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Editorial

Fire represents one of the most severe conditions encountered during the life time of a structure and therefore, the provision of appropriate fire safety measures for structural members is a major safety requirement in building design. The basis for this requirement can be attributed to the fact that, when other measures for containing the fire fail, structural integrity is the last line of defence.

In general, concrete structural members exhibit good performance under fire situations. In most cases, structural members used to be made of traditional normal strength concrete (NSC). However, in the last two decades, there have been significant advances in concrete technology. The construction industry has shown great interest in the use of high-strength concrete (HSC), due to improvements in structural performance, such as high-strength and durability, that it can provide, compared to traditional NSC. HSC is typically characterized by high-strength, good workability and durability. Studies show, however, that the performance of HSC is different from that of NSC, and may not exhibit the same level of performance in fire.

Furthermore, the spalling of concrete under fire conditions is one of the major concerns in HSC. Ths spalling of concrete, exposed to fire, has been observed under laboratory and real fire conditions in HSC specimens. Spalling is theorized to be caused by the build-up of pore pressure during heating. HSC is believed to be more susceptible to this pressure build-up because of its low permeability compared to NSC. Data from various studies show that predicting the fire performance of HSC, in general, and spalling, in particular, is very complex since it is affected by a number of factors.

In the aftermath of the September 11 terrorist attacks on the World Trade Center and the Pentagon, several issues relating to building performance, under extreme conditions (structural, material, fire), have come to the forefront. Since intense fires played a major role in the collapse of the twin towers and other buildings, the issue of material performance under extreme fire conditions has attracted significant attention from the research and engineering community.

The aim of this special issue is to present some of the latest research in the area of fire resistance of concrete. The six papers in this issue present results from both experimental and numerical studies on the various fire resistance issues, ranging from cracking in concrete at elevated temperatures to an optimum solution for overcoming spalling in HSC concrete members exposed to fire.

The first two papers deal with thermal-induced stress and associated cracking in cement-based composite at elevated temperatures. In the first part of the paper, the authors present the details of the *2-D* mesoscopic thermo-elastic damage model, and discuss thermal cracking around a single inclusion due to different coefficients of thermal expansion (CTE), strength properties, and heterogeneity. In the second part of the paper, the authors present the results of numerical studies to quantify and qualify the effects of the arrangement, shape (circular and irregular) and CTE of multi-inclusions on the thermal stresses and associated cracking in a cement-based composite. Also, the authors use these findings to discuss the thermal cracking histories of concrete with different aggregate grading arrangements.

The third paper presents a new concept for assessment and design of reinforced concrete floor systems under fire conditions. The paper introduces a three-step method to analyse the limit capacity of laterally-restrained, reinforced concrete slabs in fire. An ultimate limit state for fire loading is proposed and is used as the basis for deriving the ultimate capacity of the slab for any given fire.

The fourth paper deals with the development of a computer model for predicting the behaviour of high-strength concrete columns exposed to standard fires, a typical scenario in building columns. A simplified approach is proposed to account for spalling in HSC under fire conditions. The paper also contains results from fire resistance experiments on HSC columns and the validation of the computer program against test data.

The fifth paper presents a probabilistic approach for the assessment of deterioration and explosive spalling of high-strength concrete beams exposed to fire. The authors group the factors that cause explosive spalling into three different levels and statistically assess the significance of the individual and interacting factors.

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The last paper presents solutions for overcoming spalling in HSC concrete blocks subjected to hydrocarbon fires, a typical scenario in offshore structures. Based on detailed experimental studies, the authors present an optimum amount of polypropylene fibres to be used in lightweight high-strength concrete members to prevent spalling when exposed to hydrocarbon fires.

The papers in this special issue draw on the experience and special knowledge of academics and practitioners both in the public and private sectors in the UK, Hong Kong (China), Canada, Taiwan and the United States. The efforts of these authors and the critical assessment of the papers by reviewers, whose time and expertise are reflected in the quality of this publication, is gratefully acknowledged.

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