Experimental Investigation on Strength Behaviour of Foamed Block

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Abstract-Foamed Concrete can be defined as a type of Cellular Lightweight Concrete (CLC); it doesn't contain any Coarse Aggregate (Gravel). The whole slurry contains only the Cement, Sand, Fly ash in different proportions and Foaming agent. The foam used in the mortar can be of two types; Natural and Synthetic. The natural foam liquid can be prepared by using the Soap nuts (from small trees in the Lychee family, native to warm temperature to tropical regions of the world). The synthetic based foam agents are easier to handle and are cheap. They can be stored for a longer period. Lesser energy is required to produce these foams. The protein based foam is costly but have high strength and performance. The foam can be generated by the foam liquid using the foam generator. The slurry and the foam mixture can produce a variety of foamed concrete densities ranging from 400 to 1800 Kg/m^3.This CLC block may be used in non-structural parts of buildings like partition walls or light load bearing walls. Cellular lightweight concrete are made in different proportions based on the materials in same densities with natural foaming agent then their compressive strengths and density is tested and compared with normal weight concrete.

Keywords: Foamed concrete, Soap nuts, natural foam, Cellular lightweight Concrete (CLC).

1. INTRODUCTION

CLC Blocks (Cellular Light Weight Concrete Blocks) are made of Cellular Light weight concrete (CLC) or Foam Concrete. Cellular Light Weight Concrete (CLC) is a light weight concrete that is produced by mixing cement and fly ash slurry with pre-formed foam. Foamed concrete has a surprisingly long history and was first patented in 1923, mainly for use as an insulation material. The first comprehensive review on foamed concrete was presented by Valore in 1954 and a detailed treatment by Randi and Short and Kinniburgh in 1963, summarising the composition, properties and uses of cellular concrete, irrespective of the method of formation of the cell structure. Significant improvements over the past 20 years in production equipment and better quality surfactants (foaming agents) has enabled the use of foamed concrete on a larger scale. Cellular Light weight concrete sometimes referred to as foamed concrete is a lightweight construction material consisting of Portland cement, water, foaming agent and compressed air. The foam is formulated to provide stability and prevent draining of water. Pozzolana such fly ash and fibers are often added to mix to customize compressive and flexural strengths. Cellular concrete typically contains no aggregate. Cellular lightweight concrete is slurry of cement, sand, water, fly ash and preformed stable foam generated by foam generating machine. By trapping air bubbles within the concrete, a lightweight insulating material is formed. It has fireproofing, insulation, sound attenuation and energy absorbing characteristics.

2. LITERATURE REVIEW

The research in the field of Foam concrete has an accelerated growth in the recent years. The study on the various stages of Foam concrete are studied by many researchers, reveal the facts about Foam concrete, thus making it a practically wide applicable. Many research papers were published by various researchers, which show the engineering significance of Foam concrete are studied workability of concrete
P.S. Bhandari and Dr .K.M.Tajne:
In this research paper they have concluded that the compressive strength for cellular light weight concrete is low for lower density mixture. The performance of cellular lightweight concrete in term of density and compressive strength are investigated

Manaf:
In this study paper the main specialties of lightweight concrete are its low density and thermal conductivity. Its advantages, disadvantages and applications were studied thoroughly

Satyendra Kumar Meena, Pushpendra Kumar Meena, Rakesh Kumar Meena, Rupayan Roy and Pawan Kumar Meena:
It was studied that cellular lightweight concrete possesses high flow ability, low self-weight, minimal consumption of aggregate, controlled low strength and excellent thermal insulation properties. It has excellent resistance to water and frost, and provides a high level of both sound and thermal insulation.

K. Krishna Bhavani Sriram: This paper shows that how the cellular concrete can be used as a replacement of burnt clay bricks. An attempt is made to compare cellular lightweight concrete (CLC) Blocks and Clay Bricks, and recommend a replacement material to red brick in construction industry.

3. METHODOLOGY

The first step is to make cement slurry that is appropriate for the mix design. We will make sand cement slurry to achieve foam concrete of specific density. The second step is to make suitable foam. The foam is made separately from the slurry. Once the foam has been made it is blended in to slurry to make foamed concrete.

4. PROPERTIES OF MATERIALS

A. ORDINARY PORTLAND CEMENT

Cement is a binder, a substance used for construction that sets, hardens and adheres to other materials to bind them together. Because of their hydrating properties, they even set under water. In this project OPC grade 53 is used. OPC is a fine powder, produced by heating limestone and clay minerals in a kiln to form clinker, grinding the clinker, and adding 2 to 3% of gypsum. Ordinary Portland cement is commonly used, but rapid hardening cement can also be used if necessary. The content of cement range from 300 to 400 kg/m^3.

B. FINE AGGREGATE

To increase the density of the resulting mix, the aggregate is frequently used in two or more sizes. The aggregate serves as reinforcement to add strength to the overall composite material. Fine Aggregate may have more impact on the strength of the building than cement. Fine aggregate will consist of natural sand, manufactured sand, or a combination of the two, and will be composed of clean, hard, durable particles. Particles of the fine aggregate should be generally spherical or cubical in shape as practicable. Care must be taken to insure that contaminating substances are not present in fine aggregate stockpiles. Such substances would include dirt, dust, mud, and construction debris. The important functions of the fine aggregate are to assist in producing a dense workable and homogenous mixture. The purpose of the fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent.

C.FLY ASH

Fly ash is a fine gray powder consisting mostly of spherical, glassy particles that are produced as a byproduct in coal-fired power stations. Fly ash has pozzolanic properties, meaning that it reacts with lime to form cementitious compounds. It is commonly known as a supplementary cementitious material. The use of fly ash can improve workability of the fresh concrete and result in concrete of higher strength and lower permeability with consequent improved resistance to sulfate attack and ingress of corrosive liquids that might lead to corrosion of reinforcing steel.

D.WATER AND FOAM

Water is the most important and least expansive ingredient of concrete. The amount of water to be added to the mix depends on the composition of the mix design. Generally for lighter densities, when the amount of foam is increased, the amount of water can be decreased. The water-cement ratio must be kept as low as possible in order to avoid unnecessary shrinkage in the moulds . The range of water-cement ratio used in LFC is between 0.4 to 1.25, the appropriate value will be depending on the amount of cement in the mix, use of chemical admixtures and consistence requirement. Foaming agents are used in the field of construction, which are simply made up with proper amount of cement, fly ash, sand and foaming agent finely mix with water in particular

compressed air. The mix with foaming agents different from other mixes due to some specific qualities such as it is very eco friendly, light weight so it can be transported easily.

5. MIX PROPORTION

There is at present, no guidance or standard method for proportioning foamed concrete, because the hardened density of foamed concrete depends on the saturation level in its pores. Sample mix proportions of foamed concrete are given in table. However, conclusive mix proportions by actual trials may be worked out with the given set of site materials for required workability, plastic density and compressive strength. Reports from ACI 523.3R-93 (American Concrete Institute, 1993) shows that the process starts from the selection of unit weight of the plastic concrete, the cement content and water cement ratio.

TABLE 1 – MIX PROPORTIONS

S.NO	TRIAL MIX	CEMENT (g)	SAND (g)	FLYASH (g)	FOAM AND WATER (ml)
1.	T - 1	300	600	120	150
2.	T - 2	300	600	120	125
3.	T - 3	300	600	120	100
4.	T - 4	300	600	120	75

6. EXPERIMENTAL INVESTIGATION

INTRODUCTION

In this chapter, test to be conducted on foamed concrete to find out its strength and density. The preparing process of foamed concrete is same .Few of the trial mixes specimens are casted for choosing control mix and compressive strength test and density test were carried out on it. The results obtained are discussed in this chapter.

STRENGTH TEST

- Compressive strength test
- Density test
- Ultrasonic pulse velocity test

1. COMPRESSIVE STRENGTH TEST

The 75 mm test cubes were casted and then it was kept for curing in a constant temperature up to the day of testing. The cubes are then placed in the Compression Testing Machine (CTM). Then the load is applied to the cubes, at maximum load point the specimen shows the sign of break. That maximum value is noted as the load value. The measured compressive strength of the specimen is to be calculated by dividing the maximum applied load to the specimen during testing by the cross sectional area. Three cubes from the same mixture of foamed concrete were crushed and the average of the three results is used to define the strength of the mixture. Compressive strength of foamed concrete was recorded for 7 and 28 days.

Compressive strength = P/A

- P = Maximum load in N
- A = Cross sectional area of cube in mm Size of cube = (70 x 70x 70) mm

Fig 1- Specimen Tested for Compressive Strength (After the Load Applied)

TABLE 2 -COMPRESSIVE STRENGTH TEST (N/mm^2)

MIX TRIAL	CEMENT (g)	SAND (g)	FLYASH (g)	WATER AND FOAM (ml)	COMPRESSIVE STRENGTH (N/mm^2)	
					7 DAYS	28 DAYS
T -1	300	600	120	150	-	-
T-2	300	600	120	125	3.4	6
T-3	300	600	120	100	5.8	8
T-4	300	600	120	75	7	10

2. DENSITY TEST

Density is simply a measurement of weight per unit of volume. In the case of foam, it is measured in pounds per cubic foot (PCF) . In other words, the density of foam is expressed by measuring the weight of a single cubic foot of foam material .The density of the foamed concrete usually varies from 300 kg / m^3 to 1800 kg /

m^3. Increasing amount of foams in the concrete mixture can reduce the density of the foamed concrete

TABLE 3 - DRY DENSITY TEST RESULTS

MIX TRIAL	CEMENTS (g)	SAND (g)	FLYASH (g)	WATER AND FOAM (ml)	DRY DENSITY (kg/m^3)	
					7 days	28 days
T - 1	300	600	120	150	-	-
T - 2	300	600	120	125	1398.5	1445.9
T - 3	300	600	120	100	1445.9	1715.6
T - 4	300	600	120	75	1728.0	1800

TABLE 4 – DENSITY TEST RESULTS

MIX TRIAL	CEMENTS (g)	SAND (g)	FLYASH (g)	WATER AND FOAM (ml)	DENSITY (kg/m^3)
T - 1	300	600	120	150	1351.1
T - 2	300	600	120	125	1386.6
T - 3	300	600	120	100	1410.3
T - 4	300	600	120	75	1457.79

3. ULTRASONIC PULSE VELOCITY TEST

An Ultrasonic pulse velocity test is an in situ, nondestructive test to check the quality of concrete and natural rocks.In this test, the strength and quality of concrete or rock is assessed by measuring the velocity of an ultrasonic pulse passing.

TABLE 5 - REFERENCE VALUES

UPV Value in km/sec (V)	Concrete quality
Greater than 4	Very good to excellent
Between 4 and 3.5	Good but slight
Between 3.5 and 3	Satisfactory but loss of integrity exits
Less than 3	Poor and loss of integrity exits

Fig 2 - Direct method

Fig 3 -Semi direct method

Test conducted for Cubical specimen of size 70mm ×70mm×70mm

TABLE 6 - ULTRASONIC PULSE VELOCITY TEST

S.NO	METHOD	PATH LENGTH (L) in cm	TIME (T) in Seconds	Velocity (V)in km/s
T -1	DIRECT	7	20.3×10^{-6}	3.44
	SEMI DIRECT	4.94	10.5×10^{-6}	4.70
T-2	DIRECTS	7	24.2×10^{-6}	2.89
	SEMI DIRECT	4.94	9.9×10^{-6}	4.98
T-3	DIRECT	7	18.9×10^{-6}	3.70
	SEMI DIRECT	4.94	7.9×10^{-6}	6.25

1cm = 1×10^{-5} km 1micro sec = 1×10^{-6}sec

7. CONCLUSION

- The project proves that the foamed concrete can be prepared by using the natural foaming agent.
- Comparing to protein foaming agents , the natural foaming agents are easily available and less expensive
- The density of foamed concrete is inversely proportional to the percentage of foam that is added to the slurry / mortar.
- The compressive strength and density of foam concrete increases with age.
- Compressive strength of natural agents shows greater value on trial 3 and trial 4 in 28 days.
- Density of natural agents shows lesser value on trial 2 and trial 3 in 28 days
- The addition of industrial wastes such as fly ash, imparts great strength to the foamed concrete.

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