Electrical and electromagnetic monitoring for engineering applications: a lab test for evaluating the concrete curing phenomenon with 4D-ERT

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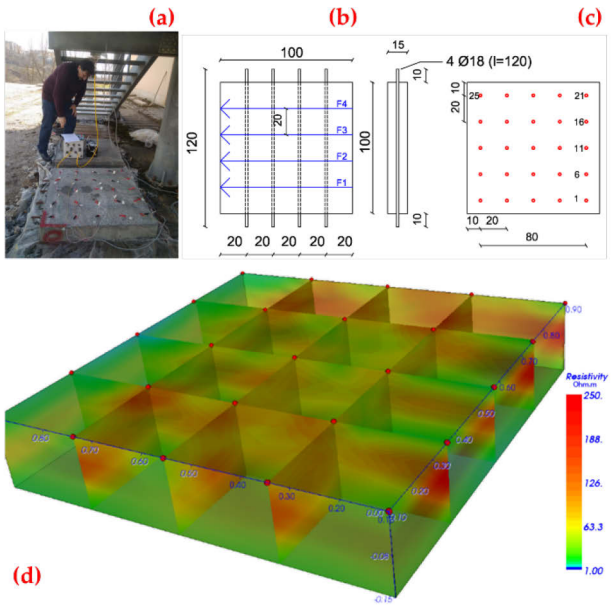
The variation of the water content of structural elements realized according the reinforced concrete (RC) technology can be effectively monitored with use of electrical and electromagnetic geophysical method. Indeed, presence of water hardly increases electrical conductivity and dielectric constant of the concrete, while its absence or limited presence causes higher electrical resistivity behaviour and a greater velocity of propagation of EM waves.

The experiment consists in the evaluation of potentialities and limits of 4-D non-destructive geophysical techniques for monitoring the concrete curing phenomenon for a month immediately following placing and finishing. In particular, time-lapse 3-D ERT and GPR surveys have been applied to a RC (Concrete C28-35, Steel B450C) panel of sizes 1 x 1 x 0.15 m, as showed in fig. 1.

25 electrodes placed every ten centimetres and distributed on five rows have used to perform geoelectrical measurements using dipole-dipole array and the Syscal Pro (red circles in fig. 1c). The electrical resistivity measurements were repeated every day for one month and measured resistivity data were inverted using the ERTLab 3D software.

Simultaneously, GPR data (2 GHz antenna coupled to SIR 3000 GPR system) were acquired (blue arrows in fig. 1b). The hyperbolas generated by the presence of four rebars of the panel are automatically picked for estimating the dielectric permittivity of the concrete; moreover, the time of the first arrivals was monitored for 30 days.



A diffuse increase of the resistivity values due to the curing of the concrete has been detected for the entire volume investigated, except for the lower zones where there is, likely, the accumulation of water (fig. 1d). This is in according with the dielectric permittivity variations showing a negative trend related to the evaporation of the water.

Figure caption: behavior of the panel recorded with ERT. As expected, the continuous decrease of the water content in the panel monitored for 30 days, caused a constant increase of the electrical resistivity values and EM velocity.