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Experimental Study on Strength and Durability Characteristics of Foam Concrete by using Synthetic Foaming Agent

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Abstract: Nowadays, builders across the world are paying increasing attention to use eco-friendly material as replacement for conventional building materials. The adverse development in construction field has initiated for using light weight concrete with good characteristics. Foam concrete is a mixture of cement, fine sand (substituted by fly ash), water and predetermined volume of foam. By diluting the foam in agent with water and aerated to form foam. Cement paste get hardens once it sticks with foam. Foaming agents may be synthetic or protein based foaming agents. Foaming agents which comes from animal proteins such as blood, bones of cows, pigs and other animal carcasses are classified under protein based. An attempt has been made to determine the strength and durability characteristics of M20 grade Foam concrete by using synthetic foaming agent.

Keywords: Foam concrete, Foaming agent, Compressive strength, Durability.

1. Introduction

Foam concrete is a mixture of cement, fine sand (substituted by fly ash), water and predetermined volume of foam. The foam concrete has both fire resistance and thermal insulation properties. The only change in case of foam concrete is omitting the usage of coarse aggregate for preparing the mix. Since air-pores are embedded inside the concrete; referred as cellular concrete. The foam generation is done by diluting the foaming agent with water and aerated to create foam. The cement paste can stick around the foam and hardens. After hardening the foam has sufficient strength to maintain the shape around the voids. Foaming agents may be synthetic or protein based foaming agents. Foaming agents which comes from animal proteins such as blood, bones of cows, pigs and other animal carcasses are classified under protein based. It is rarely used because it can easily be degraded by bacteria and other microbes. Synthetic based foaming agents are purely chemical products and they can give good strength above 1000kg/m^3 which has wider applications to structural, partition, insulation and filling grades. Its construction applications as lightweight non-structural and semi-structural material are increasing in the last few years.

Sharma et al., (2017) studied cellular lightweight concrete which is influenced by foam density. Properties of foam concrete with the fly ash as full replacement of fine aggregate were determined for a density of 1200kN/m3 and 1500kN/m3. As the age and density increases, compressive & specific strength increases considerably and properties decreases because of voids and absence of coarse aggregates.

Kanagalakshmi et al., (2015) studied the usage of quarry dust varying from 10% to 50% in foam concrete. Strength was nearly 43% more than the control foam concrete. On account of experimental investigation; it was proposed that burnt clay bricks can be effectively replaced with the foam concrete blocks.

An attempt has been made in using synthetic foaming agent to produce foam concrete of M20 grade to determine its strength and durability characteristics.

2. Materials

2.1 **Cement-** In the present study, OPC 43 grade cement is used.
2.2 **Water**- Water free from impurities is used for preparing concrete mixes
2.3 **Manufactured Sand**–M Sand as an aggregate is used for preparing concrete mix as per IS383 code.

2.4 **Synthetic Foaming Agent**-CETYL TRYMETHYLAMMONIUM BROMIDE (CTAB) is used as Synthetic foaming agent to manufacture foam concrete.

2.5 **Ground Granulated Blast Furnace Slag (GGBS)** – In the present study, 40% by weight of cement is replaced by GGBS

3. Methodology

3.1 Test on materials

Table1. Physical properties of Cement

Elements	Content
Specific Gravity	3.16
Fineness	9.33%
Standard Consistency	32%
Initial Setting time	40min
Final Setting time	285min

Table2. Physical properties of Manufactured Sand

Particulars	Values
Specific Gravity	2.62
Fineness Modulus	4.42
Water absorption	1.0%

Table3. Physical properties of GGBS

Elements	Content
Specific Gravity	2.32

Table4. Properties of CTAB

Properties	
Molecular Formula	$C_{19}H_{42}BrN$
Molecular Mass	364.45g/mol
Appearance	White powder
Melting point	237°C - 243°C
Density	1g/cm^3

3.2 Mixing of materials

A mixture of cement, sand and water is prepared separately on a non-absorbent platform. Foam is added to the prepared mixture and mixed well by using hand mixer in order to obtain a uniform mix which can be place into the mould.

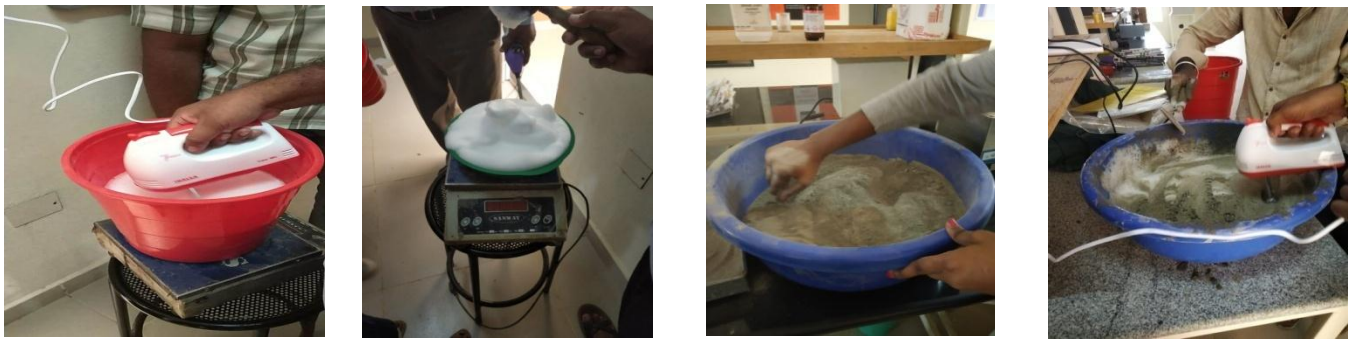

Fig.1 Mixing of materials

Table5. Mix proportion of Foam Concrete

Mixes	Cement Kg/m³	GGBS Kg/m³	Water Kg/m³	Fine Agg. Kg/m³	Vol. of foam	S/C ratio	W/C ratio
Mix 1	266.67	-	133.35	800.01	-	3	0.5
Mix 2	266.67	-	133.35	800.01	0.48	3	0.5
Mix 3	213.33	53.33	133.35	800.01	0.48	3	0.5
Mix 4	160	106.67	133.35	800.01	0.48	3	0.5
Mix 5	106.67	160	133.35	800.01	0.48	3	0.5

M1: C+S+W M2: C+S+W+F M3: C+20%+W+F M4: C+40%+W+F M5: C+60%+W+F

4. Results and Discussions

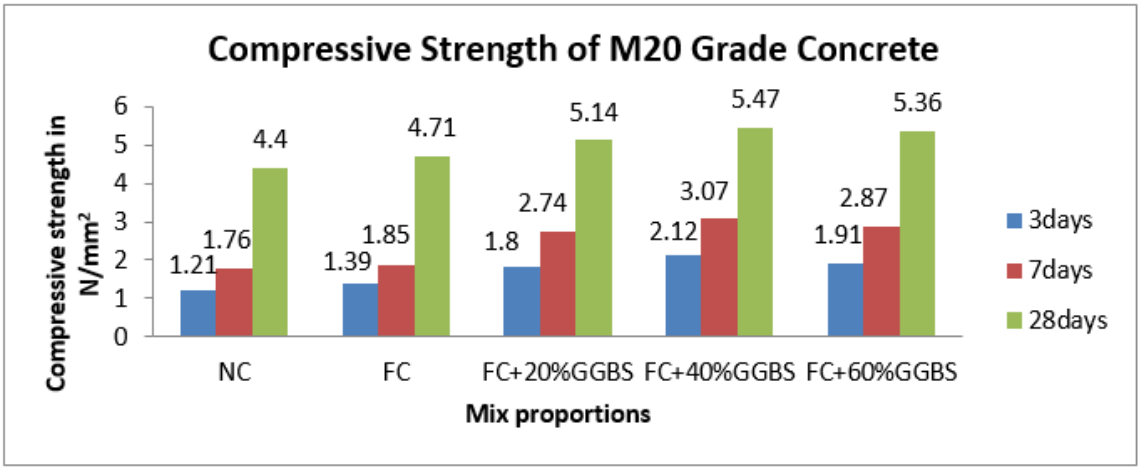

Fig.2 Compressive strength of normal and foam concrete mixes with partial replacement of GGBS by weight of cement for 3, 7 and 28days of curing

The above graph indicates that the average compressive strength test of Normal concrete (NC) & Foam concrete (FC) having density of 1200kg/m³varying with 0% to 60% replacement of GGBS by weight of cement varies by 7.04, 16.81, 24.31, 21.81% for 28 days of curing than compared to that of Normal concrete.

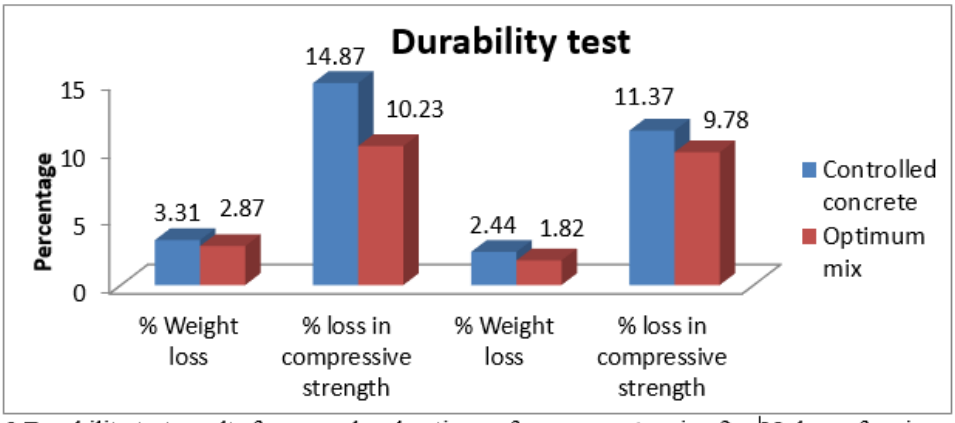

Fig.3 Durability test results for normal and optimum foam concrete mix after 28 days of curing.

The above graph indicates that the durability test results such as percentage loss in weight and compressive is less under alkalinity than compared to that of acidity for normal and optimum concrete mix after 28 days of curing.

5. Conclusions

1. The compressive strength of foam concrete is observed to be 1.07 times more than that of controlled concrete after 28days of curing.
2. The compressive strength of foam concrete with 40% replacement of GGBS by weight ofcement is observed to be 1.16 times than that of foam concrete with zero replacement after28days of curing.
3. Foam concrete with 40% replacement of GGBS by weight of cement is considered as an optimum mix because the strength result for 60% replacement is lesser when compared to that of 40% replacement.
4. Foam concrete is also called as self-levelling concrete which can be used in the sections where reinforcements are more.
5. Due to less weight, there is a reduction in dead loads thereby decrease in the size of the members is considered
6. Foam concrete has better resistance to aggressive environment than compared to that of controlled concrete.
7. Amount of surfactant required for manufacturing 1$m^3$of foam concrete is less. Therefore, it proves to be cost effective.

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