Construction and Building Materials 38 (2013) 101–109

Contents lists available at SciVerse ScienceDirect

Construction and Building Materials

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

Mechanical, microstructure and rheological characteristics of high performance self-compacting cement pastes and concrete containing ground clay bricks

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HIGHLIGHTS

- Presence of SCC admixture, strength of concrete increases up to 28 days.
- Increase of powder content of GCB, the compressive strength of concrete increases.
- Pastes made with 12.5% and 37.5% GCB show higher strength with SCC at 28–1095 days.
- Increase of GCB content increases the shear stresses values in cement pastes.
- The microstructure of GCB–OPC displayed a more dense arrangement, enhances the compressive strength.

ARTICLE INFO

Article history:
Received 30 April 2012
Received in revised form 8 July 2012
Accepted 22 July 2012
Available online 21 September 2012

Keywords:
Self-compacting concrete
Compressive strength
Rheology
Microstructure

ABSTRACT

The work aimed to utilize ground clay bricks (GCBs) in the production of self-compacting concrete. Physico-mechanical, rheological and microstructure of cement pastes and concrete were investigated. Total powder contents were 400 kg/m^3, the cement was replaced by GCB by 0.0, 50, 100 and 150 kg/m^3. The compressive strength of concrete decreased with GCB content in the absence of self-compacting concrete (SCC) admixture, whereas, increases in the presence of SCC admixture up to 28 days. Increase of GCB content up to 250 kg/m^3, the compressive strength of concrete increases. GCB enhances the compressive strength due to the pozzolanic reaction to produce additional CSH, which precipitated in some open pores. The compressive strength of OPC pastes increase with SCC admixture up to 1.5 mass%, whereas decreases with SCC admixture up to 2 mass%. On the other hand, cement pastes made with 12.5% and 37.5% GCB in the expanse of OPC cement show higher compressive strength with SCC admixture at 28–1095 days. The efficiency of SCC admixture decreases as GCB content increases up to 12.5%, whereas the efficiency increases with GCB content up to 37.5%. The presence of SCC superplasticizer, the microstructure displayed a more dense arrangement of microcrystalline C–S–H as the main hydration products with sheets of $Ca(OH)_2$ as shown in the micrograph. Useful conclusions and recommendations concerning use of 30–40 mass% of GCB in self-compacting concrete.

1. Introduction

Self-compacting concrete (SCC) is considered as a concrete that compacted under self-weight with little or no vibration effort and cohesive enough to be handled without segregation or bleeding. SCC used to facilitate and ensure proper filling and good structural performance of restricted areas and heavily reinforced structural [1,2]. So, SCC has been increasingly used in concrete construction. The principal reasons for the growing interest is because of the ease in placement in heavily reinforced areas which are otherwise difficult to access, the reduced effort in accomplishing some of the casting tasks and the significant reduction of the construction period. Additionally, the technology has improved the performance in terms of hardened material properties such as strength, durability, and surface quality [3].

SCC has many technical, social, and overall economical advantages; however its cost could be 2–3 times than normal concrete. To reduce the cost of SCC use of mineral admixtures such as fly ash, limestone filler, ground clay bricks (GCBs) and blast-furnace slag could be used to increase the slump of the concrete mix as well as improve the mechanical properties and durability of concrete. The incorporation of fly ash also reduces the need for viscosity modifying chemical admixtures and reduces cracking of concrete due to the low heat of hydration heat of hydration of the cement

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http://dx.doi.org/10.1016/j.conbuildmat.2012.07.114