International Journal of Research and Review
www.ijrrjournal.com E-ISSN: 2349-9788; P-ISSN: 2454-2237

Research Paper

Study on Properties of Foam Concrete Using Fibers

Jessie Deborah PJ[1], S.Kotteeswaran[2]

[1]Department of Civil Engineering, [2]Department of Civil Engineering,
Jaya Engineering College, Anna University, Chennai, India.

Corresponding Author: Jessie Deborah PJ

ABSTRACT

When it comes to construction, one important factor considered is cost effectiveness and affordability. To achieve cost effectiveness new materials, must be brought into use. One such material that seems useful and affordable is foam concrete. Before, about 2000years ago, Romans found out that animal blood added to sand, hot lime, water and course aggregate, formed bubbles that lasted long, making the mix more workable, long lasting. This leads to the initiation of foam concrete. Foam concrete is also called light weight concrete and thus when used as partition walls in high rise structures can reduce the dead load acting on the structure. Foam concrete is well known for its thermal, insulation and fire-resistant properties. But using foam concrete as a construction material is a major challenge due to its brittle nature. Thus here, we will be using various fibres like glass, polyester, polypropylene, rice hush ash (RHA), coconut coir ash(CCA) in proportions of .15%, 0.30%, 0.45% and their respective properties will be analyzed.

Keywords: coconut coir, Compressive strength, Foamed concrete, flexural strength, glass fibre, Lightweight concrete, polyester, polyethylene, RHA, Sustainability

INTRODUCTION

Foam concrete is one wonderful concrete component that has inevitable uses and needs in today's fast-moving world. With buildings touching the sky, that demand life and economy well insulated and fire resistant structure, the need for an advanced material is high and foam concrete with the right foaming agent, right fibre added in the right proportion can pave way for construction to be at pace with the fast moving world. Foam concrete is being used in a lot of countries for roads, fillings and insulations. But foam concrete used as construction material in very meagre, at least in a developing country like India. Here in this study, an effort has be made to determine various characteristics of foam concrete with and without fibres being added to it. It is to be noted that Rice husk and coconut coir are fibers widely available in plenty in our country and using them for construction will pave way for reuse of waste material and build an eco friendly environment.

A total of 288 cubes and 128 beams were made for ratios of .15%, .30%, .45% in various combinations of fibres and the results are discussed here. It has been identified that RHA has cement like properties and can be used as a substitute for cement provided the right super-plastizer is used.

LITERATURE REVIEW

1. "Fiber addition and its effect on concrete strength" Aiswarya Sukumar, Elson John, International Journal of Innovative Research in Advanced Engineering, Volume 1 Issue 8 (September 2014). Here various fibres were added to concrete mixes to determine their

strength. Without the inclusion of fibre, the tensile property of concrete cannot be improved.

2. "A Review on Fiber Reinforced Foam Concrete", Simi Das M A, Praveen Mathew IJSTE - International Journal of Science Technology & Engineering. Volume 3; Issue 11; May 2017. Here a review of foam concrete with its behavior with fibre reinforcement is discussed.
3. "Properties of lightweight foam concrete with the inclusion of fibres", Muhammad Hafiz Bin Ahmad,2015.
4. "Classification of literatures on foam concrete related to its constituent materials, mix proportioning, production and fresh state & hardened properties". Ramamurthy et al.(2009). By controlling the dosage of foam, various rages of densities of foam concrete can be obtained and can be used for the purpose of construction, partition, insulation and filling.

MATERIALS & METHODS

I. PROPERTIES OF FIBRES

PROPERTIES	Glass	Polypropylene	Polyester	RHA	CCA
Tensile Strength (Mpa)	1200–1700	550–700	27	38	27-35
Modulus (GN/m^2)	73.5	3.5–6.8	9.2		23
Elongation (%)	-4.8	21	45	15	12
Density (g/cc)	2.57	0.92	1.37	1.98	1.56
Coefficient of Thermal Expansion (107/ºC)	50-52.0	72-90	124	110	78

II. MIX DESIGN

Various research papers were taken as reference to arrive at this mix design.

A. Cube

Size of cube = 150X150X150 mm
No of cubes to be cast = 9 nos
Volume of foam concrete 9 X 0.15 X 0.15 X 0.15 = 0.033 /m3
Foam concrete mix ratio taken as per m3 as
Cement = 450 kgs,
Fly Ash = 411 kgs,
Water = 343 ltrs/m3
Now, the total quantity required for foam concrete = 0.033 m3
Given the required volume.
The amount of
Cement = 14.8 Kgs, Fly ash = 13.5 Kgs, Water = 11.3 ltrs
Adding 20% wastage.
There would be wastage due to the mixing of cement and flyash and also due to wind. Adding 10% wastage was tried but the quantity differed. Hence 20% is adopted in this case.
Cement = 17.76 Kgs, Fly Ash = 16.2 Kgs, Water = 13.5 ltrs
Wet density of water cement mixture = 1870 Kgs/m3
Adding 500gms of foam
The wet density of water cement ratio reduces to 1340 Kgs/m3
Fiber added in the ratio of 0.15%, 0.30% and 0.50% are 2.5, 5, 7.5 grams respectively
Hence, the mix ratio of foam concrete will be 1:0.925:0.75.

Fig1. Casting of foam concrete cubes

B. Beam w/o reinforcement

Beam dimension- 600x100x100 (mm)
Total Beams = 36 Nos.
Total quantity of Materials = 36x0.6x0.1x0.1
= 0.216m3
Cement=450 X 0.216 => 97.2 Kg
Fly Ash=411 X 0.216 => 88.2 Kg
Water=343 X 0.216 => 75 litres.
Adding 20% wastage
Cement =116.64 Kg

Fly Ash =105.84 Kg
Water =90 litres.
% of Fibre Added:
0.15 % of Cement => 17.49 Kg
0.30 % of Cement => 34.98 Kg
0.50 % of Cement => 58.32 Kg

Fig2. Casting of foam concrete beams using glass fibre.

III. TESTING OF FOAM CONCRETE

A. Compressive strength

As per IS 3495 part 1 1992,
Compressive Strength(N/mm^2)=Load/Area
Experimental analysis has shown that compressive strength of foam concrete can be improved greatly with the use of the right fibre in the right proportions

B. Flexural strength

As per IS 456,
Flexural strength = 0.7 $\sqrt{fck}$ N/mm^2
Where f_{ck} is the characteristic strength of concrete in N/mm^2

C. Water absorption

Here the testing specimen is completely immersed in water at room temperature for 24hours. Specimen is weighed. Then removed from water and placed on a wire mesh for 1 min and is weighed again.
After this, all the specimen are oven dried at 100®c to 115®c for a minimum of 24hours.
As per IS 3495 part 2 1992,
Water absorption, %=((A-B)/B)*100
Where,
A= wet mass of block, in kg
B=dry mass of block, in kg

D. Dry density

Here the density of foam concrete block is determined by
Density= weight of block/ volume of block.

Statistical Analysis

The experimental study has resulted in achieving the below graphs. The graphs were obtained with test sample blocks of about 288 cubes for compressive strength and 128 beams for flexural strength.

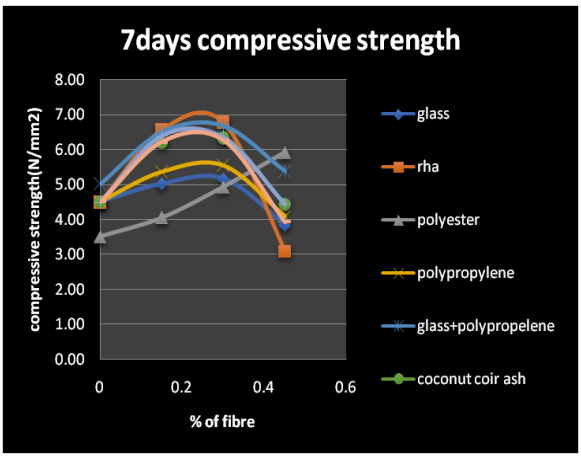

Fig. 3. Comparison of compressive strength of foam concrete block with fibres in 7 days

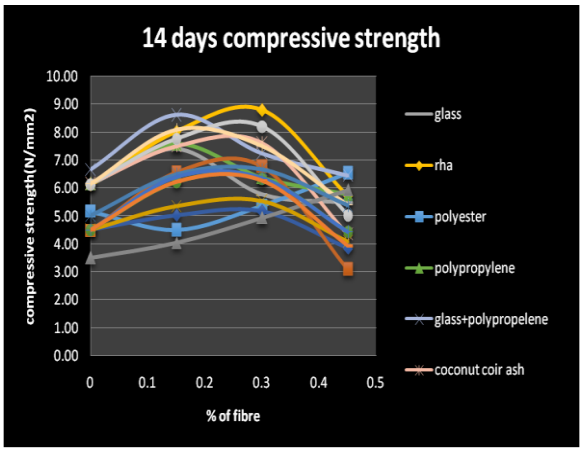

Fig. 4. Comparison of compressive strength of foam concrete block with fibres in 14 days

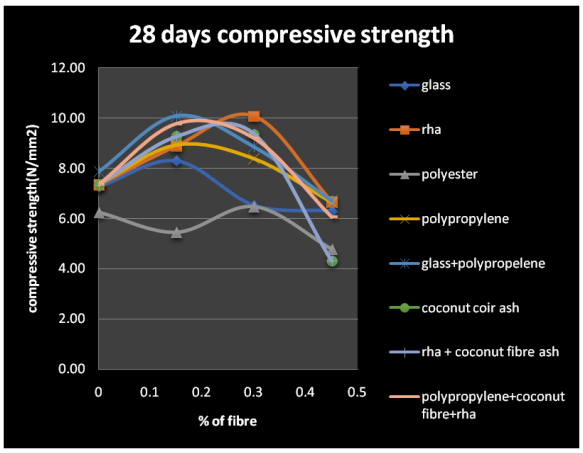

Fig. 5. Comparison of compressive strength of foam concrete block with fibres in 28 days

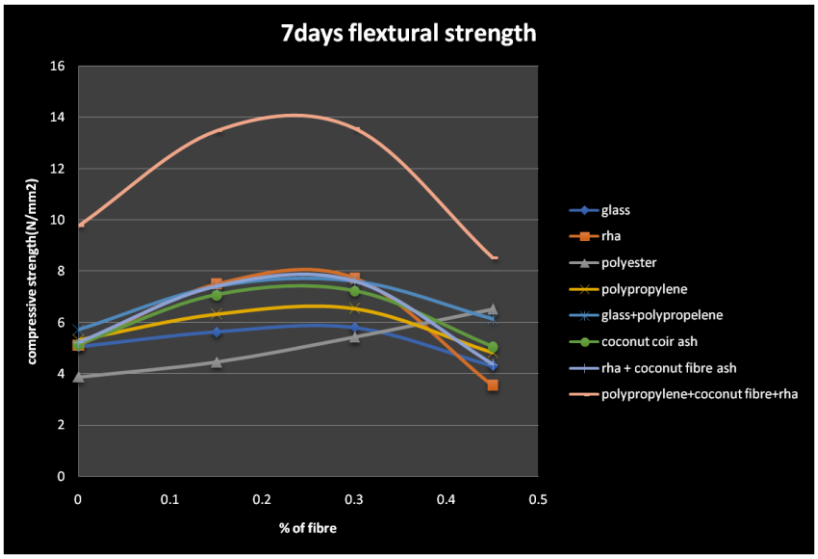

Fig. 6. Comparison of Flexural strength of foam concrete block with fibres in 7days

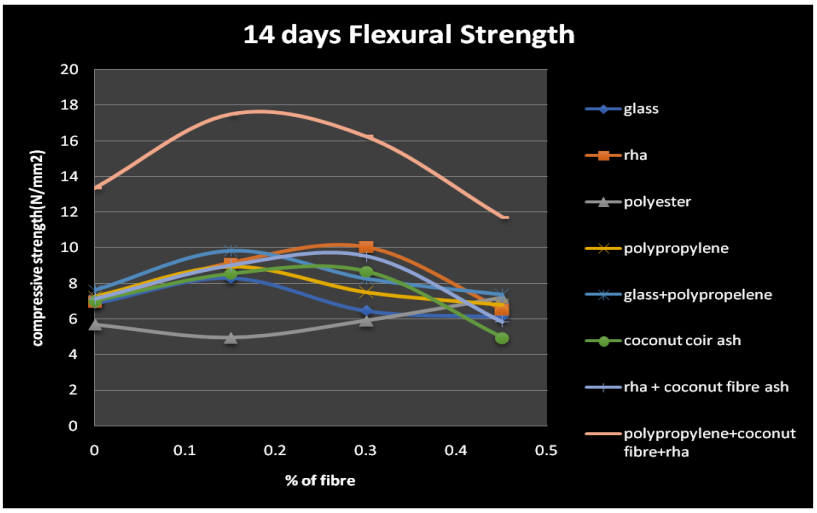

Fig. 7. Comparison of Flexural strength of foam concrete block with fibres in 14 days

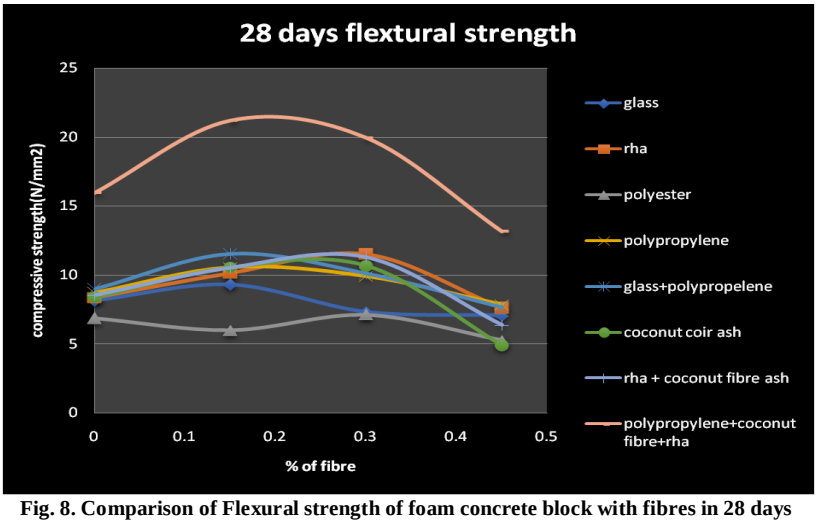

Fig. 8. Comparison of Flexural strength of foam concrete block with fibres in 28 days

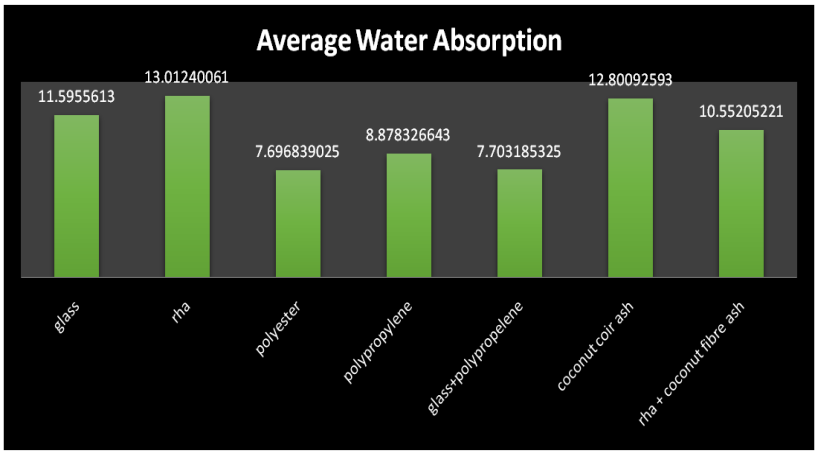

Fig. 9. Comparison of water absorption of foam concrete with fibres

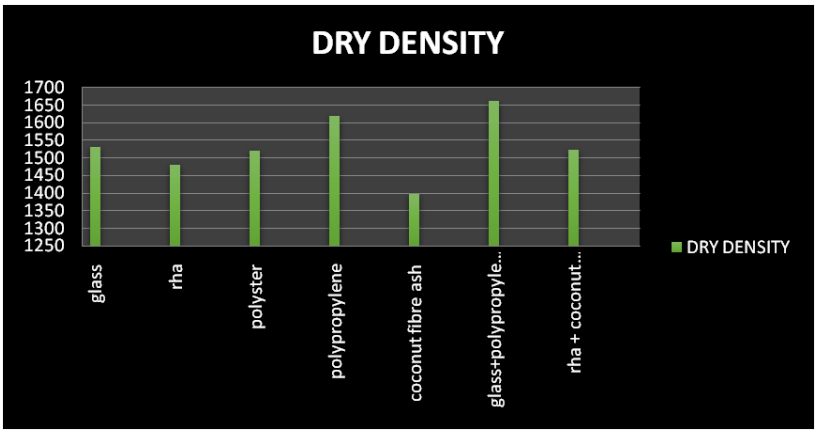

Fig. 10. Comparison of dry density of foam concrete using fibres.

DISCUSSION

From the above graph, it's evident that the test results were different for each fiber and various ratios.

1. From the graphs, it is evident that the compressive strength is the greatest for the cube with glass fiber at .15% and RHA at .30% and the lowest for polyester fiber.
2. The compressive strength of high performance foamed concrete increased with the increase of glass fibers percentages in the mixes but when the addition of glass fibers more than 0.5% will decrease the workability. For mixes without superplasticizer the best glass fibers percentages used are 0.15 and 0.30% , and for mixes with superplasticizer the best percentage is 0.5%.
3. While testing for flexural strength, From these graphs its evident that the maximum flexural strength is obtained for the combination of polypropylene, coconut fibre and RHA and is the maximum at .30%.
4. From the graph it is clear that the maximum water absorption capacity is possible foam concrete with coconut coir ash and RHA which seem to have almost similar values.
5. It is evident that dry density is the greatest for foam concrete with glass and polyprolylene and the least for foam concrete coconut fibre ash.
6. With the use of fibres with foam concrete, the compressive and flexural strength increases to certain extend. Thus a combination of polypropylene with coconut coir ash and rice husk ash can be the best additive to foam concrete at .30%.

CONCLUSION

With this study, we conclude that this is just the beginning of the

experimentation with fibres on foam concrete and with elaborate study and work, foam concrete can definitely be used as a strong construction material in the near future in high rise buildings and skyscrapers. Use of polyester is completely a failure and it is pointless to try working further with polyester on foam concrete.

Though foam concrete takes upto twice the quantity of cement in the making, it reduces labour cost and erection cost and also reduces load which will thereby result in the overall economy of the structure.

REFERENCES

- Mix design, EABASSOC Lightweight Foamed Concrete Agent, (Made in U.K.), Standard Waterproofing Engineers Co., Ltd
- Shah Surendra and Rangan (1994),"Effect of Fiber addition on concrete strength", Indian Concrete Journal
- A Review on Fiber Reinforced Foam Concrete, IJSTE - International Journal of Science Technology & Engineering. Volume 3; Issue 11; May 2017
- Production of foamed concrete with a method of mixing, Norasyikin ht. Md. Yusof
- Strength properties of polypropylene fiber reinforced concrete, Kolli. Ramujee International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, Issue 8, August 2013
- Tensile and Flexural Strengths of Coconut Shell Particle & Coir Fibre Reinforced Composite, Vinay K Singh and Jitendra Bhaskar, January 2013
- Rice husk ash blended cement: Assessment of optimal level of replacement for strength and permeability properties of concrete, K.Ganesana,K.Rajagopala,K.Thangavel
- Valore RC. (1954). Cellular concrete part 1 composition and methods of production, ACI j;50:773-96.
- Valore RC. (1954). Cellular RC, Cellular concrete part 2 physical properties. ACI J;50:817-36.
- Rudnai G. (1963). Lightweight concretes. Budapest, Akademikiado
- Van Deijk. Foam concrete. Concrete, July/August 1991, pp 49–54.
- "Aerated Concrete, Lightweight Concrete, Cellular Concrete and Foamed Concrete". litebuilt.com. Retrieved 12 September 2015.
- British Cement Association, Foamed Concrete Composition and Properties, British Cement Association, 1994.
- LithoPore™ Foamed Concrete Luca Industries International GmbH, Retrieved on 22 January 2015
- "Aerated Concrete, Lightweight Concrete, Cellular Concrete and Foamed Concrete". litebuilt.com. Retrieved 12 September 2015.
- Ecowall Project, Retrieved on 22 January 2015
- LithoPore Foam Concrete 75 – 150 Kg/m³ Luca Industries International GmbH, Retrieved on 29 March 2016
- LithoPore True Technology Luca Industries International GmbH, Retrieved on 29 March 2016
- IS 383-1970 Specification for coarse and fine aggregate from natural sources for concrete (second revision), BIS, New Delhi
- IS 456:2000 Plain and reinforced concrete-Code of practice(fourth revision),BIS, New Delhi
- IS :2185 (Part 4) 2008 Concrete masonry units- Specification Performed foam concrete blocks, BIS, New Delhi
- IS 3346-1980 Method for determination of thermal conductivity of thermal conductivity of thermal insulation materials (two slab guarded hotplate method) first revision.

How to cite this article: Deborah PJJ, Kotteswaran. Study on properties of foam concrete using fibers. International Journal of Research and Review. 2018; 5(5):187-192.

******