International Journal of Latest Engineering Research and Applications (IJLERA) ISSN: 2455-7137

Volume – 02, Issue – 07, July – 2017, PP – 07-12

Effect of Flyash on Strength Properties of Foam Concrete

[1]Akshay Reddy B, [2]Punith A, [3]Mrs. Kalyani Dongarkar
[1,2]Student, Civil Department
[3]Assistant Professor, Civil Department
Gopalan College of Engineering and Management, VTU

Abstract: With the increase in urbanisation there is a need to discover and develop sustainable materials which helps in the sustainable growth. A lightweight material for minimum self-weight which utilises the by-products or the wastes is the need of the day. Foam concrete is gaining its popularity due to its low weight. Here is an attempt to study the effect of fly ash on the strength of the foam concrete. The experiments involving four different types of mixes with partial replacement of sand by 0%, 50%, 70%, 100% flyash were conducted and 70% replacement specimen was found to give 9% more compressive strength and 8% more split tensile strength the density of 1100 kg/m3 was obtained. Thus the studies show that replacement of sand by 70% is practicable. This may help to reuse the flyash and conserve the sand which is becoming scarce these days.
Key words: Foam concrete, Light weight concrete, Fly ash, Sand replacement, protein foam

I. Introduction

Foam concrete is a unique product which has the strength of regular concrete and yet lightweight. Its durability is remarkable with sand and high dosage of fly ash making it an economical and environment friendly green product. It is a mix of cement, aggregates and air entering agents. Lightweight concrete can be made by mixing all the three basic concrete elements as per standard guidelines. Soon after, air entertaining agent is introduced at the time of foam process. Generally air volume left in lightweight concrete is more than 25%. Lightweight concrete can either be prepared at site or shaped in pre-cast blocks and panels manufactured at factory.

This mixture is volumised by addition of a foaming agent which enhances the volume and thus lightens the mixture, further this is casted in moulds to make blocks and then cured in air just like normal concrete and finally used. Foam concrete is mainly used in the construction industry. A variety of strengths and densities of the product can be produced easily and are available for different uses. A range of density can be varied as per the requirements. For non structural use like gap filling and thermal and acoustic insulation, the blocks of density 400 kg/cum-800 kg/cum are produced whereas 800 kg/cum-1200 kg/cum for partitions and walls in the form of precast blocks can be produced, For structural work the blocks of density of 1200-1600 kg/cum can be used in the form of precast or can be cast in situ.

II. Objectives of The Study

I. To study the effect of fly ash on foam concrete
II. To study the strength properties of partial and complete replacement of fine aggregates with fly ash in foam concrete mix
III. To utilise the industrial waste and save lands from hazardous landfills
IV. To reduce the carbon footprint of construction industry by reducing the cement content
V. Conversation of natural resources in general; sand in particular.

III. Comparison Between Foam Concrete and Normal Concrete

Table 1:Showing the difference between foam concrete and normal concrete

Sl. No.	Parameters	Foam concrete	Normal concrete
I.	Weight	Light weight	Heavy weight
II.	Air voids & seepage flow	Air voids are not interconnected and hence prevents seepage of water.	Air voids are interconnected and hence there is seepage of Water

III.	Use of coarse aggregate	No coarse aggregate required	Coarse aggregate required
IV.	Environmental impact	Ecofriendly product	Not eco-friendly
V.	Curing	Air curing	Water curing

IV. Literature Review

With reference to the objectives the following literature was useful:

1. This paper discusses the compressive strength and density of foam concrete through statistically designed experiments using response surface methodology. The relative influence of flyash replacement on strength and density of foam concrete is studied at lower densities allowing high strength. Confirmatory tests have shown that the relation developed by statistical treatment of experimental results can act as a guideline in the mixture proportion of foam concrete. (Published by **E.K. Kunhanandan Nambiar, K. Ramamurthy** in World Applied Sciences)

2. A study has been undertaken to investigate the effects, on the properties of foamed concrete, of replacing large volumes of cement (up to 75% by weight) with both classified and unclassified flyash. This paper reports only on the results of the compressive strength of concretes cured under sealed conditions and shows that up to 67% of the cement could be replaced without any significant reductions in strength. The calculated results compare well with the experimental results. (Published by **Kearsley EP, Wainwright PJ**)

3. Rational proportioning of preformed foam cellular concrete. This paper discusses the development of empirical models for compressive strength and density of foam concrete through statistically designed experiments. The response surface plots helps in visually analysing the influence of factors on the responses (Published by **Fred C**, **Cormick** in International Journal of Science)

V. Materials

A. Cement:

The cement used for the production of foam concrete is 53 grade Ordinary Portland Cement(OPC). Various test are performed to find out the properties of cement in determining the rate of gain of strength and uniformity of quality. The laboratory test performed are fineness test, specific gravity test, fineness test and setting time cement test. The obtained values are calibrated and compared with the standard range for determining the suitability of cement for the foam concrete.

B. Flyash:

Flyash also known as pulverised fuel ash, is one of the coal combustion products, composed of the fine particles that are driven out of the boiler with the flue gases. Flyash is used in an optimal way to replace sand in concrete production. Flyash is a heterogeneous material. $SiO2$, $Al2O3$, $Fe2O3$ and occasionally CaO are the main chemical components present in flyashes. Advantages of using flyash are reduces the dead weight of a structure and also provides excellent heat and sound insulation.

The flyash used for the foam concrete is Class F flyash. This type of flyash produces burning of harder, older anthracite and bituminous coal. This flyash is pozzolanic in nature, and contains less than 7% lime (CaO). Possessing pozzolanic properties, the glassy silica and alumina of Class F flyash requires a cementing agent, such as portland cement, quicklime, or hydrated lime—mixed with water to react and produce cementitious compounds. Alternatively, adding a chemical activator such as sodium silicate (water glass) to a Class F ash can form a geo polymer.

C. Aggregates:

The aggregate used is fine aggregates which is pulverized river sand. The sand is sieved and obtained finer than 300mm. The specific gravity of sand obtained is 2.52. No usage coarse aggregates

D. Foaming Agent: (Protein Foam)

Protein foam is innovative, powerful, highly effective foaming agent. Foam was produced by aerating an organic based foaming agent (dilution ratio 1:5 by weight) using an indigenously fabricated foam generator to a density of 40 kg/ m3. It contains natural surfactants and is mixed with organic raw materials, which work in synergy with them. The protein foaming agents are considerably better in the production of foam concrete than synthetic foaming agents because the main qualities of the protein foaming agents include the possibility to produce far firmer foam concrete of low densities.

A higher resistance of foam and better characteristics of process of foaming agent on each cubic meter of foam concrete is applied. The protein foam is produced from machine by mixing the chemicals required at specific pressure.

The Stability factor is 0.5-2.0 hours depending on the temperature and the necessary amount of foam depends on required density of constructional mixture of concrete.

VI. Methodology

The technique to prepare a foam concrete with desired properties varies slightly. For the expected density of 1000-1200 kg/cum, required mix design calculation was done as per ASTM and then the concrete was mixed in the way mentioned below:

The raw material such as cement and water were mixed to form slurry in a foam concrete mixer then pre-formed stable protein foam was introduced into the cement matrix and blended in the same mixer. The sand aggregates were partially replaced with fly ash and mixed together. Foaming agent was diluted in the ratio of 1:40 with the water and both were poured into the air compressor machine under the pressure to obtain foam. The foam obtained by mixing under pressure was poured onto mixer to obtain foam concrete. Once the Foam was completely blended, the foam concrete was ready for pouring. The foam concrete was placed manually. The foam concrete once poured achieves green strength after 24 hours and has to be left for air curing. Water curing is an optional that will be done for 7 or 28 days. For our studies only air curing was done.

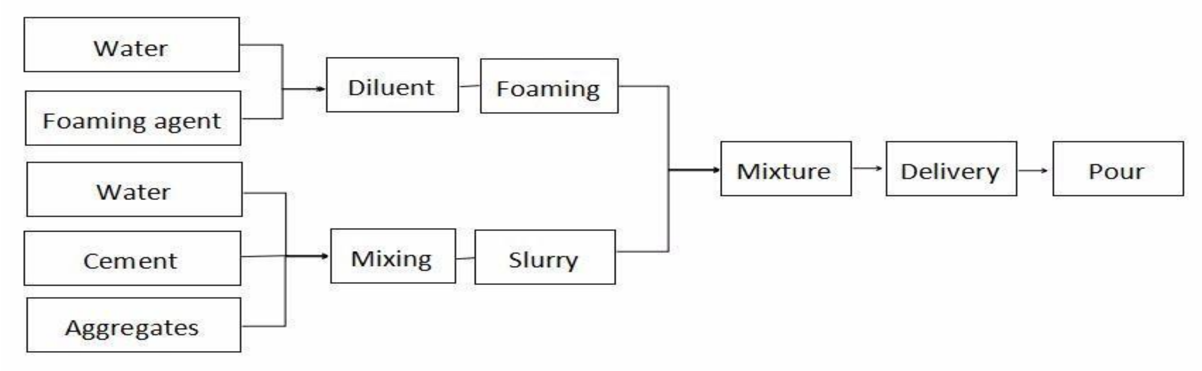

Fig. 1: Representation of Block diagram of mixing process of foam concrete

Fig. 2: Picture showing the mixing of foam concrete

In the cast-in-situ process, mixing and placing of concrete is carried out at site. The other method of pre-cast panels and blocks are available in many shape and sizes for different purposes. Hence we can achieve the density ranging 500 to 1800 kg/m3.

For the experimental purpose the foam concrete is casted in moulds in the form of cubes using the same process at required density. The length, width and depth of the cubes are 150 mm. The cubes were casted and demoulded after one day and were allowed to be cured. 4 types of moulds were prepared with 50%, 70% and 100% replacement of sand by flyash respectively.

VII. Results

The experimental investigations conducted and Factor level considered are summarized below:

Table 2: Experimental values of Compressive Strength test

Sl. No.	Cement (in Kg)	Flyash (%)	Sand (%)	Protein Foam (ml)	Load (in kN)	Compressive Strength (in MPa)
I.	2.2	0	100	150	200	8.8
II.	2.2	50	50	150	211	9.37
III.	2.2	70	30	150	216	9.6
IV.	2.2	100	0	150	215	9.5

*For the mould size of 150*150*150mm

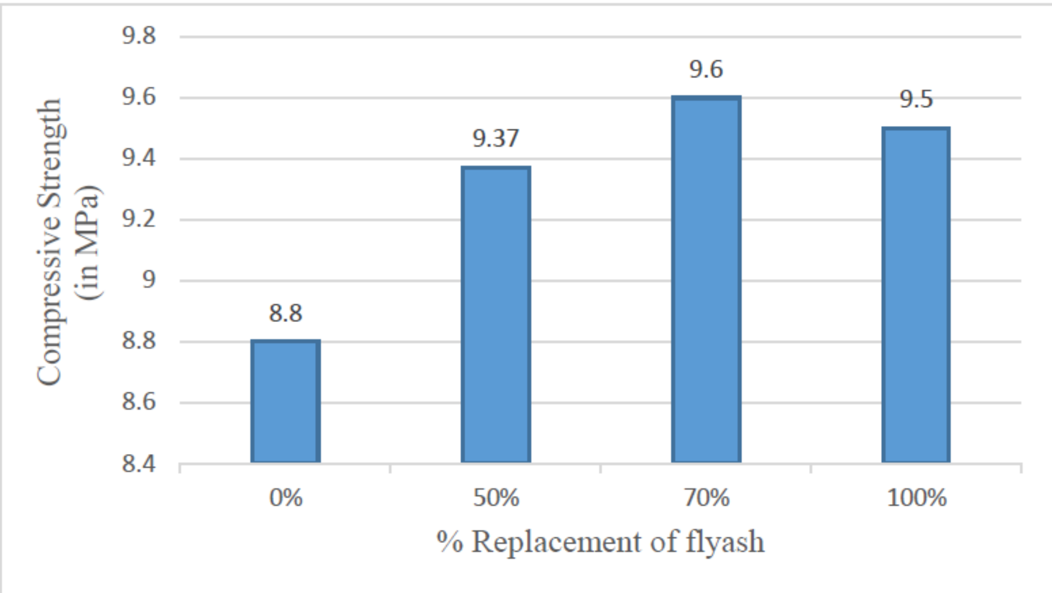

Fig. 3: Graph showing the variation of strength in Compression test

The maximum value of compressive strength is 9.6MPa for the 70% replacement of sand with flyash weight for the same proportions of cement and forming agent.

Reference Code:

IS 516 – 1959 Method of test for strength

IS 456 – 2000 Plain and Reinforced Concrete

Table 3: Experimental values of Split Tensile Strength test

Sl. No.	Cement (in Kg)	Flyash (%)	Sand (%)	Protein Foam (ml)	Load (in kN)	Tensile Strength (in MPa)
I.	2.2	0	100	150	110	6.2
II.	2.2	50	50	150	115	6.5
III.	2.2	70	30	150	120	6.7
IV.	2.2	100	0	150	118	6.6

*For the mould size of 150*150*150mm

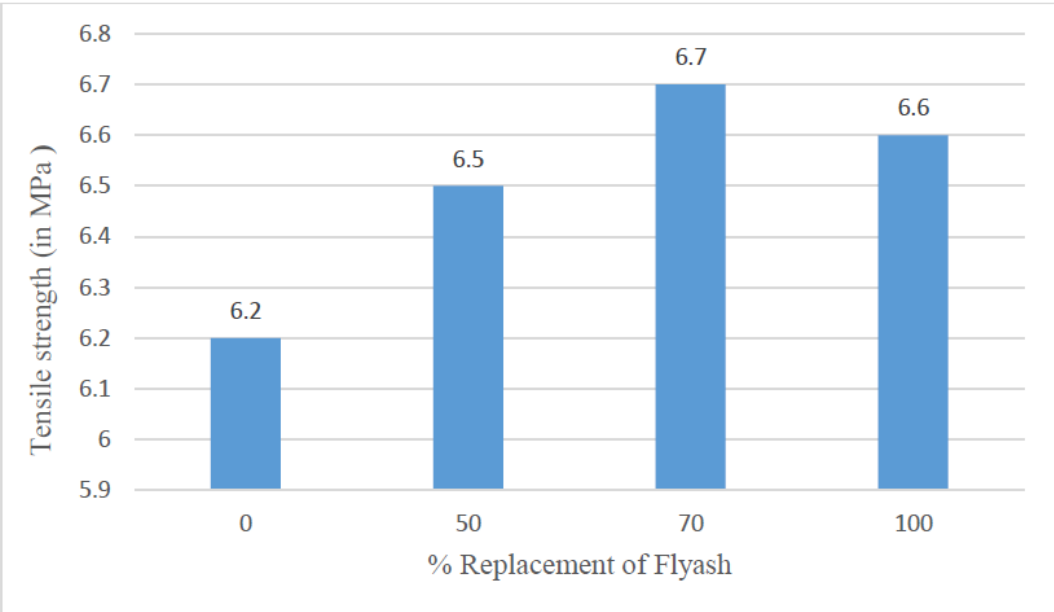

Fig. 4: Graph showing the variation of strength in Split Tensile test

The maximum value of tensile strength is 6.7MPa for the 70% replacement of sand with flyash weight for the same proportions of cement and forming agent.

Reference Code:
IS 7246 – 1974 Recommendations for use of table vibrators consolidating concrete
IS 4031 - part 7 - 1988 Method of test for strength of concrete
IS 269: 1967 Specifications for ordinary and low Portland cement IS: 650 – 1966

VIII. Advantages of Foam Concrete

- It helps to reduce the dead weight of concrete, therefore suitable for those structures which are not permissible to take the load of plain concrete. The weight of plain cement concrete is 2400 kg/m3 as compared to lightweight concrete whereas density of concrete can be achieved up to 400 kg/m3 in some special cases.

- Lightweight concrete is preferred for thermal insulation and sound barrier wall as it does have good thermal property due to availability of air voids.
- Useful for the inaccessible locations such as laid sewer lines, tunnels and tanks as it requires minimum compaction and formwork.
- Foamed concrete are useful for roof and floor screeds in high temperature locations.
- It helps to improve the fire rating of concrete surface.

IX. Conclusion

Confirmatory tests have shown that the relation developed by statistical treatment of experimental results can act as a guideline in the mixture proportion of foam concrete.

Partial replacement of sand by 0%, 50%, 70%, 100% flyash were conducted and tabulated. Out of which the 70% replacement specimen was found to give 9% more compressive strength and 8% more split tensile strength at density of 1100 kg/m3 was obtained. The replacement level for maximum strength depends on age of testing and it is 49% at 28 days and 71% at 90 days. Hence 70% flyash gives the maximum value and it is most effectively used proportion.

Replacement of sand with flyash in the mixture generally reduces the density, resulting in reduced foam volume requirement for a given density and thus indirectly contributes to strength enhancement over and above the pozzolanic and filler effect. The strength–density ratio is high for foam concrete mixes containing flyash as compared to sand.

Foam concrete are used for small works like construction of partition walls, gap filling, thermal and acoustic insulation and structural work like prefab and poured in situ structures but they are not applicable for load bearing walls as it is not capable to resist the weight of buildings. Therefore foam concrete has limited usage along with high cost rate production.

Acknowledgement

We express our gratitude towards the staff members of Duro-Vert CLC plant for their support in terms of materials and technical knowledge extended towards the course of this project.

References

[1]. Kunhanandan Nambiar EK, Ramamurthy K. Influence of filler type on the properties of foam concrete. Cem Concr Compos 2006;28:475–80.
[2]. Kearsley EP, Wainwright PJ. Porosity and permeability of foamed concrete. Cem Concr Res 2001;31:805–12.
[3]. Kearsley EP, Wainwright PJ. Ash content for optimum strength of foamed concrete. Cem Concr Res 2002;32:241–6.
[4]. Bureau of Indian standards. Specifications for 53 grade ordinary Portland cement. New Delhi, BIS, 1987. IS 12269-1987.
[5]. Valore RC. Cellular concretes—Part I. Composition and methods of preparation.
[6]. Am Concr Inst 1954;50(48a):773–95.
[7]. Rudnai G. Lightweight concretes. Budapest: Akademiai Kiado; 1963.
[8]. Fred C, Cormick Mc. Rational proportioning of preformed foam cellular concrete. ACI Mater J 1967:104–9.
[9]. Richard TG. Low temperature behaviour of cellular concrete. ACI Mater 1977;74(4):173–8.
[10]. Ho CG. Porosity-strength considerations for cellular concrete. Cem Concr Res 1972;2:91–100.
[11]. Nehdi M, Dejebbar Y, Khan A. Neural network model for preformed foam cellular concrete. ACI Mater J 2001;98(5):402–9.
[12]. Tam CTT, Lim Y, Lee SL. Relation between strength and volumetric composition of moist-cured cellular concrete. Mag Concr Res 1987; 39:12–8.

