EVALUATION OF COMPRESSIVE STRENGTH OF BLENDED FOAMED CONCRETE

[1]K Krishna Bhavani Siram
[1]Assistant Professor,
[1]Civil Engineering Department,
[1]Mahatma Gandhi Institute of Technology, Hyderabad, India.

Abstract: Foamed concrete is an inexpensive, sustainable product with competence as promising construction material. FC has become popular due to its varying densities enabling dead load reduction, leading to saving in substructure construction. The quantity of foam included in the cement slurry is the principal source of the density of foam concrete. Twelve mixes of different densities (400kg/m^3, 700kg/m^3 and 1000kg/m^3) with/without additives (fly ash, silica fume and polypropylene fiber) are casted and tested for compressive strength at age of 28 days. The SF and FA are replaced at a level of 15% and PPF is included at a volume fraction of 0.45. Tests were conducted on cubical specimens for different mix combinations and compared with control FC. The foam concrete strength declines with reducing density. The experimental results reveal an enrichment in the compressive strength with addition of polypropylene fibers. In addition, the compressive strength is improved with addition of fly ash and silica fume.

Index Terms **- Foamed Concrete (FC), Cellular Light-weight Concrete (CLC), Polypropylene fiber (PPF), Fly ash, Silica fume**

I. INTRODUCTION

Foamed concrete (FC), otherwise said to be CLC (Cellular Light-weight Concrete) has come into limelight with its eco-friendly and cost-saving techniques. The accelerated demand in the construction merged with sustainability has led foamed concrete gain its prominence. The potentiality of FC varies from providing sound and thermal insulations, and also for load-bearing structures by means of density ranging from 400 to 1800 kg/m^3. This density property is governed by addition of foam into cement slurry, with and without aggregates. From the viewpoint of materials, CLC is diversified to conventional concrete with no coarse aggregates, thereby generating the lightweight property to it. The reduced load by virtue of its regulated self-weight and its exceptional self-flowability, self-compactability properties has made foam concrete as renowned construction material, particularly in underground engineering. This contribution is due to the foam developed utilizing foam generator and then mixing it with cement slurry. Fiber addition does not modify the insulation properties of FC but improves its compressive strength. FC supports in utilization of waste disposal from thermal power plants by substituting cement with fly ash. With an escalation in environmental concerns, foamed concrete can be suggested as an option fulfilling sustainability criteria. Similarly, disposal of silica fume, which is by-product of electric arc furnace, can be hazardous causing environmental concern. These waste products, fly ash and silica fume can become an added advantage to the construction industry due to their pozzolanic properties. The primary purpose of this study is to investigate the compressive strength of FC for different density ranges excluding and including addition of fibers and pozzolanic materials.

II. MATERIALS

Cement: -

53 grade ordinary Portland cement is used for the all the specimens casted to conduct the experiment.

Foaming agent: -

Foamed concrete can be produced by two methods. (a) Pre-foaming (b) Mixed-foaming. The available foams have two sources (a) Protein based (b) Synthetic based. In this study, protein-based foam is adopted and foam concrete is prepared using pre-foaming method.

Water: - Water used in the conduct of experiment is normal drinking water.

Binders: - Fly ash and Silica fume are used in different mixes as binders.

(a) **Fly ash: -** Class F fly ash from Ramagundam thermal power plant is used.

(b) **Silica Fume (SF): -** The used SF is manufactured by Sika. It is an extremely fine black greyish pozzolanic powder whose particle size is almost less than 1µm.

Polypropylene fibers (PPF): - It is a light-weight synthetic fiber whose specific gravity is 0.90

Table – 1: Specific Gravity of materials used

Materials used	Specific Gravity
Cement	3.11
Foaming Agent	0.97
Flyash	2.10
Silica Fume	2.21
Polypropylene fibers (PPF)	0.90

III. MIX DESIGN

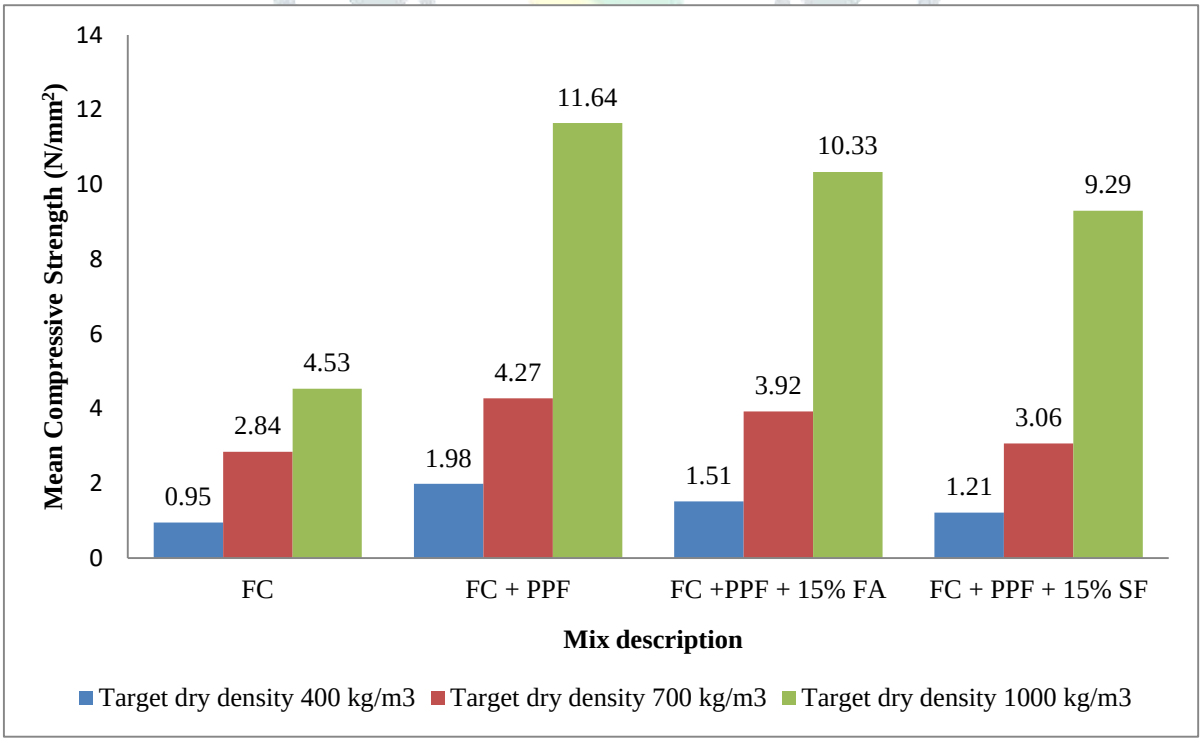
Standard method of mix design is not available for foamed concrete. The proportion of the mixes is preferred based on the density requirement. While the foam concrete mix proportions are finalized, the target density, water-binder ratios are considered. The fly ash or other pozzolana-cement ratios, the fiber volume fractions are also to be planned for, if applicable.

IV. EXPERIMENTAL PROGRAMME

There are three modules in the study carried out. In the first one, plain foam concrete prepared using cement, foaming agent and water is mixed with PPF. In the second section, 15% flyash replacing cement, is also included as an ingredient along the basic constituents of FC and PPF. In the third module, 15% of Silica fume replaces cement and is thoroughly mixed with plain PF and PPF. Cubes were casted and tested for all the three segments for varying target dry densities as 400kg/m^3, 700kg/m^3 and 1000kg/m^3. The water binder ratio used in the study is kept constant as 0.35 and the volume fraction of polypropylene fibers is maintained as 0.45 for all the cases. Cubical specimen of size 150 mm is casted and examined for compressive strength on the 28th day as an average of three specimens.

Table 2: - Mean Compressive Strength at 28 days

Mix parameters	Mix Description	Target Density	Mean Compressive Strength (N/mm^2)
FC	FC-400	400	0.95
	FC-700	700	2.84
	FC-1000	1000	4.53
FC + PPF	PF-400	400	1.98
	PF-700	700	4.27
	PF-1000	1000	11.64
FC + PPF + 15% FA	FAPF -400	400	1.51
	FAPF-700	700	3.92
	FAPF-1000	1000	10.33
FC + PPF + 15% SF	SFPF-400	400	1.21
	SFPF-700	700	3.06
	SFPF-1000	1000	9.29



Graph 1: - Mean Compressive Strength at 28 days

V. CONCLUSIONS

1. The density of FC is altered by the quantity of foaming agent in the mix.
2. Reduction in density of FC drops the value of its compressive strength.
3. Compressive strength enhances with incorporation of polypropylene fibers.
4. When Silica fume replaces cement, there is an improvement in the compressive strength but marked improvement may be obtained in the long run due to its pozzolanic effect.
5. The strength improvement with addition of fly ash is evident in higher density FC. This is because the volume of foam regulates the strength of FC.
6. There is a minimal reduction in the compressive strength by addition of 15% fly ash and 15% silica fume to FC + PPF concrete.

VI. ACKNOWLEDGEMENT

My sincere thanks to Nanolite Infratech Pvt. Ltd., Hyderabad, for their support in carrying out the experimentation work in their factory.

REFERENCES

[1] Mugahed Amran, Y.H.; Farzadnia, N.; Abang Ali, A.A., 2015. Properties and applications of foamed concrete - a review. Constr. Build. Mater., 101, 990–1005.
[2] Guo, Y. S., Kimura, K. Li, M. W., Ding, J. T., and Huang, M. J.,2000, 'Properties of High Performance Lightweight Aggregate Concrete', International Symposium on Structural Lightweight Aggregate Concrete, No. 2, pp. 548-561.
[3] Dawood, E. T., and Ramli, M., 2011. High strength characteristics of cement mortar reinforced with hybrid fibres, Construction and Building Materials 25, 2240–2247.
[4] K. Ramamurthy, E.K. Nambiar, G.I.S. Ranjani, 2009. A classification of studies on properties of foam concrete, Cem. Concr. Compos. 31 (6), 388–396.
[5] F. Zulkarnain, M. Ramli, 2011. Rational proportion for mixture of foamed concrete design, J. Teknol.55(1) 1–12.
[6] H., S. Karl, 1980. Structural lightweight aggregate concrete with reduced density-lightweight aggregate foamed concrete, Int. J. Cem. Compos. Lightweight Concr. 2 (2) 101–104.
[7] S. Van Deijk, Foam concrete, Concrete (1991) 49–53.
[8] IS 2185(Part 4): 2008 –Concrete Masonry Units –Specification., Part 4- Preformed foam cellular concrete blocks
[9] K. Krishna Bhavani Siram, 2013. Foam Concrete – The present generation's building solution, International Journal of Civil, Structural, Environmental and Infrastructure Engineering, Vol. 3, Issue 4, 59-62.
[10] D. Falliano, D. De Domenico, G. Ricciardi, E. Gugliandolo, 2018 Experimental investigation on the compressive strength of foamed concrete: effect of curing conditions, cement type, foaming agent and dry density, Constr. Build. Mater. 165, 735–749.
[11] Valore, R.C. (1954). Cellular concrete part 1 composition and methods of preparation, Journal Proceeding of American Concrete Institute, 50(5), 773-796.
[12] Kim, Y.J.; Hu, J.; Lee, S.J.; and You, B.H. 2010. Mechanical properties of fiber reinforced lightweight concrete containing surfactant. Advances in Civil Engineering, Article ID 549642, 1-8.
[13] Bentur, A.; Mindess, S. Fibre Reinforced Cementitious Composites; CRC Press: Boca Raton, FL, USA, 2006.
[14] K. Krishna Bhavani Siram, 2012. Cellular Lightweight concrete blocks as a replacement of burnt clay bricks, Intl. J. Eng. Adv. Technology, vol 2, no 2, pp 149 - 151
[15] Amran, Y.H.M. 2020. Influence of structural parameters on the properties of fibred-foamed concrete. Innov. Infrastruct. Solut. 5, 16.
[16] Kearsley EP.1999. Just foamed cement – an overview. In: Dhir RK, Handerson NA editors., " Specialist techniques and materials for construction", London:Thomas Telford; (37–227),