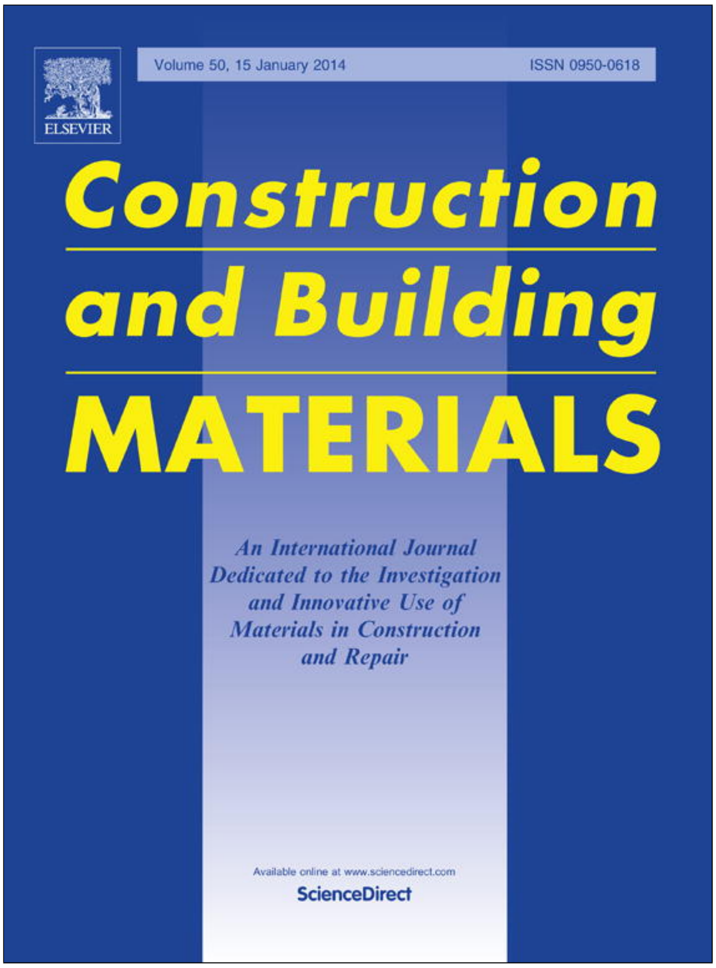
Volume 50, 15 January 2014
ISSN 0950-0618
ELSEVIER
Construction and Building MATERIALS
An International Journal Dedicated to the Investigation and Innovative Use of Materials in Construction and Repair
Available online at www.sciencedirect.com
ScienceDirect

Construction and Building Materials 50 (2014) 281–290

Contents lists available at ScienceDirect

Construction and Building Materials

journal homepage: www.elsevier.com/locate/conbuildmat

Impact of delayed addition time of SNF condensate on the fire resistance and durability of SRC–SF composite cement pastes

H. El-Didamony [a], I. Aiad [b], Mohamed Heikal [c,d,*], S. Al-Masry [a]

[a] Chemistry Department, Faculty of Science, Zagazig University, Zagazig, Egypt
[b] Petrochemical Department, Egyptian Petroleum Research Institute, Cairo, Egypt
[c] Chemistry Department, College of Science, Al Imam Mohammad Ibn Saud Islamic University (IMSIU), Riyadh, Saudi Arabia
[d] Chemistry Department, Faculty of Science, Benha University, Benha, Egypt

HIGHLIGHTS

- 1.0% SNF with 7.5 min delayed addition time work together to produce a compact structure.
- The increase the content of SNF enhances the compressive strength and bulk density of cement pastes.
- Delayed addition time, enhance the compressive strength up to 800 °C.
- Formation of compact structure and enhances the durability of the cement paste.
- Delayed addition inhibits the accessibility of penetration Cl^- and SO_4^{2-} into the cement paste.

ARTICLE INFO

Article history:
Received 3 August 2013
Received in revised form 9 September 2013
Accepted 24 September 2013
Available online 17 October 2013

Keywords:
Superplasticizers
Delayed addition time
Durability
Elevated temperatures
Bulk density
Compressive strength

ABSTRACT

This work aimed to investigate the impact of delayed addition time (DAT) of sulphonated naphthalene formaldehyde (SNF) superplasticizer on the durability and fire resistance of SRC–SF composite cement pastes immersed in both 4% $MgCl_2$ or 4% $MgSO_4$ solutions as well as at elevated temperatures up to 800 °C, respectively. The results indicate that, the compressive strength and bulk density of cement paste increase with DAT at 7.5 min up to 90 days in tap water. The cement pastes admixed with 1.0 mass% of SNF condensate at delayed addition time 7.5 min, which cured in both 4% $MgCl_2$ or 4% $MgSO_4$ for 1 year or thermally treated up to 800 °C, has the highest durability and fire resistance. This is mainly due to that, the presence of superplasticizer with delayed addition process of mixing, reduces the water demand for standard consistency, decreases the total porosity, and increases the bulk density and consequently the compressive strength of cement pastes. These factors work together to modify the microstructure producing homogeneous compact closed structure. Total sulphate and chloride contents decrease with SNF content and DAT, due to decrease the accessibility of SO_4^{2-} and Cl^- to penetration into the pore system to form ettringite and chloroaluminate hydrate which expands and softens the cement paste matrix at later ages.

1. Introduction

High performance concrete (HPC) is a novel construction material which recently has been developed. The applications of HPC in power, gas, oil and nuclear industries are increasing worldwide with the time, due to its superior structural performance, environmental friendliness and low impact on energy utilization [1,2]. The durability of cementing materials has been a major concern of civil engineering professionals over the last few decades [3–5].

Cements with low C_3A as well $Ca(OH)_2$ contents generally, exhibit good performance in sulphate environment. It is possible to produce, durable concrete with long-term strength by partial replacement of cement with supplementary cementitious materials (SCMs), such as fly ash (FA), silica fume (SF), and granulated blast-furnace slag (GBFS) [6–8].

The superior performance of pozzolanic cements containing SCMs over plain cements in minimizing sulphate and chloride attack is mainly due to the following: (i) the pozzolanic reaction of SCMs, which reduces gypsum formation; (ii) low C_3A content, i.e. dilution effect; (iii) the reduction of pH value therefore, the ettringite becomes less expansive; (iv) the formation of additional amounts of CSH, which produces a coating film on the alumina-rich and other reactive phases, thereby hindering the formation

* Corresponding author at: Chemistry Department, College of Science, Al Imam Mohammad Ibn Saud Islamic University, Riyadh, Saudi Arabia. Tel.: 00966534484605; fax: 00966112591678.
E-mail address: ayaheikal@hotmail.com (M. Heikal).

0950-0618/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.conbuildmat.2013.09.034