RESEARCH news
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Iowa's winter maintenance technologies research

By Dennis Burkheimer, Office of Maintenance, Iowa Department of Transportation

The Iowa Department of Transportation (DOT) is responsible for snow and ice removal on more than 9,000 miles of roadway in the state. With a fleet of 900 snowplow trucks and nearly 1,200 operators, supervisors and mechanics working to keep roads clear, the Iowa DOT is continually testing and evaluating new equipment, materials and methods to assist in snow and ice removal efforts. The goal is to provide safe winter roads for travelers as efficiently and effectively as possible.

This article briefly describes a number of new or improved technologies the state is testing. Highlighted topics include surface weather monitoring, equipment research developments and national pooled-fund research efforts.

Road weather information system

The Iowa DOT installed its first road weather information system (RWIS) site in 1988. Today, the department maintains 62 RWIS sites throughout Iowa. Most sites are equipped with traditional atmospheric and pavement sensors typically found on RWIS sites; however, the Iowa DOT has installed new sensors and upgrades at most locations (Figure 1). These improvements include installation of color cameras capable of taking still frame images or video to provide more detailed information about actual roadway surface conditions in the area.

New precipitation sensors called weather identifier and visibility sensors (WIVIS) that interpret the rate and type of falling precipitation and visibility distance are also being added to the RWIS sites. The WIVIS sensors will provide direct feedback to maintenance supervisors regarding potential problems in their areas and give motorists real-time roadway information that can influence their travel plans. Information from RWIS sites will be available to the public and garage personnel via the Internet at the Weatherview Web site located at www.dotweatherview.com.

If a motorist checks the Weatherview Web site and determines that it's snowing along their anticipated travel route and visibility is reduced, they may decide to make alternate plans. Based on information and images from cameras (Figure 2) and precipitation sensors, maintenance supervisors will also have more information to help them make decisions during a winter storm. If sensors indicate that light snow is falling but pavement temperatures are above freezing, the supervisor may be able to delay activation of plow operators or reduce material application rates, saving valuable resources.

Figure 1 - *RWIS tower (with labels) and camera close-up*

Figure 2 - *Image from new RWIS camera*

All RWIS sites are equipped with subsurface temperature probes that measure soil temperatures 18 inches below roadway surfaces. Because subsurface temperatures influence roadway surface temperatures, having access to these readings can help supervisors determine how to treat the roadway. In the fall, subsurface temperatures are usually much warmer than the surface or air temperature. When air temperatures fall below freezing and it begins snowing, the roadway surface may remain above freezing because it is warmed from below. In the spring, the subsurface temperature can be much colder due to long periods of cold weather. A warm front may bring above freezing temperatures and a warm rain, but road surfaces can stay well below freezing because subsurface temperatures are still cold. Warm rain on a cold pavement can create ice on the roadways very quickly.

New for 2009, the temperature data probe (TDP) is a state-of-the-art probe that measures road subsurface temperatures every three inches for the first 18 inches, and then every six inches down to six feet below the surface. The TDP provides multiple readings and even more precise information on temperatures at different levels beneath the road's surface (Figure 3).

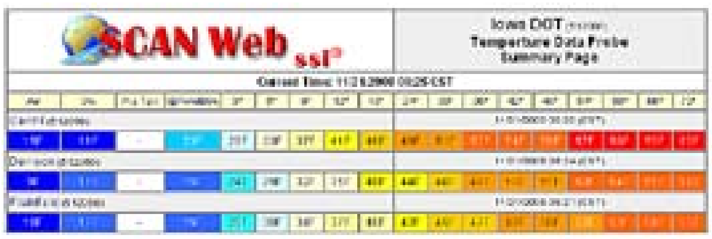

Figure 3 - ***Temperature readings at different subsurface levels using the new temperature data probe (TDP)***

Maintenance personnel may be able to use the more refined information from these sensors to help determine what will happen at the road's surface when precipitation falls. The TDP probes may also be used for other research to understand how ground temperatures at different depths influence roadway life.

Traffic sensors developed by Wavetronix® are also being added to all interstate RWIS sites and will eventually be placed on most sites throughout the state. These sensors measure average traffic speeds and count and classify traffic (Figure 4). Data collected from these systems will provide supervisors with current traffic speeds in their area and alert them to any speed reductions. This traffic and speed information will also be available to the traveling public through the Weatherview Web site.

The department plans to determine if information from these traffic sensors, combined with weather information from RWIS and weather forecast information, proves useful for measuring performance of winter maintenance operations (Figure 5). Monitoring traffic speeds during winter storms or the time required to return traffic speeds to normal could be utilized as a method for measuring the performance of snow removal operations.

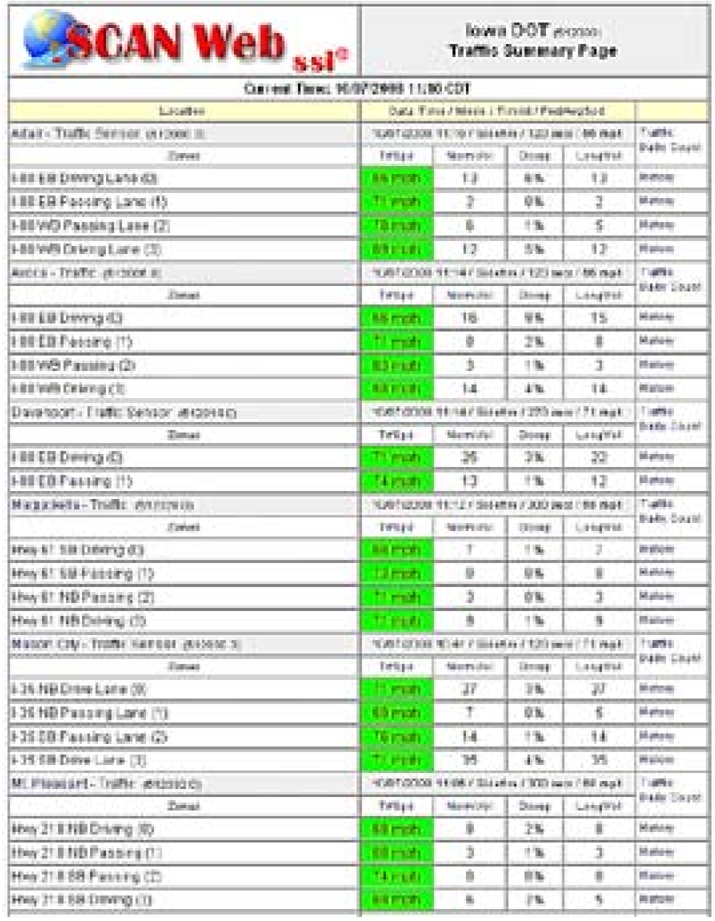

Figure 4 - ***Traffic classification and average speed display reported by Wavetronix sensors mounted on RWIS towers***

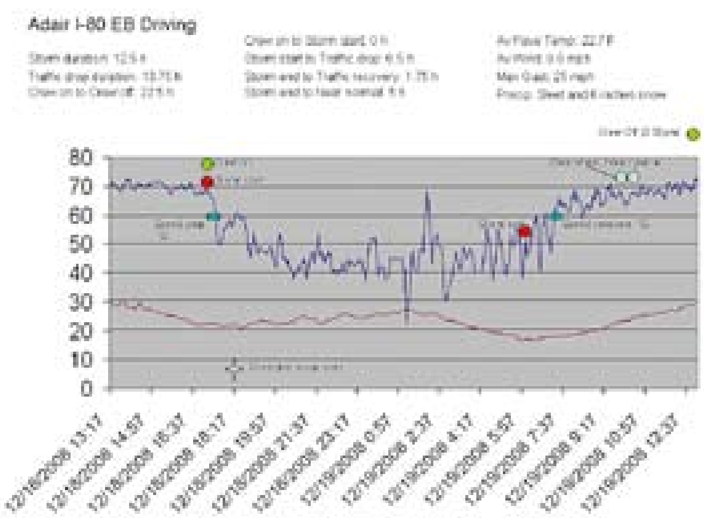

Figure 5 - ***Sample average traffic speeds combined with other winter maintenance data during a winter storm for measuring performance***

Weatherview Web site

Developed in 1999, Iowa DOT's Weatherview Web site (www.weatherview.com) was the first Internet site in the nation to combine RWIS and airport automated weather observation stations (AWOS) information and make it available to the public. Current weather conditions from nearly 100 weather reporting sites are available to anyone with Internet access. The site was designed to be an information hub for weather and travel information.

Current weather observations and the Iowa DOT's customized county-specific winter weather forecasts are also available on the site, along with a number of links to other weather and road condition information. Travelers and Iowa DOT maintenance personnel report that the site provides valuable decision-making tools. Additionally, city and county maintenance personnel, who may not otherwise have access to county-specific weather information, report that the pavement forecast data included in the weather forecast is a valuable tool during snow removal operations (Figure 6).

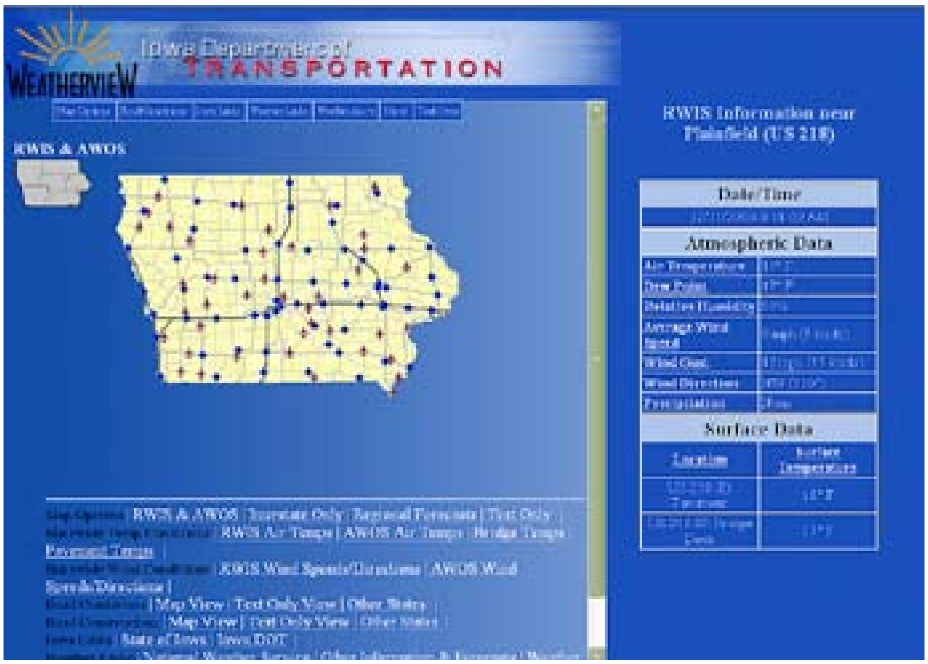

Figure 6 - ***Current Weatherview Web site's home page***
www.weatherview.com

A complete redesign of the Weatherview site is expected by December 2009, including integrated data from new sensors and cameras being installed this year. The site will be easier to navigate and new features should provide supervisors with more information about advancing storms and enhanced information about current roadway conditions in and around their areas. Travelers will be able to receive current weather and road condition information along their potential travel routes to help them make more informed travel decisions. For example, if it is snowing along a traveler's planned route and the traveler observes on the Web site that visibility is less than a quarter mile, average travel speeds are less than 30 mph and a photo (linked from RWIS) reveals snow covered roads, the traveler may decide to alter or cancel the travel plans. This increased roadway information should help travelers, maintenance personnel and others navigate Iowa roadways more safely.

Thermal mapping

A highway's surface temperatures are affected by weather and differences below the roadway surface. In the future, understanding these differences could lead to customized treatments for roads. For example, if one segment of road is 10 degrees colder than the rest because it is shaded most of the day, additional deicing chemicals may be needed at that location to treat snow or ice. Farmers are utilizing global positioning system (GPS) technology to create custom herbicide and fertilizer strategies based on soil needs. This helps them achieve greater production rates, reduce chemical use and lower costs. In the future, similar technology combined with pavement temperature information may result in custom deicer applications based on roadway surface needs.

The Iowa DOT's Office of Maintenance staff began testing and evaluating thermal mapping during the 2008-2009 winter season and plan to continue testing through 2010. This low-priced mapping system combines an infrared thermometer commonly used on maintenance vehicles, a GPS antenna and a laptop computer. A software application developed by Iowa State University allows an Iowa DOT laptop to collect and store pavement and air temperature data from the thermometer, along with location data from the GPS antenna, as a vehicle drives the roadway. This data is collected under differing weather conditions (clear skies, cloud cover, partial clouds, etc.) over time to develop a temperature profile of the road's surface.

The temperature profile can be used to correlate surface temperatures between an RWIS site and another location several miles away under the same weather conditions. The data can be displayed on maps (Figure 7) showing temperature differences along the roadway, which can then be used by garages in planning treatments during a winter storm. If continued testing is successful, the Iowa DOT may provide the system to field staff for thermal mapping roadways in their areas.

Figure 7 - ***Thermal map of roadway showing color variations for different pavement temperatures along a route***

Maintenance decision support system (MDSS)

The maintenance decision support system (MDSS) is a software application providing decision support for snow removal operations based on current and forecast weather, traffic and roadway conditions. The online system was first developed by the National Center for Atmospheric Research (NCAR) for the Federal Highway Administration (FHWA) as a one-stop site for weather and roadway treatment information to support snow removal operations (Figure 8).

Iowa was selected as the demonstration state for the first two years of testing and advised NCAR on changes needed to develop a better tool for use by maintenance supervisors. The Ames, Des Moines-north and Grimes maintenance garages were demonstration sites for the new application during the prototype period. Since prototype testing, the Iowa DOT has been actively involved in a MDSS pooled-fund program along with 14 other states led by the South Dakota DOT, and integrated treatment recommendations into daily weather forecasts received by all Iowa maintenance garages. This application provides decision-makers with recommendations on how and when to treat roads based on weather forecasts and past roadway treatments. Evaluation of the application continues throughout the state.

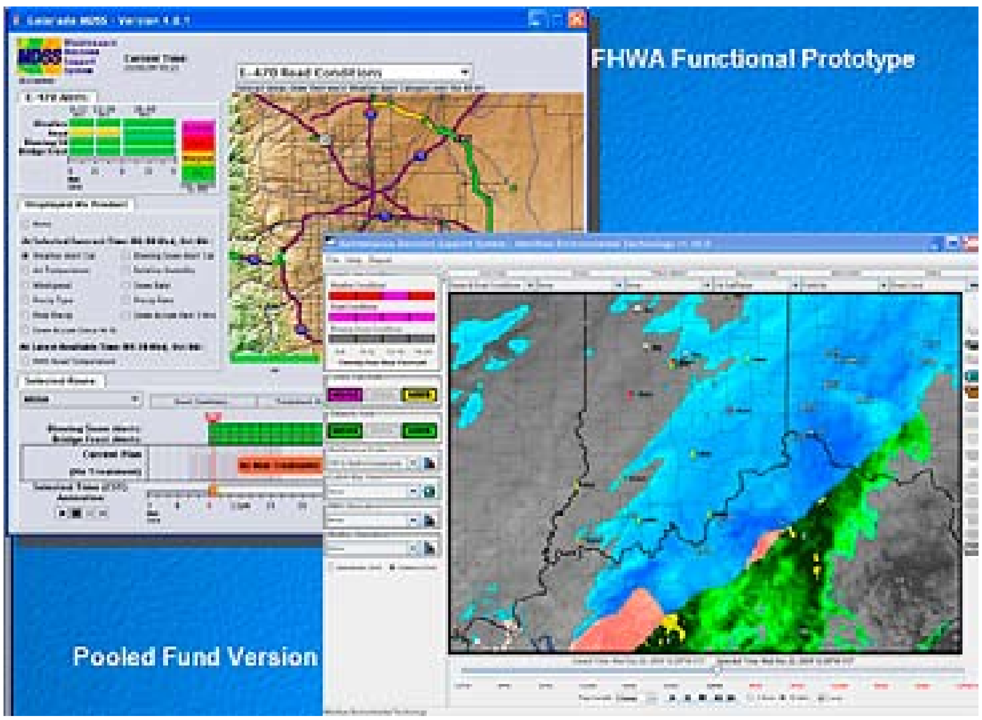

Figure 8 - ***Sample Web pages from maintenance decision support system (MDSS) application***

Thermal imaging cameras

The Iowa DOT tested a vehicle-mounted thermal imaging camera, developed by FLIR® Thermal Infrared Camera Systems Inc., at six garages during the 2008-2009 winter. Thermal imaging cameras display images based on the amount of heat emitted by objects and can reveal subtle temperature differences using different shades of gray (Figure 9). Each test truck had one camera mounted on top of the cab that was focused on the road ahead. A monitor in the cab provided the operator with black and white images from the camera. Lighter shaded areas in the display represent warm spots, while darker areas show colder spots. The goal was to determine if cameras could be used in reduced visibility situations to improve the operator's view, help identify stranded motorists during winter storms or assist in search and rescue endeavors. However, in the first year of testing, garage personnel found it difficult keeping camera lenses free of snow and ice accumulations. Additional testing is expected through the 2009-2010 winter season after modifications are made to eliminate icing problems.

Figure 9 – ***Normal nighttime view (left) and thermal image (right) showing a deer on the roadway using a vehicle mounted FLIR camera (Photo courtesy of FLIR Thermal Infrared Camera Systems Inc.)***

The Iowa DOT also owns a hand-held, color, thermal imaging camera. This camera has contributed to a better understanding of the interaction between deicing chemicals and snow and ice on the road immediately after application. Many deicing chemicals such as calcium chloride and magnesium chloride release heat when they come in contact with the road, while other deicing chemicals such as sodium chloride may actually drop the temperature of the pavement upon contact. The department has used the thermal imaging camera for testing deicing chemicals and chemical blends in the field to help find better performing deicers (Figure 10).

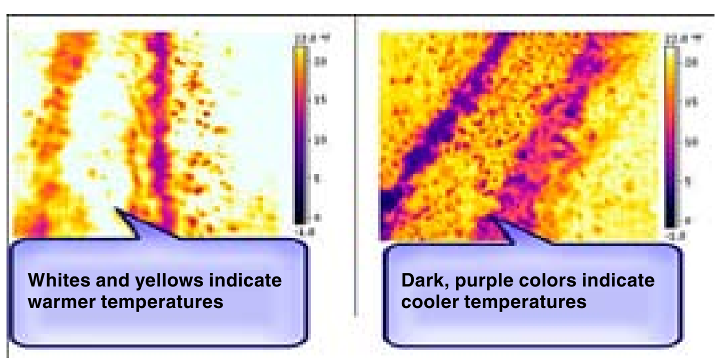

Figure 10 - ***Thermal images from a handheld FLIR camera showing temperature differences from a deicing chemical application on the roadway***

Salt brine, a mixture of rock salt and water, is a low-cost product the Iowa DOT uses for snow and ice operations. Salt brine works best when pavement temperatures are above 15 degrees Fahrenheit. When temperatures drop below 15 degrees Fahrenheit, many maintenance garages switch to calcium chloride – a deicer that works at lower temperatures. Unfortunately, calcium chloride is also approximately 10 times more expensive than salt brine, and many studies indicate it is more corrosive than salt

The department has been working to find a blend of these two deicers that will provide better performance than regular salt brine at minimal additional cost and be more effective at lower temperatures. A thermal imaging camera helps identify the amount of heat emitted by the blend and how quickly the product works to eliminate winter precipitation on the roadway. Preliminary field work indicates that a solution of approximately 80 percent salt brine and 20 percent calcium chloride melted snow and ice faster than standard salt brine, allowing test roadways to return to normal conditions faster. Continued lab and field testing in 2009-2010 is expected to help determine the optimum combination of these two deicers.

Plows, blades and cameras – equipment developments

Laser guide for wing plows

All Iowa DOT snowplow trucks are equipped with a front plow, but many are also equipped with a wing plow—typically mounted on the front right side of the truck. When combined with the front plow, a much wider path is cleared. The wing plow extends 6-8 feet beyond the front plow and its trajectory is not always clearly visible to the operator. This can result in occasional collisions with mail boxes, bridges or other roadside structures. Although these collisions are not frequent occurrences, damages can be costly. The GL3000C guidance laser for wing plows, developed by LaserLine Manufacturing Inc., is a device mounted on the cab of the snowplow truck that projects a green laser light in front of the wing illuminating the truck's projected path (Figure 11). This laser guidance device may be very helpful to operators in areas with limited right of way or numerous obstacles. The decision on purchasing additional laser guides for snowplow wings is now decided based on need by individual districts for new and existing trucks. No additional testing or evaluation of the units is expected at this time.

Figure 11 - ***Image showing the projected path of the wing plow using the laser guidance device developed by LaserLine Manufacturing Inc.***

Multiple-edge plow

The Iowa DOT has been working on ways to maximize the amount of snow or ice cleared from roadways with each pass of a plow. Generally, traditional plows have one rigid moldboard with carbide inserts in three- or four-foot sections that do not conform well to road contours, leaving up to one-half inch of snow or ice behind after each pass. Deicing chemicals applied by the truck then need to melt through precipitation left behind the plow before working on newly fallen precipitation. In theory, removing more snow and ice with the front plow during each pass should result in less deicing materials required to treat the roadway.

Multiple-blade plow

A multiple-blade plow prototype was built and tested using several garage-generated concepts during the past few years in Iowa. The multiple-blade plow incorporates three blades that can each be used independently or in combination with the others (Figure 12):

- A front carbide blade attached to the main plow,
- A scarifying blade mounted immediately behind the front plow to break up any packed snow or ice, and
- A third blade composed of rubber to squeegee any excess snow, ice or slush from the road that was missed by the first two blades.

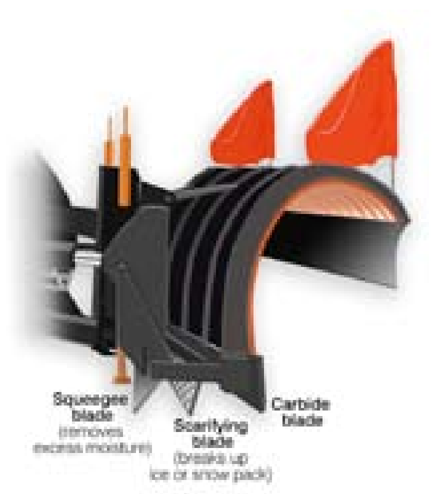

Figure 12 - ***Diagram of multiple-edge blade placement***

When slush is on the road, the operator may only need to use the rubber blade for removal to help accelerate evaporation. For a roadway with normal snow, a combination of the front plow and slush blade could be used. When deeper, packed snow is present on the roadway, the operator might use all three blades for removal operations.

Operators of the prototype multiple-blade plows report the blade does a better job of removing snow and ice from roads. During the summer of 2007, the Iowa DOT conducted field tests on a roadway near Bedford, Iowa, to measure the effectiveness of the new design when compared to traditional plows. A multiple-blade plow and a standard plow were used to remove sand from the test roadway and data was collected to determine which plow removed the most material after one pass. Although sand is not the same as snow, results showed that multiple-blade plows removed at least 20-25 percent more material than standard blades. This indicates that multiple-blade plows may be an effective tool for improved snow removal operations and potentially could reduce deicing chemical use.

To encourage participation from manufacturers in the multiple-blade plow project, the states of Ohio, Minnesota, Indiana, and Wisconsin joined Iowa in a pooled-fund effort to test several prototypes developed by plow manufacturers based on the Iowa design. Four manufacturers were selected and provided test models for the 2008-2009 winter season. One manufacturer prototype was tested in each state: Flink Company's in Iowa (Figure 13); Henderson Manufacturing Inc.'s in Minnesota (Figure 14); Henke Manufacturing's in Indiana and Ohio (Figure 15); and Monroe Truck Equipment Inc.'s in Wisconsin (Figure 16).

Manufacturer participation in the project was recognized as essential for making improvements in plow designs, modifying the designs for production facilities and marketing products in the future. Maintenance personnel at the Hanlontown garage tested the Flink plow and were very pleased with the results after the first year. They reported that it removed more snow and ice from the road and reduced noise and vibration in the cab. The Iowa DOT also has plans to work with manufacturers to develop a retrofit kit for adding a squeegee or scarifying blade to existing plows in the fleet. Additional testing of the multiple-blade plow in all five states will continue during the 2009-2010 winter season.

Flexible-edge blade

A traditional carbide cutting blade typically consists of three rigid sections of metal, each a different length (typically, 3- and 4-foot sections) that extend the length of the plow. The blades are attached to the front plow and made from steel with a narrow band of carbide channeled into the bottom of the blade for a hard cutting edge. Because traditional blades are rigid, they cannot adjust to the ruts or contours of the roadway and often leave snow or ice behind the plow after each pass. The flexible-edge blade design began at the Bedford maintenance garage. The goal was to develop a front blade that could adjust to the contours of the roadway.

Figure 13 - *Prototype plow developed by Flink Company and tested by the Iowa DOT during the multiple-blade plow project*

Figure 14 - *Prototype plow developed by Henderson Manufacturing Inc. and tested by the Minnesota DOT during the multiple-blade plow project*

Figure 15 - *Prototype plow developed by Henke Manufacturing and tested by the Indiana and Ohio DOTs during the multiple-blade plow project*

Figure 16 - *Prototype plow developed by Monroe Truck Equipment Inc. and tested by the Wisconsin DOT during the multiple-blade plow project*

Figure 17 – *Flexible-edge blade attached to front plow*

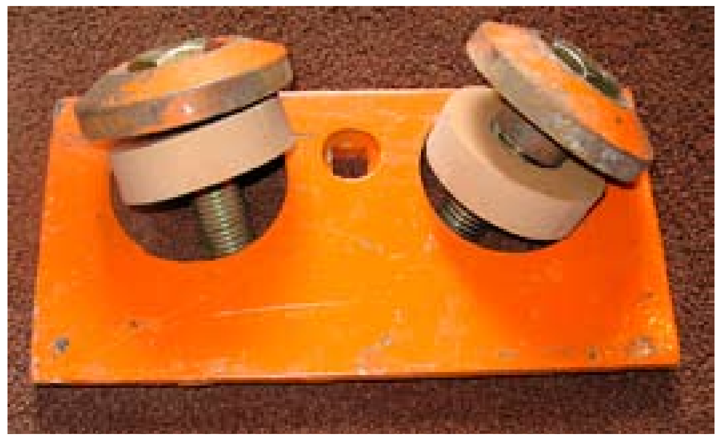

Figure 18 - *Attachment bolts for flexible-edge blade*

A prototype flexible-edge blade (Figure 17) developed at the Iowa DOT's Ames central repair shop is divided into one-foot sections and attached to the front plow with bolts surrounded by rubber (Figure 18). The rubber around the bolt holes allows the one-foot sections to move both horizontally and vertically for adjustments to roadway surface variations. The one-foot sections allow more contact points along the roadway surface and keep the blade in contact with the surface along its entire length, providing more efficient removal of snow or ice. Operators at the Hanlontown maintenance garage who tested this new blade reported the one-foot sections allow the plow to adjust to any contours in the road. They also indicated the rubber surrounding the bolts reduces noise and vibrations in the cab. In addition, operators observed less wear on blades and more uniform wear across each blade's length. Traditional blades often wear on the leading edge, but the trailing edge may wear very little. This results in uneven wear and blades must be discarded prematurely. The flexible-edge blade wears evenly across its length so it can be used in its entirety until the carbide is exhausted. Also, because the blades are in one-foot sections weighing about 15 pounds, changing a worn flexible-edge blade is much easier than changing traditional blades, which usually weigh 45-60 pounds.

Reverse-a-cast plow

The height and curvature of the front plow are key factors in how snow is discharged during removal operations. If snow rides over the back edge of the plow, it can discharge onto the windshield of the snowplow truck causing reduced visibility for the operator or increased icing on the windshield. If snow is discharged away from the plow and projected too high, it can get caught in the truck's wind stream and create a snow cloud that forms whiteout conditions for motorists behind the truck.

The reverse-a-cast plow is made of a polyethylene composite that allows adjustments in the moldboard to virtually any required configuration (Figure 19). The plow can be tightly curled to keep snow discharge low to the ground for reduced risk of snow clouds, or it can be adjusted for full-discharge in either direction away from the plow, allowing snow to be discharged far from the roadway. This reverse-a-cast plow is being tested at the Onawa maintenance garage to determine if it is an effective tool for removing and controlling snow during plowing operations.

Figure 19 - ***Demonstration showing the reverse-a-cast plow adjusted to control snow discharge***

Ceramic blades

Improvements in materials have provided new alternatives for cutting edges on snowplows compared with traditional steel blades with carbide inserts. For decades the primary blade in snow and ice removal operations was a steel blade with a carbide insert. However, in recent years, the price of carbide has nearly tripled, resulting in costs for these blades becoming a much larger portion of the snow and ice budget.

Figure 20 - ***Experimental blade by Gummi-Küper (Germany) with ceramic insert***

Developed in Germany, Gummi-Küper ceramic blades (Figure 20) appear to have the same level of hardness as carbide blades, are reportedly lightweight, maintain a better cutting edge and may eventually be cheaper than carbide blades (when they become more widely available in the United States). Limited testing was done in 2008-2009 on the blades. The Iowa DOT will continue testing two sets of ceramic blades during the 2009-2010 winter season at garages in northern Iowa. Operators will continue measuring blade wear compared to traditional blades and provide feedback on other operational issues impacting snow removal operations, such as noise and vibrations.

JOMA 6000 blades

JOMA 6000 blades (JOMA), from Black Cat Blades Ltd., are unique cutting edges combining rubber and steel blades with carbide inserts into one lightweight blade that adjusts readily to roadway contours. These blades were first tested by the Iowa DOT in 2000. At the time, the cost of JOMA blades was approximately five times higher than traditional carbide blades. Although wear tests indicated JOMA 6000 blades lasted approximately three times longer than standard carbide blades, this could not offset the higher purchase price. Operators who tested the JOMAs in 2000 thought the blades were much quieter than traditional carbide blades and said that, because of the rubber cushioning, the vibration and noise levels in the cab were greatly reduced (Figure 21).

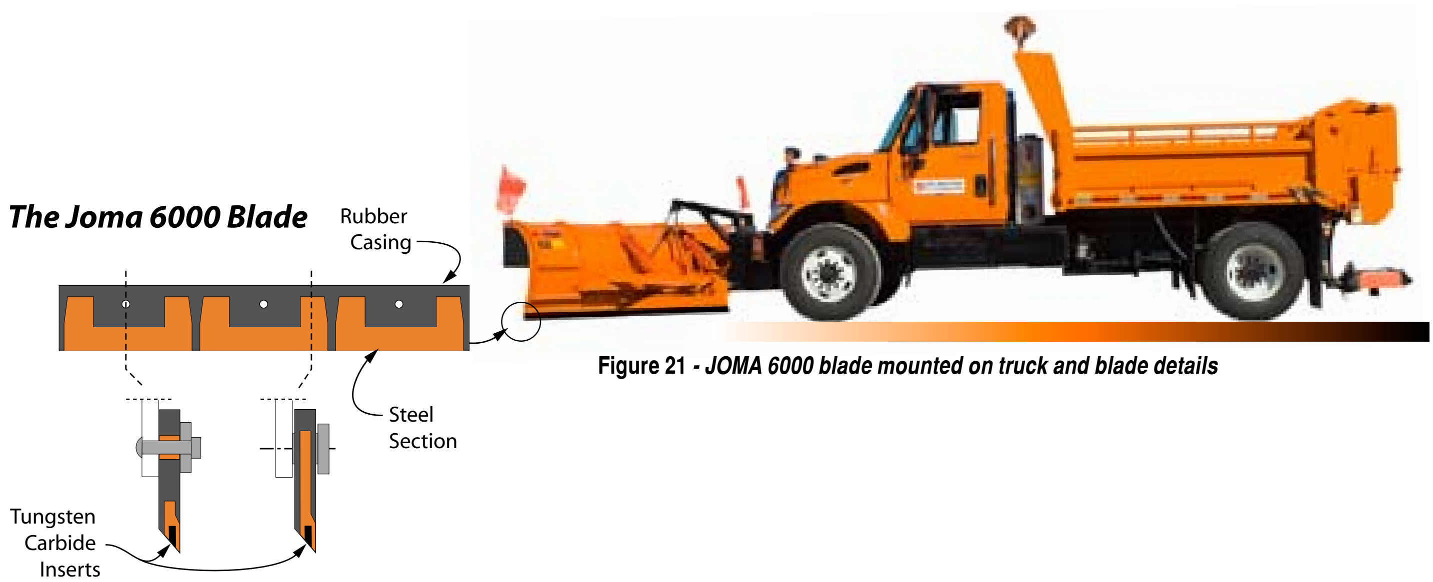

Figure 21 - ***JOMA 6000 blade mounted on truck and blade details***

In 2008, the Iowa DOT reconsidered using JOMA blades because the cost of standard carbide blades had nearly tripled in the previous eight years, but the price of JOMAs had remained nearly the same. Because of this price difference, wear tests were conducted again in 2008-2009 at five different maintenance garages in northern Iowa to determine the JOMA's cost effectiveness.

During this second round of testing, garage personnel reported three- to four-times longer wear with the JOMA blades than with the carbide-insert blades. Because the current cost of JOMAs is now only twice that of carbide blades, the product appears to be a cost-effective alternative. Operators continue praising the reduced vibration and noise levels in the cab. They also report JOMA blades clean the roadway better than traditional blades and are much easier to change because they are a much lighter than the standard blades.

Zero-velocity spreaders

Placement of salt on the roadway during a winter storm can be critical to the success of snow removal operations. The Iowa DOT has been investigating and testing zero-velocity spreaders developed by several different manufacturers for approximately seven years. Zero-velocity spreaders place deicing chemicals on the roadway at a rearward speed, matching the forward speed of the truck (Figure 22). This reduces the chance of deicing chemicals bouncing and scattering from the roadway. The spreaders also allow the operator to place materials exactly where they want to on the road, allowing compensation for strong cross winds or spreading materials across multiple lanes.

Tests done several years ago by the Iowa DOT on a closed section of U.S. 20 near Iowa Falls indicated these spreaders can retain 20–25 percent more material on roadways than traditional methods using a material spreader with spinner (Figure 23). Retaining more deicing chemicals on the road means more material is available

The spreader disperses material at a rearward speed that matches the forward speed of the truck. Material impacts the pavement at zero velocity or 0 mph.

Figure 22 - ***Image showing the concept behind zero-velocity material spreaders***

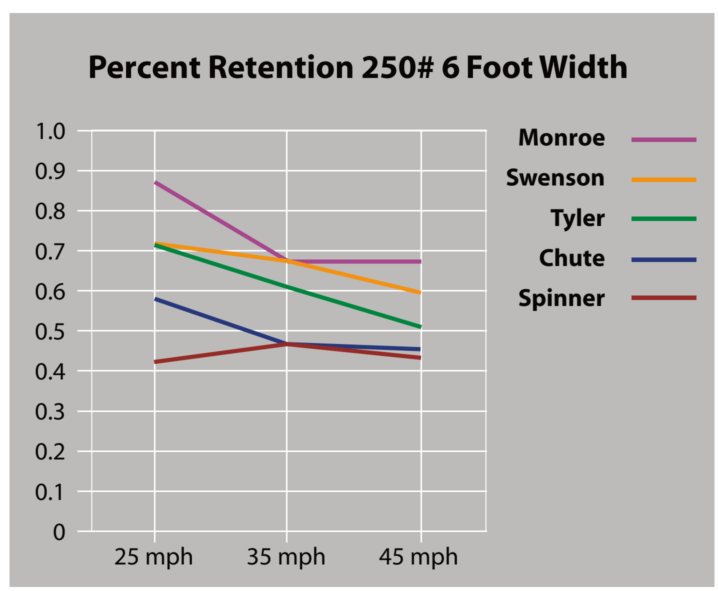

Figure 23 - ***Comparison chart of zero-velocity spreader to regular spreader***

for melting snow and ice, potentially leading to reduced application rates in the future. Early versions of zero-velocity spreaders had a tendency to plug at the salt intake area, but additional work by several Iowa maintenance garages have helped find solutions to these problems allowing the systems to be more efficient (Figure 24). Work continues with Monroe Truck Equipment to fine-tune the spreader for maximum efficiency.

Figure 24 - ***Iowa DOT adaptation of zero-velocity spreader to control material flow***

Salt monitoring cameras

During snow removal operations, salt can often clump in the spreader system causing gaps in material applications; sometimes, the spreader plugs completely. This can result in no material application over long distances. Over the years, several prototype salt monitoring systems have been developed at Iowa DOT garages for monitoring material output. These systems give direct feedback to the operator when the material-discharge rate changes. All of the prototypes worked to detect disruptions in application flow, but each had limitations.

Until recently, freezing precipitation, truck movement and vibration, salt and cold temperatures made it virtually impossible to develop a foolproof sensing system to monitor material discharge.

During the 2007-2008 winter season, the Iowa DOT began testing color cameras developed in England by Brigade Electronics PLC to help monitor material discharge near the spreader (but away from its harsh environment) and also monitor the auger system inside the bed of the truck. These $400 camera systems include two-color cameras and a seven-inch LCD color monitor. The camera system has proven to be an effective tool for operators when monitoring material applications (Figure 25) and very helpful for other maintenance operations (shoulder work, crack filling, etc.) throughout the rest of the year.

Figure 25 - ***Images from salt monitoring cameras mounted on snowplow truck***

Snowplow simulator training

In 2006 the Iowa DOT purchased a L3 Communications snowplow driving simulator to provide training for snowplow operators and other staff. The simulator is housed in a 22-foot trailer that is moved between Iowa DOT districts throughout the year. The simulator's driver training area consists of a steering wheel, floor pedals, emergency brake, transmission, gauges, and other components commonly found in a snowplow truck. The viewing area consists of three 40-inch plasma screens that project driving simulations for the trainee (Figure 26).

The training program incorporates a three-fold approach to training. Trainees rotate instruction between instructor training from experienced snowplow equipment operators, computer-based training packages using a laptop computer and hands-on driving practice with the simulator.

Figure 26 - ***Employee training using the snow plow driving simulator***

All 1,200 Iowa DOT snowplow operators have been trained on the simulator for at least one complete session; many have trained on the simulator two or more times. Simulator training provides knowledge on space, fuel and speed management; proper plowing techniques; hazard identification; and defensive driving. Training on the simulator provides a nonthreatening method of instruction for varied levels of expertise.

Snow fence research

The Iowa DOT has a long research history involving snow fences for minimizing blowing and drifting snow along Iowa highways and is continually looking for new, passive methods to control this problem. A comprehensive evaluation of standing corn snow fence configurations (Figure 27) compared to four- and six-foot tall lath fences (Figure 28) was conducted during the 2007-2008 winter season. Objectives for this research were to determine the effectiveness of standing corn compared to lath fencing, minimum amount of standing corn needed for effectiveness, and allowable distance from the roadway for snow fences to reduce costs. Results indicate the state can provide adequate snow fence from standing corn using fewer rows, and can also allow corn to be closer to the right-of-way line than previously thought.

Standing corn snow fences have been used for more than 20 years in Iowa and considered a valuable tool in the winter maintenance program. Landowners are typically paid 50 cents over the market rate for corn in exchange for corn left standing in the field through the winter season. At the end of winter, the landowner can remove the corn fence from the field.

Figure 27 - ***Typical standing corn snow fence used to control blowing and drifting snow***

Figure 28 - ***Field testing using lath snow fence***

National pooled-fund research efforts

The Iowa DOT is an active member of three winter maintenance and weather information pooled-fund research projects. Participation in the projects helps the Iowa DOT and other members conduct critical research in snow and ice removal operations by pooling research funds and expertise.

Clear Roads

CLEAR ROADS
research for winter highway maintenance

Clear Roads is an ongoing pooled-fund research partnership of several state departments of transportation and FHWA aimed at rigorous testing of winter maintenance materials, equipment and methods for use by highway maintenance crews. Launched in 2004 by experienced winter maintenance professionals, Clear Roads is a response to the need for research based on practical experience.

By conducting structured field testing and evaluation across a range of winter conditions and highway maintenance operations, Clear Roads projects deliver immediately useful data and recommendations on effectiveness, ease of use, optimum application rates, durability, and other advanced winter operations technologies. Wisconsin is the lead state for Clear Roads and provides administration and marketing services. **www.clearroads.org**

Aurora

Aurora
working to advance road weather information systems technology

Aurora is an international program of collaborative research, development and deployment in the field of road and weather information systems (RWIS). Launched in 1996 and serving the interests and needs of public agencies, the program brings together a number of United States, Canadian and European agencies. The Aurora vision is to deploy RWIS to integrate state-of-the-art road and weather forecasting technologies with coordinated, multi-agency weather monitoring infrastructures. It is hoped this will facilitate advanced road condition and weather monitoring and forecasting capabilities for efficient highway maintenance and provide real-time information to travelers. Iowa is the lead state for Aurora and provides administration and marketing services. **www.aurora-program.org**

Snow and Ice Pooled-Fund Cooperative Program (SICOP)

American Association of State Highway and Transportation Officials
AASHTO
The Voice of Transportation

The Snow and Ice Pooled-Fund Cooperative Program (SICOP) was developed in 1994 by the American Association of State Highway and Transportation Officials (AASHTO). A principal mission of this winter maintenance program (WMP) is to ensure requisite testing and evaluation of potentially implementable international or domestic winter maintenance technologies are performed and results of these efforts are dispersed and easily understood and integrated into individual state and municipal operational programs.

Additionally, the WMP works to establish a holistic systems approach to snow and ice control in the United States involving the vehicle, driver, equipment, materials, and practices for managing roadway and bridge snow and ice. A SICOP snow and ice list-serve was created in 1996 to link the snow and ice control community and provide easy communication for problem solving and information sharing. Currently, more than 800 people from countries around the world actively communicate using the list-serve. This program is under the oversight of AASHTO's Winter Maintenance Technical Service Program (WMTSP). **www.sicop.net**

Iowa's continuing winter maintenance research

Winter maintenance research and developments of the Iowa DOT described in this issue of *Research News* represent some of the latest technologies, methods, materials and equipment for improving snow removal operations in Iowa. The Iowa DOT's Office of Maintenance will continue investigating better ways to use deicing materials, monitor and disperse roadway weather information and improve equipment technologies in the future.

For more information on maintenance snow and ice technology research, contact Dennis Burkheimer at the Iowa DOT's Office of Maintenance at 515-239-1355 or dennis.burkheimer@dot.iowa.gov.]

SAVE THE DATE
August 20-21, 2009
Mid-Continent Transportation Research Symposium

Iowa State University
Ames, IA

Sponsored by:

- Iowa Department of Transportation
- Iowa State University's:
  - Center for Transportation Research and Education
  - Department of Civil, Construction, and Environmental Engineering
  - Midwest Transportation Consortium
- Wisconsin Department of Transportation
- University of Wisconsin's Midwest Regional University Transportation Center
- The University of Iowa's Department of Civil and Environmental Engineering

For contact and registration information:
www.intrans.iastate.edu/events/midcon2009/index.htm

About the author

Dennis Burkheimer, winter operations administrator, Iowa DOT Office of Maintenance, has worked for the Iowa DOT for the past 22 years. He received a Bachelor of Science degree from Iowa State University and has actively involved in a number of national winter research projects investigating winter maintenance equipment, materials, methods and transportation weather monitoring during the past 15 years.

!NEW VIDEO!
Iowa's Road Weather Information System (RWIS) at Work

The Research and Technology Bureau has a new video on its Web site! Visit **www.iowadot.gov/research/index.htm** and learn how the Iowa DOT plans to install new sensors and upgrades to most RWIS sites, including:

- Color cameras
- New precipitation sensors
- New subsurface temperature probes
- New Speed sensors
- Revision of the Weatherview Web site

!RECENT RELEASE!

Watch the recently released four-project video **Research 2008*, Transportation Research Projects at Work - Making a Difference***
This short research video highlights:

- Precast Bridge Approach Applications
- Urban Teen Driver Study
- Winter Maintenance Innovation
- Bridge Monitoring Using Sensors

Both videos can be viewed using either video streaming or Media Windows Player.

Iowa Department of Transportation
Research and Technology Bureau
A Driving Force of Innovation
www.iowadot.gov/research

The Bureau of Research and Technology enhances the Iowa DOT's ability to deliver efficient and effective transportation services by actively promoting research partnerships, knowledge and technology transfer, intelligent transportation systems, and information technology.

For more information, see http://www.iowadot.gov/operationsresearch or call Mary Starr at 515-239-1590.

Iowa Department of Transportation, 800 Lincoln Way, Ames, IA 50010

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