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Stephen O. Ekolu

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Model for practical prediction of natural carbonation in reinforced concrete: Part 1-Formulation

Stephen O. Ekolu
Department of Civil Engineering Science, University of Johannesburg, South Africa,
sekolu@uj.ac.za, sekolu@gmail.com

Abstract

A model is proposed for prediction of natural carbonation in reinforced concrete (RC) structures, and is potentially applicable to existing and new RC structures. The major components of the model comprise mathematical functions applied to predict the influence of concrete composition, and environmental factors on natural carbonation.

This paper introduces the model concept and explains its structure including derivation, optimization and calibration. Over 163 data sets taken from a 10-year carbonation study were used in the model development and calibration. Only the experimental data that were based on outdoor natural exposure environment were employed in this research. Also in this study, the proposed model is compared with fib-Model Code 2010 using carbonation predictions generated from 346 data sets involving real world, highway structures. It is shown that the proposed model is comparably accurate and involves mainly basic tests with no major anticipated costs.

Keywords: Carbonation modelling; mathematical formulation; service life; reinforced concrete; supplementary cementitious materials; durability design

1. Introduction

Among the major concrete deterioration processes, corrosion of steel reinforcement is the most widespread and common source of degradation in concrete (PCA, 2002), and is induced either by carbonation from CO_2 in the atmosphere or by chloride attack. Prediction models can be used either at design stage for design of new structures or during repair and maintenance of existing structures. For example, models for shrinkage and creep prediction are now employed for design purposes and are recommended in internationally recognized codes such as ACI 209, 1997; BS 8110, 1997; RILEM B3, 1995; Wendner et al., 2013; CEB-FIP 1978, 1990a,b; AS3600, 2009; SANS 10100, 2000. With respect to reinforcement corrosion, no similar achievements have been made in modeling, although some significant progress has occurred over the past two decades, leading to proposal of some practical

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