Investigations on the detectability of water intruding into the sealing of bridges using electrical resistivity measurements

Carla Driessen, Michael Raupach

[1]*Institute of Building Materials Research,*
RWTH Aachen University
Schinkelstrasse 3, 52062 Aachen, Germany

Abstract In the context of a current joint research project an all-over realtime humidity-monitoring is being developed. This monitoring concept is realised through an interlayer which consists of textile reinforced concrete. By means of changes in the electrolyte resistance, measured between two carbon meshes, leakages will be detected. If water soaks into the concrete a drop in the measured electrolyte resistance appears. The goal of current investigations is to work out thresholds in order to be able to define the size of the leakage and the level of risk for the bridge construction.
After the investigation of this question through numerical simulations, accompanying measurements are carried out on specimens in the laboratory and on different demonstrators under real (traffic) conditions. Therefore the impact of the different materials such as mortar, carbon meshes and coating are investigated separately and in combination under real conditions examining the influence of different temperatures and humidity.

Keywords: textile reinforced concrete, carbon, resistivity measurements

Laboratory Tests

Since numerical simulations showed that theoretically leakages with a size of a few percentages of the total measuring field are detectable [1, 2], laboratory tests on specimen with a size of 440 x 480 x 35 mm³ were performed. Therefore the Smart-Deck structure with two carbon meshes with a spacing of 15 mm was used. The mortar was filled up to 10 mm below the lower and above the upper Carbon mesh. Picture 1 shows one of the specimens before filling the mortar into the formwork and after curing.

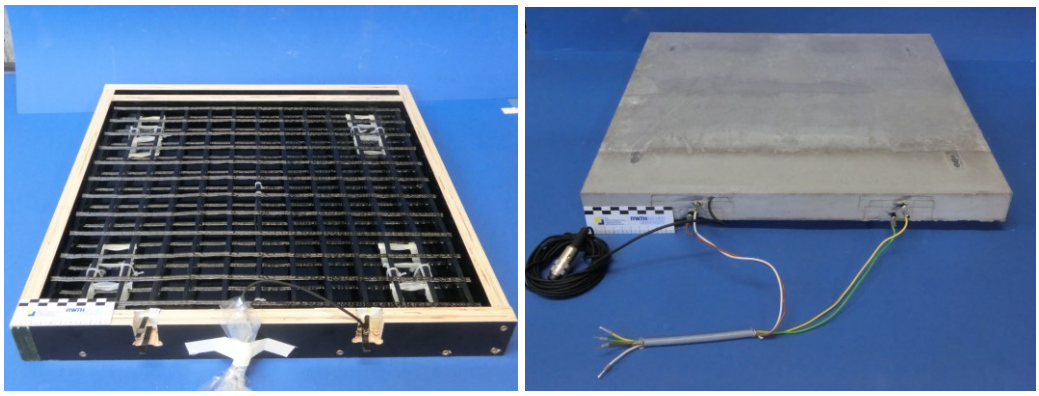

Figure 1: Exemplary specimen

To investigate which size of leakages is detectable under different conditions, the size and form of the leakages were varied as well as the testing temperature and the measuring frequencies. To simulate the leakages, water basins were applied on top of the specimen, to generate a constant water supply, because it is assumed that in case of a leakage in the sealer

the water will accumulate between the sealer and the Smart-Deck layer. Figure 2 shows the test setup.

Figure 2: Specimen with two leakages, rectangular, 8 % of total surface

In contrast to the expectations the reference resistivity measurement without applied water showed an increase in resistance over the time. So the simulated leakages could only lead to a depressed increase, which is shown in Figure 3.

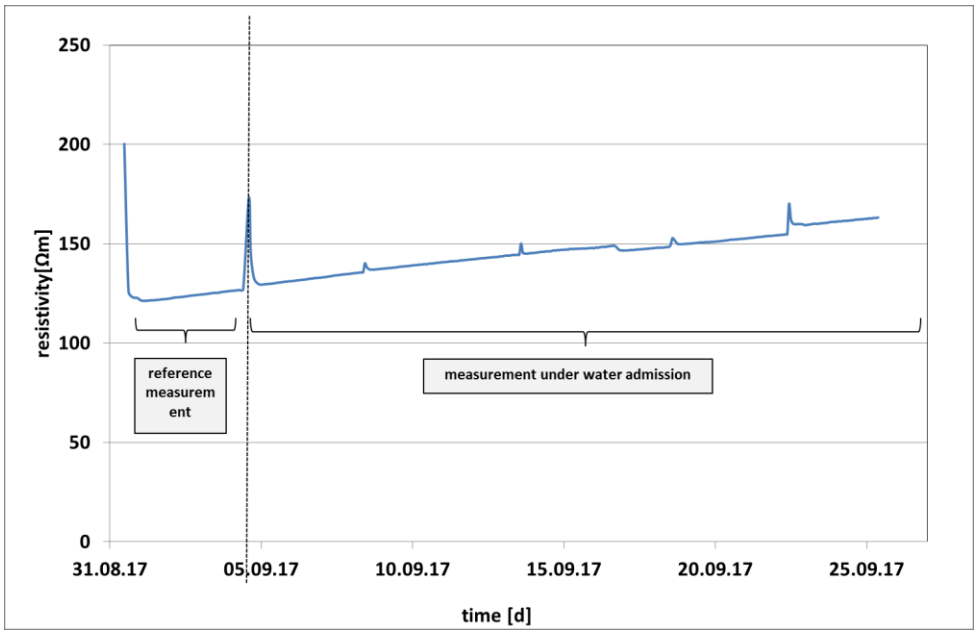

Figure 3: Plot of the resistivity measurement [3]

Further tests are carried out to investigate this effect.

Tests on an outdoor demonstrator

Additionally measurements on an outdoor demonstrator with a size of approximately 100 m² were performed. The demonstrator has four electrically disconnected measuring fields. On

each measuring field a different leakage size and form was build. Figure 4 shows the demonstrator with the water basins. The remaining field was coated with epoxy (in yellow).

Figure 4: Outdoor demonstrator of Smart-Deck [4]

The following diagram shows the resistivity values, the temperature and the temperature compensated resistivity values. It can clearly be seen that the resistivity values follow the fluctuations in temperature which means that the measuring technique seems to work reliably. Furthermore it can be said that no short circuit exists between the two carbon meshes.

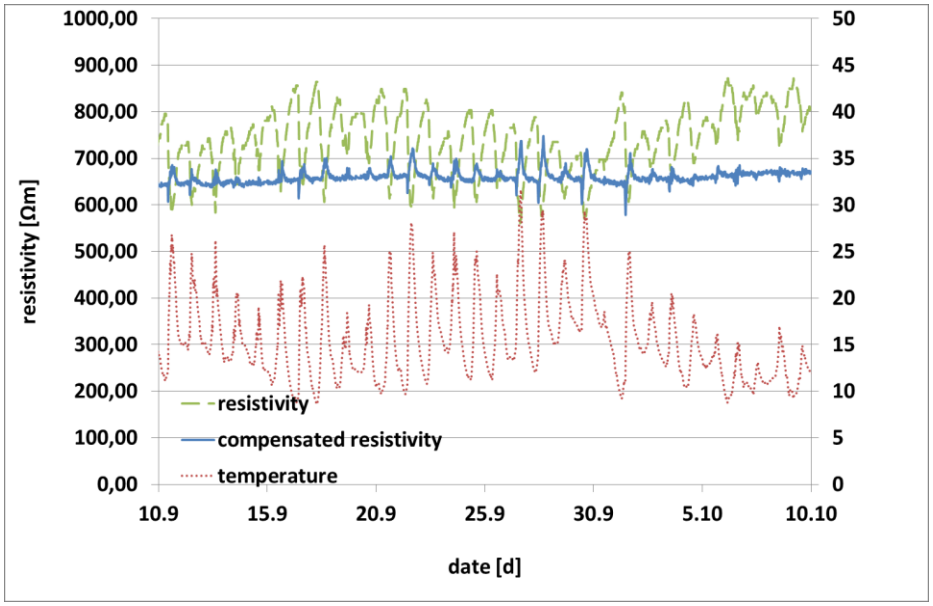

Figure 5: Temperature, resistivity and temperature compensated resistivity of one exemplary measuring field of the demonstrator [3]

Conclusion and Outlook

- Tests on an outdoor demonstrator showed that the functionality of the full-surface monitoring in principle works

- In laboratory tests an increase of resistivity over time was monitored. Finding the reason for that increase is the main task in ongoing investigations.

- In 2018 a second demonstrator will be constructed. This time the demonstrator will be applied on a real bridge deck under real traffic conditions.

References

1. Driessen, C. ; Raupach, M.:
“Numerical Simulations for the Detection of Leakages in the Sealing of Bridges by Changes in the Electrolyte Resistance”. Montpellier : CEFRACOR, 2016. - In: EUROCORR 2016. European Corrosion Congress, Advances in Linking Science to Engineering, Montpellier, France, 11-15 September 2016

2. Driessen, C.; Raupach M.
“Numerical simulations for the detection of leakages in bridge deck sealers through resistivity measurements” in VIII International PhD Student Workshop on Service Life and Durability of Reinforced Concrete

3. Driessen, C. ; Raupach, M.:
“Investigations on the detectability of water intruding into bridge deck sealings by electrical esistivity measurements”. ICCRRR 2018, South Africa, 2018 (not yet published)

4. Krell, N. « Investigations on the detectability of water intruding into mortar by electrical resistivity measurements » (Master thesis, ibac, RWTH University

ACKNOWLEDGEMENT

The authors would like to thank the BMBF for sponsoring the project and the project executing organization,“VDI Technologiezentrum GmbH (VDITZ)” for the support.
(http://www.eurovia.de/standort/17866-niederlassung-bauwerksinstandsetzung).
The project partners:
Eurovia Beton GmbH, Niederlassung Bauwerksinstandsetzung,Hofheim-Wallau (Projektkoordinator);Bundesanstalt für Straßenwesen, Bergisch-Gladbach; FTA GmbH, Albstadt; Massenberg GmbH, NL Bürstadt; Sto SE & Co. KGaA, Stühlingen; Institut für Massivbau (IMB), RWTH Aachen