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Building a better bridge

Unlike steel, salt corrosion can't plague polymer spans

TOM GREENWOOD
Commuting

David Guralnick / The Detroit News

Civil engineering student Eslam Solimena is testing carbon fiber rods, seen as a more durable component for future bridges.

It might be cheap and effective, but salt is also destructive.

Transportation experts say salt corrosion is believed to be one of the main culprits in three incidents in the last week when chunks of concrete rained down on drivers in Metro Detroit.

Nabil Grace, structural engineer and director of Innovative Materials Research at Lawrence Technological University, said he may have the solution — steel-free bridges.

"We have developed a new bridge system to solve the problem of salt-induced corrosion," Grace said. "The answer is to use carbon fiber enforced polymers instead of steel. We've already done it."

In 2001, Southfield and the Michigan Department of Transportation built the first bridge in the world that doesn't use steel. The Bridge Street Bridge — which spans the Rouge River near Eight Mile and Telegraph — consists of two separate spans: one each for traffic entering and leaving an industrial park, Grace said.

The incoming bridge is made of steel and concrete, and with normal maintenance, has an expected life span of about 40 years. The bridge carrying outgoing traffic is made with concrete and carbon fiber technology; not a speck of steel.

"We expect it will last twice as long as the conventional bridge," Grace said.

"The carbon fiber bridge has over 200 sensors in it which we can 'talk' to via computer every two hours about how it is holding up. We compile the data and send it on to MDOT. After five years, I'm happy to report that the 'bridge with a brain,' as we call it, it is holding up fine."

While humans need salt to survive, experts said bridges and roads would be much better if they were on a salt-free diet.

"The biggest problem is that salt gets down to the steel rebar and accelerates corrosion," said Mark Grazioli, sales and material engineer for MDOT.

"The rebar grows larger from the corrosion and forces its way upwards, popping up the concrete. This creates more cracks, which then leads to more seepage."

For the past 30 years MDOT has been combating the problem by using epoxy-coated rebar, which creates a shield against corrosion, Grazioli said.

But bridges older than 30 years — like the Groesbeck Road Bridge over Interstate 696, which lost concrete Tuesday morning — don't have that protection.

"We've looked at using other types of anticing materials, but they've all proven to be equally corrosive or are too expensive," said Tony Kratofil, Deputy Region Engineer for MDOT.

> ***"This problem isn't going to go away. We have to be more aggressive ... until then concrete will continue to fall from bridges."***
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> Dr. Nabil Grace, structural engineer and director of Innovative Materials Research at Lawrence Technological University

"We have had discussions about the carbon fiber technology and still consider it to be experimental. However, we will be using it to

build three bridges on the Southfield Freeway in 2009."

Kratofil called the bridge experimental because it's only been used in one since 2001. He said it will take years of observation to determine whether carbon fiber is the cure to corrosion.

According to the Environmental Literacy Council in Washington, D.C., as well as the Jan.-Feb. 2005 edition of Governmental Engineering, alternative deicers have their pros and cons.

- Sand isn't corrosive, but it can clog roadway drains and ditches. It absorbs grease and oil and eventually finds its way into the watershed, where it clouds the water and threatens aquatic life.
- Magnesium chloride, calcium chloride, sodium chloride and calcium magnesium acetate are all derived from salt and are still somewhat corrosive. Michigan is one of many states that use salt on their roads. Among them are New York, Massachusetts, Vermont, Maine, Wisconsin, Connecticut, New Hampshire, Ohio, Indiana, Illinois and Maryland.

"Salt is cheap, readily available and effective," Kratofil said.

Michigan isn't the only state with crumbling bridges.

Earlier this month, a large lump of concrete plummeted from a span in St. Louis, smashing onto the freeway.

"It was a very large section of concrete," said Dennis Heckman, a structural resource manager for the Missouri Department of Transportation. "A car crashed into it, but luckily the driver received only minor injuries. We determined that salt had corroded the rebar and was a major contributing factor to the collapse."

According to Grace, the cost of the new carbon fiber technology is running about four to five times the cost for a similar amount of steel. Grace said the cost of the Bridge Street Bridge was about $8 million, as compared to costs of $3 million to $5 million for a bridge with steel.

"The important thing is to look at the cost in the long run," Grace said. "It will cost less because it will need maintenance less often over the decades. This problem isn't going to go away. We have to be more aggressive ... until then concrete will continue to fall from bridges."


David Guralnick / The Detroit News

Nabil Grace of Innovative Materials Research says new carbon fiber costs about four to five times more than steel.


David Guralnick / The Detroit News

One span of the Bridge Street Bridge uses concrete and carbon fiber technology, which should give it a longer life span than bridges that have steel.


Elizabeth Conley / The Detroit News

Unlike the Bridge Street span, bridges like the Schaefer in Melvindale are susceptible to salt damage.