Performance of Concrete Structures in Argentine Environments

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Introduction

Reinforced concrete. performance throughout its useful life is related to the intrinsic characteristics of its component materials, their interrelationship and the nature and aggressive characteristics of the surrounding environment.

Theoretical knowledge about the causes and mechanisms of portland cement concrete failure, as well as of the techniques to minimise or eliminate their consequences, is available. Laboratory experiments and concrete performance in different environments have been extensively reported in the literature. It should be borne in mind that portland cement concrete has been used for over a century and there are currently constructions that date back to that age.

As regards reinforced concrete, field experience is much more limited since its intensive use is restricted to the past five decades and, therefore, most of the structures in service are not of significant age. Rebar corrosion is the most serious problem.

This paper is part of a research project that has been carried out for many years. Its objective is to study the field performance of structures built in the province of Buenos Aires, Argentina, located in different environments (rural, urban and industrial environments, and urban-marine subenvironments) in order to contribute to the knowledge of the "in situ" performance of the material.

Environmental characteristics

Temperature, rainfall and relative humidity conditions, as well as the number of clear, overcast and rainy days (National Weather Forecast - 1971-1980 period) for rural, urban and urban-marine environments are reported. Mean annual temperatures are in the range 14 - 16°C. Industrial environments are characterised by the presence of contaminants from chemical, petrochemical, and siderurgical industries.

Evaluation methods

Evaluated structures, located in a rural environment and urban-marine subenvironment, were selected at random, considering only the characteristics of the environment to which they were exposed. The evaluations of structures located in urban and industrial environments correspond to studies conducted according to the deterioration found. A visual inspection was made first in all cases. Depth of carbonation and rebar cover thickness were determined in some instances.

Concrete cores were extracted from some structures to study the mineralogical and petrographic characteristics of the aggregates. Tests were performed by spraying uranyl acetate to detect possible signs of the alkali-silica reaction (ASR). These tests were supplemented with analysis under an optical microscope. The physical, chemical and/or mechanical properties of the material were also established. The working scheme used follows the guidelines set by *DURAR Manual de Inspeccion, Evaluacion y diagnostico de Corrosion de Estructuras de Hormigon Armado.* CYTED.

Concluding remarks

From these findings, which will have to be supplemented with new surveys of structures, it can be concluded that:

a) Technological developments over the past years, especially those related to concrete performance in different aggressive environments, are not applied adequately in the field.

b) Most of the structures evaluated in different environments, which were constructed before 1950, exhibit adequate field performance, no rebar corrosion processes or concrete damage being detected.

c) In structures exposed to rural environments (moderately aggressive) signs of rebar corrosion can be detected at ages under 20 years due to lack of or insufficient cover depth that is carbonated. In structures located in aggressive environments (marine or industrial), the problem is more critical.

d) In structures executed with aggregates petrographically classified as non-reactive, no signs of reaction are detected, as expected. In other structures, where aggregates with high strained-quartz contents and undulatory extinction angles greater than 20° were used, external reaction signs (cracks, gels, etc.) appear at greater ages when the alkali content is high. It has been found that some aggregates have satisfactory performance in the structure although in accelerated tests they exhibit high reactivity or fall into a classification where late reacting deleterious aggregates coexist with others of innocuous characteristics.

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