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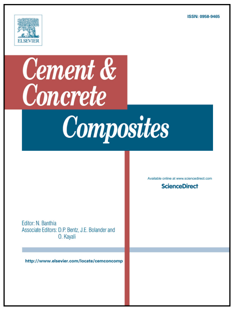

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Deterioration and Recovery of FRC after High Temperature Exposure

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Abstract

In general, physical properties of concrete deteriorate after high temperature exposure and this is a result of some morphological changes occur in microstructure of concrete. After heating some new phases occur in concrete and these have a tendency to react with water and carbon dioxide at the post heating stage. The most common one is expansive rehydration of CaO by turning into $Ca(OH)_2$ and this reaction should be avoided for concrete of which mechanical properties deteriorated after heating. Since, $Ca(OH)_2$ is a soluble product in water, water re-curing after high temperature exposure can be beneficial. Also using steel fibers in concrete may be useful to restrain the stresses occurred due to this expansion and polypropylene fibers can be used to reduce the pore pressure in concrete during heating. Therefore, 8 groups of 0.45 w/c ratio of concrete were produced by using different fibers and air entraining admixture. Cubic concrete specimens (15 cm on a side) were cast and only one face of the specimens was subjected to 1000 °C. K-Type thermocouples were placed in concrete specimens to monitor temperature change during heating. Two re-curing methods, air and water, were applied to specimens following the cooling period. SEM, EDX, XRD and TGA investigations were conducted to evaluate the morphological changes in concrete. Then effects of these changes on the residual mechanical properties of concretes were evaluated.

1. Introduction

Temperature increase in a material produces additional strains and stresses, which may affect mechanical behavior of the material. In cement-based materials there is another mechanism influencing the behavior of the material during temperature exposure. Cement-based materials, especially structural concrete, contain high amount of water molecules in their crystal structures. Breaking of water bonds due to increasing temperature may trigger morphological changes in microstructure resulting in deterioration of concrete. Also evaporated free water molecules cause high vapor pressure in the pores of concrete and sometimes this internal pressure reaches tensile strength of concrete. On the other hand, concrete is incombustible and performs satisfactorily for a long time under fire and no toxic fumes are emitted [1]. Therefore, concrete has good properties in terms of fire resistance. However, various kinds of deteriorations were observed on the concrete specimens, which were subjected to fire or high temperatures such as spalling, crazing, cracking, color changes, mass and strength losses due to aforementioned changes in its morphology and physical structure [2-7]. Also, these deteriorations may be seen following the cooling period [7, 8]. Because of the fact that, the stable microstructure of concrete turns to reactive phases (especially CaO and C_2S) after fire. These phases react with water or carbon dioxide and produce new formations in concrete, which may result in physical changes. As a result, a detailed repairing process such as replacing damaged layer of concrete with fresh concrete can be essential after fire.