Methodology of a predictive tool for corrosion prediction and risk-based maintenance in reinforced concrete structures.

Paulo Claude, Patrick Rougeau, Jonathan Mai-Nhu

CERIB, Epernon, France

Frédéric Duprat, Thomas De Larrard

LMDC, Toulouse, France

Louis Marracci, Pascal Guedon

Arcadis, Paris, France

Contact: P.CLAUDE@cerib.com

Abstract

This paper contributes to the understanding and prediction of the corrosion condition of steel in reinforced concrete structures while proposing solutions to reduce both financial and ecological costs associated with their maintenance. It presents a comprehensive tool and methodology for predicting maintenance and repair in maritime structures and bridges that are exposed to carbonation and chloride ingress. The tool incorporates various resources, including numerical and analytic models, as well as an experimental results database based on existing literature. This database facilitates the conversion of composition parameters into input parameters for the durability models. The application of this tool is demonstrated on a maritime structure in this paper. Deterministic and probabilistic predictions using the Monte Carlo method are utilized to determine the optimal time for inspection and maintenance operations.

Keywords: Reinforced concrete; Corrosion; Carbonation; Chloride ions ingress; Modelling; Experimental results database; Probabilistic approach.

1 Introduction

The maintenance and repair of civil engineering and maritime reinforced concrete structures pose significant challenges for project owners. One of the main causes of failure in these structures is the corrosion of steel reinforcements [1]. This corrosion process is typically divided into two stages: initiation and propagation [2]. The concrete that surrounds the steel reinforcement has a high pH value, typically above 13 for traditional concrete [3]. This alkaline environment ensures that the steel remains in a passivated state, which protects it from corrosion (pH > 9, Pourbaix diagram [4]). The initiation phase of corrosion occurs when aggressive species penetrate the concrete and alter its cementitious matrix. These substances can cause depassivation of the steel when they reach the vicinity of the reinforcement, leading to the propagation of corrosion.

Chloride ion penetration and carbonation are the two main factors responsible for the initiation of

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