Experimental Study on Properties of Light Weight Foam Concrete

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Abstract - *Concrete is the most consumed material on this earth next only to water. It is very difficult to imagine any civil engineering structure without the use of concrete and reinforcement. The weight of concrete material is one of the major concern in design of high rise. Very few carried out study on predicting the properties of foam concrete from the knowledge of its mixture proportions. In this study, foam agent is used to make light weight concrete along with fly ash replacing the cement in definite proportions. The influence of fly ash replacement on strength and density of foam concrete is studied and it is estimated that replacement of fine aggregate with fly ash will help in increase within the strength of froth concrete at lower densities permitting high strength to density quantitative relation. The strength properties of concrete is carried out for density of concrete varying from 800 to 1200kg/m^3 and with different proportion of fly ash. The experimental results have shown that the foam concrete possess good strength and can be a sustainable cost effective material in construction industry.*

Key Words: **Foam concrete, density of concrete, fly ash, compressive strength, flexural strength**

1. INTRODUCTION

The Foamed concrete possess characteristics such as high strength-to-weight ratio and low density. The dead loads due to self-weight of concrete on the structure can be reduced by using foamed concrete and contributes to energy conservation, and lowers the labor cost during construction. It additionally reduces the price of production and transportation of building parts compared to traditional concrete and has the potential of being employed as a structural material. Foam Concrete could be a distinctive product that has the strength of the cement and nevertheless light-weight. Its sturdiness is exceptional with sand and high dose of ash creating it a cost-effective and setting friendly inexperienced product. 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 rather like traditional concrete and eventually used. Foam concrete is especially employed in the development business. A variety of strengths and densities of the product can be produced easily and are available for different uses. A range of density, starting from 400 kg/cum-800 kg/cum (gap filling and thermal and acoustic insulation), 800 kg/cum-1200 kg/cum for partitions and walls (precast blocks), 1200-1600 kg/cum for structural work like prefabricated and poured in situ structures. Foam concrete is both fire and water resistant. It possesses high (impact and air-borne) sound and thermal insulation properties. Foam concrete is analogous to traditional concrete because it uses a similar ingredients. However, foam concrete differs from standard concrete in this the utilization of aggregates within the former is eliminated. A foam aeration agent is employed to soak up humidness for as long because the product is exposed to the atmosphere, permitting the association method of the cement to progress in its ever-continuing strength development.

The various benefits of foam concrete are:

• Reduces the dead weight of a structure.
• Can be manufactured to precise specifications of densities.
• Possess excellent workability, can be made cast in different forms
• Can be nailed, planed, drilled and sawn.
• Provides excellent heat and sound insulation.
• Can be applied with all traditional surface finishes – paint, tiles, carpets etc.
• Fire resistant.

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2. LITERATURE REVIEW

Several of the earlier investigations on foam concrete provides a elaborate discussion on its composition, physical properties and uses. The first comprehensive review on cellular concrete together with foam concrete was given by B. Karthikeyan, etal studied on the properties of lightweight foam concrete with addition of different binders like Fly ash, Micro silica, SiO2 powder, clay and rice husk ash. The results are elaborately discussed with respect to compressive strength, split tensile strength, and water absorption. Zhao et al prepared foam concrete of 900 kg/m3 density by adding expanded perlites and the results shown that the foamed concrete possess a thermal conductivity of 0.1334 w/(m·k) and a 28 d compressive strength of 3.2 MPa. Chen and Liu prepared foamed concrete of 800 kg/m3 by using OPC (with a 28 days compressive strength of 72.5 MPa), high alumina cement (92.4% SiO2), PP fiber, and EPS fiber. The results gave ample 28 days compressive strength of 11.0 MPa and a high thermal conductivity of 0.25 w. SerkanSubasi studied the influence of using fly ash in high strength light weight aggregate concrete which is produced with expanded clay aggregate on physical and mechanical properties of the concrete. The cement content with 450 Kg/m3 produced high strength value and the mechanical properties was enhanced by using 10% fly ash. Valore and a detailed treatment on variation of properties of light weight concrete was given by Short and Kinni-burgh. Mydin investigated the performance of the properties of foamed concrete in replacing volumes of cement of 10%, 15% and 20% by silica fume. The overall results showed that there's a possible to utilize silicon oxide fume in foamed concrete, as there was a noticeable enhancement of thermal and mechanical properties with the addition of silica fume. McCormick [4] has designed the mix proportion for different density of concrete based on solid volume calculation. Kamaya et al (1996) acknowledged that it's desirable to use non-organic materials, which have specific surface area higher than 7500 cm^2/g as supplementary material, for the production of high strength foam concrete. Richard reviewed the thermal and mechanical characteristics of foam concrete. Hoff studied that porosity-strength model for cellular concrete created with hydraulic cement, water and preformed foam. Durack and Weiqing projected a strength-gel house magnitude relation relationship for foam concrete. Nehdi et al. presented a non-traditional approach to the prediction of density and compressive strength of foam concrete mixtures based on the Artificial Neural Network (ANN) technology. For wet cured foam concrete, the relation between strength and volumetric composition, particularly water content and air voids, has been formulated by Tam et al. using Feret's and Power's equation, for a small range of water–cement ratios (0.6–0.8) and sand– cement ratios (1.58–1.73). Kearsley and waggonwright investigated the effect of substitution giant volume of cement with ash and equations supported effective water–cement quantitative relation and binder quantitative relation are developed to predict the strength of froth concrete made from cement paste of different densities at different ages. Most of those studies connected strength to density, gel–space ratio or porosity. Limited work has been according on predicting the properties of froth concrete from information of its mixture proportion. Further, studies on foam concrete victimisation ash as partial/complete replacement for filler have proved that the employment of ash ends up in higher strength to density magnitude relation and facilitates its high volume utilization. This study tries to develop empirical models for predicting the density and compressive strength of froth concrete from the mixture composition details like filler–cement magnitude relation, addition of ash as partial/complete replacement for sand and foam volume, through systematically designed experiments. Spinnery studied on Non-shrinking foam concrete replacing cement with an equal amount of cementitious fines which can be fly ash, slag cement etc.

3. OBJECTIVE

The main objectives of this study are:

• To investigate the properties of foam concrete.

• To study the influence of fly ash on properties of foam concrete.

• To evaluate the strength of foam concrete with different percentage of fly ash.

4. MATERIALS AND METHODOLOGY

4.1 Materials

Cement: The Ordinary Portland Cement of 53 grade conforming to IS: 12269-1987 is used. The various tests performed for the cement. The specific gravity of cement was found to be 3.157. The initial and final setting time for cements are found to be 29 minutes and 340 minutes.

Sand: The river sand conforming to the requirements of IS: 383 – 1970 is used as fine aggregate. The river sand is washed and screened to eliminate deleterious materials and over size particles. The properties of sand such as specific gravity and water absorption are found to be 2.52 and 1.14 % respectively.

Foaming agent (Protein Foam): 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. 1 liter of foaming agent is diluted in 40 liters of water

Flyash: Class F fly ash conforming to ASTM C 618-89 are used in this present study.

4.2 METHODOLOGY AND MIX PROPORTIONS

The mix proportions were arrived at as per the procedure given in ASTM C 796-97. As the standard deals with only cement slurry, the procedure was modified to include cement–sand–fly ash components. As the foam is added to the wet mix, the consistency of the wet mix is very important to get the desired design density, which is expressed in terms of water–solids ratio required to produce this consistency, and its range is narrow for a given mix. Based on several trails, the percent flow (consistency), measured in a standard flow table (without raising/ dropping of the flow table as it may affect the foam bubbles entrained in the mix) was arrived at as 45 ± 5%. Earlier studies by the authors have shown that within this range, the water–solids ratio does not affect compressive strength. As the water–solids requirement for obtaining this flow values varied for mixes with and without fly ash replacement (0.3–0.4 for mixes without fly ash and 0.35–0.6 for mixes with fly ash at different replacement levels). The Raw Materials are Cement, Water and Foaming Agent. Cement and Water are mixed to form a slurry in a special Foam Concrete Mixer, then Pre-formed stable foam is introduced into the cement matrix and blended in the Foam Concrete mixer. Once the Foam is completely blended, then Foam Concrete is ready for pouring. The Foam Concrete can be placed either manually or mechanically using a special Foam Concrete Pump. The Foam Concrete once poured achieves Green strength after 24 Hours, and has to be let off for curing for a period of 28 days.

The quantity of the materials required for 1 cubic meter of concrete as per mix design is given in Table.4.2.1

Table 4.2.1 Quantity of materials for 1m³ concrete

Sl.No.	Ingredients	Quantity
1	Cement	350 kg
2	Fly ash	550 kg
3	Protein Foaming agent	1 : 40
4	Water	150 litres

The quantity of raw materials required to produce varying density of concrete is given in Table 4.2.2

Table 4.2.2 Quantity of Materials Used

Sl.No	Density(kg/m3)	Cement (kg)	Flyash (kg)
1	800	17.4	27.4
2	1000	17.4	27.4
3	1200	17.4	27.4

5. RESULTS AND DISCUSSION

5.1 Compressive Strength

The compressive strength of foam concrete at varying densities was determined at the age of 7 and 28 days and shown in Fig.1. The tests were conducted as per IS standard using compression testing machine. The total 30 number of concrete cubes of 150mmx150mmx150mm are prepared. The 7-days and 28 days compressive strength of varying density concrete shown an increasing trend in compressive strength as number of curing period increases. The compressive strength of 800 kg/m³ density concrete at 28 days strength is lesser that of 7 days strength. It can further be observed that the maximum compressive strength is obtained for concrete of density 1200kg/m³ at 28 days

Table 5.1 Average Compressive Strength (N/mm²)

Sl.No	No of days curing/ Density	Average Compressive strength (N/mm²)	
		7 Days	28 Days
1	800kg/m3	3.92	2.36
2	1000 kg/m3	3.4	3.84
3	1200 kg/m3	4.14	5.77

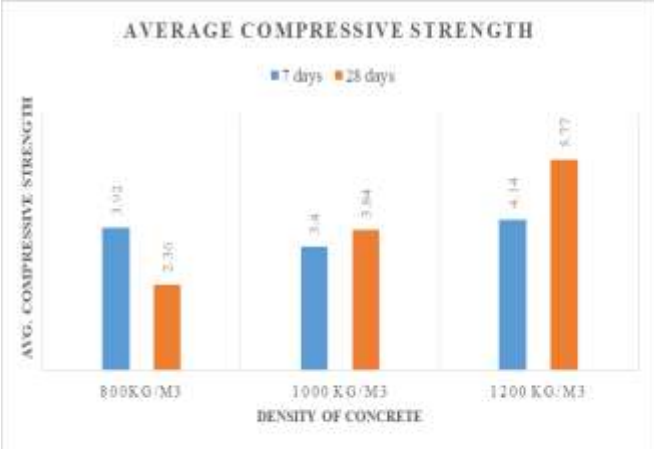

Fig.1 Average Compressive Strength for 7 days and 28 days

5.2 Flexural Strength:

The various flexural values for the samples are tabulated for different density of concrete are given in Table.5.2. The flexural strength of 800 kg/m³ concrete is decreasing with increase in curing period. It is evident form the fig that the maximum 28 days strength of foam concrete was found to be 1.44 N/mm² for 1200 kg/m³ concrete mix. This value is far more than the value calculated from the expression $0.7\sqrt{fck}$ (where fck is the characteristic strength of concrete) as specified by IS: 456 (Indian Standard Specifications).

Table 5.2 Average Flexural Strength (N/mm²)

Sl.No	No of days curing	Average Flexural strength (N/mm²)	
		7 Days	28 Days
1	800kg/m3	0.98	0.66
2	1000 kg/m3	0.84	0.95
3	1200 kg/m3	1.03	1.44

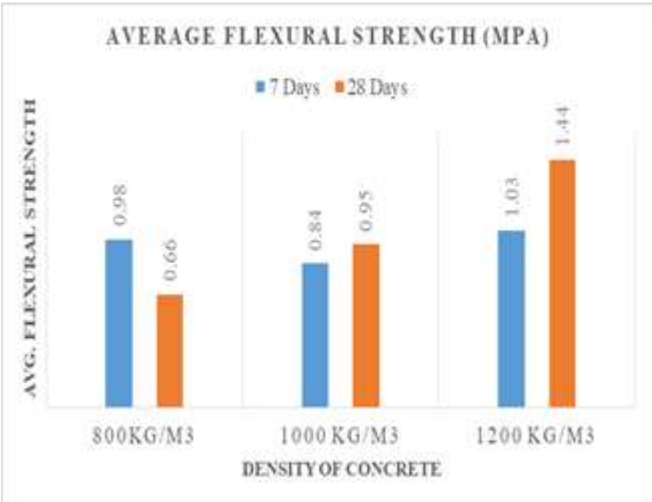

Fig.2 Average Flexural Strength for 7 days and 28 days

6. CONCLUSIONS

Conclusions pertain to the experimental investigations conducted on foamed concrete of varying densities are summarized below. Fly ash when used as partial/complete replacement for fine aggregate; cause an increase in compressive strength. The replacement level for maximum Strength depends on age of testing; it is 49% at 28 days and 71% at 90 days by replacement of sand with fly ash 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 higher than the pozzolanic and filler result. The strength – density magnitude relation is high for foam concrete mixes containing ash as compared to sand. Based on the test results, it can be concluded that the foam concrete can be used as replacement for heavy weight concrete depends on purpose of the structure

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