Research & Development Highlights

93-207 Technical Series

Carbonation in Canadian Buildings

Introduction

Carbonation occurs when concrete reacts with naturally occurring carbon dioxide. This time-dependent phenomenon changes the passivity of concrete over steel, allowing the onset of corrosion of that steel and fracturing of the surrounding concrete. Carbonation of concrete has recently caused considerable interest in Europe and Australia, where it is known to be the cause of current problems. Although Canadian building stock is younger than the carbonation-troubled European structures, it was considered prudent to assess the likely occurrence of future carbonation-induced decay of steel-reinforced concrete in high-rise residential structures in Canada. In 1986, Canada Mortgage and Housing Corporation (CMHC) embarked on a three-phase study related to Canadian residential structures: funding a literature review and analysis of other research, an assessment of the likely impact of carbonation in Toronto, and this current national survey.

Research Program

This report presents the findings and conclusions from the third phase of the study and is based on core samples removed from a number of buildings in five additional major cities across Canada where concreting practices and climate conditions were thought to be conducive to carbonation. A separate report presents the preliminary findings from an assessment of existing commercial anti-carbonation coatings.

Findings

Concrete carbonation is generally progressing in all areas of the country, except the west coast. Corrosion of embedded reinforcing steel in concrete, as a result of carbonation, is not yet a major problem in Canada. Localized situations exist within buildings where carbonation-induced corrosion can occur.

An extremely simple and qualitative test using phenolphthalein has been demonstrated to be a reasonable indicator of the relative degree of penetration of carbonation. The actual depth of the carbonation front is typically deeper than indicated by this test.

The study findings confirm that concrete cover, and the quality of the concrete in that cover, are the most important factors in controlling corrosion of embedded reinforcing steel. Within the Canadian context, even if the carbonation front reaches the reinforcing steel depth, prompt initiation of corrosion does not necessarily result, but the potential for future corrosion is greatly increased.

Implications for the Housing Industry

It is unclear why concrete in Canada does not appear to have the same degree of carbonation-related corrosion as found in Europe. Explanations may rely on differences in the quality of construction, including the degree of consolidation of the concrete, the nature of the cementitious systems, and differences in the climate to which the external members were exposed.

Although the work provides an evaluation of structures built more than 15 years ago, the findings have value in regard to structures constructed since that time. Here there may be a potential for an increased susceptibility to carbonation because of the more recent and extensive use of supplementary cementing materials and the lower cement content used to produce concrete with a given strength. The new GSA Code A23.1-M90 emphasizes the use of good quality concrete and adequate depth of cover required is necessary.

There is no general or simple system for predicting whether a structure in a particular geographical area is susceptible to carbonation.

The study data show that problems will not normally be experienced in horizontal surfaces but can be expected in vertical surfaces with reduced concrete cover or localized reduced quality (e.g., cracked or poorly consolidated).

The study data provides an early warning of the situation in Toronto and five other Canadian cities. An orderly approach can be chosen for further research into Canadian carbonation-related materials and surface treatments.

In its current concern for writing concrete restoration standards guidelines and advisory documents, CSA should find value in the information derived from this study.

Teams experienced in investigating corrosion-related failure in Canadian concrete structures can be readily trained to address carbonation issues.

Housing Research at CMHC
Under Part IX of the National Housing Act, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.
This factsheet is one of a series intended to inform you of the nature and scope of CMHCS technical research program.

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Research Reports: Concrete Carbonation in Canadian
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Research Consultant: Robe, Halsall & Associates

A full report on this research project is available from the Canadian Housing Information Centre at the address below.

The Research and Development Highlights factsheet is one of a wide variety of housing-related publications produced by CMHC.

For a complete list of Research and Development Highlights, or for more information on CMHC housing research and information, please contact:

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