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INVESTIGATION ON FOAM CONCRETE AS A STRUCTURAL MATERIAL

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Abstract - *The foam concrete is type of light weight concrete that exhibits superior properties in comparison to conventional building roof materials. This study deals with developing ferro-foam panel where the flexural property of foam concrete is been addressed using ferro mesh. The ferro foam panel (0.5mx0.5m) is casted using light weight foam concrete and galvanized welded square mesh of 1mm size. Foamed concrete is prepared by blending cement mortar with dense foam generated using the protein-based foam agent with dilution 1:30. The behavior of ferro panel is analyzed under static load. Experimental study has been carried out to evaluate the effect of just replacing the river sand by using m-sand used in foam concrete and to study the flexural strength and structural performances of welded square mesh ferro foam panel. The experimental results depict that the ferro foam panel can be used as an effective alternative to roof material both in terms of its structural properties and cost effectiveness.*

***Key Words*: Ferro foam panel, light weight foamed concrete, flow test, moment capacity etc…**

1. INTRODUCTION

The primary use of structural lightweight concrete is to reduce the dead load of concrete structures, which then allows the structural designer to reduce the size of the beams, columns, and other load bearing elements. There are many studies going around the world regarding all types of lightweight concrete. Foam concrete is produced when foam is added to cement based slurry. The foaming agent is diluted with water to produce the foam. The cement paste or slurry sets around the foam bubbles and when the foam being to degenerate, the paste has sufficient strength to maintain its shape around the voids. Foam concrete is created by uniform distribution of air bubbles throughout the mass of concrete. The foam cells must have walls, which remain stable during mixing, transportation, pumping and placing of fresh concrete. The cells, or bubbles are discrete and range in size between 0.1 and1mm. Foam concrete is a free flowing and can be placed without compaction.

2. MATERIALS AND THEIR PROPERTIES

a) Cement: OPC of 53 grade

b) Sand: 1. River sand

2. M-sand.

c) Water: tap water

d) Foam agent: Protein based foam agent in 1:30 dilution

2.1 Materials for preparation of panel

a) Foam concrete with density 2000 kg/m^3

b) Welded square mesh having 1mm diameter, 10 mm spacing

c) Dimensions of panel: (500*500*90) mm^3

3. MIX DESIGN

From literatures it was inferred that density of the mix plays vital role in compressive strength. The compressive strength decreases exponentially with the reduction in the density of the foam concrete. The reason behind is that the other parameters like sand-cement ratio and foam percentage has indirect effect on density of the mix. As a result, target density is used over target mean strength as in case of conventional concrete mix.

Target density is assumed as 2000kg/m^3

$D = C+W+F$

Where,

D = assumed target plastic density (kg/m^3)

C= cement content (kg/m^3)

W = weight of water (l/m^3)

F = fine aggregate content (kg/m^3)

3.1 Selection of water cement ratio

Since it is a flowable concrete, the water-cement ratio is assumed 0.55 based on experiments. Adopt, water/cement: 0.4 and foam/cement: 0.15. The foam was produced using a protein-based foam agent in ratio of 1:30 dilution in water.

3.2 Quantity of materials Required to get desired density.

One of the objectives of this paper is to evaluate the effect of replacing the river sand by using m-sand used in foam concrete and to study the flexural strength and structural performances of welded square mesh ferro foam panel. The following are quantity of materials is followed and thus exposed to a series of experiments. 1:1 ratio of cement mortar is selected, and the river sand is replaced by 40% by m-sand based on experiments to get maximum compressive strength.

a) Cement = 784.313 kg

b) River sand = 470.5878 kg

c) m-sand = 313.7252 kg

d) Water = 313.7252 kg and

e) Foam agent = 117.646kg.

Table 1: Mix proportion

Cement	R-sand	M-sand	water	Foam agent	Assumed density
784.31	470.58	313.52	313.52	117.6	2000 kg/m³
1	0.6	0.4	0.4	0.15	

4.0 TESTS CONDUCTED ON FRESH CONCRETE

4.1 Slump Test

The inverted slump test as shown in below figure was conducted to determine the consistency of the foamed concrete in accordance with BS EN 12350-8:2010 (British Standard Institution, 2010). After mixing of the mortar with stable foam, the produced lightweight foamed concrete was filled into the inverted slump flow cone without compaction and vibration. The cone is raised and allowed the foamed concrete to spread freely. The spread diameter values were measured with a measuring tape in orthogonal direction. Average value was taken to control the fluidity consistency of the fresh mixed lightweight foamed concrete. The obtained slump values are 240 mm in y direction and 220 mm in the x direction respectively. Hence 230 mm is the average value of fresh mixed light weight foam concrete.

Figure 1: Measuring the slump value in x direction

5.0 TESTS CONDUCTED ON HARDENED CONCRETE

Foam concrete, when made with high-quality materials and with appropriate proportioning yields strong structural and service bearing capacity along with enhanced durability, thereby making it necessary to evaluate the hardened properties of concrete. Following are the series of tests carried out,

a) Compressive strength test on foam concrete

b) Split tensile strength test on foam concrete

c) Flexural strength test on foam concrete:

i) Flexural strength of beam

ii) Flexural strength of panel

5.1 Flexural tests on ferro foam panel

In the experimental set up, the panel is simply supported on all four edges and the load is centrally placed. The behavior ferro foam panel under a static load is examined. The failure load is noted, and crack pattern has been seen with having width 0.5cm.

Figure 2: Flexural test on ferro foam panel

Figure 3: Failure of specimen under ultimate load

Figure 4: Crack pattern observed in specimen

6. RESULTS AND DISCUSSION

6.1 Compressive Strength test

Compressive strength is one of the important qualitative characteristic of concrete in relation to its strength. Cube of size 150*150*150 mm are used and tested at 3,7,14, and 28 days of curing in water under controlled laboratory conditions. The samples were tested using hydraulic compression machine. The results thus obtained were plotted as seen in fig-5

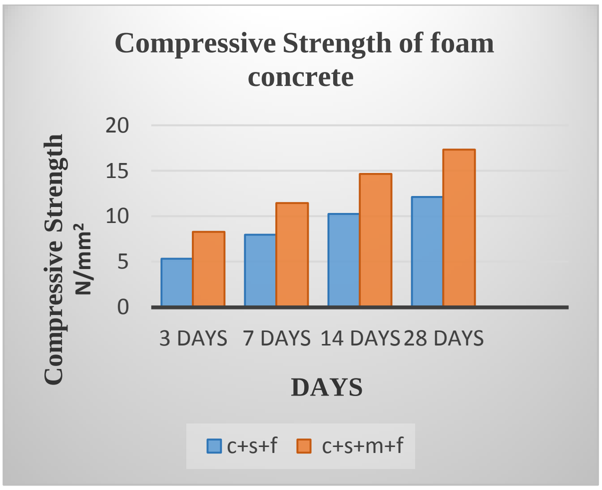

Figure 5: Compressive strength of foam concrete

From the above results, it is observed that the compressive strength increased by 30% in comparison with control concrete for different ages such as 3,7,14 and 28 days.

6.2 Split Tensile strength test

In this indirect method of measuring the tensile strength of concrete, cylindrical specimens with diameter as 150mm and the length as 300 mm were subjected to split tensile test under compression testing machine. The load was subjected until the specimen fails vertically. The results thus obtained from the experiment were plotted as seen in fig-6

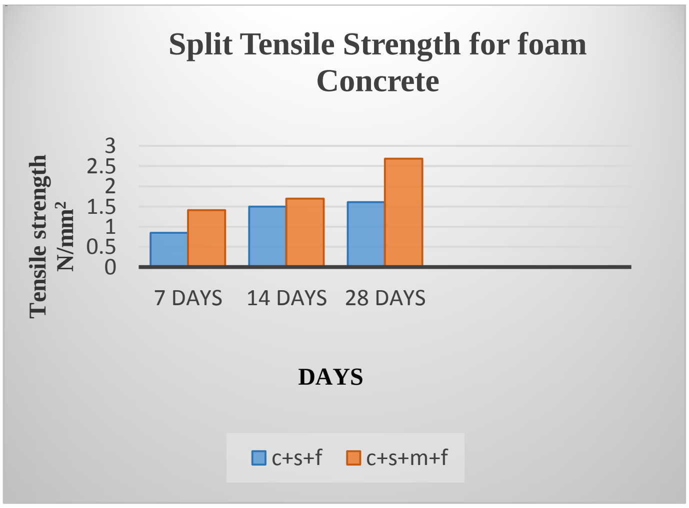

Figure 6: Split tensile strength of foam concrete

From the above results, it is observed that the tensile strength increased by 30% in comparison with control concrete for different ages such as 7,14 and 28 days.

6.3 Flexural Strength on beam

Flexural strength is the measure of tensile strength of concrete to resist failure in bending. Plane beam of size 500*100*100 mm were casted and tested for flexural strength at 28 days of curing in water at controlled laboratory conditions. The results thus obtained from the experiment were plotted as shown in the fig-7

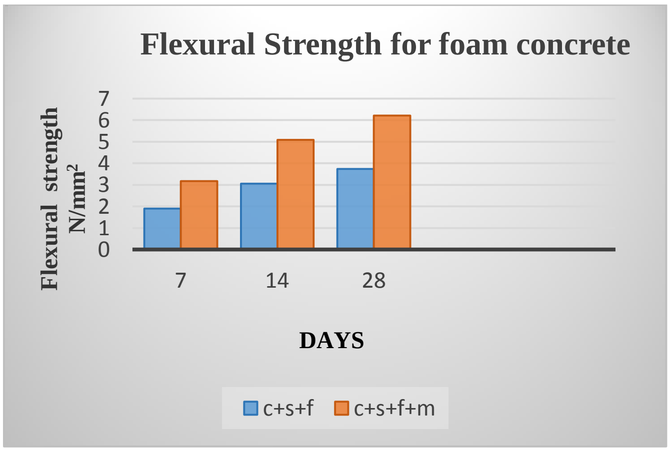

Figure 7: Flexural strength of foam concrete beam

From the above results, it is observed that the flexural strength increased by 30% in comparison with control concrete for different ages such as 7,14 and 28 days.

6.4 FLEXURAL STRENGTH ON PANEL

The flexural strength on foam concrete filled panels coupled with welded square mesh having 1mm diameter and 10 mm spacing : ferro foam panel, having dimensions 500*500
*90 mm was simply supported with concentrated load at the center. The 28-day cured ferro foam panel showed a failure pattern under an ultimate load as seen in the Figure 8.

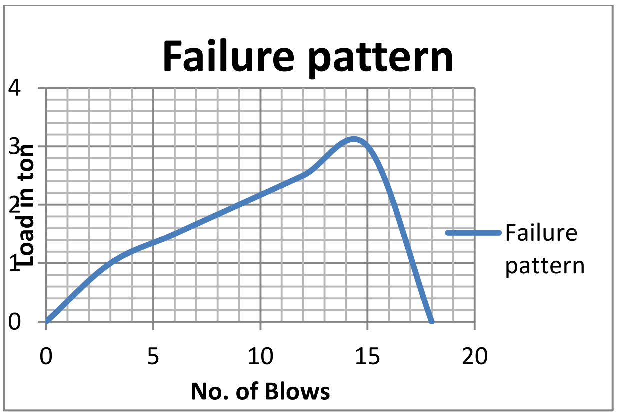

Figure 1: Failure pattern for panel under an ultimate load

7. CONCLUSIONS

- The Compressive Strength of Foam Concrete increases with age.
- M-sand had a beneficial effect on significantly increase in Compressive Strength of Foamed Concrete.
- The foamed concrete mixed proportions can be used for making partition walls in buildings.
- The initial findings have shown that the foam concrete has a desirable strength to be an alternative construction material for the industrialized building system.
- Significant reduction of overall weight results in saving structural frames, footing or piles and rapid and relatively simple construction.
- Foam concrete requires no vibration or compaction and it fills all cavities, voids and seams over a long distance. It offers fast and settlement free construction with good heat insulation and air content. It has good thermal insulation, good freeze/thawing properties and has excellent fire resistance properties.
- Obtained compressive strength is greater class AA bricks, hence it can be preferred for partition wall.
- Moment carrying capacity of ferro foam panel (0.465KN-M) is comparatively slightly higher than ferrocement panel (0.2KN-M), hence it can use as alternative roof panel instead of ferrocement panel.

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