EXPERIMENTAL STUDY ON FOAM CONCRETE

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ABSTRACT

Objective:
In this project we are doing an experimental study on foam concrete. The main aim of our project is to produce a foam concrete with properties such as thermal resistance, sound proof, light weight and with sufficient compressive strength. It is produced by using cement, fine aggregate, water, bleaching powder, and hydrogen peroxide solution.

Methodology:
The following are the two tests that had been conducted on the materials that had been used for preparing of foam concrete they are: bulk density and specific gravity for fine aggregate and for cement. Then after the production of foam concrete the following tests are being done they are water absorption test, bulk density test and the compressive strength test.

Conclusion:
This type of concrete is cost efficient and also it is light weight as coarse aggregate is not being used in the production process of it. It can be used as a filler material in the construction process.

Key word: *Sound Proof, water absorption, thermal resistance.*

INTRODUCTION

Foam concrete also called as cellular concrete is an innovative material that can be used as a filler material. It is porous in nature and so it a light weight material with low density. It is made up of cement, fine aggregate, water and foaming agent which may be aluminium powder or zinc powder or bleaching powder and hydrogen peroxide. The foaming agent which is used in our project is bleaching powder and hydrogen peroxide. It can be used in the construction of non-load bearing wall and in partition wall. Foam concrete (also called as cellular concrete) is an innovative material that can be used as a filler material. Foam concrete is typically made of water,cement, sand and foaming agent. Foam concrete is porous in nature. It is a light weight material with low density. It is eco-friendly.[1,3,5,7]

TYPES OF FOAM CONCRETE

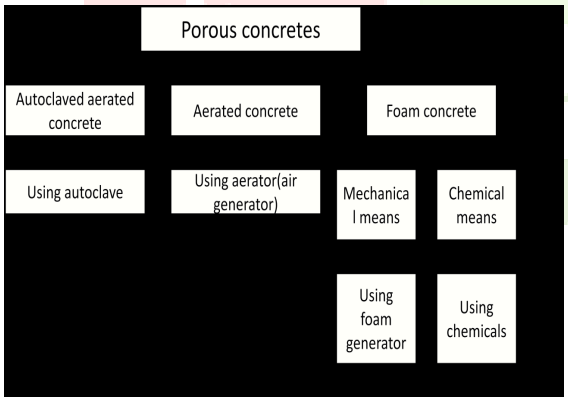

Figure 1 Types of Foam concrete

ADVANTAGES

- Low density
- Excellent thermal insulation
- Low overall cost of construction
- Better fire resistance
- Better sound insulation
- It is possible to produce in any shape
- Once placed, requires no maintenance
- No compaction required
- Resistant to freeze-thaw cycle

Figure 2 Foam Concrete

METHODOLOGY

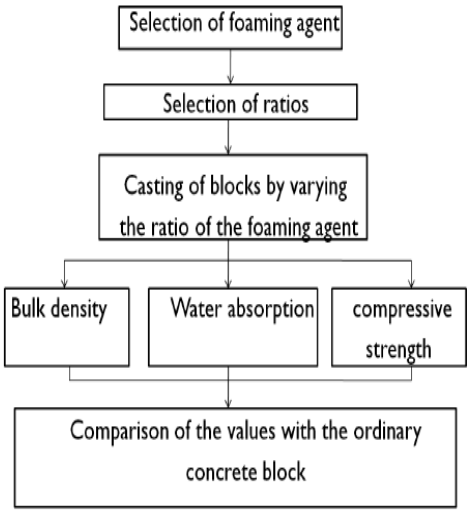

Figure 3: Methodology Chart

MATERIALS USED

- Cement
- Fine aggregate
- water
- Hydrogen peroxide
- Bleaching powder

CEMENT

Cement used for the experiment were ordinary Portland cement (OPC).The cement was used in standard bags and transferred later to air tight steel drums to avoid deterioration of the quality.

WATER

The water used for mixing and curing of concrete is clean and free from harmful impurities such as oil, alkali, acids etc.

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FINE AGGREGATE

The fine aggregate used for all the specimens was river sand.

FOAMING AGENTS

The foaming agents used for all the specimens was calcium hypochlorite and hydrogen peroxide.

HYDROGEN PEROXIDE SOLUTION

Hydrogen per oxide is a chemical compound with the formula H_2O_2. It is the simplest peroxide (a compound with an oxygen-oxygen single bond) and in its pure form is a colourless liquid, slightly more viscous than water. H_2O_2 solution is used as a foaming agent.

BLEACHING POWDER

Calcium hypochlorite is known as in an in organic compound with form $Ca[ClO_2]$. As mixture with lime and calcium chloride, it is marketed as Chloride powder or bleach powder for water treatment and as a bleaching agent.

CHEMICAL REACTION TAKING PLACE

- ✓ The foaming agent to be used is a mixture of Bleaching powder and Hydrogen peroxide solution
- ✓ The foaming agent reacts with calcium hydroxide present in the cement and releases oxygen gas, which makes the concrete porous.

MOULD DETAILS

Moulds are made using wood. The nominal dimension of the mould is 210*160*210mm. The inner dimension of the mould is 200*150*200 mm.

TEST ON MATERIALS

- Specific gravity
- Density

SPECIFIC GRAVITY

It is defined as the ratio of the weight in air of given volume of material to the weight in air of an equal volume of distilled water.

DENSITY

Density of any sample or material is generally defined as the mass per unit volume.

Density=mass/volume

TEST DATA ON MATERIALS

Cement used : OPC
Specific gravity of cement : 3.
Specific gravity of water : 1
Specific gravity of sand : 2.48
Bulk density of cement : 1440kg/m^3
Bulk density of sand : 1483kg/m^3

SELECTION OF WATER CEMENT RATIO

Max w/c ratio : 0.5
Adopted w/c ratio : 0.5

EXPERIMENTAL INVESTIGATIONS

The foam concrete blocks has been manufactured and has been subjected to compressive strength on 1st day, 3rd day, 7th day, 14th day and 28th day strength and has been tabulated below

COMPRESSIVE STRENGTH OF CONCRETE IN PERCENTAGE

Table 1 Compressive Strength % according to number of days

AGE	STRENGTH PERCENTAGE
1 DAY	16%
3 DAYS	40%
7 DAYS	60%
14 DAYS	90%
28 DAYS	99%

From the table, it is clear that concrete gains its strength rapidly in the initial days of casting (i.e.) 90% is only 14days. When its strength have reached 99%in 28 days, still concrete continues to gain strength after that period, but that rate of gain in compressive strength is very less when compared to that in 28 days. So since the concrete is 99% at 28 days it almost does to its final strength.

TEST ON FOAM CONCRETE BLOCK

- Dry density
- Wet density
- Compressive strength
- Water absorption.

These tests are made by varying the proportions of foaming agent that is being added. The above tests are done for the ordinary Portland cement concrete also. Then the obtained results are being compared between the foam concrete and the ordinary Portland cement concrete.

SPECIFIC GRAVITY TEST:

$$\text{Specific gravity} = \frac{(W2 - W1)}{(W2 - W1) - (W3 - W4)}$$

Specific gravity of cement

Weight of empty pycnometer bottle,

W 1 =0.610 kg

Weight of pycnometer bottle + dry cement, W 2=1.160 kg

Weight of pycnometer bottle + dry Cement + kerosene,

W 3 =1.660 kg

Weight of pycnometer + kerosene, W 4 =1.290 kg

$$\text{Specific gravity of cement} = \frac{(W2 - W1)}{(W2 - W1) - (W3 - W4)}$$

$$\text{Specific gravity of cement} = \frac{(1.160 - 0.610)}{(1.160 - 0.610)(1.660 - 1.290)}$$

$$= 3.10$$

Therefore, specific gravity of cement = 3.10

BULK DENSITY OF SAND

$$\text{Density of material} = Wt - Wc / Vc$$

Bulk density of sand

Empty weight of cubical measure, Wc= 7.010 kg

Volume of the cube, $Vc=0.15*0.15*0.15 m^3$

Weight of the cube with sand after 25 times tamping, Wt= 12.015 kg

$$\text{Density of sand} = \frac{(Wt - Wc)}{Vc}$$

$$\text{Density of sand} = \frac{(12.015 - 7.010)}{(0.15*0.15*0.15)}$$

$$= 1483 \text{ kg/m}^3$$

Therefore, density of sand = $1483 kg/m^3$.

Various proportions of foaming agent added are

Bleaching powder: hydrogen peroxide ratio= 3:1

Weight of the foaming agent for 1 ratio = 2.5% of wt. of cement

Weight of the foaming agent for 2 ratio= 5% of wt. of cement

Weight of the foaming agent for 3 ratio = 7.5% of wt. ofcement

Weight of the foaming agent for 4 ratio = 10% of wt. of cement

Calculation for 1 ratio st

Bleaching powder: hydrogen peroxide ratio = 3:1

Weight of the foaming agent for 1 ratio = 2.5%of wt. of cement st

Weight of foaming agent for 1 block= 4.432*2.5/100

= 0.1108 kg

Weight of bleaching powder for 1 block = 0.1108*3

(3+1)
= 83.1 g

Quantity of H_2O_2 solution for 1 block = 0.1108*1

(3+1)
= 27.7 ml

IT IS SIMILAR FOR ALL RATIO INSTEAD OF 1^{ST} RATIO USE 2^{ND}, 3^{RD}, 4^{TH} RATIO AND FIND OUT.

TEST ON FOAM CONCRETE

BULK DENSITY OF FOAM CONCRETE

Three blocks shall be dried to constant mass in a suitable oven heated to approximately 100°C. After cooling the blocks to room temperature, the dimensions of each block shall be measured in centimetres to the nearest Millimetre and the overall volume computed in cubic centimetres.The blocks shall then be weighed in kilograms to the nearest 10 gm.

The density of each block calculated as follows:
Density in kg/m= Mass of block in kg * 10Volume of block in cm^3

WATER ABSORPTION OF FOAM CONCRETE

Test procedure

Three full size blocks shall be completely immersed in clean water at room temperature for 24 hours. The blocks shall then be removed from the water and allowed to drain for one minute by placing them on a 10 mm or coarser wire mesh, visible surface water being removed with a damp cloth, the saturated and surface dry blocks immediately weighed. After weighing all blocks shall be dried in a ventilated oven at 100 to 115°C for not less than 24 hours and until two successive weighing at intervals of 2 hours show an increment of loss not greater than 0.2 percent of the last previously determined mass of the specimen.

The water absorption calculates as given below:

Absorption, percent =(A-B) * 100 B
where A = wet mass of unit in kg.
B = dry mass of unit in kg.

COMPRESSIVE STRENGTH OF FOAM CONCRETE

Test procedure

Eight full size units shall be tested within 72 hours after delivery to the laboratory, during which time they shall be stored continuously in normal room air. For the purpose of acceptance, age of testing the specimens shall be 28 days. Specimens shall be tested with the centroid of their bearing surfaces. The load up to one-half of the expected maximum load may be applied at any convenient rate, The compressive strength of a concrete masonry unit shall be taken as the maximum load in of the unit in square millimetres. Report to the nearest 0.1 N/mm^2 separately for each unit and the average for the 8 full units.

Fig 4 Surface preparation of Foam Concrete

Compressive strength = Force in **N/mm^2.**

Area

Figure 5 Compression Test

OBSERVATION

Table 2. For 1st ratio

Sample block Number	Dry mass Kg	Wet mass Kg	force KN
1.	**9.745**	**10.585**	**310**
2.	**9.815**	**10.675**	**330**
3.	**10.105**	**10.990**	**320**
4.	**10.165**	**11.030**	**325**

Table 3. For 2 nd ratio

Sample block Number	Dry mass Kg	Wet mass Kg	Force KN
1.	**11.185**	**12.010**	**490**
2.	**11.22**	**12.05**	**510**

3.	10.835	11.62	460
4.	11.05	11.85	480

Figure 6 Crushed Foam Concrete Cube

Figure 7 Failure of cube

Figure 8 Internal Structure of Foam concrete block

CALCULATIONS

For 1st ratio 1st block:

Wet weight (A) = 12.010kg
Dry weight (B) = 11.185kg
Size of block = 20*15*20 cm

Force = 490KN
Wet density = 12.010*/(20*15*20)=2002 kg/m^3
Water absorption = (A-B)*100/B
=(12.010-11.185)*100/11.185 = 7.403%
Compressive strength= force/area
=490 * 10 / (200*200)3
= 12.25 N/mm^2 .
THE CALCULATION IS SIMILAR BUT VALUES ARE DIFERENT.

RESULTS & CONCLUSION

Table 4 Result Comparison for 4 samples

Sample block no.	Dry density Kg/m^3	Wet Density Kg/m^3	Water absorption %	Compressive strength N/mm^2
1	1864	2002	7.403	12.25
2	1870	2008	7.397	12.75
3	1805	1936	7.245	11.5
4	1840	1975	7.337	12

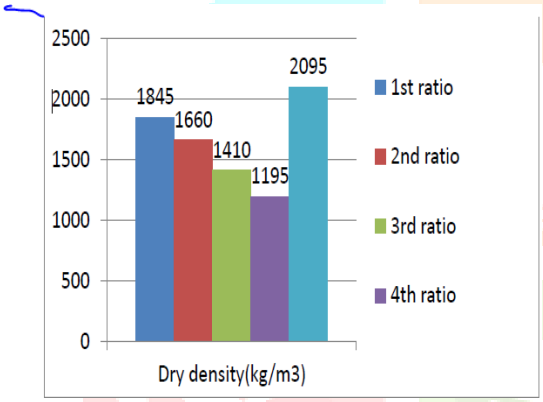

Fig 8 Dry Density Result Diagram

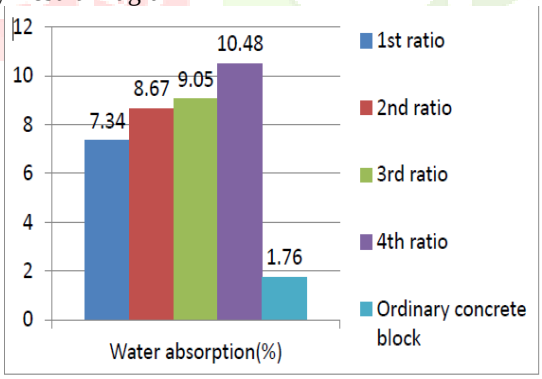

Fig 9 Water Absorption % Result

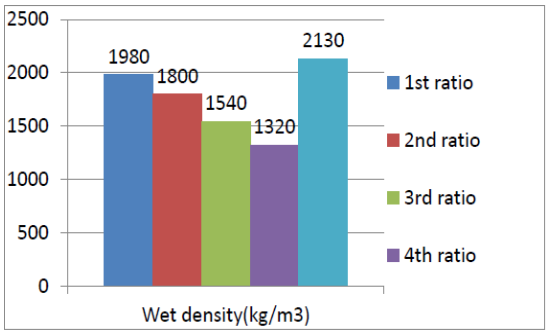

Fig 10 Wet Density Comparison Chart

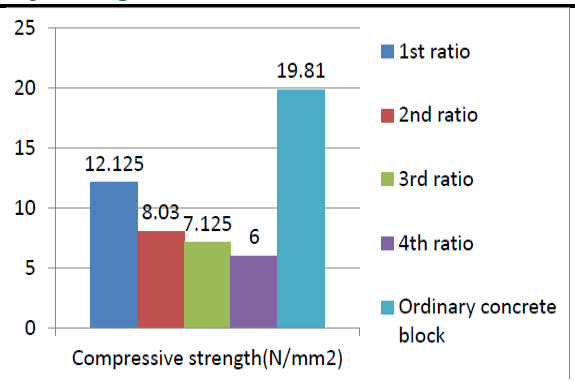

Fig 11 Compressive Strength Result Comparison

CONCLUSION

The experimental investigation is carried out to study the behaviour of solid block by using the foaming agent(Hydrogen peroxide and bleaching powder). The test results are compared with that of conventional solid blocks.
The following observation has been inferred:

1. The increase in the percentage of foaming agent resulted in better porosity.
2. The increase in the percentage of foaming agent resulted in lesser compressive strength.
3. The increase in the percentage of foaming agent resulted in lesser density.
4. The increase in the percentage of foaming agent resulted in increase in water absorption.

REFERENCE

To Refer Journal:

1. Indu Susan Raj, Dr. Elson John, " Study on the properties of air entraining concrete for masonry block", International Journal of Scientific Engineering and Technology (ISSN : 2277-1581) Volume No.3 Issue No.11, pp : 1367-1370.
2. A. Just, B. MiddenDorf, " Microstructure of high strength of foam concrete", Materials Characterization Volume 60, Issue 7, July 2009, Pages 741–748
3. Ali. J. Hamad, " Production and application of aerated light weight concrete", International Journal of Materials Science and Engineering Vol. 2, No. 2 December 2014
4. Dhawal Desi, " Development of light weight concrete" , available at http://www.engineeringcivil.com/development-of-light-weight-concrete.html

To Refer Code Book:

5. IS 2185 Part-4: 2008 "Code of practice for preformed foam cellular blocks"
6. IS 456:2000, " code of practice for plain and reinforced concrete"

To Refer Book:

7. Ravindra K. Dhir, "Use of foam concrete in construction". Thomas Telford publishing.
8. Dr. Azree, " Foamed concrete properties at elevated temperatures". Lambert academic international publishing.
9. B.F.Boult, " Foam concrete". N.Z. concrete Research association.
10. M.S. Shetty, " Concrete Technology". S. Chand pulisher, 2005.