International Journal of Scientific Engineering and Technology (ISSN : 2277-1581)
Volume No.3 Issue No.11, pp : 1367-1370 01 Nov. 2014

A Study on the Properties of Air-Entrained Concrete for Masonry Blocks

Indu Susan Raj, Dr. Elson John
Civil Engineering Department, Kerala (India
indususanraj@yahoo.com, elson78@gmail.com

Abstract: ***The aim of this study is to produce a light weight concrete for developing masonry block. Six dosages of aluminium powder (0.1, 0.2, 0.5, 1, 2 and 5%) by weight of cement are used to produce aerated (gas) concrete. Based on earlier investigations, cement to fine aggregate ratio of 1:1 have been adopted and water cement ratio is fixed as 0.5 by trial and error method. The wet and dry densities were observed. Addition of more than 5% aluminium powder reduces compressive strength and densities drastically. From this research, cement blocks were produced and compared with commercially available concrete blocks for its densities and compressive strength and found that the blocks made with aerated concrete is as good as or better than the conventional solid blocks.***

Keywords: *Aluminium powder, cement blocks, compressive strength, density, water cement ratio*

I INTRODUCTION

A. Light weight concrete

Light weight concrete can be defined as a type of concrete which includes an expanding agent which increases the volume of mixture while reducing the dead weight. It is lighter than conventional concrete with a dry density below 2000 Kg/m^3 .The main specialties of the light weight concrete are the low density and low thermal conductivity. There are many types of light weight concrete which can be produced either by using light weight aggregate or by using an air entraining agent. In this research, aluminium powder has been used as the air entraining agent. The fine powder of aluminium reacts with the calcium hydroxide in the cementatious system produces hydrogen gas. This hydrogen gas in the mix gives the cellular structure and makes the concrete lighter than the conventional concrete.

B. Aerated (Gas) concrete

Aerated concrete is obtained by a chemical reaction generating a gas in fresh mortar, so that when it sets it contains a large number of gas bubbles. Finely divided aluminium powder in various percentages by weight of cement is used for producing aerated concrete. The reaction of aluminium powder with a hydroxide of calcium or alkali from the cement liberates hydrogen, which forms bubbles in the wet mix. The bubbles expand the cement paste and concrete rises. The mix hardens with the voids left by the bubbles intact.

C. Objectives

The objectives of this study are:

1) To develop a light weight concrete with air entraining agent.

2) To study the properties of light weight building blocks using light weight concrete

D. Scope of the project

1) This study is limited to the performance based only on a single brand of super grade Portland Pozzolana cement.

2) This study is confined to a single air entraining agent from a single manufacturer that is aluminium powder.

3) The study is done for single cement: sand ratio (1:1).The influence of using aluminium powder as a partial replacement of cement in other ratios is not covered in the present study.

4) The percentage replacement of aluminium powder is limited to six categories that are 0.1, 0.2, 0.5, 1, 2 and 5% replacement of cement. The effects which can be observed in different other percentages of replacements were not included in the present study.

5) Water- cement ratio of 0.5 is used in mortar mix.

6) Study is restricted to a particular type of superplastizier.

II MATERIALS

A. Cement

Cement is the most important ingredient of concrete which acts as a binding agent between the aggregate and enhances the strength. In this study, Portland Pozzolana Cement (PPC) was used.

Table 1 Physical Properties Of Cement

Specific gravity	2.87
Compressive strength of cement mortar cubes (Mpa)	
3days	17.4
7days	20.4
28 days	44

B. Fine aggregate

In this research, natural river sand is used as fine aggregate.

Table 2 Physical Properties Of Fine Aggregates

Specific gravity	2.52
Water absorption (%)	1.15
Fineness modulus	3.26

C. Aluminium powder

Fine, uniform, smooth metallic powder free from aggregates available from market is used in this research and it has an atomic weight of 26.98.

D. Superplastizier

The dosage of superplastizier adopted is 0.2 percentages by weight of cement and viscocrete 10R3 used as superplastizier in this research.

III Experimental Works

A concrete mix having the proportions of (1:1) by weight of cement and sand with water cement ratio of 0.5 is used

throughout the tests of mortar mix and six proportions of aluminium powder (0.1,0.2,0.5,1,2,5%) by weight of cement are used for partial replacement of cement.

For making concrete blocks 1:1 and 1:2 proportions of cement : sand are used with constant water cement ratio 0.5 and the percentage replacement of aluminium powder are (0.5 and 1%) by weight of cement.

The dry cement and sand are mixed for one minute in a mixer. 80% of water is then added and mixing is continued for another one minute. Remaining 20% of water is then added along with measured quantity of superplastizier and further mixing is continued for another two minutes. The aluminium powder is then added to the mixed concrete just before pouring in to the mould.

Before pouring to the mould, the spread test is conducted and the spread is maintained between 200 and 250mm.The wet and dry densities of each mix is found out. The cubes of face area 50cm^2 and blocks of size 300mm × 200cm× 150mm are cast. The mix obtained is a flow able type and thus no vibration or compaction is needed. The use of aluminium powder caused the expansion of concrete which led to irregular shapes and dimensions. The expanded layers were cut to form the leveled surface. The cast cubes and blocks are tested for compressive strength at 3, 7 and 28 days.

IV ANALYSIS OF RESULTS AND DISCUSSIONS

A. Spread

The mix is poured into the Vicat mould and filled and leveled. Then this mould is raised and allowed to spread. The spread is measured at right angles. The average of two values gives the actual spread of the mix.

B. Density

Table 3 shows the values of wet and dry densities for aerated (gas) concrete specimens which produced by using different percentages of aluminium powder. Results shows that the wet and dry densities of aerated (gas) concrete decreases with the increase of the percentage of aluminium powder.

This reduction in density with the increase of percentage of aluminium powder is due to the increase of tiny bubbles in the wet mix which is formed by aluminium powder.

TABLE 3 :Comparision Of Densities At Various Percentages Of Aluminium

Al (%)	Wet Density (Kg/m^3)	Dry Density (Kg/m^3)		
		3 Days	7 Days	28 Days
0.0	2015	2060	2080	2060
0.1	1910	1802	2040	2020
0.2	1801	1742	2023	1910
0.5	1650	1548	1750	1870
1.0	1572	1420	1640	1800
2.0	1248	1402	1430	1490
5.0	1180	1310	1361	1475

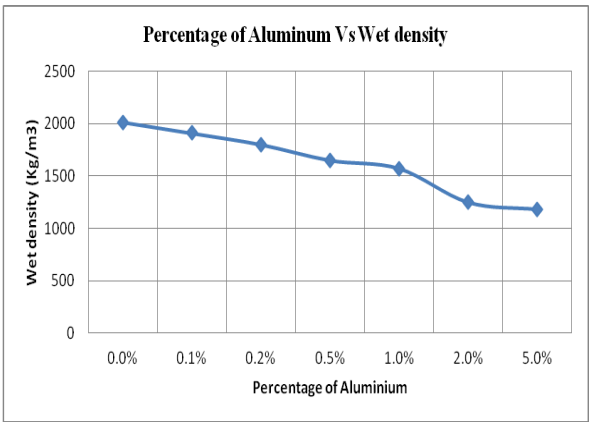

Fig 1 Wet densities of aerated concrete

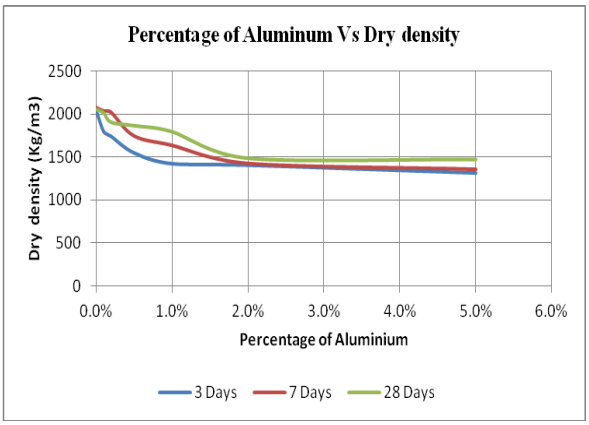

Fig 2 Dry densities of aerated concrete

C. Compressive strength

The compressive strength test results are presented in Table 4. Fig 3 shows the relationships between compressive strength of aerated concrete and the percentage of aluminium powder. It is clear that the compressive strength decreases with the increase in percentage of aluminium powder.

TABLE 4
COMPARISION OF COMPRESSIVE STRENGTHS AT VARIOUS PERCENTAGES OF ALUMIN IUM

Aluminium (% by Wt of Cement)	Compressive strength (N/mm2)		
	3 Days	7 Days	28 Days
0.0%	17.4	20.4	44
0.1%	3.74	6	14.4
0.2%	12	16.6	17.2
0.5%	7.4	15.73	14.47
1.0%	1.47	4.93	14.8
2.0%	2.8	3	7.6
5.0%	0.4	0.6	2.5

International Journal of Scientific Engineering and Technology (ISSN : 2277-1581)
Volume No.3 Issue No.11, pp : 1367-1370 01 Nov. 2014

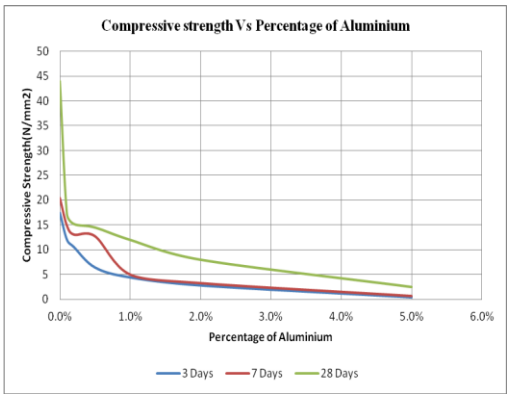

Fig 3 Compressive strength of aerated concrete with various percentage of Aluminium powder at 3, 7 and 28 days.

From the observations of the mentioned table and figure, it can be noticed that, with the addition of aluminium powder, the aerated concrete specimens suffered sufficient decrease in their compressive strength. Thus reduction increases with increasing percentage of aluminium powder and the compressive strength is very low when the percentage of aluminium powder reaches to 5% by weight of cement.

Table 5 Densities Of Aerated Concrete BLOCKS (Kg/m^3)

Percentage of Aluminium	Cement: Sand =1:1		
	3 Days	7 Days	28 Days
0.5	1750	1870	1890
1	1630	1720	1800

Table 6 Compressive Strength Of Aerated Concrete Blocks (N/Mm^2)

Percentage of Aluminium	Cement :Sand =1:1		
	3 Days	7 Days	28 Days
0.5	1.267	4.8	7.58
1	3.81	3.52	4.01

Table 7 Densities Of Aerated Concrete Blocks (Kg/M^3)

Percentage of Aluminium	Cement: Sand =1:2		
	3 Days	7 Days	28 Days
0.5	1830	1870	1890
1	1810	1810	1830

Table 8 Compressive Strength Of Aerated Concrete Blocks (N/Mm^2)

Percentage of Aluminium	Cement :Sand =1:2		
	3 Days	7 Days	28 Days
0.5	2.967	4.5	7.35
1	3.33	3.81	4.29

Table 9 Densities Of Commercially Availableconcrete Blocks (Kg/M^3)

Block 1	Block 2	Block 3	Block 4
2222	2055	2055	2167

Table 10 Compressive Strength Of Commercialy Available Concrete Blocks (N/Mm^2)

Block 1	Block 2	Block 3	Block 4
2.47	1.42	1.97	3.45

V CONCLUSIONS

From the experimental investigation described in this paper, it can be concluded that

1) Aerated concrete of density 1910-1180 Kg/m^3 can be produced by using aluminium powder.

2) The density of aerated concrete decreases with the increase in the percentage of aluminium powder. The percentage of reduction in density is between 5.45 – 20 % when the percentage of aluminium powder is varied between 0.1- 5% by weight of cement.

3) Compressive strength of aerated concrete also decreases with the increase in aluminium powder percentage.

4) The optimum percentage of aluminium powder is less than 2% by weight of cement. This percentage gives suitable properties for aerated concrete which can be used for masonry purposes.

5) The compressive strength of aerated concrete blocks is observed to be more than that of commercially available cement blocks.

REFERENCES

i. Neville, A. M, "Properties of concrete," London, fourth edition, 2005

ii. Jihad Hamad Mohammad, Ali Jihad Hamad, "A classification of lightweight concrete: materials, properties and application review", International Journal of Advanced Engineering Applications,Vol 7,ISS.1,PP.52-57(2014)

iii. Prof .Dr. Mohammed Mosleh Salman,Lec.Sawsan Akram Hassan, "Empirical formulas for estimation of some physical properties of gas concrete produced by adding aluminium powder", Journal of Engineering and Development ,Vol.14,No.4,December (2010).

iv. Khamphere Jitchaiyaphum, Theerawat Sinsiri,Prinya Chindaprasirt,"Cellular light weight concrete containing pozzolan materials", The Twelfth East Asia Pacific Conference on Structural Engineering and construction (2011)

v. Vivek Sood, Ashok Kumar, "Effect of additives on the development of non-autoclaved cellular light weight blocks", International Journal OF IT, Engineering and applied sciences research, Volume 2, N: 5, (2013)

vi. Alonge O Richard and Mahyuddin Ramli, "Experimental production of sustainable light weight foamed concrete", British Journal of applied science and technology (2013)

vii. Mangala Keshava, K V Vijayendra and S Rangunnath ,"Strength efficiency of commonly used block work masonry", International Journal of Earth Sciences and Engineering, Vol 3,pp586-598 (2010)

viii. Dr. .N. Arunachalam, V Mahesh, P.Dileepkumar and V.Sounder, "Development of innovative building blocks", ISOR Journal of Mechanical and Civil Engineering, pp01-07

ix. Nagesh. Mustapura, H.Eramma,"Experimental investigation on cellular Light weight concrete blocks for varying grades of density" ,International Journal of Advanced Technology in Engineering and Sciences, Vol 2,(2014)

x. T.M Prakash, Dr.B.G Naresh Kumar and Dr. Karisiddappa,"Strength and Elastic properties of Aerated concrete blocks (ACBs)",International Journal of Chemical ,Environmental and Biological sciences, Vol 1,(2013)

xi. K.Krishna Bhavani Siram, "Cellular Light-Weight Concrete Blocks as a Replacement of Burnt Clay Bricks", International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, Issue-2, December (2012)

xii. Elvis .M. Mbadike and N.N Osadere, "Effect of Incorporation of Aluminium Waste in Concrete Matrix Using Different Mix Ratio and Water Cement Ratio", International Archive of Applied Sciences and Technology Int. Arch. App. Sci. Technol; Vol 5 March (2014)