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Experimental Research on Glass Fiber Reinforced Concrete Beam using Foundry Sand

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Abstract*— *Todays concrete has a various chemical and mineral admixture to arrange the rising demands for constructability, service life and performance. This project work intends to investigate the possibility of producing low cost enhanced performance concrete by foundry sand. The compressive, tensile and flexural strength of various proportional concrete is compared with the conventional concrete.

The present research work is aimed at studying the effect of the physical and chemical properties of foundry sand in M_{20} grade concrete. Based on previous literature which was 0 percentage without foundry sand and glass FIBRE that is control mix. 10, 20 and 30 % of foundry sand and 0.2,0.4 and 0.6 % of glass FIBRE on weight basis are considered for the present study. Along with this conplast sp430 is added as a superplasticizer. The main objective is to assess the impact of using foundry sand as partial replacement for fine aggregates and glass FIBRE as admixture in fresh and hardened properties of concrete along with the studies on mechanical properties.

Key words: Flexural behavior, Glass FIBRE, foundry sand, conplast sp430, mechanical properties

I. INTRODUCTION

Concrete is a binding material by the combination of cement, fine aggregate, coarse aggregate and water. Concrete is a mixture of fine aggregate, coarse aggregate and along with cement. It is a composite material, that hardens over time most often within the past a lime-based cement binder, like as lime putty, like as a calcium aluminate cement or with hydraulic cement to form hydraulic cement concrete but sometimes with other hydraulic cements. Mostly ordinary Portland cement is used.

The ordinary Portland cement has the lime, silica, alumina, iron oxide and magnesia. The aggregate efficiently carries the compression load so that the concrete has more compression strength. However, the cement holding the mixture in situ can crack, mostly it will be weak in tension allowing the structure to fail. Reinforced concrete adds either steel reinforcing bars, steel fibers, glass fibers, or plastic fibers to hold tensile loads.

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II. MATERIALS USED

A. Glass Fibre Reinforced Concrete

Concrete mix of Glass fibre-reinforced concrete have high strength and highly resistant to alkali fibre which is embedded in the mix. To show the differences while offering a synergistic combination of properties that cannot be achieved with either of the components acting alone, fibres retain their both physical and chemical identities by this method. Mostly, fibres are the principal load-carrying members. The fibres provide reinforcement for the matrix and other useful functions in fibre-reinforced composite materials. Glass fibre last a long time, it can be coloured, shiny or dull. It is low, maintenance, anti-magnetic, fire resistant, good electrical insulator and waterproof.

Fig.1. Alkali Resistance Fibre

Table-I: Properties of Glass Fibre

Properties	*Values*
Fiber length	10µm
Fiber diameter	3µm
Tensile strength	4137N/mm^2
Aspect ratio	3.33

B. Foundry Sand

Foundry sand is a uniformly sized high-quality silica sand which is used for a casting process in a concrete. It is produced by the produced by the production of ferrous and non-ferrous metals. It is a clean sand. This sand has a high-quality silica. The main advantage is the production process is simple, when compared to other process. The cost of foundry sand is very economic. It has a lower production cost. The rate of production will be higher.

Fig. 2. foundry sand

Table-II: Physical Properties of Foundry Sand

Property	***Values***
Specific gravity	2.45
SSD absorption (%)	0.45
Coefficient of permeability	

Table-III: Chemical Properties of Foundry Sand

Compounds	***Fine aggregate***
SiO_2	79.60
Al_2O_3	7.30
Fe_2O_3	3.10
CaO	1.40
MgO	2.30
Na_2O	0.60

C. Super Plasticizer

It is a chemical admixture. workability of the get increased while using super plasticizer in the concrete. In this paper conplast sp430 is used which is chloride free. Based on the sulphonated naphthalene polymers the super plasticizing admixture is selected. The main target is to reduce the water demand in the concrete mix which will also use to increase the strength at early stage and also provide the excellent acceleration of strength gain at early ages. It will sufficiently improve the workability of concrete in site mixed and without increasing the water demand in precast concrete. To improve the high ultimate strength and greater durability.

It will help in the reducing concrete permeability. When compared to other ordinary sulphonated melamine admixture it will maintain the increased workability levels for longer duration. The flowing concrete permits easier construction with quicker placing and compaction by using this super plasticizer.

Fig. 3. Conplast sp430

Table-IV: Properties of Super Plastizer

Property	***Values***
Appearance	Brown liquid
Chloride content	Nil to BS 5075 / BS: EN934
Air entrainment	Less than 2% additional air entrained at normal dosages
Cohesion	Cohesion is improved due to dispersion of cement
Specific gravity	1.18 @ 25°C
Fire	Conplast sp430 is water based and non-flammable

Table-V: Mix Proportion

Cement (kg/m³)	***Fine aggregate*** kg/m³	***Coarse aggregate*** kg/m³	***w/c ratio***
363	676.26	1173.88	0.5
1	1.8	3.2	0.5

III. EXPERIMENTAL INVESTIGATION

A. Mix designation

In this study, total of six different mixes were employed to cast specimen, contains all the ingredients of the conventional concrete with design mix ratio of 1: 1.8: 3.2 and characteristic compressive strength of 30MPa. The reference mix specimen is designated as control mix and all the other mixes consist of foundry sand 10,20 and 30 % by its weight of fine aggregate and 0.2, 0.4and 0.6 % of glass fibre as an admixture in the concrete. The proportion of were designated as mix M1, M2, M3, M4, M5, M6, M7, M8, M9 & M10 respectively. The mix proportions are given in table below. For control specimen the w/c ratio is 0.5 and the same amount of water is used for all other specimen. The chemical admixtures conplast sp430 are also used by 0.2,0.4 and 0.6 % of weight of water.

The following table represents the mix proportion used for all other specimens. The mix composition is varied for cement, partially replaced by foundry sand (FS) and Glass fibre (GF) as an admixture.

Table-VI: Mix Designation

Mix	***Composition***
M1	0% FS and 0% GF
M2	10% FS and 0.2% GF
M3	20% FS and 0.2% GF
M4	30% FS and 0.2% GF
M5	10% FS and 0.4% GF
M6	20% FS and 0.4% GF
M7	30% FS and 0.4% GF
M8	10% FS and 0.6% GF
M9	20% FS and 0.6% GF
M10	30% FS and 0.6% GF

These are the mix designation used to identify the flexural behaviour of the concrete mix the percentages of the glass fibre may vary to find the mechanical behaviour of the glass fibre reinforced concrete.

B. Preparation of specimens and method

The compressive strength, split tensile strength and flexural strength where carried out to identify the behaviour of foundry sand and properties of alkali resistance glass fibre. The cubes with the dimension of 150×150×150 mm where casted based on the below table 7. The specimens where casted with the required materials like cement, fine aggregate, coarse aggregate, foundry sand and admixture as glass fibre. With this the addition of super plasticizer as conplast sp430 constantly as a 1 % in a weight of cement which is used as the reduction of water in the concrete mix.

The same materials are used for the cylinder specimens with different dimensions like 150×300 mm.

The materials get mixed thoroughly with either hand mixing or other by the machine mixing the concrete mix is get ready to place in the required mould. Before filling the concrete in the mould, the oil should be applied fully inside the mould so that the concrete mix not stick in the mould. The specimens will be casted separately for the both 7 days and for 28 days. The concrete mix get split into 3 parts before putting inside the mould. The separated parts will be placed into 3 layers in the mould. For each layer there should be at least of 25 damping's so that the specimens will be avoided from voids and honey combs.

C. Testing of specimens and method

Compressive strength: The casted specimens are getting demould after 24 hours. The specimens get cured for the required days like 7 & 28 days. After the completion of curing process, the specimens get completely dry for the testing process. The specimens are placed in the UTM machine and the load will be applied on the surface of the specimens. The load will be applied until the specimens get cracked. The end load gets noticed to identify the compressive strength of the M_{20} grade of casted specimens.

Fig. 4. Cube compression strength

Split tensile strength: The procedure is same as the compression strength the shape of the specimens will get differ for compression strength the specimens shape will be in cube shape and for split tensile strength shape of the specimen will be cylinder. The specimens will get split in to two during this testing.

Fig. 5. Split tensile strength

IV. RESULTS AND DISCUSSION

A. Mechanical properties of concrete

C1. Compressive strength: the compressive strength results at 7 days and 28 days cured M_{20} grade concrete with varying percentages of replacement of foundry sand as a fine aggregate and glass fibre as an admixture. Fig 4 shows the compressive results for the 7 days curing. The results get compared with normal conventional mix concrete. The M_6 grade of concrete mix which is 20% of foundry sand and 0.4 % of glass fibre reaches the optimum value. When compared to the conventional concrete 10% get increased.

Table-VII: Compressive value for 7 days

Designation	*Load (KN)*	*Compression Value (N/mm^2)*
M1	51	22.23
M2	60	29.65
M3	57	26.15
M4	61	26.6
M5	66	28.77
M6	75	32.7
M7	49	21.36
M8	65	28.34
M9	52	22.67
M10	65	28.34

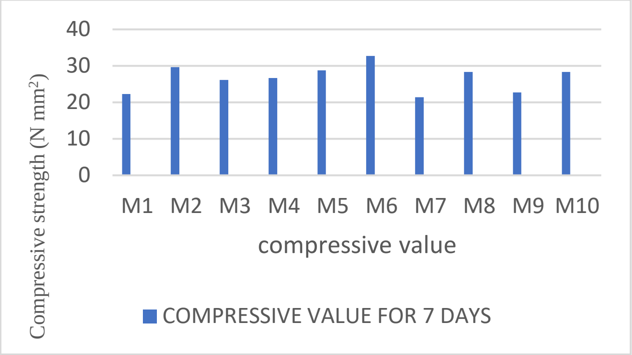

Fig. 6. Compressive strength for 7 days

Fig 7 shows the compressive strength value for 28 days curing. This result shows that when compared to conventional concrete 6 % is increased. These days also shows that the optimum value reaches in the M_6 grade of concrete mix this mix ratio is 0.4 % of glass fibre and 20% of foundry sand.

Table-VIII: Compressive value for 28 days

Designation	*Load (KN)*	*Compression Value (N/mm^2)*
M1	60	26.16
M2	66	28
M3	68	29.6
M4	69	30.08
M5	71	30.95
M6	76	33.14
M7	58	25.28
M8	69	30.08
M9	76	26.59
M10	70	30.52

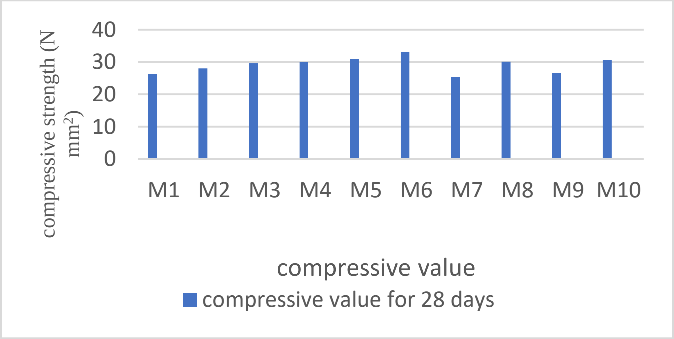

Fig. 7. Compressive strength for 28 days

C2. Split tensile strength: split tensile results at 28 days cured M_{20} grade concrete with various percentages of replacement of foundry sand for fine aggregate and the addition of glass fibre as admixture in a concrete mix.

This test is taken to identify the tensile strength of the M_{20} grade of concrete mix. In the below chart represents that M_9 as an optimum value. Which is 20 % foundry sand and 0.6 % of glass fibre as an admixture.

Table-IX: Tensile value for 28 days

Designation	*Load (KN)*	*Tensile value (Mpa)*
M1	198	2.8
M2	184	2.6
M3	228	3.2
M4	202	2.8
M5	164	2.3
M6	198	2.8
M7	224	3.16
M8	242	3.4
M9	233	3.29
M10	201	2.8

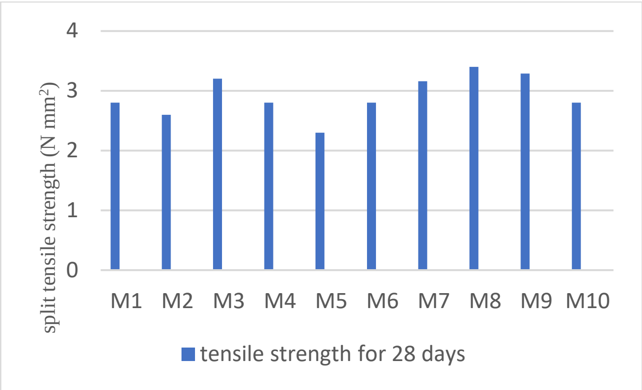

Fig. 8. Tensile strength for 28 days

From the above test results the 20 % of foundry sand as a partial replacement of fine aggregate and 0.4 % of glass fibre as an admixture increases the compressive strength of the concrete. 20 % of partial replacement of foundry sand for a fine aggregate and 0.6 % of glass fibre as an admixture increases the tensile strength to the concrete mix. The above values are compared with the conventional M_{20} grade of concrete.

V. CONCLUSION

Glass fibre reinforced concrete helps to increase workability of concrete. To reach the peak moment capacity just before the failing the glass fibre will be used. By comparing the various percentages of glass fibre in the concrete shows the ductility behaviour of fibre. The effects of addition of glass fibre on the strength and mode of failure of high strength concrete unto 33.14 N/mm^2 cube compressive strength where experimentally investigated. The following conclusion where based on the results of compressive strength and split tensile strength is carried out at 7and 28 days.

1.Maximum compressive strength was obtained 0.6 percentage of fibre 30 percentage of foundry sand and achieved 26.16 N/mm^2 increase over the reference mix without fibres. 33.14 N/mm^2 strength increase was recorded with 0.4 % of glass fibre and 20 % of foundry sand which can consider the optimal value for compressive strength and that increase after is nominal.

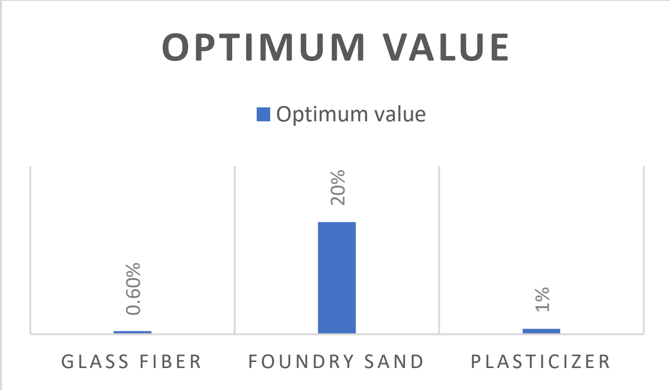

Fig.9.Optimum value (compressive value)

2.The ratio of 7 days and 28 days compressive strength increased from 32.7 N/mm^2 to 33.14 N/mm^2 as fibre percentage increased from 0.0 to 0.6 and foundry sand percentage increased from 0 to 30.

3.The split tensile strength of fibre and foundry sand increased continuously reaching 3.4 % increased at 0.6% of glass fibre 10 % of foundry sand.

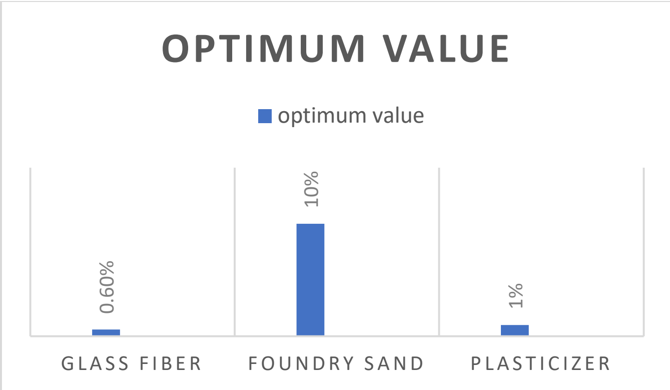

Fig.10. Optimum Value (Tensile Strength)

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