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# Experimental Investigation on Sand Replaced Foam Concrete

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**Abstract:** ***Foam concrete is an inconstant material that consists of cement based mortar mixed with volume of air at least 20%. This element is non-load bearing structure that has lesser strength than the conventional concrete. Because the light weight such as dead load and non-structural partitions it is mostly used in many construction field and also quiet popular. Due to its low strength, certain materials had used to enhance the strength. A study on the effect of M-sand, Eco-sand and Foundry sand as replacement material aerated concrete were conducted. In this project the compressive strength test, dry density test and water absorption test was conducted. This report presents probability of the usage of foaming agent as 4%, 8%, 12%, 16% added to the volume of water added to the concrete. Trial mix was formulated for the concrete mix as target mean strength of 1700kg/m$^3$. Test were conducted on concrete block size of 150mm x 150mm x 150mm to investigate its compressive strength, dry density and water absorption of the concrete blocks. The results were compared to the conventional specimen. It found that the dry density of foam concrete almost 50% lesser than the conventional concrete the result was reported.***

**Keywords:** light weight concrete, foaming agent, 3 types of sand (M-sand, Eco sand, Foundry sand), conventional concrete

## 1. Introduction

Foamed concrete is manufactured by a kind of mechanical foaming method, which makes the vesicant foam in the foaming system of the foaming machine, and then the foam can be fully and evenly mixed with the material such as cement paste. And then we construct or mould by the pumping system inside the foam machine. It is a new type of building materials which contains many closed bubbles and is formed in the natural conservation. Because of foam concrete has light weight, good insulation properties, good fire-proof performance, good seismic performance, durability and other excellent construction performance; it has a very broad application prospect and significance of the research in the construction market in our country.

### 1.1 Scope of the Project

- In recent scenario every residential area needs soak pit in order to reduce the cost of manufacturing and handling charges. We can use foam concrete soak pit as a replacement.
- In recent times sculpturing works need more amounts of time and funds, for manufacturing and handling, in order to increase the workability, we can use foam concrete.
- We can use them for stage flooring purpose and sealing design.

### 1.2 Objective of the Project

- To determine the influence of the density and compressive strength of foamed concrete with and without sand replacement.
- To compare the density and compressive strength of a foam concrete with normal weight concrete.
- To compare the percentage strength gain of foam concrete over normal weight concrete.
- Compare the specific strength (strength to density ratio) of foam concrete with a light weight concrete.
- The foam concrete mixed proportions can be used for making partition walls in building.

## 2. Methodology

In this project a comparison of light weight concrete with conventional concrete are done. We had revised many journals; with an idea we had casted with three different sand foamed concrete and a foaming agent of 4%,8%, 12% and 16 % were added. By adding all these materials casting work had been completed. After curing for 7 days, 14 days, 28 days compressive strength test, density test and water absorption test may conducted. Then finally results are compared.

## 3. Materials Collection

In materials collection, cement, Fine Aggregate and foaming agent are taken. Materials and its properties are followed below.

### 3.1 Cement

Cement in general sense, are adhesive and cohesive Materials which are capable of bonding together particles of solid matte into a compact durable containing compounds of lime as their chief constituents, its primary function being bind fine and coarse particles together.

### 3.2 Fine Aggregate

#### 3.2.1 M-SAND

M-sand is manufactured from crushed aggregates produced from hard granite stone which is cubically shaped with

grounded edges, washed and graded with consistency to be used as a substitute of river sand. M-sand is a substitute river sand for construction purpose, sand produced from hard granite stone by crushing. The crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material. The size of M-sand is less than 4.75mm. Figure 1 represents a sample of M-Sand.

**Figure 1:** M-sand

### 3.2.2 Foundry Sand

Foundry sand is clean, uniformly sized, high quality silica sand, used in foundry casting process. The sand is bonded to form moulds or patterns used for ferrous (iron and steel) and non-ferrous (copper, aluminum, brass) metal castings. Figure 2 represents a sample of Foundry Sand.

**Figure2:** Foundry sand

### 3.2.3 ECO-SAND

Eco sand are very fine particles, a bi-product from cement manufacture, which can be used to increases efficiency in concrete. Its micro-filling effect reduces pores in concretes and provides better moisture resistivity and thus durability. It has more consistent grading than many extracted aggregates. For this study eco sand obtained from ACC cement factory, Madukkarai, Coimbatore. Table 1 represents the physical properties of Eco sand and Table 2 represents the chemical properties of Eco- sand. Figure 3 represents a sample of Eco-sand.

**Figure 3:** Eco-sand

**Table 1:** Physical Properties of Eco-Sand

| S.NO | PROPERTIES | RESULT |
|---|---|---|
| 1 | Specific gravity | 2.42 |
| 2 | Fineness modulus | 0.028 |

**Table 2:** Chemical Composition of Eco-sand

| S.NO | CHEMICALS | AMOUNT% |
|---|---|---|
| 1 | Silica | 68.1 |
| 2 | Alumina | 10.7 |
| 3 | Potassium | 4.3 |
| 4 | Calcium | 2.2 |
| 5 | Iron | 1.7 |
| 6 | Sodium | 0.6 |
| 7 | Magnesium | 0.5 |
| 8 | Lossof Ignition | 11.5 |

### 3.3 Foaming Agent

The containers holding foaming agent must be kept air-tight and under temperature not exceeding 25 degree centigrade. This way the shelf-life is guaranteed for 24 months from the date of invoice. once diluted in 4 parts of portable water, the emulsion must be used as soon as possible. Figure 4 represents a Mixing of Foaming Agent.

**Figure 4:** Mixing of Foaming Agent

### 3.4 Water

Water is also a very important element in concrete as it is responsible for the hydration of cement in concrete. Water quality and quantity should be carefully observed as it helps in producing strength giving cement gel. Normal consumable water is generally suitable for concrete.

### 3.5 Concrete Hand Mixing

Concrete hand mixer is preferable because for mixing cement slurry and it is also used in generating foam volume. Some

specification of concrete hand mixer is having mixer power: 350W (or 0.5hp), rotating speed: 14000rpm, power supply: 220-240V/50Hz. Figure 5 represents a mixer.

**Figure 5:** Mixer

### 3.6 Mix Design and Mix Details

There is no standard method for proportioning foamed concrete (i.e. mix design), but it is calculated by obtaining specified target plastic density. On the basis of target plastic density, a theoretical mix design is to be formulated and site trials are undertaken and the results from the site trials are used as mix design for the foamed concrete. A tolerance on plastic density was considered about 100 kg/m$^3$ of the target plastic density.

Since the foam concrete is in slurry form higher water-cement ratio is required so assuming W/C is 0.35.

Assuming a target plastic density of 1700 kg/m$^3$
Water-cement ratio W/C is 0.35 (assuming)
Proportion =1:2 (Cement: FA)
D = c + w + f
1700= 510+170+1020
1700=1700kg/m$^3$

### 3.7 Mix Ratio

Mix ratio - 1:2 (1:0.5:0.5)
Cement: Fine aggregate (M sand: Eco sand: Foundry sand)

**Table 3:** Mix ratio

| CEMENT Kg/$m^3$ | Fine aggregate Kg/$m^3$ | M-SAND Kg/$m^3$ | ECO SAND Kg/$m^3$ | FOUNDRY SAND Kg/$m^3$ |
|---|---|---|---|---|
| 510 | 1020 | 510 | 255 | 255 |

### 3.8 Mix Details

- MIX 1 : adding foaming agent 4% of volume of water added 1:2 (1:0.5:0.5) with cement /water ratio 0.35
- MIX 2 : adding foaming agent 8% of volume of water added 1:2 (1:0.5:0.5) with cement /water ratio 0.35
- MIX 3 : adding foaming agent 12% of volume of water added 1:2 (1:0.5:0.5) with cement /water ratio 0.35
- MIX 4 : adding foaming agent 16% of volume of water added 1:2 (1:0.5:0.5) with cement /water ratio0.3

**Table 4:** Mix details

| S.NO | MIX | CEMENT (kg) | FINE AGGREGATE | | | WATER CONTENT | FOAMING AGENT ADDED (%) |
|---|---|---|---|---|---|---|---|
| | | | M-SAND (kg) | ECO-SAND (Kg) | FOUNDARY SAND (Kg) | | |
| 1 | MIX1 | 510 | 510 | 255 | 255 | 170 | 4% |
| 2 | MIX2 | 510 | 510 | 255 | 255 | 170 | 8% |
| 3 | MIX3 | 510 | 510 | 255 | 255 | 170 | 12% |
| 4 | MIX3 | 510 | 510 | 255 | 255 | 170 | 16% |

## 4. Experimental Result

In this paper we study about the foam concrete with sand replacement. And three test are conducted (i) Compressive Strength test, (ii) Dry density test,(iii) Water Absorption test. Above mentioned test results are discussed below.

### 4.1 Density Test

Weight of the sample is taken using weighting scale and average weight of the samples is taken. Density of the sample is the ratio of average weight of the sample to the volume of the sample. By increasing foaming agent the dry density of foam concrete also increases. Here 16% of added foaming agent to the concrete mixture gives the minimum results. The minimum dry density attained was 1530 kg/m$^3$ Table 5 represents density test.

**Table 5:** Density test

| S.NO | SPECIMEN (150mmX150mm) | %OF FOAM ADDED | 7 DAYS (MPa) | 14 DAYS (MPa) | 28 DAYS (MPa) |
|---|---|---|---|---|---|
| 1 | M1 | 4% | 1710 | 1702 | 1694 |
| 2 | M2 | 8% | 1676 | 1670 | 1659 |
| 3 | M3 | 12% | 1597 | 1591 | 1586 |
| 4 | M4 | 16% | 1540 | 1536 | 1530 |

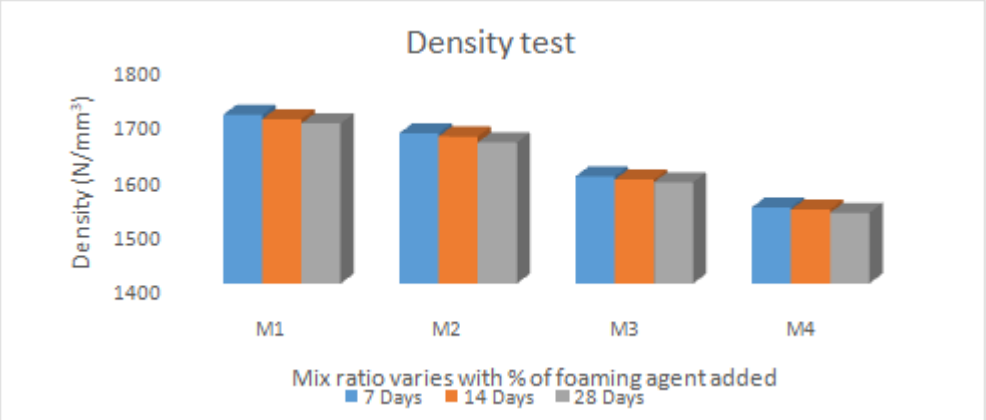


**Figure 6:** Density test

### 4.2 Compressive Strength Test

The 150 mm test cubes were cast in steel mould and de-moulded after ± 24 hours. Then it was kept for curing in a constant temperature room up to the day of testing. Table 6 represents the compressive strength value. And Figure 7 represents the compressive strength of concrete. By increasing foaming agent the compressive strength of a foam concrete is decreases. Here 4% of adding foaming agent to the concrete mixture gives maximum results the maximum compressive strength attained in this project is 8.75 $N/m^2$ Figure 8 represents the photo of compressive strength of cubes and crack pattern.

**Table 6:** Compressive strength test

| S.NO | SPECIMEN (150X150) | % OF FOAM ADDED | 7 DAYS (MPa) | 14 DAYS (MPa) | 28 DAYS (MPa) |
|---|---|---|---|---|---|
| 1 | M1 | 4% | 3.15 | 5.18 | 8.75 |
| 2 | M2 | 8% | 2.51 | 4.27 | 6.80 |
| 3 | M3 | 12% | 1.98 | 3.33 | 5.35 |
| 4 | M4 | 16% | 1.73 | 2.16 | 4.68 |

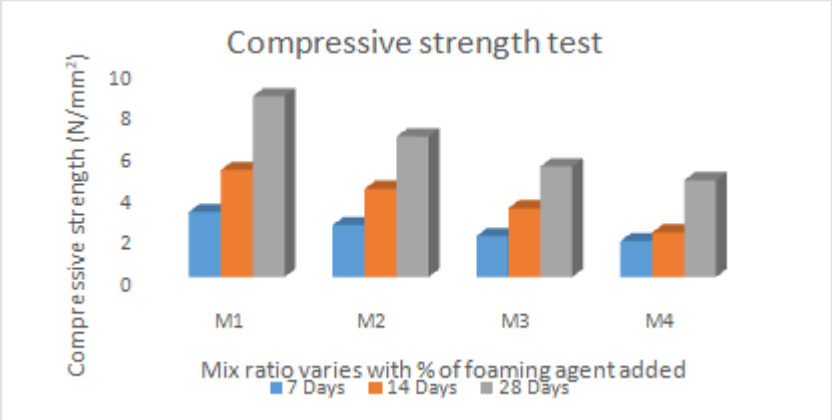


**Figure.7:** Compressive strength test

**Figure 8:** Compressive Strength of Cubes and Crack Pattern

### 4.3 Water Absorption Test

The specimen was immersed in water for 24 hours and weighed (W1) then they kept in a ventilated oven for one hour and weighed (W2). By increasing foaming agent the water absorption of the concrete also increases because of void ratio present in the foam concrete. 16% added foaming agent which gives minimum result. The minimum water absorption occur in the concrete in mix M1that is 0.85% Table 7 represents the water absorption values and Figure 9 represents the water absorption test.

**Table 7:** Water absorption test

| S.NO | SPECIMEN (150X150mm) | %OF FOAM ADDED | %OF WATER ABSORBED |
|---|---|---|---|
| 1 | M1 | 4% | 1.68 |
| 2 | M2 | 8% | 1.20 |
| 3 | M3 | 12% | 0.97 |
| 4 | M4 | 16% | 0.85 |

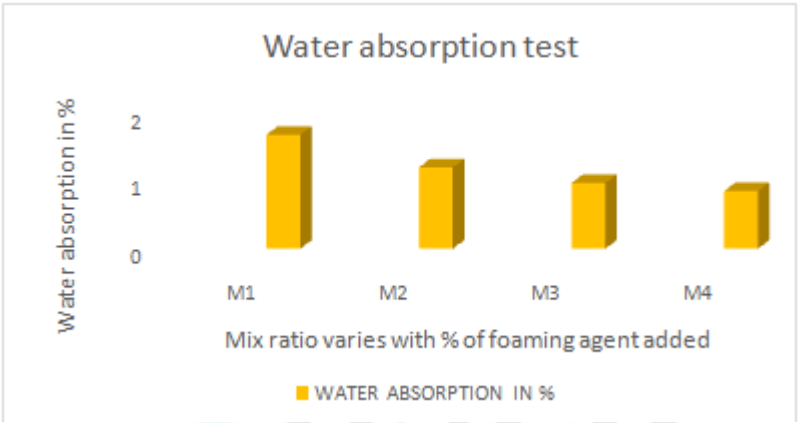


**Figure 9:** water absorption test

## 5. Conclusion

Light weight properties of the light weight concrete results into steadiness of the light weight concrete in the structures of the building. As the impact of the earth quake is directly proportional to the weight of the building, the building constructed using light weight concrete are more reliable and safer.

In our project an experimental result is compared between conventional concrete and light weight concrete, and maximum compressive strength attained was 8.75N/mm$^2$. This is (4% of foaming agent added) Light weight concrete has an attractive appearance and is readily adaptable to any style of architecture. The Density of Foamed Concrete is inversely proportional to the percentage of foam that is added to the slurry/mortar. With some gap the compressive strength and density of concrete increases, The Compressive Strength of Foamed Concrete increases with increase in the Density. Fine aggregate had a beneficial effect on increase in Compressive Strength of Foamed Concrete. De-moulding of higher density foamed concrete panels is possible after 24 hours but it requires minimum 3 days for lower density foamed concrete panels.

## 6. Further Studies

For future study along with foaming agent we may add steel fiber to enhance the strength of the concrete. By adding lightweight materials like (fly ash, bagasse ash, rice husk etc.) or the replacement of fine aggregate to reduce the density of concrete. For future study along with the concrete blocks we may use foam concrete for beam and column. By knowing the material properties and concrete properties of foam concrete we are going to study about the Ultra-light weight concrete. (ULC)

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