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Glass Fiber Reinforced with Partial Replacement of Cement with Fly Ash

Hifzurrahman
Student
Al Falah University Dhauj, Faridabad
Haryana
asif.3621@gmail.com

Zeeshan Khan
Assistant professor
Al Falah University Dhauj, Faridabad
Haryana
Zeshu93@gmail.com

Mirza Aamir Baig
Associate professor
Al Falah University Dhauj, Faridabad
Haryana
aamirmirzagarri@gmail.com

Abstract: Concrete is one of the most widely used construction material in today's world. Cement is one of the essential constituents of the concrete. Environmental issues are also playing a vital role in today's world, the production of cement one of the major constituent of concrete leads to release the of a significant amount of carbon dioxide a greenhouse gas contributing 7% of greenhouse gas emission to the earth atmosphere, beside deforestation and burning of fossil fuels. Safe disposal of glass waste generated in day to day life due to limited life span and after use, it is either stockpiled or sent to landfill is also a challenging task. There is now a significant worldwide interest to solve the environmental problem caused by industrial waste and other material by including such material in the manufacture of concrete. The effort has been made in the concrete industry to use waste glass in concrete production not only provide significant environmental benefits but also enhances performances of concrete when used in optimum amounts. IN this study, glass fibers in different volume fraction with 20%, 30% and 40% replacement of cement by fly ash have been to study the effect on compressive strength, split tensile strength, of concrete and compared it to the conventional concrete. For each mix standard sizes of cubes, cylinders and as per Indian Standards were cast and tested for compressive strength and split tensile strength at age of 28days.

Keywords: Glass fiber, Concrete, Fly ash, Compressive Strength, Tensile Strength.

INTRODUCTION

Cementitious materials in the form of mortars or concretes are used as construction material since they are cheap, durable and have adequate compressive strength and stiffness for structural use. Due to its very low tensile strength and low ductility, it cannot be used directly for structures. Concrete is probably the most widely used man-made construction material in the world. Also, any type and shape of the component of the structural member can be fabricated when the concrete is green either in a factory or at the place of casting.

Fibers prevent micro cracks from widening. The addition of fibers makes components ductile and tough. Conventional concrete cracks easily. When concrete is reinforced with randomly dispersed fibers, we get favorable behavior for repeated loads. Advanced cement based materials and improved concrete construction techniques provide opportunities for the design of structures to resist severe load resulting from earthquakes, impact, fatigue, and blast environments.

In the case of the structure of odd shapes, it is very difficult to ascertain the proper placement of reinforcements however, this problem does not arise in the case of fiber reinforced concrete and also the progress of work can be achieved at much faster rate. FRC is very ductile and particularly well suited for structures which required to exhibit:

•Shrinkage control of concrete:

- High thermal resistance
- Resistance to impact, blast and shock loads and high fatigue
- Resistance to seismic hazards.
- The degree of improvement
- Very high flexural, shear and tensile strength

The advantage of using fly ash is obvious. Fly ash is a by-product of coal burning in power plants, its utilization saves the energy required to produce the cement.

The objective of this study:

- The unit cost of concrete can be reduced by partial replacement of cement with fly ash.
- To obtain the properties of ingredients of concrete including fly ash and glass fiber.
- To study the mechanical properties.
- To compare the result.

2. LITERATURE REVIEW

1. Yogesh Iyer Murthy The experimental work dealt with the use of glass fiber in concrete which was obtained from the glass industry as a waste product. It was found that the compressive strength of concrete did not increase much but the flexural strength showed almost 30% increase in strength. The slump value found to be decreased with increase in fiber content. It was found that the use of fiber glass in concrete not only improved the properties of concrete but also small cost cutting.

2. KRENCHEL (1974) studied the effect of randomly distributed glass fibers on the flexural strength, compressive strength, tensile strength and young's modulus of elasticity of the material. He concluded that as the fibers content increases, the strength increases showing optimum strength at 0.75% reinforcement by weight. Related your research work Content related your research work

3. MUZHIR S.M, NAVI S.Q.A, QADEER ASLAM AND ISRAIL MOHD. (1996) The present study on FRC as an alternative to timber for the door, window frames and beams as the environmentalists are aware of the afforestation. In view of keeping ecology in balance, the FRC can be used as a good alternative to building material.

4. Topçu and Canbaz (2007) demonstrated through experiments that the addition of fibers provide better performance for concrete, while fly ash in the mixture may adjust the workability and strength losses caused by fibers, and improve strength gain. The results are based on experimental investing at ions in which co nor e t e was produced with three different replacement ratios of fly ash and three different types of steel and polypropylene fibers.

5. R. Satheesh Raja, et al. This paper describes the mechanical behavior of fly ash impregnated E-glass fiber reinforced polymer composite (GFRP). Initially, the proportion of fiber and resin were optimized from the analysis of the mechanical properties of the GFRP. It is observed that the 30 wt% of E-glass in the GFRP without filler material yields better results. Then, based on the optimized value of resin content, the varying percentage of E-glass and fly ash was added to fabricate the hybrid composites. Results obtained in this study were mathematically evaluated using Mixture Design Method. Predictions show that 10 wt% addition of fly ash with fiber improves the mechanical properties of the composites.

3. METHODOLOGY

The stated procedure with utmost precision in this study. All the material required were collected and their various properties (i.e. mechanical, chemical, physical etc.) were studied from different tile sources, in detail. After that M_{30} Grade of the concrete mix was design as per IS 456-2009 and IS 456-2000. In this paper, glass fiber in different volume fraction with 20%, 30% and 40% replacement of cement by fly ash has been used to study the effect on compressive strength, split tensile strength. The result was recorded (compressive strength, split tensile) at age of 28 days.

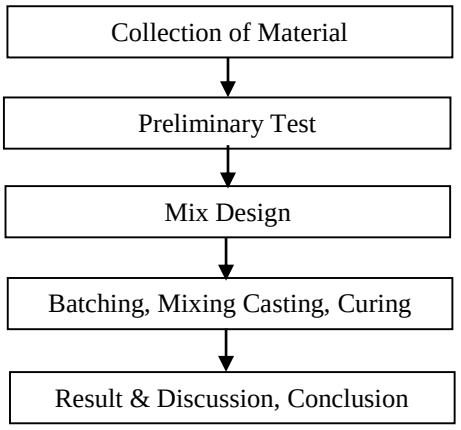

FIG 1: Experimental methodology

4. MATERIALS

CEMENT: The cement has been tested for the physical properties as per IS: 8112 standards.

Table 1: Cement Properties

S.No.	Description of Test	Test Results Obtained
1	Cement used	OPC 43 grade
2	Specific gravity of cement	3.15
3	Finesse (Sieve Analysis)	95% passing (90mm)
4	Standard Consistency	33%

FINE AGGREGATE

Table 2: Fine Aggregate Properties

S.NO.	Description of Test	Test Results Obtained
1	Specific gravity of fine aggregate	2.64
2	Water absorption of fine aggregate	0.80%
3	Grading of fine aggregate	Zone-II

COURSE AGGREGATE

Table 3: Coarse Aggregate Properties

S.No.	Description of Test	Test Results Obtained
1	Specific gravity of coarse aggregate	2.7
2	Water absorption of coarse aggregate	0.81%
3	Grading of coarse aggregate	2^{nd} grade
4	Aggregate Impact Value	26.33%
5	Crushing Value	22.56%

FLYASH

The fly ash was procured from National Thermal Power (NTPC) in Gautambudhnagar (U.P.)

Fineness of test fly ash : 8.4%

Specific gravity of fly ash : 2.55

Table 4: Chemical Properties of Fly Ash

Chemical	SiO_2	Al_2O_3	Fe_2O_3	Na_2O	MgO	CaO	SO_3
%	61.24	25	8.71	0.09	0.09	4.22	0.49

GLASS FIBER

Class E fiber was used. Fiberglass is an immensely versatile material due to its light, inherent strength, weather resistant finish,and variety of surface texture.

CONCRETE MIX PROPORTION

M_{30} Grade of concrete was adopted with water cement ratio of 0.40. The mixture was designed as per IS 10262-2009 and IS 456-2000.

CASTING & CURING

In this study, to achieve a target compressive strength of 30 MPa. Fly ash was used to replace ordinary Portland cement at varying percentage of 20%, 30% and 40% of cement. The E-Glass fibers of 1%, 1.5% and 2% by mass of cement were used.

Table 5: Concrete Proportion

S.NO.	MIX CODE	FLY ASH%	GLASS %
1	M30	0%	0%
2	F20G1	20%	1%
3	F20G1.5	20%	1.50%
4	F20G2	20%	2%
5	F30G1	30%	1%
6	F30G1.5	30%	1.50%
7	F30G2	30%	2%
8	F40G1	40%	1%
9	F40G1.5	40%	1.50%
10	F402	40%	2%

NOTE: The concrete mix code table describe the the mix proportion of the mix code**.**

RESULT AND SISCUSSION

The compressive strength & split tensile strength of concrete specimens was tested at 28 days .The values of compressive strength of mixes at 28 days are shown below in the Table.

TABLE 6: Value of Compressive strength & Split tensile strength for 28 days

Mix CODE	Sample No	Peak Load (KN)	Peak Stress	Average Compressive Strength	SPLIT TENSILE STRENGTHN(N/mm^2)	
M30	1	689.8	30.65	30.52	2.51	2.53
	2	670.5	29.8		2.67	
	3	700.2	31.12		2.42	

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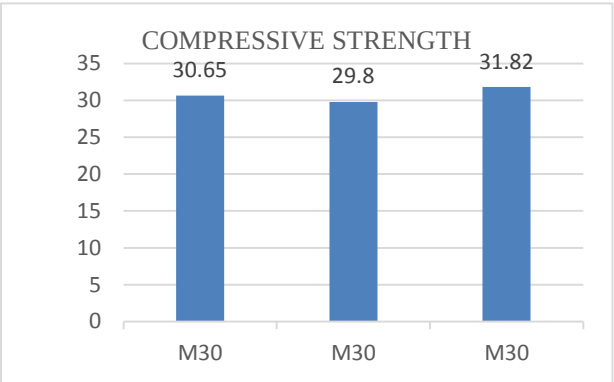

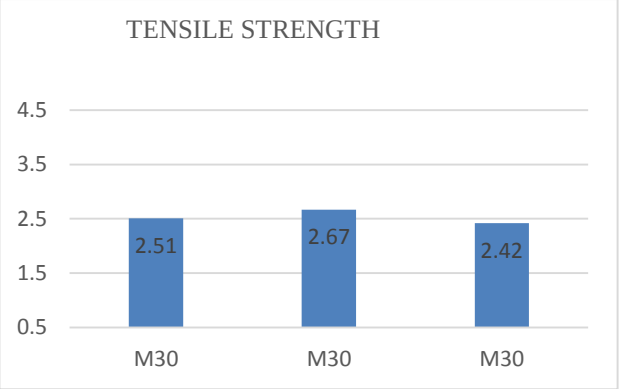

FIG 1: **Compressive strength value for 28 days.**

FIG 2: Tensile strength value for 28 days.

TABLE 7: Value of Compressive strength & Split tensile strength for 28 days

Mix CODE	Sample No	Peak Load (KN)	Peak Stress	Average Compressive Strength	SPLIT TENSILE STRENGTHN(N/mm^2)	
F20G1	1	642.8	28.56	28.89	3.11	2.97
	2	649.1	28.84		2.67	
	3	669.5	29.72		2.98	
F20G1.5	1	638.5	28.37	28.84	2.89	2.97
	2	644	28.62		2.96	
	3	664.8	29.54		3.07	
F20G2	1	643.1	28.58	29.78	3.82	3.75
	2	676.7	30.04		3.53	
	3	668.7	29.72		3.92	
F30G1	1	560.6	24.91	24.56	1.28	1.38
	2	532.1	23.64		1.37	
	3	565.9	25.15		1.51	
F30G1.5	1	547.4	24.32	25.26	1.71	1.81
	2	576.1	25.6		1.83	
	3	582.5	25.88		1.90	
F30G2	1	581.04	25.82	25.89	1.57	2.03
	2	590.9	26.26		2.03	
	3	576.3	25.61		2.08	
F40G1	1	410.06	18.22	18.53	.84	.98
	2	439.2	19.52		1.02	
	3	401.7	17.85		1.08	
F40G1.5	1	400.3	17.79	19.7	1.27	1.33
	2	460.1	20.44		1.28	
	3	470	20.88		1.44	
F40G2	1	456.3	20.28	20.97	1.55	1.66
	2	462	20.53		1.65	
	3	497.5	22.11		1.80	

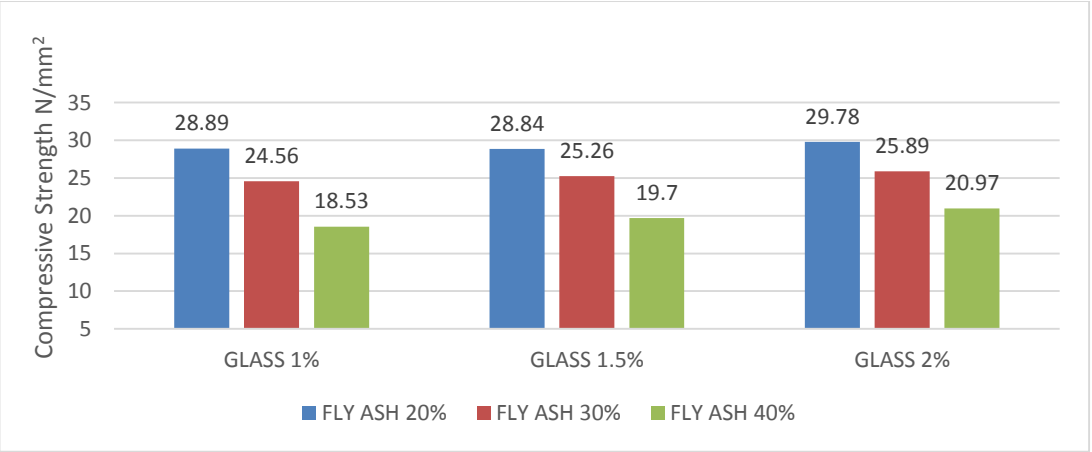

FIG 3: Compressive strength value for 28 days

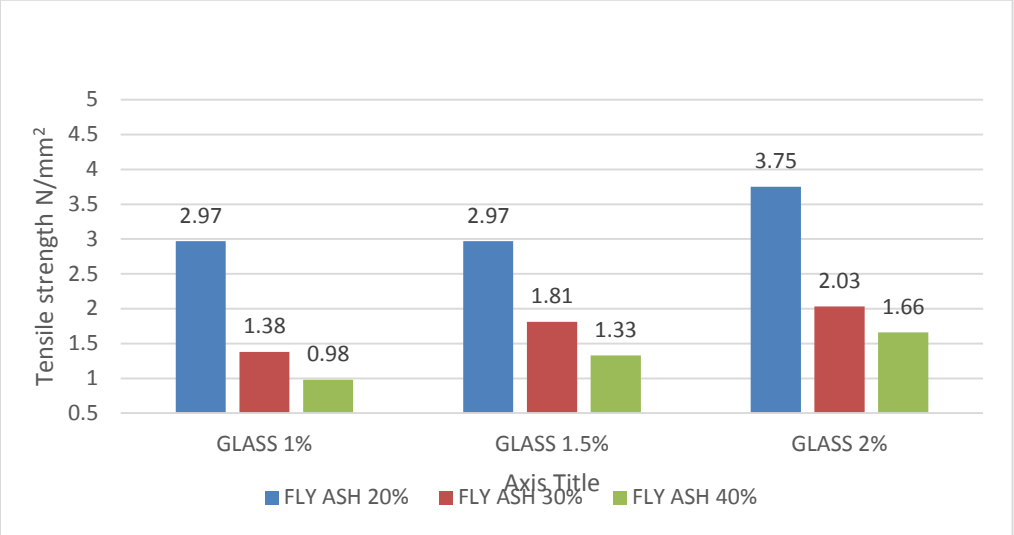

FIG 4: Tensile strength value for 28 days

COMPRESSIVE BEHAVIOUR OF SPECIMENS

The maximum compressive strength value is obtained when 20% of cement replaced with fly ash along with 2% of glass fiber. Compressive strength value gradually increased with the increase of glass fiber percentage.

SPLIT TENSILE STRENGTH BEHAVIOUR OF SPECIMENS

Split tensile strength of concrete increase gradually with the percentage of glass fiber. And it decrees with an increase in fly ash content. The maximum split tensile strength value is obtained when 2 0 % cement replaces with fly ash along with 2% glass fiber.

CONCLUSIONS

In this paper, I made an attempt to study the properties of glass fiber reinforced concrete with partial replacement of fly ash with cement. The maximum compressive strength value for 28 days is obtained when 20% cement replaced with fly ash along with 2% glass fiber. Compressive Strength increases with the increase of glass fiber. And with an increase of fly ash Compressive Strength decreases. However, 20% replacement of cement with fly ash along with 1%, 1.5% & 2% glass fiber showed an increase in the compressive strength by increasing fiber percentage. The maximum split tensile strength value for 28 days is obtained when 20% cement replaced with fly ash along with 2% glass fiber. Due to the addition of glass fiber split, tensile strength increased and is optimum when. 20% cement replaced with fly ash along with 2% glass fiber.

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