RESEARCH BRIEF

Saving Resources Through Accurate Materials Delivery

Sand, road salt and other deicing chemicals help combat dangerous winter road conditions and keep the traveling public safe, but this protection comes with a price. These materials can affect the environment and highway infrastructure, and they may hasten the corrosion of vehicles. A 2004 NCHRP study reported that snow and ice control on the U.S. highway system carries an annual price tag of about $2 billion in direct costs and another $5 billion in indirect costs, such as those associated with corrosion and environmental impacts.

Need for Research

In balancing the benefits and drawbacks of using deicing materials, transportation authorities aim to use "the right amount at the right time." To meet this goal, many winter maintenance trucks use automated material delivery systems—controlled by vehicle ground speed—to discharge materials to the roadway at the desired rate. Two types of ground-speed controllers are used: open-loop systems, which monitor truck speed during operation, and closed-loop systems, which monitor both truck speed and spreader discharge performance.

However, it is unclear how accurate these systems are in preventing wasteful overuse of materials. A research project was needed to determine the precision and accuracy of these systems in delivering the desired quantities of salt and other chemicals.

Objectives and Methodology

Winter maintenance vehicle spreaders deliver solid materials, including salt and abrasives (sand) or a mixture of the two. Some systems are also equipped to prewet solid materials with a liquid, such as salt brine, before delivery to the roadway; prewetted salt may work more quickly, and prewetting can help keep materials on the roadway. This study was concerned with the accuracy of automated systems in delivering these materials in their various combinations, with a focus on dry materials. The two broad objectives of the research were:

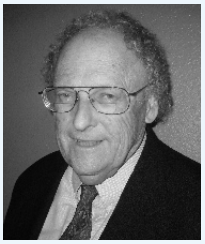
- To learn how accurately ground-speed-control units manage the spreader discharge of salt and other materials.
- To determine whether ground-speed-control units provide the material savings expected compared with manually controlled units.

The study did not seek to compare manufacturers' systems nor to make product recommendations.

The research project ran from 2005 to 2007 in three phases:

1. **Literature search and preparation.** This step built a knowledge base for formulating a test methodology. A key part of this was involving the manufacturers of manual and ground-speed controllers, who helped provide product information, manuals and recommended calibration procedures.
2. **Calibration and yard testing.** The investigators created and evaluated test methods for assessing the operational capability of different controllers. Test methods accounted for different controller types, material types and application rates, and spreading speeds. Representatives of each controller manufacturer attended the calibration and testing of their units.
3. **Simulated field testing.** Investigators tested seven different controllers in use by several Clear Roads partner states. They were tested using different modes of operation, material application rates, and spreading speeds to simulate a range of winter operating conditions. Key data collected included the controller settings as compared to both actual measured discharge and to design discharge of the salt, sand and liquid prewetting chemicals.

Investigator



"This research helped operators and controller manufacturers alike to better understand the functioning and capability of salt spreading systems."

–Bob Blackburn
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To validate recommended calibration practices, this research took advantage of warm-weather months to carefully capture and measure actual salt output in a controlled setting.

Results

The research demonstrated that the automatic spreader/controller systems can achieve significant savings compared with manually controlled systems; this supports the trend toward automatic systems over the last several years. Analysis showed possible savings with a closed-loop ground-speed controller to be as large as 47 percent for an application rate of 400 pounds of salt per mile. In addition, researchers found greater savings for variable-speed roadway tests that included stop-and-go conditions than for freeway tests at a more constant speed, which may be of significant interest to city winter maintenance departments.

Another key finding was that ground-speed-control systems characterized as closed-loop (which monitor both truck speed and spreader discharge) outperformed open-loop systems. The highly integrated closed-loop systems delivered material at a much more accurate rate.

This research project also produced valuable hands-on experiences. For example, data analysis revealed that if the truck bed is lowered for storage or loading rather than raised and ready for roadway operation during calibration of a tailgate spreader, the calibration and resulting spread rates will be inaccurate. This type of system must be calibrated with the truck in its in-service configuration. In addition, the researchers learned the importance of the entire delivery system when evaluating calibration. A truck's ground-speed-control system is only as good as the components that make up its solid material delivery system, including hydraulics, gear ratios and motors.

Benefits and Further Research

This project's findings compelled the Clear Roads partners to take the extra step of developing a practical tool for winter maintenance operators: a **spreader calibration guide.** With an expected release date of fall 2008, this document will provide both general guidelines and specific calibration procedures to foster accurate and efficient systems. Useful for transportation managers and operators alike, it will cover the how, when and why of calibration and can serve as the cornerstone of statewide spreader/controller calibration programs.

The results of this project and the calibration guide, when used to their fullest potential, will yield material cost savings for local and state winter maintenance operators. One possible next step would be to perform a cost-benefit study of an operator's winter maintenance season in order to attach cost savings numbers to good calibration practices. In addition, based on the high variability of prewetting liquid performance seen in this project, further research into how well the current prewetting systems deliver liquid—including analyzing delivery rate accuracy and evaluating methods of application to the dry salt during spreading—could be another valuable avenue of investigation.

Project Champion

"The results of this research project show the importance of ground-speed controls for managing material output, and also show that ground-speed controllers are just one part of an overall delivery system."

–Dennis Burkheimer
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Brief prepared by
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This brief summarizes project CR2005-02, "Calibration Accuracy of Manual and Ground-Speed-Controlled Salters," produced through the Clear Roads winter maintenance pooled fund project, #TPF-5(092). Clear Roads' lead state is Wisconsin DOT, 4802 Sheboygan Ave., Madison, WI 53707. Dennis Belter of Indiana DOT is the Clear Roads Technical Advisory Committee Chair (dbelter@indot.in.gov).