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IOWA STATE UNIVERSITY  
Institute for Transportation

## The relationships between weather and roadway safety

It is no secret that inclement winter weather significantly impacts traffic safety. In fact, between 2010 and 2014, Iowa saw more than 8,000 winter weather-related crashes, including 190 fatalities and serious injuries and 2,200 minor injuries.

In recent years, the Iowa DOT has collected large amounts of detailed data pertaining to winter weather, traffic safety, and winter maintenance operations. Because of the amount of detail in this data, a thorough examination of the interactions between all three became possible.

### The study

The study, funded by the Iowa DOT and recently completed in September 2019, set out to analyze the relationships between road weather conditions and crash occurrences in Iowa while also developing crash frequency and severity models that consider weather-related factors. In particular, the researchers used snowplow automatic vehicle location (AVL) data to examine the effects of winter maintenance operations on roadway safety and mobility.

“Our project explored multiple data sets to better understand these relationships,” said lead researcher Jing Dong, a transportation

engineer at ISU's InTrans.

The developed models utilized data from various sources covering the winters of 2016 to 2017 and 2017 to 2018 and eight Iowa city centers. The weather data, obtained from automated weather observing system (AWOS) and road weather information system (RWIS) units, were fed into the Iowa Environmental Mesonet system, which provides highly granular data across Iowa. And while crash data was extracted from the Iowa DOT crash database, AVL data from snowplows captured metrics such as date and time, longitude and latitude, travel speed, plow position, and material spreading rate.

### The findings

Using this data, the models found that roughly a 50/50 split of winter weather-related crashes occurred during a winter storm (i.e., during precipitation) versus outside of a winter storm. The large proportion of crashes outside of a winter storm may have been attributed to the persistence of adverse pavement conditions after the storm ended and possibly drivers' false sense of safety.

The study also found that crashes resulting from winter events were found to be less severe than comparable crashes during the

*Weather and roadway safety continued on page 3*



An InTrans researcher recently analyzed the relationships between weather and crash occurrences

## Acronyms and Abbreviations in *Technology News*

AASHTO	American Association of State Highway and Transportation Officials
APWA	American Public Works Association
FHWA	Federal Highway Administration
ICEA	Iowa County Engineers Association
IHRB	Iowa Highway Research Board
InTrans	Institute for Transportation (at ISU)
Iowa DOT	Iowa Department of Transportation
ISU	Iowa State University
LTAP	Local Technical Assistance Program
MUTCD	Manual on Uniform Traffic Control Devices
NACE	National Association of County Engineers
TRB	Transportation Research Board



U.S. Department of Transportation  
Federal Highway Administration



### About LTAP

LTAP is a national program of the FHWA. Iowa LTAP, which produces *Technology News*, is financed by the FHWA and the Iowa DOT and administered by the Institute for Transportation at Iowa State University:

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## From the Director: A season of gratitude

Each fall, when the holiday season rolls around, the hearts and minds of many people turn to the subject of gratitude, including mine. More recently, however, I have tried to remind myself to regularly do this with everything that occurs throughout the year. It would be nice if this type of reflection occurred in the moment, but more often than not it occurs later. The objective, of course, is to make the “in the moment” approach to gratitude a habit and this takes consistent practice. I’ve read that something must be done regularly anywhere from at least 21 days to more than 2 months to form a habit. With wide variations and variability, of course. We do know that the chemistry and operation of the brain can be changed and, as I noted in my previous column, motivation and habits are connected.

Thanksgiving is my favorite holiday. It automatically engages thoughts of “thankfulness” or gratitude. But what if our motivation was to be grateful on a more regular basis and we wanted to form that into a habit? There are a couple of practices I’ve done relatively regularly to encourage this type of thinking at other times of the year, but in this busy world it is easy to forget them. Thanksgiving reminds us. One approach is simply a reminder to myself to be thankful for everything and have no complaints about anything. For me, this tends to kick in when I am proceeding through the cold wind and snow of Iowa’s winters or some other difficult situation. “Thanks for everything, I have no complaints about anything.” For some this may seem a little over the top: “Really Keith, everything?” However, forming a habit takes practice and

it’s hard to describe, but in that moment the “cold” wind because less defined, is no longer an enemy, and it becomes part of the journey. A second approach, which is probably not new to most of you reading this column, is a simple regular acknowledgment of just a few things I am grateful for each day (and attempting to do this for at least a few weeks). I find myself starting small, “I am grateful for the chair I’m sitting in.” There are times, however, where I have to stop myself because the daily list gets longer and longer. It’s a wonderful experience. This practice also often provides insights of gratefulness in those situations that may have initially appeared to be harsh (e.g., the “cold” wind). It’s also important to realize that just being able to make these lists is something to be grateful for.

This fall Iowa LTAP completed a couple Safety Informational Circuit meetings that included some interesting subjects for the home, road, and shop. We had a highly diverse audience (e.g., equipment operators, engineers, police, etc.) at these meetings. We also offered some Occupational Safety and Health Administration (OSHA) and bridge-related training. Early next year, we’ll be back with trainings in work zone safety, bridge inspection, and hydraulics software. New courses in avoiding/managing contract claims and roundabouts will also be offered. We also hope to advertise another InTrans innovation day and local bridge innovation day.

Have a joyous and safe holiday season and new year.

With all my gratitude. ■

Keith

*Weather and roadway safety continued from page 1*

same timeframe. Weather-related crashes were found to have a greater proportion of property damage only or PDO crashes and a lower proportion of major injury and possible injury crashes.

While counterintuitive, higher crash counts and frequencies were correlated with a higher number of snowplow passes (i.e., greater snowplow activity). This is because the number of snowplow passes directly correlated to storm duration, in that snowplows travel greater distances and spread more material during longer storms.

“We found that more salt use is associated with less crashes in a city. Also, almost one-third of winter weather crashes occurred before

a snowplow pass was recorded, suggesting a higher crash risk in the early hours of the winter storm. Proactive maintenance actions and real-time information might help mitigate such risk,” said Dong.

Many of these crashes were found to have occurred along interstate routes. Because these routes have multiple lanes and are plowed frequently, interstate crashes likely occurred close to a snowplow pass. Crashes on Iowa routes tended to occur when plow passes were temporally further away from the time of the crash. Interestingly, the crash severity model showed that these routes are less safe than interstate routes and that both US and Iowa routes had a higher propensity for severe crashes than interstate routes.

These findings can ultimately help inform decision makers about how maintenance operations impact safety.

“Many agencies in the US have implemented AVL in recent years. Yet, navigating the massive data stream proves to be challenging. This project serves as the first step to explore ways of using the data to support Iowa DOT decision making,” said Dong.

Want to know more? Read the full report here: <https://intrans.iastate.edu/research/completed/relationships-between-weather-and-roadway-safety/>.

*Article written by Brandy Haenlein, a communication specialist with InTrans. ■*

## Video demonstrates epoxy injection process

*Bridge Engineering Center project shows value of method*

An estimated 120 to 150 Iowa DOT structures need an epoxy injection treatment to boost their service life, and that doesn't include all the local-owned bridges in need of repair. However, until recently, there's been little guidance on performing the process despite its use for decades.

New research conducted by ISU's Bridge Engineering Center (BEC) and a video produced with Iowa DOT staff offers specifications for and a demonstration of the epoxy injection process, respectively.

“This is a repair technique that I believe can be very beneficial in extending the life of the local agency bridges, and today, the local agencies don't have the funding to replace bridges every year. Therefore, to maintain our structures, we need to adopt a preservation mind set, and this is one of the bridge preservation techniques I wanted to introduce to the local agencies,” explained Iowa DOT Bridges and Structures Bureau Field Engineer Eric Souhrada.

The video takes viewers through the entire process of completing an epoxy injection



**Dewight Jones, Iowa DOT District 5 Bridge Maintenance Specialist, drills holes for the epoxy injection**

from the traffic control setup to the post-procedure cleanup.

Though the video demonstrates the procedure on a pre-stressed beam bridge that had a polymer concrete (PC) overlay, Souhrada stresses that there are multiple uses for epoxy injection beyond the demonstrations, which also includes an epoxy injection after crack chasing.

“There's a multitude of uses for epoxy injection on bridges, which I always want to stress, because if you're going to invest the money in the epoxy injection equipment, you want to use it for multipurpose and not

just a singular use,” said Souhrada.

Aside from PC overlays, Souhrada said epoxy injection can be used on continuous concrete deck slabs, hit prestressed concrete beams, concrete curb repairs, and deck joint repairs.

The bridges that make the best candidates for epoxy injection have between 10 and 50 percent delamination, and the procedure can extend the service life of a bridge for at least 4 years and typically between 5 and 10 years.

The video, which features Souhrada and Iowa DOT District 5 Bridge Maintenance Specialist Dewight Jones, is available here: <https://youtu.be/jv2d70J3Pp8>. The BEC's research is available here: <https://bec.iastate.edu/research/completed/investigation-and-evaluation-of-the-iowa-department-of-transportation-bridge-deck-epoxy-injection-process/>.

People with questions or interested in an in-person demonstration can contact Souhrada at (515) 290-2841. ■

## Iowa LTAP Mission

To foster a safe, efficient, and environmentally sound transportation system by improving skills and knowledge of local transportation providers through training, technical assistance, and technology transfer, thus improving the quality of life for Iowans.

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# Research aims to prepare local agencies for CAV future

Estimates for the adoption of connected and autonomous vehicles (CAVs)—and the level of autonomy—vary from just a few years to decades.

“More is known than unknown, and the most likely path forward is that cars will have more and more driver-assist technologies like lane-keeping or back-up cameras, side cameras, and slowly getting more and more connected,” said InTrans Director Shauna Hallmark, who recently led a research project with co-principal investigators Theresa Litteral and David Veneziano on preparing local agencies for CAVs.

“We’re going to be transitioning for quite a bit,” said Hallmark.

The considerable timeline makes it difficult for local agencies to ready their roadways for these new technologies. However, there are plenty of modest modifications that local agencies can implement today that will help them prepare for the inevitable arrival of CAVs.

Much of what local agencies can do falls under maintenance activities and increased consistency across agencies, both of which will also assist drivers today.

“The more we can move to standard configurations, the less potential for confusion in these systems,” said Veneziano, who is also the LTAP Safety Circuit Rider. “Consistency is so important.”

Some specific actions agencies can take to prepare for CAVs include:

- Pavement markings: Place lane lines after resurfacing, maintain quality lane lines, and consider adopting 6-inch lane lines at some point in the future
- Signing: Maintain in good condition with good retroreflectivity and ensure the signs are not blocked by vegetation or other obstructions
- Maintenance: Implement timely maintenance especially when surface



David Veneziano presents on how local agencies can prepare now for CAV

degradation, such as potholes, occurs

- Pavement markings: Place lane lines after resurfacing, maintain quality lane lines, and consider adopting 6-inch lane lines at some point in the future
- Standardization: Review signing and marking practices to ensure consistency in terms of sign use, placement, and application
- Data capture: Develop inventories of features most likely to be impacted by CAVs, such as features relevant to speed limits or safety warning messaging
- Communication infrastructure: Consider future communication needs in highway plans and share those needs with vendors when upgrades are contemplated

Maintenance and consistency efforts are especially important when it comes to winter maintenance, as snow and ice could obscure roadway markings and signs, causing difficulties for both CAVs and for human drivers.

“Getting roads cleared off sooner will help the connected vehicles, the CAVs, but it will also help the human driver, and I think that’s the biggest takeaway. Everything that you do for CAVs is also really good for the human driver,” said Hallmark.

More details are available in the report here: <https://intrans.iastate.edu/research/completed/preparing-local-agencies-for-the-future-of-connected-and-autonomous-vehicles/>. ■



# Otta seal offers economic surfacing option for low-volume roads

County roads departments in Iowa spend more than \$110 million per year maintaining the over 71,000 miles of unpaved, gravel road surfaces in the state.

Otta seal surfacing, a technology used throughout northern Europe and Africa, offers a low-cost solution to county road engineers. Until recently, however, the technology had not been tested in Iowa.

Halil Ceylan, a professor in Civil, Construction and Environmental Engineering and director of the Program for Sustainable Pavement Engineering and Research (PROSPER) at InTrans at ISU, has been studying the issue for the past few years to determine both the feasibility of using Otta seals in the state and their cost-effectiveness.

“We can provide a better surface for around the same investments,” said Ceylan during a workshop on Otta seal last fall. “Otta seal can be utilized as an alternative rehabilitation strategy to both unpaved roads and deteriorating road infrastructure systems.”

The initial Iowa test was on a Cherokee County hot-mix asphalt roadway, which had been treated with crack seal, in 2017. Since then, the project has expanded to include at least 40 segments in six Iowa counties (Buchanan, Cherokee, Humboldt, Louisa, Ringgold, and Winneshiek) and seals were completed on both gravel roads



Otta seal construction process: binder spraying, aggregate application, and rolling compaction

and deteriorating portland cement concrete pavements.

One of the more recent test sites had county staff and equipment complete the work, rather than using a contractor as the other test sites had employed.

The process involves binder spraying the roadway, then aggregate application, and rolling compaction. The process is typically done twice on a stretch of roadway about two weeks apart and sweeping before the second application. Ceylan emphasizes the importance of base stabilization before Otta seal application and proper compaction and applying the right rates of binder and aggregates for long-term successful performance of Otta seal technology.

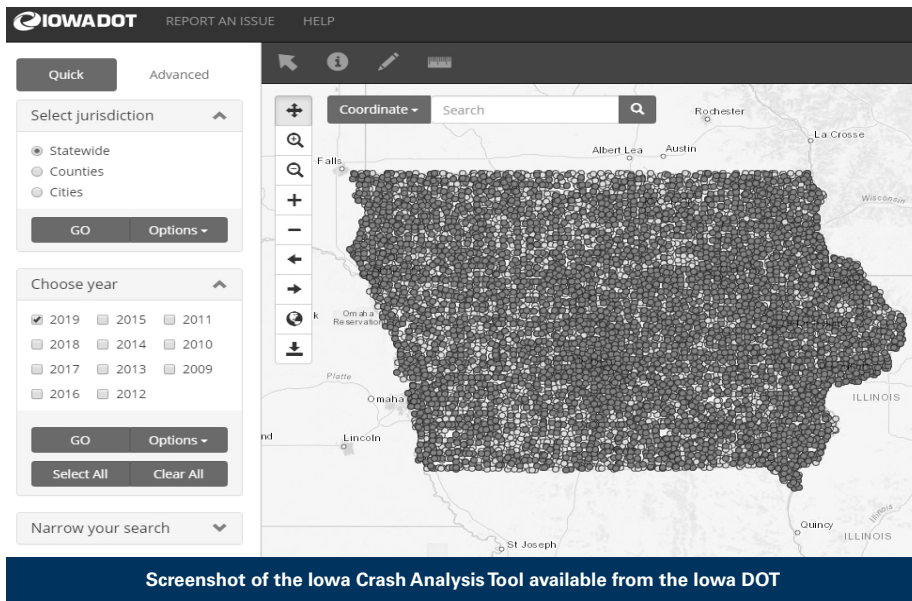
Ceylan stresses that communication with communities is key, particularly when using Otta seal surfacing on non-gravel roads as the process does initially leave roadways looking like they’re gravel but over time do resemble an asphalt road. International Roughness Index (IRI) tests bear out that the ride on an Otta seal surface is smoother than gravel roads. ■

## Additional information

Want to know more? More information about Otta seal is available on the LTAP site from a series of recordings from last fall’s workshop: <https://iowaltap.iastate.edu/otta-seal-surfacing-workshop/>.

More details on Ceylan’s research can be found here: <https://intrans.iastate.edu/research/completed/evaluation-of-otta-seal-surfacing-for-low-volume-roads-in-iowa/> for the completed Phase I study and <https://intrans.iastate.edu/research/in-progress/evaluation-of-otta-seal-surfacing-for-low-volume-roads-in-iowa-phase-ii-study-comprehensive-laboratory-evaluation-and-characterization-and-full-scale-field-implementation/> for the ongoing Phase II study. ■

# Iowa Crash Analysis Tool (ICAT)



Now available online at <https://icat.iowadot.gov/>, the Iowa DOT's Iowa Crash Analysis Tool or ICAT allows users to visualize and create, use built-in tools, and extract data about crashes that happened in their cities, counties, or even statewide.

After clicking the link or visiting the webpage, users will be taken directly to the tool. The state of Iowa will be front and center on the map and is made up of a series of red and gray dots, which represent active search criteria (red) and not selected criteria (gray).

It should be noted that the tool starts

with a set of defaults, which includes a "Statewide" jurisdiction search and the current year. There are options to change these defaults in the panel on the left side of the webpage. This panel allows users to customize their search. For example, a sample search could include crashes that occurred just in Boone County in 2018. Users can then use the tools located next to the panel to zoom into the map to view specific roads and intersections.

The tool offers a variety of options catered to suit a number of user preferences, which includes both quick and advanced

search options. The quick option allows users "quick" access to base level data while the advanced setting further narrows the jurisdiction search criteria.

Another unique feature of ICAT is the ability to switch basemaps, accessible via a dropdown menu at the top right of the map. This allows users to configure the way the maps look by switching up county boundaries and topographical images.

And the icons on the very top of the webpage direct users on how to extract their searched data as reports, including specific characteristics like crash, driver, event, road, and vehicle characteristics reports. Another icon lets users create bar graphs, line charts, and pie charts. A final icon also directs users on how to create collision diagrams from their data and export them.

The website is continuously being updated, with different tools being added and activated. For more information on how the ICAT tool and website works, visit <https://iowadot.gov/traffic/icat-tutorial/> to watch the Iowa DOT's tutorial, which explains it all as a step-by-step guide.

*Article written by Brandy Haenlein, a communication specialist with InTrans. ■*

## In brief: Lasting LTAP impacts

Agencies using LTAP's Equipment Loan Program typically request to borrow equipment for about a month, so it was unusual when Hamilton County staff only needed the RoadVista Sign Retroreflectometer for a couple weeks.

It turned out that they had a reason for the relatively quick-turnaround time.

After a fire in their shop, they wanted to check whether the reflectivity of the signs they kept there had been affected by the

smoke. They had approximately 300 signs in the shop and needed to determine whether all of them might be damaged to the point of needing replacement or resheeting.

Replacing them all would have cost nearly \$10,000.

However, upon checking all 300 signs with the LTAP retroreflectometer, shop staff determined approximately 60 of their signs, or just 20 percent, had to

be replaced or resheeted, reducing their potential replacement costs by thousands of dollars.

With its purpose fulfilled, the retroreflectometer was returned to LTAP and is again available for loan here: <https://iowaltap.iastate.edu/retroreflectometer/>. Check out all the equipment LTAP has available for loan here: <https://iowaltap.iastate.edu/equipment-loan-program/>, and share your impact story with us! ■

# Workshop and conference calendar

Date	Event Name	Location	Contact
<b>January 2020</b>			
7–9	Avoiding and Managing Construction Contract Claims	Ames	Keith Knapp
<b>February 2020</b>			
11–13	Bridge Inspection Refresher Training (NHI Course 130053)	Ames	Paul Albritton
18	Modern Roundabouts: Intersections Designed for Safety (NHI Course 380096)	Ames	Keith Knapp
19	AutoCAD Basics	Ames	David Veneziano
25	Culvert and Bridge Backwater Program Workshop	Ames	Paul Albritton
<b>March 2020</b>			
9	Iowa Work Zone Safety Workshop	Ames	Paul Albritton
12–13	ISAC Spring Conference	Des Moines	Keith Knapp
17	Iowa Work Zone Safety Workshop	Storm Lake	Paul Albritton
18	Iowa Work Zone Safety Workshop	Council Bluffs	Paul Albritton
23	Iowa Work Zone Safety Workshop	Waterloo	Paul Albritton
24	Iowa Work Zone Safety Workshop	Cedar Rapids	Paul Albritton
25	Iowa Work Zone Safety Workshop	Ottumwa	Paul Albritton
26	Culvert and Bridge Backwater Program Workshop	Cedar Rapids	Paul Albritton
<b>April 2020</b>			
1	Iowa Work Zone Safety Workshop	Ames	Paul Albritton
22	Culvert and Bridge Backwater Program Workshop	Denison	Paul Albritton
<b>May 2020</b>			
11–22	Safety Inspection of In-Service Bridges – 2 Week (NHI Course 130055)	Ames	Paul Albritton

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## Event details and online registration

Watch for details and online registration information, by specific dates and events, on the Iowa LTAP Workshops page, <https://iowaltap.iastate.edu/workshops/>. ■

## New safety training resources available on LTAP site

LTAP has compiled a series of 22 safety training topics to assist local public works and county secondary roads departments with their safety training for employees. Each page has an overview and videos and/or documents on the particular topic, which include OSHA Recordkeeping Training for Management, Excavation Safety, Winter Safety Training, and Bloodborne Pathogens. Check it out: <https://iowaltap.iastate.edu/2020-safety-resources-main-face/>. ■



City of Clive employees accept their plaque for winning the Iowa Build a Better Mousetrap competition for their submission of a custom rivet press during a celebration at their offices in October along with LTAP Director Keith Knapp, center right, and Clive Mayor Scott Cirksena, right

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