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Crack Identification in Concrete with Electrical Resistance Tomography

***Kimmo Karhunen[1], Aku Seppänen[1], Anssi Lehikoinen[1], Paulo Monteiro[2] and Jari P. Kaipio[1]**

[1] Department of Physics
University of Kuopio
P.O.B. 1627
FI-70211 Kuopio
Finland
Kimmo.Karhunen@uku.fi
http://physics.uku.fi/~kkarhune

[2] Department of Civil and
Environmental Engineering
University of California Berkeley
725 Davis Hall
UC Berkeley, Berkeley, California
monteiro@ce.berkeley.edu
http://www.ce.berkeley.edu/~paulmont/

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ABSTRACT

Non-destructive testing (NDT) of concrete is an important issue in civil engineering industry. The aims of NDT include assessment of cracking, estimation of location and corrosion rate of rebars, and estimation of chemical and physical conditions of the cement paste (e.g. carbonation, chloride content and humidity). Various modalities have been applied for NDT. For example cracking of concrete has been evaluated - in addition to visual inspection - with interferometry, acoustic and ultrasonic techniques, infrared thermography and electrical methods.

Electrical techniques hold potential for estimating many concrete parameters, although they are often criticized for their poor spatial resolution. In this paper we demonstrate how the resolution of electrical modalities can be improved considerably by 1) accurate modelling of the measurements and 2) utilizing appropriate prior information of the target. We apply Electrical Resistance Tomography (ERT) to locating cracks and delaminations in concrete. In ERT alternating currents are injected to the target through an array of electrodes attached on the surface of the target, and the resulting voltages between electrode pairs are measured. Using the boundary voltage data corresponding to set of different current injection patterns the conductivity distribution is computed. Recovering the three dimensional conductivity distribution from the voltage data is an ill-posed inverse problem, and prior information of the target is needed in the reconstruction. In the case of crack detection we often have *a priori* information of the crack orientation. This prior information can be utilized in the reconstruction by using *anisotropic smoothness priors* [1] - the conductivity is smooth in the (assumed) direction of cracks and non-smooth in the direction perpendicular to assumed crack orientation.

Figures 1-3 illustrate the results of ERT applied to imaging cracks (or crack-like

defects) in concrete. In order to obtain good electrical contact to concrete, wet Cu-CuSO-electrodes were used in ERT measurements.

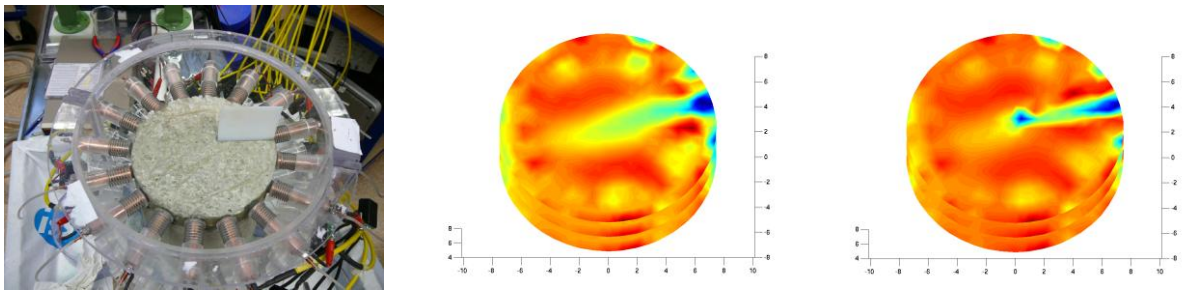

Figure 1 Left) The photo of the target including (a crack-like) plastic plate casted inside a concrete cylinder. Middle) Reconstruction with (standard) isotropic smoothness prior. Right) Reconstruction with anisotropic smoothness prior (higher smoothness in radial direction than in tangential direction).

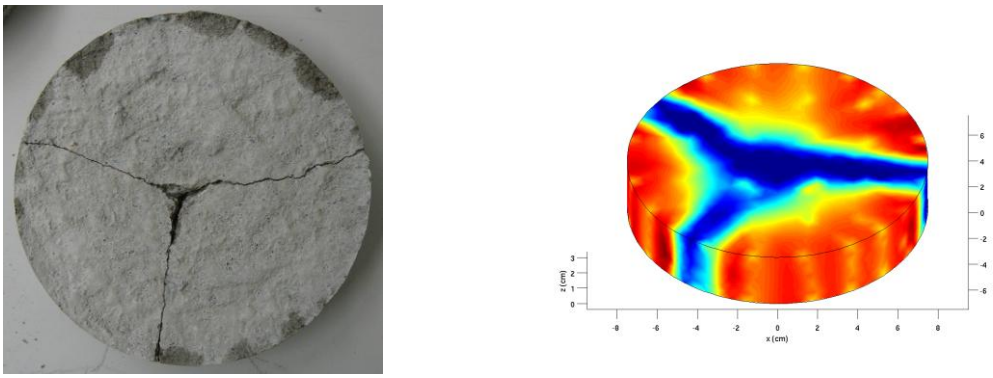

Figure 2 Left) Cracked concrete cylinder. Right) reconstruction with anisotropic smoothness prior.

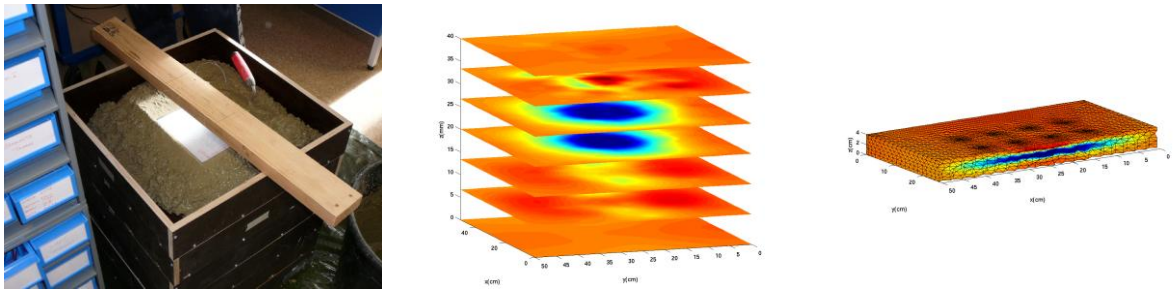

Figure 3 Slab geometry: the measurements were acquired from the top surface only. Left) Photo of the target taken during casting. Plastic plate simulates delamination in concrete. Middle and Right) Reconstruction with anisotropic smoothness prior.

REFERENCES

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