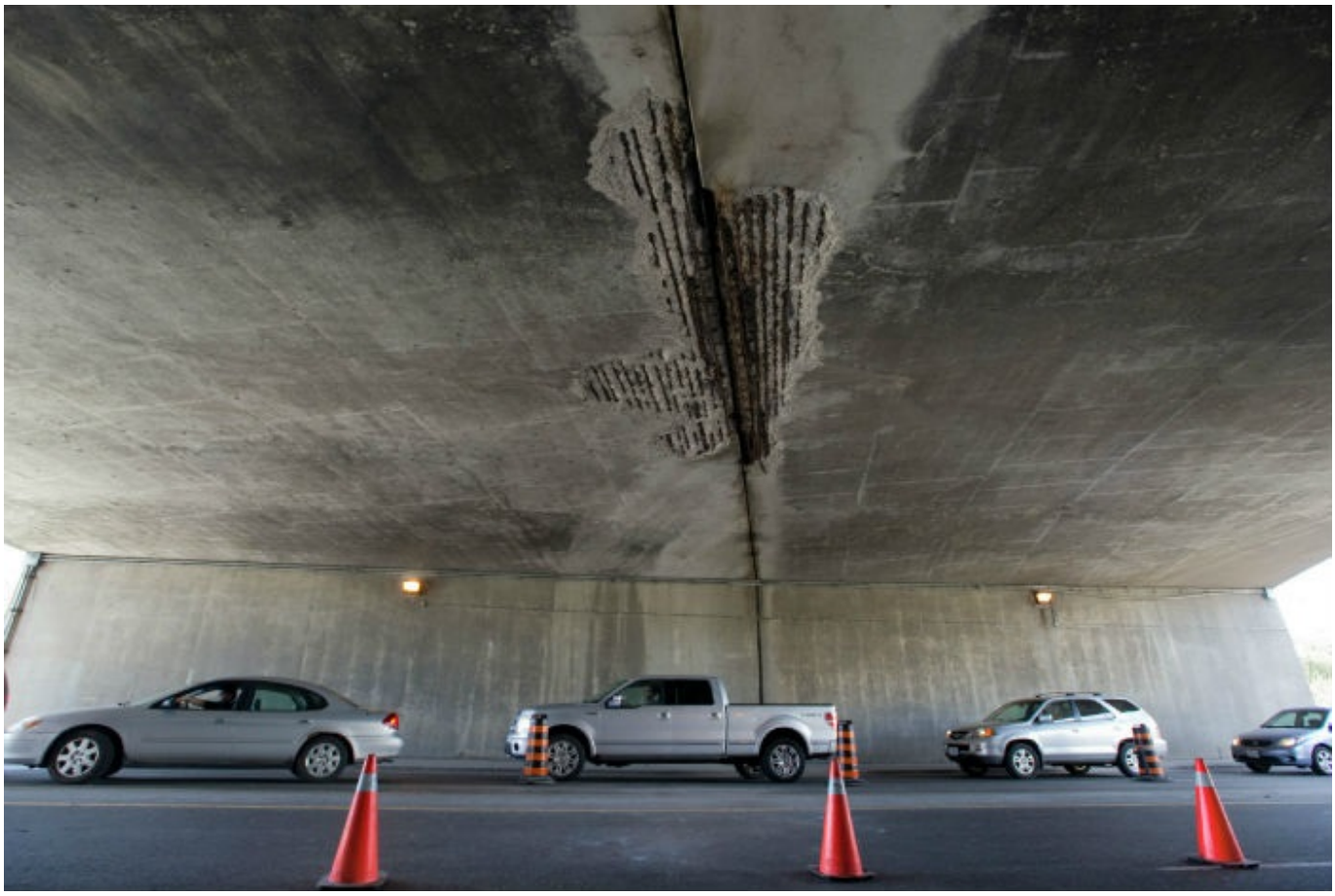


Collaboration between North Carolina State University and the University of Eastern Finland has produced a new technology that can detect and respond to damage in concrete structures with far greater speed.

The solution is an electrically conductive coat of paint which can easily be applied to new or existing structures. As the paint can incorporate any number of conductive materials, such as copper, this “sensing skin” is relatively inexpensive.

“The sensing skin could be used for a wide range of structures, but the impetus for the work was to help ensure the integrity of critical infrastructure such as nuclear waste storage facilities,” said Dr. Mohammad Pour-Ghaz, an assistant professor of civil, construction and environmental engineering at NC State.

“The idea is to identify problems quickly so that they can be addressed before they become big problems and – in the case of some critical infrastructure – so that public safety measures can be implemented,” Pour-Ghaz added.

Electrodes are applied around the perimeter of a structure and the “sensing skin” paint applied on top. A computer program then runs a small current between two of the electrodes at a time, cycling through a number of possible electrode combinations.

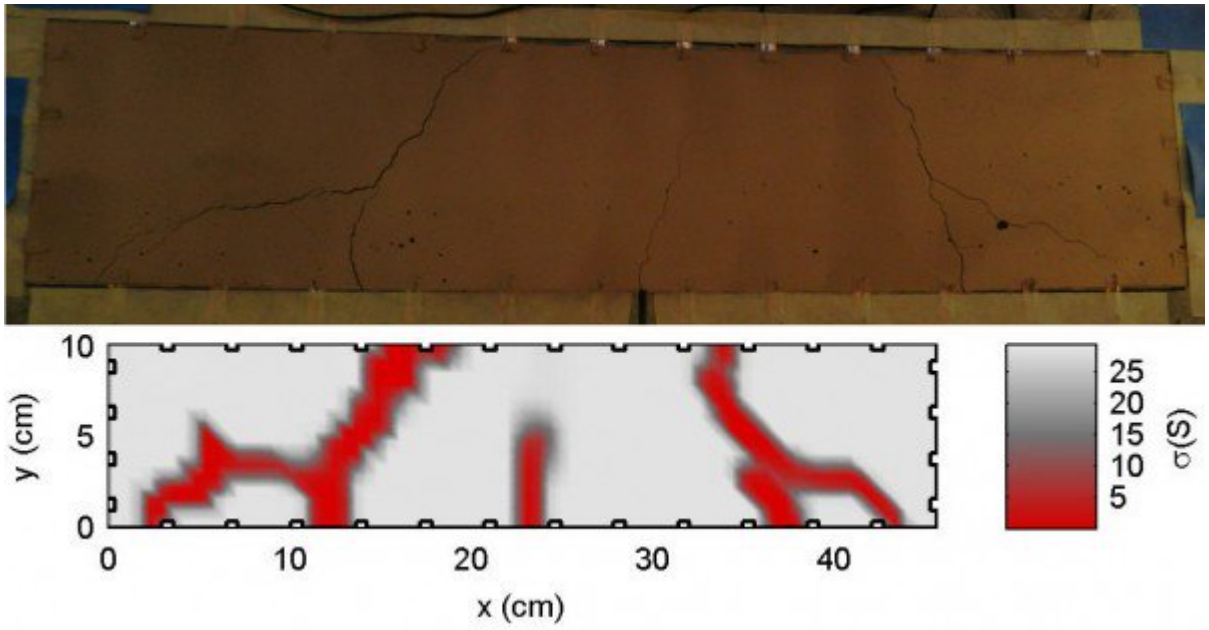
Every time the current runs between two electrodes, a computer monitors and records the electrical potential at all of the electrodes on the structure. This data is then used to calculate the sensing skin’s spatially distributed electrical conductivity.

Cracking of the concrete substrate results in the rupture of the sensing skin, decreasing the electrical conductivity of the sensing skin locally.

The most complex and difficult aspect of the research has been the development of the most effective analytical tools. The decrease of the conductivity is detected with Electrical Impedance Tomography (EIT) imaging, while a suite of algorithms allow researchers to both register damage and to determine where the damage has taken place.

Application-specific models and computational methods in the image reconstruction, including the use of a Total Variation (TV) prior model, also give an approximate correction of the modelling errors caused by the inhomogeneity of the painted sensing skin.

“Determining the location of the damage based on the measured electrode potentials is a challenging mathematical problem,” said Dr. Aku Seppänen, an Academy Research Fellow from the Department of Applied Physics at the University of Eastern Finland as well as co-author of the paper. “We had to develop new computational methods to more reliably determine where the damage is. Ultimately, I think our work represents an advance over previous algorithms in terms of accuracy.”



“Sensing skin” technology detects cracks in concrete

To date, the effectiveness and accuracy of the sensing skin has only been tested on a small scale, using concrete beams less than a metre wide.

“Our next step is to extend this to large geometries,” Pour-Ghaz says. “We want to show that this will work on real-world structures.”

The research paper was published in the journal Smart Materials and Structures and was supported in part by the Academy of Finland.

Source: Sourceable