Accepted Manuscript

Evaluation of water content gradient using a new configuration of linear array four-point probe for electrical resistivity measurement

A.Q. Nguyen, G. Klysz, F. Deby, J.-P. Balayssac

PII: S0958-9465(17)30636-4

DOI: 10.1016/j.cemconcomp.2017.07.020

Reference: CECO 2870

To appear in: *Cement and Concrete Composites*

Received Date: 19 February 2016

Revised Date: 12 December 2016

Accepted Date: 17 July 2017

Please cite this article as: A.Q. Nguyen, G. Klysz, F. Deby, J.-P. Balayssac, Evaluation of water content gradient using a new configuration of linear array four-point probe for electrical resistivity measurement, *Cement and Concrete Composites* (2017), doi: 10.1016/j.cemconcomp.2017.07.020.

Evaluation of water content gradient using a new configuration of linear array four-point probe for electrical resistivity measurement

A.Q. Nguyen, G. Klysz, F. Deby, J-P. Balayssac

LMDC, INSA/UPS Génie Civil, 135 Avenue de Rangueil, 31077 Toulouse cedex 04 France.

Keywords: NDT, concrete, resistivity, reinforcement, water content gradient, inversion

Abstract:

The electrical resistivity is used in this study to assess the moisture content of the concrete, because of their good correlation. A new process using four point probes to measure the electrical resistivity of concrete is described in this paper. It is based on the exploitation of the short circuit induced by the reinforcement in the concrete structure. A numerical model is also made to simulate the resistivity measurements on concrete by also taking into account the electrochemical parameters of the reinforcement. The obtained results have shown the ability of the new measurement process to assess the gradient of the moisture content of the concrete cover.

1. Introduction

Concrete electrical resistivity measurement is considered as one of the NDT methods for in-situ assessment of concrete and for monitoring its corrosion (Andrade et al., 2000; Lataste et al., 2003). This parameter is related to some degradations of reinforced concrete such as chloride penetration (Polder, 2001), carbonation (Nasser et al., 2010) and the corrosion of the reinforcement (Alonso et al., 1988; Millard, 1991). These phenomena cannot take place without the presence of water. Moisture content is linked to reinforced concrete durability as it greatly influences the reinforcement corrosion. The aim of this paper is to assess the water content gradient in concrete cover by using a non-destructive technique.

The electrical resistivity value is used because of its sensitivity to moisture content. Many works have shown that electrical resistivity is influenced by the degree of water saturation, the porosity and the salinity of concrete (Saleem et al., 1996; Lataste, 2002; Feliu et al., 1989; Plooy et al., 2013). Hence this property is a good indicator of concrete durability. However, there are very few works available in the literature regarding the assessment of water content gradients in concrete by means of resistivity. Moreover, in reinforced concrete, the effect of steel on resistivity measurements is significant (Millard, 1991; Garzon et al., 2014). Therefore the influence of rebar on electrical resistivity measurement is studied and discussed in this paper through both experimental and numerical work.

In the experimental campaign, unreinforced and reinforced slabs were studied, with a special installation in the laboratory to create a moisture gradient in the concrete. A novel process of measurement was used on the unreinforced slab and over the rebar on the reinforced one. In this study the reinforcements were used as a part of the technique to assess the moisture gradient of the concrete cover. Two types of gradient, the drying gradient and the moistening gradient, were considered to test the ability of the new process to evaluate the water gradient.