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Some Experimental Study on Splitting Tensile Strength of High Performance Concrete Using Supplementary Cementing Material and Glass Fibre

KEYWORDS: Fly Ash (class-F) (FA), Glass-Fibre (GF), High Performance Concrete (HPC),

Neel Shah	Dr. Indrajit. N. Patel
P.G Student, B.V.M ENGG. COLLEGE, VALLABH VIDHYANAGAR	Associate professor, B & B INSTITUTE OF TECHNOLOGY, VALLABH VIDHYANAGAR

ABSTRACT *Cement concrete is only next to water in terms of the amount of material used on our planet. The popularity of concrete owes to its economy, ability to be cast into any shape, ability to be fabricated practically anywhere and last but not the least, its inherent durability. High-Performance Concrete (HPC) exceeds the properties and constructability of normal concrete. High-performance concretes are made with carefully selected high-quality ingredients and optimized mixture designs; these are batched, mixed, placed, compacted and cured to the highest industry standards. High performance concrete is widely used in construction because of its high strength, high workability, and high durability. Such concretes will have a low water-cementing materials ratio of 0.20 to 0.45. Plasticizers are usually used to make these concretes fluid and workable. The different types of pozzolonic materials like FLY ASH, GGBS, SILICA FUME, RHA, etc. are used in concrete in replacement of cement to produce a high performance concrete. We prepared design mix with fly ash as pozzolonic material with replacement of volume of cement. . The present paper outlines the experimental investigation conducted on the use of glass fibre with structural concrete and class F fly ash and also on strength aspect of concrete. GFRC has advantage of being light weight and thereby reducing the overall cost of construction there by bringing economy in construction. The inclusion of fly ash in glass fibre reinforced concrete reduces the environmental pollution. This paper describes the experimental study of splitting tensile strength through standard HPC test practice laid down by Bureau of Indian Standards,(BIS) and make concrete sustainable.*

1. Introduction

Concrete the most widely used construction material has several desirable properties like high compressive strength, stiffness, durability under usual environmental factors. At the same time concrete is brittle and weak in tension. Plain concrete has two deficiencies, low tensile strength and a low strain at fracture.

The concrete without any fibres will develop the cracks due to plastic shrinkage, drying shrinkage. The development of these micro cracks causes elastic deformation of concrete. The addition of fibres in the plain concrete will control the cracking due shrinkage and also reduce the bleeding of water. Fibres help to improve the post peak ductility performance, pre- crack tensile strength, fatigue strength, impact strength and eliminate temperature. Fibre reinforced concrete is better suited to minimize cavitation / erosion damage in structures such as sluice - ways, navigational locks and bridge piers where high velocity flows are encountered.

Fly ash is a by-product of the thermal power plants. Fly ash is a highly effective pozzolanic material. Fly ash is used in concrete to improve its properties like compressive strength, bond strength, and abrasion resistance; reduces permeability. The use of fly ash in concrete from 20% to 30%, a standard mix design procedure was developed. Higher flexural strength gained by the adding of glass fibre. . Glass fibre is available in continuous or chopped lengths. Glass fibre reinforced concrete manufactured by spray or premix process has proven to be an attractive material for a wide range of applications. Glass fibre–reinforced concrete (GFRC) consists basically of a cementitious composed of cement, sand, water, and admixtures, in which short length glass fibres are dispersed.

2. Significance and Objectives of Research

The present paper outlines the experimental investigation of Splitting Tensile Strength for HPC mixes of grade M25 and M30 by replacing 0, 30, 40, and 50 percentage of the mass of cement with Fly Ash and 0.1, 0.2 percentage of Glass Fibre and using a super plasticizer. Also, an attempt is made to find the optimum cement replacement level by Fly Ash and Glass Fibre for better strength of HPC.

3. Experimental Programme

A. Materials

Table 1 Property of Materials

Material	Specific Gravity	Reference Code
Cement	3.14	IS 4031 & IS 12269-1987
Fine Aggregate	2.675	IS 383-1987
Coarse Aggregate	2.85	IS 383-1987
Fly Ash	2.18	IS 3813-2003
Glass Fibre	-	ASTM C 1666
Super Plasticizer	1.42	IS 9103-1999

B. Mix Design

Mix design was done based on I.S 10262-2009.

Table 2: Mix Design for M25 Grade

Design Mix No.	Fibre (Kg/m3)	Cement (kg/m3)	Fly Ash (kg/m3)	Fine Aggregate (kg/m3)	Coarse Aggregate (kg/m3)		Water (lit)
					10mm	20mm	
Design mix A1	0	350	0 (0%)	744.53	427.98	815.05	175
Design mix A2	0.35	245	105 (30%)	700	493.52	730.48	175
Design mix A3	0.7	245	105 (30%)	700	493.52	730.48	175
Design mix A4	0.35	210	140 (40%)	690	486.26	719.14	175
Design mix A5	0.7	210	140 (40%)	690	486.26	719.14	175

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Design mix A6	0.35	175	175 (50%)	690	486.26	719.74	175
Design mix A7	0.7	175	175 (50%)	690	486.26	719.14	175

Table 3: Mix Design for M30 grade

Design Mix No.	Fibre (Kg/m3)	Cement (kg/m3)	Fly Ash (kg/m3)	Fine Aggregate (kg/m3)	Coarse Aggregate (kg/m3)		Water (lit)
					10mm	20mm	
Design mix B1	0	390	0 (0%)	711.00	498.0	736	168
Design mix B2	0.35	273	117 (30%)	698	486	720	168
Design mix B3	0.7	273	117 (30%)	698	486	720	168
Design mix B4	0.35	234	156 (40%)	685	479	710	168
Design mix B5	0.7	234	156 (40%)	685	479	710	168
Design mix B6	0.35	195	195(50%)	685	479	710	168
Design mix B7	0.7	195	195(50%)	685	479	710	168

4. Experimental Set Up

- **Splitting Tensile Strength**

Testing of hardened concrete plays an important role in controlling and confirming the quality of cement concrete works. The purposes of testing hardened concrete is to confirm that the concrete used at site has developed the required strength Systematic testing of raw materials, fresh concrete and hardened concrete are inseparable part of any quality control programme for concrete, which helps to achieve higher efficiency of the material used and greater assurance of the performance of the concrete with regard to both strength and durability. The test methods should be simple. The splitting tensile strength was performed as per IS 5819-1999.

Fig-1 Splitting Tensile Strength Set Up

5. Test Results

Table 4: 7, 28, and 56 days Splitting Tensile Strength for M25 Grade of Concrete

	% of Replacement Cement by Fly Ash	% Addition of Glass Fibre	7 Days Tensile Strength (N/mm²)	28 Days Tensile Strength (N/mm²)	56 Days Tensile Strength (N/mm²)
M25	0	0	3.92	4.7	5.92
	30%	0.1%	3.2	4.15	5.2
	30%	0.2%	3.31	4.32	5.61
	40%	0.1%	2.85	3.98	4.8
	40%	0.2%	3.1	4.14	5.32
	50%	0.1%	2.2	3.59	4.49
	50%	0.2%	2.57	3.72	5.07

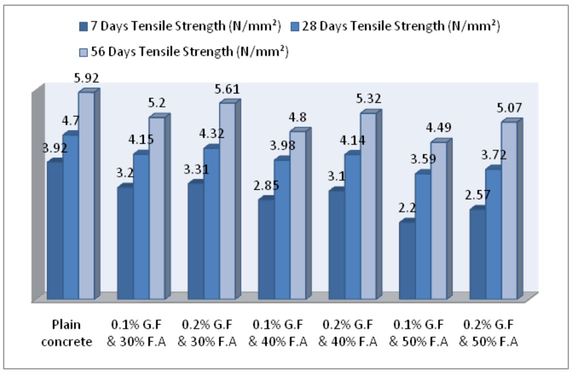

Fig. 2 Splitting Tensile Strength for 7, 28 and 56 days for M25 Grade Concrete

Table 5: 7, 28, and 56 days Splitting Tensile Strength for M30 Grade of Concrete

	% of Replacement Cement by Fly Ash	% Addition of Glass Fibre	7 Days Tensile Strength (N/mm²)	28 Days Tensile Strength (N/mm²)	56 Days Tensile Strength (N/mm²)
M30	0	0	4.45	5.95	6.36
	30%	0.1%	4.1	5.37	5.72
	30%	0.2%	4.18	5.6	6.12
	40%	0.1%	3.3	4.8	5.53
	40%	0.2%	3.62	4.98	5.98
	50%	0.1%	2.2	3.59	4.96
	50%	0.2%	3.24	4.2	5.39

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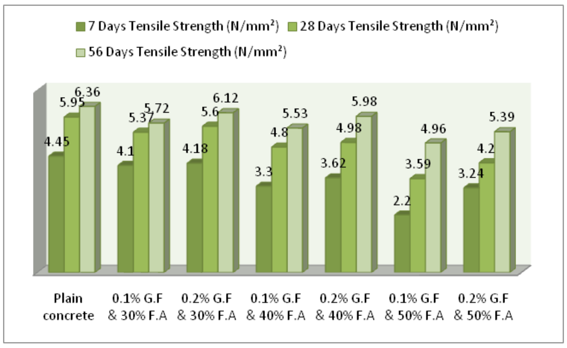

Fig. 3 Splitting Tensile Strength for 7, 28 and 56 days for M30 Grade Concrete

6. Conclusion

1. It is observed that 0.2% glass fibre in different grade of concrete give better performance in strength aspect at the age of 7,28 and 56 days.
2. As compared to the plain concrete of M25 grade splitting tensile strength reduced about 6%, 10% and 14% respectively 30%, 40% and 50% of fly ash with 0.2% glass fibre at 56 days.
3. It is also observed that split tensile strength decrease with the high replacements of fly ash with cement in concrete.
4. Splitting tensile strength reduced about 3%, 6% and 10% respectively with 30%, 40% and 50% of fly ash with 0.2% glass fibre as compared to the plain concrete of M30 grade at 56 days.
5. With all replacement of cement and 0.20% glass fibre inclusion all mix gain desired splitting tensile strength at 28 days as per BIS 456-2000 and there is continuous gain in strength beyond 28 days.

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