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Experimental Investigation on Durability Properties of Foam Concrete Using Fiber

A. Dhanalakshmi[1*], Dr. M. Shahul Hameed[2$],

[1]Research Scholar, Department of Civil Engineering, P.S.R. Engineering College, Sivakasi, Tamil Nadu, India.

[2] Professor and Dean (Research), Department of Civil Engineering, P.S.R. Engineering College, Sivakasi, Tamil Nadu, India.

Email: dhanalakshmicvl@psr.edu.in*, dean_research@psr.edu.in[$]

ABSTRACT

The experimental analysis of the compressive strength and durability qualities of lightweight concrete mixtures containing fiber and fine particles is the main focus of this study. The relationship between the density and compressive strength of concrete mixtures with varying proportions and durability characteristics, such as water absorption and acid attack, is proposed in this work. Foam concrete is composed of cement, fine aggregate, water, and a foaming agent. It is a lightweight concrete with densities ranging from 300 to 1800 kg/m^3. Fibre reinforced foam concrete, or FRFC, is utilized in addition to foam concrete fiber. Fiber consumption prevents weakening, shrinking, and cracking. The ingredients of the concrete used in this study are fly ash, cement, recron-3s fiber, artificial foaming agent, and powdered marble sludge as a filler. The target design density for each specimen is 1600 kg/m3. Foam concrete is treated with recron-3s fiber at a rate of 0.2% to 0.4%. An increase in fiber content results in stronger concrete.

Key words: Fly Ash, Marble Sludge Powder, Foaming Agent, Compressive Strength, Acid Attack, Water Absorption.

I. INTRODUCTION

Foam concrete, also known as light weight foam concrete (LWFC), is a type of light cellular concrete that can be used for structural, partition walls, and non-constructional components. Its density ranges from 300 to 1800 kg/m3. Because the foamy elements in the mortar produce random air gaps, the foam concrete has better thermal isolation properties, is easier to work with, and requires less cement and aggregate. The characteristics of the aggregate and cement mortar matrix utilized determine the strength of the concrete mixture. Adding fine aggregate to the concrete mixture in full substitution of coarse aggregate is one way to increase the strength of the concrete. Contrarily, FRFC has a lower energy-absorbing capability than standard concrete due to its "ductility or inelastic deformation capacity," albeit its weight is a concern. Precast concrete panels made of fiber-aerated lightweight concrete (FALC) have a promising future in the construction of both small and large buildings. Lightweight aggregate concrete's versatility and FRFC's dependability. Three ways of curing foam concrete have been studied: immersion in water, water spraying, and dry air curing. The effects of curing foam concrete with saturated H2SO4 water solution have been examined. Relative humidity greatly influences and raises the compressive strength of low density concrete, according to a study that examines the impacts of various curing settings. The samples treated with humidity have the highest compressive strength after 28 days, according to another study that examines the effects of curing concrete with water, air, and humidity.

II. MATERIAL USED

2. Materials

Cement, fly ash, powdered marble sludge, foaming agent (sodium sulfo aluminate), fiber (recron-3s), and water are used in the making of foam concrete. The foam generator is used to create foam.

2.1. Cement

To prepare the sample, Ordinary Portland Cement that complied with IS 4031 was utilized. In this investigation, OPC 53 grade was utilized. It establishes the concrete's strength and additional characteristics in both its fresh and hardened states. It is the only technically regulated component of concrete, as well as the active part of the binding medium. In this investigation, ordinary Portland cement (OPC), also marketed as DALMIA cement, was utilized.

2.2. Fly ash

One of the byproducts of burning coal that occurs naturally is fly ash, which is very similar to volcanic ash in composition. In today's modern power producing plants, combustion temperatures rise to about 2800ºF when coal is burned. the naturally occurring, non-combustible minerals that result from burning coal from fly ash and bottom ash. Lightweight aggregate material known as bottom ash settles to the boiler's bottom where it is collected. The material that is transported off with the flue gases is called fly ash, and it can be gathered and kept in silos for testing and classifying its beneficial uses. As the cement hydrates, fly ash combines with pozzolona to produce more of the strong binder that keeps concrete together.

2.3. MARBLE SLUDGE POWDER

One byproduct of the marble business is marble powder. It is acquired via the procedures of sawing and shaping. It is gathered as slurry close to the industry's disposal location. It mixes with the water and makes it unsafe to use again. Both the environment and human health are impacted by the presence of heavy metals. To lessen its effects, we must make use of this garbage. There are numerous applications for leftover marble powder in concrete. Reclaimed marble powder can be utilized as a filler to lower the overall amount of voids in concrete. Recycled marble powder can be added to concrete as an additive to alter its strength.

2.4. FOAMING AGENT

Vegetable proteins are hydrolyzed to create protein-based standard foaming agents or hydrolyzed protein agents. This causes more than just the odd fluctuation in quality because of how strongly scented these foaming chemicals are. Under sealed conditions, their shelf life is around a year. In this project, synthetic foaming agents are utilized. To create lightweight concrete, foaming agents lower the density of the concrete. Chemicals known as synthetic foaming agents lower the surface tension of liquids and are widely employed in the construction industry worldwide to create bricks, blocks, CLC concrete, and other materials where a high density is required. Compared to other foaming agents, synthetic foaming agents take less energy to manufacture. It is strongly advised to use in the building industry, as the need for lightweight concrete is growing over time.

2.5. FIBRE

Compressive strength is increased by the usage of fiber. Crack control also makes use of drying shrinkage and plastic shrinkage. The market offers a variety of fiber options, such as synthetic and natural fiber. Recron-3s is a virgin blend of polyster and polyprolene. It is a synthetic fiber with a unique shape and design that is used in mortar and concrete to cover up imperfections in the latter. Fibers that are triangular have superior surface bonding. In this project, Recron-3s were utilized as reinforcing material.

2.6. WATER

If there are significant levels of organic compounds, dissolved solids, or suspended solids in the water, it is best to avoid it. The water utilized in this project complies with IS 456: 2000 requirements.

III. EXPERIMENATL PROCEDURE

3. MIX PROPORTION

Table 1: Mix Proportion

S.No	Mix	Cement(%)	Flyash(%)	Marble Sludge Powder(%)	Fibre(%)
1.	FRFC1	100	100	0	0.2
2.	FRFC2	100	80	20	0.2
3.	FRFC3	100	60	40	0.2
4.	FRFC4	100	40	60	0.2
5.	FRFC5	100	20	80	0.2
6.	FRFC6	100	0	100	0.2
7.	FRFC11	100	100	0	0.4
8.	FRFC21	100	80	20	0.4
9.	FRFC31	100	60	40	0.4
10	FRFC41	100	40	60	0.4
11.	FRFC51	100	20	80	0.4
12.	FRFC61	100	0	100	0.4

3.1. COMPRESSION STRENGTH TEST

Concrete cube specimens are tested for hardness using the compression test. A 150 x 150 x 150 mm cube needs to be cast. Depending on the type of concrete, the specimen should be allowed enough time to harden before being adequately cured. After curing, it should be checked for maximum load by loading it into the compression testing apparatus. To find compression strength, divide the maximum load by the cross-sectional area. the weight exerted on the cast cubes' other side. The specimen was put under the highest load possible until a failure was noted.

Compressive strength = P / A

Where, P = ultimate Load in N, A = area of cube in mm^2

3.2. WATER ABSORPTION TEST

After casting, the 150 x 150 x 150 mm size cube was submerged in water for 28 days to cure. After being oven dried for 24 hours at 85ºC, these specimens were weighed once again to ensure mass consistency. This weight was recorded as the cube's dry weight (W1). The specimen was then submerged in water for a whole day. Then this weigth was noted as the wet weigth(W2) of the cube.

Water absorption (%) = [(W2-W1) / W1] x 100

Where, W1 = oven dry weigth of cubes in grams, W2 = after 24 hours wet weigth of cubes in grams.

3.3. ACID RESISTANCE TEST

A concrete cube specimen with a 150 mm size was evaluated for acid resistance after 18 days of cure. The cube specimens were weighed and submerged for 56,90 days in water that had been diluted with 5% hydrochloric acid by weight. After removing the specimens from the acidic water, the cubes' surfaces were cleaned. The specimens' weight and compressive strength were then determined, and the average percentage of weight and compressive strength loss was computed.

IV. RESULT AND DISCUSSION

4. TEST ON HARDENED CONCRETE

Tests on hardened concrete were performed to determine its compressive strength following a 28-day water curing period.

4.1 COMPRESSIVE STRENGTH OF CONCRETE

Table 2: Test result on compression Test for 0.2% fibre

For (0.2 % fibre)				
S.No	**Specimen**	**Mix proportions**	**Compressive strength (N/mm^2)**	
			7 Day	**28Day**
1.	FRFC 1	100% F.A	8	10.66
2.	FRFC 2	80%F.A+20%MSP	10.5	12.5
3.	FRFC 3	60%F.A+40%MSP	13.33	16.5
4.	FRFC 4	40%F.A+60%MSP	11.11	13.33
5.	FRFC 5	20%F.A+80%MSP	11.06	13.13
6.	FRFC 6	100%MSP	4.44	8.56

The compressive strength results shown above are strong for the FRFC 3 mix. After seven days, the compressive strength is 13.33 N/mm 2, and after twenty-eight days, it is 16.5 N/mm^2 as shown in fig1.

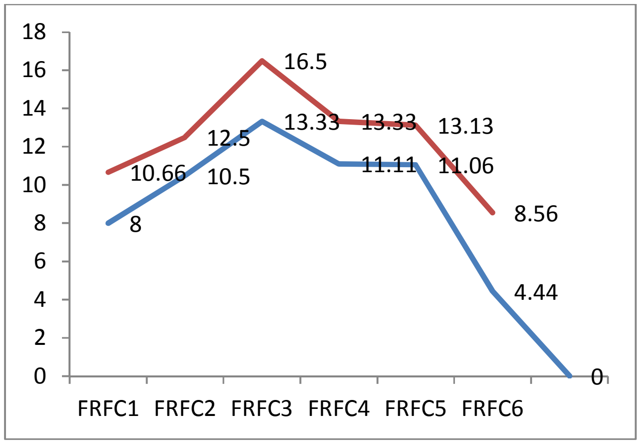

Fig 1: Compressive strength (N/mm^2) for 0.2 fiber

Table 3: Test Result on compression Test for 0.4% fibre

S.No	Specimen	Mix proportion	Compressive strength (N/mm^2)	
			7 Day	28 Day
1.	FRFC11	100% F.A	4.41	8.5
2.	FRFC21	80%F.A+20%MP	5.33	9.33
3.	FRFC31	60%F.A+40%MSP	6.21	10.33
4.	FRFC41	40%F.A+60%MSP	5.6	9.56
5.	FRFC51	20%F.A+80%MSP	5.1	9.14
6.	FRFC61	100%MSP	4.44	8.56

The above results of compressive strength will achieved in FRFC 31mix is high. That compressive strength result 6.21 N/mm^2 for 7 days and 28 days strength is 10.33 N/mm^2 as shown in fig2.

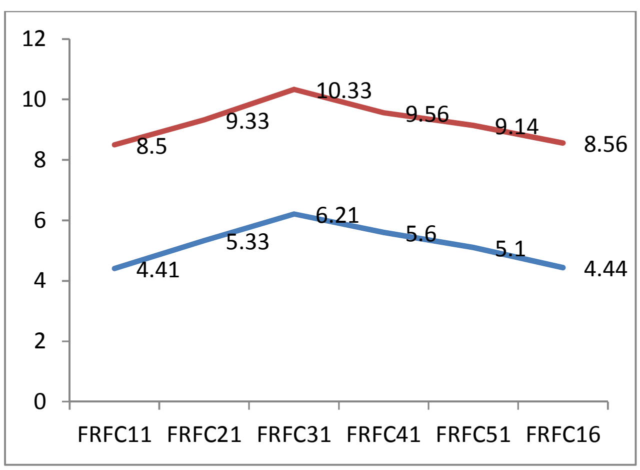

Fig 2: compressive strength (N/mm^2) for 0.4 fiber

4.2 WATER ABSORPTION TEST

Table 4: Test results on water Absorption

Mix	Dry Weight (W1)	Wet Weight (W2)	% of Water Absorption
FRFC 1	3.20	4.80	1.60
FRFC 2	3.40	5.20	1.80
FRFC 3	3.84	5.44	1.06
FRFC4	4.82	6.69	1.87
FRFC5	3.44	4.50	1.61
FRFC 6	3.06	4.40	1.34

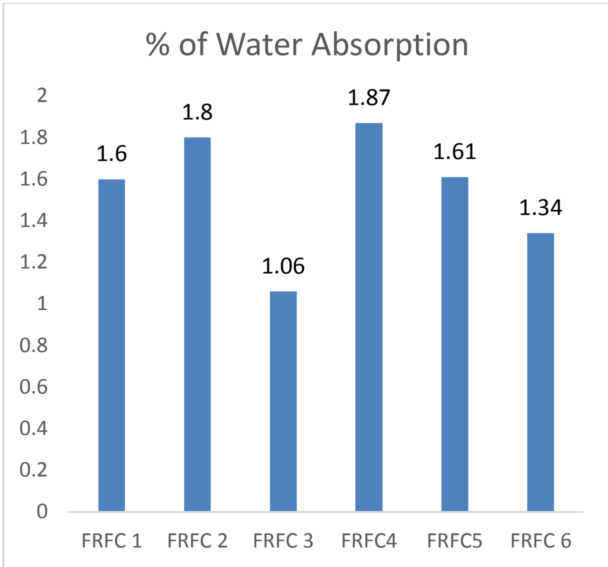

Fig 3: water Absorption Test (%) for 0.4 fiber

4.3 ACID ATTACK

Table 5: Test Results on acid attack (H_2SO_4)

Mix	Weight (kg)			Compressive strength (N/mm^2)		
	Before curing	After curing	Reduction of weight %	Before curing	After curing	Reduction of strength %
FRFC 1	5.58	5.35	2.98	10	8.9	25.6
FRFC2	6.08	5.68	3.14	15.4	12.6	28.7
FRFC3	5.85	5.45	3.05	13	10.6	20.5
FRFC4	6.20	5.40	3.12	10.2	8.8	25.6
FRFC5	5.57	5.24	3.00	14	11.4	30.1
FRFC6	5.7	5.30	2.80	9	8.2	27.8

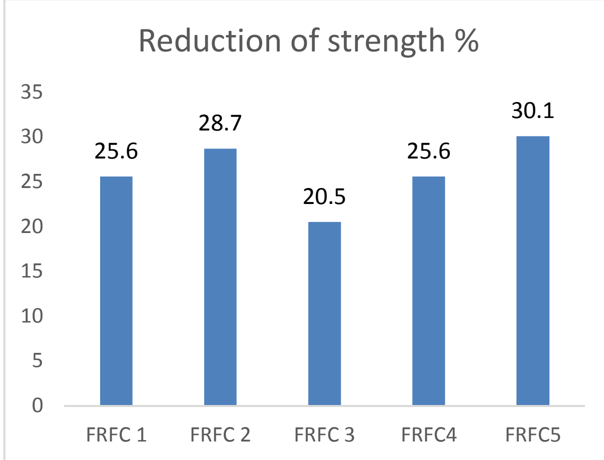

Fig 4: Acid Attack Test Weight (%)

V. CONCLUSION

The FRFC3 & FRFC31 mix will have attained a high compressive strength. After seven days, the compressive strength was 13.33 N/mm2, and after twenty-eight days, it was 16.5 N/mm2. It is stated that the low compressive strength In comparison to target strength and normal concrete, FRFC1 and FRFC 6 likewise have low compressive strengths. It was found that the addition of flyash to concrete results in a drop in its dry density and an increase in strength. It was shown that while adding MSP increases the density of the concrete and sometimes goes over the limit for lightweight concrete, it also helps to boost strength. The compressive strength of concrete is increased by lightweight foamed concrete that uses Recron-3s fiber. The FRFC 3 mix performs well in terms of acid resistance. When compared to other proportions, the FRFC 3 has a higher rate of water absorption. The strength and density of foamed concrete are lower than those of normal concrete.

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