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Experimental Study on Foam Concrete

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ABSTRACT
Experimental Study on Foam Concrete involves to prepare a foam concrete using locally available detergent to produce foam, which is having a chemical composition to produce ample amount of Foam. The study consists of Comparing Foam concrete cube with conventional concrete or regular cube of cement concrete. In this study the compressive Strength of foam concrete cube and conventional concrete cube of cement concrete is carried out to produce light weight concrete cube which is having enough compressive Strength.
Keywords **—** Detergent, cement, sand, UTM, Mix Design.

I. INTRODUCTION

Foam concrete is a lightweight concrete. It has low self-weight, Slightest aggregate consumption (coarse aggregate is not used), high fluidity, controlled low strength and thermal insulation. The density of the concrete can be reduced by introducing Foaming Agents. The production method and the materials used affects the properties of foam concrete. Unlike other porous lightweight concrete, prefabricated foams with foaming agents are added to fresh cement paste and mortar. The air pores brought by the foams constitute 10–90% by volume of the hardened body. One of the advantages of foam concrete is its weight reduction (up to 80%) compared to conventional concrete. The air bubbles are evenly distributed in the foam concrete body. The pore structure may be affected during the mixing, transportation, and placement of fresh concrete, so it should have fixed walls. Air bubbles range in size from approximately 0.1 to 1 mm. The density of foam concrete is mainly affected by the amount of foam and varies between 400 and 1600 kg/m3. It can be used for structural, partitioning, insulation and filling applications with excellent acoustic/thermal insulation, high fire resistance, lower raw material costs, easier pumping and finally no compaction, vibration or leveling.

It emerges as an economical and innovative contribution to the production of lightweight building blocks, partition wall systems, panels, walls, blocks, road fill and roof insulation. It is preferred to produce foam concretes, bridge fill, insulated wall panels and floor insulation [5]. Researchers show interest in high energy-saving materials in terms of energy savings. In this respect, foam concrete, which is a lightweight, porous material with a high strength-to-weight ratio, stands out. It is widely used in modern buildings. It also offers advantages, such as transportation, cost, and production. Today, understanding the properties of foam concrete is of interest to researchers, and many studies focusing on different properties of foam concrete are being conducted. The properties of foam concrete vary depending on many factors. Factors such as foam type, cement type, mineral additives, aggregate type, and the properties of the air spaces created directly affect the strength, fresh and hardened properties of foam concrete. This review article examines the materials that make up foam concrete, their fresh and hardened properties, the changes in their strength and microstructure. In this concrete, a foaming agent introduced is Detergent.

II. MATERIALS USED TO PREPARE FOAM CONCRETE

Cement: Portland Pozzolana cement (PPC) of Grade 43 is ordinary Portland cement blended with pozzolanic material like fly ash, calcined clay, rice husk ash etc. Portland cement clinker is blended with specified quantities of gypsum and pozzolanic materials to produce Portland pozzolana cement.

Sand: M – Sand is the short name for “Manufactured Sand”. This is artificial sand, manufactured in the factory itself. Due to the increase in demand for good quality sand, the quantity of naturally occurring sand is decreased day by day. So to compensate for the increasing demand & shortage of naturally occurring sand, artificial sand is Used.

Foam Agent: Cleaning Agents (anionic And Non-ionic Surfactants, Enzymes), Water Softeners (sodium Carbonate And Sodium Aluminosilicate), Fabric Whitener, Sodium Perborate, Anti-redeposition Agent, Perfume, Washer Protection Agent (sodium Silicate) And Processing Aids (sodium Sulphate).

III. PROPERTIES OF FOAM CONCRETE.

Workability: With the increase in density, the spread of light concrete increases. Foam concretes with low densities have high foam content. Therefore, the mixtures become harder, causing a decrease in the settling flow. The increase in the w/c ratio causes the water film on the particles to thicken.

Thus, the viscosity decreases, and the diffusion of foam concrete increases.

Consistency: The fresh state properties of foam concrete are evaluated in terms of two factors; consistency and stability. Using Marsh cone and flow cone diffusion tests, the flow times of foam concrete are obtained, so the consistency of the foam concrete can be evaluated.

Stability: It has been observed that there is a 48% spread as the appropriate workability value of foam concretes with the use of typical materials. The foam used can have different effects on stability.

Dry Unit Weight (Density): The density of foam concrete can be evaluated under two headings as fresh and dry density. It is recommended that the difference between fresh and dry density is 100–125 kg/m3. Dry density controls the mechanical, physical and durability properties of foam concrete, while the fresh density ensures the volume required for the design mix and pouring control.

Drying Shrinkage: Foamed concretes have the disadvantage of high drying shrinkage and are affected by foam volume, aggregate type, mineral additive, fiber content and water content. The cracking phenomenon is particularly related to the uneven volume change during the curing process due to the temperature difference caused by the heat of hydration under the thermally semi-adiabatic condition of the matrix.

Air Void Structure and Porosity: The strength and durability properties of cement-based materials are affected by the porosity, permeability, pore size and distribution of the material. If we consider the pore structure of foam concrete in general, it has three types of porosity: gel pores, capillary pores, and air pores. While capillary and air pores affect the strength properties of foam concrete, gel pores have no effect on the strength. The pore distribution and size of the foam concrete directly affect its mechanical and physical properties.

Fig. 1 Foam Concrete Cube (Test sample 1).

Water Absorption: Foam concretes designed for interiors, such as wall elements inside the building, are generally not exposed to water. In such cases, water absorption is not important, as foam concrete will not be affected by freezing–thawing. In this context, the water absorption is important as freeze–thaw effects posing a threat to foam concrete if it is used as an external element. Foam concretes used as external elements and structural elements are required to have low water absorption values.

Compressive Strength: Compressive strength is affected by parameters such as density, mixture components used, aggregate, mineral additive, water content, foam, curing and porosity. The amount of water has a significant effect on the compressive strength of foamed concrete. It was reported that small changes in the water content of foam concrete do not affect the strength as in normal concrete. An increase in the w/c ratio can provide an increase in strength. The reason for this can be demonstrated by the formation of pores that grow with the amount of water. With the increase in large pores and capillary pores, the density of the air voids decreases and the strength increases.

Flexural Strength: The ratio between flexural strength and compressive strength of foam concrete is in the range of 0.25–0.35. When the sand-containing mixtures of foam concrete and the mixtures with Foam Agents are compared, higher values are observed in those containing sand. This is thanks to the improved shear capacity found between the sand particle and the paste phase. Flexural strength increases with the increase in dry density. However, adding Foam Agents decreases the flexural strength. This is because Foam agents contributes to strength in later ages.

IV. METHOD AND MIX DESIGN

In total Four cube were cast, three sample cube is prepared from adding the foam agents which is locally available Detergent in Different Proportions. One test sample is Prepared by using conventional method to compare this test sample. Foam concrete is made by adding water, Foam Prepared from Detergent and Portland Pozzolana cement with a M sand. The foam paste solidifies to give a low-density concrete.

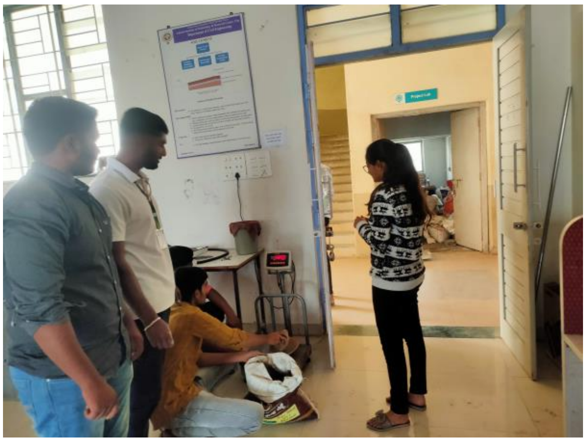

Fig. 2 Weighing of Material.

The production of foam concrete using detergents was divided into two steps shown in Photo. 2 and Photo. 3.

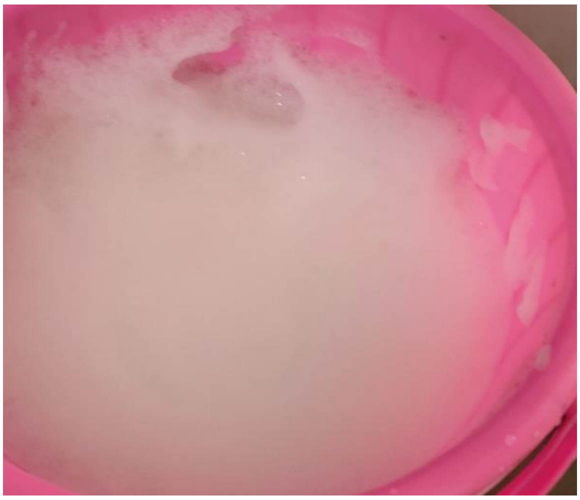

Fig. 3 Preparing Foam Concrete

First, the required quantities were calculated. The said amount of detergent was added to water. Foam is Prepared in the bucket with the help of Paint stirrer.

Then the calculated amount of cement and sand which was already graded was mixed in the foam slurry. The mixer was allowed to run for 5 minutes till the uniform air-entrained concrete mix was prepared. Each mix design was used to prepare, three samples of Foam Concrete and One Sample of conventional Concrete which were thereafter in the series of testing carried out. The water cement ratio is kept constant at 0.6 throughout the manufacture of different mix designs.

V. RESULTS AND DISCUSSION

The parameters and properties of foam concrete chosen for this study were compressive strength, density, water absorption and acid resistance. These parameters are interlinked with one another. The cube volume remains constant in foam concrete Volume of void is variable depending upon the percentage of foaming material added to the mix. The fluctuating percentage of foaming material will produce fluctuating voids in mix causing wavering level of porosity and thus unsteady density. The density of casted cubes thus has direct effect on its water absorption, compressive strength and partially on acid resistance properties.

The detergent (Wheel Powder) has been used for the first time for making foam concrete. The density of foam or lightweight concrete is dependent upon life of bubbles created by foaming agent in a mix. For M25 concrete mix, the recommended ratio is 1:1:2, which means 1 part cement, 1 part sand, and 2 parts aggregate (by volume). The mixing percentages of Material selected in the study were cement, sand, and detergent (0.4-0.46% by weight of cement). The average percentage of each material such as cement (60%), sand (40%) and (For Sample 1 detergent used is 0.40% by weight of cement). The results against each Sample followed a similar trend, that is for sample 2 (Detergent 0.6% by weight of cement) and for Sample 3 (Detergent used 0.8% by weight of cement).

Fig. 4 Compression test on Universal Testing Machine (Sample 1)

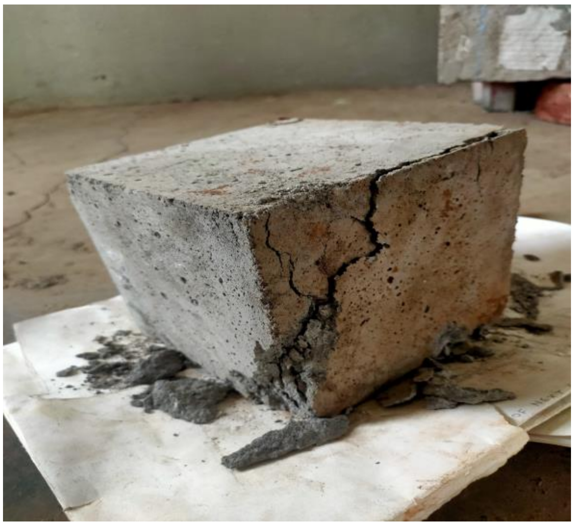

Fig. 5 Failure Pattern after 28 days on cube. (sample 2)

Based on above comparison, detergent has satisfactorily qualified the requisite parameters set for a foam concrete. The detergent mixed foam concrete showed 21% lesser cost for 1 cubic-foot mix as compared to commercial foaming agent.

TABLE I
MATERIAL TESTING

Sr. No	**Material Testing as per Indian Code of Practice**		
	Test	**Samples**	**Remark**
1	Compressive Test	(150 mm) Cube	In order of IS 516-1959 Sample were Cured till the date of Testing.
2	Water Absorption	(150 mm) Cube	Oven Drying Samples samples were used by immersing them for 48 hours in water. Weight of Sample recorded before and After

			immersion.
3	Acid Resistance	(150 mm) Cube	Oven dried sample were kept in 5% in HCL acid for 28 days. It is then oven dried for 24 days and difference in weight is recorded.
4	Oven drying Method	(150 mm) Cube	The cube was oven dried for 24 hours at temp of 100 degree Celsius. Oven drying of each sample were recorded.
5	Weight	(150 mm) Cube	The weight of Each sample is Decreased by 10% as compared to conventional concrete cube.

TABLE II
COMPARISION OF SAMPLES WITH CONVENTIONAL CONCRETE CUBE

Sr. No	Samples	Weight (Kg)	Compressive Strength after 28 days (Failure Load)
1	Conventional Concrete Cube	7.310 kg	514 KN
2	Sample 1 (Detergent 0.4%)	7,110 kg	300 KN
3	Sample 2 (Detergent 0.6%)	6,902 kg	290 KN
4	Sample 3 (Detergent 0.8%)	6,704 kg	275 KN

VI. CONCLUSIONS

Today, understanding the properties of foam concrete is of interest to researchers, and many studies focusing on different properties of foam concrete are being conducted. The properties of foam concrete vary depending on many factors. Factors such as foam type, cement type, mineral additives, aggregate type, and the properties of the air spaces created directly affect the strength, fresh and hardened properties of foam concrete. This Research Paper examines foam concrete, their fresh and hardened properties, and the changes in their strength.

1. The Percentage increase in Foam Agent (Detergent) the Weight of Concrete cube decreases and the Compressive strength of concrete as compared to conventional concrete cube also Decreases.
2. The increase in the foam volume significantly reduces the consistency, and the increased air voids overlap and increase the amount of combined pore and pore size affect strength.
3. The increase in the amount of foam also affects the density of the foam concrete.
4. An increase in the amount of paste increases the amount of drying shrinkage.
6. Foam stability affects the strength properties of foam concrete. The foam stability affects properties, such as the selected foaming agent, aggregate, and water amount used.
7. The foam concrete prepared in this study was cost effective along with satisfying requisite properties for foam concrete. The detergent mixed foam concrete showed 21% lesser cost for 1 cubic-foot mix as compared to commercial foaming agent.

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