Experimental Study On Hybrid Fibre Concrete With Using GGBS And M Sand

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Abstract - Concrete is the most widely used everyday construction material. The advancement of concrete technology can reduce the utilization of natural resources and energy sources and lessen the burden of pollutants on environment. Presently large amounts of GGBS generated in industries with an impact on environment and humans. Conventional concrete has two major defects: low tensile strength and a destructive and brittle failure. In an attempt to increase concrete ductility and energy absorption, fibre reinforced concrete has been introduced. The present investigation revealed the effect of using GGBS and M Sand as a partial replacement of cement and fine aggregate along with optimum percentage of polypropylene and steel fiber. For this study (M30) grade concrete is designed. Partial replacement of cement with GGBS will be made for varying percentages such as by weight 0%, 10 %, 20% and 30% .Along with M Sand as fine aggregate and with optimum fibre percentage as polypropylene (0.4%) and steel fiber (0.6%) respectively. From this study the strength properties of the concrete have been investigated.

Keywords - GGBS, M Sand, Hybrid Fibres, Compressive Strength, Split Tensile Strength, Flexural Strength

1.INTRODUCTION

Concrete is widely used in structural engineering with its high compressive strength, low cost and abundant raw material. But common concrete has some shortcomings, for example, low tensile and flexural strength, poor toughness, high brittleness, and so on that restrict its application. To overcome these deficiencies, additional materials are added to improve the performance of concrete.

In Past, a lot of experimental work was carried out on fibre reinforced concrete having different types of fibres to study their improved engineering properties in compressive strength, tensile strength, flexural strength etc. The fibres are able to prevent surface cracking through bridging action leading to an increased impact resistance of concrete. Most of the fibres used in practice contain one type of fibre or more than one type of fibre. Recent years have seen considerable interest in the fibre hybridization particularly combinations of metallic and non-metallic fibres. For optimal behaviour, different types of metallic and non-metallic fibres are to be combined.

The mechanical properties such as compressive strength, flexural strength and flexural toughness etc. of Hybrid Fibre Reinforced Concrete (HFRC) are to be investigated by different investigators. And to be achieved using slag instead of cement, and using M Sand instead of River sand.

OBJECTIVE OF PRESENT STUDY

The project started with objective of achieving the following,

1. To determine the optimum percentage combination of Hybrid FRC.
2. To compare the strength of concrete cube containing hybrid fibres with fixed 1% proportions of volume of the concrete with normal concrete beams.
3. To reduce river sand usage in construction and safeguard environment. So, M-Sand is to be used.
4. To determine the optimum replacement of cement with Slag without affecting the concrete strength.

2. LITERATURE REVIEW

2.1 LITERATURE ON FIBRE CONCRETE

Rana A. Mtasher, Dr.Abdulnasser, M. Abbas &Najaat H. Ne'ma said that the main purpose of this investigation is to study the effects of polypropylene fiber on the compressive and flexural strength of normal weight concrete. Four mixes used polypropylene fiber weight with 0.4, 0.8, 1.0 and 1.5% of cement content. To provide a basis for comparison, reference specimens were cast without polypropylene fiber. The test results showed that the increase of mechanical properties (compressive and flexural strength) resulting from added of polypropylene fiber was relatively high. The increase was about 64 percent for compressive strength, while, and in flexural strength was about 55.5 percent.

2.2 LITERATURE ON FIBRE CONCRETE WITH M SAND

Mr.Bhaveshkumar, Mr.Sandip did investigation on concrete properties by partially replacing river sand by manufactured sand. The manufactured sand is from chikhli region of Gujarat. Natural sand has been replaced by manufactured sand in 0%, 25%, 50%, 75% and 100%. The grade of concrete considered for experiment is M25 with water cement proportion of 0.5. Slump test was performed to measure the workability of the mix, also concrete cubes were cast to ascertain the concrete compressive strength and compare it with the reference mix. The outcome showed that the workability decreases as the percentage of manufactured sand increases. In other words, the mix becomes harsh with the increase in percentage of manufactured sand. Also, there was enhancement of compressive strength with increase in replacement level. The maximum

compressive strength was observed for mix containing 100% of manufactured sand. Hence manufactured sand gives satisfactory results and can be used as partially or completely in making the concrete.

2.3 LITERATURE ON REPLACEMENT OF CONCRETE WITH GGBS AND M SAND

AndriyaAnnal and Priya Rachel Did study on high performance concrete using GGBS and M sand, for which concrete grade of M20 was considered with water cement ratio of 0.38. The GGBS has been varied into three proportions 30%, 40% and 50% with 100% of river sand replaced by M sand. The concrete cubes were casted and compressive strength at the age of 14 days was observed. The outcome showed that compressive strength increases with increase in GGBS content, also for variation with 50% GGBS and 100% M sand, there was increase in compressive strength to the extent of 92.65% almost double compared to control mix. Thus, it defines that manufactured sand meets the design requirements and can be used in place of river sand.

2.4 LITERATURE ON HYBRID FIBRE CONCRETE

V.Arivudamai, R.Velkennedy In this study, the acid attack test is performed on the fiber reinforced concrete incorporating with manufactured sand silica fume and coconut shell. The grade of concrete is M50. Silica fume is partially replaced with 10 % by the weight of cement and manufactured sand is partially replaced with 40% by the weight of sand. The coconut shell is partially replaced for coarse aggregate by 20%. Additionally three types of fibers are used such as steel fiber, sisal fiber, and coir fiber. The volume fraction of fibers ranges from 0 to 3%. The aim of this study is to evaluate the acid resistance of the fiber reinforced high performance concrete. From the experimental investigation, it was found that there is improvement in acid resistance for fiber reinforced high performance concrete when compared to plain cement concrete. Also fiber reinforced concrete improves the cracking resistance compared to plain cement concrete.

3. MATERIAL DETAILS

Cement

Ordinary Portland cement of grade 43 conforming to in this experimental study.

Table 1: Properties of cement

Properties	**Result**	**Permissible limits as per IS 12269-1987**
Fineness	3%	≯10%
Specific Gravity	3.15	3.5
Initial Setting Time	30 min	≮ 30 min
Final Setting Time	550min	≯ 600 min

Fine aggregate

River sand is used as fine aggregate. By conducting Sieve Analysis, and compared with grading table from IS 383-1970, it was found that the sand used belongs to the Zone 2.

Table 2: Properties of fine aggregate

Properties	**Value**
Fineness modulus	3.24
Specific Gravity	2.41
Size	Passing through 4.75mm sieve

Coarse aggregate

Coarse aggregate is sieved to 20 mm and the passed out is used in this analysis.

Table 3: properties of coarse aggregate

Properties	**Value**
Fineness modulus	4
Specific Gravity	2.73
Size	Passing through 20 mm and retaining in 10mm sieve

Ground granulated blast furnace slag

GGBS is by-product obtained during iron manufacture. The parameters are tabulated below.

Table 4: properties of GGBS

Chemical compound	**Percentage**
Specific surface	380%
Sio_2	33.8%
Al_2o_3	22.1%
Fe_2o_3	2%
Cao	34.5%

Manufacture sand

Manufactured sand or M-Sand, as it is popularly known is made by powdering hard granite rocks using heavy machinery.

Table 5: properties of GGBS

Property	**Value**
Specific gravity	2.55
Fineness modulus	4.45
Water absorption	6.2%
Surface texture	Smooth
Zone	II

Polypropylene fibre

Polypropylene fibre is obtained as continuous mono – filaments with circular cross section. It is a synthetic carbon polymer .Polypropylene fibres are tough with low tensile strength and modulus of elasticity. A blend of steel with polypropylene fibre can arrest plastic cracking in fresh concrete and drying shrinkage cracking in hardened concrete. It is also to improve the post-cracking toughness.

Table 6: Properties of Polypropylene fibre

Property Table	Result
Length	50mm
Diameter	0.5mm

Steel fibre

Steel fibres have equivalent diameters of 0.15mm to 2 mm and length from 7 mm to 75 mm. Generally the aspect ratio ranges from 20 to 100. It poses high tensile strength ranging from 0.5 - 2.0 GPa and with modulus of elasticity of 200.

Table 7: Properties of Steel fibre

Property Table	Result
Length	42mm
Diameter	1.0mm

4. MIX DESIGN

Concrete is made with the design mix ratio of 1: 1.68: 3.69 with the water cement ratio of 0.45.

5. EXPERIMENTAL RESULTS

Compressive strength results

For compressive strength test , cube specimens of dimensions 150mmx 150mm were casted for M30 grade of concrete.
Compressive strength=load / Area (MPa)

Table 8: Results of compressive strength

S.no	Mix	Mix ratio		Average compressive strength at 28 days (MPa)
		GGBS %	M Sand%	
1	M1	0	0	30.98
2	M2	20	30	26.80
3	M3	20	40	35.91
4	M4	20	50	28.53
5	M5	30	20	29.11
6	M6	30	30	29.00
7	M7	30	40	26.31
8	M8	30	50	20.75

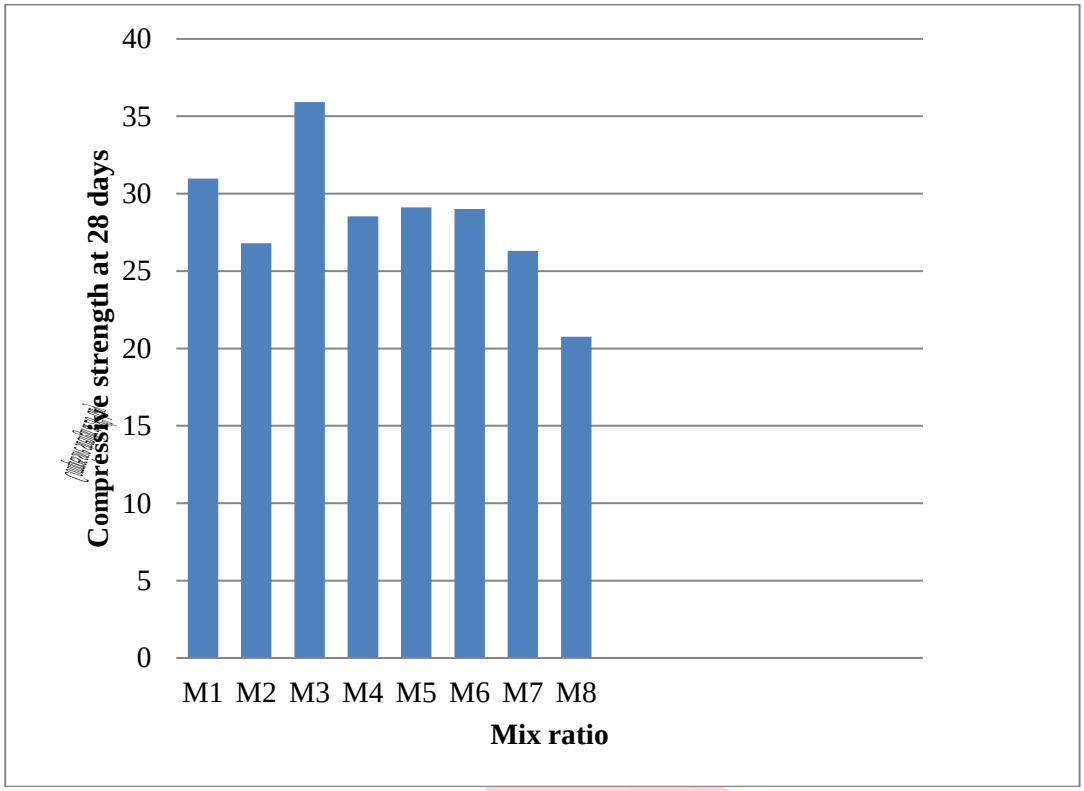

Fig 1 Compressive strength at 28 th day

From the graph, it can be seen that the compressive strength of the concrete mixes with M3, M5, M6 are nearer to conventional compressive strength. The highest strength was obtained at 20% replacement of GGBS and 40%replacement of M Sand along with fixed percentage of polypropelene (0.4) and steel fibre (0.6) was found about 35.91 MPa compared with conventional concrete.

Split tensile strength results

For tensile strength test, cylinder specimens of dimension 150mm dia and 300 mm length were cast.
Tensile strength= 2P/**Π**dl. Where P=Failure of load, D= Dia of cylinder, L=Length of cylinder.

Table 9: Results of split tensile strength

S.no	Mix	Mix ratio		Average split tensile strength at 28 days (MPa)
		GGBS %	M Sand%	
1	M1	0	0	3.96
2	M2	20	30	2.45
3	M3	20	40	4.24
4	M4	20	50	3.41
5	M5	30	20	3.04
6	M6	30	30	3.01
7	M7	30	40	3.79
8	M8	30	50	2.67

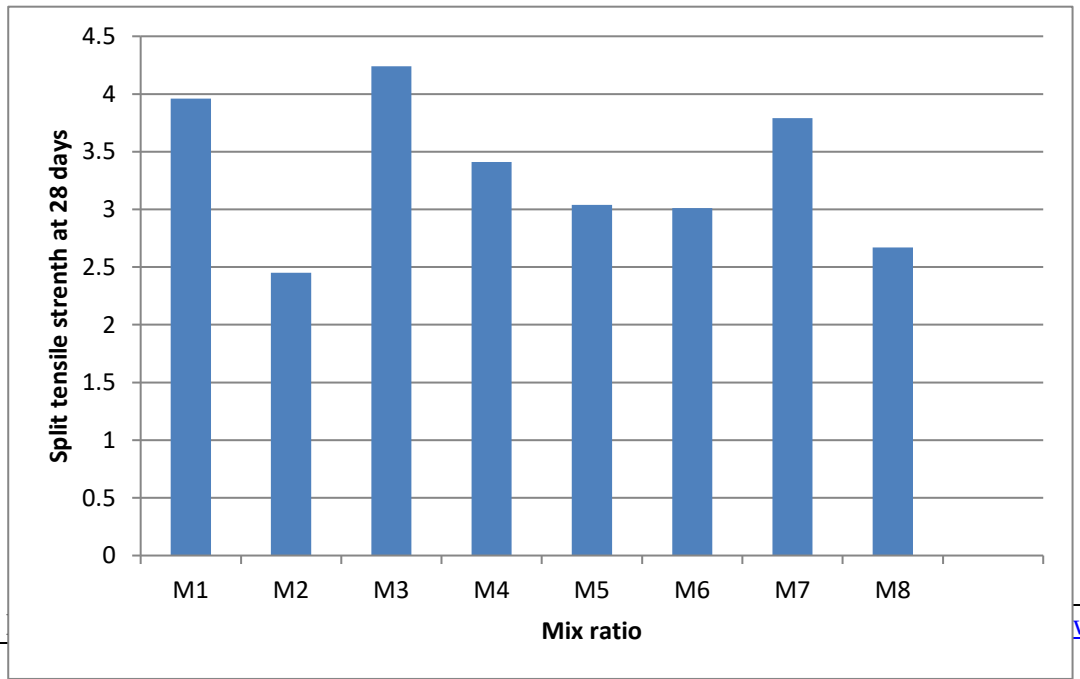

Fig 2 split tensile strength test at 28 th day

From this graph, it can be seen that the split tensile strength of the concrete mixes with M3, M5, M6 are nearer to conventional split tensile strength. The highest strength was obtained at 20% replacement of GGBS and 40%replacement of M Sand along with fixed percentage of polypropylene (0.6) and steel fibre (0.4) was found about 4.24 MPa compared with conventional concrete.

Flexural strength results

The flexural strength of concrete prism was determined based on IS:516-1959. Beam specimens of size 150mm x 150mm x 700mm were casted.

Table 10: Results of flexural strength

S.no	Mix	Mix ratio		Average flexural strength at 28 days (MPa)
		GGBS %	M Sand%	
1	M1	0	0	8.29
2	M2	20	30	6.22
3	M3	20	40	8.71
4	M4	20	50	7.47
5	M5	30	20	6.84
6	M6	30	30	7.05
7	M7	30	40	6.01
8	M8	30	50	5.19

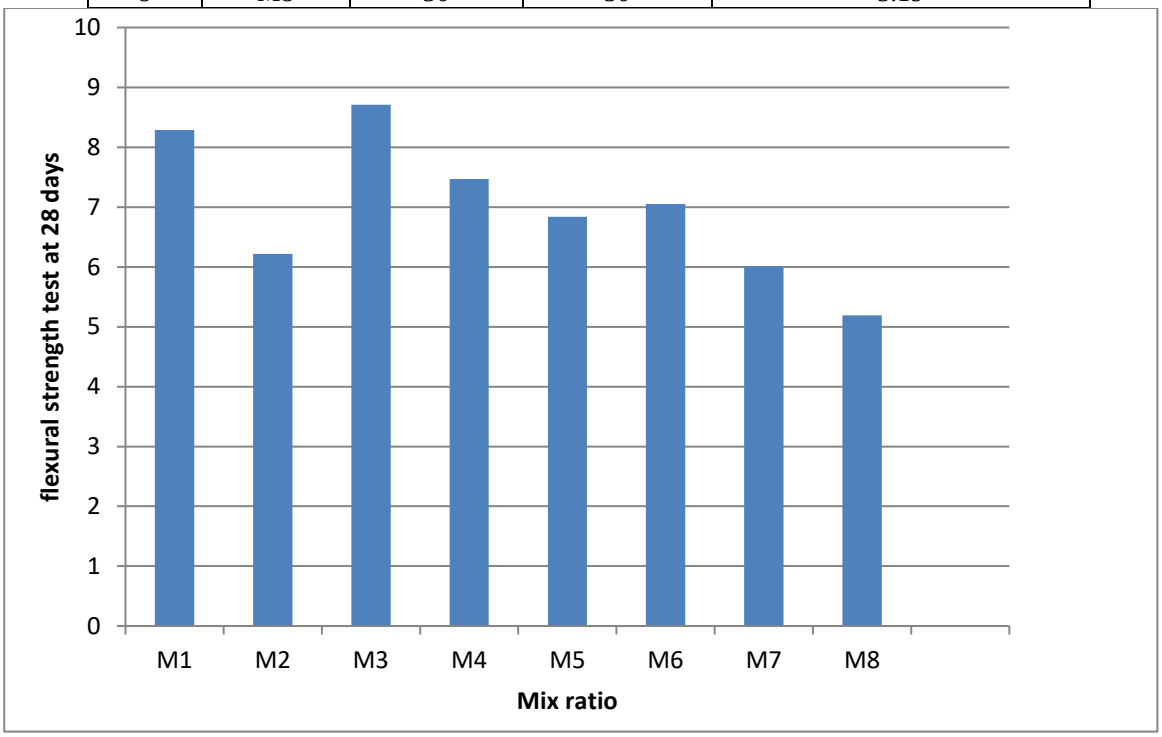

Fig 3: Flexural strength test reslts

From this graph, it can be seen that the flexural strength of the concrete mixes with M3, M5, M6 are nearer to conventional flexural strength. The highest strength was obtained at 20% replacement of GGBS and 40%replacement of M Sand along with fixed percentage of polypropylene (0.6) and steel fibre (0.4) was found about 8.71 MPa compared with conventional concrete.

6.CONCLUSION

In standard curing method the compressive, split tensile and flexural strength of concrete increased with the addition of steel and polypropylene fibre. the test results proved that the inducing of the fibres and natural sand replaced by M Sand and cement replaced by GGBS has a greater values on the aspect of study made compared to the normal M30 grade mix design.

The compressive strength results shows a 13.73% increase in strength for 28 days curing by the hybrid fibre concrete along with 20% of GGBS and 40% of M Sand.the split tensile strength results shows a6.60% increase in strength for 28 days curing and the flexural strength results shows a 4.2% increase in strength for 28 days curing.

7.REFERENCES

[1] Anju Mary Ealias., Rajeena, A.P., Sivadutt, S., Life John. 2014. Improvement of Strength of Concrete with Partial Replacement Of Course Aggregate With Coconut Shell and Coir Fibers. IOSR Journal of Mechanical and Civil Engineering. 11, 16-24.

[2] Aitcin, Pierre-Claude et al, "The Use of Fibre Reinforced Concrete for Highway

[3] Rehabilitation," Etude #231, IGM85- 305-231, Industrial Materials Research Institute, National Research Council of Canada, 1985

[4] "Concrete Shatter Resistance Under Compressive Loading of Fibermesh vs. Plain,"
[5] F.E.D. Report No. 6, Fibermesh Inc. (Tests performed by Paul P. Kraai), 1985
[6] ChetanKhajuria, "Use of Iron Slag as Partial Replacement of Sand to Concrete" International Journal of Science, Engineering and Technology Research (IJSETR),
[7] Volume 3, Issue 6, (June 2014)
[8] Duggal.S.K,Building Materials, Revised 2nd Edition , New international Publishers.
[9] Eswari .s "Experimental Investigation On Flexural Performance Of Hybrid Fibre Reinforced Concrete" International Research Journal Of Engineering And Technology (IRJET) (June-2015)
[10] Faseyemi Victor Ajileye, "Investigations on micro silica (silica fume) as partial cement replacement in concrete", Global Journal of researches in engineering Civil And Structural engineering, Volume 12, Issue 1, Version 1.0, January 2012
[11] Gambhir.M.L,Concrete technology, 4th edition, Tata Mc-Graw hill education Pvt.Ltd,