EXPERIMENTAL INVESTIGATION ON THE COMPRESSIVE STRENGTH AND PERMEABILITY OF FOAMED CONCRETE USING DIFFERENT FILLER MATERIALS

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Abstract

Foam concrete is a type of porous concrete it is similar to aerated concrete. It is a type of lightweight concrete. The mix usually having cement, filler (commonly sand) and foam, have densities vary from 300kg/m3 to 1800kg/m3. One of the main disadvantages of foam concrete is the large consumption of fine sand as filler material. Usage of different types of fillers in foam concrete can minimize the usage of fine river sand significantly and make the work economic and eco-friendly. This study focus on to investigate the various effect on foamed concrete by using different filler material like glass powder, plastic powder, crumb rubber powder, soil, GGBS, quarry dust. Further, aim is to compare its compressive strength and permeability properties of foam concrete by using various filler material.

Keyword: Foamed Concrete, density, permeability, compressive strength and filler material.

1.INTRODUCTION

- FC has so far been applied primarily as a filler material in civil engineering works. However, its good thermal In recent years, the construction industry has shown significant interest in the use of foamed concrete (FC) as a building material due to its many favorable characteristics such as lighter weight, easy to fabricate, durable and cost effective.
- Foam concrete is produced under controlled conditions from cement, filler, water and a liquid chemical, that is dilute with aerated to form the foaming agent.
- FC is a material consisting of Portland cement paste or cement filler matrix (mortar) with a homogeneous pore structure created by introducing air in the form of small bubbles.
- With a proper control in dosage of foam and methods of production, a wide range of densities (400 – 1600 kg/m3) of FC can be produced thus providing flexibility for application such as structural elements, partition, insulating materials and filling grades.
- Acoustic performance indicates its strong potential as a material in building construction.
- In fact, there has been widespread reported use of FC as structural elements in building schools, apartments and housing in countries such as Libya, Russia, Brazil, Malaysia, Mexico, Saudi Arabia, Indonesia, Egypt and Singapore.

2. BACKGROUND OF STUDY:

- In addition to Ordinary Portland cement (OPC), Rapid Hardening Portland Cement has been used for reducing the setting time and to improve the early strength of foam concrete.
- Fly ash and GGBs have been used in the range of 30% - 70% and 10% - 50%, respectively, as cement replacement to reduce the cost, enhance consistency of mixture, and reduce heat of

hydration, while contributing towards long-term strength.
- Foam concrete is produced either by Pre-foaming method or mixed foaming method.
- Pre foaming method comprises production of base mix and stable preformed aqueous foam separately, and then thoroughly blending foam into the base mix.

3. MATERIAL PROPERTIES AND MIX PROPORTIONS

3.1. Materials

3.1.1. Glass Powder

Glass powder in Concrete increases the compressive, tensile and flexural strength effectively when compared with conventional concrete.

3.1.2. Plastic Powder

Plastic associates products based have been considered as the world most Consumer packaging solution. This waste is non degradable in the natural

3.1.3. Crumb Rubber Powder

In addition to the decrease in unit-weight, the crumb concrete also exhibited better sound and thermal properties. However, due to the low strength and stiffness of rubber concrete. Appeared to be lower than of plain concrete.

3.1.4. Quarry Dust

Quarry dust is by product of the crushing process which is a to use as aggregates for concreting purpose, especially as fine

3.1.5. Soil Powder

Foam concrete, also named cellular concrete, offers many ad- vantages as a building material. Indeed, it features a low density, a low thermal conductivity and a valuable fire and water resistance

3.1.6. GGBS (Ground Granulated Blast furnace Slag)

GGBS in concrete increases the strength and durability of the concrete structure. It reduces voids in concrete hence reducing permeability.

SR. NO	FILLER MATERIALS	DENSITY IN Kg/m^3
1.	Glass Powder	1650
2.	Plastic Powder	673
3.	Crumb Rubber Powder	570-730
4.	Soil Powder	1-1.6 (g/cm^3)
5.	GGBS	1100-1300
6.	Quarry Dust	1680

Table 1: Density of Filler Materials

4. WHAT IS FOAMING AGENT?

A foaming agent is a material that facilitates formation of foam such as a surfactant or a blowing agent. A surfactant, when present in small amounts, reduces surface tension of a liquid (reduces the work needed to create the foam) or increases its colloidal stability by inhibiting coal scene of bubbles.
According to Ramamurthy and nambiar (2009), foamed concrete is produced either by pre foaming method or mixed foaming agent.
A blowing agent is a gas that forms the gaseous part of the foam. Foam agent control the concrete density through a rate of air bubbles created in the cement paste mixture. Foam bubbles are defined as enclosed air voids formed due to the addition of foam agent.
The content of the foam agent has a considerable effect on properties of both fresh and the hardened concrete.
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During oil well drilling, a foaming agent is used to facilitate foam formation in water so as to use it as a drilling fluid.
Drying shrinkage of foam concrete is 4-10 times higher than normal concrete. It reduces with increase of density.
The solid matrix of cementations slurry surrounding the fine cell structure of the foam concrete greatly reduces the capillary action through the material.

Drilling fluid foaming agents should be able to withstand high temperature, high salinity, entrained oil, hard water and other solids which are usually present during operations.

5. ADVANTAGES OF FOAM CONCRETE:

Does not settle
Free flowing
Low water absorption
Non hazardous
Reliable quality control
Low cost
Fire resistant
Cost efficient

6. DISADVANTAGES OF FOAM CONCRETE:

Compressive strength reduce as density increases
Difficulty in finishing
Time of mixing longer
Very sensitive with water content in mixture

7. MAIN FEATURES AND CHARACTERISTICS OF FOAM CONCRETE:

Type of foam concrete
Sort of foam concrete according to average density
Non-autoclave foam concrete
28 day compressive strength
Thermal Conductivity

8. EXPERIMENTAL METHODS:

Compressive strength

Permeability

9. MIX DESIGN OF FOAM CONCRETE:

Although there are no standard methods for proportioning foamed concrete, the general rules regarding w/c ratio, free water content and maintaining a unit volume apply, but it is a specified target plastic density that becomes a prime design criterion.

- Size of the mold for foam concrete is = 100*100*10mm
- Proportion of the mix = 1:2.5
- OPC = 53 Grade

10. PROPORTION OF FOAM ACCORDING TO W/C RATIO AND DENSITY OF FILLER MATERIAL

Filler materials	Density	W/cRatio	Foam volume
1.GGBS	1200	0.25	35-25%
2.Glass powder	1650	0.50	15%
3.Plastic powder	673	0.35	40%
4.Soil powder	1600	0.35	15-5%
5.Crumb Rubber powder	750	0.45	50-40%
6.Quarry dust	1680	0.42	20-25%

Table 2: Proportion of foam according to w/c Ratio and filler material

10.1. Foaming Agent:

The quality of foam concrete is critical to the stability of foamed concrete and will affect the strength and stiffness of the final product; therefore good quality foam was produces by blending the foaming agent.
Foaming agent we has used is CLC (Cellular lightweight Concrete) Foaming Agent. It is Prepared with raw material in presence of ca(OH)2 and a small Portion of NaHSO3. For improving the stability it is modified with the addition of several kinds of gel and surfactants.

Fig: Foaming Agent

11. ADDITIVES (SUPERPLASTICIZERS):

This admixtures can be used as water reducers, maintaining a fixed workability. Polycarboxylate ether superplasticizer was used as a water- reducing agent to maintain sufficient workability of the unfoamed mixture (without foam) and to produce a high strength foamed concrete with low water/binder ratio. Superplasticizers used in the amount of .3% weight of cement.

Fig . Superplastizeer

Dry mixing of the material:

Wet mixing of material

12. METHODOLOGY:

The first step is to make a cement slurry that is appropriate for the mix design. The second step is to make suitable foam. The foam is made separately from the slurry. Once the foam has been made it is blended in to the slurry to make foamed concrete.

13. MAKING OF SLURRY:

The cement we used for the slurry is Ordinary Portland Cement. First we dry mix the cement and filler material after which water is added into it. The water: cement ratio is 0.35 as per mix design. To increase the compressive strength we add superplasticizer of low dosage.

Water used to proudce foam is potable and for best performance,it should not exceed 250C.

We used 50ml Foam agent per litre of water.

(Water+Foaming agent) (Mixing) (Stable Foam)

Casting of the cube

Fig: Mixing of Raw Material

Filling of the cubes:

Size of the cubes is 100*100*10

Fig : Light Weight cubes

De-mouling of the cubes:

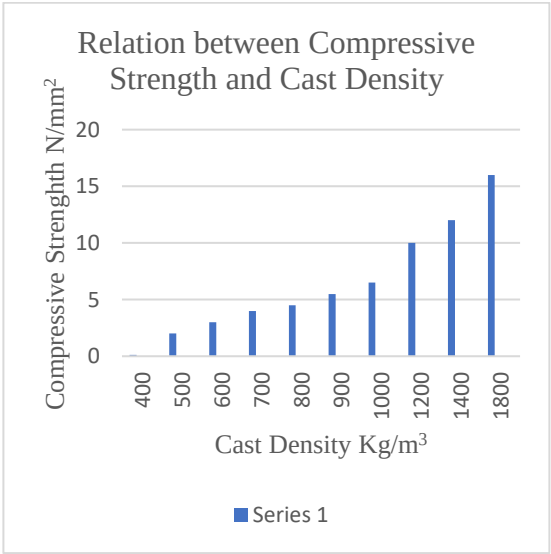
- Initial setting time of Foam concrete of Light Weight Concrete it
- 12 hours and can be demould after 24 hours.
- But in the case of low density Foam concrete take the time will be
- Initial setting time = 24 hour
- Final setting time 3 Days

Fig: Demoulding of the cubes

Curig of the cubes:

For 24 hours let the cubes let the concrete cubes in water.
After which use the wet bags for keep them moist.

Fig : Curing of the cube



14. EXPERIMENTAL SETUP

Compressive Load testing

Cracking of the cube

15. RESULTS OF THE EXPERIMENTS:

GGBS

GGBS

Sr no	Age in Days	Load in Kn	Comp. Strength	Avg. comp. Strength
1	7	220	6.76	
2	7	236	6.82	7.16 N/mm^2
3	7	251	7.91	

Table 3: Results At 7 Days

Sr no	Age in Days	Load in Kn	Comp. Strength	Avg. comp. Strength
1	28	241	9.12	
2	28	259	9.61	9.61 N/mm^2
3	28	270	10.12	

GGBSat 28 Days

Sr no	Age in Days	Load in Kn	Comp. Strength	Avg. comp. Strength
1	7	200	4.21	
2	7	229	4.29	4.43 N/mm^2
3	7	262	4.80	

Plastic Powder at 7 Days

Sr no	Age in Days	Load in Kn	Comp. Strength	Avg. comp. Strength
1	28	296	5.76	
2	28	306	5.85	5.65 N/mm^2
3	28	321	5.34	

Plastic Powder at 28 Days

Sr no	Age in Days	Load in Kn	Comp. Strength	Avg. comp. Strength
1	7	196	9.13	
2	7	212	9.81	9.82 N/mm^2
3	7	230	10.52	

Glass Powder at 7 Days

Sr no	Age in Days	Load in Kn	Comp. Strength	Avg. comp. Strength
1	28	256	11.18	11.31 N/mm^2
2	28	261	11.52	
3	28	292	11.5	

Glass Powder at 28 Days

Sr no	Age in Days	Load in Kn	Comp. Strength	Avg. comp. Strength
1	7	192	10.28	10.45 N/mm^2
2	7	220	10.87	
3	7	236	11.22	

Soil Powder at 7 Days

Sr no	Age in Days	Load in Kn	Comp. Strength	Avg. comp. Strength
1	28	235	12.36	14.15 N/mm^2
2	28	298	14.49	
3	28	321	15.62	

Soil Powder at 28 Day

Sr no	Age in Days	Load in Kn	Comp. Strength	Avg. comp. Strength
1	7	153	8.12	9.10 N/mm^2
2	7	169	9.28	
3	7	182	9.91	

Quarry Dust at 7 Days

Sr no	Age in Days	Load in Kn	Comp. Strength	Avg. comp. Strength
1	28	216	12.12	13.03 N/mm^2
2	28	278	13.16	
3	28	291	13.82	

Quarry Dust at 28 Days

Sr no	Age in Days	Load in Kn	Comp. Strength	Avg. comp. Strength
1	7	150	*4.62	5.35 N/mm^2
2	7	162	5.19	
3	7	180	6.25	

Crumb Rubber Powder at 7 Days

Sr no	Age in Days	Load in Kn	Comp. Strength	Avg. comp. Strength
1	7	216	12.12	13.03 N/mm^2
2	7	278	13.16	
3	7	291	13.82	

Crumb Rubber Powder at 28 Days

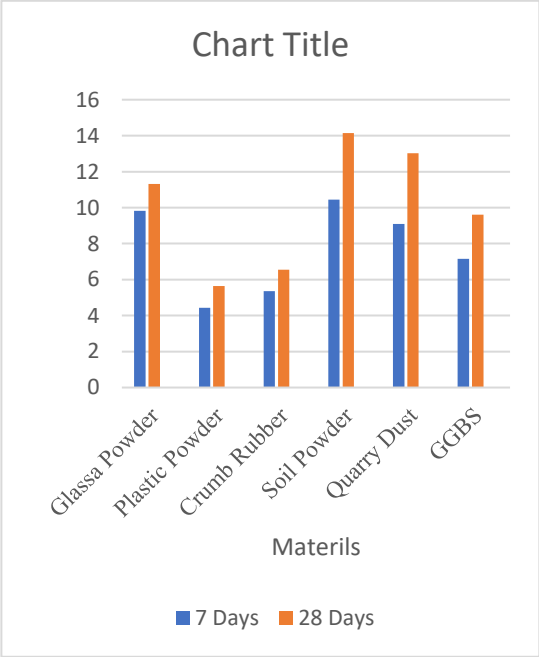


Fig: 7 and 28 Days compressive strength chart

16. PERMEABILITY OF FOAMED CONCRETE

- The main aim of this part of this study was to investigate what effects the addition of the foam had on porosity and its relationship with strength.
- The strength and porosity of foamed

concretes with different casting densities were compared to those of cement pastes with different water/cement ratios.

- Foamed concrete is produced under controlled conditions from cement, filler, water and a liquid chemical that is diluted with water and aerated to form the foaming agent.
- There is different density for different materials.
- Temperature is 110-115^{0}C of oven.
- Permeability is found after the oven drying the sample.

17. FORMULA TO FOUND OUT THE PERMEABILITY:

Water Abortion = (Wet Weight-Dry Weight) *100

(Dry weight)

Sr no	Materials	Density	Density after oven Drying
1	Glass Powder	1650	1504
2	Plastic Powder	673	582
3	GGBS	1200	1118
4	Crumb Rubber	750	652
5	Soil Powder	500	471
6	Quarry Dust	1680	1562

Fig: Density after oven drying

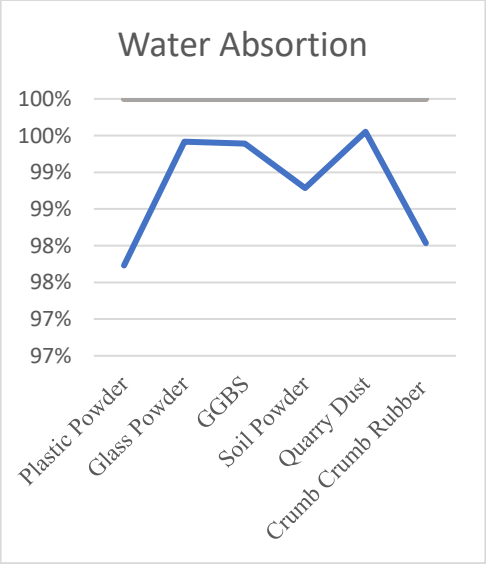


Fig: Water abortion after oven drying

18. COMPARISON OF CONVENTIONAL CONCRETE WITH FOAM CONCRETE

Sr No	Parameters	Conventional Concrete	Foam Concrete
1	Basic Raw Materials	Cement,Sand,Agg,Water	Cement,Sand,Water
2	Application	Load Bearing	Thermal Insulation -Partion Walls
3	Dry Density	2400	400-1800
4	Aging	No	Gain Strength
5	Thermal Insulation	Normal	Very Good
6	Sound Insulation	Normal	Very Good
7	Easy in Working	Normal	Very Good

19. CONCLUSION

Foam Concrete has a desirable Strength to be an alternative construction material.

The compressive strength of Foam concrete is low for lower density mixture.

De-moulding of higher density foam concrete panels is 3 days for lower density foamed concrete panels which is a limitation.

Improved structural efficiency in terms of strength to density ratio resulting load reduction on the structure and substructure.

The strength of foam concrete is low for low density mixture.

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