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EFFECT OF FLY ASH AND ALUMINIUM POWDER ON STRENGTH PROPERTIES OF CONCRETE

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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/m³. 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 compressive 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 compressive strength and split tensile strength. It is found that, after adding up of aluminum powder, there is a gradual decrease in compressive strength and split tensile strength. Combination of fly Ash (15%) and Aluminum powder (0.25%) gives higher compressive strength and split tensile strength.

KEYWORDS: Fly ash, aluminum powder, Compressive strength, Split Tensile Strength.

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 compressive strength and split tensile strength of fly ash concrete.
- To investigate compressive strength and split tensile strength of concrete with combinations of Fly ash and aluminum powder.
- To compare the results obtained for control concrete, fly ash based concrete and fly ash light weight concrete.

III. LITERATURE REVIEW:

Selvaraj. R (2015), they estimated that every human being is using around two tones of concrete in one way or the other. 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. The results and graphs are discussed in detail.

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 cement slurry. The effect of aluminum powder on the final product is evaluated by various tests such as density, water absorption and compressive

strength test were conducted. In the case of aerated concrete, 0.15% aluminum powder helps in gaining strength.

Mr. Ashish S. Moon, et.al, (2015), foam concrete (a type of aerated lightweight concrete) does not contain any coarse aggregate. Also the foam concrete requires no compaction. But concrete flows with ease from outlet to restricted and irregular cavities to fill. Lightweight foamed concrete is used in low strength capacity for building and civil construction purposes as a result of its peculiar features such as low thermal conductivity, low self-weight and self-compacting features hence its high workability. The main aim of this project is to classify aerated lightweight concrete into foamed concrete and non-autoclaved concrete.

IV.PROPERTIES OF MATERIALS:

4.1 CEMENT:

In this experiment, Zuari cement of 53 grade OPC conforming to IS: 12269–1987 was used for the entire project work. The cement was purchased from single source and was used for casting of all specimens. 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

4.2 FINE AGGREGATE:

Locally available river sand confirming to IS specifications was used as the fine aggregate in the concrete preparation. 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

4.3 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. It has been tested for Physical and Mechanical Properties such as Specific Gravity, Sieve Analysis, and the results are shown in table 3. For the preparation of concrete coarse aggregate of combination of 20mm and 10mm size aggregates of ratio 1.5:1 was used.

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

4.4 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 Aluminum Powder

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

4.5 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 is 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

4.6 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.

5. MIX PROPORTION:

Quantities of Ingredients per cum of M20 Grade Concrete are shown in table 6.

5.1 TEST SPECIMENS:

Concrete test specimens consist of 150 mm × 150 mm × 150 mm cubes, cylinders of 150 mm diameter and 300 mm height. Concrete cube specimens were tested at 3, 7 & 28 days of curing to obtain the compressive strength of concrete. At the age of 28 days the cylinders were tested for its split tensile strength. The rate of loading is as per the Indian Standard Specifications.

Table 6 – Mix Proportions for M20 Grade Concrete per m^3

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

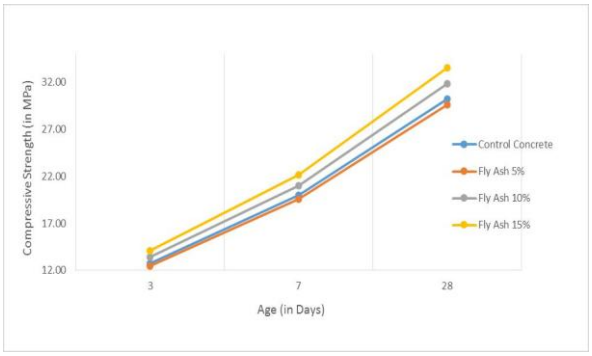
VI. RESULTS AND DISCUSSIONS:

6.1 COMPRESSIVE STRENGTH:

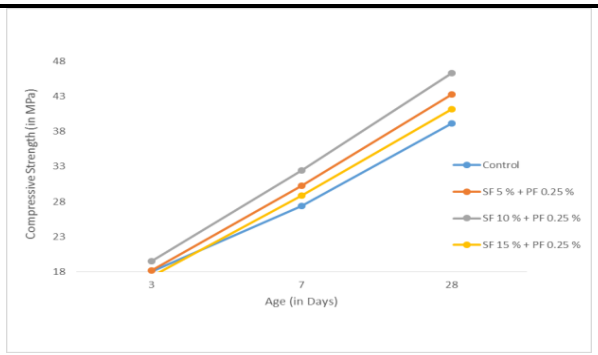
The cube compressive strength indicates the average of three test results. It can be observed that the compressive strength of concrete prepared by all proportions of Fly Ash as replacement of Cement exhibits more strength than the control concrete, The Concrete with 15% Fly Ash shows higher percentage increase in Compressive Strength compared to remaining replacements. With addition of Aluminum Powder, The Compression Strength decreases with increase in content of Aluminum Powder. The highest Compressive strength achieved with addition of Aluminum Powder is 78.53% of Control Concrete at Fly Ash 15% with 0.25% of Aluminum Powder.

Table 7 Cube Compressive Strengths of M20 Grade Concrete

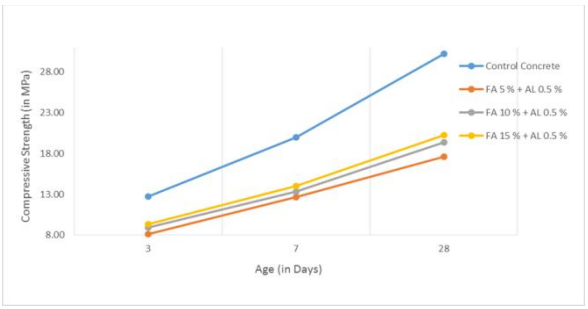
Concrete	FA	AL	Compressive strength		
			3 Days	7 Days	28 Days
Control	0	0	12.70	19.96	30.24
FA 5 %	5	0	12.44	19.54	29.621
FA 10 %	10	0	13.38	21.03	31.86
FA 15%	15	0	14.08	22.12	33.52
FA 5 % + AL 0.25 %	5	0.25	9.01	15.45	21.46
FA 10 % + AL 0.25 %	10	0.25	10.66	16.69	23.18
FA 15 % + AL 0.25 %	12	0.25	10.93	17.10	23.75
FA 5 % + AL 0.50 %	5	0.5	8.10	12.68	17.61
FA 10 % + AL 0.50 %	10	0.5	8.90	13.35	19.35
FA 15 % + AL 0.50 %	15	0.5	9.33	13.99	20.28
FA 5 % + AL 1 %	5	1	5.04	8.69	12.59
FA 10 % + AL 1 %	10	1	5.30	9.15	13.26
FA 15 % + AL 1 %	15	1	5.65	8.62	14.13



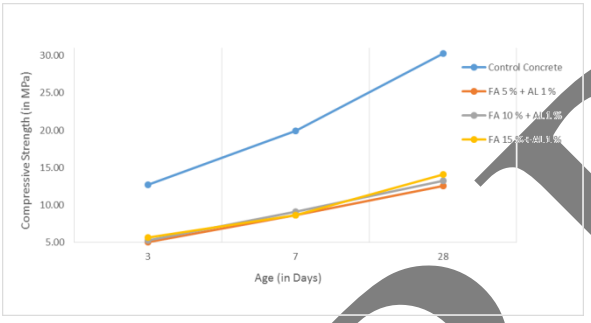
i) 0.% Aluminum Powder



(ii) 0.25% Aluminum Powder

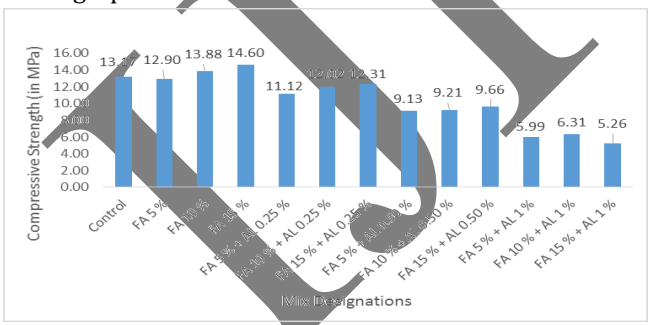


(iii) 0.5% Aluminum Powder

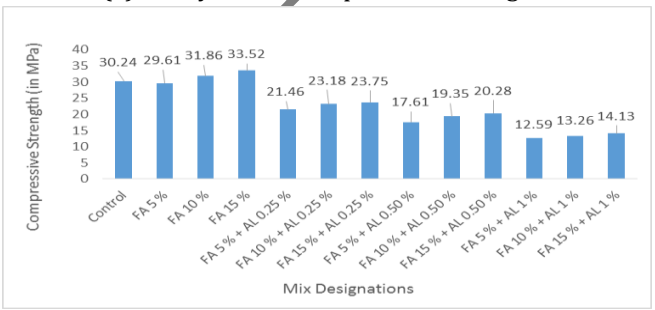


(iv) 1% Aluminum Powder

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 above graphs.



(a) 7 days Cube Compressive Strength



(b) 28 days Cube Compressive Strength

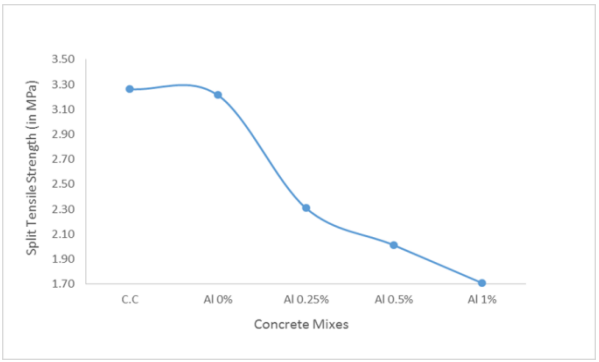
The variation of 7 – Days and 28 Days Compressive Strength of Concrete with Fly Ash (5%, 10% & 15%) and (0.25%, 0.5% and 1%) of Aluminium Powder shown in above bar charts.

6.2 SPLIT TENSILE STRENGTH:

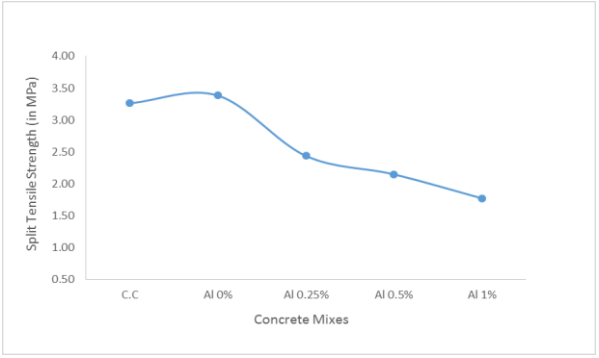
It can be observed that Specimens containing 15% Fly Ash exhibits improved Split Tensile Strength compared to the rest. The Percentage increase in Tensile Strength goes up to 7.67 % for 15% Fly Ash Specimens. With 15% Fly Ash and 0.25% of Aluminium Powder, 76.07% of Split Tensile Strength of Control Concrete.

Table 8 Split tensile strength of M20 grade concrete

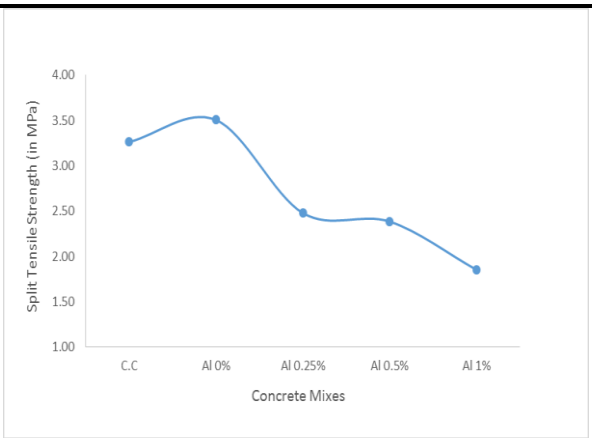
Concrete	FA	Al	Split Tensile Strength (in Mpa)
Control	0	0	3.26
FA 5 %	5	0	3.21
FA 10 %	10	0	3.38
FA 15 %	15	0	3.51
FA5%+ AL0.25%	5	0.25	2.31
FA10%+ AL0.25%	10	0.25	2.44
FA15%+ AL0.25%	15	0.25	2.48
FA5%+ AL0.5%	5	0.5	2.01
FA10%+ AL0.5%	10	0.5	2.15
FA15%+ AL0.5%	15	0.5	2.38
FA5%+ AL1%	5	1	1.71
FA10%+ AL1%	10	1	1.77
FA15%+ AL1%	15	1	1.85



i) 5% Fly Ash



(ii) 10% Fly Ash



(iii) 15% Fly Ash

The variation of split tensile strength of concrete with Fly Ash (5%, 10% & 15%) and (0%, 0.25%, 0.5% and 1%) of Aluminum Powder is shown in above graphs.

VII. 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 Compressive Strength and split tensile strength. With addition of Aluminum Powder, The Compression Strength and split tensile strength decreases with increase in content of Aluminum Powder. The highest Compressive strength achieved with addition of aluminum Powder is 78.53% of Control Concrete at Fly Ash 15% with 0.25% of aluminum Powder. With 15% Fly Ash and 0.25% of Aluminum Powder, 76.07% of Split Tensile Strength of Control Concrete. This reduction in compressive and split tensile 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.

VIII.ACKNOWLEDGMENT:

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