Cement and Concrete Research 41 (2011) 1167–1176

Contents lists available at ScienceDirect

Cement and Concrete Research

journal homepage: http://ees.elsevier.com/CEMCON/default.asp

Effects of mixing energy on technological properties and hydration kinetics of grouting mortars

Keisuke Takahashi [a,*], Thomas A. Bier [b], Torsten Westphal [b]

[a] UBE Industries, Ltd. Seavans North Bldg, 1-2-1, Shibaura, Minato-Ku, Tokyo 105-8449, Japan
[b] Institut für Keramik, Glas- und Baustofftechnik der TU Bergakademie Freiberg, Germany

ARTICLE INFO

Article history:
Received 19 February 2011
Accepted 19 July 2011

Keywords:
Mixing energy
Rheology (A)
Hydration products (B)
Shrinkage (C)
Admixture (D)

ABSTRACT

During slurry preparation, effects of certain phenomena on fluidity and hardening characteristics of cement-based grouts have been reported. Deterioration of fluidity and hardening will affect the slurry performance, quality of workmanship and result in subsequent structural defects. There has been little research conducted on the effects of mixing energy during slurry preparation which has focused on the reasons or mechanisms for changes in characteristic properties. This work describes and measures the effects of several mixing parameters on properties of grouting materials, such as fluidity, hardening characteristics, shrinkage, heat of hydration, ion elution and crystallographic structure using X-ray diffraction and SEM. The results indicate that long mixing processes cause deterioration in fluidity and setting properties. These observations can be explained by acceleration in hydration kinetics and changes in microstructures and subsequent changes in dispersion states due to different mixing durations.

1. Introduction

Grouting materials are self-flowable mortars. Some construction methods involving earthquake resistant design and sewage drain rehabilitation use grouting materials to fill and reinforce gaps and cavities [1]. For these applications grouts need to have good fluidity and stable hardening characteristics to ensure their optimum placement and flawless integrity of construction. Continuous mode equipment and discontinuous mode equipment such as batch type mixers and concrete mixers are usually used to produce grouting slurries. Fernandesa et al. reported that slurry characteristics differed with the equipment types due to differences in mixing capacities [2]. It has been reported that certain phenomena during slurry preparation and pumping conditions can adversely affect fluidity and hardening characteristics. The deterioration of fluidity and hardening will cause filling problems and subsequent structural defects. Very little research on the influence of mixing energy during slurry preparation and pumping has focused on the reason or mechanisms for changes in characteristic properties. Sugiyama and Uomoto suggested that differences in dispersion conditions, depending on dispersing agent, as well as differences in the form of hydrates, affected micro-pore structures and strength of cement pastes [3]. Martinez-Ramirez et al. described slurry preparation using continuous mode equipment and suggested that slurry preparation influenced some results such as apparent density, strength and shrinkage [4]. Baskoca et al. investigated relationships between mixing time and slump loss and strength using a concrete mixer [5]. Tsutsui and Ouchi examined relationships between pumping distance and fluidity of concrete [6].

All this research points to the fluidity and hardening of the slurry being affected by the mixing energy during the slurry preparation and pumping, which is dependent on the equipment used and the composition of grouting materials. This investigation into the reasons for the mechanisms of change in characteristic properties is therefore a significant one. The results of this work should consequently ensure ideal placement of grouting and perfect, integral construction.

The effects of several mixing parameters on properties of grouting materials such as fluidity, hardening characteristics, shrinkage, heat of hydration, and ion elution are described and measured using X-ray diffraction (XRD) and scanning electron microscopy (SEM). Our objective is to evaluate whether the long mixing processes cause deterioration of fluidity and setting properties. These observations can be explained by acceleration in hydration kinetics, changes in microstructures and subsequently changes in dispersion states due to different mixing durations.

2. Experimental

2.1. Materials

The grouting materials consist of cement, aggregate and admixture.

* Corresponding author.
E-mail addresses: akaherudasen2000@yahoo.co.jp (K. Takahashi), Thomas.Bier@ikgb.tu-freiberg.de (T.A. Bier), Torsten.Westphal@ikgb.tu-freiberg.de (T. Westphal).

0008-8846/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.cemconres.2011.07.005