Adding a small amount of corn-based alcohol to liquid salt brine can reduce brine's corrosive effects without damaging concrete or affecting the brine's ability to melt snow and ice.

RESEARCH SOLUTIONS

Evaluating the anti-corrosive effects of deicer additives

During a typical winter season, snowplows across the state apply millions of gallons of liquid deicers to Iowa's roads to reduce crashes and improve safety. Though effective at melting snow and ice, these deicing products can also cause significant damage to vehicles and transportation infrastructure. In 2020, the Iowa Highway Research Board (IHRB) discovered several organic additives that can make the deicers less corrosive. The current research project explored the potential of these additives and produced guidance to help Iowa's winter maintenance professionals maximize the performance of the modified deicers.

THE NEED

Like other cold-weather states, Iowa DOT deices its roadways with salt brine during the winter season. While this concentrated saltwater solution is inexpensive and can effectively keep snow and ice from accumulating on roads, it is corrosive to steel and causes significant and costly damage to vehicles and the rebar that's often embedded in bridge decks to provide structural support.

Previous research, funded in part by the IHRB, found that adding a small amount of corn-derived alcohols, or polyols, to salt brine can make the deicer much less corrosive. However, the research did not investigate the exact ratio of polyols needed to inhibit corrosion in liquid deicers or the effect of the deicer-polyol mixtures on concrete strength and durability.

To answer these questions and to learn whether the strategies

(continued)

"Modifying deicers with organic additives can reduce and prevent corrosion, which can help vehicles and infrastructure last longer and save taxpayers significant costs on repairs and replacements."

— **VANESSA GOETZ,**
IHRB State Research Program Manager

can be combined for even greater results, the IHRB sought to evaluate the ideal formulations and application procedures for deicer-polyol mixtures.

RESEARCH APPROACH

After reviewing completed research about the effects of deicers on concrete, researchers selected three commercially available polyols to study: sorbitol, mannitol, and maltitol. Small quantities of each of the polyols, ranging from 0.5 to 3 percent by weight, were added to a standard brine mixture of 23 percent salt. Next, the different brine-polyol solutions and a brine-only solution were applied to more than 100 concrete test specimens. The specimens were then exposed to months of freeze-thaw cycles and wet and dry environments to simulate real-world conditions. A range of laboratory tests determined the strength and performance of the treated concrete.

This research also synthesized a new organic coating material that can be applied to steel before it's placed in concrete to preemptively protect it from chloride exposure. To understand whether this organic coating — a combination of water, soy protein, and food-grade sorbitol — could be used to protect the rebars, researchers applied the coating and assessed it for bond strength with concrete and corrosion resistance.

WHAT IOWA LEARNED

Adding just 1 percent of any of the three polyols to salt brine can reduce the deicer's corrosivity by as much as 95 percent. Importantly, none of the additives showed signs of damaging the concrete or reducing the deicer's ice-melting capabilities.

Tests of the rebar with the new organic coating also demonstrated increased corrosion resistance and improved mechanical properties. While the coating could be used as an effective repair treatment for epoxy-damaged rebar, applying it in the field may be challenging as it is not commercially available yet.

New guidance for mixing and applying the deicing products was developed to help maintenance crews across the state maximize their effect.

PUTTING IT TO WORK

Iowa is the largest producer of corn in the world. With research showing that this readily available commodity can solve the widespread problem of salt corrosivity, Iowa is well positioned to be a leader in this developing field.

This study provided winter maintenance professionals with practical solutions that can be put into practice immediately. Future research could further explore the optimal application methods for coating the rebar, determine the coating's shelf life, and evaluate the products' effectiveness under real-world conditions.

ABOUT THIS PROJECT

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