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# The Bridge

A quarterly newsletter from Michigan's Local Technical Assistance Program

The Michigan Department of Transportation prepared for the failure of the Silver River culvert by planning its failure in a way that ensured continued safe use of the crossing and its replacement structure that pays tribute to the original historic structure and blends with the natural beauty of the location.

## Success in the Face of Failure:
## The Story of Keweenaw County's Silver River Bridge

Victoria Kaplewski, Technical Writer
*Center for Technology & Training*

Photo: Courtesy of MDOT

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Michigan's Local Technical Assistance Program

"By failing to prepare, you are preparing to fail. …Success is the residue of planning," said United States Founding Father and polymath Benjamin Franklin in the 1700s. Franklin's words about preparation and planning as the keys to success, unbeknownst to him at the time, summarize the story of the Silver River Bridge in Michigan's Keweenaw County.

### The "Bridge" over Silver River

Built in 1945, the Silver River "Bridge" on M-26 in Keweenaw County was a culvert that commanded attention with its attractive local sandstone and fieldstone walls. A parking area on one side of the culvert allowed passers-by to access the river below, enjoy views of the impressive culvert, and hike to the Upper and Lower Silver River Falls.

Founded on bedrock, the 15-foot-span, 70.5-inch-rise historic culvert was constructed from stacked block with mortar as well as concrete for the head walls, return walls, and abutments. Surprisingly, the Silver River culvert had no internal reinforcement, according to Raja Jildeh, the engineering consultant project manager with Fishbeck. The culvert opening was corrugated metal on concrete footings and set 90 degrees to the centerline of the road.

On the south end of the culvert, the Silver River approaches the structure, flowing straight at the retaining wall, and then "meanders very quickly to the east alongside the return wall" until it reaches the culvert opening, explains Jildeh. As the river passes through the 32-foot long culvert (opening-to-opening), the river drops about a foot. Upon exiting the culvert, the river flows straight away, down a series of waterfalls.

"It's not great geometry for a typical stream culvert," added Jordy Maloney, assistant region bridge engineer for the Michigan Department of Transportation (MDOT) Superior Region, explaining that the ideal is to have the stream aligned straight towards the middle of the culvert so "everything flows nicely and doesn't cause too much erosion".

Nevertheless, Jildeh noted, "That old structure was built so long ago: it was a really good structure—it was built in 1945 out of non-reinforced concrete and it lasted all these years!"

### Signs of Change

For most of its life, the Silver River culvert was inspected on a biennial cycle, according to Maloney. Then, sometime between 2016 and 2018, the shoulder of the road on the south side of the culvert began to settle and create a depression that held water.

"We weren't sure what the cause was, but we started investigating it closely," said Maloney. What they found was a "slight deflection" along the retaining wall and slight undermining along the footing of the retaining wall. "There were no proper scour countermeasures in that area," added Jildeh, which he believed was contributing to some of the problems.

So, Maloney and his team shortened their culvert inspection frequency to an annual cycle for closer observation. Additionally, an MDOT

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# Letter from the Editor

An anonymous-attributed quote reminds us, "To appreciate the beauty of a snowflake, it is necessary to stand out in the cold." Yes, there is truth to this snippet of wisdom. But, while at first it might sound overly harsh that one has to stand in the cold, there's nothing to say how one must go about standing in the cold. Bundle up!

I pick up this idea of being out in the cold because, after weeks of yoyoing between 90- and 60-degree days, we had several frosty mornings last week with temperatures in the 30s and 40s, and our outdoor hose system for our animals' automatic waterers even developed ice and slush! Before heading outdoors to work, we're now layering up to stay warm. So, even though it's only autumn, it's none too soon to present this issue of *The Bridge* with an article that gives you strategies for staying safe while working in the cold.

We are also sharing with you the fascinating story of the Silver River Bridge in Keweenaw County. While pages of The Bridge typically highlight successes, we hope this story inspires you to innovate solutions that maximize our transportation network's serviceability and prioritize safety. It's a story about regular and thorough bridge inspection, planning and preparation, and collaboration in managing a historic structure.

In these pages, we begin a series looking back at innovations used in Michigan and submitted as part of the Michigan Local Technical Assistance Program (LTAP) Great Ideas Challenge. We revisit the winner of the 2017 contest—the emulsion tail—and see if and how Ingham County Road Department is using this innovation today.

Also, this issue explores what's involved in being a good, effective leader at every level in an organization. We talk with three local road-owning agency employees in Michigan and Illinois to see how they've been applying strategies of effective leadership.

Finally, these pages bring up the hot topic of brines. We share the art and science of anti-icing and deicing with brines. And, we look at resources available for local road-owning agencies to determine optimal brine application rates.

In every issue, the success of our articles depends on your stories and your innovations. If you've never participated in an article for *The Bridge* but have a story about an innovation at your agency, we invite you to reach out to us with your suggestion by emailing us at ctt@mtu.edu. We want to hear about your innovative engineering projects, operations and management strategies, shop products and practices, and safety resources.

Till next time, we'll be listening to you and working on articles that we hope are engaging and useful for Michigan's road-owning agencies that we serve.

*Victoria*

Photo: Shutterstock

# How to Lead Before You Manage

Charlie Fredericks, MPA, *Streets Engineering Technician, City of Eagan, Minnesota*
Reprinted from *APWA* December 2022 with permission
Sidebars by Allison Szlachta, *Technical Writing Intern, Center for Technology & Training*

## *Practicing leadership from a non-management role*

It is a common belief that leaders are only those in roles with official authority—such as having direct reports, supervisory duties, or ranking highly within an organization. This assumption would effectively mean that the only way to become a leader is to first become a manager. When in reality, leadership is a skill that can (and should) be learned, practiced, and refined long before "Manager" is in your title...the question is how?.

"Lead by example!" How many times have you heard that ambiguous advice? While it's true that a leader should set a good example, let's be honest, that phrase is utterly useless when trying to practice specific aspects of leading. However, hidden in the details of what that phrase might really mean, we find actionable and explicit advice that can be practiced by anyone.

### Mindset

The mindset of a leader drives what they do and why; it is the lens through which they process and respond to the various situations they come across. For example, a leader's mindset will determine how feedback from a teammate is received; one may see it as a threat to their authority, while another will see it as an opportunity to learn and grow. Psychologist Dr. Carol Dweck coined the terms that describe these two examples, as the fixed mindset and the growth mindset, respectively; the latter being a belief that you, and others, are capable of improving talents and intellect.

Developing a growth mindset starts with acknowledging and learning from failures. Fear of failure is a common thing, especially for those of us early in our careers or starting a new role. If we acknowledge our inevitable failures and start seeing them as learning opportunities rather than setbacks, we become better equipped to continually push the boundaries of our own growth and that of our team. The obstacles along the way become challenges to take on, and failure becomes a

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### Mindset

The best leaders know how to keep and open mind, learn, and grow: "When I became a leader I thought I had to have answers for everything," shared Tom Deschaine, a transportation maintenance supervisor for the Houghton County Michigan Department of Transportation Maintenance Facility who began his career as a transportation maintenance worker before becoming a supervisor.

Jason Pauling had a similar experience. Pauling, street supervisor for Carol Stream Public Works Department in Chicago, Illinois, recalled, "I started off thinking I knew everything when I took over as a supervisor and thought I could do this job by myself and didn't listen to anyone."

Both Deschaine and Pauling realized that wasn't the right approach. Despite having been a maintenance worker for 20 years, Deschaine says he'll "never know everything, so it's important to be willing to learn". He says that, when his way of doing a task or technique doesn't work out as he expects, he "talks to people who have done it, makes adjustments and changes, and tries a different way of doing it". Like Deschaine, Pauling has also adopted this growth mindset. He shared, "Showing weakness and asking for help is not a negative thing in leadership; it's a good thing because it shows that you're more open to change and new ideas and, as a leader, you're supposed to listen to others."

Aside from adopting a growth mindset, it's important to understand how individual strengths contribute to the team and workplace success, according to Sheryl Siddall, managing director for Washtenaw County Road Commission. "One's organization is only successful if everyone is doing their job as well as possible," she explained. "Each individual is equally important to making their organization move forward—I don't drive a truck, but I need truck drivers to ensure good roads for Washtenaw County." She says she "respects" what her frontline employees do as well as her supervisory staff and the decisions they make.

Leading by example can be done well by adopting open-mindedness, a growth mindset, and a strong self-awareness of how one's individual strengths help the whole team to achieve success. ■ *AS*

chance to learn and grow.

### Systematic Thinking

The next time your team is problem-solving, notice the first thing that the group likely does is dive right into finding a solution and discussing next steps. When that happens, you have a perfect opportunity to practice leadership. Effective leaders learn to think systematically, collecting information, analyzing the cause of a problem, then proposing next steps based on this analysis. This can be practiced by simply asking the right questions: "Do we have the information we need to fully understand the problem?" ..."Can we focus on determining the cause of the problem?"... "Can we start by clarifying our goals for this project?" Good leaders ask more questions and make fewer statements, and you certainly don't need to be a manager to ask more questions. Doing so allows you to lead a group through a much more effective dialog.

Of course, our line of work does not always grant us the luxury of time; we are emergency responders, after all. Yet the practice of thinking systematically will prepare you to make the best decisions possible, even when a situation requires urgency.

### Asking for Feedback

Great leaders are great learners, and it's the endless pursuit of growth that pushes them to continually improve. A vital aspect of continuous growth is receiving feedback, and the ability to do so skillfully takes practice.

To be clear, the "you're doing a great job, keep doing what you're doing" or the "nice work on that!" is not the feedback you seek, that's praise. And while it may be nice to hear, it could not be less helpful to our growth. To get the feedback that will be helpful, you need to ask for feedback tactically. "Do you have any feedback for me?" is not tactical because it will rarely produce a helpful response. Instead, ask open-ended, specific questions that solicit feedback on a specific event (what I call micro level feedback):

"What did you hear when I presented my thoughts on that proposal?" ... "When I led that project, how often did I create space for others to share their thoughts and ideas?" ... "In that meeting, how could I have improved my communication?"

### Receiving Feedback

Receiving feedback on your behaviors and traits (what I call macro level feedback) at work is also important and can be accomplished in various ways, but the most effective tends to be anonymous online surveys. These types of surveys are often big picture but provide detailed feedback for you to use in setting and refining goals on a consistent basis. Do others see you as approachable? Do they think you acknowledge and learn from failures? Are you open to change and responsive to their ideas? These are the questions that will be answered, giving you insight into the perspective of those around you, allowing you to continually improve and become a more effective leader at any level of your organization.

If you seek either type of feedback in a face-to-face setting, give your full and undivided attention (this means your cell phone isn't even in the room). Listen intently, resisting the impulse to defend or correct what they are saying. Receiving feedback can be tough,

### Systematic Thinking

Systematic thinking allows one to break down complex issues into smaller, more manageable components.

"The first thing is to figure out if this is something that I myself really need to address or something that is better delegated," said Sheryl Siddall, managing director of Washtenaw County Road Commission (CRC), about the problem-solving process at her agency. "When I assign a problem, I usually discuss what it is and what the intention would be on how it should be handled, so my employees have the confidence that they're going to handle it well."

In trying to solve a problem, Tom Deschaine, transportation maintenance supervisor for the Houghton County Michigan Department of Transportation Maintenance Facility, suggests that the most important first step is to assess the cause of the problem. "If it's a problem on the road, the first thing is to try to 'get eyes' on it and, if it's a personnel problem, see if you can talk it out," he explained. "Understanding the problem and communication are key."

Deschaine continued, "There is no such thing as a dumb or silly question; you might have a question no one has thought of before." He added, "Communicate to get all sides of the problem".

"Everyone has different ideas on how to do things," said Deschaine about the possible solutions to a problem. "There are many different ways to get to the same end result, and a lot of the potential solutions are just as efficient as each other. Whatever works best for the team is what we go with."

Making sure to follow up on whether and how a problem is solved is an important last step, according to Siddall.

Systematic thinking ensures that everyone involved is aligned towards a common goal. ■ *AS*

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and it is a skill that takes practice to do well.

You may find yourself disagreeing with what you are hearing; this prompts an opportunity to practice self-awareness and notice your reactions, but never offer contradictory evidence or contest their claims. If you defend yourself, you are going to seem closed off to feedback and there is a good chance that's the last time you hear candid advice from that person—not at all the outcomes you are trying to achieve.

### Giving Feedback

The day will come, if it hasn't already, where your colleagues seek your insight on their growth and development, and the tables are turned. Similar concepts can be applied when giving feedback as a leader; be specific and reference real situations, encourage and coach consistently, be attentive during the conversations, and ask for their feedback in return. Learning how to effectively seek and receive feedback will better prepare you to give helpful feedback in return, helping others continue their own growth and development.

Learning from our failures, thinking systematically, and utilizing feedback to continue our growth are all essential skills of leadership that we can practice and refine without "Manager" in our title. They are just a few of the skills we must practice and refine if we want to reach our full potential as leaders, and eventually help others do the same. ■

*This is a short summary of a few ways I have found to be helpful in my practice of leadership, but I know there are many others; I would love to hear your thoughts on these ideas and other ways that you lead and practice leadership from non-management roles! For those in management roles, which leadership skill do you wish you would have practiced or refined more prior to becoming a manager? How could those of us non-managers best learn and practice that skill? Reach out to me, or better yet, share with an aspiring leader in your organization during a conversation on the topic.*

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## Feedback

"If you're going to ask for feedback, really want it," said Sheryl Siddall, managing director of Washtenaw County Road Commission. "People are going to recognize if you have no sincerity in asking or if you've already made up your mind."

Feedback is critical in the workplace—inspiring creativity and idea generation and making employees and colleagues feel as though their opinions and ideas are valued. "When someone's asked for feedback, it does make them feel pretty good," noted Tom Deschaine, a transportation maintenance supervisor for the Houghton County Michigan Department of Transportation Maintenance Facility. "It's nice to be included in projects or asked for your opinion."

But, asking for feedback on a problem is a more delicate situation. "Don't go into that discussion by saying, hey, we have a problem, because that's basically incorporating the other person into the issue as well," advised Jason Pauling, street supervisor for Carol Stream Public Works Department in Chicago, Illinois. "I like to say instead, hey, I have an issue, this is what's going on, I'm currently working on it but I'm looking for some advice from you on what you think I should do." Another strategy Pauling uses is to write a list of solutions or pros and cons to an option; he then shares the list with the person whose advice he's seeking and asks for their thoughts.

In asking for feedback, Siddall says it's important to share credit for any successes that come from the collaboration but to take singular responsibility for any failures. "That way, people aren't afraid to assist you or provide feedback in the future," she said.

Not all feedback is positive or desired. "You may not agree with what they're saying, " said Pauling, "but still be willing to listen and learn."

Actively listening— receiving feedback well— shows your team that you value them and what they have to say. "Listening is when the person comes in and you give them your full, undivided attention," Pauling said. "Make sure you're not on your computer, make sure your cell phone is not on the table, and most importantly make eye contact and listen to everything they have to say."

"Truly listen," affirmed Siddall. "Obviously, you've got your own idea but, if there's opportunities to incorporate what you're hearing, then do it where you can."

Deschaine, too, emphasizes the value of feedback. "I always try to get feedback from the workers in the garage," he shared. "Everybody has different ideas on how to do things—just because my way is the way I've always done it, doesn't mean it's the only way to get the job done."

Success lies in our ability to embrace other perspectives and view feedback as an opportunity for professional development. ■ *AS*

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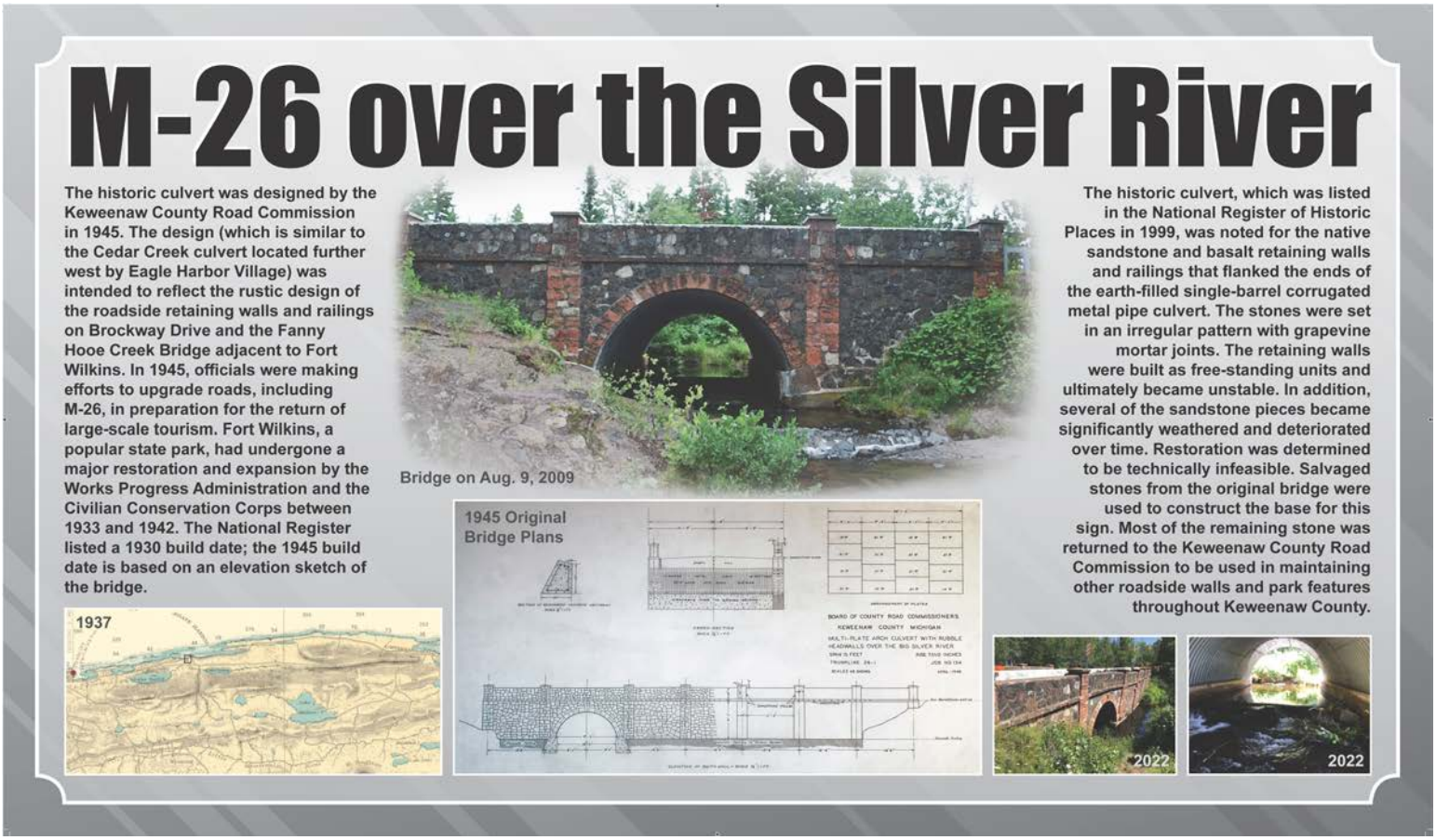

Interpretive sign on monument near the new Silver River Bridge (Courtesy of MDOT)

▶ surveyor began collecting data on the culvert every three months. "We wanted the actual data to help us monitor and quantify how much movement the structure was experiencing," explained Maloney.

But, when the logistics of getting a surveyor to the site for measurements and photographs every three months began to prove challenging, Maloney was told about tilt sensors from MDOT's statewide bridge group in Lansing. The tilt sensors, however, wouldn't directly measure the movement of the structure since things like footings can move horizontally or vertically with no tilt involved. Despite that limitation, being able to monitor the degree of tilt in real time was a "good option", according to Maloney, because it provided MDOT a way to monitor the culvert 24/7 and between times when survey or culvert inspection data collections.

"As time passed, we did see what appeared to be more movement," Maloney shared. "Visually, it appeared that the retaining wall started pulling out more, and we were able to quantify it." In fact, he said the south wall was moving up to an inch a year.


Deterioration of the south wall of the Silver River culvert (Courtesy of MDOT)

## Planning for Success

"We knew we had to get this fixed," said Maloney, adding that MDOT initially hoped to preserve the existing historic structure. At first, they considered stabilizing the structure with soil nails, but they ruled out soil nails because of the limited soil and irregular bedrock surrounding the culvert.

Another option MDOT considered was adding grout bags and riprap along the culvert's footing. But, as MDOT wasn't sure about what was causing the settlement of the roadway and movement of the retaining wall, they couldn't be sure this countermeasure would prevent further settlement and tilting of the wall.

One viable solution for stabilizing the existing culvert involved placing sheets of steel across the entire face of the vertical wall and adding external bracing, effectively compensating for the lack of internal reinforcement.

However, Maloney said that option

presented a problem: "It wouldn't work to preserve the historic nature and aesthetics of the culvert." He continued, "So, ultimately, we realized that there was no way to salvage this structure without replacing it."

While a replacement structure would allow MDOT to address the various factors contributing to settlement and movement of the Silver River culvert, pursing that option presented a major complication: Building bridges is a lengthy process that involves design, environmental clearances, construction itself and, in some cases, State Historic Preservation Office (SHPO) requirements. A complete closure of the culvert for the two-year design-and-construction process would have been a "nightmare" in terms of rerouting road users in this rural, tourist-hotspot area on an up-to 40-mile detour, according to Maloney.

"Our geotechnical people looked at the soils and where the top of the slope would end up in the event of a major wall failure, and we used this information to locate where to place a sawcut in the pavement above the culvert," said Maloney, explaining that the sawcut would create "a clean break point where the sacrificial pavement would all slide down and nothing else would be pulled away with it". He added, "We were confident in our analysis, and we felt we could leave a single lane open that would allow for traffic to remain on the structure while still keeping people safe."

So, MDOT sawcut the culvert's overlying roadway pavement parallel to the centerline and cordoned off the lane closest to the bowing retaining wall with temporary barriers. They placed temporary traffic lights to direct the flow of traffic in the useable lane.

A complete closure of the crossing and construction on the replacement structure were planned to begin on April 24, 2023. Two days before the contractor was scheduled to begin work, the Silver River culvert failed. Maloney commented, "Although it was unfortunate to see the structure fail, we were relieved to see that it failed in the way we had planned and that our plan did keep people safe."

## Replacing the Silver River Culvert

The new structure has a 53-foot 9-inch span, 10 feet of clearance, and a 46-foot 5-inch distance between openings. It is constructed with eight prestressed concrete I-beams. The new Silver River Bridge reopened to traffic on June 30th.

Along with the replacement, the angle between the stream crossing and road was refigured from 90 degrees to 60 degrees. "The new angle of crossing replicates more of the natural river's path as determined by MDOT hydraulics engineers" related Jildeh.

But, since the new bridge was replacing an attractive historic culvert in a picturesque place, the structure would need additional aesthetic consideration.

## "Beautiful thoughts build a beautiful soul"

So said motivational speaker Wayne W. Dyer.

In kind, one can say that thoughts of beautiful bridges lead to the building of beautiful bridges. Such thoughts for MDOT Landscape Architect Jaime Nauta are what she calls her "inspiration photos".

Nauta was tasked with crafting the aesthetics of the new Silver River Bridge. Per SHPO, the replacement would need to be as aesthetically pleasing as the original structure while not mimicking the original structure. "While a replacement structure can look similar to the historic culvert, SHPO wants more of a modern take on the old culvert," explained Nauta.

Her inspiration came in the photo of a bridge in Minnesota. That bridge had concrete retaining walls with an angular-shaped stone pattern pressed into them and end blocks rising up on each side like bookends.

"That's what I was going for with the Silver River Bridge—something different than what we usually do yet something with simplicity in its design," said Nauta. "I wanted the new bridge to be special and unique because the old Silver River Bridge was so unique-looking and special."

Nauta gave the contractor her aesthetic concept but, during the construction process, the contractor expressed concern about a gap in the design of the return walls where debris would collect. So, with another inspiration photo in hand, Nauta and the contractor found

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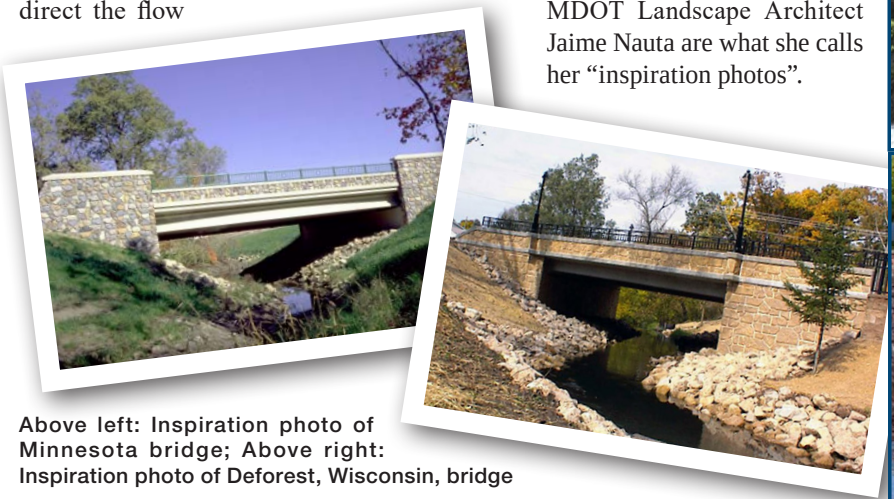

Above left: Inspiration photo of Minnesota bridge; Above right: Inspiration photo of Deforest, Wisconsin, bridge

Left: Top – Silver River Culvert, Bottom – Silver River Bridge (Images: Courtesy of MDOT/MDOT Photography Unit)

# Silver River Bridge (continued from page 7)

▶ a way to bring the two inspirations together in the new Silver River Bridge. "The return wall end blocks were lowered," she explained, "but, I got to incorporate the stone with the angular block pattern and two smooth horizontal bands, one at the top and one at the bottom of the bridge deck mimicking the original capstone and framing the bridge deck."

The "stones" of the new bridge are form liners—concrete poured in a form that has custom options including a stone texture. After some curing, the form is peeled off the concrete. "We have a special provision—it's called simulated stone masonry—and it requires the contractor to have experience in painting," Nauta elaborated. She says the process of painting the concrete to replicate the look of stone usually involves four or five colors to create a natural appearance.

"It's an art," she added. "It takes a lot of finesse, a lot of practice, to get it to look realistic."

Aside from the aesthetics, simulated stone masonry holds up better than stone construction, and the painting requires little maintenance. "We have some simulated stone masonry bridges that we did 20 plus years ago and, to my knowledge, we've never gone back to touch it up," related Nauta, noting that any fading of the paint adds to the natural appearance since real stone lightens in sunlight over time.

Some stone from the original Silver River culvert was rebuilt into an interpretative sign to preserve the memory of the historical structure that once stood at the site.

## How Success was Planned

Maloney and Jildeh underscore the importance of bridge inspection and data collection for the Silver River Bridge. Regular and thorough inspections of the Silver River culvert alerted MDOT early to the deflecting retaining wall. Jildeh added, "When [MDOT] did notice it was moving, they gauged the movement, so we had technical data that reports how much movement over given time."

With that early detection and ongoing data collection, MDOT was able to prepare and plan for success. Maloney advised, "Plan to replace a failing historic structure as soon as possible." He continued, "Start considering your options and, for historic bridges, start the discussion early since they require more coordination."

Part of the Silver River Bridge success story relied on "early buy-in" from hydraulics and geotechnical staff, suggested Jildeh. "Those two portions of bridge design are most important," he shared. Hydraulics and geotechnical experts were able to guide a failure of the Silver River culvert while simultaneously keeping it safely open to road users and were able to develop a new bridge orientation that was more harmonious with the natural riverbed.

Aerial view of Silver River bridge; left side of photo is north, right is south (Courtesy of MDOT Photography Unit)

Beyond the guided failure and the construction of a new structure, the new Silver River Bridge is an aesthetic success story. "Look for inspiration!" said Nauta, emphasizing the planning phase of developing the architectural details for the bridge. "You never know what the possibilities are or what you can do until you look at what others have done." Incorporating ideas from various inspirations, says Nauta, can lead to a "unique and new" design, just like it did for the new Silver River Bridge. ■

# Working When It's Cold Outside

Victoria Kaplewski, *Technical Writer*
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Photo: CTT Archive

When ambient temperatures hover in the low 80s (degrees Fahrenheit), the clothed human body can achieve a thermoneutral state, wherein the body's normal blood flow creates dry heat loss and consequently is able to regulate its temperature at 98.6 degrees Fahrenheit.[1,2] In a thermoneutral state, the body maintains its normal temperature without sweating to cool itself down or shivering to warm itself up.[1,2]

With the onset of autumn's cooler daytime temperatures and wet weather, it's important to familiarize oneself with the dangers related to working in the cold and the ways workers can protect themselves.

Cooler temperatures increase workers' risk of having their skin temperature reduced and subsequently their internal—or core—body temperature. When this occurs, it's called 'cold stress'. Cold stress manifests in several forms and can lead to tissue damage and death.[3,4]

## Here's potential cold stress situations to watch for:

### *Up to 60 Degrees & Wet Feet*

When temperatures drop to around 60 degrees, workers can contract **trench foot** if their feet become wet and cold for a prolonged length of time. Wet feet lose heat 25 times faster than dry feet.[3,4] To counteract this heat loss, the body constricts blood vessels to the feet, effectively cutting off circulation—a condition called trench foot, or immersion foot.[3,4] Trench foot is characterized by numbness, tingling, pain, and redness of skin in the feet, as well as bleeding under the skin and gangrene.[3,4]

If a worker encounters trench foot, remove wet boots and socks, dry feet, and avoid walking to prevent tissue damage.[3,4]

### *32 to 60 Degrees & Exposed Skin*

Repeated exposure of skin, which has a normal temperature of about 91 degrees Fahrenheit, to air temperatures between 32 and 60 degrees can cause small blood vessels near the surface of the skin to become inflammed, causing a condition known as **chilblains**.[3,4] Symptoms of chilblains include pain, redness, itching, blistering, and even ulcerations.[3,4]

First-aid for chilblains is slowly warming the skin and cleaning blisters or ulcers. Corticosteriod cream can be used to reduce itching, and bandages should be used to cover blisters or ulcers.[3,4] Scratching should be avoided.[3,4]

### *Up to 40+ Degrees & Chilled from Rain/Sweat*

When the body fails to maintain its normal temperature and drops to less than 95 degrees Fahrenheit, it becomes hypothermic.[3,4,5] Cold temperatures speed up the rate at which the body loses heat. Symptoms of **hypothermia** range from

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# Working When It's Cold Outside (continued from page 9)

▶ uncontrolled shivering as the body tries to rewarm itself to loss of coordination, confusion or disorientation, slurred speech, slow breathing (and heart rate), dilated pupils, and unconsciousness. Hypothermia can be fatal.

First-aid for hypothermia involves removing wet clothing; wrapping the person in warm blankets; giving warm, sweetened, non-alcoholic drinks if person is conscious; and placing towel-wrapped warm bottles or hot packs in person's armpits, sides of chest, and groin.[3,4,5] Do not try to rewarm the person too quickly or try to rewarm the person's arms and legs as this can cause stress on the heart.[5] Seek medical attention.

### *Below 32 Degrees & Exposed or Covered Skin*

When temperatures fall below freezing, the skin—whether exposed or covered—is susceptible to frostbite, which is freezing of the skin and underlying tissues.

The earliest stage of frostbite is called **frostnip**. In cases of frostnip, the skin becomes cold and may experience a prickly feeling, numbness, inflammation, or discoloration.[3,4,6] At this stage, tissue damage is not permanent.[3,4,6] Frostnipped skin should be rewarmed slowly.[3,4,6]

Frostnip progresses into superficial and then deep **frostbite**, where the skin becomes hard and assumes a waxy appearance.[3,4,6] In some cases, frostbitten skin may actually feel warm.[3,4,6] It is often accompanied by joint or muscle stiffness, creating clumsiness.[3,4,6]

In cases of frostbite, remove wet clothing, protect affected area from cold, avoid using the affected area, and seek medical attention.[6]

## Cold Weather Precautions

### *Dress for the Weather*

The first line of defense for working outside in the cold is proper clothing.

Dressing appropriately for cold weather involves triple-layering clothing in a way that optimizes different textiles for maximum moisture wicking and insulation.[7] Closest to the body should be a layer that wicks away moisture from the body, keeping skin dry, and provides ventilation. A middle layer should provide insulation even when wet in order to help the body retain its heat, and help keep moisture away from the skin. The outermost layer should block the wind and protect from rain and snow while still being breathable to prevent perspiration and overheating.

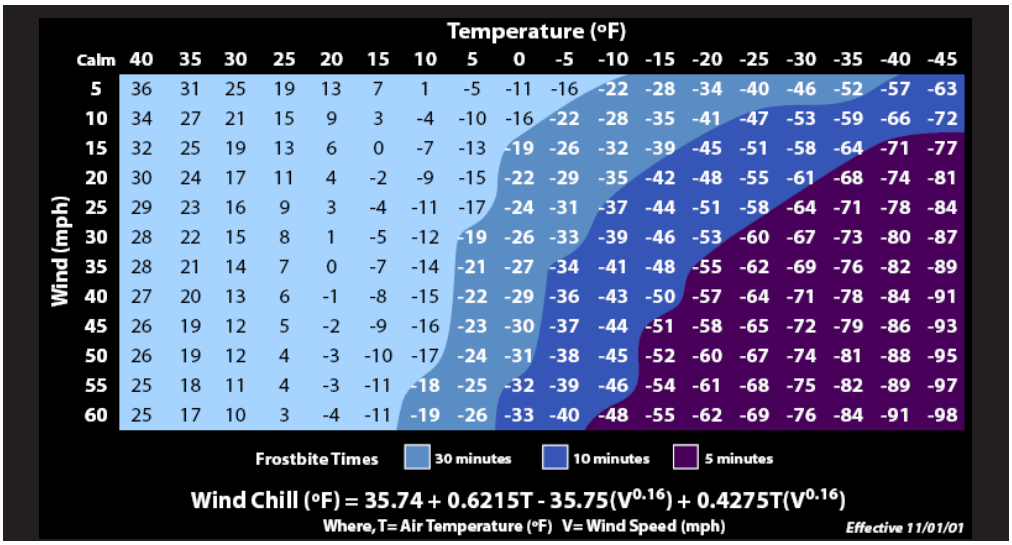
Footwear should be insulated and waterproof, and gloves should be insulated and water resistant.[3,4,7]

Most importantly, a hat that provides insulation and wind resistance can help the body retain up to 50 percent of the body's heat and keep other parts of the body feeling warm.[1]

### *Warmest Time of Day*

When possible, outside work in cold weather should be scheduled when the day is warmest. This practice helps to limit exposure to extreme cold temperatures.[3,4] Also, if and when possible, outside work on days with extreme cold temperatures should be rescheduled to another day.

When gauging how cold is too cold, the outside temperature is not enough. Wind will make cold air feel even colder and will cause the body to work harder to stay warm. Therefore, "wind chill" is a combination of ambient air temperature and wind speed that gives a "feels like" temperature. It's important to pay attention to wind chill when working outside for any length of time because wind chill increases the risk of cold stress. The National Weather Service *Wind*




National Weather Service *Wind Chill Chart*

## Did You Know?

Whether you are working in the cold or rain or heat, layering is a clothing technique that will keep you comfortable and dry. Here's what you need to know about layering for the cold:

### Base Layer (Next to Skin)

***What it does:*** Wicks away moisture from the skin, keeping you dry
***Materials:*** Natural fibers, like silk or merino wool, are generally considered the best. Synthetics like nylon or polyester may be able to function as a base layer.
***Note:*** Weight ratings (light weight, mid weight, or heavy weight) indicate an extra layer of functionality, that is, the garment provides some insulation.

### Middle Layer

***What it does:*** Insulates, helping your body retain its heat, and manages moisture, keeping it away from the skin
***Materials:*** Polyester fleece (in 100 to 300 weight ratings), down-filled jacket (in 450 to 900 fill ratings), synthetic-filled jacket, or merino wool.
***Note:*** See a comparison of these materials at https://nailthetrail.com/comparison-of-mid-layer-materials/.

### Outer Layer

***What it does:*** Protects from wind, snow, and rain, and provides breathability
***Materials:*** Hard shell (in waterproof or water resistant) and soft shell
***Note:*** See a comparison of these materials at https://nailthetrail.com/softshell-vs-hardshell-jackets/. Some waterproof jackets may be non-breathable.

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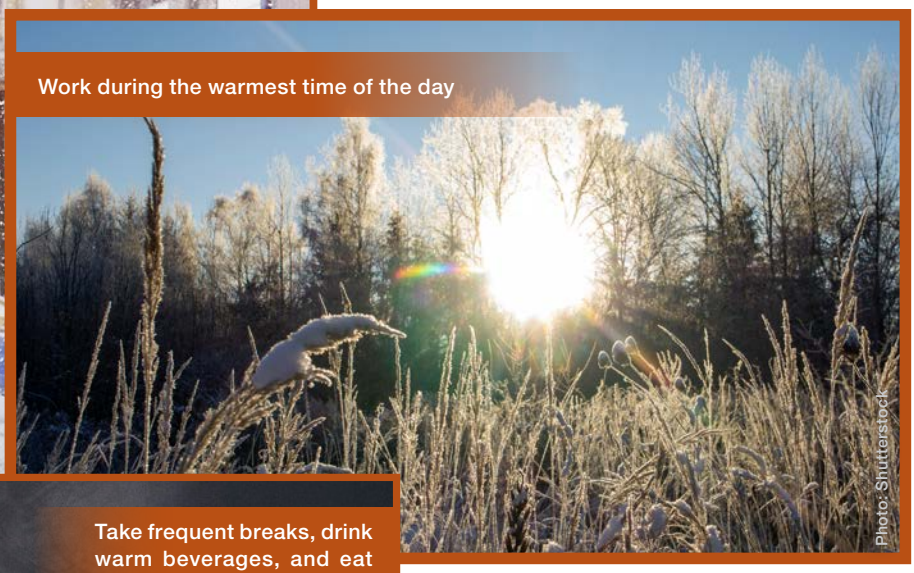



How to stay warm while working in the cold

*Chill Chart* (https://www.weather.gov/safety/cold-wind-chill-chart) illustrates the time to frostbite at different wind chills.[8]

### *Breaks and Beverages*

Just like working in extreme heat, it's important to take frequent breaks when working in extreme cold.[3,4] These breaks allow the body to return to its normal temperature.[3,4] Drinking warm, sweetened, non-alcoholic, non-caffeinated beverages also helps the body to stay warm while providing energy for its metabolic processes.[3,4] High-carbohydrate meals and snacks also give the body energy.[3,4]

## Working Around Cold Water

Did you know that cold water "drains body heat up to 4 times faster than cold air", according to the National Weather Service?[9] And, when is water cold enough to interfere with the body's physiological processes? At anything less than 77 degrees Fahrenheit, according to the International Olympic Committee![10]

Cold water immersion can be deadly in seconds due to cold water shock, which is an automatic gasp reflex followed by hyperventilation upon contact with cold water and rapid cooling of the skin.[10,11,12] This shock response can last anywhere from one to five minutes.[10,11,12] Within the first five to 15 minutes of cold water immersion, the body experiences cold incapacitation, whereby the veins constrict to decrease blood flow to the extremities in order to protect vital organs.[10,11,12] As a consequence, there is a loss of movement.[10,11,12] The longer a person remains in cold water, the greater the chances of experiencing hypothermia and the not-fully-understood fatal phenomenon know as "circum-rescue collapse" or "afterdrop", which occurs during or immediately following rescue and may be caused by rapid changes in blood pressure as the skin and core temperatures try to reach an equilibrium or by unsafe (e.g., rapid, uncontrolled) rewarming techniques.[13]

Experts recommend dressing for water temperatures, which includes wearing a wet or dry suit when water temperatures are 50 to 70 degrees Fahrenheit or less.[10,12] This thermal layer can help reduce cold shock. Also, wearing a life jacket when working around water improves chances of survival.[10,12] ■

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# The Art—and Science—of Deicing with Liquids

*Dr. Scott Koefod, Principal Scientist, Cargill Deicing Technology*
*Reprinted from Minnesota LTAP* Technology Exchange *with permission*

I suspect the general population greatly underestimates the difficulty of winter road maintenance and the skill required by frontline plow drivers. Returning roads quickly to a safe condition following a snowstorm may be likened to operating on a patient—a patient who is constantly moving and whose diagnosis is changing from minute to minute!

Among the most challenging aspects of winter road maintenance is that it is often a wildly moving target. We have an ever-growing range of tools, chemicals, and techniques to deal with icy roads, but the optimum application of these tools will vary depending on frequently changing conditions of weather, forecast, traffic, pavement type, and level of service demand—just to name a few.

Thus, while our industry has made great advances in winter road maintenance over the past 20 years, the inherent complexity of the task will always require a great deal of "art"—that intuitive understanding of how to deal with ever-changing conditions that only comes from real-world experience.

However, art is only made better by a deeper understanding of the tools available (the "paints" and "brushes" of the trade), and this is where the science of deicing can assist the art. Under the controlled conditions of the laboratory, we can learn things about how our deicing tools work that are difficult to learn under the very uncontrolled conditions in the field.

The most important deicing chemical tool that has been developed in recent years is probably the liquid deicer. The appropriate use of liquids has been shown over many years of experience to permit dramatic reduction in the amount of road salt needed. But using liquids is considerably more complex than using road salt alone—hence the need for both art (field experience) and science (knowing what different liquids and blends will actually do under different conditions).

Liquids provide two main values: fast ice melting and precision application. When applied as anti-icers, liquids permit much more efficient application of a small amount of chemical (just enough to prevent snow bonding at the pavement surface) than can be accomplished with rock salt. And long years of field experience have shown that anti-icing under the right conditions can result in a cost savings of 75 percent compared to deicing a road that has become ice bonded.

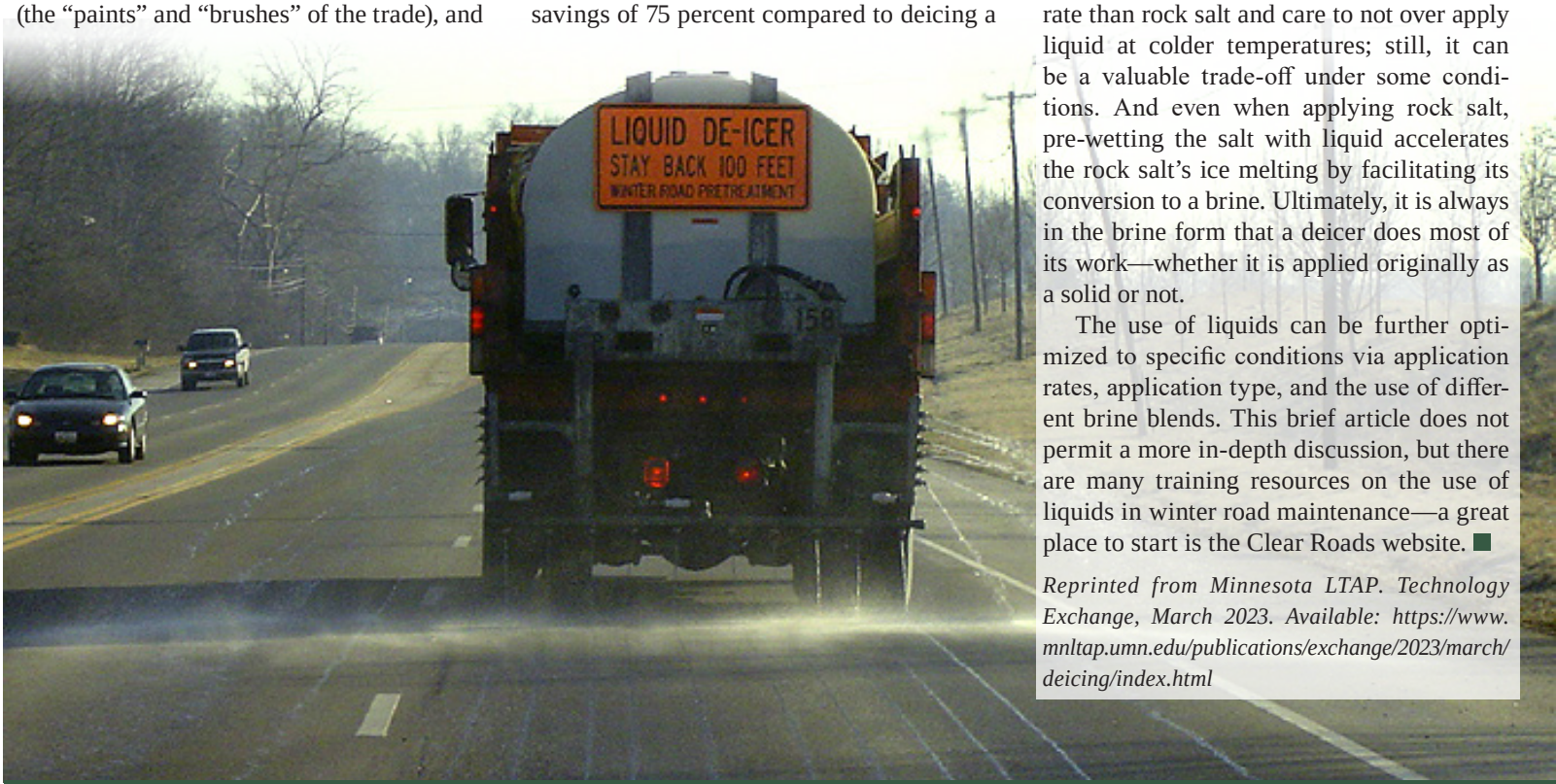
Furthermore, liquids even improve the application efficiency of rock salt. A general rule of thumb is that rock salt wetted with a liquid will adhere to the road better than dry salt, permitting about 30 percent lower salt application rates.

The other fundamental value that liquids provide is accelerated ice-melting speed. The value of this should not be underestimated. The ice-melting performance of any chemical is constrained by two things: ice-melting capacity (how much total ice can be melted per pound of chemical) and ice-melting speed. As the temperature drops, rock salt melts less ice and melts more slowly. Any melting capacity that has not had enough time to occur before the salt is plowed or knocked off the road is wasted.

There is nothing that can be done to change ice-melting capacity at a given temperature, but liquids enable us to increase ice-melting speed. In Direct Liquid Application deicing, brines can provide enormously faster ice melting than rock salt. They do this at the price of reduced ice-melting capacity, which in turn requires a higher application rate than rock salt and care to not over apply liquid at colder temperatures; still, it can be a valuable trade-off under some conditions. And even when applying rock salt, pre-wetting the salt with liquid accelerates the rock salt's ice melting by facilitating its conversion to a brine. Ultimately, it is always in the brine form that a deicer does most of its work—whether it is applied originally as a solid or not.

The use of liquids can be further optimized to specific conditions via application rates, application type, and the use of different brine blends. This brief article does not permit a more in-depth discussion, but there are many training resources on the use of liquids in winter road maintenance—a great place to start is the Clear Roads website. ■

*Reprinted from Minnesota LTAP. Technology Exchange, March 2023. Available: https://www.mnltap.umn.edu/publications/exchange/2023/march/deicing/index.html*



# Great Ideas—Where They Are Today

## In Focus: Ingham County Road Department's Emulsion Tail

Allison Szlachta, *Technical Writing Intern*
Center for Technology & Training

**Ultimately, it is always in the brine form that a deicer does most of its work, whether it is applied originally as a solid or not.**

### Did You Know?

Recently publicized Michigan Department of Environment, Great Lakes, and Energy regulations on the use of brine on Michigan roads reportedly won't affect the use of brine in anti-icing and deicing operations.[1,2]

So, at what rate should brines be applied for optimal anti-icing? A December 2021 report released by the Clear Roads Pooled Fund provides application rate guidance for salt brine blends for anti-icing and deicing.[3] The report offers gallon-per-lane-mile recommendations for dry and liquid applications of rock salt or salt brine, calcium chloride, magnesium chloride, Geomelt, and calcium-magnesium acetate, on various frost, snow, and sleet conditions.[3]

While the Clear Roads report includes references to uses of potassium acetate (KAc), a newer report by the Minnesota Local Roads Research Board calls for caution in its use in watershed areas because KAc is "predicted to be above the toxic limit for water fleas".[4]

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Ingham County Road Department's emulsion tail, an innovation submitted as part of the Michigan LTAP 2017 Great Ideas Challenge. Inset: Close-up view to the emulsion tail (Photos: Courtesy of Ingham CRD)

*In this series, we will be revisiting Great Ideas Challenge submissions previously featured in The Bridge to see if and how the innvoations are being used today.*

Innovation is the introduction of something new, according to Merriam-Webster. But, for the innovative to be successful, they must stand the proverbial test of time. The use of an innovation over time can reveal the different applications of the innovation and its relevancy in various situations. One award-winning innovation was piloted and tested by time in Ingham County.

### County Roads

Ingham County has a lot of rural roads that get very little traffic and can quickly deteriorate, making them susceptible to large potholes and cracks. Previous methods, such as spray patching or crack sealing require five or six crew members to be sent out to repair the road surface. Spray patching disperses a mixture of hot asphalt emulsion and crushed aggregate using forced air onto the desired area. Crack sealing places an adhesive sealant onto the pavement surface. After one of those methods was completed, crews conducted a chip seal operation. A thin film of heated liquid asphalt is sprayed onto the entire road surface, sealing all of the repairs. While these methods are effective, they can be very laborious, time consuming, and inconvenient. Traffic delays and road closures become a problem, especially in rural settings where a single road closure can cause a significant detour.

One man from the Ingham County Road Department developed a device specific to his county's roads, which became an award winning idea in LTAP's 2017 Great Ideas Challenge. Tom Gamez, a previous director of operations for the Ingham County Road Department recognized this problem. He knew there had to be a better way to keep these roads in quality condition. He came up with a device called an emulsion tail.

This innovative tool was used to solve a specific road maintenance problem the area was having. While the problem the device was designed to solve no longer exists, the tool has still been proven effective at fulfilling its purpose during its time of use.

### An Innovation at Work

The tail consisted of a rubber mat that was dragged along the road, forcing the emulsion into the cracks. It helped spread the emulsion before the aggregate was placed on top. The device was constructed from a rigid rubber matting, a metal (Telespar) frame and arms,

**Learn more about the emulsion tail!**
**Great Ideas Challenge entry details:**
https://michiganltap.org/great-ideas/past-entries

**The Bridge 31.2 article:**
https://michiganltap.org/sites/michiganltap.org/files/bridge-newsletter/bridge31-2.pdf

▶ continued on next page

# Great Ideas—Where They Are Today (continued from page 13)

▶ steel chain, a 12-volt tarp motor, and miscellaneous nuts and bolts. Current Director of Operations Andrew Dunn recalled, "A lot of these materials we had laying around so the cost was minimal." The total cost of materials is about $650, making this device an affordable option when sealing roads. Not only was the emulsion tail inexpensive to manufacture, it required less time and labor to complete a road surface as compared to your typical sealing and patching. This process eliminated the need for spray patching and a working crew of five to six members. Over 150 hours of labor was saved for each mile the emulsion tail was used.

Chip sealed road in Ingham County (Photo: Courtesy of Ingham CRD)

## When Time Changes Needs

While the emulsion tail was more than effective at filling road cracks, it is no longer in use today. The tail was designed to seal asphalt surfaces that were four years older or more. The older the asphalt, the more severe cracking there is. Dunn explains that Ingham county no longer has roads with that extreme degree of cracking. "Seventy-five percent of our roads are chip sealed now," he shared. "Everything we're encountering at this point is either a new surface or a previously chip sealed surface, which are different scenarios." In fact, all of Ingham County's roads, even the older ones, have already been chip sealed in the last 2 years. "We're not dealing with the cracking like they were before, and that's why we haven't used the tail", he added.

The tail's general shape and structure did not allow it to lay different levels of emulsion into the surface. This was also a problem, at times, because some road cracks require different amounts of emulsion in order to be fully covered. Aggregate applications require the emulsion to be a certain thickness. Dunn recalled, "In some cases, the emulsion tail would thin out the emulsion to where it was almost too thin to get the proper embedment of stone."

However, the emulsion tail's benefits are still present within the community. This device was able to repair and extend the life of many roads for several years. It saved workers and county residents time and money.

## County Roads

Since becoming director of operations, Dunn works to maintain the creative freedom and flow of ideas that Gamez originally fostered. "Anytime you can take an idea and build something, even if it doesn't stay in use, you learn something," Dunn reflected. "The discussions that happened along the way make it worth trying."

No idea, no matter how big or small, should go unnoticed. Even if an idea doesn't yield the desired outcome, the knowledge gained along the way is invaluable. Trying new things with minimal risk is a valuable trait that drives one towards unforeseen solutions and success. ■

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The Center for Technology & Training (CTT) is a part of the Department of Civil, Environmental, and Geospatial Engineering at Michigan Technological University in Houghton, Michigan. The mission of the CTT is to develop technology and software, coordinate training and conduct research to support the agencies that manage public infrastructure. In support of this mission, the CTT houses Michigan's Local Technical Assistance Program, which is part of a national effort sponsored by the Federal Highway Administration to help local road agencies manage their roads and bridges. For more information, visit ctt.mtu.edu.


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The Local Technical Assistance Program (LTAP) is a nationwide effort funded by the Federal Highway Administration and individual state departments of transportation. The goal of the LTAP effort is to foster a safe, efficient, and environmentally sound surface transportation system by improving skills and increasing knowledge of the transportation workforce and decision makers.

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*November 29-30 – webinar*

**Local Public Agencies: Property Disposal, Valuation, and Good Faith Offer**
*November 30 – Dimondale/virtual*

**2023 Asset Management Training**
*Bridge Asset Management Webinar: December 5*
*Updating a Bridge, Pavement, or Compliance Plan Webinar: December 7*

**2023 Roadsoft Special Topics: Tips & Tricks**
*December 5 – webinar*

**2024 Materials Acceptance Process Seminar (Virtual)**
*2023: December 6*
*2024: January 11; January 31, February 22; March 14; April 10*

**2023 Intermediate MERL Training**
*Bid Utility Tool Webinar: December 6*
*Local Job Manager Webinar: December 7*

**2023 Transportation & the Environment Conference**
*December 12 – Mount Pleasant*

**MARK YOUR CALENDAR: 2024 County Engineers' Workshop**
*February 6-8 – Manistee*

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