifying and documenting best practices in snow and ice control be repeated on a regular basis to ensure currency in this important and dynamic field.

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