Glass Fiber-Reinforced M30 Grade Concrete with Manufactured Sand: A Study on its Mechanical, Durability, and Microstructural Properties

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***Abstract*—The major problem that the world is facing today is the environmental pollution. In the construction industry mainly the production of ordinary Portland cement (OPC) will cause the emission of pollutants which results in environmental pollution. The production of one ton of Portland cement emits approximately 850kg of CO2 into the atmosphere. An effort in this regard is the replacement of Portland cement with materials of biological origin or by-product materials such as Glass Fibers and manufactured sand in place of natural sand etc. Tests were carried out on 150mmX150mmX150mm cubes. In the present work, the strength characteristics and Bond were studied. To study the BOND STRENGTH of concrete by using pullout test method (IS 2770-part1), by 16mm diameter Mild and HYSD steel bars were used.**

***Index Terms*—FiberReinforced, Glass, Manufactured Sand**

I. INTRODUCTION

1.1 General

Concrete is a compound structure material conforming of Cement, Water and Aggregates in suitable proportions. The Chemical response between cement and water binds the Aggregates into a hard Solid Mass. Concrete Structures have come truly common in Civil Engineering Constructions Worldwide. Concrete is the most extensively used material in construction assiduity. It has come a universal structure material for its high Compressive Strength, adaptability of gaining any shape and form and its resistance to fire and erosion with veritably low conservation costs. Concrete with high strength along with long term continuity, utility is the need of the day. With the environmental issues raising because of birth of beach from gutters, the demand for relief of Beach is extensively adding. The drop in vacuity of Natural beach is also a cause for the demand for relief of Sands worldwide. Civil masterminds have to promote the use of Manufactured Sand as the demand for ban on beach mining is adding day by day in colorful regions 1.2 Manufactured Sand Crushing the Rock to gain the needed grain size of total can be nominated as Cultivated sand (M- Sand). The coarser gravestone is crushed in a special gravestone clincher in order to achieve the required grain size and the material is washed to remove the fine gemstone greasepaint. The characters of Concrete with River Sand is compared with characteristics of Concrete with M- Sand and Glass fibre to prove that M-Sand is a good relief of Natural Sand and to study the best of Glass fiber on Characteristics of Concrete. We believe that Manufactured Sand is commodity rather more specific than just classified clincher dust The end is to produce material that can be used as 100 relief for the stylish quality natural sand, where natural sand is the usual choice. The Manufactured Aggregates i.e., crushed hard gemstone in construction technology have been in use since Roman times. still, natural aggregates feel to be provident, for the same reason Manufactured aggregates are concentrated to regions or systems where vacuity of Natural aggregates is really low. 1.3 Natural Sand Vs Manufactured Sand River Sand is formed by the waste process of hard gemstone which occurs naturally by which the swash sand attains smooth face texture and shape. The humidity carried by the sand in between patches helps for the plasticity of concrete. But the characteristics of concrete is affected important by ground and complexion content of swash sand which is necessary indeed after fine grading of sand because of its natural circumstance. Grading to gain the needed fineness modulus between2.4 to3.1 becomes

tough for swash sand. As we've no control over natural processes, it has been confirmed that across colorful regions of south the probability of getting compatible quality of sand in terms of grading and sediment and complexion content is truly low.

1.5 Glass Fiber

Glass fiber also named as Fiber glass is a light weight, extremely strong, robust material made by Extremely fine fibers of Glass. The low-cost raw materials used to produce it and its low brittle nature make Glass fiber dependable than other metals whose bulk strength and weight properties are less favorable compared to Glass fiber. Glass being the most familiar, oldest performance fiber since 1930s, can be readily produced by molding. It can be stated that the strength and continuity increase with reasonable percentage of addition of glass fiber supplements in concrete mix. The factors of Glass Fiber Reinforced Concrete are Portland Cement, water, Aggregates both coarse and fine with alkali resistant glass fiber as reinforcing material. The Tensile and Impact Strength of concrete are bettered by the use of GFRC. GFRC is being used substantially in nonstructural industries like façade panels which use about 80 of GFRC for its production, Sanitation networks and unrecoverable decorative form works and have been applied in various structural elements for 30 years. The durability of Glass fiber has been an issue as its reactivity to alkalinity of cement mortar is high, but significant progression in technology lead to the invention of utmost dependable, durable alkali resistant Glass fibers. And the wide range of mortar essentials available which help embrittlement of GFRC make it a safe structure material in construction industry present. The recent studies by known concrete precast industries have been carried out to check the trustability of Glass fiber as a structure material, as its low importing and enhanced tensile strengths attract the technicians each over the world. Especially the need for lightweight concretes for easy transport and installation led to the exploration on Glass fiber. The reinforcing systems with carbon or glass sand and stainless-steel bars are analyzed to obtain GFRC with high continuity which leads to erosion free concrete. The characteristic properties of Glass fiber are yet to be known in detail, indeed if they're extensively used in nonstructural elements, with average mechanical properties. The mechanical strengths, Young's modulus, creep and loss and stress-strain figures are determined for Glass fiber using experimental results. Indeed, though the material characteristics depend substantially on the production styles, tests are carried out with different percentages of cementitious matrix in plain mortar to gain needed mechanical properties.

Scope of present work Review and exploration of glass fibers Investigation and laboratory testing on concrete moulds. Analysis the results and recommendation for farther exploration work. 1.7 Applications of GFRC worldwide 1.7.1 Cladding Much earlier, in the late 1970's, GFRC panels are used on exterior wall of prefabricated timber frame buildings constructed to meet the shortage of dwellings in Scotland. 1.7.2 Road and Rail sound walls Throughout the world, new roadways and mass conveyance rail systems contend for space in formerly developed civic areas. The result is that major business routes are set up near to marketable and domestic areas and it becomes necessary to suppress noise pollution to the surroundings. GFRC noise walls are being decreasingly used since they are light in weight and offer simplicity and speed of construction without taking the use of heavy lifting. 1.7.3 Ducts and Channels For drainage and transporting liquids represent another operation for GFRC. commercially available high volume, rainwater drainage channel used in parking lots, road and trace operations. These channels are designed for optimum inflow capacity and are available in different cross-sectional sizes with lengths were ranging up to 2 measures (6.6 bases). Further, these channels are light, easy to install in long sections with reduced excavation, conservation free, and bear smaller ground traps or manholes due to their superior hydraulic performance. The channels are produced by vibration casting AR fibers mix into two-part mold.

II. LITERATURE REVIEW

2.1 General In this design it has been achieved to review the literature available in the field of Fiber Reinforced Concrete by using manufactured sand. Some of the important literature connected with this content is furnished below.

2.2 Literature Review

Chandramouli. K,et al., (2010) conducted a study to probe the strength properties of glass fiber reinforced concrete. The author has observed that the addition of glass 1fibres increases the compressive strength from 20 to 25 & increased the tensile & flexural strength from 15 to 20. The author also has observed that addition of glass fibers reduces the bleeding of concrete & reduces the probability of cracks.

P. Sangeetha, (2011) has concluded that Glass fiber with combination of admixtures shows good result both in compressive & impact test. Eng. Psthiwar.N. Shakoret.al, (2011) have observed that glass fiber helps the concrete to increase compressive strength until indicated limit. For1.5 of cementitious weight gained the best results have been attained as compared to other results. The author also has set up that the air entrainment affects the tensile strength to compressive strength rate particularly in rich composites.

III. MATERIAL PROPERTIES

3.1 General The experimental program was carried out to estimate the mechanical properties i.e., compressive strength and split tensile strength with replacing glass fiber. The program involves casting and testing of total samples. The samples of standard cubes of 150mmx150mmx150mm are casted with and without glass fiber. In first batch the samples were cast with 0 fiber content and remaining four batches were cast by using fiber varying with 1, 2 and 3 by the weight of the cement. The materials generally used in the concrete mix are cement, fine aggregate (M- Sand & River Sand), coarse aggregate, fibers & water. The materials used in this design for concrete mix are, 3.2 Materials used The materials used in the investigation are: Cement Aggregates Fine Aggregates River Sand Manufacturing Sand (M-sand) Coarse Aggregates Glass fibres Mild Steel bars and HYSD bars Water

IV. OBJECTIVES OF INVESTIGATION

4.1M-Sand:

Natural Sand has been used for making of mortar or Concrete since the invention of Cement.

The word Natural Sand itself states that it's a Naturally occurring Material, which is generally formed by weathering effect of rocks

due to various factors.

Generally, Sands are available in Riverbeds and ocean props whereas the nearest available resource is given preference.

still, Sand in Sea Shore isn't preferred due to its high Salt Content which largely decreases the Durability of Concrete.

By this the use of River sand is adding day by day, which is dropping the availability of this natural resource, so there's a need to find

an alternative or a substitute for River Sand.

M- Sand is artificially being sand in Stone Crushing manufactures called Crusher Dust which can be a perfect substitute for Natural

sand as it can be crushed into needed sizes and its reactivity to acid and base circumstances is also truly less.

So, in this research M- Sand has been used as substitute for River sand in different percentages and various tests has been carried out.

V. MIX DESIGN

5.1 General: In thisproject, IS 10262-2009 have been used to know the proportions for the M30 grade of Concrete, and the Mix Design is as mentioned below.

5.2 Mix Design for M30Grade Concrete:

M-30 GRADE CONCRETE MIX DESIGN		
As per MORT&H&IS 10262-2009		
I	Stipulations for Proportioning	
	Grade	M30
	Cement	OPC 53 grade
	Maximum size of Aggregate	20 mm
	Minimum Cement content (kg/m3)	310 kg/m3
	Maximum Water/ Cement Ratio	0.45
	Workability (slump)	50-75 mm (Slump)
	Exposure Conditions	Normal
	Supervision	Good
	Aggregates	Crushed Angular Aggregates
	Maximum Cement Content	540 kg/m3
	Chemical Admixture used	Superplasticizer

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VI. EXPERIMENTAL INVESTIGATIONS

6.1 General

In this disquisition the exploratory examination is completed to acquire the Compressive strength quality, Split Tensile, Workability and Durability of M30 evaluation of cement by partly substituting of bond with M- sand and Glass fiber. In the present examination, Concrete specimens were readied with different extents of Glass fiber and M- sand 25%, 50%, 75%, 100% of bond replacement of weight. Quantities of Materials to be used in this Project

Were

CC = Conventional Concrete of M30 Grade

M1 = 25% of Manufacturing Sand substituted M30 Grade Concrete

M2 = 50% of Manufacturing Sand substituted M30 Grade Concrete

M3 = 75% of Manufacturing Sand substituted M30 Grade Concrete

M4 = 100% of Manufacturing Sand substituted M30 Grade Concrete

6.2 Mixing of Concrete At first the mixed design is carried in ACI system the figure of solid mix requires complete literacy of different properties of the component materials. seasoning, for illustration, bond and M- sand are blended, to which the fine total and coarse aggregate are included and fully blended. Water and Glass fibers are measured precisely. At that point it is added to the dry mix and it's fully blended until a mix of even shading and thickness is fulfilled which is also prepared for throwing. Before throwing of samples, workability is measured as per the code IS 1199- 1959 by droop and compaction variable tests.

6.3 Workability of Concrete: The workability of the concrete was set up by using slump cone test. The slump outfit consists of a conical shape frustum of top diameter 10 cm and bottom diameter 20 cm with a height 30 cm. The concrete mix is placed in slump cone in three equal layers. Each layer was tempered by given 25 blows with a bullet end tamping rod. After completion of last layer redundant concrete was removed and position. instantly the slump cone was raised overhead, this allows the concrete subside. The subsidence of concrete was known as SLUMP. The slump value can be measured by taking the difference between height of subside concrete and mould height. The following table gives a clear image about slump values for different workabilities.

6.4.1 Casting

The basic moulds were fitted like that there are no gaps between the plates of themoulds.However, they were filled with plaster of Paris, If there is any gap. The moulds were then greased and kept ready for casting After the completion of the casting, the samples were vibrated on the table vibrator for 2 minutes. At the end of vibration, the external surface was made a plane using trowel.

6.6.2 Split Tensile Strength of Concrete

Assuming concrete specimen behaves as an elastic body a uniform side tensile stress of Part elasticity (Ft) action alone the perpendicular

plane causes the failure of the specimen, which can be calculated from the formula.

$Ft = 2P/\pi DL.$

Were,

P= load at failure,

D= Diameter and

L=length of the cube.

The load condition produces a high compressive stress incontinently below the two generators to which the weight is applied. But the

larger portion corresponding to depth is subordinated to a steady tensile stress acting horizontally. It's estimated that the compressive

stress is acting for about1/6 depth and the remaining5/6 depth is subordinated to tension. The main advantage of this system is that the

same type of specimen and the same testing machines as are used for the compression test can be employed for this test. Strength

determined in the splitting test is believed to be near to the true tensile strength of concrete, then the modulus rupture.

VII. EXPERIMENTAL RESULTS AND DISCUSSIONS OF TEST RESULTS

7.1 General

In this chapter the results of workability, compressive strength, split tensile strength and durability tests for different Concrete Mix

proportions of M30 with varying percentage of M-sand and Glass fiber replaced with cement are shown and talked over.

7.2 Workability

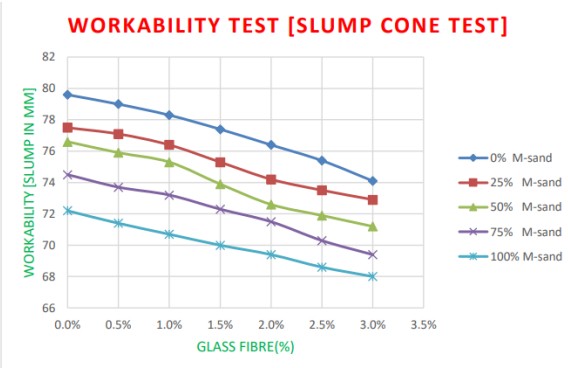

Table 7.2 Compressive Strength for 7 days for different proportions of M-sand and Glass fiber

7 days Compressive strength(N/mm2)					
	M30				
Glass fibre(%)	0% M-sand	25% M-sand	50% M-sand	75% M-sand	100% M-sand
0%	22.3	23.3	24.5	25.7	26
0.5%	22.7	23.9	25	26.2	26.6
1%	23.2	24.6	25.5	26.9	27.2
1.5%	23.35	24.8	25.9	27.2	27.75
2%	23.7	25.3	26.1	27.7	28.4
2.5%	23.9	25.4	26.8	28.1	28.8
3%	24.3	25.9	27.4	28.6	29.4

7.6 DISCUSSIONS OF TEST RESULTS:

7.6.1 Workability Test:

Bythe replacement of Manufacturing sand in the place of Natural Sand, the Workability of Concrete is decreased by 9.54% up to
100% replacement. It is also further changed with the addition of glass fibers of 0%,0.5%,1%,1.5%, 2%,2.5% & 3%. Workability is
decreased by 1.88%, 6.2%, 7.06%, 6.99%, 5.83% for CC, M1, M2, M3, M4 mixes with glass fiber of of 0%,0.5%,1%,1.5%, 2%,2.5% &
3%addition.

7.6.2 Compression Test:

For 7 days:

By the replacement of Manufacturing sand in place of Natural Sand, the Compressive Strength of Concrete is gained by 16.67%
up to 100% replacement. It is also further changed with the addition of glass fibers of of 0%,0.5%,1%,1.5%, 2%,2.5% & 3%. Compressive
Strength is gained by 9%,10.76%,11.89%,11.33%,13.13% for CC, M1, M2, M3, M4 mixes with glass fiber of 0%,0.5%,1%,1.5%, 2%,2.5%
& 3% addition.

For 28 days:

Bythe replacement of Manufacturing sand in place of Natural Sand, the Compressive Strength of Concrete is gained by 7.88% up
to 100% replacement. It is also further changed with the addition of glass fibers of of 0%,0.5%,1%,1.5%, 2%,2.5% & 3%. Compressive
Strength is gained by 5.71%,5.6%, 5.48%,5.38%,5.29% for CC, M1, M2, M3, M4 mixes with glass fiber of of 0%,0.5%,1%,1.5%, 2%,2.5%
& 3% addition

VIII. CONCLUSIONS

Based on the test examination, we can conclude that the mix of M- sand and Glass fiber can be employed as Ordinary Portland bond
replacement for solid readiness up to a reasonable extent. Based on experimental results the following conclusions are drawn.

1. By replacing the Natural sand with M- sand at different percentages say 0%, 25%, 50%, 75%, 100%, Workability is reduced by0.79%
to14.52% and alike, By using Glass fiber at different percentages say 0%,0.5%,1%,1.5%, 2%,2.5% & 3%, Workability is reduced by1.4%
to12.15%.
2. By replacing the Natural sand with M- sand at same percentages as above the 7 days and 28 days Compressive Strength is increased
by1.96% to11.15% and1.76% to9.62% respectively and likewise by using Glass fiber at same amounts as above the 7 days and 28 days
Compressive Strength is increased by4.10% to9.31% and2.47% to6.15% respectively.
3. By replacing the Natural sand with M- sand at same percentages as above the 7 days and 28 days Split Tensile Strength is increased
by2.95% to13.33% and2.21% to10.31% respectively and likewise by using Glass fiber at same amounts as above the 7 days and 28 days
Split Tensile Strength is increased by6.55% to19.13% and4.20% to12.43% respectively.
4. By replacing the Natural sand with M- sand at same percentages as above the 3 days, 7 days, 14 days and 28 days Bond Strength is
increased by2.95% to13.33% ,2.68% to12.12%,2.75% to12.33% and2.21% to10.31% respectively and likewise by using Glass fiber at

same amounts as above the 3 days, 7 days, 14 days and 28 days Bond Strength is increased by2.95% to15.67%,2.68% to16.11%,2.75% to14.56% and2.21% to16.73% respectively.

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