International Journal of Advanced Information Science and Technology (IJAIST) ISSN: 2319:2682
Vol.6, No.7, July 2017 DOI:10.15693/ijaist/2017.v6i7.1-6

Effect of Fly ash and Aluminum Powder on Concrete

Dr. K. Chandrasekhar Reddy[1], S. Dinesh Kumar[2]
Professor of Civil Engineering & Principal[1],
PG Student, Department of Civil Engineering[2]
[1, 2] Siddharth Institute of Engineering & Technology,
Puttur, Andhra Pradesh, India

Abstract: Light weight concrete (LWC) shall be stated as a type of concrete which includes as a rising agent and it increases the quantity of mixture despite the fact that lowering the dead weight. When compare to normal concrete its weight is less and dry density lesser than 2000kg/m^3. The major specialties of the LWC are the less density and low thermal conductivity. The objective of this investigation is to develop the most economical light weight concrete for building with satisfactory amount of strength. Fly ash replacement is fixed to as 5%, 10%and 15 % of the cement in the mixture. The percentage addition of aluminum powder is limited to three categories that are 0, 0.5 and 1 to the light weight concrete mixture. At 15 % replacement of fly ash, the tested concrete block have maximum flexural strength and the density is maximum at 5% replacement of fly ash. It is found that, after adding up of aluminum powder, there is a gradual decrease in flexural strength and density. Combination of fly Ash (15%) and Aluminum powder (0.25%) gives higher flexural strength and Density.

***Index terms*:** Fly ash, Aluminum powder, Flexural strength, Density of concrete.

I. INTRODUCTION

Structural lightweight concrete is generally made by using artificial lightweight aggregates and usually requires higher binder contents than its normal weight counterparts in order to reach structural strength levels. In last few decades, rapidly increasing fuel prices caused the production costs of cement and artificial lightweight aggregates to increase, both of which are burnt in large kilns in production phase. Resultantly, the pursuit of lowering production costs has renewed the interest in utilization of natural lightweight aggregates and pozzolans in lightweight concrete production. Currently, there are many studies
on structural lightweight concrete majority of which are focusing on those with artificial lightweight aggregates. However, only a limited number of studies exist with a focus on natural lightweight aggregates and even less with a focus on natural perlite aggregate. Besides, there is no recorded study on self- compacting high strength lightweight concrete with natural perlite aggregate and perlite powder. The literature also lacks the investigation of mechanical properties and durability characteristics of structural lightweight concretes in comparison to those of normal weight

concretes of similar specific strength (a.k.a. structural or strength efficiency). In many cases, it is the specific strength of concrete rather than strength itself which determines its suitability for a particular application. Therefore, a comparison of concrete properties at similar specific strength is more logical than a comparison at similar strength

II. OBJECTIVE

- To investigate flexural strength and density of fly ash concrete.
- To investigate flexural strength and density of concrete with combinations of Fly ash and aluminum powder.
- The results obtained for control concrete, fly ash based concrete and fly ash aluminum light weight concrete are compared with each other.

III. LITERATURE REVIEW

Selvaraj.R (2015), according to his study per capita consumption of concrete is approximately two tones; the usage includes construction of all civil engineering structures. Gas concrete is one category of concrete family falls under light weight concrete. Volume and void increase in mortar is studied by adding aluminum powder to cement mortar of proportion 1:3 with and without alkali solutions. An effort is made to optimize the percentage of aluminum powder and alkalinity of mixing solution. Various properties of concrete such as sorptivity, water absorption, micro structure, density etc. are examined for gas concrete.

Ahsan Habib, et.al., (2015), in this experiment, generation method of hydrogen gas was used for the aeration process. For various percentages of OPC, as described in the gasification method, aluminum powder is added to the slurry. To evaluate the effect of aluminum powder on concrete various tests such as density, water absorption and compressive strength test were carried out. In the case of aerated concrete, 0.15% aluminum powder helps in gaining strength.

Aruova Lyazat. Dr (2014), Aerated concretes belong to the most effective materials for fencing structures of buildings of different purpose. The component made out of aerated concrete has high strength, freeze resistance, low average density, fire safety, high air and vapour transmission while giving comfortable living conditions inside the building.

Aerated concrete of non-autoclaved hardening on physical and mechanical properties, close to properties of autoclaved aerated concrete (D<600, M>35, F>50), is intended to be produced by mechano-chemical activation of raw components, optimization of quality of aerated concrete macro porous structure and complex use of production as well as fuel and power complex wastes.

IV. EXPERIMENTAL INVESTIGATION

4.1 Properties of Materials

4.11 Cement

In this experiment, Zuari cement of 53 grade OPC conforming to IS: 12269–1987 was used for the entire project work. The some of the physical properties of cement was listed in Table 1.

Table 1 Properties of cement

S. No	Characteristics	Test results	Requirements as per IS 12269 – 1987
1	Fineness (retained on 90-µm sieve)	7%	<10%
2	Normal Consistency	30%	--
3	Initial setting time of cement	180 min's	30 minutes (minimum)
4	Final setting time of cement	330 min's	600 minutes (maximum)
5	Expansion in Le-chatelier's method	1.5 mm	10 mm (maximum)
6	Specific gravity	3.11	3.10 – 3.25

4.12 Fine Aggregate

Locally available river sand confirming to Indian Standard specification was used as the fine aggregate in the preparation of concrete. The important properties of fine aggregate are shown in Table.2.

Table 2 Properties of Fine Aggregate

S.No	Property	Value
1	Specific Gravity	2.58
2	Fineness Modulus	2.8
3	Grading of Sand	Zone – II

4.13 Coarse Aggregate

Machine Crushed granite aggregate confirming to IS 383-1970 consisting 20 mm maximum size of aggregates has been obtained from the local quarry were used. The coarse aggregate used in this project is tested for Physical and Mechanical Properties such as Specific Gravity, Sieve Analysis, and the results are shown in table 3. Coarse aggregate of size 20mm and 10mm of ratio 1.5:1 ratio is used in concrete mixture.

Table3. Properties of Coarse Aggregate

S.No	Property	Result
1	Specific Gravity	2.67
2	Bulk Density (Loose)	14.80 kN/m^3
3	Water Absorption	1.2%
4	Fineness Modulus	7.52

4.14 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. The aluminum powder of grade was used in this project. It had a density of 0.55 g/cm^3, the aluminum powder confirmed to IS 438-2006 and ASTM B 212 – 99. Aluminum powder is commonly used as an air entraining agent to obtain light weight concrete by a chemical reaction producing hydrogen gas in fresh mortar, so that it contains large number of air voids in the mortar.

Table 4 Properties of Aluminium powder

S.No	Property	Result
1	Specific Gravity	2.7
2	Color	Silver
3	Melting Point	660^0c
4	Form	Powder

4.15 Fly Ash

Fly ash produced in modern power stations of India is of good quality as it contains low sulphur & very low unburnt carbon i.e. less ignition loss. In many of newly constructed thermal power stations following technique like dry fly ash evacuation and storage system are implemented to use fly ash in various applications. By pneumatic system the fly ash is evacuated from Electrostatic Precipitators (ESP) and it is stored in silos. By bags and by loading fly ash in open truck or closed tankers it is transported for use. Based on the ESP design it consists of 6 to 8 rows or fields. Last field or row of EST is the field besides chimney. In the first field of ESP, coarse particle of fly ash are collected. In the subsequent fields of

electrostatic precipitator the fineness of fly ash particles increases. Some of the properties of fly ash are as follows.

Table 5 Properties of Fly Ash

S.No.	Ingredient	Value
1	Silica (SiO_2)	56.88 %
2	Aluminum trioxide (Al_2O_3)	27.65 %
3	Ferric oxide (Fe_2O_3 + Fe_3O_4)	6.28 %
4	Titanium dioxide (TiO_2)	0.31 %
5	Calcium oxide (Cao)	3.6 %
6	Magnesium oxide (MgO)	0.34 %
7	Sulphate (SO_4)	0.27 %
8	Loss of ignition (LOI)	4.46 %
9	Specific gravity of Fly Ash	2.12

4.16 Water

Water used for casting and curing of concrete test specimens is free from impurities which when present can adversely influence the various properties of concrete.

4.2 Concrete Mix Proportion

In the present experimental investigation, the influence of combined application of various types of steel fibres on M20 grade concrete is studied.

M20 grade of concrete were designed as per the Indian Standard code of practice. The various ingredients of M20 concrete are shown in Table 6.

Table 6 Ingredients per cum of M20 Grade Concrete

Mix Identification	Cement (kgs)	Fly Ash (kgs)	Aluminum Powder (kgs)	Fine Aggregate (kgs)	Coarse Aggregate (kgs)	Water (lit)
Control	358	0	0	686	1116	209.5
FA 5 %	340	12.5	0	686	1116	209.5
FA 10 %	323	24.5	0	686	1116	209.5
FA 15 %	305	36.5	0	686	1116	209.5
FA 5 % + AL 0.25 %	340	12.5	0.895	686	1116	209.5
FA 10 % + AL 0.25 %	323	24.5	0.895	686	1116	209.5
FA 15 % + AL 0.25 %	305	36.5	0.895	686	1116	209.5
FA 5 % + AL 0.50 %	340	12.5	1.79	686	1116	209.5
FA 10 % + AL 0.50 %	323	24.5	1.79	686	1116	209.5
FA 15 % + AL 0.50 %	305	36.5	1.79	686	1116	209.5
FA 5 % + AL 1 %	340	12.5	3.58	686	1116	209.5
FA 10 % + AL 1 %	323	24.5	3.58	686	1116	209.5
FA 15 % + AL 1 %	305	36.5	3.58	686	1116	209.5

Test Specimens

Concrete test specimens consist of 100 mm × 100 mm × 500 mm prisms and 150 mm × 150 mm × 150 mm cubes. Concrete prism, cube specimens were tested at 28 days of curing to obtain the flexural strength and density of concrete. The rate of loading is as per the Indian Standard Specifications.

V. RESULTS AND DISCUSSIONS

5.1 Flexural Strength Test

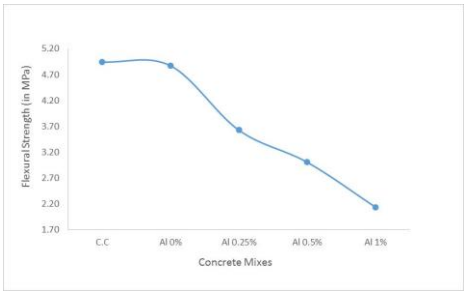
Prisms of size 100mm×100mm×500mm were prepared and it is tested for its flexural strength. It can be observed that the flexural strength of concrete prepared by all proportions of Fly Ash as replacement of Cement exhibits more strength than the control concrete, The Concrete with 15% Fly Ash shows higher percentage increase in flexural Strength compared to remaining replacements. With addition of Aluminum Powder, The flexural Strength decreases with increase in content of Aluminum Powder. The highest flexural strength is achieved with addition of

Aluminum Powder is 78.75% of Control Concrete at Fly Ash 15% with 0.25% of Aluminum Powder.

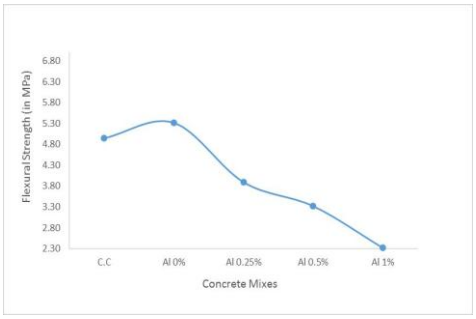
Table 7 Flexural strength of M20 grade concrete

Concrete	FA	AL	Flexural strength (in Mpa)
C.C	0	0	4.94
FA 5%	5	0	4.87
FA 10%	10	0	5.13
FA 15%	15	0	5.31
FA 5%+Al 0.25%	5	0.25	3.36
FA 10%+ Al 0.25%	10	0.25	3.83
FA 15%+ Al 0.25%	15	0.25	3.89
FA 5% + Al 0.5%	5	0.5	3.00
FA 10% + Al 0.5%	10	0.5	3.21
FA 15% + Al 0.5%	15	0.5	3.32
FA 5% + Al 1%	5	1	2.14
FA 5% + Al 1%	10	1	2.22
FA 5% + Al 1%	15	1	2.32

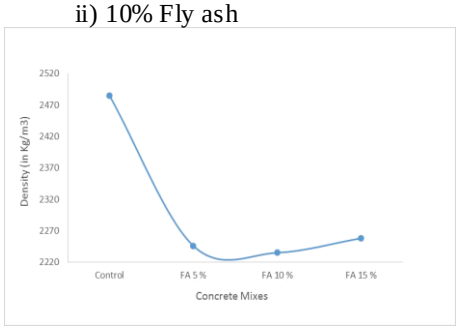
Variation of the Cube compressive strength of Control Concrete Vs Fly Ash (5%, 10% & 15%) with 0%, 0.25%, 0.5% and 1% Aluminium Powder is shown in below graphs.



i) 5% Fly ash



ii) 10% Fly ash



iii) 15% Fly ash

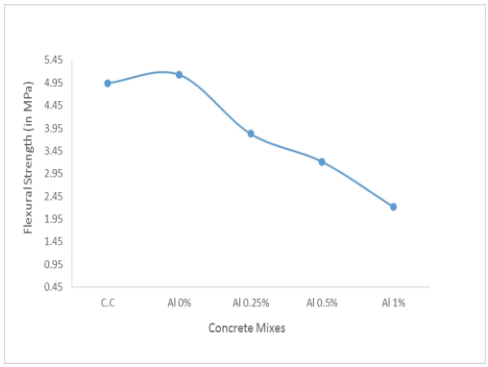
5.2 Density of Concrete

Concrete cubes of size 150mm×150mm×150mm are casted and kept in the water tank for 28 days. After 28 days the density of the concrete is determined. The density of concrete at various combinations of fly ash and aluminum powder is tabulated below.

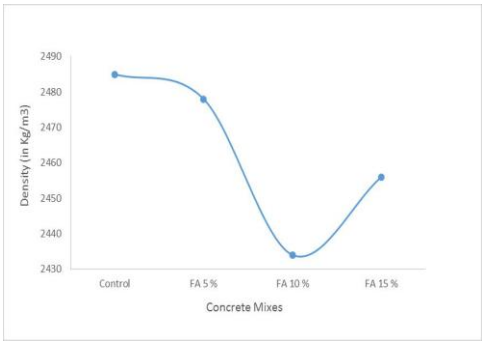
Table 8 Density of M20 grade concrete

Concrete	FA	CA	Density (Kg/m^3)
C.C	0	0	2485
FA 5%	5	0	2478
FA 10%	10	0	2434
FA 15%	15	0	2456
FA5%+ AL 0.25%	5	0.25	2246
FA 10%+ AL 0.25%	10	0.25	2235
FA 15%+ AL 0.25%	15	0.25	2258
FA 5%+ AL 0.5%	5	0.5	2134
FA 10%+ AL 0.5%	10	0.5	2158
FA 15%+ AL 0.5%	15	0.5	2036
FA 5%+ AL 1%	5	1	1816
FA 10%+ AL 1%	10	1	1714
FA 15%+ AL 1%	15	1	1735

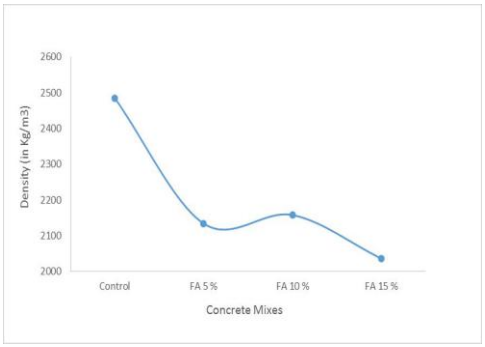
Variation of the density of Control Concrete Vs Fly Ash (5%, 10% & 15%) with 0%, 0.25%, 0.5% and 1% Aluminium Powder is shown in below graphs.



i) 5% Fly ash



ii) 10% Fly ash



Iii) 15% Fly ash

VI. CONCLUSIONS

Fly ash is considered as one of the industrial waste product and that cannot be easily disposed. By the way of using fly ash in the manufacturing process of light weight concrete, we can able to reduce the amount fly ash waste. The light weight concrete is a different conventional concrete in certain materials and applications. The features of light weight concrete are higher strength to weight ratio as compared with conventional concrete, enhanced in thermal and sound insulation, reduced dead load in the structure reduce of structural elements and to minimize the steel reinforcement. The mineral admixture of fly ash improves the workability and strength properties of light weight concrete. From the test results, it was concluded that the Concrete with 15% Fly Ash shows higher percentage increase in flexural strength. With addition of Aluminum Powder, The Flexural strength and density decreases with increase in content of Aluminum Powder. The highest flexural strength achieved with addition of aluminum Powder is 78.75% of Control Concrete at Fly Ash 15% with 0.25% of aluminum Powder. With the addition of Fly ash maximum density is attained at 5% of fly ash. Least Density is observed for 10% Fly Ash and 1% Aluminum Powder is 1714 Kg/m^3 which is 31% less dense compared to Control Concrete. The maximum density is achieved at 15% fly ash and 0.25% aluminum powder and it is 90% of control concrete. This reduction in flexural strength with the increase of percentage of aluminum powder is due to the increase of tiny bubbles in the wet mix which is formed by aluminum powder.

VII. ACKNOWLEDGMENT

Thankful to staff of Civil Engineering department In our Institute for their help in this work.

REFERENCES

[1] M. S. Shetty, Concrete Technology Theory & Practice, Published By S. CHAND & Company, Ram Nagar, New Delhi

[2] Narayanan. N, Ramamurthy. K, (2000): Structure And Properties Of Aerated Concrete: A Review, Elsevier, pp. 321-329.

[3] Sohani N. Jani, Darshan S. Shah, (2014), Analysis of Microstructure and Properties of AAC Block With Its Manufacturing Process, Journal of International Academic Research for Multidisciplinary, Volume 2, pp. 278-285.

[4] Indu Susan Raj, Dr. Elson John,(2014) , A Study On The Properties Of Air-Entrained Concrete For Masonry Blocks, International Journal Of Scientific Engineering And Technology, Volume No.3, pp : 1367-1370.

[5] Ashish S. Moon, (2015), foam Concrete Can Be Used For Sustainable Construction As A Building Material, International Journal For Scientific Research & Development| Vol. 3, pp.1428-1431.

[6] Selvaraj. R, (2015), Study On Gas Concrete Using Aluminium Metal Powder As Gas Producing Agent, International Journal Of Engineering Science Invention Research & Development; Vol. Ii,Pp:31-40.

[7] Tumadhir Merawi Borhan (2015), Effect Of Using Recycled Lightweight Aggregate On The Properties Of Concrete, Journal Of Babylon University, Vol. (23).

[8] Ahsan Habib, Hosne Ara Begum, Eng. Rubaiyet Hafiza (2015), Study on Production of Aerated Concrete Block In

Bangladesh, International Journal Of Innovative Science, Engineering & Technology, Vol. 2, pp: 200-203.

[9] Shamsuddoha.M, Islam. M. M and Noor. M. A (2015), Feasibility Of Producing Lightweight Concrete Using Indigenous Materials Without Autoclaving.

[10] Ali J. Hamad (2015), Materials, Production, Properties and Application of Aerated Lightweight Concrete: Review, International Journal of Materials Science and Engineering Vol. 2, pp. 152-157.

[11] Oksana Poznyak, Andryy Melnyk (2014), Non-Autoclaved Aerated Concrete Made of Modified Binding Composition Containing Supplementary Cementitious Materials, Budownictwo I Architektura, Volume.13 (2), pp. 127-134.

[12] Aruova Lyazat. Dr (2014), Process Parameters Of Production Of Non-Autoclaved Aerated Concrete On The Basis Of Complex Use Of Ash And Gypsum-Containing Wastes, Mediterranean Journal Of Social Sciences Mcser Publishing, Volume 5, pp.2565-2571.

Authors Profile

Dr. K. Chandrasekhar Reddy is having more than two decades of experience in teaching and industry. He has wide experience as a Civil Engineer, Teacher and as an Administrator. He has published more than fifty papers.

S. Dinesh Kumar is pursuing Master of Technology in Structural Engineering in Siddharth Institute of Engineering & Technology, Puttur, AP, and India.