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An Experimental Investigation on the Effect of Manufactured Sand and Different Fibres in High Strenth Concrete

[1]B.Rachana, [2]K.Sahithi
[1]M.Tech Student, [2]Assistant Professor

Abstract:- Concrete is the most widely used construction material today. Increase in construction activities have led to an increase in demand for the various raw materials in concrete, especially river sand which is the conventionally used fine aggregate. Due to increase in mining process, the availability of this river sand is becoming scarce. This led to researches on alternate materials as ingredients of concrete that are in no way inferior to the conventional materials. Manufactured sand (M-Sand) was one of the alternate materials proposed. Though manufactured sand has many advantages, one of the major areas of concern is the fine material of size 150 micron and down removed during the manufacturing process and accumulated as a waste material.

The purpose of this research is to experiment ally investigate the effect of M-sand in structural concrete by replacing river sand and develop a high strength concrete. It is proposed to determine and compare the differences in properties of concrete containing river sand and m-sand. It is also proposed to use different fibres and chemical admixtures to increase the strength and workability of concrete respectively. The investigations are to be carried out using several tests which include workability test, compressive test, tensile test, and flexural test.

Keywords:- *Manufactured sand, Natural Sand, chemical admixture, fibres, compressive strength, flexural strength.*

I. INTRODUCTION

With the world wide decline in the availability of construction sands along with the environmental pressures to reduce extraction of sand from rivers, the use of manufactured sand as a replacement is increasing. With the ban on sand mining implemented by different states, and with the increasing demand for river sand for construction works, many civil engineers have expressed the need to promote use of manufactured sand in the construction industry. As per reports, manufactured sand is widely used all around the world and technicians of major projects around the world insist on the compulsory use of manufactured sand because of its consistent gradation and zero impurity. Concrete mix design of M60 grade was done according to Indian Standard code Concrete cube; beam and cylindrical specimens were tested for evaluation of compressive, split tensile & Flexural strength respectively.

The concrete exhibits excellent strength with 100% replacement of natural sand, so it can be used in concrete as viable alternative to natural sand. A Concrete add with various percentages of different fibers used. The compressive strength of concrete obtained at the ages of 7, 28, 56, days.

II. RESEARCHSIGNIFICANCE

Normal concrete lacks required strength and durability which are more often required for large concrete structures such as highrise buildings, bridges and structures under severe exposure condition. Due to booming construction activities natural sand is becoming scarce due to excessive non scientific methods of mining from the river beds. For these reasons it is necessary to produce a concrete with improved high strength, with suitable materials. This research shows the effective utilization of by product fibres and M-sand in High Strength Concrete.

III. MATERIALS USED

- *Cement*

Portland Pozzolana cement of 53 Grade conforming to IS 8112 -1989**,** and the specific gravity of cement was found to be 3.15.Many tests were conducted to cement some of them are consistency tests, setting tests, etc. It the properties of cement are given in table 1

S.NO	PROPERTY	VALUE
1	Specific gravity	3.15
2	Initial setting time	45 min
3	Final setting time	385 min
4	Fineness modulus	6%

Table 1: Properties of Cement

IV. MANUFACTUREDSAND

For aggregate produces concrete aggregate are end products while for concrete manufacturers, aggregates are raw materials to beused for concrete production. The quality of aggregates can be influenced while raw materials, gravel or rock may have characteristics which can't be modified by the production process. One extremely important factor is

consistent supply of course, fine aggregate. In this regard a course aggregate produced by crushing basaltic stone and river sand is the major natural source of fine aggregate in our country. However the intense construction activity is resulting in growing shortage and price increase of the natural sand in the country in addition the aggregate and concrete industry are presently facing a growing public awareness related to environmental threats.

Therefore, looking for a viable alternative for natural sand is a must. One alternative used as replacement is the use of M sand. Due to the forecast shortfall in supply of natural sand and increased construction practices time will come when M sand will play a significant role as an ingredient in concrete production.

When rock is crushed and sized in quarry the main aim has generally been to produce course aggregate and road construction materials. M sand is defined as a purpose made crushed fine aggregate produced from suitable source materials. Manufactured sand has been produced by variety of crushing equipments including cone crushers, impact crushers, roll crushers, road rollers etc., The raw material for M sand production is the parent mass of rock. It is based on the parent rock that the chemical, mineral properties, texture, composition of sand would change. The properties of M Sand are given in table 2

S.NO	PROPERTY	VALUE
1	Specific gravity	2.68
2	Fineness modulus	5.2
3	Water Absorption	7.0%
4	Surface texture	Smooth

Table 2. Properties of M Sand

A. River-Sand

Good quality natural river sand is readily available in many areas and may be easily obtained and processed. As with the gravels that they often accompany, the sand deposits may not have been laid uniformly, meaning a potential change inequality. The properties of River-Sand are given in table 3

S.NO	PROPERTY	VALUE
1	Specific gravity	2.55
2	Fineness modulus	4.45
3	Water Absorption	6.2%
4	Surface texture	Smooth

Table 3. Properties of River-Sand

B. Super plasticizer

In order to improve the workability of high-performance concrete, super plasticizer in the form of Sulphonated Naphthalene Polymers complies with IS 9103:1999 and ASTM C 494 type F as a high range water reducing admixture (CONPLAST SP 430) was used. This had 40% active solids in solution. The specific gravity is 1.22.It is a brown liquid instantly dispensable in water.

C. Conplast Sp 430

The properties of CONPLAST SP 430are given in table 4

S.NO	PROPERTY	VALUE
1	Appearance	Brown liquid
2	Specific gravity	1.220-1.225@30°C
3	Watersoluble chloride	Nil
4	Alkali content	Lessthan 5g.Na_2O
5	Chloride content	0.2% Max
6	Air entrainment	Nil
7	Nitrate content	Nil

Table 4. Properties of CONPLAST SP 430

V. FIBRES

A. Glass fibres

Glass fibresare made of silicon oxide with addition of small amounts of other oxides. Glass fibresare characteristic for their high strength, goodtemperature and corrosion resistance, and low price. Alkali resistant E-glass fibresof 12mm length, 0.014mm nominal diameter, specific gravity of 1.9 and density of 2650 kg/m3 were used.

The glass fibers used in concrete suppressed the localization of micro cracks in to macro cracks hence tensile strength increase. It improves durability of concrete by increasing the strength of concrete. The aspect ratio of Glass Fibers is 857.1. The number of fibers per 1 kg is 212 million.

Binani Chopped Strands are chopped from continuous "E" - glass fibres. The chopped strands are free flowing and are designed to resist the rigors of compounding whilst allowing the finished moulding to develop satisfactory mechanical properties. The properties of Glass furbearer given in table 5

S.NO	PROPERTY	VALUE
1	Diameter (μm)	12
2	Specific Gravity	2.60
3	Failure strain	3.0%
4	Elasticity (GPa)	80
5	Tensilestrength (Gpa)	2.5
6	Elongation	2.5-4.8%

Table 5. Properties of Glass fibre

B. Recron3Sfibres

Recron 3s Fibresare Engineered Micro Fibres with a unique "Triangular" cross section, used as a Secondary Reinforcement Concrete. It arrests shrinkage cracks and increases resistance to water penetration, abrasion and impact. It makes concrete homogenous and also improves the compressive strength, ductility and flexural strength together with improving the ability to absorb more energy.

Recron3s Fibresare manufactured in an ISO 9001:2000 facility for use in concrete as a "Secondary Reinforcement" at a rate of dosage varying from 0.1% to 0.4% by volume (0.9kgs/Cu.m – 3.60kgs/Cu.m). Fibres comply with ASTMC 1116, Type 111 Fibre Reinforced Concrete. The properties of Recron3s are given in table6.

C. Mix proportions

In this study, control mix A was designed as per IS 10262:1986 to achieve a target compressive strength of 60 Mpa. River sand was used to100% replace M-sand using Portland pozzolana cement (PPC). The various fibres of 0.1%, 0.3% and 0.5 % by volume fraction of concrete were used. The casted cubes are test for 7, 28, 56 days Compressive strength, Split tensile strength & Flexuralstrength.

Various fibres

- Glassfibres
- Recron 3sfibres
- Polyester - Type:CT2024.
- Polypropylene - Type:CTP2424

SI.NO.	PROPERTIES	UNITS	POLYESTER TYPE:CT2024	POLYPROPYLENE TYPE:CTP2424
1	Shape		Triangular	Triangular
2	Cut Length	Mm	3/ 4.8/ 6/ 12/18/ 24	3/ 4.8/ 6/ 12/ 18/ 24
3	Effective Diameter	Microns	20-40	25-40
4	Specific Gravity		1.34 - 1.39	0.90 – 0.91
5	Melting Point	Deg.C	250 - 265	160 – 165
6	Tensile Strength	Mpa	480 - 730	320 – 490
7	Elongation (initial)	%	20 – 60	60 -90
8	Young's Modulus	Mpa	>5000	>4000
9	Alkaline Stability		Very good	Very good

Table 6. Physical properties of Recron 3s fibres

D. Mix design

Trial number	Unit	Cement	Fine aggregate	Coarse aggregate (20 mm& 12.5mm)	Water (lt/m^3)	W/C
1	Kg/m^3	600	375	1324	190	0.3
	Ratio	1	0.62	2.20		

Table 7. Mix Design

Mix id	T	T1	T2	T3	T25	T26	T27	T28	T29	T30
Cement(kg/m^3)	600	600	600	600	600	600	600	600	600	600
FA(kg/m^3)	375	375	375	375	375	375	375	375	375	375
CA(kg/m^3)	1324	1324	1324	1324	1324	1324	1324	1324	1324	1324
Glass fibres-%	-	0.1	0.3	0.5	-	-	-	-	-	-
Polyester-%	-	-	-	-	0.1	0.3	0.5	-	-	-
Polypropylene-%	-	-	-	-	-	-	-	0.1	0.3	0.5
Conplastsp 430-%	1	1	1	1	1	1	1	1	1	1
Water (lt/m^3)	190	190	190	190	190	190	190	190	190	190

Table 8. Concrete Mix proportions

T – M sand without fibres
T1, T2 & T3 -M-sand with glass fibres 0.1, 0.3 & 0.5% by vol of concrete
T25,T26 & T27-M-sand with Polypropylene fibres 0.1, 0.3 & 0.5% by vol of concrete T28, T29 & T30 -M-sand with Recron 3s fibres 0.1, 0.3 & 0.5% by vol of concrete.

A total no. of 10 mixes was cast using different percentages of various fibres by volume of concrete. The proportion of Cement, M-sand, Coarse Aggregate, and Fibres & Water was

kept same for all mixes. Table 7 shows Mix design and Table 8 shows the Concrete Mix proportions. Various parameters used in the research are given below:

- Concrete mix ratio:1:0.62:2.20
- Water cement Ratio:0.30
- Fibre percentages by volume of concrete:
  - Glass fibres- 0.1%, 0.3% &0.5%.
  - Polyester (Recron3s) – 0.1%, 0.3% &0.5%.
  - Polypropylene – 0.1%, 0.3% &0.5%.
  - Polyester (Recron3s) – 0.1%, 0.3% &0.5%.
  - Polypropylene – 0.1%, 0.3% &0.5%.
- Super Plasticizer (CONPLAST SP 430) –1%
- Mixwith0%Fibres content was declared as control mix.

VI. RESULT AND DISCUSSION

Compressive Strength test
Compressive Strength Test Results

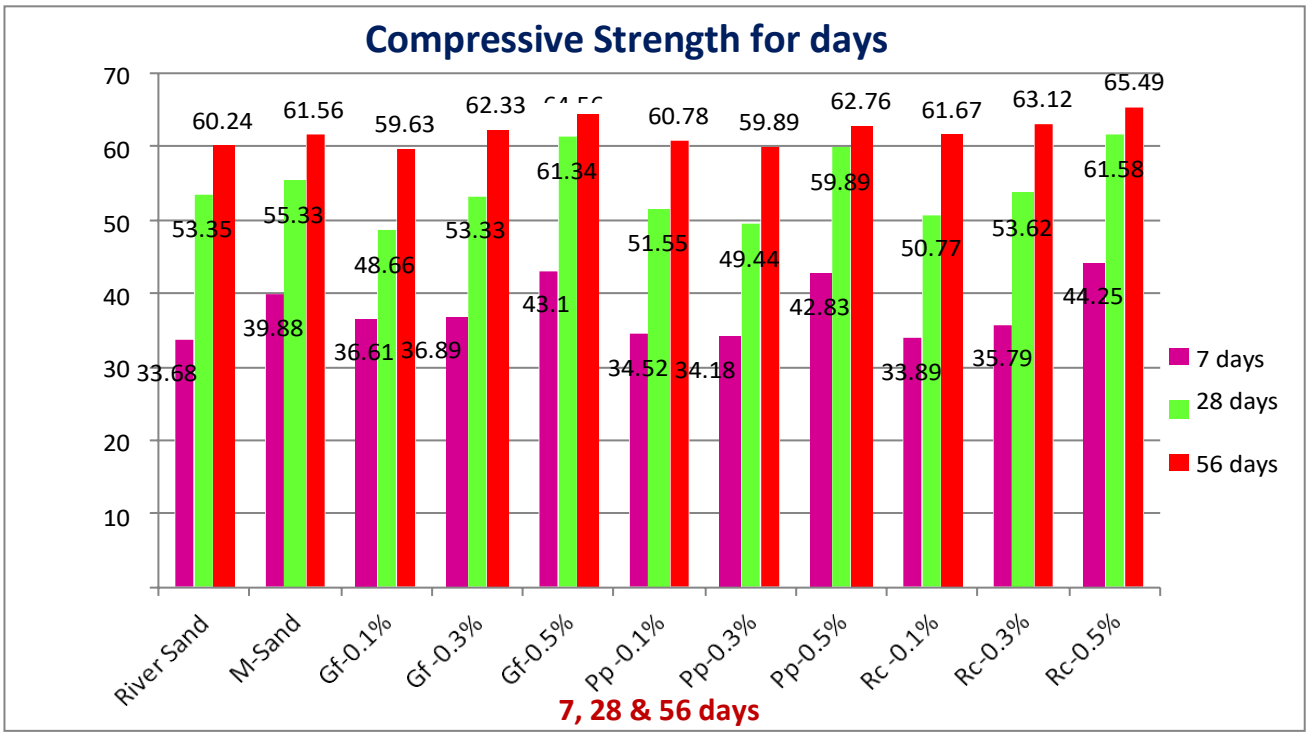
SI.NO	Cube ID	Compressive Strength (N/mm^2)		
		7 days	28 days	56 days
1	River Sand	33.68	53.35	60.24
2	M-Sand	39.88	55.33	61.56
3	Gf-0.1%	36.61	48.66	59.63
	Gf -0.3%	36.89	53.33	62.33
	Gf-0.5%	43.10	61.34	64.56
4	Pp -0.1%	34.52	51.55	60.78
	Pp-0.3%	34.18	49.44	59.89
	Pp-0.5%	42.83	59.89	62.76
5	Rc -0.1%	33.89	50.77	61.67
	Rc-0.3%	35.79	53.62	63.12
	Rc-0.5%	44.25	61.58	65.49

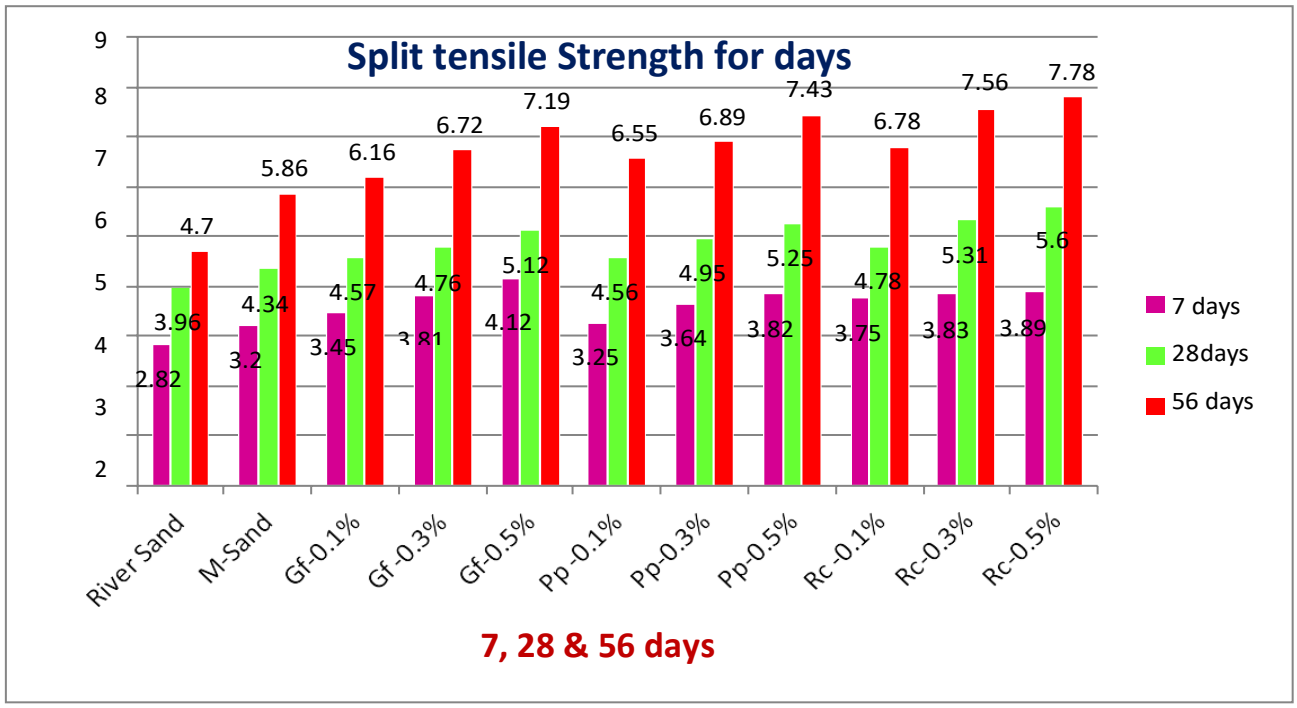
Split Tensile Strength

Split Tensile Strength Test

Results

SI.NO	Cube ID	Split tensile Strength (N/mm^2)		
		7 days	28 days	56 days
1	River Sand	2.82	53.35	60.24
2	M-Sand	3.20	55.33	61.56
3	Gf-0.1%	3.45	48.66	59.63
	Gf -0.3%	3.81	53.33	62.33
	Gf-0.5%	4.12	61.34	64.56
4	Pp -0.1%	3.25	51.55	60.78
	Pp-0.3%	3.64	49.44	59.89
	Pp-0.5%	3.82	59.89	62.76
5	Rc -0.1%	3.75	50.77	61.67
	Rc-0.3%	3.83	53.62	63.12
	Rc-0.5%	3.89	61.58	65.49

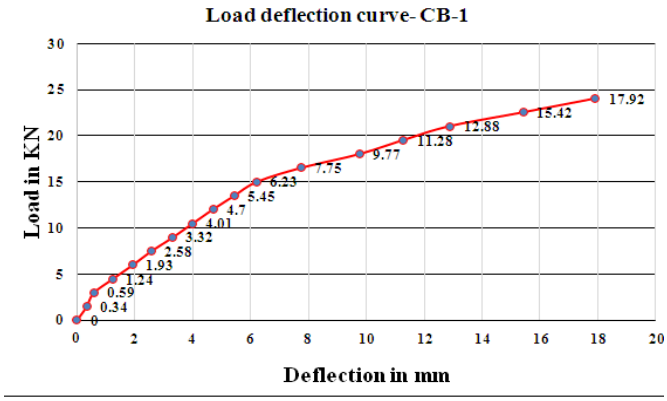




Flexural Strength Test
Behavior of Control Specimen

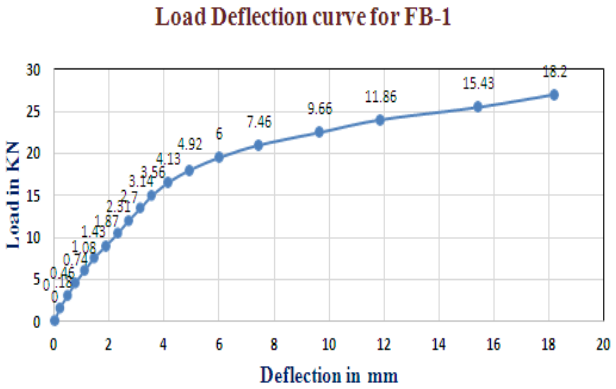
Control Specimen of RC beam Test Results

Behavior of M-Sand with glass fibre RC Beam



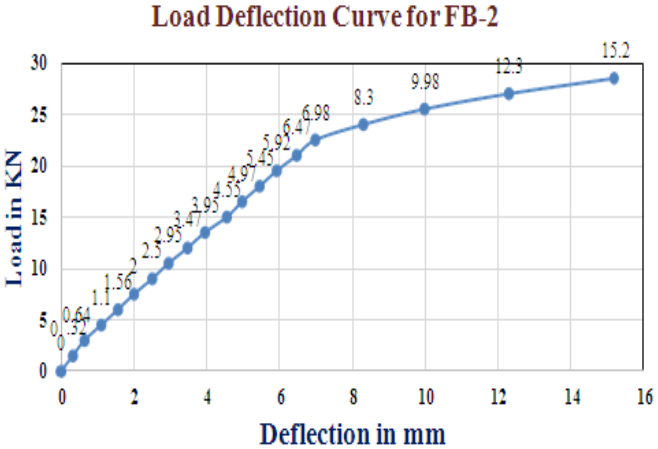
Load Deflection Behaviors for Control RC Beam

Sl. NO	Load in KN	Central Deflection in (mm)
1	0	0
2	1.5	0.34
3	3	0.59
4	4.5	1.24
5	6	1.93
6	7.5	2.58
7	9	3.32
8	10.5	4.01
9	12	4.70
10	13.5	5.45
11	15	6.23
12	16.5	7.75
13	18	9.77
14	19.5	11.28
15	21	12.88
16	22.5	15.42
17	24	17.92

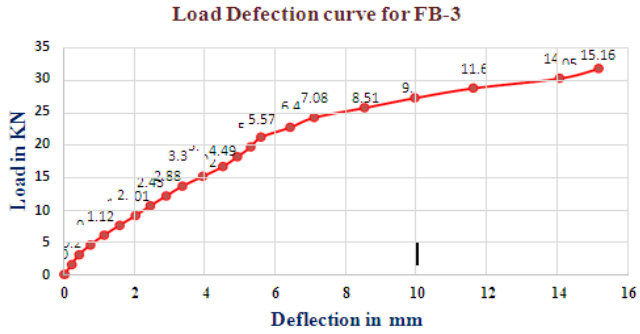


Load Deflection Behavior for M-Sand with glass fibre RC Beam

Sl. NO	Load in KN	Central Deflection in (mm)
1	0	0
2	1.5	0.34
3	3	0.59
4	4.5	1.24
5	6	1.93
6	7.5	2.58
7	9	3.32
8	10.5	4.01
9	12	4.70
10	13.5	5.45
11	15	6.23
12	16.5	7.75
13	18	9.77
14	19.5	11.28
15	21	12.88
16	22.5	15.42
17	24	17.92



Load Deflection Behavior for M-Sand with Polypropylene fibre RC Beam



Load Deflection Behavior for M-Sand with Recron 3s fibre RC Beam.

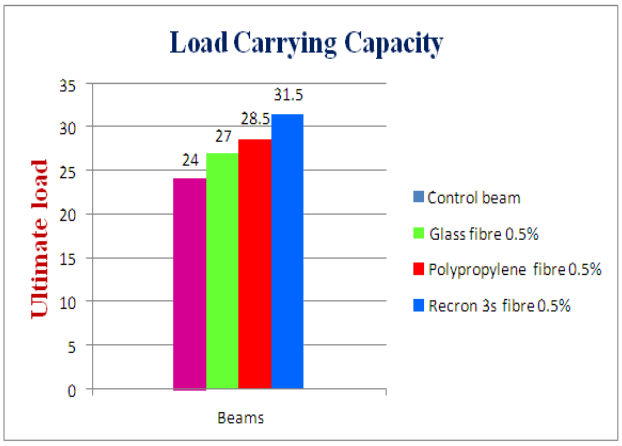
Behavior of M-Sand with Polypropylene fibre RC Beam:

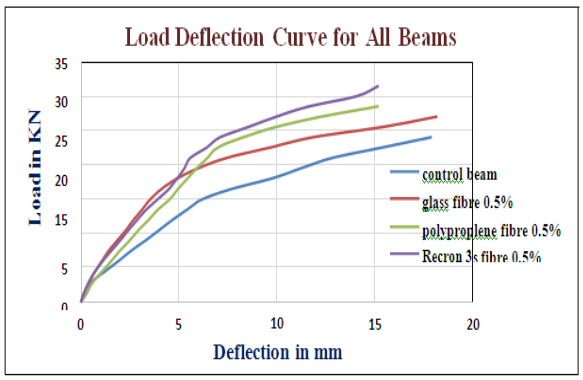
M-sand with Polypropylene fibre RC beam Test Results

SI.No	Load in KN	Central deflection in (mm)
1	0	0
2	1.5	0.32
3	3	0.64
4	4.5	1.10
5	6	1.56
6	7.5	2.00
7	9	2.50
8	10.5	2.95
9	12	3.47
10	13.5	3.95
11	15	4.55
12	16.5	4.97
13	18	5.45
14	19.5	5.92
15	21	6.47
16	22.5	6.98
17	24	8.30
18	25.5	9.98
19	27	12.30
20	28.5	15.20

Comparison of Test Results

Load Carrying Capacity





Load Deflection Behaviors of All the Beams

VII. CONCLUSIONS

A Comprehensive study had been carried out on various journals and books related to the high strength concrete with manufactured sand and various fibers. All the literatures are studied in the field manufacture sand, different fibers and chemical admixture. From the results it is concluded that the

M-Sand can be used as a replacement for fine aggregate. It is found that 100% replacement of fine aggregate by M-Sand give maximum result in strength aspects than the conventional concrete. The appropriate materials necessary for

the preparation of specimens for experimentations have been achieved. The quantity of specimens and the tests to be conducted have been predetermined. The adding percentage of 0.1%, 0.3%, 0.5% in glass, Polypropylene, Recron 3s fibers. The maximum strength attains the percentage of 0.5%. The results proved that the replacement of 100% of fine aggregate by M-Sand & fibres induced higher compressive strength and higher split tensile strength.

The workability of concrete was increase as well as decrease the slump values because the manufactured sand was more water absorption compare to the river sand. The increase the workability in concrete adding some percentage of admixture like Super Plasticizer. These also the workability increase minimum values. So alternate chemical admixture used in the manufactured sand and increase the slump values.

The compressive strength of the grade M60 concretes made with PPC. The results show that the 7, 28 and 56 days compressive strengths ranged from 39.88, 53.33, 61.56 MPa, respectively. The 100% replaced river sand in to manufactured sand to meet the requirement of grade M60 concrete.

The 7, 28, and 56 days splitting tensile strengths of the concretes ranged from 3.20, 4.34 and 5.86 MPa, respectively. The corresponding flexural strengths for 28 Days strength is 16 MPa. It appears that the 100% replaced river sand in to manufactured sand to meet the requirement of grade M60 concrete.

It is possible to design a concrete incorporating up to 0.5% Recron 3s that meets the strength requirement of grade M60 concrete; such concrete will develop acceptable early age's strength, higher strength at later ages, and compared to other fibers and control concretes of similar grade made with PPC only. The both compressive & split tensile strength ranged from 7, 28 and 56 days of (44.25,61.58 & 65.49) MPa and (3.89,5.60 & 7.78) Mpa respectively. The flexural strength from 28 Days compare to all the beams 21 MPa.

The high strength concrete using manufactured sand with Recron 3s fibres. The maximum strength attains the cube, cylinder and beam is 0.5% of fibres by volume of concrete. The cost also minimum for compare to other fibres.

Usage of Recron 3s fibre will reduce the cost of maintenance by reducing the micro cracks and permeability and hence the strength & durability will increase. It is found that use of Recron3s fibre reduces the segregation. Thus the environmental effects, illegal extraction of sand and cost of fine aggregate can be significantly reduced.

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