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Experimental Research on Foam Concrete with Partial Replacement of Fine Aggregates by Blast Furnace Slag, Fly Ash, and Glass Powder

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ABSTRACT- Aerated concrete blocks are made according to the design proportions in this project. Cement, fine particles, a foaming agent, and water are the ingredients of foam concrete. Sand prices are significantly rising these days. We may lower the cost of sand by replacing it with a replacement material. In the current investigation, sand is partially substituted by varying weights and quantities of blast furnace slag, fly ash, and glass powder. To gain a better understanding of the utilization of blast furnace slag, Fly Ash, and glass powder in various literatures, their impact on Compressive Strength foam concrete is explored.

KEYWORDS- Foam concrete, Light weight, blast furnace slag, fly ash and glasspowder and compressive strength.

I. INTRODUCTION

Porous concrete is a form of foam concrete. It is comparable to aerated concrete in terms of properties and applications. Aerated concrete, lightweight concrete, and porous concrete are all synonyms. To execute the concrete, foam concrete has no aggregates and simply sand, cement, water, and stable foam. This procedure contains microscopic contained air bubbles inside the mortar, resulting in lighter concrete. There are two methods for manufacturing foamed concrete: prefoam method and inline method. The inline approach is classified as either wet or dry. There are two types of foam used to manufacture foamed concrete, foam concrete (flow chart:1.1 foam concrete): wet foam and dry foam.

A foamed concrete has an air content of greater than 25%, distinguishing it from highly air entrained materials. The density of foamed concrete can range from 500kg/m3 to 1600kg/m3 and its strength can range from less than $1N/mm^2$ to $25N/mm^2$.

The cement content of the mix, the water/cement ratio, the cement-to-sand ratio, and the sand qualities all influence the strength of foamed concrete. In general, high compressive strength is produced by employing a high cement content, a low water/cement ratio, and sand. In general, the workability and strength tests will be used to study the qualities of foamed concrete. The trial will include workability and strength tests, as well as a slump test. This concrete will be tested before it is cast into the mould, thus fresh concrete will be used to assess the workability of the concrete mix, and strength tests will be performed after 7 and 28 days.

In recent years, research in the field of foam concrete has advanced. Many researchers have investigated the many phases of Foam concrete, revealing the facts about Foam concrete, making it a practically broad usable material. Many study articles have been published by various scholars that demonstrate the engineering relevance of foam concrete and concrete workability.

II. RELATED WORKS

Foam Concrete is constructed out of a mixture of raw materials such as fine aggregates, Ordinary Portland Cement, Water, and a foaming agent to generate air gaps in the concrete due to its low weight.[1].

The quantity of water and sand in the Foam Concrete determines its density. Densities ranging from 400 kg/m3 to 1600 kg/m3 may be obtained by combining the ingredients in the right proportions, and can be used for a variety of construction components such as structural, partitions, insulation, and filling grades[2].

However, it differs from ordinary concrete mixtures in that the particles are removed and replaced with air spaces by the application of a foaming agent[3]. The foaming agent also

works as a substance that absorbs humidity in the atmosphere for as long as it is exposed to it and aids in the hydration process of cement. However, it differs from ordinary concrete mixtures in that the particles are removed and replaced with air spaces by the application of a foaming agent. The foaming agent also works as a substance that absorbs humidity in the atmosphere for as long as it is exposed to it and aids in the hydration process of cement. Because the concrete is comprised of foaming agent, the quality of the foam agent and its creation determines the quality of the foam concrete[4]. As a result, aerating the agent before adding it to the cement slurry is advised in order to obtain high-quality concrete. Because there are numerous similarities between the two forms of foam concrete, knowledge of conventional foam concrete is beneficial for the study of high-strength foam concrete[5]. Studies on conventional and high-strength foam concrete were evaluated in this context. According to prior research, the manufacture and qualities of foam concrete are primarily influenced by: i) the kind of elements and their amounts in the concrete mixture; and ii) the manufacturing process. [6], highlighted that concrete is a critical component used in the construction industry all over the world, where the fine total is common sand The use of sand in construction activities leads in compelled mining. Because of incredible mining, natural assets are being depleted, which causes an increase in scour profundity and, on occasion, surge risk. As a result, the use of alternative materials in concrete is becoming unavoidable. Marble is an important material used in the construction industry. Marble powder is produced by handling plants during the cleaning and cutting of marble squares, and around 20 - 25% of the processed marble is converted into powder form. One of today's major environmental challenges is the destruction of marble powder material from the marble industry. This study proposes employing waste marble powder developed by the business itself as a fine total in solid, replacing ordinary sand. The substitution is done partially and totally in the amounts of 10%, 15%, and 20%, and the influence on cement characteristics is determined. **[7],** that was mentioned Cement, water, fine aggregate, and air spaces make up foamed concrete.

It is quite homogenous and lacks coarse aggregate phase. The properties of foamed concrete are determined by the binder and foaming agent employed. Natural and synthetic foaming agents are employed in this application. The binding substance is partially replaced with silica fume, which gives more strength than foam concrete without silica fume. This research article which analyses the study development of silica fume influence on foamed concrete performance based on foam concrete attributes and preparation procedure.

Ali J. Hamad 2014 [8], When compared to traditional concrete, foam lightweight concrete has various benefits such as enhanced strength to weight ratio, reduced coefficient of thermal expansion, and effective sound insulation due to air gaps inside aerated concrete. This research focuses on the differentiation of aerated lightweight concrete into foamed concrete and autoclaved concrete. It also displays the raw ingredients used in aerated concrete, agent kinds, characteristics, and applications. Each foamed and autoclaved concrete production technique is categorised. The review of the literature on aerated lightweight qualities focuses on porosity, permeability, compressive strength, and splitting strength.

Qin xin [9], explained based on the features of foam concrete and the made prior analyses the research progress of the effect of blending materials, admixtures, and fibres on the performance of foamed concrete, presents the problem of foam concrete development and application in current research, and emphasises that sustainable development is the basic idea of foam concrete further research and application in the future.

Provided an experimental investigation on the viability of using quarry rock dust and marble sludge powder as 100 percent replacements for natural sand in concrete[10]. Green concrete durability tests have been attempted in comparison to natural sand concrete.[11] The compressive, split tensile strength, and durability investigations of quarry rock dust concrete are almost 14% higher than ordinary concrete. The concrete's resistance to sulphate attack was considerably improved. Green concrete is an excellent approach to minimise pollutants while also improving concrete durability in harsh environments.[12]

III. MATERIALS AND METHODLOGY

The use of Portland cement or Portland blast furnace slag cement that adheres to the appropriate ASTM is recommended by ACI 523.1R-92 [American Concrete Institute, 1992]. The mixing water for foam concrete should be fresh, pure, and drinkable, according to ACI 523.3R-93 [American Concrete Institute, 1993]. This is especially crucial when employing protein-based foaming agents, since any organic contamination might reduce the quality of the foam generated [British Cement Association, 1991]. Foam bubbles are introduced into the cement paste and the concrete produced to obtain the low specific gravity of foam concrete. Foam bubbles are air gaps surrounded by the wall of a foaming agent solution. Synthetic foaming compounds, such as resin soap, and protein-based foaming agents, such as hydrolyzed protein, are both common.

According to ACI 523.3R-93 [American Concrete Institute, 1993], preformed foam is made by combining the foaming agent, water, and compressed air (created by an air compressor) in specified quantities in a foam generator calibrated for a discharge rate. Table 1 shows the Properties of Fly Ash.

Blast furnace slag is an iron byproduct. As blast furnace slag, iron companies generate a considerable amount of non-biodegradable waste. It can be obtained from local companies and used to substitute fine aggregate in concrete.

Table 1: Properties of Fly Ash

S.No.	Properties	Values
1	Silica (SiO_2)	56.87 %
2	Aluminium trioxide (Al_2O_3)	27.65 %
3	Ferric oxide (Fe_2O_3 + Fe_3O_4)	6.28 %
4	Titanium dioxide (TiO_2)	0.31 %
5	Magnesium oxide(MgO)	0.34 %
6	Loss of ignition (LOI)	4.46 %
7	Specific gravity of Fly Ash	2.12

Glass powder from stores and shattered glass sheets are not recycled and end up in landfills. The use of glass powder in concrete makes the environment safer. This waste glass powder can be used as a replacement for sand in the production of foam concrete. Many individuals have reported effective usage of waste or recycled materials as constituents, such as sewage sludge ash [cook and walker, 1999], crushed excavated material, slaked lime, crushed broken ceramic bricks, and waste from brown coal combustion material of foam concrete.Future building materials that are light, durable, and easy are being sought for by foresight organizations all across the world. Foamed concrete is an alternate material that has the ability to meet all of these requirements. Mix Foam concrete design Foam preparation and casting Cubes and Cylinders of Concrete Compressive strength of foam concrete is compared. Foam concrete is compared to other aspects such as cost effectiveness, adaptability, and so on. The compressive strength of foam concrete was evaluated and the results were compared. In that cement and fine aggregates test results shows in table 2.

IV. RESULTS AND DISCUSSION

IS 3495 (Part 1): 1992 compressive strength tests were performed on five brick specimens. The exam was divided into two stages: "Specimen Preparation and Testing." Grinding was used to reduce unevenness in bed faces, resulting in smooth and parallel faces. Because bricks are readily broken, grinding has to be done with extreme caution. Specimens were submerged in room temperature water for 24 hours figure 1 shows that the comparision of test trails.

Table 2: Cement and fine aggregates test results

Properties	Values
(A)Cement	
Grade of Cement	53
Specific gravity	3.15
Initial setting time	75 min
Final Setting Time	360 min
(B)	
Fineness Modulus	2.58
Specific gravity	2.65

Table 3: For Foam Concrete Mix – 1
(Containing Cement & Fine Aggregates)

S.No	Age of Concrete (days)	C/S area (mm^2)	Load (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (MPa)
1	7	22500	143	6.55	6.296
2		22500	140	6.22	
3		22500	142	6.11	
4	14	22500	246	10.93	10.8
5		22500	243	10.8	
6		22500	240	10.66	
7	28	22500	340	15.11	15.230
8		22500	345	15.33	
9		22500	343	15.24	

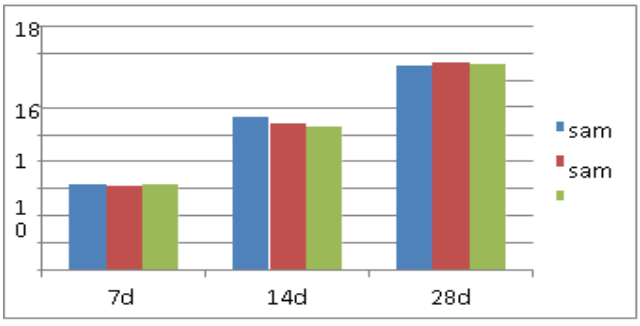

Figure 1: Comparision of Test Trail

Table 4: For Foam Concrete Mix – 1 (Containing Cement & Fine Aggregates)

S.No	Age of Concrete (days)	C/S area (mm^2)	Load (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (MPa)
1	7	22500	43	6.55	6.296
2		22500	44	6.22	
3		22500	42	6.11	
4	14	22500	110	10.93	10.8
5		22500	115	10.8	
6		22500	113	10.66	
7	28	22500	200	15.11	15.230
8		22500	205	15.33	
9		22500	202	15.24	

V. CONCLUSIONS

The density of foamed concrete is related to the amount of foam added to the slurry/mortar.

As foam concrete ages, its compressive strength and density increase. Fine aggregate had a considerable impact on the compressive strength of foamed concrete.In this study, we compared foam concrete to other foam concretes that are alternative materials for fine particles.

Mix-1 is a pure foam concrete including cement, fine particles, a foaming agent, and water(see table 3 and 4). For 28 days, its compressive strength is 15.230 Mpa.

In mix -2, 50% of the fine aggregate is replaced by blast furnace slag and 10% by fly ash by weight. For 28 days, its compressive strength is 9.0 Mpa. Because fly ash has a poor compressive strength, the compressive strength of mix-2 is lowered by 41% when compared to mix-1.

In mix-3 fine aggregate is replaced by 40% of blast furnce slag, 5 % of fly ash and 10 % glass powder by weight. Its compressive strength is 11.332MPa for 28 days. mix-3 compressive strength reduced by 25 % compared to mix-1. while compared to mix-2 it is increased by 25% . Because we decreased fly ash and increased glass powder.

As said earlier sand cost is increasing, if usage of sand content reduce by replacing substitute materials then we justify the idea which came. In this study materials which used replacement of sand are not attained standard value compared to conventional foam concrete mix.

The initial strength growth for foamed concrete is more than that of regular weight concrete, and the strength gain after 28 days is greater than that of normal weight concrete.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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