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Determining chloride content profiles in concrete using an Electrical Resistivity Tomography device

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Abstract:

Chloride penetration in concrete can lead to steel corrosion which is one of the major pathologies affecting reinforced concrete's durability. The development of methods to investigate chloride penetration is essential to predict and update the service life of the structure. A non-destructive (ND) DC-electrical technique is used in this study: this Electrical Resistivity Tomography (ERT) device is arranged in a Wenner configuration and measures apparent resistivities. Apparent resistivities are then inverted in order to obtain a resistivity profile versus depth. In parallel, a calibration method relating the resistivity to the chloride content for each type of concrete is used to obtain the chloride profile versus depth. This methodology was applied to a chloride diffusion experimental program on two concrete formulations and one mortar. The profiles evaluated by NDT are then compared to those obtained by a destructive method (potentiometric titration). Both types of profile fit relatively well, thus, the presented methodology is validated for determining chloride content profiles by means of a non-destructive ERT device. The evaluation of the uncertainty range of successive processes (measurement, inversion and calibration) underlines the importance on including the uncertainties in the interpretation of the ND profiles in future research.

Keywords: Resistivity, chloride, NDT, diffusion, concrete durability

1. Introduction:

The deterioration of reinforced concrete structures in marine environment is mainly due to the corrosion of steel induced by the penetration of chloride ions [1]. Chloride ions can penetrate into concrete through multiple mechanisms including diffusion, adsorption, permeation and surface deposit of airborne salts [2-7]. By penetrating into the cover concrete, the chloride ions destroy the passive layer that protects the reinforcing steel bars from corrosion. The corrosion mechanism induces a reduction of the steel surface area and rust production on the bars resulting in an increase of the total volume up to 600% [8, 9]. The consequences then

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