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Comparison of Compressive and Split Tensile Strength of Glass Fiber Reinforced Concrete with Conventional Concrete of M_{20} & M_{30}

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ABSTRACT

Concrete is most widely used construction material in the world. Now-a-days the world is witnessing the construction of more and more challenging and difficult engineering structures. So, the concrete need to possess very high strength and sufficient workability. The world is developing high performance concrete by adding various fibres, admixtures in different proportions. Various fibres like glass, carbon, Poly propylene and aramid fibres provide improvement in concrete properties like tensile strength, fatigue characteristics, durability, shrinkage, impact, erosion resistance and serviceability of concrete. Fibre Reinforced Concrete has found many applications in Civil engineering field. Glass Fiber Reinforced Concrete (GFRC) is a recent introduction in the field of concrete technology. GFRC has advantage of being light weight, high compressive strength and flexural strength. To improve the long term durability an Alkali resistance glass fiber reinforced concrete is invented .The aim of the work is to study the properties of the effect of glass fibers as reinforcement in the concrete for different proportions.

Keywords: *Glass fibers, Cement, Coarse aggregates, Fine aggregate, Workability, Compressive strength, Split tensile strength.*

I. INTRODUCTION

1.1 What is glass fibre?

Glass Fibre is chemical inorganic fibre, obtained from molten glass of a specific composition. This glass is compound of quartz sand, limestone, kaolin, calcium fluoride (fluorspar), boric acid, natrium sulphate, and clay. Glass fibre is made of natural materials, so that its products are ecologically pure and not harmful to human health. Glass fiber is highly light permeable and can be a semiconductor having excellent electronic, heat, and sound insulation capacities. Although not as strong or as rigid as carbon fiber, it is much cheaper and significantly less brittle.

1.2 Glass fibre reinforced concrete

Glass Fiber Reinforced Concrete is actually cement mortar with countless strands of embedded glass fiber. The principal material asset of GFRC is tensile strength or the ability to have strength when stretched. This tensile strength characteristic creates dramatically enhanced impact strength gives the two primary assets of conventional concrete, which are compressive strength and longevity. Alkali resistant fibres act as the principle tensile load carrying member while the polymer and concrete matrix binds the fibres together and helps transfer loads from one fibre to another. Strength of GFRC is developed due to high contents of alkali resistant glass fibers and acrylic polymer. Since the cement contents are high, and the ratio of water to cement is low, the GFRC strength under compressive loads is high.

II. METHODOLOGY

Summarized information about materials used in the present study and their characteristics are presented herein

2.1 Cement

Cement acts as a binding agent for materials. Cement as applied in Civil Engineering Industry is produced by calcining at high temperature. It is a mixture of calcareous, siliceous, aluminous substances and crushing the clinkers to a fine powder. The cement used in this experimental investigation is ordinary Portland cement 53 grade.

2.2 Water

Water to be used in the concrete work should be free from injurious amount of soils, free from acids, alkalis and inorganic impurities and free iron, vegetable matter which are likely to have adverse effect on concrete or reinforcement

2.3 Coarse aggregate

The sizes of coarse aggregate used in this experimental investigation are of 20mm, 10mm and 6mm sizes crushed angular in shape.

2.4 Fine aggregate

Locally available river sand was used. The sand was dried before used to avoid problem of bulking. The sand is tested according to IS 2386-1963.

2.5 Glass Fibers

Anti-Crack HD is an engineered alkali-resistant (AR) glass fiber designed to reduce plastic shrinkage cracking in concrete and mortars

III. "CASTING OF THE SPECIMENS"

A tilting type rotary drum mixer was used. All the ingredients were placed in the mixture and water was added during rotation. Then glass fibre was mixed with the ingredients and mixing was continued.

IV. "DETAILS OF MATERIALS USED IN CONCRETE CUBES AND CYLINDERS"

Table 1: Quantity of materials for M_{20} concrete cubes

Sl.no	Quantity of materials	Weights
1	Quantity of cement	492.5 kg/m3
2	Quantity of fine aggregate	666.9 kg/m3
3	Quantity of coarse aggregate	1128kg/m3
4	Quantity of water	197 kg/m3
5	Water cement ratio	0.40

Table 2: Quantity of materials for M_{30} concrete cubes

Sl.no	Quantity of materials	Weights
1	Quantity of cement	394 kg/m3
2	Quantity of fine aggregate	737.7 kg/m3
3	Quantity of coarse aggregate	1147.4kg/m3
4	Quantity of water	197 kg/m3
5	Water cement ratio	0.60

Table 3: Quantity of materials for M_{20} concrete cylinders

Sl.no	Quantity of materials	Weights
1	Quantity of cement	2.61 kg
2	Quantity of fine aggregate	3.53 kg
3	Quantity of coarse aggregate	5.98 kg
4	Quantity of water	1.044 litres

Table 4: Quantity of materials for M_{30} concrete cylinders

Sl.no	Quantity of materials	Weights
1	Quantity of cement	2.08 kg
2	Quantity of fine aggregate	3.90 kg
3	Quantity of coarse aggregate	6.08 kg
4	Quantity of water	1.044 litres

Table 5: Quantity of fibres for concrete cubes

Sl.no	grade of concrete	Quantity of cement	% of fibre	Quantity of fibre
1	M_{20}	1.662 kg	1%	16.62 gms
2	M_{20}	1.662 kg	3%	49.86 gms
3	M_{30}	1.329 Kg	1%	13.29 gms
4	M_{30}	1.329 Kg	3%	39.87 gms

Table 6: Quantity of fibres for concrete cylinders

Sl.no	grade of concrete	Quantity of cement	% of fibre	Quantity of fibre
1	M_{20}	2.61 kg	1%	26.1 gms
2	M_{20}	2.61 kg	3%	78.3 gms
3	M_{30}	2.088 kg	1%	20.88 gms
4	M_{30}	2.088 kg	3%	62.64 gms

V. RESULTS

5.1 Compressive test

The Steel mould of size 150 x 150 x 150 mm is well tighten and oiled thoroughly. The concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and were allowed for curing in a curing tank. They were tested in 200-tonnes electro hydraulic closed loop machine. The test procedures were used as per IS: 516-1979.

"**Figure 1:** Compression test specimen"

5.2 Split tensile strength test

Concrete cylinders of 15cm diameter and 30cm long are used. The concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and were allowed for curing in a curing tank for 28 days and they were tested in 200-tonnes electro hydraulic closed loop machine.

"**Figure 2:** Split tensile strength test specimen"

Table 7: Compressive strength of cubes for 7days with M20 & M30 GFRC

Sl.no	Grade with % of fibre	Sample-1 (N/mm^2)	Sample-2 (N/mm^2)	Sample-3(N/mm^2)
1	M_{20} with 1% fiber content	19.67	19.00	17.43
2	M_{20} with 3% fiber content	22.24	24.62	25.16
3	M_{30} with 1% fiber content	25.02	27.07	25.81
4	M_{30} with 3% fiber content	28.24	27.73	29.05

Table 8: Compressive strength of cubes for 28 days with M20 & M30 GFRC

Sl.no	Grade with %of fibre	Sample1(N/mm^2)	Sample2 (N/mm^2)	Sample 3 (N/mm^2)
1	M_{20} with 1% fiber content	29.81	28.79	26.42
2	M_{20} with 3% fiber content	33.71	34.31	32.13
3	M_{30} with 1% fiber content	37.92	41.02	39.12
4	M_{30} with 3% fiber content	42.79	42.03	44.02

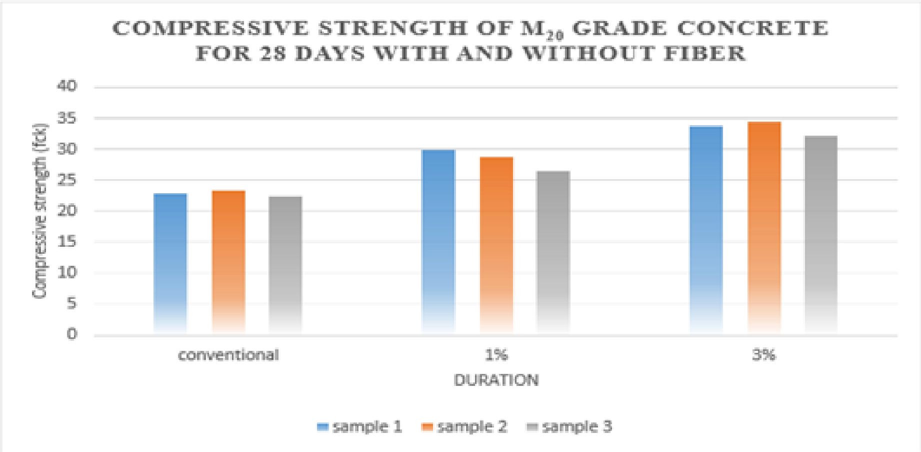
Table 9: Split tensile strength of cylinders for 7 days with M20 & M30 GFRC

Sl.no	Grade with % of fibre	Sample no 1 (N/mm^2)	Sample no 2 (N/mm^2)	Sample no 3 (N/mm^2)
1	M_{20} with 1% fibre content	2.02	2.72	2.65
2	M_{20} with 3% fiber content	3.16	3.38	3.30
3	M_{30} with 1% fiber content	3.24	2.85	3.16
4	M_{30} with 3% fiber content	3.51	3.28	3.36

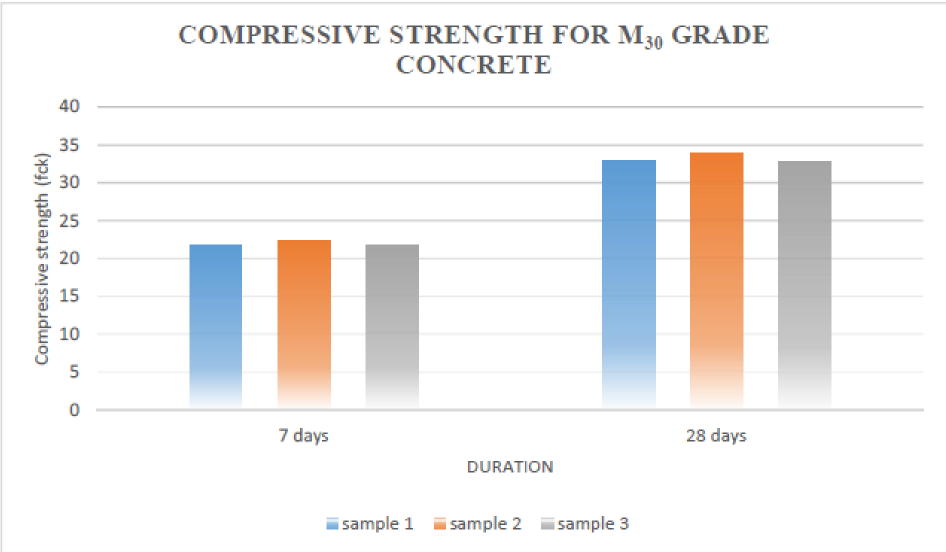
Table 10: Split tensile strength of cylinders for 28 days with M20 & M30 GFRC

Sl.no	Grade with % of fibre	Sample no 1 (N/mm^2)	Sample no 2 (N/mm^2)	Sample no 3 (N/mm^2)
1	M_{20} with 1% fibre content	3.16	4.13	4.02
2	M_{20} with 3% fiber content	4.79	5.13	5.01
3	M_{30} with 1% fiber content	4.91	4.32	4.79
4	M_{30} with 3% fiber content	5.32	4.97	5.10

Figures 3 and 4 present the variation of compressive strength of M_{20} and M_{30} concrete with and without addition of fibres.

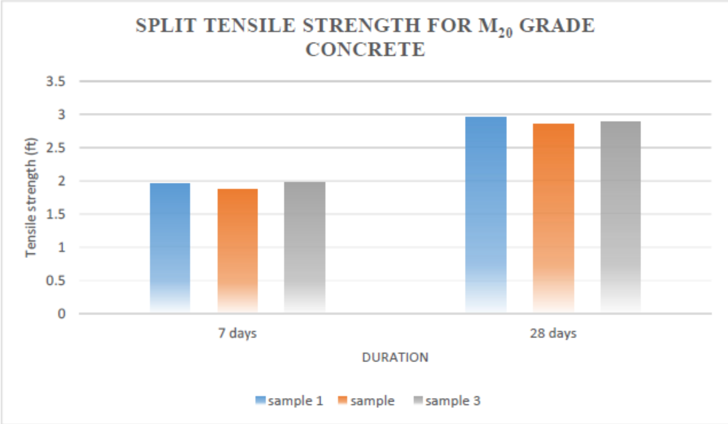


"**Figure 3:** Variation of Compressive Strength M_{20} grade concrete with and without fibre."



"**Figure 4:** Variation of compressive strength of M_{30} grade concrete with and without fibre."

Figures 5 and 6 present the variation of split tensile strength of M_{20} and M_{30} concrete with and without addition of fibres.



"**Figure 5:** Variation of split strength of M_{20} grade concrete with and without fibre."

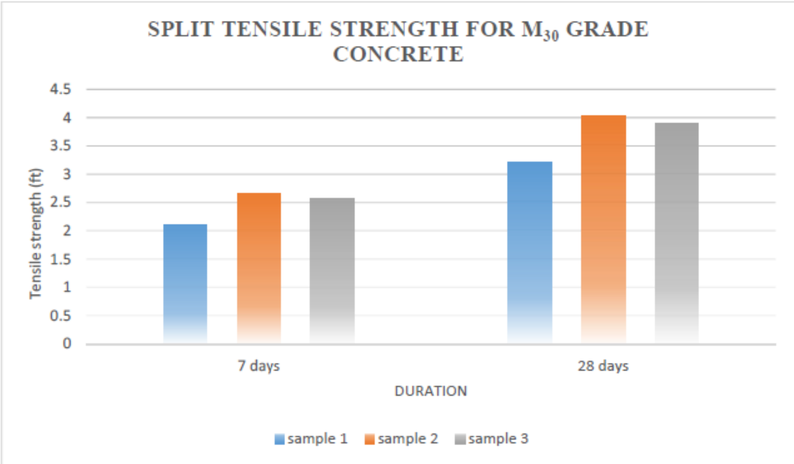


Figure 6: Variation of split strength of M_{30} grade concrete with and without fibre."

VI. Conclusions

The paper concluded that the addition of glass fibers at 0.5 % by volume of concrete reduces the cracks under different loading conditions

- With increase of fibre content to1% of cement content the compressive strength increased by 29%, 18% for M20 and M30 respectively and workability is decreased correspondingly
- With increase of fibre content to3% of cement content the compressive strength increased by 51%, 30% for M20 and M30 respectively and workability is decreased correspondingly
- With 1% increase of fibre content the split tensile strength increased by 39%, 23% for M20 and M30 and workability is decreased.
- With 3% increase of fibre content the split tensile strength increased by 74%, 31% for M20 and M30 and workability is decreased

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