AN EXPERIMENTAL INVESTIGATION ON FIBER REINFORCED FOAM CONCRETE

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Abstract: **Foam concrete is a light weight concrete having lower density ranges from 300 kg/m^3 to 1800 kg/m^3 which consist of cement, fine aggregate, water and foaming agent. In this foam concrete, there is no coarse aggregate is used for production of foam concrete. In fiber reinforced foam concrete (FRFC), in addition to foam concrete fiber is added. Fiber is added to prevent shrinkage crack and improve its strength, concrete is made up of cement, fly ash, Marble sludge powder as filler, synthetic foaming agent and recron-3s fiber. The target design density of each specimen is 1600 kg/m^3. In this Project recron-3s fiber was added in the foam concrete under two different proportions such as 0.25% and 0.5% were used. Increase of fiber content which increases the strength of the foam concrete. The strength properties of compressive strength and Split Tensile Strength were determined.**

Keywords**: Foaming Agent, Fly Ash, Marble Sludge Powder, Compressive Strength, Split Tensile Strength.**

I. INTRODUCTION

Foam concrete, is referred as Lightweight Cellular Concrete (LCC), Low Density Cellular Concrete (LDCC). In foam concrete, no coarse aggregate is used for production. It may also be called as "foamed cement". The density of foam concrete usually varies from 300 kg/m^3 to 1600 kg/m^3. The density is normally restrained by substituting fully or part of the fine aggregate with foam. Foam concrete is a adaptable building material with a simple production method. In foam concrete compounds utilization of fly ash in the slurry mix is cheaper, and has less environmental impact. Foam concrete is composed in a variety of density ranges from 200 kg/m^3 to 1,600 kg/m^3 depending on the application. Its high level thermal and acoustical insulating qualities make it a very different application than conventional concrete.

Fiber-reinforced concrete is one accommodate fibrous material that improves its structural solidity. Several fiber types in concrete fabricating more outstanding resistance to impact, abrasion and destruction. A higher length of steel or synthetic fibers can completely replace reinforcement or steel in certain situations. Exaggerated and hereditary fibres give various concrete properties. Besides, the FRC nature changes with a change in the concrete and fibrous substances, geometry, distribution, orientation and density.

Foam concrete is obtained from mixing base mix with preformed foam. The material properties of foam concrete may have a significant effect on the structural performance of the LWFC structures. The strength behaviors which give a significant and positive response to their structural behaviour. It consists of cement, sand, water, and foams. As a remuneration of economic and performance enrichments, many researchers were initiating additives or replacements to the FC, such as fly ash, silica fume, superplasticizer, fibres, and others. There is no specific method to regulate the mixing proportions**.**

II. OBJECTIVE

To determine the Strength of Fiber Reinforced Foam Concrete and to be found out by with the help of conducting Compressive Strength and Split Tensile Strength.

III. LITERATURE REVIEW

Marcin Kozłowski et al., (2018) The targeted density denoted is 400-1400 kg/m^3. Fly ash is used. The commercial foaming agent is used. Density of FC is 20% higher than FCA. The strength of specimen to freeze-thaw cycles is 15% lower values. The Compressive Strength, Modulus of elasticity and Flexural Strength get decreased when the density of the foamed concrete decreased. 5% addition of fly ash causes the decrease of the Compressive Strength, Flexural Strength and Modulus of Elasticity of foamed concrete.

Yanbin Fu et al., (2020) This paper describes manufacturing and material properties like drying shrinkage, compressive strength, stability and pore structure. The experimental results implies that the compressive strength of FC increases with density and confining pressure. Synthetic and Protein based Surfactants are used. The usage of fibers such as Polypropylene, glass and polypropylene and palm oil, Steel, coconut, waste paper cellulose, carbon used in 0.2% and 1.5 of mixture volume. Finally it is concluded that foam concrete with uniformly distributed closed circular airpores, it shows good thermal and mechanical properties.

Devid Falliano et al., (2019) The protein based foaming agent called Foamin C was used. Three dry densities are targeted, they are 400 kg/m^3, 600 kg/m^3, 800 kg/m^3. Three different fiber content were analysed like 0.7%, 2%, 5%.When we are adding 2 and 5% of fiber, it results in the increase of flexural strength.

IV. EXPERIMENTAL INVESTIGATION

CEMENT:

In this study, OPC 53 grade was used. The Ordinary Portland Cement confirming to IS 4031 was used for the preparation of specimens. Cement is a binding material which is used to bind the fine and coarse aggregates, and used to fill the voids in between fine and coarse aggregates to form a dense mass. Cement constitutes about 10% of the volume of concrete mix. It is the active portion of the binding medium and only technically controlled element of concrete. Ordinary Portland cement (OPC) commercially known as DALMIA cement was used in this study.

Table 1 Properties of Cement

S.NO	PROPERTIES	CEMENT
1	Specific Gravity	3.18
2	Fineness	2.2
3	Consistency	35%
4	Initial setting	30min

FLY ASH:

Fly ash is the natural product which exist from the coal combustion process and it is similiar to volcanic ash. Volcanic ash concrete was used years and years ago to produce Roman concrete structures that exist and function today e.g., the Pantheon, Coliseum, and ancient aqueducts. The temperature 2800°F is generated when it is burnt in todays modern electric generating plants, combustion temperatures. The non- combustible minerals that occurs from flaming coal form bottom ash and fly ash. Bottom ash falls to the boiler bottom for ash collection and it is a light-weight aggregate material. Fly ash is carried off with the flue gases, where it is collected andit can be stored in silos for testing. Fly ash exposes as a pozzolana with the lime in cement as it hydrates, creating more of the durable binder that holds concrete together.

Table 2 Properties of Flyash

Sl.NO	PROPERTIES	FLY ASH
1	Specific Gravity	2.56
2	Fineness	3.5

MARBLE SLUDGE POWDER

Marble powder is one of the solid waste material which is generated in marble industry during marble processing such as sawing and shaping. It is collected as slurry near the dumpsite of the industry. It mixes with the water and makes it unfit for reuse. Due to the presence of heavy metals it affects the environment and also the human health. To reduce its effect we have to use this waste. The Waste marble powder can be take advantage of in concrete in different ways. Waste marble powder can be used either as filler or as fine aggregate in concrete and helps to reduce the total void content in concrete. In concrete waste marble powder can be used as an admixture, so that the strength can be altered. In this project, the marble sludge powder used as filler material and collected at sivakasi.

Table 3 Properties of Marble Sludge Powder

Sl.NO	PROPERTIES	MARBLE SLUDGE POWDER
1	Specific Gravity	2.56

FOAMING AGENT

There are several types of foaming agents are available. Protein based standard foaming agents or hydrolyzed protein agents are made by protein hydrolysis from vegetables. This leads not only to infrequent variations in quality, due to the contradicting raw materials used in different batches. Thelife time of foaming agentunder sealedcondition is about 1 year. Synthetic based foaming agent is used in this investigation.

Table 4 Physical Properties of Foaming Agent

S.No	Parameters	Foaming Agent
1	Appearence	Colour less to pale yellow
2	Active matter%	28 min
3	pH (1% Aqueous solution)	6.5 – 8.5
4	Sodium Sulphate %	1.0 %
5	Sodium Chloride %	0.5 %
6	Un - Sulfated Matter %	1.0%
7	1 – 4 Dioxane ppm	30 max

FIBRE

Fibres are used in concrete to improve the compressive strength. Also used to control crack is plastic shrinkage and drying shrinkage. There are several types of fibre are available in market such as natural fibre, synthetic based fibre. Recron 3s is a virgin polyester & polypropylene fiber. It is a specially engineered and Triangular shaped synthetic fiber and it is used to overcome shortcomings of concrete and mortar. Triangular fibers provide higher surface bonding. In this project, Recron 3s used as a fibre.

V. MIX PROCESS

In this study, Cement, Fly Ash, Marble Sludge Powder, Foaming Agent is used. Fly Ash is used as a cementitious material, Marble Sludge Powder is used as a filler material. There is no standard methods to determine the proportioning of foamed concrete. The trial and error method is often followed to achieve foam concrete with desired properties. So we assumed density of foam concrete as 1600kg/m^3. Assuming a target plastic density (D, kg/m^3),water/cement ratio (w/c) and cement content (C, kg/m^3) ,the water (W, kg/m^3), fly ash (F, kg/m^3),contents of the base mix are calculated as follows:

$$D = C+W+F \quad \text{- (1)}$$

The fly ash, cement, MSP, and fiber are mixed thoroughly in a dry state. The foam was generated by using manpower. Synthetic foaming agent is used for producing foam. Foaming agent is diluted with water. Then finally the dry mixed materials and foam was thoroughly mixed, and then the fresh foam concrete was produced. The fresh FRFC thus obtained was cast immediately in moulds.

VI. CASTING OF SPECIMEN

CUBE

Ordinary Portland Cement (53) grade is used in the concrete matrix. The fly ash and MSP replace the fine aggregate and added in different ratio. MSP is added in the ratio of 10%, 20%, 30%, then Recron fiber is added as 0.25 and 0.2%, then mixed for concrete. For each specimen, 2 cube with sizes of 150mm x 150mm x 150mm were casted to test the characteristic strength of the mix.

CYLINDER

Ordinary Portland Cement (53) grade is used in the concrete matrix. The fly ash and MSP replace the fine aggregate and added in different ratio. MSP is added in the ratio of 10%, 20%, 30%, then Recron fiber is added as 0.25% and 0.2%, then mixed for concrete. For each specimen, 2 cube with sizes of 150 mm diameter and 300mm height were casted to test the characteristic strength of the mix.

VII. CURING OF THE SPECIMEN

All the casted conventional and FRFC specimens such as cube, cylinder were cured by immersing into water for 28 days until testing. The specimens are tested at 7^{th} day, and attained 40% strength. Cubes are cured for 28 days and attained full strength. The specimens were brought out from water approximately after 24 hours before testing and keep at room temperature till testing.

VIII. MIX PROPORTION

Table 5 Mix Proportion for FC and FRFC

MIX	CEMENT (%)	FLY ASH (%)	MSP (%)	FIBRE (%)
FC	100	-	-	-
FC 1	100	100	-	-
FC 2	100	90	10	-
FC 3	100	80	20	-
FC 4	100	70	30	-
FRFC1	100	80	20	0.25
FRFC2	100	80	20	0.50

IX. RESULTS AND DISCUSSION

The Compressive strength and Split tensile test on fiber reinforced foam concrete has been conducted and its results have been discussed in this chapter.

COMPRESSIVE STRENGTH TEST

Table 6 Compressive Strength of FC

Mix	Compressive Strength (N/mm^2)	
	7 Days	28 Days
FC	3.39	5.54
FC 1	3.55	5.80
FC 2	4.00	6.53
FC 3	4.44	7.26
FC 4	4.25	6.94

The highest values of compressive strength for foam concrete without fiber is 7.26N/mm^2 after 28 days with addition of 80% Fly ash, 20% MSP in to the mix called FC is obtained high strength.

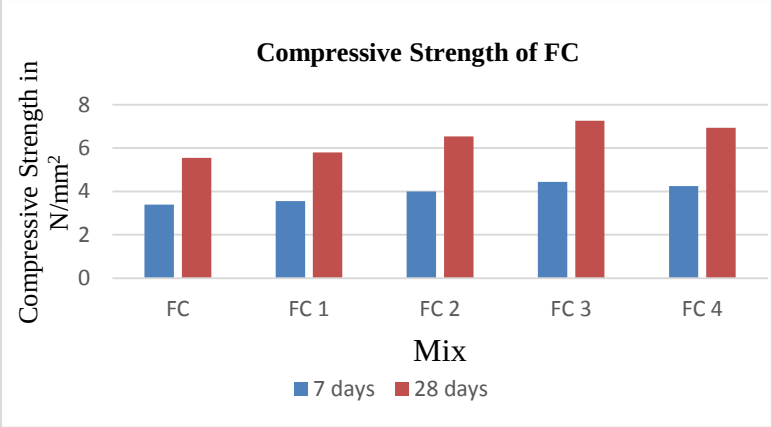

Figure 1 Compressive Strength of FC

Table 7 Compressive Strength of FRFC

Mix	Compressive Strength (N/mm^2)	
	7 Days	28 Days
FRFC5	6.66	10.88
FRFC6	7.55	12.34

The Maximum values of compressive strength for foam concrete with fiber is 12.34 N/mm^2 after 28 days with addition of 80% Fly ash, 20% MSP and 0.5% in to the mix named FRFC2 is obtained high strength.

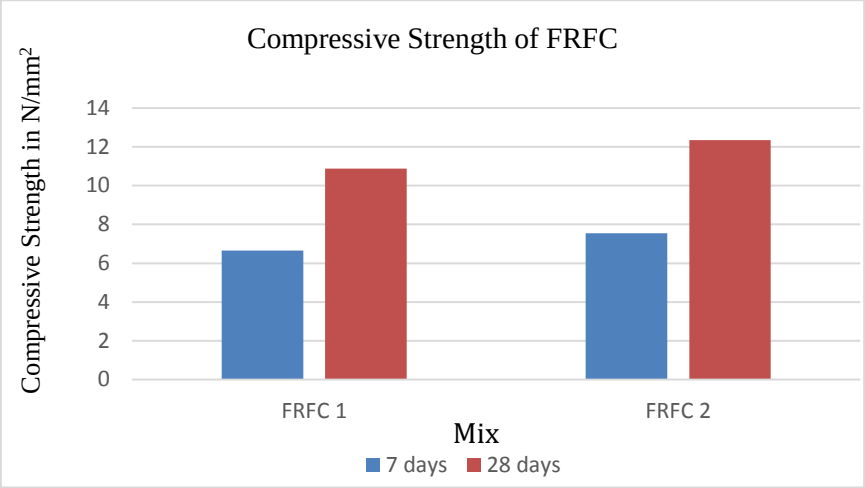

Figure 2 Compressive Strength of FRFC

SPLIT TENSILE STRENGTH TEST

Table 8 Split Tensile Strength of Foam Concrete

Mix	Load (KN)	Split Tensile Strength (N/mm^2)
FC	40	0.56
FC 1	50	0.71
FC 2	60	0.85
FC 3	80	1.13
FC 4	70	0.99
FRFC 1	110	1.55
FRFC 2	90	1.27

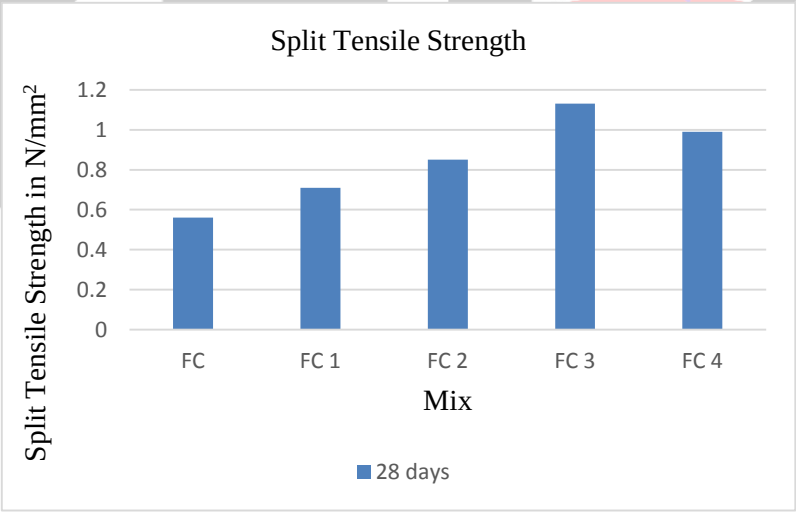

FIGURE 3 Split Tensile Strength of FC

Table 9 Split Tensile Strength of FRFC

Mix	Load (KN)	Split Tensile Strength (N/mm^2)
FRFC 1	90	1.27
FRFC 2	110	1.55

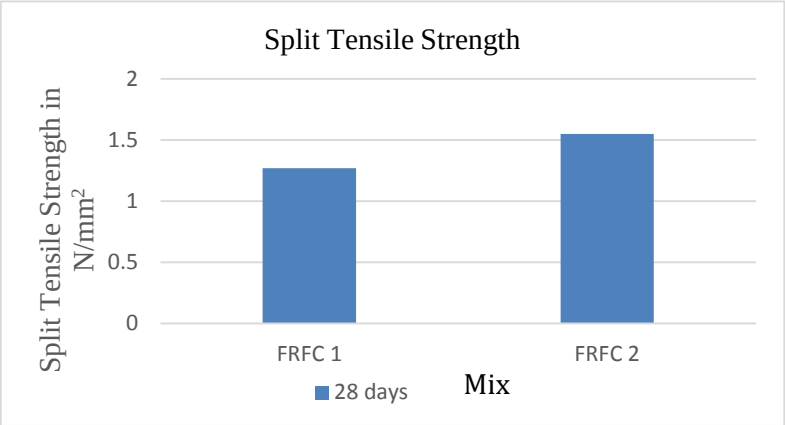

Figure 4 Split Tensile Strength of FRFC

The highest values of Split tensile strength for foam concrete with fibre is 1.55 N/mm^2 after 28 days with addition of 80% Fly ash, 20% MSP and 0.5% in to the mix named FRFC2 is obtained high strength.

X. CONCLUSION

The addition of Fly Ash helps in increase of strength and it reduces the dry density of concrete. The addition of MSP helps in increase of strength but increases the density of concrete and in certain condition it exceeds the lightweight concrete limit. Light weight foamed concrete using Recron 3s fiber increases the compressive strength of concrete. When compared to the conventional concrete strength and density is lower for foamed concrete.

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