Sustainable Light Weight Green Concrete Blocks Fabricated Using Disparate Foaming Agents

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Abstract- Concrete being a combination of raw materials like cement, sand, water, and aggregate are manufactured abundantly in the world. There lies an increasing demand for these natural resources due to rapid urbanization. And recent advancements have various solutions to counteract this demand. At present, various types of concrete have been developed providing green solutions to the environment. One such solution is light weight green foam concrete blocks. Foam concrete (FC) is defined as a light weight cellular concrete with random air-voids created from the mixture of foaming agents in mortar. It is a versatile building material which is inexpensive, has low density (400-1950kg/m^3), less environmental impact and widely recognized for it's high flowability, low cement content, low aggregate usage, excellent thermal insulation, fire resistance and sound absorbance. The primary aim of the study will be to contrast a conventional brick block with the foamed concrete block, with regards to it's mechanical and durability properties, thereby checking it's suitability to replace the conventional brick. Also, the latterly published study, vaticinates that the global market for foam concrete will continue to proliferate owing to the increased exposure of application areas in under developed and developing countries, hence this study can help assuage customer solicitude and further encourage the wider application of FC in civil engineering.

Keywords –Durability, Foam concrete (FC) blocks, Inexpensive, Low density, Mechanical property

I. INTRODUCTION

Foam concrete (FC) blocks are defined as the light weight cellular concrete blocks with random air-voids created from the mixture of foaming agents in mortar.They have the potential of being an alternative to the conventional brick blocks, because they reduce the dead loads on the structure and foundation, which contributes to energy conservation, lowering the cost of production and the labor cost during the construction and transportation. The properties of the foam concrete blocks depends on the type of binder and the foaming agent used. The foaming agents used are categorized as natural foaming agent (or protein based foaming agent) and synthetic foaming agent. In this paper, for the study of foam concrete blocks, two types of foaming agents are used namely, soap nut (natural foaming agent) and sodium laureth sulphate ((SLS) synthetic foaming agent). Also, the binders used are cement and flyash. The prime focus of the paper is to differentiate the properties of the foam concrete blocks with respect to the foaming agents, and thereby reviewing those results with properties of a conventional first class brick blocks. Forbye, this study will augment the application of the green eco-friendly foam concrete blocks in the civil engineering discipline.

II.EXPERIMENTAL PROGRAM

The comprehensive work was organized based on the programme of action illustrated below.

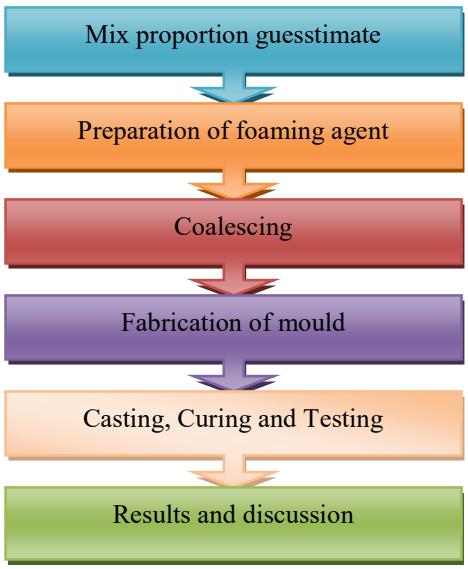


Figure 1. Methodology

III. PROTOTYPE FABRICATION

3.1 Mix Proportion-

In case of conventional concrete the material proportion can be found out for the required strength as per codal provisions, where as for foamed concrete, there is no standard method for proportioning because the density of hardened foam concrete is determined based on the level of saturation in it's pores.Mix design of foam concrete depends upon the volume of foam, cement content, and the filler material. Therefore, for this investigation, the mix proportion adopted is 1:1:1 (Cement : Flyash : River sand).

3.2 Preparation of Foaming Agent-

Soap nut (Natural foaming agent)- 400 grams of soap nut was taken and put to boil, unit the external layer was softened. The solution was then filtered and taken for the preparation of foam.

Sodium Laureth Sulphate (Synthetic foaming agent)- 200 grams of SLS was mixed with the water of pH range 7 for the preparation of foam because, according to the IS code 456 (2000), the pH value of mixing and curing water for concrete preparation shall not have less than 6 pH value.

Manual methods were used to generate foam, and usage of foam generator was eliminated. Also, it was inferred that, protein based foaming agent requires more energy for foam production when compared to the synthetic based.

Figure 2. Manual foam preparation

3.3Coalescing-

Foam concrete can be prepared using two methods such as *pre-foaming Method* (the foam and the mortar are prepared separately and then mixed as a whole)*and mix-foaming method*(the foam and other components are mixed together without any separate preparation). The type adopted for the study is pre-foaming method. The mortar prepared should have a thick slurry texture, with the capability of self compaction.

Figure 3. Preparation of the mix using pre-foaming method

3.4 Fabrication Of Mould-

There ain't any standardized mould size for casting foam concrete. Hence, a wooden framework containing moulds of size 100mm X 100mm X 100mm was fabricated.

Figure 4. Paradigm

3.5 *Casting, Curing and Testing-*

As per IS 456 (2000), the test resultsof the sample shall be the average of the strength of three specimens and the individual variation should not be more than ± l5 percent of the average. If the value obtained is more, then test result of the sample are invalid. Therefore, a number of cube specimens were casted for both foaming agents, and were considered for the 7^{th} day and 28^{th} day tests, to determine the compressive strength and to determine the percentage of water absorption.

(a)

(b)

(c)

Figure 5. (a) Casting of specimens (b) Compressive strength test using universal testing machine(UTM) (C)Yielded specimen

IV. Results and Discussion

4.1 Water Absorption Test-

The test procedure involves drying a specimen, weighing it, then immersing it in water for specified amount of time (about 24 hours), and weighing it again. The increase in weight as a percentage of the original weight of the respective specimen is expressed as it's absorption (in percent).The following Table 1 and Table 2 represents the dry density, wet density and absorption percentage of the specimens casted and the average values of these durability properties are depicted in the form of chart in Figure 6 and Figure 7.

Table -1 Density And Absorption Results Of Specimen Containing Synthetic Based Foaming Agent

Type	Dry density (kg/m^3)	Wet density (kg/m^3)	% Absorption
Sodium Laureth Sulphate (SLS)	1650	1720	4.2
	1710	1780	4.09
	1655	1735	4.83
	1715	1770	3.1
	1725	1785	3.5
	1730	1805	4.3
Average	1690	1770	4.0

Table- 2 Density And Absorption Results Of Specimen Containing Natural Foaming Agent

Type	Dry density (kg/m^3)	Wet density (kg/m^3)	% Absorption
Soap Nut	1770	1850	4.5
	1810	1875	3.5
	1780	1860	4.4
	1765	1820	3.2
	1790	1865	4.2
	1780	1845	3.7
Average	1780	1850	3.9

Figure 6. Comparison of absorption percentage

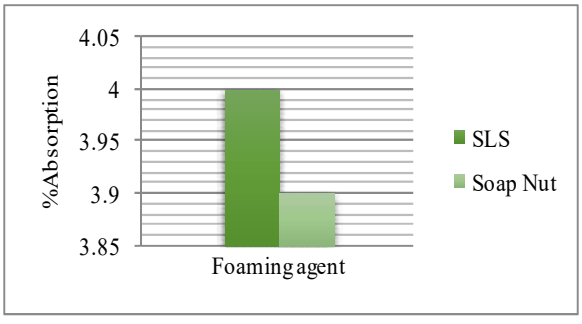
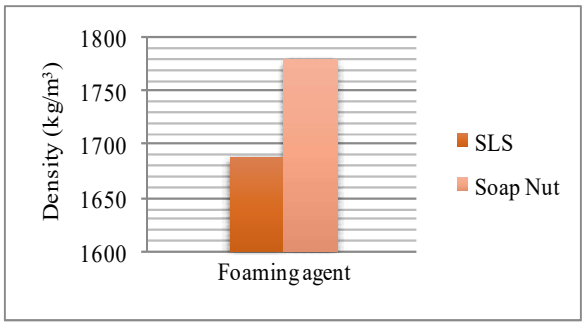


Figure 7. Comparison of dry density

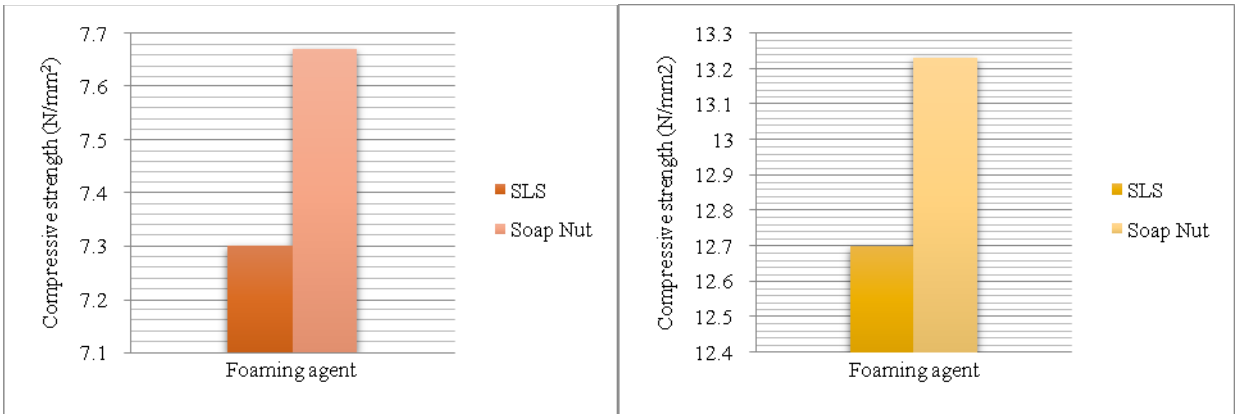


4.2 Compressive Strength Test-

The process involves casting of the the cubes, allowing them to set, demoulding the hardened specimen and immersing in water tub or tank for curing. The cubes are removed respectively after 7th and 28th days from the curing pit and tested for their compressive strengths. The concrete generally remains alacritous in the initial days, which connotes, it procures most of it's strength within 28 days. Later on it's strength increases but by a small amplitude. The following Table 3 renders the mechanical property of the specimen and the difference between the compressive strengths, obtained at the end of 7th and 28th day tests are delineated in the Figure 8.

Table -3 Compressive strength results for 7th and 28th day

Type	Compressive strength (N/mm^2)	
	7th day	28th day
Sodium Laureth Sulphate (SLS)	7.6	13.10
	7	12.24
	7.2	12.76
Average	7.3	12.7
Soap Nut	7.7	13.14
	7.5	12.75
	7.8	13.80
Average	7.67	13.23



(a) (b)

Figure 8 (a) 7th day compressive strength result comparison (b) 28th day compressive strength result comparison

4.3 Scrutinization Of Results-

The characteristics of a robust 1st class conventionalbricks are collated with results obtained for the green concrete blocks fabricated using different foaming agents in the following Table-4.

Table-4 Collating the results

Properties	Light weight green concrete block		Conventional 1st class brick block
	SLS	Soap Nut	
Density (kg/m^3)	1690	1780	1500 to 1800
Water absorption (%)	4	3.9	Under 20%
Compressive strength (N/mm^2)	12.7	13.23	3.5 to 10.5

IV.CONCLUSION

Thence, based on the test results acquired,it can be inferred that,

1) The foamed concrete blocks casted using natural foaming agent had less water absorption percentage and more dry density when compared to the synthetic based foaming agent.

2) The compressive strength of specimen containing natural foaming agent had more strength than the specimen containing synthetic based foaming agent.

3) The values obtained for the respective parameters of light weight green concrete blocks are within the radius of conventional brick blocks. Hence, replacing the latter with the former can accord with the increasing demands of sustainable outlook for countries worldwide, in construction.

4) Oodles of infrastructures,demand for various new environmental protecting and sustainable materials, in which these light weight foamed concrete blocks plays a key role. Withthe support of the government, with regards to the policy or in the economicaspect, the more scientific research outputs can be obtained, which is propitious to enhance establishment and reform ofthe relevant industrial systems, thereby assuaging the consumer concerns.

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