Nationwide from 2005 to 2010, 733 highway crew workers lost their lives — approximately half due to motorists intruding into work zones. This is why MnDOT has been systematically researching the cause of intrusions and how to prevent them.

More than 150 work zone intrusion crashes are thought to occur each year in Minnesota. This summer MnDOT work crews began testing a state-of-the-art intrusion alarm system developed by defense industry contractors. The system detects the speed and trajectory of approaching vehicles. If there’s a threat, it alerts at-risk construction workers, who are tracked and notified via warning devices attached to hard hats or vests. The system also transmits audio and visual warnings to the oncoming vehicle.

Effectively notifying approaching motorists has been an ongoing concern for MnDOT, which has investigated different signage and enforcement methods, as well as sounds and lights, to alert distracted drivers (Reports 2017-07 and 2016-06).

Other research-backed initiatives to improve work zone safety include:
- A comprehensive, user-friendly reporting system for road crews to report work zone intrusions (Report 2018-09).
- A prototype for sending in-vehicle warning messages to motorists via smartphones (Reports 2017-19 and 2016-38).
- Development of a manual for temporary barriers, truck-mounted attenuators and other positive protection devices (TRS 1703).
- Improvements to automated flagger device (Report 2017-09).
- Update to MnDOT’s temporary traffic control guidance based on a study by local agencies (Report 2016RICO9).

“Our analysis suggests that societal crash costs could be reduced by $5 million to $26 million per year, depending on the resulting effectiveness of the intrusion alarm technology.”

—Gerald Ullman, Senior Research Engineer, Texas Transportation Institute
In-Vehicle System Provides Dynamic Warnings for Roadway Curves

Further development and field operational testing of the system is planned. A project in progress is collecting data about the speeds at which drivers travel through curves to better identify the thresholds at which a warning may need to be displayed. Drivers tend to ignore curve advisory speeds, which are commonly set at conservative levels. Research is needed to help determine how to effectively get drivers’ attention and reduce their speed.

TECHNICAL SUMMARY 2018-12

“This in-vehicle warning system is potentially an inexpensive solution that could save lives on rural roads.”

—Bradley Estochen, Traffic Safety Engineer, MnDOT Office of Traffic, Safety and Technology

New Software Models MnPASS HOT Lane Changes

To determine whether in-vehicle alerts would distract drivers, researchers recorded where drivers’ visual attention fixated during a closed-course experimental trial. This heat-map display shows the duration of one driver’s focus, from shortest (green) to longest (red).

In-house software helps MnDOT engineers design high-performing, cost-effective concrete pavements.

MATERIALS & CONSTRUCTION – MnDOT developed its own concrete pavement design software, MnPAVE-Rigid, in 2014, which incorporates federal mechanistic-empirical design guidance adapted for Minnesota conditions. An upgrade was needed, however, to improve usability and expand the range of inputs for traffic, subgrade type, base type and thickness.

The new MnPAVE-Rigid 2.0 software is not only easier to use, it allows concrete pavement designers to select from more options for aggregate base types and pavement thicknesses, and use actual rather than estimated traffic values.

Researchers developed the software on Java 2.0, which allowed MnDOT to avoid expensive systems and enables the agency to upgrade the software internally as needed.

TECHNICAL SUMMARY 2018-17

Upgrading MnPAVE-Rigid Design Software

Do Clear Bioseals Work?

Frost heave occurs when water seeps into the road base, freezes and expands. During spring thaw, the base weakens, which can lead to surface cracks and potholes. Since 1995, MnDOT has required frost-free materials—coarse gravel, sand and other materials—in asphalt pavement subgrades at depths of 30 to 36 inches, based on load requirements. Whether this practice was effective at all locations was unclear, however, and sometimes it was unnecessary.

To determine necessary pavement structure requirements, researchers studied 72 Minnesota sites with different soil and pavement types to develop pavement profiles that looked for correlations between winter ride quality and construction characteristics. They developed spread sheets that included different frost depth predictions and soil type characterizations that engineers can use to optimize their use of frost-free materials. MnDOT is evaluating these results and plans to conduct a pilot implementation.

TECHNICAL SUMMARY 2018-06

MAINTENANCE & OPERATIONS

Do Clear Bioseals Work?

Frost action causes significant damage to roadways by expanding and thawing beneath pavement. It is the principal culprit behind spring potholes.

MAINTENANCE & OPERATIONS – Frost heave occurs when water seeps into the road base, freezes and expands. During spring thaw, the base weakens, which can lead to surface cracks and potholes. Since 1995, MnDOT has required frost-free materials—coarse gravel, sand and other materials—in asphalt pavement subgrades at depths of 30 to 36 inches, based on load requirements. Whether this practice was effective at all locations was unclear, however, and sometimes it was unnecessary.

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TECHNICAL SUMMARY 2018-06

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TECHNICAL SUMMARY 2018-06
### Calendar

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/12</td>
<td>LRRB RIC fall meeting, St. Cloud</td>
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<tr>
<td>10/17</td>
<td>LRRB fall meeting, Stearns County</td>
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<tr>
<td>10/23-24</td>
<td>Toward Zero Deaths Conference, Mankato</td>
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<tr>
<td>10/31</td>
<td>MnDOT TRIG meeting, Arden Hills</td>
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<tr>
<td>11/1</td>
<td>CTS Transportation Research Conference, Minneapolis</td>
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<tr>
<td>11/1</td>
<td>National Cooperative Highway Research Program (NCHRP) problem statements due</td>
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### In This Edition

- Preventing Work Zone Intrusions with Alert System
- New Software Models MnPASS HOT Lane Changes
- Design Tool Offers Alternatives to Protect Pavements from Frost Damage