



HAL
open science

Inversion of non-invasive resistivity measurements in four electrodes configuration for corrosion characterization in reinforced concrete samples

Julia Holzhauser, Julien Gance, Yannick Fargier, Christophe Chiaberge,
Stéphanie Betelu

► To cite this version:

Julia Holzhauser, Julien Gance, Yannick Fargier, Christophe Chiaberge, Stéphanie Betelu. Inversion of non-invasive resistivity measurements in four electrodes configuration for corrosion characterization in reinforced concrete samples. EUROCORR 2023 - The Annual Congress of the European Federation of Corrosion, Aug 2023, Bruxelles, Belgium. hal-04122061

HAL Id: hal-04122061

<https://brgm.hal.science/hal-04122061v1>

Submitted on 8 Jun 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Inversion of non-invasive resistivity measurements in four-electrodes configuration for corrosion characterization in reinforced concrete samples.

Julia HOLZHAUER, Iris Instruments, Orléans / France

Julien GANCE, Iris Instruments, Orléans / France

Yannick FARGIER, Université Gustave Eiffel, Bron / France

Christophe CHIABERGE, BRGM, Orléans / France

Romain RODRIGUES, BRGM, Orléans / France

Stéphanie BETELU, BRGM, Orléans / France

In the context of corrosion diagnosis in reinforced concrete (RC), non-invasive four-point electrical measurements represent, by many aspects, an interesting alternative to classical three-point characterization with rebar connection. As a matter of fact, the four-point surface measurement without connection to the rebar, is known to be sensitive to the rebar corrosion. Yet, this rebar effect was first seen as a drawback to the method, initially meant to provide a reliable estimation of the structure durability by assessing the concrete resistivity.

The first advantage of this method, namely its absence of rebar connection, comes with a complexification of the current paths within the RC structure. Part of the current diffuses only in the concrete while a residual part will penetrate in the rebar depending on its corrosion current density j_{corr} . The determination of the rebar corrosion through that kind of measurement is therefore less straightforward than for three-point measurements. However, by multiplying the acquisition points and running an Electrical Resistivity Tomography (ERT), it becomes conceivable to spatially image the RC structure. The four-point resistivity data may be inverted in order to recover both the instantaneous corrosion rate of the rebar as well as the matrix electrical properties and heterogeneities.

We developed a laboratory ERT experiment (CorImager®-device from IRIS Instruments) designed to sequentially run multiple four-point measurements on prismatic reinforced mortar specimens of dimensions 10 x 10 x 40 cm³. The device, composed on the one hand of 96 electrodes distributed over the 4 faces of a corset-like antenna (see Fig.1), and on the other hand of an acquisition central enabling multi-

channel measurement and switching, provides us with a 3D investigation of our probe. Our samples collection gathers about thirty specimens, most of them armed, differing in the mix or in the rebar preparation. Some have been specifically designed to test the widely reckoned ability of this method for heterogeneous matrix characterization, on our unusually small sample dimension.



Figure 1 : On the left view of the open antenna counting 96 electrodes, on the right view of the acquisition central together with the closed antenna disposed within a confining unit

Preliminary results on such a heterogeneous sample, bearing two polystyrene resistive inclusions of dimension $4 \times 4 \times 3 \text{ cm}^3$ in a regular CEMI mortar matrix such as $w/c = 0.5$ and $s/c=3$, have already shown that this method can concomitantly provide, by data inversion, an image of the matrix heterogeneity (see Fig.2) together with an estimation of a uniform corrosion value. This j_{corr} -value of 16 mA/m^2 obtained through inversion of ERT data, was comparable to the values of $8 \pm 2 \text{ mA/m}^2$ determined by classical three-points measurements.

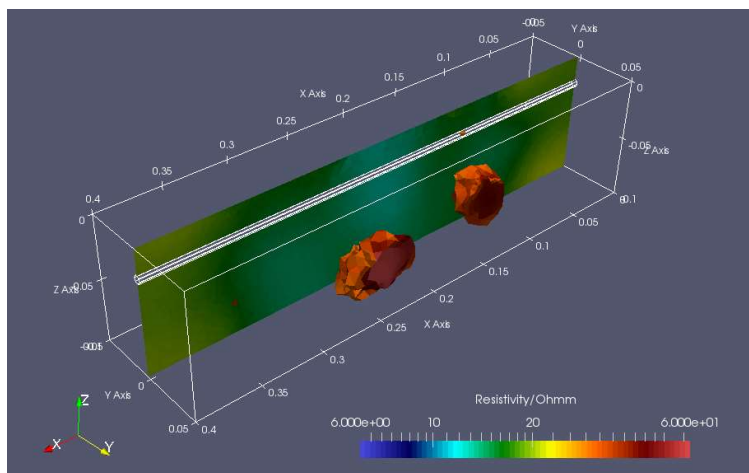


Figure 2: Results of ERT data inversion on a reinforced mortar sample having two resistive inclusions.