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EXPERIMENTAL INVESTIGATION ON LIGHTWEIGHT FOAMED CONCRETE WITH SILICA FUME AND POLYPROPYLENE FIBERS

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Abstract — with the increase in demand for structures which are light in weight, the usage of foamed concrete in structural applications are steadily increasing by researcher and industrialist. Lightweight foamed concrete (LFC) is normally created from mixing stable foam to cement paste or mortar. In this work , the foamed concrete in addition with silica fume and polypropylene fibers is used and tested with different curing age of 7, 28 and 56 days. Specimens were tested for compressive strength. The addition of silica fume is made as replacement of fly ash by different ratios such as 0%, 15% and 30%.

Keywords — *foamed concrete, silica fume, polypropylene fibers.*

1. INTRODUCTION

Reducing the self-weight of a structure is undoubtedly considered an advantage in construction if not a necessity in some cases. In order to that using lightweight concrete is one way of the best way of achieving such reduction. Foamed concrete is one type of light weight concrete which created a uniform distribution of air bubbles throughout the mass of concrete. It is mainly produced by combination of preformed foam into cement paste or mortar. The main advantage of this material is the ease of production that makes it possible to produce this concrete at any location with relatively simple and inexpensive materials and equipment. It is commonly made by two different methods. Method 1 consists of mixing a preformed foam (surfactant) or mix-foaming agents into the cement and water slurry. As the concrete hardens, the bubbles disintegrate, leaving air voids of similar sizes. Method 2, known as autoclaved aerated concrete (AAC), consists of a mix of lime, sand (or fly ash), cement, water, and an expansion agent (aluminum powder) that is poured into a mold. The reaction between the aluminum powder and cement causes microscopic hydrogen bubbles to form, increasing the concrete to about five times its original volume. The applications of foamed concrete have previously been non-structural and made use of the aesthetic, thermal, fire-resistant and void filling properties. Its properties make lightweight foamed concrete an ideal building material for residential building construction, thus the material is now being developed into a building material for structural applications.

2. EXPERIMENTAL DETAILS

A. Materials

Cement: Based on BIS 12:1996, ordinary Portland cement is usually used as the main binder for foamed concrete. Portland cement is a hydraulic cement that when mixed in the proper proportions with water, will harden under water (as well as in air). The cement used shall be of the following

a) 53 grade Ordinary Portland Cement conforming to IS: 12269.
b) Setting time by vicat's apparatus as per IS: 4031 and IS: 5513.
c) Compressive strength on cement as per IS: 4031, IS: 650, IS: 10080

Fig.1.Cement

Fly Ash: Class F Fly ash is normally used in foamed concrete with specific graviy of 2.09 conforming to ASTM.

Fig.2.Fly ash

Foaming Agent: The type of foaming agent using is chemical auxiliary agent which is transparent colorless of density 1.06 kg/m^3. The ph value is . – 7.2 and it is stable chemical.

Fig.3.Foam

Silica fume: used silica fume of specific gravity of 2.2.

Fig.4.Silica fume

Polypropylene Fiber: synthetic fibres of modified polypropylene are use in fibre-reinforced concrete and mortars. Fibre of 12mm size with density of 0.91 g/cm^3 is used.

Fig.5.Polypropylene Fiber

B. Test procedure

Process of casting

The concrete mix design indicating the proportions of various ingredients:

Requirements of foamed concrete mix design

The requirements which form the basis of selection and proportioning of mix ingredients are:

- The minimum compressive strength required from structural consideration.
- The adequate workability necessary full compaction with the compacting equipment available.
- Maximum water-cement ratio and/or maximum cement content to give adequate durability for the particular site conditions.
- Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.

Following are the mix proportions considered:

MIX PROPORTION 1

Table 1.1 Mix proportions 1

MATERIAL	QUANTITY
Cement	1.18 kg
Fly ash	2.83 kg
Silica fume	-
Water	600 ml
Foam	5 ml
Foam water	100 ml

MIX PROPORTION 2

Table 1.2 Mix proportions 2

MATERIAL	QUANTITY
Cement	1.18 kg
Fly ash	2.41 kg
Silica fume	0.4245 kg
Water	950 ml
Foam	5 ml
Foam water	100 ml

MIX PROPORTION 3

Table 1.3 Mix proportions 3

MATERIAL	QUANTITY
Cement	1.18 kg
Fly ash	1.981 kg
Silica fume	0.85 kg
Water	1000 ml
Foam	5 ml
Foam water	100 ml

Foamed concrete was produced in a laboratory using a hand mix by adding the foam to a base mix. The ratio considered for the mixes are 1:2.4. The foamed concrete produced was divided to three mix proportions: Mix 1, which used only cement, fly ash and polypropylene fiber as the binder, Mix 2, which combined the cement, fly ash, 15% of silica fume and polypropylene fiber as the binder and finally Mix 3, which combined the cement, fly ash, 30% of silica fume and polypropylene fiber as the binder. The proportions are shown in mix proportion Tables 1.1, 1.2, 1.3. The mixing sequence consisted of combing the binder material with water and mixing it until a homogeneous base mix was achieved. Then PP fibers were added and mixed for another 3 min. The foam is generated and added immediately to the base mix and mixed for a minimum duration until there was no physical sign of the foam on the surface and the foam was uniformly distributed throughout the mix. Cubes 150 mm in size were used for testing the compressive strength at 7, 28 and 56 days. The specimens were stripped approximately 24 h after casting. After that, the specimens were placed for curing and cured until taken out and tested at the required testing ages. Compressive strength testing was carried out in a testing machine with a 2,000 KN capacity. The results correspond to the mean values of at least three tests. During our test, the value of a single test was not more than 10% of the average value of three specimens.

RESULTS:

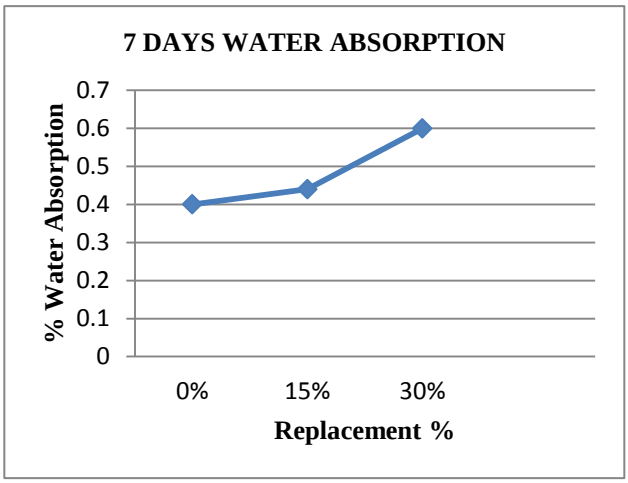
The considered mix proportions are casted, done curing and tested against the mix proportions. The compressive strength, water absorption and density of the blocks are listed in the below table:

SEVEN DAYS TEST RESULTS:

1. Water absorption

Table 2.1 Seven Days Water Absorption Result

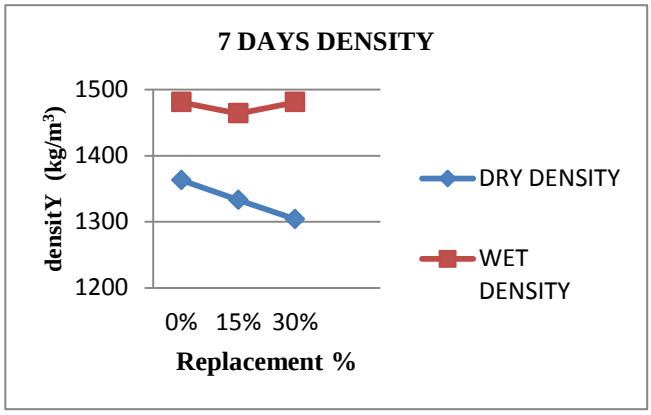
	Dry weight(kg)	Wet weight (kg)	Water absorption %
Mix 1	4.6	5	0.4
Mix 2	4.5	4.94	0.44
Mix 3	4.4	5	0.6



2. Density

Table 2.2 Seven Days Density Result

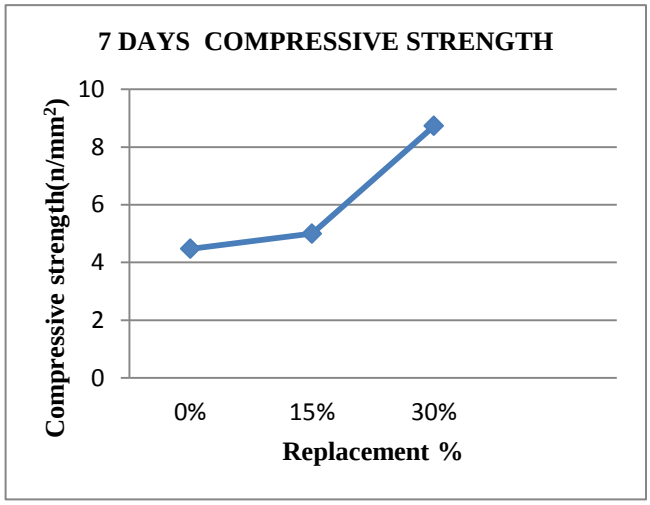
	Dry weight(kg)	Wet weight(kg)	Dry density (kg/m³)	Wet density (kg/m³)
Mix 1	4.6	5	1363	1481
Mix 2	4.5	4.94	1333	1464
Mix 3	4.4	5	1304	1481



3. Compressive strength

Table 2.3 Seven Days Compressive Strength Result

	Compressive strength (N/mm²)
Mix 1	4.47
Mix 2	5
Mix 3	8.73

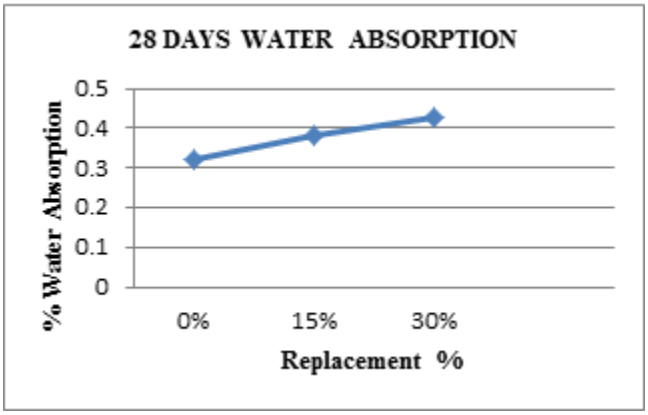


TWENTY EIGHT DAYS TEST RESULTS:

1. Water absorption

Table 3.1 Twenty Eight Days Water Absorption Result

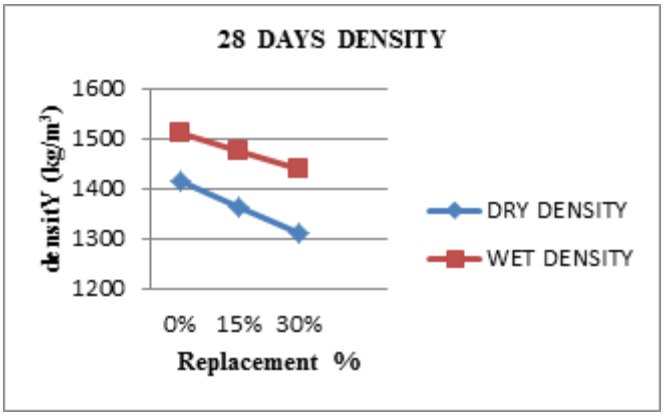
	Dry weight	Wet weight	Water absorption
Mix 1	4.78	5.1	0.32
Mix 2	4.6	4.98	0.38
Mix 3	4.43	4.86	0.43



2. Density

Table 3.2 Twenty Eight Days Density

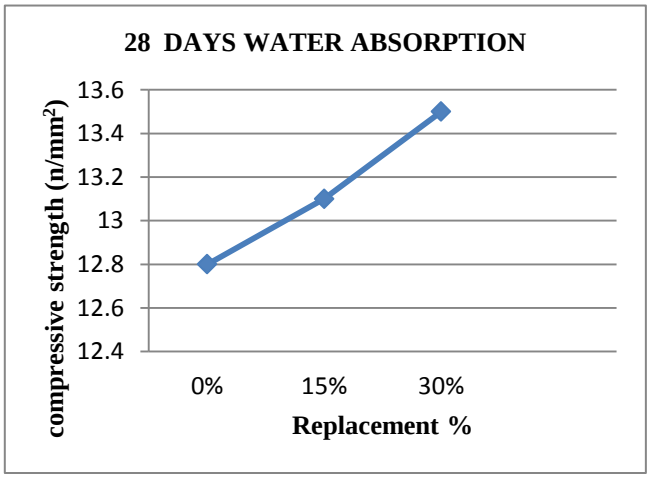
	Dry weight(kg)	Wet weight(kg)	Dry density (kg/m^3)	Wet density (kg/m^3)
Mix 1	4.78	5.1	1416	1511
Mix 2	4.6	4.98	1363	1476
Mix 3	4.43	4.86	1312	1440



3. Compressive strength

Table 3.3 Twenty Eight Days Compressive strength

	Compressive strength (N/mm^2)
Mix 1	12.8
Mix 2	13.1
Mix 3	13.5

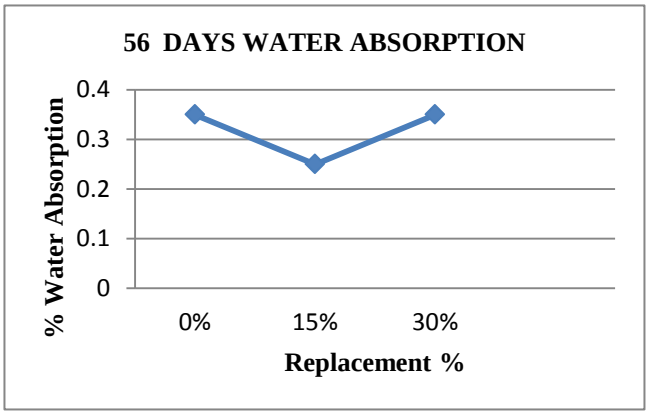


FIFTY SIX DAYS TEST RESULTS:

1. Water absorption

Table 4.1 Fifty six Days Water Absorption

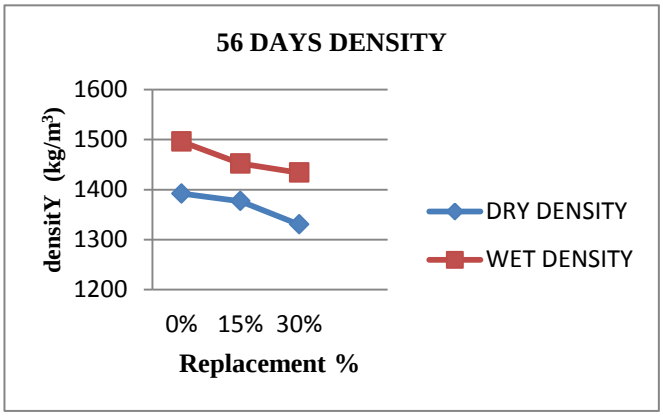
	Dry weight	Wet weight	Water absorption
Mix 1	4.7	5.05	0.35
Mix 2	4.65	4.9	0.25
Mix 3	4.49	4.84	0.35



2. Density

Table 4.2 Fifty six Days Density

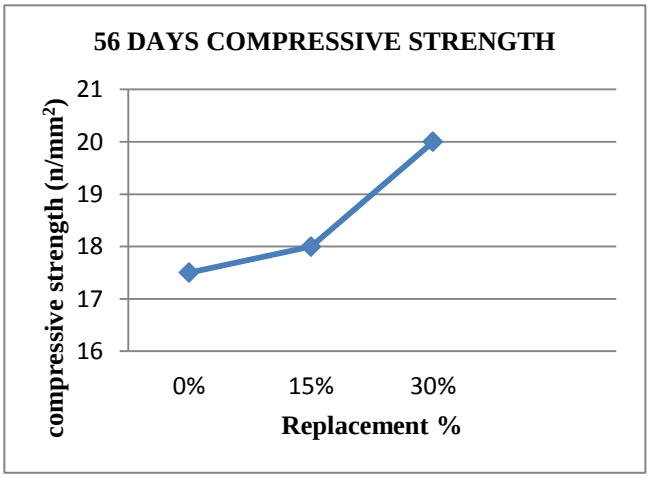
	Dry weight(kg)	Wet weight(kg)	Dry density (kg/m^3)	Wet density (kg/m^3)
Mix 1	4.7	5.05	1392	1496
Mix 2	4.65	4.9	1377	1452
Mix 3	4.49	4.84	1330	1434



3. Compressive strength

Table 4.3 Fifty six Days Compressive strength

	Compressive strength (N/mm^2)
Mix 1	17.5
Mix 2	18
Mix 3	20



3. CONCLUSIONS

From the test presented in this paper, the following conclusions can be drawn:

- The silica fume and fly ash combination provides improvement in both strength and workability of foamed concrete.
- The results for mixes investigated in this study showed that higher compressive strength of foamed concrete is attained in higher replacement of silica fume.
- The replacement of higher amount of silica fume also showed that its compressive strength is attained in early stages itself.

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