AN EXPERIMENTAL STUDY ON EFFECT OF BOND STRENGTH OF M_{30} GRADE CONCRETE BY USING MANUFACTURED SAND AND GLASS FIBER

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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.

Keywords: *ordinary Portland cement, concrete, sand, glass fiber.*

1.0 INTRODUCTION:
Concrete is a composite building material consisting of Cement, Water and Aggregates in suitable proportions. The Chemical reaction between cement and water binds the Aggregates into a hard Solid Mass. Concrete Structures have become very common in Civil Engineering Constructions Worldwide. Concrete is the most widely used material in construction industry. It has become a universal building material for its high Compressive Strength, adoptability of gaining any shape and form and its resistance to fire and corrosion with very low maintenance costs. Concrete with high strength along with long term durability, serviceability are the need of the day. With the environmental issues raising because of extraction of sand from rivers, the demand for replacement of Sand is widely increasing. The decrease in availability of Natural sand is also a cause for the demand for replacement of Sands worldwide. Civil engineers have to promote the use of Manufactured Sand as the demand for ban on sand mining is increasing day by day in various regions. Due to its consistent gradation with minimum impurities, manufactured sand is reported to be a widely used material by the technicians of major projects all round the world. According to IS code provisions, M30 grade concrete was made and is checked for Compressive, Split Tensile and Durability respectively. It can be stated that by use of manufactured sand in place of river sand, the strength of concrete is very much increased. The increase in usage of glass fiber in various categories has influenced even the construction field. The flexibility and non toxic nature of today's glass fiber makes it a suitable building material and a very good additive for concrete mix. So, in this Investigation along with replacement of Natural Sand with Manufactured Sand we also study the behavior of concrete with inclusion of glass fiber in different percentages. The compressive, Split Tensile Strength and durability are tested for concrete cubes made of different percentages of M-sand and Glass fibre. For Durability tests, Concrete is cured both in Acid and Base and decrease in weights and Compressive Strengths are tested.

Need for the present work
The advent of high strength concrete has helped construction activity in many ways for example to build high rise buildings by reducing column sizes and increasing available space and to put the concrete into service at much earlier age etc. concrete is

the most widely used building material today which is prone for cracking. The reasons for cracks in concrete may be because of several structural and environmental factors, but most of the cracks are formed in concrete due to its weak Tensile strength, for which it cannot withstand tensile loads and starts shrinking and when this shrinking is restrained by the structure, cracks occur. The Glass fibers are randomly oriented in concrete which controls the occurrence of cracks, by improving the crack resistance. The cracks occurring due to heavy loads even after using glass fiber are restricted from widening because of the fibers present across the cracks. Thus it can be stated that introduction of glass fiber in concrete improves both its mechanical properties and durability.

Objectives:

The main objectives of this project are as below:

i. To develop fiber reinforced concrete by replacing natural sand by manufacturing sand and small proportions of chopped alkali resistant glass fibers.

ii. To examine the workability of manufacturing sand and using admixture in concrete.

iii. To investigate the performance of these concrete terms of its compressive strength, split tensile strength and bond strength.

2.0 LITERATURE REVIEW

- **Chandramouli. K, et.al**, (2010) conducted a study to investigate the strength properties of glass fibre 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 fibres reduces the bleeding of concrete & reduces the probability of cracks.
- **P. Sangeetha,** (2011) has concluded that Glass fibre with combination of admixtures shows good result both in compressive & impact test.
- **Eng. Psthiwar. N. Shakor et.al,** (2011) have observed that glass fiber helps the concrete to increase compressive strength until indicated limit. For 1.5% of cemetitious weight gained best results have been obtained as compared to other results. The author also has found that the air entrainment affects the tensile strength to compressive strength ratio particularly in rich mixes.
- **Surendra. P. Shah, et.al,** (1987) to investigate the toughness of GFRC panels subjected to accelerated aging. The author has observed that the reduction in flexural strength & toughness when exposed to an accelerated aging environment.
- **Mohamed S. Issa& S.M. Elzeiny**, (2011) reported the flexural behaviour of cantilever concrete beams reinforced with GFR polymer bars. The author has observed that theoretical analysis gives 30% lower than the experimental ultimate flexural capacity for GFRP reinforced cantilever beams.
- **S.U. Kannan, et al**, (2010) conducted experiments on the effect of AR Glass polymer fibers in self compacting and self curing concrete. Based on the results obtained the author has concluded that the lowest volume of fibers 0.2% makes the concrete impermeable with good workability and more compressive strength. The author has also pointed out that the maximum compressive strength & maximum resistance to penetration is obtained at 1% volume of fibres with 0.8% of super plasticizer.
- **Mahendra. R. Chitlange&Prakash. S. Pajgade**, (2010) have investigated the strength properties of artificial sand as fine aggregate in SFRC. The author has reported that there is consistent increase in the strength of plain concrete when natural sand is fully replaced by artificial sand. The author has also pointed out that the full replacement of natural sand by aritificial sand considering the

technical, environmental & commercial factors is effective.

- **H.M.A. Mazes, et.al,** (2011) have conducted studies to determine the relative performance of concrete by using powder sand. From the experiments the author has observed that the compressive strength of mortar & concrete using stone powder gives impressive result than that of normal sand.
- **V.R.K. NarasinhaRaju, T. Appa Reddy**, (2009) have conducted experiments for different concrete mix proportions at different percentage replacement levels of river sand by manufactured fine aggregate. The author has concluded that the replacement of natural sand by manufactured fine aggregate improves the workability & compressive strength.

MATERIAL PROPERTIES

Composition of Ordinary Cement

Ingredient	Percentage (%)	Range
Lime (Cao)	62	62-67
Silica (Sio_2)	22	17-25
Alumina (Al_2o_3)	5	03-Aug
Calcium Sulphate ($Caso_4$)	4	03-Apr
Iron Oxide (Fe_2o_3)	3	03-Apr
Magnesium (Mgo)	2	0.1-3

Properties of River-Sand

S.No	PARTICULAR	VALUES
1.	Specific gravity	2.604
2.	Fineness Modulus	2.85
3.	Water Absorption	1.23%
4.	Bulk Density	
	Loose Sand	1424kg/m3
	Compacted Sand	1625kg/m3
5.	Grading of River Sand	Zone – II
6.	Surface Texture	Smooth

According to IS 383: 1970, coarse aggregate may be described as crushed gravel or stone when it results from crushing of gravel or hard stone. The coarse aggregate procured from quarry was sieved through the sieved of sizes 20 mm and 10 mm respectively. The aggregate passing through 20 mm IS sieve and retained on 10 mm IS sieve was taken. Specific gravity of the coarse aggregate is 2.7.

Coarse Aggregate

OBJECTIVES OF INVESTIGATION

M-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 is a naturally occurring Material, which is generally formed by weathering effect of rocks due to various factors.
- Generally Sands are available in River beds and Sea shores whereas the nearest available resource is given preference.
- However, Sand in Sea Shore is not preferred due to its high Salt Content which highly decreases the Durability of Concrete.
- By this the usage of River sand is increasing day by day which is decreasing the availability of this natural resource, so there is a need to find an alternative or a replacement for River Sand.
- M-Sand is artificially occurring

sand in Stone Crushing factories called Crusher Dust which can be a perfect replacement for Natural sand as it can be crushed into required sizes and its reactivity to acid and base circumstances is also very less.

- So, in this Investigation M-Sand has been used as replacement for River sand in different percentages and various tests has been carried out.
- It has been used in percentages of 25%, 50%, 75%, 100% replacements for River Sand and several cubes have been casted in these percentages for investigation.
- Workability test, Compressive Strength Test, Split Tensile Strength Test and Durability tests for Compressive Strength and Weights have been carried out both in Acidic and base circumstances.
- The Strengths of these cubes have been compared with Strengths of Cubes with 0% M-sand i.e.., 100% River Sand such that the percentage increase or decrease in Compressive Strength, Split Tensile Strength, Workability and Bond Strength.
- The main objective of using M-sand is to draw the Impact of it on various implying factors of Concrete's utility and to check whether it can be a better replacement for River sand.
- The Strengths of Cubes are checked at different percentages of both Glass fibre and M-sand i.e., at 1% Glass fibre with varying percentages of M-sand i.e.., 25%, 50%, 75%, 100% and is compared without M-sand with 1% Glass fibre.
- Similarly it is checked for 1%, 2%, 3% of Glass fibre with varying percentages of M-sand i.e., 25%, 50%, 75%, 100% and results are noted.

MIX DESIGN

Mix Design for M30:

M-30 CONCRETE MIX DESIGN		
As per IS 10262-2009 & MORT&H		
A-1	Stipulations for Proportioning	
1	Grade Designation	M30
2	Type of Cement	OPC 53 grade confirming to IS-12269-1987
3	Maximum Nominal Aggregate Size	20 mm
4	Minimum Cement Content (MORT&H 1700-3 A)	310 kg/m3
5	Maximum Water Cement Ratio (MORT&H 1700-3 A)	0.45
6	Workability (MORT&H 1700-4)	50-75 mm (Slump)
7	Exposure Condition	Normal
8	Degree of Supervision	Good
9	Type of Aggregate	Crushed Angular Aggregate
10	Maximum Cement Content (MORT&H Cl. 1703.2)	540 kg/m3
11	Chemical Admixture Type	Superplasticiser Confirming to IS-9103

A-2	Test Data for Materials	
1	Cement Used	Coromandal King OPC 53 grade
2	Sp. Gravity of Cement	3.15
3	Sp. Gravity of Water	1.00
4	Chemical Admixture	BASF Chemicals Company
5	Sp. Gravity of 20 mm Aggregate	2.884
6	Sp. Gravity of Sand	2.605
7	Water Absorption of 20 mm Aggregate	0.97%
8	Water Absorption of Sand	1.23%
9	Free (Surface) Moisture of 20 mm Aggregate	Nil
10	Free (Surface) Moisture of Sand	Nil
11	Sieve Analysis of Individual Coarse Aggregates	Separate Analysis Done

EXPERIMENTAL INVESTIGATIONS

In this investigation the exploratory examination is completed to acquire the Compressive strength quality, Split Tensile, Workability and Durability of M30 evaluation of cement by halfway supplanting of bond with M-sand and Glass fibre. In the present examination, Concrete examples were readied with different extents of Glass fibre 0%,1%,2%,3% and M-sand 0%,25%,50%,75%,100% of bond substitution of weight

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Quantities of Materials to be used in this Project

	Cement (kg/m^3)	River Sand (kg/m^3)	Manufacturing Sand (kg/m^3)	Coarse Aggregates (kg/m^3)	Glass Fibers (kg/m^3)		
					1%	2%	3%
CC	380	711	-	1283	2.29	4.58	6.876
M1	380	533.25	182.94	1283	2.29	4.58	6.876
M2	380	355.5	365.88	1283	2.29	4.58	6.876
M3	380	177.75	548.81	1283	2.29	4.58	6.876
M4	380	0	731.75	1283	2.29	4.58	6.876

Where

CC = Conventional Concrete of M30 Grade

M1 = 25% of Manufacturing Sand replaced M30 Grade Concrete

M2 = 50% of Manufacturing Sand replaced M30 Grade Concrete

M3 = 75% of Manufacturing Sand replaced M30 Grade Concrete

M4 = 100% of Manufacturing Sand replaced M30 Grade Concrete

Mixing of Concrete

At first the mixed design is carried in ACI method the outline of solid blend requires complete learning of different properties of the constituent materials. fixings, for example, bond and M-sand are blended, to which the fine total and coarse total are included and completely blended. Water and Glass fibres are measured precisely. At that point it is added to the dry blend and it is completely blended until a blend of uniform shading and consistency is accomplished which is then prepared for throwing. Before throwing of examples, workability is measured as per the code IS 1199-1959 by droop and compaction variable tests.


Mixingcement+M-sand+River sand+Glass fibre

Degree of Workability

Degree of Workability	Slump Value
Very low	___
Low	25-75
Medium	50-80
High	90-100
Very high	_____


Compressive Strength with CTM

- **SLIP OF BARS:**

During slip the bar comes out of the cube as shown in figure 3.12.2: which will occur in case of MILD steel bars.

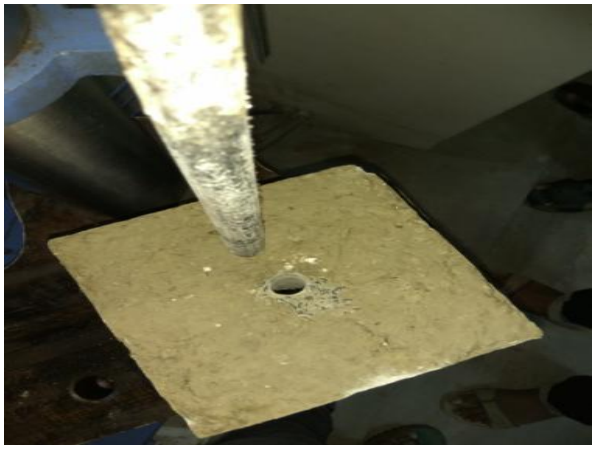


Fig Slipping of bar

YIELDING OF BARS:

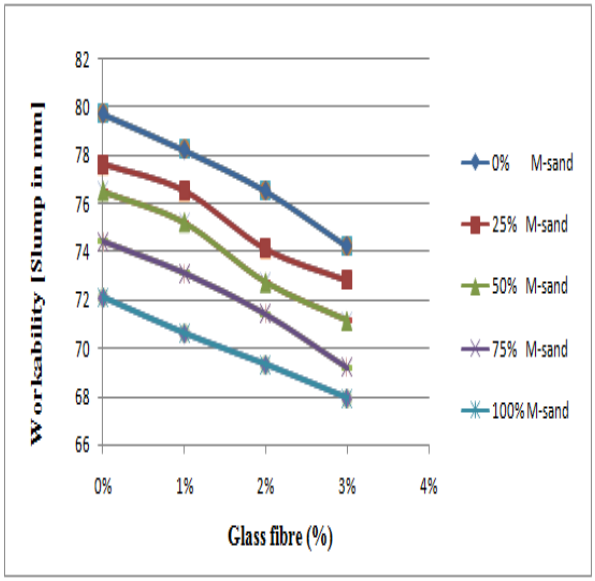
In yielding of bars the may broken during testing without slipping as shown In figure 3.12.3 which will occur in case of HYSD bars.

Fig Yielding of Bar

EXPERIMENTAL RESULTS & DISCUSSIONS OF TEST RESULTS

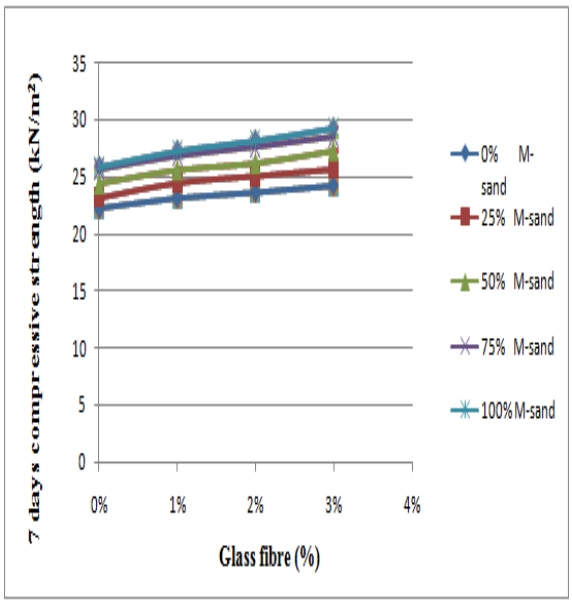
Workability test with different proportions of M-sand and Glass fibre

Workability [Slump in mm]					
	M30 Grade Concrete				
Glass fibre(%)	0% M-sand	25 % M-sand	50 % M-sand	75 % M-sand	100 % M-sand
0%	79.7	77.6	76.5	74.4	72.1
1%	78.2	76.5	75.2	73.1	70.6
2%	76.5	74.1	72.7	71.4	69.3
3%	74.2	72.8	71.1	69.2	67.9

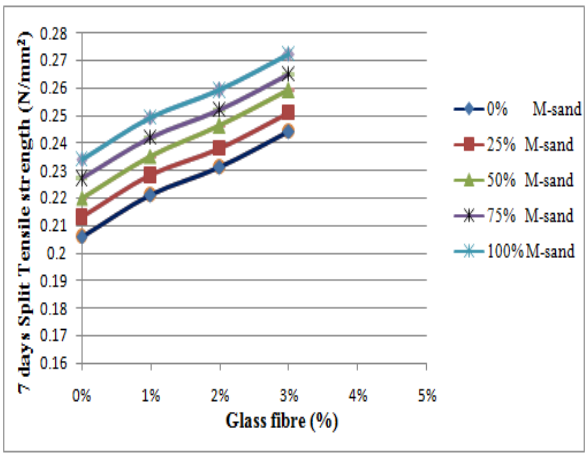


Compressive Strength for 7 days for different proportions of M-sand and Glass fibre

7 days Compressive strength(N/mm^2)					
	M30				
Glass fibre(%)	0% M-sand	25% M-sand	50% M-sand	75% M-sand	100%M-sand
0%	22.2	23.2	24.4	25.6	25.9
1%	23.1	24.5	25.6	26.8	27.3
2%	23.6	25.1	26.2	27.6	28.2
3%	24.2	25.7	27.3	28.5	29.3



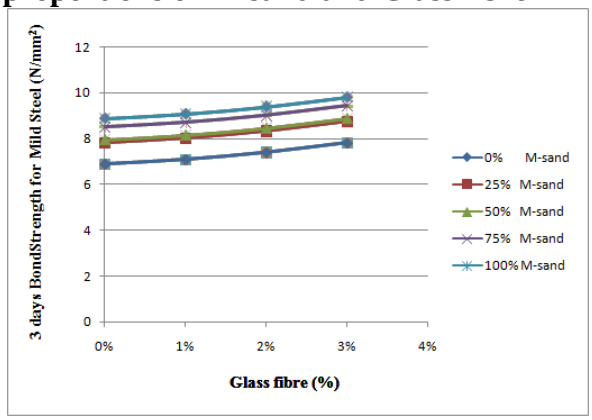
Effect of M-sand and Glass fibre on 7 days Compressive Strength of Concrete



Effect of M-sand and Glass fibre on 7 days Split tensile strength of Concrete

BOND STRENGTH OF CONCRETE

Bond Strength for 3 days for different proportions of M-sand and Glass fibre



DISCUSSIONS OF TEST RESULTS:

Workability Test:

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

Compression Test:

For 7 days:

By replacement of manufacturing sand in place of Natural Sand, the Compressive Strength of Concrete is increased by 16.67% up to 100% replacement. It is also further varied with addition of glass fibers of 1%, 2% & 3%. Compressive Strength is increased by 9%, 10.76%, 11.89%, 11.33%, 13.13% for CC, M1, M2, M3, M4

mixes with glass fiber of 1%, 2% & 3% addition.

For 28 days:

By replacement of manufacturing sand in place of Natural Sand, the Compressive Strength of Concrete is increased by 7.88% up to 100% replacement. It is also further varied with addition of glass fibers of 1%, 2% & 3%. Compressive Strength is increased by 5.71%, 5.6%, 5.48%, 5.38%, 5.29% for CC, M1, M2, M3, M4 mixes with glass fiber of 1%, 2% & 3% addition.

Split Tension Test:

For 7 days:

By replacement of manufacturing sand in place of Natural Sand, the Split Tensile Strength of Concrete is increased by 13.59% up to 100% replacement. It is also further varied with addition of glass fibers of 1%, 2% & 3%. Split Tensile Strength is increased by 18.45%, 17.84%, 17.73%, 16.74%, 16.24% for CC, M1, M2, M3, M4 mixes with glass fiber of 1%, 2% & 3% addition.

For 28 days:

By replacement of manufacturing sand in place of Natural Sand, the Split Tensile Strength of Concrete is increased by 24.84% up to 100% replacement. It is also further varied with addition of glass fibers of 1%, 2% & 3%. Split Tensile Strength is increased by 5.48%, 12.59%, 33.23%, 29.33%, and 21.45% for CC, M1, M2, M3, M4 mixes with glass fiber of 1%, 2% & 3% addition.

Bond Strength:

For 3 days:

By replacement of manufacturing sand in place of Natural Sand, the Bond Strength of Concrete is increased by 28.88% up to 100% replacement. It is also further varied with addition of glass fibers of 1%, 2% & 3%. Bond Strength is increased by 13.50%, 11.89%, 11.70%, 14.47%, and 10.47% for CC, M1, M2, M3, M4 mixes with glass fiber of 1%, 2% & 3% addition.

For 7 days:

By replacement of manufacturing sand in place of Natural Sand, the Bond Strength of Concrete is increased by 21.18% up to 100% replacement. It is also further varied with addition of glass fibers of 1%, 2% & 3%. Bond Strength is increased by 10%, 9.29%, 8.76%, 8.56%, 8. 25% for CC, M1, M2, M3, M4 mixes with glass fiber of 1%, 2% & 3% addition.

For 14 days:

By replacement of manufacturing sand in place of Natural Sand, the Bond Strength of Concrete is increased by 17.98% up to 100% replacement. It is also further varied with addition of glass fibers of 1%, 2% & 3%. Bond Strength is increased by 8.45%, 7.79%, 7.54%, 7.39%, 7.16% for CC, M1, M2, M3, M4 mixes with glass fiber of 1%, 2% & 3% addition.

For 28 days:

By replacement of manufacturing sand in place of Natural Sand, the Bond Strength of Concrete is increased by 20.47% up to 100% replacement. It is also further varied with addition of glass fibers of 1%, 2% & 3%. Bond Strength is increased by 7.62%, 6.89%, 6.69%, 6.44%, and 6.33% for CC, M1, M2, M3, M4 mixes with glass fiber of 1%, 2% & 3% addition.

CONCLUSIONS

Based on the test examination, we can conclude that the blend of M-sand and Glass fibre can be utilized as Ordinary Portland bond substitution for solid readiness upto 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 by 0.79% to 14.52% and Similarly, By using Glass fibre at different percentages say 1%, 2%, 3%, Workability is reduced by 1.4% to 12.15%.
2. By replacing the Natural sand with M-sand at same percentages as above the 7 days and 28 days Compressive Strength is increased by 1.96% to 11.15% and 1.76% to 9.62% respectively and similarly by using Glass fibre at same quantities as above the 7 days and 28 days Compressive Strength is increased by 4.10% to 9.31% and 2.47% to 6.15% 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 by 2.95% to 13.33% and 2.21% to 10.31% respectively and similarly by using Glass fibre at same quantities as above the 7 days and 28 days Split Tensile Strength is increased by 6.55% to 19.13% and 4.20% to 12.43% 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 by 2.95% to 13.33%, 2.68% to 12.12%, 2.75% to 12.33% and 2.21% to 10.31% respectively and similarly by using Glass fibre at same quantities as above the 3 days, 7 days, 14 days and 28 days Bond Strength is increased by 2.95% to 15.67%, 2.68% to 16.11%, 2.75% to 14.56% and 2.21% to 16.73% respectively

REFERENCES

- *Surendra.P.Shah, James I.Daniel&DarmavanLudirdja, "Toughness of Glass Fibre reinforced concrete panels subjected to accelerated aging", PCI Journal, Sept – October 1987 PP 83-88.*
- *Eng.Pshtiwan.N.Shakor&Prof.S.S.Pimplikar, "Glass Fibre Reinforced concrete use in construction", AKGEC Journal of Technology, vol.2, No.1 PP55-59.*
- *Eng. Pshtiwan. N. Shakor, Prof. S.S. Pimplikar, "Glass Fibre Reinforced Concrete use in Construction" International Journal of technology and Engineering system, Jan-March 2011-vol.2, No.2.*
- *Chandramouli.K, SrinivasaRao.P, Pannirselvam.N, SeshadriSekar.T, Sravana.P., "Strength properties of Glass Fibre concrete" ARPN Journal of Engg. & Applied Sciences, Vol.5, No.4, April 2010, PP 1-6.*
- *Darren Eddie, Ahmed Shalaby, and Sami Rizkalla, "Glass Fibre Reinforced Polymer Dowels for concrete pavements" ACI structural Journal, March – April 2001, PP 201-206.*
- *Mohamed S.Issa and S.M.Elzeiny, "Flexural Behaviour of cantilever concrete Beams reinforced with glass fibre reinforced polymers bars" Journal of civil Engg&Construction Technology Vol.2 (2) February 2011, PP 33-44.*