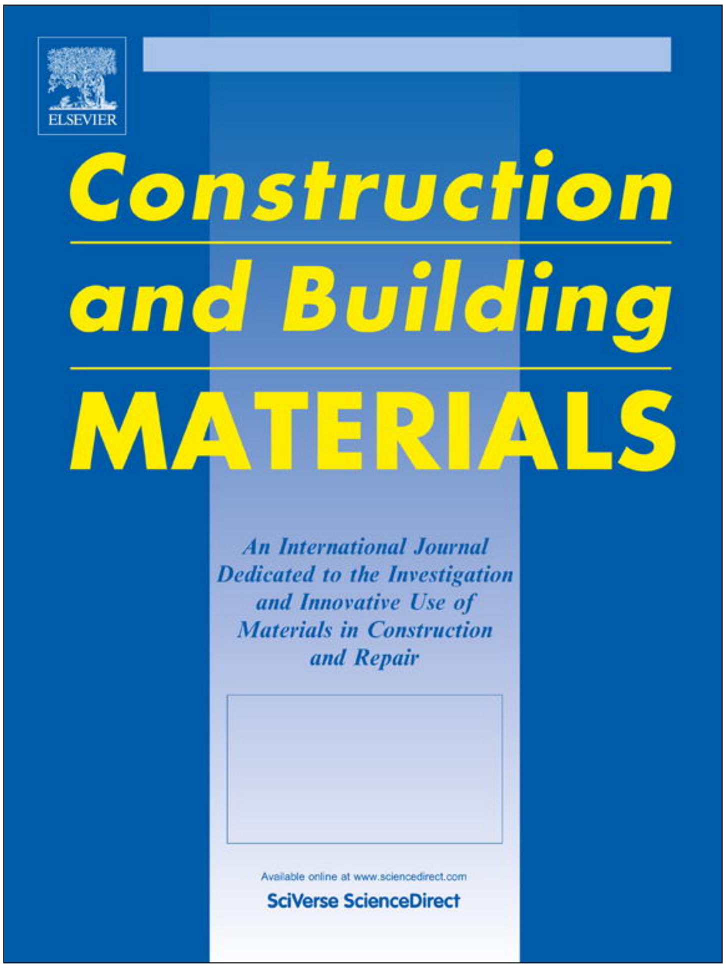
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Effect of delaying addition time of SMF superplasticizer on the physico-mechanical properties and durability of cement pastes

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ABSTRACT

This research aimed to investigate the influence of delaying addition time of laboratory prepared sulphonate melamine formaldehyde (SMF) superplasticizer on the physico-mechanical characteristics and durability of cement pastes subjected to elevated temperature up to 800 °C, or immersed in 4% $MgSO_4$ and 4% $MgCl_2$. The compressive strength increases with delayed addition time at 7.5 min up to 90 days. The cement pastes containing 1.0 mass% SMF superplasticizer, with delayed addition time at 7.5 min, has highest compressive strength, bulk density and lower total porosity. The presence of SMF superplasticizer with delaying addition time process of mixing increases the compressive strength, bulk density and decreases the total porosity. These work together to produce a compact structure, inhibiting the chloride and sulphate ions penetration, hence the total sulphate and chloride contents decrease.

1. Introduction

The water–cement system is highly sensitive to superplasticizers addition of small amounts of superplasticizers enhance the efficiently of workability properties, but they often associated with strong, undesired retardation phenomena of the setting of the cement paste. Superplasticizers are frequently used in concrete technology to improve the workability of concrete for demanding applications. The addition of superplasticizers aimed to two objectives; first, controlling the flow properties and second, the reduction of the water to cement ratio while maintaining workability to reach high strength and durability. It is well known that the delayed addition of superplasticizers in cement-based mixes enhances significantly the effectiveness of their dispersing power in comparison to the direct addition [1–4]. Also, delayed addition modifies the microstructure (rather than simultaneous addition) or vigorous mixing (rather than hand-mixing) that either influences the hydration of cements in the presence of superplasticizer or strongly modify the microstructure [5]. This is because in the latter a higher fraction of superplasticizer molecules becomes entrapped in early-forming hydrate layers and, consequently, lose their action as dispersing agents. Flatt and Houst [6] proposed that superplasticizer forms organomineral phases by intercalation, coprecipitation, or micellization around the cement particles. Superplasticizer either absorbed by hydrated phases or incorporated into organomineral phases is expected to provide no dispersing effect.

Uchikawa et al. [2] confirmed that sulphonate naphthalene formaldehyde (SNF) polymer is adsorbed more particularly on the C_3A hydration products, when the immediate addition procedure is adopted. The superplasticizing effect is improved with SNF delayed addition because of the lower adsorption of the polymer on the C_3A hydration products. The influence of the delaying addition time on the rheological properties of cement pastes was investigated [4,7].

The literature survey has a limited data about the effect of the delayed addition of superplasticizers on the durability of cement in aggressive attack or at elevated temperatures.

The present investigation evaluated the influence of delaying SMF addition time of laboratory prepared sulphonate melamine formaldehyde superplasticizer (SMF) on the physico-mechanical properties and durability of cement pastes subjected to elevated temperatures up to 800 °C, and immersed in 4% magnesium sulphate and chloride solutions.

2. Materials and methods

The materials used in this work were sulphate resisting cement (SRC) provided from El-Masria Cement Company, Suez, Egypt and condensed silica fume (SF) from Ferrosilicon Alloys Company (Edfo, Aswan, Egypt). The chemical composition of these materials is shown in Table 1.

Sulphate resisting cement (SRC) was mixed with 10 mass% silica fume in a porcelain ball mill with four balls for 2 h using a mechanical roller to insure complete homogeneity. Different mixes were mixed with the required water of standard consistency according to ASTM Designation: C187–92, 2008 [8]. The polymer dosage of the admixture was chosen as 0.0, 0.5, 1.0, 1.5 and 2.0 mass%; the standard water of consistency were 28.7%, 27.5%, 19.5%, 17.5% and 17.0% respectively [9]. Only 75% of the mixing water was initially added and mixed for 3 min, then the rest added after

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