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Editorial

Sustainability of Civil Engineering Structures – Durability of concrete

A 1987 UN conference defined sustainable developments as those that "meet present needs without compromising the ability of future generations to meet their needs". What does this mean to the construction industries, which are among the largest consumers of materials and energy and also significant polluters? What are these industries doing to ensure that natural resources are not being depleted or damaged? These requirements pose momentous challenges to the construction industry and point to the needs for improved understanding through research, education, and effective communication amongst the interested parties. For the cement and concrete industries, there is a pressing societal need to address the depletion of raw materials, the deterioration of civil infrastructure, the rising cost of energy, and the accumulation of waste, to name a few of the challenges.

Sustainability of Civil Engineering Structures has been an ongoing problem for the construction industry and society on the global scale since the inception of codes and standards. It has taken the industry almost one century to develop codes and standards for designing structures that can sustain extreme loads, during which time it provided little considerations to the ageing and deterioration of the structures. The same argument can be extended to the academic institutions where engineers have been trained in the areas of structural engineering and engineering mechanics but have been given little training on the performance and durability of civil engineering materials. Unfortunately, we cannot afford another century to develop a new generation of codes and standards nor can we afford to continue with the same training principles for our professionals. It is without a doubt an overwhelming problem that the industry must overcome for it to become a sustainable industry and part of a sustainable society.

Although the durability of concrete structures, or the lack of it, surfaced in the 1980's, the design codes and standards have not been able to address this requirement for many reasons. Durability of concrete depends on the quality of the material, quality of the construction, quality of the design, and the exposure conditions. With the exception of design, these requirements are difficult to characterize with certainty because they are both inter- and intra-dependent, and because the quality of the construction and to a lesser extent the quality of the material, depend on the human factor that remains a source of uncertainty. Nonetheless, new standards are being developed by ACI, CSA and ISO on durability and environmental management for concrete and concrete structures, as a first step to address sustainability requirements.

This special issue of Cement and Concrete Composites is a compilation of best papers that were presented on durability of concrete at the 2nd Canadian Conference on Effective Design of Structures under the theme Sustainability of Civil Engineering Structures, held in June 2008 at McMaster University, Canada. The twelve papers that were selected provide a spectrum of topics being researched in North America and Europe on durability and sustainability of concrete structures. They include research on nano and micro-structure of concrete, service life and durability prediction models for concrete and concrete structures, models for characterizing the rheological properties of fresh concrete, corrosion monitoring techniques for reinforced concrete structures, and the reuse and recycling of materials from construction and demolition waste and post-consumer waste in concrete.

Understanding the nano and micro-structure of concrete is paramount for understanding the root causes of the durability problems and provides a critical step for developing remedies to improve the long term performance of concrete. Two papers are included on this emerging research field. Three papers present different modeling techniques for predicting the service life of concrete exposed to chlorides. A model for predicting the scaling resistance of dry cast concrete due to freezing and thawing in the presence of deicing salt is the subject of one of the papers. One paper assesses the capabilities of published models for predicting the rheological properties of fresh concrete. It has been shown that rheological properties of fresh concrete can be used to control its quality. Corrosion of steel reinforcement is the number one durability problem for concrete. Monitoring of steel corrosion has been employed to ensure the durability of reinforced concrete structures. However, the types of sensors and measurement techniques used to assess corrosion activities have been questionable. To address this dilemma, one paper evaluates the results of reinforcement corrosion that was collected by embedding sensors in reinforced concrete structures. Construction and demolition waste is 15–30% of solid waste entering landfills in Europe, Canada and the United States. The opportunities and challenges for reuse and recycling of construction materials and post-consumer waste are discussed in four of the twelve papers. These papers reflect the needs of the cement and concrete industries and aim to provide solutions to the aforementioned challenges.

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