Technische Universität München

News Release

Munich, 13/02/2016

HealCON investigates innovative materials

Concrete with self-healing powers

Bridges, tunnels and roads: Concrete is the main component of our infrastructure. And when the structural elements need to be repaired, it often leads to long traffic jams. In the HealCON project an international team of scientists, including researchers from the Technical University of Munich (TUM), has set out to develop concrete that can heal itself. The healing agents they use include bacteria and a material that is also used in diapers.

Small cracks can form in concrete due to permanent loading or variations in temperature. As Prof. Christian Grosse from the Chair of Non-destructive Testing (NDT) at TUM explains, the cracks do not usually pose any direct threat to the stability of structures: "However, water and salts can penetrate the concrete and damage the affected components."

Three healing mechanisms

Repairing infrastructure is expensive and can result in long traffic jams. In the EU research project HealCON, an international team of researchers is working toward the development of concrete that can repair itself. The scientists are examining three different self-healing mechanisms.

- **Bacteria as mini construction workers**

Certain bacteria produce calcium carbonate as a metabolic product. The scientists soak balls of clay with the spores of these bacteria and mix the balls into concrete. Once water penetrates the concrete, the microorganisms become active and release calcium carbonate, one of the main components of concrete. "The bacteria can close cracks of up to a few millimeters in width in a matter of a few days," says Grosse.

- **Hydrogels as gap fillers**

Hydrogels are polymers that absorb moisture. They are used in diapers, among other things. Materials containing hydrogels can expand to ten or even 100 times their original size. Cracks that form in concrete can be healed by a hydrogel that expands when it comes into contact with moisture, thus preventing the water from penetrating further without expanding the cracks.

Technical University of Munich   Corporate Communications Center   80290 München   www.tum.de

Dr. Ulrich Marsch	Head of Corporate Communications	+49.89.289.22779	marsch@zv.tum.de
Stefanie Reiffert	Media Relations	+49.89.289.10519	stefanie.reiffert@tum.de

- **Greater strength thanks to epoxy resin**

Epoxy resins or polyurethane can be encapsulated and mixed into the concrete. When the concrete cracks, the capsules break open and the polymer is released. It forms a hard mass that seals the crack. It also has a positive side-effect: It increases structural stability.

Looking into concrete

Grosse and his colleagues specialize in testing how well these healing agents work in individual cases. They use non-destructive testing methods to do this, for example acoustic emission technology.

Pressure is exerted on a concrete block that contains one of the healing agents. When the concrete cracks, acoustic waves are generated, which are measured using sensors. By means of the measurement data, the scientists not only can establish that cracks have formed but also can determine precisely where.

Following the healing process, the researchers carry out the experiment again. If the healing process was not successful, there are few new acoustic waves, as the cracks are still there. If the cracks have been filled, new ones arise – but in different places. “The localization of the crack sounds clearly indicates whether a remedy works or not,” explains Grosse.

Testing structural components using ultrasound

While acoustic emission analysis is suitable for laboratory applications, a different technology must be used for real-world on-site testing of large concrete components. “In this case, we use continuous ultrasound pulses,” explains Grosse.

The scientists measure the time required for ultrasound pulses to propagate through the concrete. Cracks prevent the transmission of the signal, and as a result it needs more time to traverse the material. If the cracks have been filled, the pulses go through the material faster again. The strength of the signal also declines noticeably in the case of damaged material.

Promising results have already been obtained from experiments carried out under laboratory conditions. The next stage will involve the use of the self-healing material in actual building components (sections of bridges or tunnels). After this, the technologies will have to be adapted for use in standard concrete production and construction methods.

Technical University of Munich Corporate Communications Center 80290 München www.tum.de

Dr. Ulrich Marsch	Head of Corporate Communications	+49.89.289.22779	marsch@zv.tum.de
Stefanie Reiffert	Media Relations	+49.89.289.10519	stefanie.reiffert@tum.de

The Entrepreneurial University.

Technische Universität München

The HealCON project is being funded as part of the European Union's 7th Framework Programme for Research and Technological Development (FP7/2007-2013) under grant agreement number 309451. The project is coordinated by Ghent University (Belgium).
Official project website: http://www.HealCON.ugent.be/

Highresolution photos:
https://mediatum.ub.tum.de/?change_language=en&id=1291076#1291076

Contact:
Prof. Dr. Christian Grosse
Centre for Building Materials
Chair of Non-destructive Testing
Tel: + 49.89.289.27221
grosse@tum.de
www.zfp.tum.de

Technical University of Munich (TUM) is one of Europe's leading research universities, with more than 500 professors, around 10,000 academic and non-academic staff, and 39,000 students. Its focus areas are the engineering sciences, natural sciences, life sciences and medicine, reinforced by schools of management and education. TUM acts as an entrepreneurial university that promotes talents and creates value for society. In that it profits from having strong partners in science and industry. It is represented worldwide with a campus in Singapore as well as offices in Beijing, Brussels, Cairo, Mumbai, San Francisco, and São Paulo. Nobel Prize winners and inventors such as Rudolf Diesel, Carl von Linde, and Rudolf Mößbauer have done research at TUM. In 2006 and 2012 it won recognition as a German "Excellence University." In international rankings, TUM regularly places among the best universities in Germany.
www.tum.de