Construction and Building Materials 95 (2015) 486–496

Contents lists available at ScienceDirect

Construction and Building Materials

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

Effect of fineness and dosage of aluminium powder on the properties of moist-cured aerated concrete

E. Muthu Kumar, K. Ramamurthy *

Building Technology and Construction Management Division, Department of Civil Engineering, Indian Institute of Technology Madras, Chennai 600 036, India

HIGHLIGHTS

- Behaviour of different fineness of aluminium powder were studied.
- Assessing the rate of aeration with respect to change in fresh density.
- Variation in dosage of aluminium powder and water–cement/solids ratio affects the fresh and hardened properties.

ARTICLE INFO

Article history:
Received 13 March 2015
Received in revised form 28 June 2015
Accepted 14 July 2015
Available online 25 July 2015

Keywords:
Aluminium powder
Aerated concrete
Fineness
Workability
Compressive strength
Water absorption

ABSTRACT

The influence of fineness of aluminium powder through an evaluation of variation in the workability of the mix, rate of aeration and fresh density with time, dry density, compressive strength and water absorption of aerated cement paste and mortar were studied. Flow table test clearly distinguishes variation in initial workability of the mixes for the variations in water–cement ratio, whereas the Marsh cone test is suitable for reflecting the reduction in workability of the mix with time caused by aeration. The dosage of aluminium powder required to achieve a desired density reduces with an increase in its fineness. Inconsistent with the dosage of aluminium powder required, for a given dry density or compressive strength of aerated cement paste or mortar, the water absorption increases with fineness of aluminium powder. For a given fineness of aluminium powder, appropriate dosage and water–cement ratio required has to be identified based on the desired density and strength, or strength to density ratio.

1. Introduction

A systematic classification of research on aerated concrete has been presented by Narayanan and Ramamurthy [1] (2000). Some of the salient contributions reported after this review, are summarized below. In order to enhance the performance of aerated concrete, several additives were tried, viz., (i) air-cooled slag as a replacement for sand and lime [2], (ii) zeolite as replacement for quartzite to improve the thermal conductivity [3], (iii) the effect of clayish crushed stone along with lime to study the strength and homogenous and dense structure system [4], (iv) bottom ash as replacement of cement to enhance the physical, mechanical and microstructure properties of autoclaved aerated concrete [5], (v) studies on temperature variation in aerated concrete to observe the mechanical properties and volumetric stability [6], (vi) replacement of cement with palm oil fuel ash and the effect of aluminium powder and superplasticizer on the strength and density of aerated concrete [7], (vii) natural zeolite as a replacement of quartz particle and bubble generating agent [8], (viii) incinerated bottom ash as replacement of aluminium powder and as a source of silica [9], (ix) durability and thermal properties of autoclaved aerated concrete (AAC) [10], (x) improving energy efficiency by using powder industry waste [11], (xi) use of copper tailings and blast furnace slag to reduce the CO_2 emission in production of AAC [12], (xii) short polymeric fibres used as internal reinforcement for non-autoclaved aerated concrete (NAAC) [13] and (xiii) phosphogypsum used as activator and filler in NAAC [14]. The aeration level is reported to be influenced by a dosage of aluminium powder, alkalinity of cement and water–cement ratio [1].

The compressive strength is reported to be influenced by the shape, size and method of pore formation, age of the sample, direction of loading, characteristics of ingredients used and method of curing [15]. Earlier studies considered the influence of dosages of aluminium powder by keeping the fineness of aluminium powder constant [16].

An in-depth study on the influence of fineness of aluminium powder must include the effect of water content and the dosage

* Corresponding author.
E-mail address: vivek@iitm.ac.in (K. Ramamurthy).

http://dx.doi.org/10.1016/j.conbuildmat.2015.07.122
0950-0618/

Table 1
Chemical composition of Portland Pozzolana Cement.

Elements	CaO	SiO_2	MgO	Al_2O_3	Fe_2O_3	SO_3	K_2O
Composition mass (%)	51.98	26.85	0.86	10.78	5.67	2.97	0.89

Table 2
Previous studies using range of dosage of aluminium powder.

Author (year)	Aluminium powder dosage (%)		Dry density (kg/m^3)
	Min.	Max.	
Yang et al. [14]	0.05 (s)	0.1 (s)	560–840
Huang et al. [12]	0.1 (s)		610.2
Holt and Raivio [18]	0.2 (c)	0.5 (c)	450–800
Bonakdar et al. [13]	0.2 (c)	0.5 (c)	500–750
Narayanan and Ramamurthy [1]	0.25 (c)	0.5 (c)	800–1600

(s) – by weight of solid, (c) – by weight of cement.

of aluminium powder. This paper focuses on evaluating the variation in workability of the mix with time, rate of aeration, fresh and hardened density, compressive strength and water absorption of aerated concrete, both using paste and mortar studies, while studying the influence of fineness and dosage of aluminium powder.

2. Materials and methods

Portland Pozzolana Cement (PPC) conforming to IS 1489 [17], and potable water available in the laboratory have been used. The chemical composition of cement is presented in Table 1. For mortar studies, a cement–sand mix of 1:1 by weight has been adopted using pulverised sand passing through 600 micron with specific gravity of 2.4. The range of water–cement/solids ratio has been determined based on preliminary studies, i.e. the water–cement ratio was varied from 0.4 to 0.8 for studies on cement paste, whereas the water–solids ratio for mortar studies was varied between 0.3 and 0.6 (instead of the conventional practice of water to cement ratio, water to solids ratio has been used as the basis). Commercially available aluminium powder with four grades of fineness, designated as C50, C75, C85 and C95 (C50

Table 3
Composition of aerated cement paste and mortar.

Parameters	Aerated cement paste	Aerated mortar
Raw material	Cement	Cement + pulverised sand (600 µ)
Aluminium powder dosages by weight of cement	0.25–0.5%	0.25–0.5%
Aluminium powder fineness	C50, C75, C85 and C95	C50, C75, C85 and C95
Water–cement/solids ratio	0.4–0.8	0.3–0.6

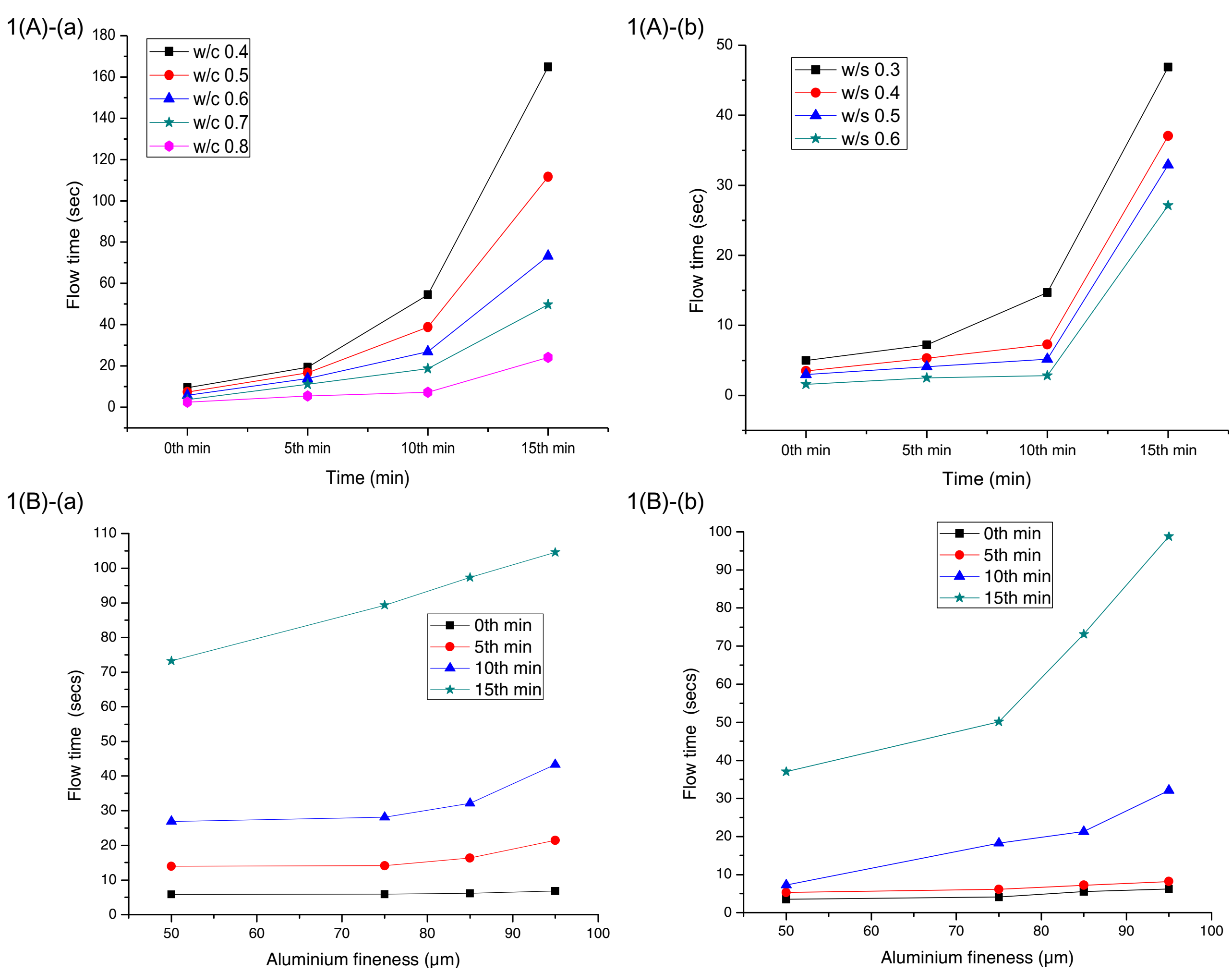

Fig. 1. (A) Flow time for aerated cement paste (a) and aerated mortar (b). (B) Flow time for aerated cement paste (a) and aerated mortar (b).