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An Investigation on Prefabricated Foamed Concrete Sandwich Panel Subjected To Out-of-Plane Bending

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Abstract - *Steel – Concrete Composite construction is widely accepted technique in the construction industry. Sandwich composite panel is heterogeneous in nature. The reduction in weight of concrete helps easy removal, transport and erection of precast products. So necessity of light weight precast panels arises there. Here we have discussed about two different varieties of panels, which can be used further for the construction purpose. Composite panel consist of three layers of two different materials (concrete and steel). Panels are created with corrugated steel sheet or decking sheet sandwiched between foamed concrete and fiber reinforced foamed concrete. Behaviors of sandwich panels were studied in detail. Advantages and disadvantages of light weight panel construction are examined here. It was found that advantages are more compared to the disadvantages. Determination of Compressive strength, split tensile strength, modulus of elasticity is done. Four point bending test is conducted here for the panels. Load deflection values are obtained.*

Key Words: Foamed concrete, sandwich composite panel, light weight panel

1. INTRODUCTION

Today steel – concrete composite construction is widely accepted technique in the universe. Sandwich composite panel is heterogeneous in nature, with the help of respective advantage of two materials overall weight, Size of section and cost of construction reduced. Concrete is week in taking tension and steel is good in taking the tension. That means, Sandwich construction with low cost materials can not only be more lightweight but also more cost effective, especially because the advancement and automation of production processes results in a reduction of the production cost for lightweight sandwich panel. The combination of materials to utilize their favorable properties is the basic idea of composites engineering. With a monolithic material, a thickness increase leads to an increase of both weight and material cost of a panel. Sometimes, clumsy or sagittal ideas derived from studies, by the experimental confirmations, points to the great innovations, but i know that it is not trifling in nature. Structural weight reduction is the major consideration and the sandwich construction is frequently used instead of increasing material thickness.

2. MATERIALS USED

2.1 Cement

Ordinary Portland cement (53 grade) confirming to IS: 12269-1987 was used for all the concrete mixtures. The tests were conducted according to IS 4031-1988.The physical properties are given in Table 1.

Table -1: Physical Properties of Cement

Sl. No.	Properties	Recommended Value	Value
1	Specific gravity	26-33 [16]	3.12
2	Standard consistency	Not less than 30 [17]	30 %
3	Initial setting time (in minutes)	Not greater than 600 minutes [17]	65
4	Final setting time (in minutes)	3.10 to 3.16 [15]	270

2.2 Foaming Agent

A vegetable protein is used as the forming agent. It is used to produce foam concrete of density ranging from 200 up to 1600 kg/m^3. The foaming agent is protein, contains natural surfactants and is mixed with organic raw materials.

2.3 Fly Ash

Class F fly ash is used for the project. It is bought from RMC, Aluva. Specific gravity is 2.7.Chemical composition of fly ash is as shown in table:

Table -2: Chemical Composition of Fly Ash

Sl No	Ingredients	Percentage
1	Silicon dioxide(SiO_2) + Aluminum oxide(Al_2O_3) + Iron oxide(Fe_2O_3)	88
2	Silicon dioxide(SiO_2)	58
3	Reactive Silica	26
4	Magnesium oxide (MgO)	1.62
5	Total chlorides	0.0096

2.4 Coir Fiber

Coir fibers are found between the hard, internal shell and the outer coat of a coconut. The individual fiber cells are narrow and hollow, with thick walls made of cellulose. After they had been extracted, the coir fibers were dried at 70°C to 80°C. The coir was treated to avoid the degradation factor. This process consists of immersing the coir fibers into 5% sodium Hydroxide (NaOH) solution for 24 hours to remove the first layer. The obtained fibers are washed abundantly with water to remove the NaOH, dried again in furnace at 70°C to 80°C for next 24 hours. The coir fibers were then soaked into 5% of silicone and 95% of methanol solution for 4 hour and dried at 70°C for next 24 hours curing time. Physical properties are given in Table 4.

Table -3: Physical Properties of coir fiber

SI No	Properties	Range
1	Density(g/cm^3)	1.15-1.33
2	Elongation at break (%)	18-30
3	Tensile strength(MPa)	140-150
4	Young modulus(GPa)	4-5
5	Water absorption (%)	130-180

2.5 Decking Sheet

Composite deck sheets substitute the tensile reinforcement in the concrete slab. This is made possible by the composite action developed between two dissimilar materials like concrete and steel by the provision of shear connectors at the interface of the two materials.

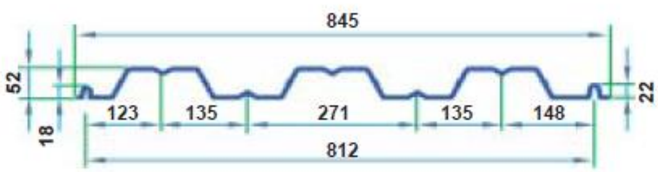

Fig -1: Decking Sheet of 0.8 mm Thickness

3. PREPARATION OF TESTED SPECIMEN

The mixtures were cast in 150×150×150mm steel cube moulds, 150×300mm cylinder moulds and 1200×600×100 panel moulds. For each mix 3 cubes, 6 cylinders and 3 panels were casted. The specimens were subjected to water curing for a period of 7, 28 Table 5 shows the mix designation.

Table -4: Mix Designation

Mix Designation	Description
FC	Normal foamed concrete
FRFC	Fiber reinforced foamed concrete

4. TEST RESULTS

4.1 Compressive Cube Strength

Control specimen was casted for 7 and 28 days for checking the compressive strength and made to water cure. Another set of cubes were casted using 0.2% by volume of coir fiber. Compressive cube strength of sample are shown in Fig. 2.

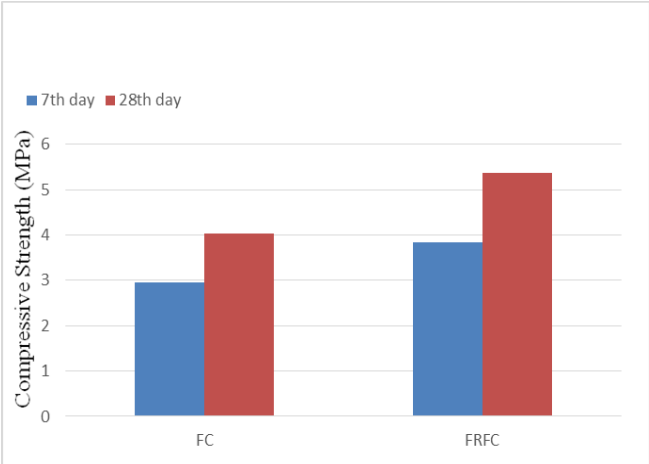

Chart-1: Comparison of Compressive Strength

4.2 Modulus of Elasticity

Modulus of elasticity of concrete mix was measured at 28 days. Modulus of elasticity value is higher for fiber reinforced foamed concrete. Flexural strength result of sample are shown in Fig. 2

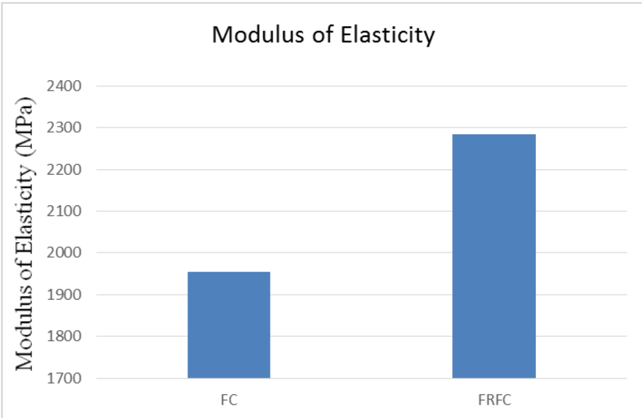

Chart-2: Comparison of Modulus of Elasticity

4.3 Split Tensile Strength

Splitting test is an indirect test used for determining the tensile strength of concrete. Split tensile strength result of sample are shown in Fig. 3.

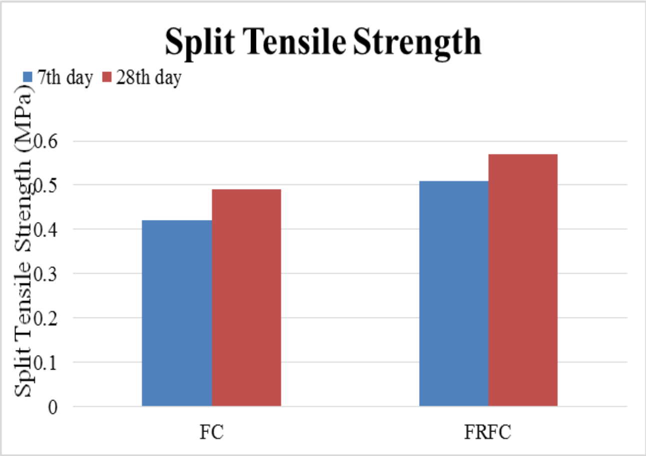

Chart-3: Split Tensile Strength Vs Mix Designation

4.4 Four point Bending Test for Panels

Fig -2 Crack on panel after loading

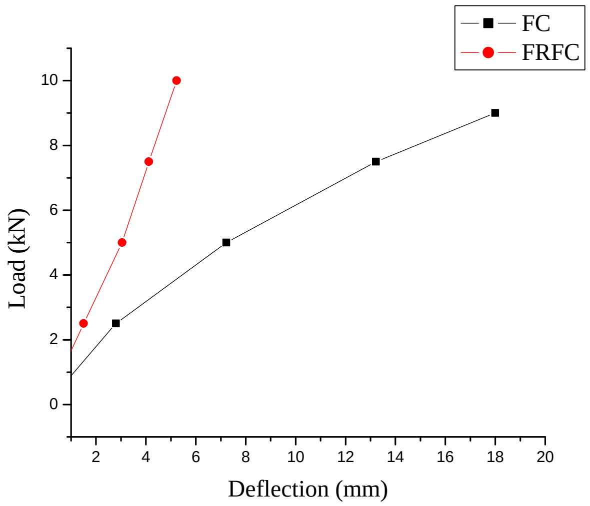

Chart -4: Load Vs Deflection graph

5. CONCLUSION

In concrete construction, self-weight represents a very large portion of the load on the structure, and there are considerable advantages in reducing the density of concrete. Furthermore using lightweight concrete improves construction and handling techniques; larger units are often desirable; obviously transportation and on-site handling would be made more economical. Lightweight concrete reduces the cost of formwork and steel and it also increases productivity. Giving better thermal insulation than ordinary concrete.

Based on the experimental investigations the following conclusions are made:

- It was observed that fiber reinforced foamed concrete gives better strength than conventional foamed concrete. Fiber reinforcement enhances the compressive strength of foamed concrete, which is attributed to the increase of specimen integrity by the fibers.

- The 7th day compressive strength of fiber reinforced foamed concrete increased by 36.94% than normal foamed concrete. Similarly 28th day compressive strength of fiber reinforced concrete increased by 39.58% than normal foamed concrete.

- Modulus of elasticity value increases by 16.86%. The addition of fibers helps in stress redistribution and reducing strain localization and thus increases the modulus of elasticity of fiber reinforced concrete.

- It is found that the fibre reinforcement drastically increases the tensile strength of the foamed concrete and also prevents a sudden failure of the specimens, which is in contrast to the brittle behaviour of plain foamed concrete specimen.

- The percentage increase of 7th day split tensile strength of fiber reinforced foamed concrete is 21.42 than normal foamed concrete and that for 28th day is 16.32. Fibers prevent sudden failure of the specimen. Premature failure was observed which is due to the large voids formed during fabrication.

- The fiber reinforcement improves the structural response of composite sandwich panels by increasing the maximum load carrying capacity before the failure of the specimen.

- The first shear crack was initiated in the bottom face of the sandwich panel directly under one of the loaders very near to it. Fiber added foamed concrete shows, high strength compared to other two panels because, fiber acted as a tension layer above the decking sheet and it could take more load compared to the other panels.

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