Probabilistic and predictive performance-based approach for assessing reinforced concrete structures: the APPLET project

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Summary

The full set of researches and studies performed within the APPLET project has provided major results in terms of questioning and perspectives for the assessment and the management of concrete structures. The project has contributed to a knowledge improvement of the physical phenomena, an evaluation of the testing procedures, proposals for developing a probabilistic performance-based approach in standards, a deep thought about methodologies (performance-based approach, diagnosis…) which are of primary importance for stakeholders, and the development of a database on material properties. The APPLET project was dedicated to provide predictive models and methodologies. The studies have highlighted that the performance-based approach must be probabilistic in order to manage uncertainties and variability, both on the model parameters and on the electrochemical diagnosis. To base such an approach, a lot of care has been spent to characterize the variability of the most sensitive parameters through extensive experimental programs. The scientific results of the APPLET project constitute an essential step forward for the development of an efficient, rational and pertinent life-cycle analysis of concrete structures.
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1. Introduction

Reinforced concrete is one of the most used composite materials in civil engineering. The knowledge of its long-term performance and the influence of the close environment make difficult a precise assessment of the structural durability of these structures over time. A structure may be subject to physical, mechanical or chemical deteriorations. The chemical factors are often the most important since the concrete can be degraded by reactive processes (dissolution, expansion) of its constitutive components. Air, water or soils are known to help aggressive agents to move inside concrete and then to modify its properties. Some of these agents (chlorides or carbon dioxyde) are responsible of one of the most common degradation mechanism in concrete: corrosion. The amount of these agents can exceed a threshold value and the corrosion kinetics can become very important and the degradation can affect serviceability and structural safety. Generally speaking, the corrosion mechanisms can be divided into three distinct phases (Fig.1). The first one is the corrosion initiation (the aggressive agents modify the electrochemical environment of the reinforcement steels); the second phase consists in the development of corrosion inducing concrete cracking (due to the expansive properties of the corrosion products). The third phase is related to a noteworthy development of the corrosion that will affect the serviceability and the structural safety (i.e. the long term structural performance due to an excessive loss of cross-sections and ductility of the reinforcement steel. Nevertheless, the available information regarding these phenomena remains incomplete, due to uncertainties on the geometrical sizes, the material properties, the degradation

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