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Study On The Influence of Fly Ash on A Partial Replacement of Cement In Aerated Concrete

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ABSTRACT

Light weight concrete blocks are used as an alternative for conventional blocks in masonry to reduce self-weight. Cellular light weight concrete masonry has attained a wide popularity in recent years owing to its sustainability, density, low thermal conductivity and use of less mortar joints. A simple way to produce aerated concrete is to add an air entraining agent to the concrete mix. Due to the wide range of air entraining agents available commercially, a design approach using an arbitrary air entraining agent for producing aerated concrete with certain density and compressive strength has to be developed. In this study, aerated light weight masonry blocks are developed using Aluminium powder.The light weight concrete can also incorporate additives like fly ash as a replacement to cement, which can lead to the consumption of waste products which are otherwise leads to environmental pollution.Seven dosages of Aluminium powder (0.1,0.2,0.25, 0.5,1,2 and 5%) by weight of cement are used to produce aerated (gas) concrete. A cement to fine aggregate ratio of 1:1 have been adopted and water cement ratio is fixed as 0.45 by trial and error method. The wet and dry densities and compressive strength are determined. Addition of more than 5% Aluminium powder reduces compressive strength and densities drastically.

KEYWORDS: Aluminum powder, Aerated concrete, Fly ash, density, compressive strength

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INTRODUCTION

Light weight concrete can simply be defined as concrete, which by one means or another has been made lighter than conventional concrete. The very familiar product can be made from sand and gravel which has so long been a major building material. One of the main properties that are associated with light weight is its low density[1]. Lower density translates into a reduction in weight and this means reduction in dead load. In a construction perspective, buildings made with lighter material will indirectly reduce the overall size in the foundations and structural elements, an important factor especially in the construction of high-rise buildings, and therefore reduce construction cost as a whole. With its light weight characteristics, the use of light weight concrete will also result in faster building rates because of lower haulage and easy handling. Light weight concrete also possesses low thermal conductivity, which improves with a decrease in density. Aerated concrete also has a higher fire resistance and good sound absorbing properties as well. In addition to that, aerated concrete can be sawn, cut, nailed and drilled with ordinary wood working tools.

The main aim of this study is to develop a suitable sustainable mix for light weight concrete by partial replacement of cement with Fly Ash which in turn can be used for developing masonry blocks[4].

The first phase of work is the material characterization of the ingredients. The mix proportions are to be done by trial and error method. Cubes of sizes $50cm^2$ phase area are were cast in order to study its strength characteristics. The fluidity was assessed with flow test with a mini slump. The compressive strength and dry density of the mixeswere also determined.

Objective of the project:

The objectives of the experimental study are:

1. To study the influence of partial replacement of cement with Fly Ash in light weight concrete which can be used for developing masonry blocks

Scope of the Project:

The experimental investigation is planned as under:

- This study is confined to the performance based only on one brand of OPC available in the market.
- This study is confined to a single air entraining agent, i.e., Aluminium powder.
- The study is done for single cement: sand ratio of 1:1.

- The percentage replacement of Aluminium powder is limited to seven categories that are 0.1,0.2,0.25, 0.5,1,2 and 5% replacement of cement.
- Only one water cement ratio is selected for the study.

EXPERIMENTAL SECTION

Materials

Ordinary Portland cement (53grade) conforming to Indian Standard, fine aggregate belongs to Zone II, Fly Ash (ASTM class F), Aluminium powder, superplasticizers and deionized water are used for the study. The properties of cement and fine aggregate are given in Table 1.

Table 1: Physical Properties of materials

S. No	Properties	Values
1	Specific gravity of cement	2.65
2	Standard consistency of cement	33%
3	Specific gravity of fine aggregate	2.52
4	Water absorption of fine aggregate (%)	1.15
5	Water cement ratio	0.45
6	Cement: sand ratio	1:1

The mortar mix is prepared with cement to sand ratio 1:1with various percentages of Aluminum powder (0.1%, 0.2%,0.25%, 0.5%, 1%, 2%, 5%). The spread test was conducted for each mix for the assessment of the fluidity (Figure 1). Mortar cubes of 50cm^{2}are cast to determine the compressive strength at 7 and 28 days of water curing.

Figure 1: Spread of the mix

Specimen Preparation

Mortar cubes are cast in-order to study the compressive strength of mortar with Aluminum powder [2]. Three specimens each for 7 and 28 days are prepared. Total of 8 mixes have prepared, out of which one is control mix with no Aluminum powder. The moulds were partially filled in the fresh state and the excess material bulged out were removed with the help of a sharp knife (Figure 2). Dosages of Aluminium powder used are 0.1%, 0.2%, 0.25%, 0.5%, 1%, 2% and 5% for various mixes. A cement to sand ratio of 1:1 is selected for all the mixes. The percentage of super plasticizer is fixed as 0.2% by weight of cement. The water cement ratio adopted is 0.45. The water cement ratio is kept constant for all the mixes as it has direct link with the density of the aerated light weight concrete.

Figure 2: Final stage after hydration of aerated concrete occurred

Procedure

Weighed cement and sand are mixed for one minute. At the end of one minute, the Aluminium powder is added into the dry mix because it has a tendency to float on the mixing water. The ingredients are mixed until the Aluminium powder is thoroughly distributed in the mix. Then the water and the superplastizer were added together in the dry mix. The superplasticizer were mixed in the water as it is observed earlier that it improves the efficiency of the superplasticizer. After adding the water the mix were again mixed for two more minutes. Excessive mixing time can lead to the start of reaction of Aluminium with water and starts producing air. Therefore, it is advisable to pour the aerated concrete mix into the mould before the reaction starts.

RESULTS AND DISCUSSIONS

This experimental programme deals with the observation of the results from the various tests conducted on aerated concrete by using Aluminum powder as air entraining agent in the first phase and then partially replacing cement with Fly Ash in the second phase of the study. Tests are performed under standard laboratory conditions and compressive strength were determined at 7 and 28 days of water curing. The results are given in Table 2 and the same is plotted in figure 4 and 5.

Table.2: Comparison of results at various percentages of Aluminum powder

S No	Aluminum (% by Wt of Cement)	Spread (mm)	Dry Density (Kg/m^3)		Compressive Strength (N/mm^2)	
			7 Days	28 Days	7 Days	28 Days
1	0.0%	230	2040	2020	20.4	44.0
2	0.2%	225	2023	1910	16.6	17.2
3	0.25%	220	2045	1890	15.73	16.4
4	0.5%	210	2080	1870	15.0	14.47
5	1.0%	200	1640	1800	4.93	14.8
6	2.0%	180	1430	1490	3.0	7.6
7	5.0%	150	1361	1500	0.6	2.5

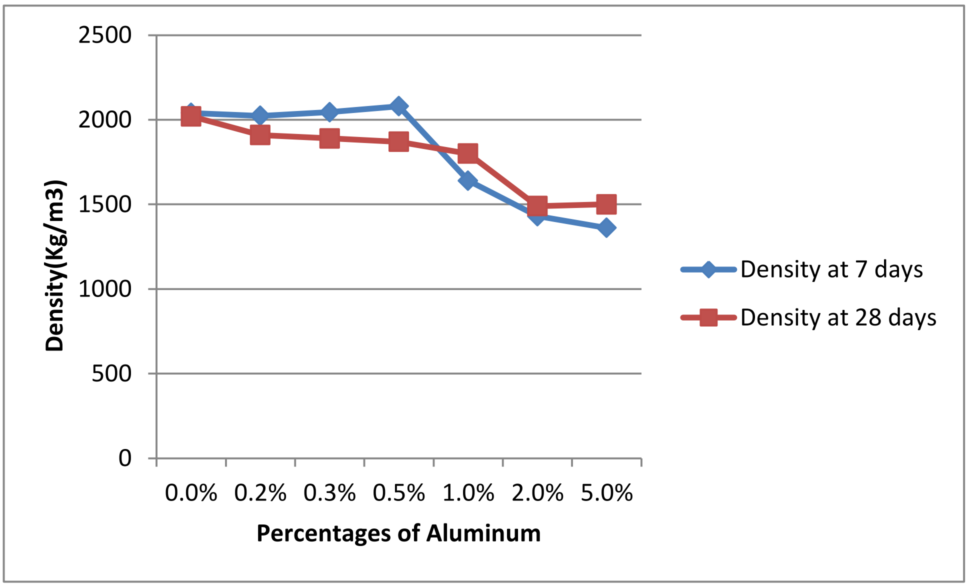

Figure 4: Variation of density at various percentages of Aluminum

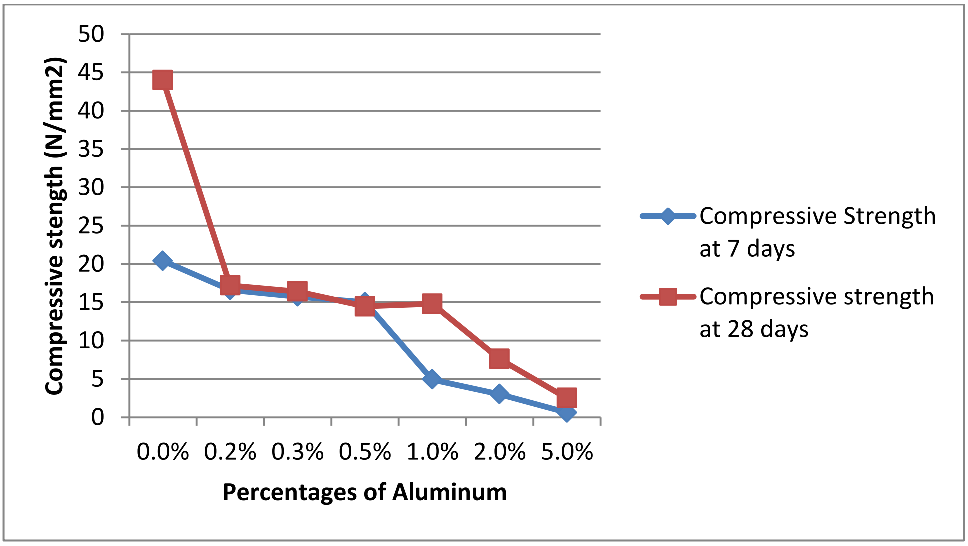

Figure 5: Variation of compressive strength at various percentages of Aluminum

From the observations of the table and figure, it can be noticed that, with the addition of Aluminium powder, the aerated concrete specimens showed significant decrease in compressive strength. Thus reduction in strength increases with increase in the percentage of Aluminium powder and the compressive strength is very low when the percentage of Aluminium powder more than 1% by weight of cement.

Density and compressive strength of percentage variation of Fly Ash

Flyash was used for the partial replacement of cement at various percentages (15%, 20%, 25% and 30%) by weight of cement in the air entrained concrete mix by addition of Aluminum powder at selected two optimum percentages (0.25% and 5%) by weight of cement and the density and compressive strength is investigated for the specimens at 7 and 28 days of water curing.The results are shown in Table 3and the Figure. 5-8 shows the respective variations at optimum percentages of Aluminum powder.

Table 3: Comparison of results at various percentages of Fly Ash

S No	Aluminum (% by Wt of Cement)	Fly Ash (% by Wt of cement)	Dry Density (Kg/m^3)		Compressive Strength (N/mm^2)	
			7 Days	28 Days	7 Days	28 Days
1	0.25%	15%	1774	1718	10.8	16.0
2		20%	1765	1710	11.2	22.0
3		25%	1757	1701	13.8	24.0
4		30%	1747	1694	11.0	20.4
5	0.5%	15%	1749	1670	9.0	18.5
6		20%	1740	1661	13.2	20.2
7		25%	1733	1653	14.7	26.0
8		30%	1722	1645	11.6	21.0

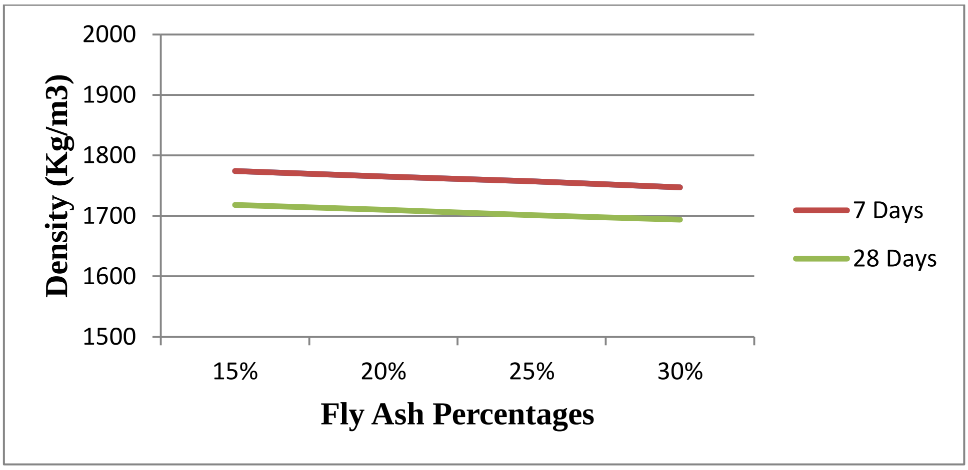

Figure 5: Variation of density at various percentages of Fly Ash at 0.25% of Aluminum powder

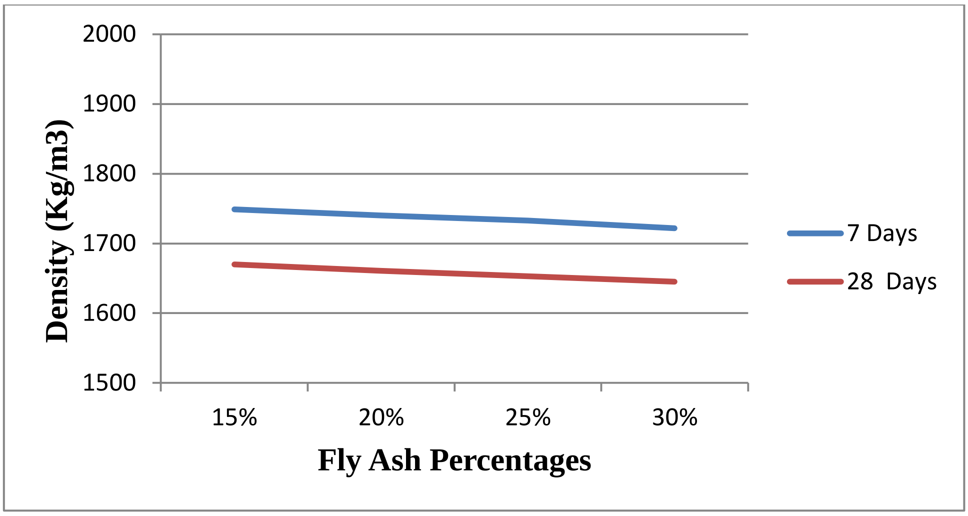

Figure 6: Variation of density at various percentages of Fly Ashat 0.5% of Aluminum powder

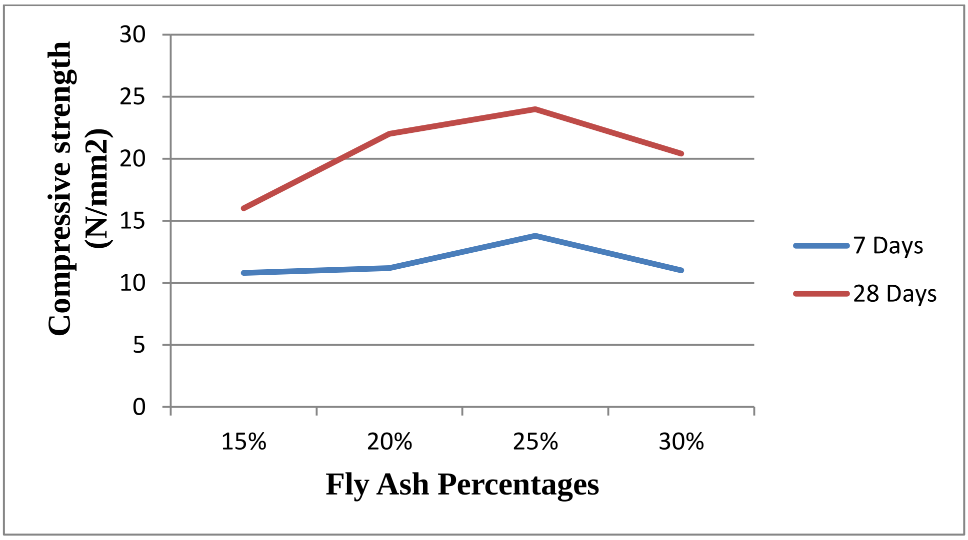

Figure 7: Variation of compressive strength at various percentages of Fly Ash at 0.25% of Aluminum powder

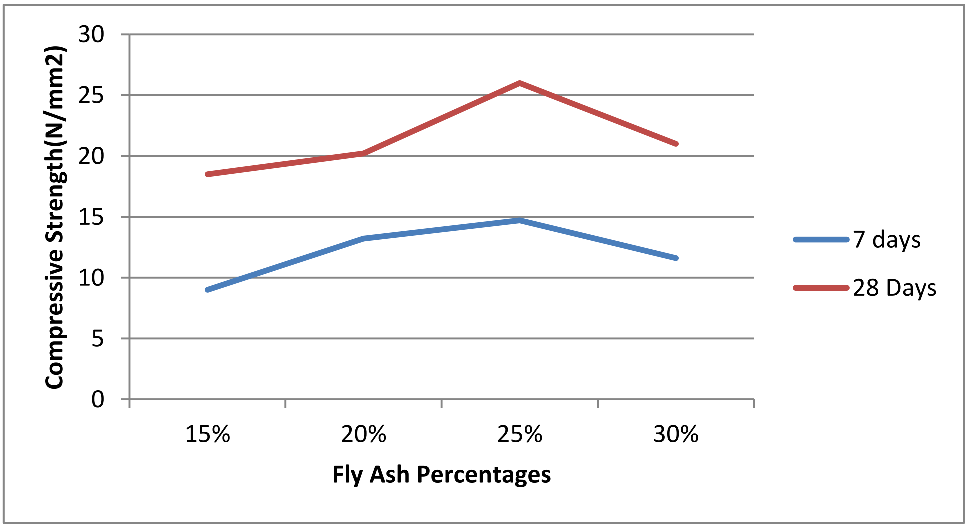

Figure 8: Variation of compressive strength at various percentages of Fly Ash at 0.5% of Aluminum powder

From the Table 3 and Figure 5-8, it is found that with the addition of Fly ash, the compressive strength will show an increase in compressive strength and the mix by replacing 25% of weight of cement with Fly ash will give highest strength. Again the specimen with 0.5% Aluminum powder and 25% Fly ash gave almost the same strength.

CONCLUSIONS

From the experimental investigation conducted, it can be concluded that

- The compressive strength reduces significantly after 0.25% of Aluminum powder addition. So 0.25% and 0.5% is considered as optimum and is used for further studies.
- At 20% replacement of cement with Fly Ash, density in the range of 1700 Kg/m^3 at 0.25% and 1650 Kg/m^3 at 0.5% of Aluminum powder addition respectively.
- At 20% replacement of cement with Fly Ash, density in the range of 22 N/mm^2 at 0.25% and 20 N/mm^2 at 0.5% of Aluminum powder addition respectively.
- The aerated concrete with 0.5% of Aluminum powder and partial replacement of 20% of cement with Fly Ash is suitable for masonry purposes.

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