



## A Study on Mechanical Properties of Fly Ash Based Concrete with the Addition of Glass Fibre

Authors

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### Abstract

*The present day world is going through the construction of very innovative and unsymmetrical engineering structures. Glass fibre is a material consisting of numerous extremely fine fibers of glass. Quite often, concrete possess very high flexural and shear strength properties. Researchers all over the world are attempting to develop high performance concretes by using various fibres and other admixtures in concrete up to certain proportions with low water-cement ratio. Glass-fibre reinforced concrete (GRC) is a material made of a cementitious matrix composed of cement, sand, water and superplasticizers, in which short length glass fibres are dispersed. It has been widely used in the construction industry till now for non-structural elements, like thin slab panels, piping and roof tiles ..etc. GRC offers many advantages, such as being lightweight, fire resistance, good appearance and strength. To increase the applications of Glass Fibre Reinforced High-Performance-Concrete (GFRHPC) in India, greater understanding of GFRHPC produced with locally available materials and indigenously produced mineral admixtures is essential. The present study includes testing of concrete cubes with different glass fibre proportions for its strength correspondingly at 28 days.*

**Keywords** –glass fibres, admixtures , fly ash , concrete.

### Introduction

During the last few decades, some cement companies have started using fly ash in manufacturing cement, known as 'Portland pozzolana cement' (PPC). The use of fly ash in concrete is found to affect resulting strength characteristics adversely at early age. One of the ways to compensate for the early-age strength loss associated with the usage of fly ash is by incorporating fibres, and designing the mix with less w/c ratio which have been proved very efficient in enhancing the strength characteristics of concrete. The addition of fibres to concrete considerably improves its structural characteristics such as flexural strength, compressive strength, tensile strength. Fibre reinforced concrete contains short discrete fibres that are uniformly distributed and randomly oriented. Fibres include steel fibres, glass fibres, synthetic fibres and natural fibres each of which lend varying properties to the concrete. The hybrid combination of metallic and non-metallic fibres can offer potential advantages in improving concrete properties.

Basically fibers can be divided into following two groups

1. Fibers whose moduli is lower than the cement matrix such as cellulose, nylon, glass fibre
2. Fibres with higher moduli than the cement matrix such as asbestos, steel etc.

Fibres having lower modulus of elasticity are expected to enhance strain performance whereas fibres having higher modulus of elasticity are expected to enhance the strength performance of concrete in shear and tension. The character and performance of HFRC changes depend on the properties of concrete and the fibers. The properties of fibers that are usually of interest are fiber concentration, fiber orientation, and fiber distribution

and aspect ratio which is the ratio of its length to diameter. Using a single type of fiber may improve the properties of FRC to a limited level.

The use of optimized combinations of two or more types of fibres in the same concrete mixture can produce a composite with better engineering properties than that of individual fibres, steel fibre, which is stronger and stiffer, improves the first crack strength and ultimate strength, while the glass fibre, which is more flexible and ductile, leads to improved toughness and strain capacity in the post cracking zone.

It has been shown recently that by using the concept of glassization with two different fibers incorporated in a common cement matrix, the glass composite can offer more attractive engineering properties because the presence of one fiber enables the more efficient utilization of the potential properties of the other fiber.<sup>[1]</sup>

## Materials

**Cement:** OPC 53 grade conforming to IS 12269-2013.

**Coarse aggregate:** The crushed aggregate of 20 mm down size, from nearby quarry were used.

**Fine aggregate:** locally available natural river sand from bhima river of maximum size 4.75mm.

**Fly ash:** class F fly ash from raichur thermal power plant.

**Superplasticizer:** SP conplast 430

**Glass fiber:** E type glass fibre.

## Methodology

The concrete mix was designed for M30 grade as per IS 10262-2009 and workability test were performed because low w/c ratio of 0.44 and appropriate dosage of superplasticizer was adopted. Workability is carried out by conducting the slump test and compaction factor test as per IS 1199-2018

Compaction factor test is the workability test for concrete conducted in laboratory. The compaction factor is the ratio of weights of partially compacted to fully compacted concrete. It was developed by Road Research Laboratory in United Kingdom and is used to determine the workability of concrete.

The compaction factor test is used for concrete which have low workability for which slump test is not suitable.

**Compressive strength:** The concrete cube samples of 150x150x150 mm size were casted and cured and tested for 28 days.

**Split tensile strength:** The cylinders of size 150 mm dia and height 300mm were tested

**Flexural strength:** The prism beam of dimension 100x100x500 mm were tested in UTM machine for corresponding strength in flexure.

## Mix Proportions

The mix proportion of M30 design as per IS 10262-2009 is 1:2.2:3.10 for w/c ratio 0.44 and variations for constituents is done as below for studying the result analysis

	Fly ash	Glass fibre	Superplasticizer
M30	0%	0%	4%
M1	10%	0.8%	4%
M2	20%	1.8%	4%

## Results and Discussions

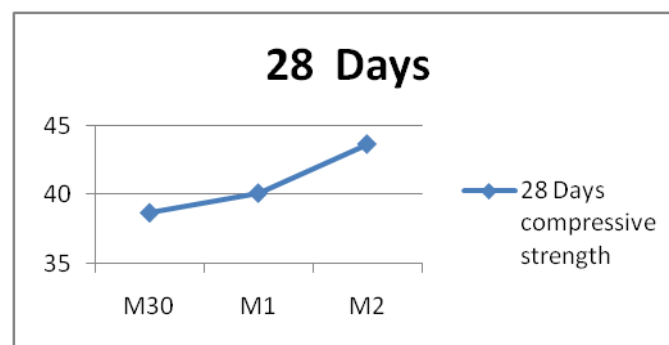
The workability of different concrete mixes has shown a decline in compaction factor from 0.97 to 0.85, since the percentage of fibre has been increased from 0.80 to 1.80%. Also it was observed that slump value was obtained less than 100 mm because the concrete mass was stiff and sticky and addition of fibre as well as lower water content depicted initially that water was absorbed by fly ash and superplasticizers loosens the fine particles for effective utilization of water. Overall nature of concrete was self compacting type but required

manual tamping due to the presence of fibres and to overcome the slump loss, so that lumps wouldn't be formed and concrete takes the shape of the mould.

The below results further explain that compressive strength values are satisfying with reference to M30 concrete and flexural capacity results achieved are more than conventional M30 due to less drying shrinkage and moisture loss and crack formation.

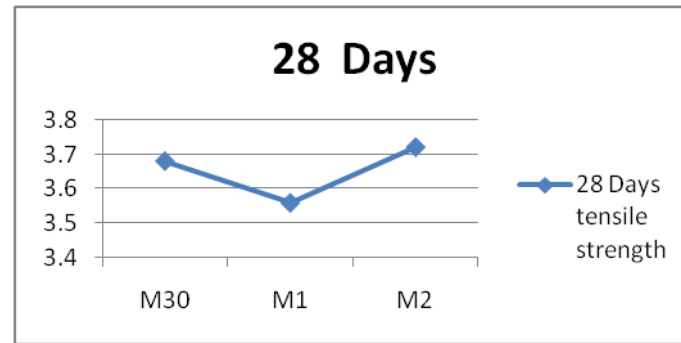
### Compressive strength

sample	Mix	% fibre	Compressive strength at 28 days (N/mm <sup>2</sup> )	Average compressive strength (N/mm <sup>2</sup> )
1	M30	0%	39.11	38.71
2			40.40	
3			36.62	
1	M1	0.8%	39.90	40.14
2			40.17	
3			40.35	
1	M2	1.8%	44.84	43.70
2			43.91	
3			42.40	



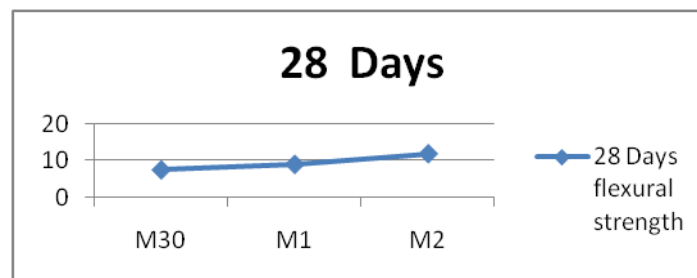
### Split Tensile Strength:

sample	Mix	% fibre	Tensile strength at 28 days (N/mm <sup>2</sup> )	Average tensile strength (N/mm <sup>2</sup> )
1	M30	0%	3.39	3.68
2			3.77	
3			3.89	
1	M1	0.8%	3.82	3.56
2			4.07	
3			2.80	
1	M2	1.8%	3.68	3.72
2			3.40	
3			4.10	



### Flexural strength:

sample	Mix	% fibre	flexural strength at 28 days (N/mm <sup>2</sup> )	Average flexural strength (N/mm <sup>2</sup> )
1	M30	0%	7.30	7.51
2			8.10	
3			7.15	
1	M1	0.8%	9.72	9.01
2			9.23	
3			8.08	
1	M2	1.8%	11.61	11.91
2			11.27	
3			12.85	



### Conclusion

The experimental study of fly ash based concrete shows the resulting loss of workability and minimum required slump value. It is further necessary to conclude that by using low aspect ratio fibre and changing the type of fibre with lower moduli fibre, the above difficulty could be eliminated. The compressive strength, tensile and flexural strength achieved is much considerable and almost 40% more than designed value for M2 and 1.8% fibre bath mix. The superplasticizer has played a major role for 4% dosage level, in future studies optimum dosage can be obtained for economy and fibre can be used in combination of steel fibre or carbon fibre for high strength and high performance level concrete. The less early strength of fly ash replacement can also be tackled by restricting maximum replacement of cement to < 20%.

### References

1. Muntadher Ali Challob, VikasSrivastava (Effect of Fly Ash and Steel Fibre on Portland Pozzolana Cement Concrete) International Journal of Engineering Trends and Technology (IJETT) – volume 5 number 3 - Nov 2013.

2. Parveen ,Ankit Sharma(Structural Behaviour of Fibrous Concrete Using GlassFibres) International Journal of Modern Engineering Research (IJMER) www.ijmer.com Vol.3, Issue.3, May-June. 2013 pp-1279-1282 ISSN: 2249-6645.
3. Dhillon, Ramandeep, Sharma, Shruti and Kaur, Gurbir.(EFFECT OF STEEL AND GLASS FIBRES ON STRENGTH CHARACTERISTICS OF FLY ASH CONCRETE) International Journal of Research in Advent Technology, Vol.2, No.3, March 2014 E-ISSN: 2321-9637.
4. Vikrant S. Vairagade\*, Kavita S. Kene (Experimental Investigation on Glass Fiber Reinforced Concrete) International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 2, Issue 3, May-Jun 2012, pp.1037-1041
5. Khadake S.N. ,Konapure C.G.(An Investigation of Steel Fiber Reinforced Concrete with Fly Ash) *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*ISSN: 2278-1684 Volume 4, Issue 5 (Nov-Dec. 2012), PP 01-05.
6. MarijanSkazlić(Development and Application of GlassFibre Reinforced Concrete) Coventry University and The university of Wisconsin Milwaukee Centre for By-products Utilization, second international conference on Sustainable Construction Materials and Technologies June 28 – June 30, 2010, UniversitaPolitecnicadella Marche, Ancona, Italy.Main Proceedings ed. J Zachar, P Claisse, T R Naik, E Ganjian. ISBN 978-1-4507-1490-7.
7. IS 8112-1939 , “Specification for Cement”,Bureau of Indian Standards, New Delhi.
8. M.S.Shetty, “Concrete Technology Theory and Practice” S Chand company limited , New Delhi .