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Effect of GI Fiber on Strength and Durability Characteristics with Varying Percentage of GGBS to the Cement and Partial Substitution of M-Sand by Natural Sand

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ABSTRACT

In the concrete the cement is the main constituents which are produced by naturally available raw materials. In this experimental study is about strength and durability analysis of concrete. In this experiment the cement is replaced by GGBS is produced by industrial waste. The GGBS shows chemical properties similar to cement. The GGBS will reduce the cost of concrete by replacing the cement. This experiment is mainly focus on strength and durability characteristics of M25 Grade concrete is designed according to IS:10262-2009. Concrete in this the cement is replaced by GGBS 10% , 20%, 30%, 40%, 50% and also in this experiment the fine aggregate is replaced by manufacturing sand by 60%. Manufactured sand which is eco-friendly material this serves as a perfect replacement for the fast depleting and excessively mined river sand. And to increase the tensile strength we are adding the additional 1% GI (galvanized iron) fibers are added to increase the strength of concrete. This is compared with the convential concrete by cube, prism and cylindrical specimens are tested in compressive, split & flexural strength test is to find out the strength analysis and acid attack test is conducted to study the durability of the concrete.

Keywords: GGBS, Cement, Natural Sand, M-sand, Coarse Aggregate, GI Fiber, Compressive Strength, Split Tensile, Flexural Strength, Acid Test

I. INTRODUCTION

Concrete is a highly demanding building material, and the construction industry is now costly due to a corresponding increase in demand in the construction sector. In recent years, more and more attention has been paid to environmental problems and a change over from the high-production, high-consumption, high-waste society of the past to a zero-emission society is now considered as important. The world needs an eco-friendly building material. Basically the concrete is made of cement, sand, coarse aggregate, water and plasticizers if needed. The current specific construction practice is unsustainable because it consumes about 100 million tons of cement per year, and it is not environmentally friendly. The production of cement is characterized by a large amount of energy consumption and a large amount of carbon dioxide emissions of large quantities of CO_2 gas. Therefore this investigation is taken up with a view to verify the suitability, feasibility and potential use of M sand as a replacement for river sand in concrete mixes along with cement is partially replaced by GGBS [Ground Granulated Blast Furnace Slag]. In this the cement and sand are the most essential ingredients in the concrete due to much expensive in the cost in this the cement is most expensive material to reduce the concrete cost the industrial waste material GGBS is replacing up to 50% of cement. Due to the high demand and availability of natural sand, we usually use natural resources such as riverbeds or embankments, so we are using m-sand. M-sand is a material that considers the use of N-sand instead of materials. In this experiment, the fiber was added to increase the strength. Fiber reinforced concrete is more efficient than ordinary concrete. FRC is defined as a random but uniformly dispersed staple fiber, which may be a steel polymer and a natural material. Provide reinforcement for strengthening the tension area of the concrete. Different types of fibres used to improve mechanical strength or improve the properties of Portland cement concrete (PCC) is called fiber reinforced concrete (FRC). The improved performance of fiber reinforced concrete improves bending, stretching and dynamic strength, ductility and toughness. Commonly used fiber types include: steel, galvanized iron, glass, polymer, carbon,

asbestos and natural fibres. Polymers include: polypropylene fiber, polyethylene, polyester, acrylic & aramid fibres. In this study, attempts will be made to study the characteristics of FRC using GI fibres as a reinforcing material, possibly resulting in increased crack resistance, increased flexural strength and compressive strength of concrete, which is derived from extensive literature surveys.

II. LITERATURE REVIEW

[1] Mohammad Moyunddinet[2015]studied that partial replacement of naturally available sand with M sand & the cement is replaced by GGBS with the addition of different dosage of admixture in this experiment is carried out by M30 grade design in first phase he studied the optimum strength by replacement 0,20%, 40%, 60%, 80%, 100% of river sand by m-sand and he got optimum strength at the 60% replacement in the second phase he kept the M-sand constant as 60% constant and he replaced the cement by 10%,20%,30%40% of GGBS and he got the optimum strength of compressive, flexural and split tensile strength at 30% GGBS replacement.

[2] Christina Mary V And Kishore[2015] In this Studied the durability of high performance concrete with addition of GGBS instead of cement and M-sand by natural sand. This replaced GGBS with 10%, 20%, 30%, 40% & 50%of cement, 50% natural sand and 50% of M-sand. The concrete grade is M40, the water cement ratio is 0.45, the super-plasticizer SP430, and the dosage is kept at 0.7%. The study included compressive strength tests, flexural strength tests and tensile strength tests. Second, the durability tests that RCPT, comfort and acid attack 30 days have also been focused. The results showed that the maximum compressive strength was 10% GGBS and 50% M sand compared with the nominal concrete. In addition, the splitting tensile strength is greatest 10% GGBS and 50% M-sand. Wherein the flexural strength test shows the highest value of 30% GGBS and 50% of M-sand. Rest all combinations were with low chloride ion penetration. For mixes with 40% and 50% GGBS compared with other combinations sorpitivity was low. Lastly results of acid attack showed slight decrease in compressive strength for all combinations.

[3] Andriya Annal And Priya Rachel[2016] The high performance concrete using GGBS and M sand was studied, taking into account the M20 concrete grade with a cement ratio of 0.38. GGBS has changed to three proportions of 30%, 40% and 50%. And 100% of the river sand replaced by M-sand. Pour the concrete cube, observe the compressive strength at 14 days of age. It understood that the compressive strength increases with the increase in GGBS content, and increases with the change of 50% GGBS and 100% M sand, and the compressive strength increases by 92.65%, almost doubling The Therefore, it defines the sand to meet the design requirements and can be used instead of river sand**.**

[4] Mr.Bhaveshkumar, Mr.Sandip[2014]The nature of the concrete was investigated by replacing the river sand by making the sand. The sand is made from the chikhli area of Gujarat. Natural sand is replaced by 0%, 25%, 50%, 75% and 100% sand. Consider the concrete grade of M25, cement ratio of 0.5. A slump test was performed to measure the workability of the mixture, and also a concrete cube to find out the compressive strength of the concrete and compare it to the reference combination. The results show that the machinability decreases with the increase of the amount of sand. In other words, the mixture becomes harsh as the amount of sand is increased. In addition, as the level of substitution increases, the compressive strength also increases. For a mixture containing 100% sand, the maximum compressive strength was observed. Thus, the sand can be satisfactorily achieved, either partially or entirely, for the manufacture of concrete.

[5] Manoj Kadiwal, Girish Hombal[2016] in this paper increase in percentage of GGBS, the compressive strength of concrete is also increasing. Maximum compressive strength was observed for mixtures containing 30% GGBS and 100% M-sand. Further increase in GGBS reduces the strength of the concrete. Therefore, the best alternative to GGBS cement is 30%. Compared with the traditional concrete, the proportion of compressive strength increased by 3.71%. The results of the split tensile strength is same as those of the compressive strength, and the increased tensile strength of the GGBS content increases. The maximum split tensile strength was observed for mixtures containing 30% GGBS and 100% M-sand. Compared with the

traditional concrete, split tensile strength increased by 31.91%. The results of flexural strength show that the increase in GGBS content increases the flexural strength. The maximum flexural strength was observed by mixing with 40% GGBS and 100% M-sand. The flexural strength increased by 22.03% compared with the control group. The water absorption test showed that the addition of GGBS increased the water absorption of concrete.

III. OBSERVATION

1. This experiment is mainly focus on strength of concrete and durability characteristics of M25 concrete is designed according to IS [IS:10262-2009]&[IS:456-2000].
2. In this experiment the cement is replaced by GGBS is produced from the industrial waste. The GGBS shows chemical properties similar to OPC. The GGBS will reduce the cost of concrete.
3. In this cement is replaced by GGBS 10%, 20%, 30%, 40%, 50%.
4. This experiment the fine aggregate is replaced by manufacturing sand by 60% of River sand which is eco-friendly solutions that makes a perfect replacement for the fast depleting and excessively mined river sand.
5. To increase the tensile strength we added the additional 1% GI (galvanized iron) fibres in the concrete.

IV. METHODOLY AND MATERIALS

In this research work is to analyze the strength properties. GGBS replaced with cement and natural sand is replaced by M sand, adding fiber. Concrete tests are carried out in accordance with IS regulations. The test uses conventional concrete, GGBS is 0%, 10%, 20%, 30%, 40%, 50%, M sand is 60%, and fiber is 1% ratio. A comparative study was conducted before the final conclusion was reached, that is, conventional and modified concrete.

The following methodology is adopted for the proposed work.

1. Collection of articles and journals to understand and get the idea on the research work conducted on subject of work.
2. The properties of materials such as cement, GGBS, natural sand, M sand, coarse aggregate and fiber to be studies by conducting the tests as per BIS
3. To obtain the mix proportion for M25 Grade concrete by IS method 10260: 2009
4. Calculate the mix proportion of various material such as cement replaced by GGBS (0%, 10%, 20%, 30%, 40%, and 50%), natural sand with M sand (60%), coarse aggregate with GI fiber (1%).
5. The concrete specimens are prepared such as cube for compressive strength, cylinders for split strength and prisms for flexural strength and also cubes for acid test.
6. The curing of specimens for 7 days and 28days.
7. The compressive, split tensile and flexural strength are evaluated.
8. The durability of M25 grade with replacement of GGBS and M Sand with fiber replacement concrete by 5% [H_2SO_4] concentration of sulphuric acid.
9. Analysis is carried out with modified concrete and conventional concrete

A. MATERIALS USED AND BASIC TEST RESULTS

1. Cement [43 Grade Chettinad]
2. Ground Granulated Blast Furnace Slag [GGBS]
3. Fine aggregate [zone-II]
4. Manufacturing Sand [Granite Waste zone-II]
5. Course Aggregate [20mm down]
6. Water [portable water]
7. Galvanized Iron Fiber [GI]

Table 1 Cement Properties

SL. NO	PROPERTIES	RESULTS
(1)	Specific Gravity	3.14
(2)	Initial setting time	45min
(3)	Final setting time	600min
(4)	Normal consistency.	32%
(5)	Finesse modulus	97.45%

Table 2 GGBS Properties

PARAMETERS	PERCENTAGE
Calcium oxide	37.34%
Aluminum oxide	14.42%
Iron oxide	1.11%
Silicon dioxide	37.73%
Magnesium oxide	8.71%
Manganese oxide	0.02%
Sulphide Sulphur	0.40 %

Table 3 Natural sand Properties

SL. NO	PROPERTIES	RESULTS
(1)	Specific Gravity	2.68
(2)	Finesse modulus	4.45
(3)	Water absorption	0.85%

Table 4 M Sand Properties

SL. NO	PROPERTIES	RESULTS
(1)	Specific Gravity	2.71
(2)	Finesse modulus	5.2
(3)	Water absorption	1.25%

Table 5 Coarse Aggregate Properties

SL. NO	PROPERTIES	RESULTS
(1)	Specific Gravity	2.7
(2)	Finesse modulus	7.15
(3)	Water absorption	1.2%
(4)	Impact value	8.5%

V. MIX DESIGN

Table 6 Mix Design for M25 Grade

SL. NO	MATERIAL	QUANTITY Kg/M^3
1	Cement	433
2	Fine aggregate	695
3	Coarse aggregate	1079
4	Water	197Lts
5	Water-Cement Proportion	0.45

VI. TESTS ON CONCRETE

Table 7:- Tests conducted in this experiment are as fallows.

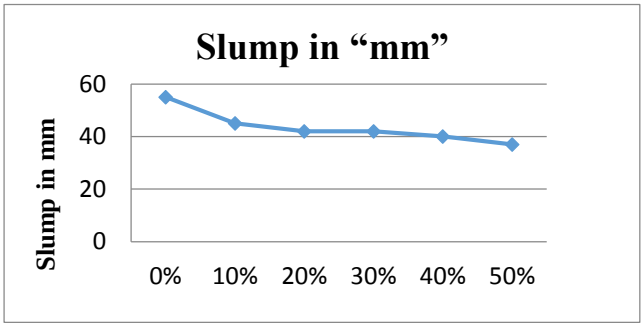
SL.No	STATE	TYPE OF TEST
1	Fresh concrete	Slump cone test
2	Harden concrete	Compressive strength test
		Split tensile strength
		Flexural strength
		Durability test

A. Slump Cone Test:

Measuring the workability of fresh concrete is usually done using the indirect method slump test in this study; the slump test was conducted to determine its workability. Slump cone was filled by 3 layers with 25 times temping on each layer. Diameter of the temping rod was 5/8 inch. Figure shows the workability measurement

Table 8:- Slump Values

Sr No	Percentage of GGBS	Slump in "mm"
1	0%	55
2	10%	45
3	20%	42
4	30%	42
5	40%	40
6	50%	37



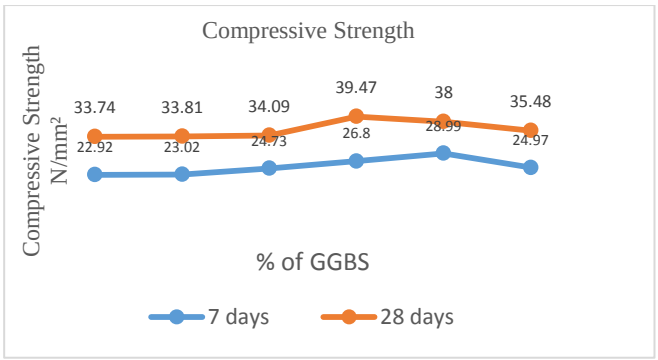
Graph no.1:- The graph shows as increase in the GGBS content in concrete decreases in the workability.

B. Compressive Strength Test.

Compressive strength of concrete is conducted at 7 & 28 days with the help of CTM shown in figure. Loading at rate of 4 kn/sec by the CTM over the specimens. Compressive strength of the cube is determined as per [IS ;516-1959]. Fig shows the compressive strength test of the specimen. The test is conducted in a 1000 kN compression testing machine with a rate of loading controller.

Table 9 Compressive Strength of Cube

SL.No	% of GGBS + M Sand 60% + Fiber 1%	Comp. Strength 7days N/mm²	Comp. Strength 28days N/mm²
1	0%	22.92	33.74
2	10%	23.02	33.81
3	20%	24.73	34.09
4	30%	26.80	39.47
5	40%	28.99	38.00
6	50%	24.97	35.48



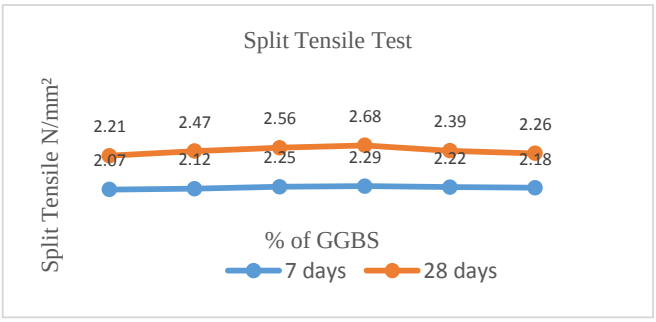
Graph no.2:- The graph shows the results of compression strength at 7 and 28days and the optimum strength in 30% of GGBS,60% m-sand and 1%GI fiber.

C. Concrete Split Tensile Strength

In this study, split test is conducted to find out the tensile strength of concrete. the testing of cylindrical specimen done at 7 and 28 days with the help of CTM Loading rate was 4 kn/sec by the CTM over the specimens. Tensile strength test of the cube is determined as per [IS ;5816-1970] Failure surfaces of concrete have been also observed after crushing of the specimens. Fig shows the tensile strength test of the specimen.

Table 10 Split tensile Strength of Cylinder

SL.No	% of GGBS + M Sand 60% + Fiber 1%	Split Strength 7days N/mm²	Split Strength 28days N/mm²
1	0%	2.07	2.21
2	10%	2.12	2.47
3	20%	2.25	2.56
4	30%	2.29	2.68
5	40%	2.22	2.39
6	50%	2.18	2.26



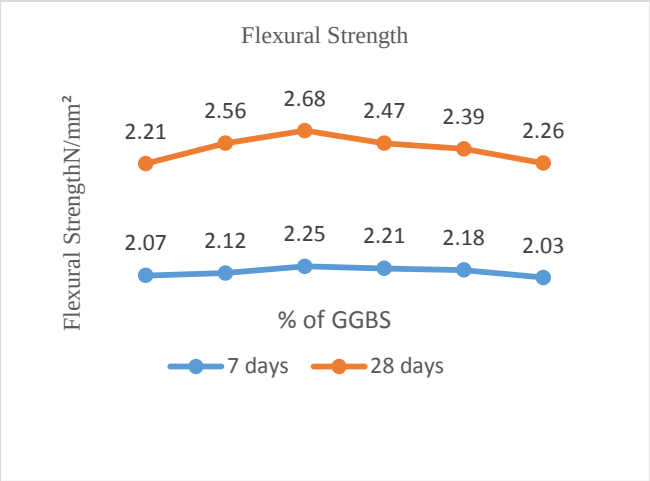
Graph no.3:- The graph shows the results of split strength at 7 and 28 days and the optimum strength in 30% of GGBS,60% m-sand and 1%GI fiber.

D. Flexural Strength Test

Flexural test is conducted to determine the flexural strength of specimen. Testing is done at 7 & 28 days with the help of Universal Testing Machine (UTM). Loading rate was 4 kn/sec by the UTM over the specimens. Flexural strength of the cube is determined as per [IS ;516-1959]. Fig shows the tensile strength test of the specimen

Table 11 Flexural Strength of Beam

SL.NO	% OF GGBS + M SAND 60% + FIBER 1%	FLX. STRENGTH 7 DAYS N/mm^2	FLX. STRENGTH 28 DAYS N/mm^2
1	0%	2.07	2.21
2	10%	2.12	2.56
3	20%	2.25	2.68
4	30%	2.21	2.47
5	40%	2.18	2.39
6	50%	2.03	2.26



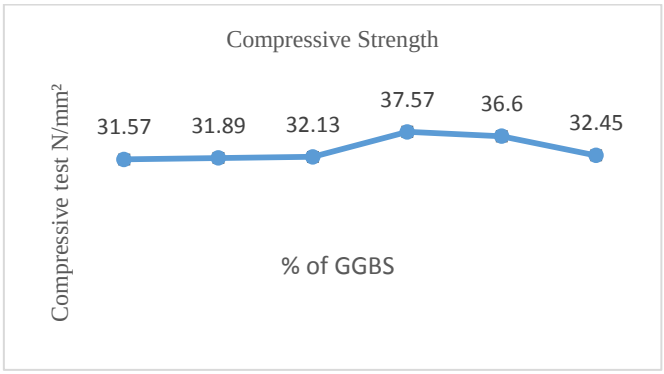
Graph no.4:- The graph shows the results of flexural strength at 7 and 28 days and the optimum strength in 20% of GGBS,60% m-sand and 1%GI fiber.

E. Durability Test

In the durability test is carried out by testing the cube 150x150x150mm first specimens are cured 28days in portable water and then the specimens are inserted in the acid[H_2SO_4 5% Concentration] 28 days and after those specimens are tested in compressive strength.

Table 12 Compressive Strength of Cubes

SL.NO	% OF GGBS + M SAND 60% + FIBER 1%	COMPRESSIVE STRENGTH N/mm^2
1	0%	31.57
2	10%	31.89
3	20%	32.13
4	30%	37.57
5	40%	36.6
6	50%	32.45



Graph no.5:- The graph shows the results of durability test results by compression strength at 28 days and the optimum strength in 30% of GGBS,60% m-sand and 1%GI fiber.

VII. CONCLUSIONS

1. Increase in the GGBS content in the concrete affects (decreases) the workability.
2. As the percentage of GGBS increases, so the compressive strength of concrete also increases. Maximum compressive strength was observed for mix containing 30% GGBS, 60% M-sand& 1% GI. Further GGBS increase, decreases the strength of concrete. Therefore the optimum replacement for cement with GGBS was 30%.
3. Maximum split tensile strength was observed for mix containing 30% GGBS and 60% M sand and 1% of GI fiber.
4. Maximum flexural strength was observed for mix containing 20%GGBS and 60% of m-sand and 1% of GI fiber.
5. Using of m-sand helps in good gradation and gives smooth finish. The homogeneity of mix was good

therefore the m-sand is the perfect replacement of river sand.

6. Manufacturing sand is the best alternative for river sand and it helps to reduce the environmental issues and also well in economical balance.

VIII. FUTURE INVESTIGATION

1. In our study we have designed M25; the study can also be extended.
2. In order to improve workability adds the super plasticizers.
3. Comparative study can also carried out with other types of fibers available for fiber reinforced concrete.
4. We replaced the GGBS by 10% interval to know the accurate value replacement reduce the interval of replacement
5. In our study we use m-sand as granite waste. Comparative study can also carried out with different type of manufacturing sands.

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