EXPERIMENTAL INVESTIGATION ON M-SAND WITH STEEL FIBRE IN SELF COMPACTING CONCRETE

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ABSTRACT: Natural river sand is expensive due to excessive cost of transportation from natural sources. Also large-scale exploitation of these sources creates environmental problems. As environmental transportation and other constraints make the availability and use of river sand less attractive, a substitute or replacement product for concrete industry needs to be found. River sand is most commonly used fine aggregate in the production of concrete poses the problem of acute shortage in many areas. Whose continued use has started posing serious problems with respect to its availability, increases in cost and environmental impact. In such a situation the Manufacture Sand can be an economic alternative to the river sand and which is cost effective. This study presents the behavior of self compacting concrete (SCC) with the replacements material. The fine aggregate is partially replaced with Manufacture sand. . In addition to that steel fibers are to be added in proper proportion. Suitable dosage of super plasticizers are also should be added for achieving increased workability. The objective of the investigation is to develop a reinforced concrete beam with manufacturing sand as partial replacement for fine aggregate. Then the results are to be compared with the conventional beams.

Keywords: M-sand, Testing, Analyzing the strength.

INTRODUCTION

The development of Self-Compacting Concrete (SCC) has recently been one of the most important developments in the building industry. The purpose of this concrete concept is to decrease the risk due to the human factor, to enable the economic efficiency, more freedom to designers and constructors and more human work. It is a kind of concrete that can flow through and fill gaps of reinforcement and corners of moulds without any need for vibrations and compacting during the pouring process. Because of that, SCC must have sufficient paste volume and proper paste reology. Paste volumes are usually higher than for conventionally placed concrete and typically consist of high powder contents and water-powder ratios.

The main advantage of using SCC is that it offers high homogeneity, fluidity and less segregation, minimal concrete voids and uniform concrete strength. Since low cement ratio is adopted it is possible to achieve early strength, quicker remoulding and faster use of elements and structures. The impact due to the use of vibrators is eliminated by the use of SCC in construction. Compaction of SCC is carried out in all parts of the formwork, including the hardly accessible parts, without any additional external force and no gravitational force, that is as a result of self weight of concrete.

The filling ability and stability of SCC in the fresh state can be defined by four key characteristics: passing ability, flow ability, segregation resistance and viscosity. Such properties are achieved by addition of chemical additives to the concrete. The growing use of concrete in special architectural configurations and closely spaced reinforcing bars have made it very important to produce concrete that ensures proper filling ability, good structural performance and adequate durability.

The improved construction practice and performance, combined with the health and safety benefits, make SCC a very attractive solution for both precast concrete and civil engineering construction. The elimination of vibrating equipment improves the environment on and near construction and precast sites where concrete is being placed, reducing the exposure of workers to noise and vibration.

It cannot be sacrificed to attain high strength. High ultimate strength is generally accompanied by a low W/C ratio. Good quality fine particles of waste materials or by-products particularly mineral admixtures and super plasticizer make the cement concrete sustainable with improved long term performance because of least permeability and very slow chemical reaction with harmful compounds present in the concrete.

MANUFACTURED SAND

Fine aggregate is an essential component of concrete. The most commonly used fine aggregate is natural river sand. The global consumption of natural sand is very high due to the extensive use of concrete in various civil engineering structures. In particular, the demand of natural sand is quite high in developing countries owing to their rapid infrastructural growth. The term 'natural sand' is used to identify the material traditionally recovered from geologically recent deposits of sand.

Therefore, the construction industries of developing countries are in stress to identify alternative materials to lessen or eliminate the demand for natural sand.

These materials act as a rock flour or filler and have advantages in the concrete mix. The effect of this material on water demand still requires careful monitoring and needs to be considered in mix design. The filler grade content of these fine materials is reduced by washing it with water to produce a clean, saleable 'sand' product. M-Sand stands for Manufactured Sand. M-sand is crushed aggregates produced from hard granite stone which is cubically shaped with grounded edges, washed and graded with consistency to be used as a substitute of river sand, which often exceeds the permissible limit of 15% specified by IS:383-1970.

Fig 1.1 Manufacture Sand

STEEL FIBER IN CONCRETE

Steel fiber reinforced concrete has gradually advanced from a new, rather unproven material to one which has now attained acknowledgment in numerous engineering applications. Lately it has become more frequent to substitute steel reinforcement with steel fiber reinforced concrete.

Many types of steel fibers are used for concrete reinforcement. Round fibers are the most common type and their diameter ranges from 0.25 to 0.75 mm. Rectangular steel fibers are usually 0.25 mm thick, although 0.3 to 0.5 mm wires have been used in India. Deformed fibers in the form of a bundle are also used. The main advantage of deformed fibers is their ability to distribute uniformly within the matrix. Though steel fiber reinforced concrete has numerous advantages, it has certain concerns that are yet to be resolved completely.

Fig 1.2 Steel Fiber

MATERIAL TESTING

To investigate the properties of the materials such as cement, fine aggregate and coarse aggregate used for casting the specimens. Various laboratory tests were performed and the test results obtained were compared with the Indian Standard values. The test results are tabulated below.

Test for Cement

The following experiments were conducted to find the properties of cement as per IS-4031: 1988(Part-4)

i. Standard Consistency Test
ii. Initial Setting and Final Setting Time Test
iii. Specific Gravity Test
iv. Compression Strength test for Mortar Cube

These results have been tabulated in table 3.1 to table 3.5

Weight of cement (g)	Percentage of water added(in terms of weight of cement)	Volume of water added(ml)	Penetration from bottom (mm)
400	28	112	37
400	30	120	36
400	32	128	31
400	34	136	25
400	36	146	16
400	38	152	6

Table 3.1 Standard Consistency of Cement

Time at which water is added to cement(min)	Time at which the needle fails to pierce the test block by 5.0±0.5mm(min)	Initial setting time (min)
0	45	45

Table 3.2 Initial Setting Time of Cement

Time at which water is added to cement(min)	Time at which the needle makes an impression on surface of block(min)	Final setting time (min)
0	369	369

Table 3.3 Final Setting Time of Cement

S.NO	Description(kg)	Trial 1	Trial 2	Trial 3
1	Weight of Pycnometer(W_1)	675	675	675
2	Weight of Pycnometer + cement(W_2)	1303	1309	1311
3	Weight of Pycnometer +cement +kerosene(W_3)	1775	1780	1783
4	Weight of Pycnometer +kerosene(W_4)	1401	1401	1401
5	Specific gravity	3.10	3.14	3.16

Table 3.4 Specific Gravity of Cement

CALCULATION

Specific gravity of cement

$$= \frac{W2 - W1}{(W2 - W1) - (W3 - W4) X0.79}$$

$$= \frac{1.303 - 0.675}{(1.303 - 0.675) - (1.775 - 1.401)}$$

= 3.10

The mean Specific gravity of cement = 3.13

S.No	Period of curing(days)	Compressive strength(N/mm^2)
1	3	36.56
2	7	45.34
3	28	54

Table 3.5 Compressive Strength of Mortar Cube

Test for Fine Aggregate

The following experiments were conducted to find out the properties of fine aggregate as per IS-2386: 1963(Part-3)

i. Sieve Analysis Test
ii. Specific Gravity Test
iii. Water Absorption Test

The results have been tabulated in table 3.6 to table 3.8

CALCULATION

$$\text{Fineness Modules} = \frac{\text{Total cumulative \% weight retained}}{100} = \frac{278.2}{100} = 2.78$$

S.No	Description	Trial
1	Weight of saturated surface dry sample w_1(g)	1000
2	Weight of oven dry sample w_2(g)	987.23
3	Water absorption	0.89%

Table 3.7 Water Absorption of Fine Aggregate

S.No	Description(g)	Trial 1	Trial 2	Trial 3
1	Weight of Pycnometer(W_1)	670	670	670
2	Weight of Pycnometer + cement(W_2)	1415	1410	1419
3	Weight of Pycnometer+cement +water(W_3)	1836	1831	1843
4	Weight of Pycnometer +water(W_4)	1534	1534	1534
5	Specific gravity	2.65	2.64	2.69

Table 3.8 Specific Gravity of Fine Aggregate

S.No	Description(g)	Trial 1	Trial 2	Trial 3
1	Weight of Pycnometer(W_1)	670	670	670
2	Weight of Pycnometer + M-Sand(W_2)	680	681	681
3	Weight of Pycnometer+M-Sand +water(W_3)	776.56	776.5	777
4	Weight of Pycnometer +water(W_4)	770	770	770
5	Specific gravity	2.906	2.444	2.750

Table 3.9 Specific Gravity of Fine Aggregate (M-Sand).

S.No	Description(g)	Trial 1	Trial 2	Trial 3
1	Weight of Pycnometer(W_1)	670	670	670
2	Weight of Pycnometer + M-Sand(W_2)	680	681	681
3	Weight of Pycnometer+M-Sand +water(W_3)	776.56	776.5	777
4	Weight of Pycnometer +water(W_4)	770	770	770
5	Specific gravity	2.906	2.444	2.750

The mean Specific gravity of Fine Aggregate (M-Sand) = 2.69

Table 3.9 Specific Gravity of Fine Aggregate (M-Sand).

S.No	Sieve Opening Size	Weight of F.A Retained (g)	Cumulative Weight of F.A retained (g)	Cumulative Percentage of F.A Retained (g)	Cumulative percentage of F.A passing
1	4.75mm	10	10	1.0	99.0
2	2.36mm	40	50	5.0	95.0
3	1.18mm	235	285	28.5	71.5
4	600µ	304	589	58.9	41.1
5	300µ	291	880	88.0	12.0
6	150µ	96	975	97.5	2.5
7	75µ	25	1000	-	-
8	Pan	0	0	-	-
	Total	1001		Total=278.9	

Table 3.10 Sieve Analysis of Fine Aggregate (M-Sand)

CALCULATION

$$\text{Fineness Modules} = \frac{\text{Total cumulative \% weight retained}}{100} = \frac{278.9}{100} = 2.78$$

S.No	Description	Trial
1	Weight of saturated surface dry sample w_1(g)	1000
2	Weight of oven dry sample w_2(g)	991.31
3	Water absorption	0.869 %

Table 3.11 Water Absorption of Fine Aggregate (M-Sand)

CALCULATION

$$\text{Water absorption} = 100 \times \frac{W_1 - W_2}{W_1}$$

$$= (1000-989.83/1000) \times 100$$

$$= 0.89\%$$

Test for Coarse Aggregate

The following experiments were conducted to find out the properties of coarse aggregate as per IS-2386: 1963(Part-1)

- **i.** Water absorption Test
- **ii.** Impact Test
- **iii.** Specific Gravity Test
- **iv.** Sieve Analysis Test

The results are given in table 3.9 to table 3.12.

S.No	Description(g)	For size 12mm Aggregate (g)
1	Weight oven dry sample(w_1)	1000
2	Weight of saturated Sample(w_2)	1002
3	Water absorption	0.2%

Table 3.12 Water Absorption of Coarse Aggregate

CALCULATION

$$\text{Water absorption} = \frac{W2-W1}{W1} \times 100$$

$$= \frac{1002-1000}{1000} \times 100$$

$$= 0.2\%$$

S.No	Weight of sample (A) (g)	Aggregate Passed Through 2.36mm Sieve (B) (g)	Weight Retained in Sieve (C) (g)	Aggregate Impact Value (%)	Mean (%)
1	575	41	534	7.13	7.72%
2	580	49	538	8.44	
3	573	44	533	7.6	

Table 3.13 Impact of Coarse Aggregate

CALCULATION

$$\text{Aggregate Impact value} = \frac{B}{A} \times 100$$

$$= \frac{41}{575} \times 100$$

$$= 7.13\%$$

S.No	Description(g)	Trial 1	Trial 2	Trial 3
1	Weight of empty bottle (w_1)	670	670	670
2	Weight of bottle + Coarse Aggregate(w_2)	1397	1390	1395
3	Weight of bottle + Coarse Aggregate + water (w_3)	1978	1978	1979
4	Weight of bottle + water (w_4)	1534	1534	1534
5	Specific gravity of Coarse Aggregate	2.68	2.7	2.71

Table 3.14 Specific Gravity of Coarse Aggregate

CALCULATION

$$\text{Specific gravity of coarse aggregate} = \frac{w_2 - w_1}{[w_4 - w_1] - [w_3 - w_2]}$$

$$= \frac{1397-670}{(1534-670)-(1981-1397)}$$

$$= 2.68$$

The mean Specific gravity of coarse aggregate = 2.69

CALCULATION

$$\text{Fineness Modules} = \frac{\text{Total cumulative \% weight retained}}{100}$$

$$= \frac{751.25}{100}$$

$$= 7.5$$

S.No	I.S sieve size (mm)	Quantity retained (g)	% retained	Cumulative percentage retained	Cumulative percentage passing
1	40	-	-	-	100
2	37.5	-	-	-	100
3	22.4	-	-	-	100
4	20	1030	51.5	51.50	48.5
5	10	966	48.3	99.80	0.2
6	4.75	3	0.15	99.95	0.05
7	2.36	-	-	100	-
8	1.18	-	-	100	-
9	600µ	-	-	100	-
10	300µ	-	-	100	-
11	150µ	-	-	100	-
12	Pan	-	-	100	-
Cumulative Percentage Retained				= 751.25	

Table 3.15 Sieve Analysis for Coarse Aggregate

Steel

The steel reinforcing bars of Fe500 grade are tested under universal testing machine up to failure. The test is conducted based on IS 1786:2008.

MIX DESIGN

General

In the design of self compacting mix, the relative proportions of the key components may be considered by volume rather than by mass, the mix design is obtained by trial and error method from fresh concrete test. Indicative properties of materials are for self compacting concrete are,

- Water ratio by volume is to be 0.80 to 1.00
- Total content to be 160 to 240 liters (400-600kg) per m^3.
- The sand content may be more than 38% of the mortar volume.
- Coarse aggregate content should normally be 28 to 35% by volume of the mix.
- Water/cement ratio is selected based on strength. In case water content should not exceed 200liters/m^3.

The below represent typical acceptance criteria for SCC as per Standards.

S.No	Test Method	Property	Unit	Typical Range of Values	
				Minimum	Maximum
1.	Slump Flow	Filling ability	mm	600	800
2.	V-Funnel	Filling ability	sec	8	12
3.	L-Box	Passing ability	h_2/h_1	0.8	1.0

Table 3.16 Typical acceptance criteria for SCC

After selecting the raw material quantity and water cement ratio, mix should be tested at full scale at the laboratory for trial and error method. In the event of getting satisfactory performance, the mix should be readjusted in respect of type and quantity of filler material, proportion of F.A. or C.A. and dosage of viscosity modification agent. Try also alternative type of VMA which may be more compactable. In this mix with viscosity modification agent of 0.3% of Glenium B233 is added for flow ability of concrete.

Slump Test

The concrete slump test is an empirical test that measures the workability of fresh concrete. More specifically, it measures the consistency of the concrete in that specific batch. This test is performed to check the consistency of freshly made concrete. Consistency is a term very closely related to workability. It refers to the ease with which the concrete flows. It is used to indicate the degree of wetness. Workability of concrete is mainly affected by consistency i.e. water mixes will be more workable than drier mixes, but concrete of the same consistency may vary in workability. It is also used to determine consistency between individual batches.

Fig 3.2 Slump Flow test on fresh concrete.

In slump cone test, the flow ability of concrete is checked by considering the slump flow value (mm). Self Compacting Concrete (SCC) need to attain the flow ability of slump flow value above 600 to 800mm.Viscosity modification agent, 0.3% of Glenium B233 is added to the concrete mix for flow ability.

Following are slump flow values measured for 0%, 25%, 50% and 75% of River
Sand replaced by M-Sand.

M-Sand (%)	Flow value(mm)
0	648
25	628
50	613
75	598

Table 3.17 Slump Flow Test

L-Box Test

In L-box test, the flow ability of concrete is checked by considering the L-box ratio (H2/H1). Self Compacting Concrete need to attain the L-box ratio (H2/H1) range from 0.8 to 1.0.

Fig 3.3 L-Box Test on fresh concrete.

Following are L-box flow test values measured for 0%, 25%, 50% and 75% of
River Sand replaced by M-Sand.

M-Sand (%)	L-Box Flow(h_2/h_1)
0	0.93
25	0.88
50	0.86
75	0.84

Table 3.18 L-Box Flow Test

V-Funnel Test

In V-funnel test, the flowability of concrete is checked by considering flow time of concrete mix in seconds.Self Compacting Concrete need to attain the V-funnel flow time range from 8 sec to 12 sec.

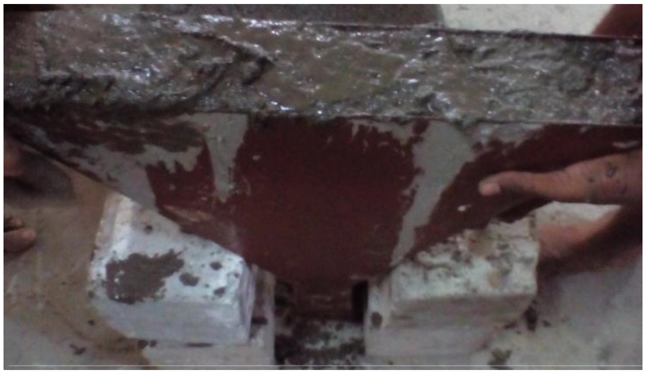


Fig 3.4 V-Funnel test on fresh concrete.

Following are V-Funnel flow test values measured for 0%, 25%, 50% and 75% of
River Sand replaced by M-Sand.

M-Sand (%)	V-Funnel Flow(sec)
0	8
25	9.02
50	10.5
75	10.8

Table 3.19 V-funnel Flow Test

Mix Design proportion of concrete:

The below table shows the mix design proportion for M_{30} grade concrete for SCC and it has passed all the fresh concrete flow ability and passing ability tests.

Cement (Kg/m^3)	Fine aggregate (Kg/m^3)	Coarse aggregate (Kg/m^3)	Water (Kg/m^3)	W/C	VMA
462.93	759.45	928.21	208.3	0.45	0.3%

Table 3.20 Mix Proportion of M_{30} grade concrete

The viscosity modification agent (VMA) used in this project is Gelinum B233.

Mix ratio obtained for the above proportion 1: 1.64: 2 (M_{30}) for SCC.

Compressive Strength Test

Cube specimen of size 150X150X150mm is to be cast for the mix proportion. After curing for required period the specimen were tested using compressive testing machine. The curing periods are 7days and 28days and tested to find the compressive strength of concrete and the result obtained is being tabulated below.

$$\text{Compressive strength } (N/mm^2) = \frac{\text{max.load}(N)}{\text{cross sectional area}(mm^2)}$$

Table 3.21 Compressive Strength of M Sand

Specimen Mix	Compressive Strength N/mm^2	
	7 days	28 days
SCC Conventional	19.33	31.1
M-Sand25%	23.33	33.33
M-Sand50%	22.66	32
M-Sand75%	20	28.88

Table 3.21 Compressive Strength of M-Sand

Specimen Mix	Compressive Strength N/mm^2	
	7 days	28 days
SCC Conventional	23.33	33.31
M.S 25% S.F 0.2%	26.22	38.33
M.S 50% S.F 0.4%	26.66	38.46
M.s75% S.F 0.6%	22.66	32.44

Table 3.22 Compressive Strength of M-Sand With Steel Fiber

Split Tensile Test

Cylinder specimen of size 300mm height and 150mm diameter are to be cast for the mix proportion. After curing for required period the specimen were tested using compressive testing machine.

The curing periods are 7days and 28days and tested to find the split tensile of concrete and the result obtained is being tabulated below.

Specimen Mix	Split Tensile N/mm^2	
	7 days	28 days
SCC Conventional	2.3	3.11
M-Sand 25%	2.4	3.19
M-Sand 50%	2.37	3.14
M-Sand 75%	2.1	2.76

Table 3.23 Split Tensile Strength of M-Sand

Specimen Mix	Split Tensile N/mm^2	
	7 days	28 days
SCC Conventional	2.5	4.11
M.S 25% S.F 0.2%	2.6	4.39
M.S 50% S.F 0.4%	2.63	4.54
M.s75% S.F 0.6%	2.3	3.76

Table 3.24 Split Tensile Strength of M-Sand with S.F

S.No	Name of Test	Value	Codal Standard
1	Specific Gravity of Cement	3.13	IS:4031(Part-3)1988 Range 3.15
2	Standard Consistency of Cement	32%	IS:4031(Part-4)-1988 Penetration 5-7mm
3	Initial Setting Time of Cement	69 min	IS 12269-1987 Should not be less than 30 mins cl 5.3
4	Test on final setting time of cement	369 min	IS 12269-1987 Should not be more than 600mins cl 5.3
5	Average Compressive strength test of cement mortar cube (28days)	54 N/mm^2	Not less than 53 N/mm^2 as per IS 12269-1987
6	Specific gravity of FA	2.65	2.6-2.7
7	Sieve analysis of FA	FM=2.78	MediuM-Sand 2.6-2.9
8	Water absorption test on FA	0.89%	IS:2386(Part-3)1963
9	Specific gravity of FA(M-Sand)	2.69	2.6-2.7
10	Sieve analysis of FA(M-Sand)	2.789	MediuM-Sand 2.6-2.9
11	Water absorption test on FA(M-Sand)	0.869%	IS:2386(Part-3)1963
12	Specific gravity test for CA	2.69	FOR C.A 2.7
13	Water absorption test for CA	0.2%	5%
14	Sieve analysis of CA	FM=7.5	IS:2386(Part-1)1963
15	Impact test of CA	7.72%	IS:2386(Part-4)1963 Range-7-12.5%

Table 3.24 Summary of Material Testing Results

DESIGN OF BEAM

Data

Effective length =1200mm

Depth =150mm

Breadth = 100mm

Self-weight $= 0.1\times0.15\times25$

$= 0.375$ kN/m

Moment acting

$M_{SW} = wl^2/8$ Eq.1

$= 0.375\times1.5^2/8$

$= 0.1$ kN-m

$M_{LL} = 0.4\times P/2$

$= 0.4\times21.25$

$= 8.5$ kN-m

$M_u = 8.6$ kN-m

S.F for S.W $= (W\times L)/2$ Eq.2

$= (0.375\times1.5)/2$

$= 0.28$ kN

Total S.F= 21.25 + 0.28

= 21.53KN

Check for $M_{u,\ limit}$

Mu, limit $= 0.138\times f_{ck}\times b\times d^2$ Eq.3

$=0.138\times30\times100\times130^2$

$= 9.3$ KN-m

Since, $M_u < M_u$ limit the section is underreinforced.

$$M_u = 0.87 \times f_y \times A_{st} \times d \left(1 - \left(\frac{Ast \times fy}{fck \times b \times d}\right)\right) \quad \text{Eq.4}$$

$$8.6 \times 10^6 = 600 \times A_{st} \times 100 \times \left(1 - \left(\frac{Ast \times 600}{40 \times 100 \times 130}\right)\right)$$

A_{st} req = $150mm^2$

Provide 2 bars of 10mm diameter bars (Ast provided = $170mm^2$) and 2 bars of 8mm at top.

% of steel = $100 \times A_{st} / bd$ Eq.5

$= (100 \times 158) / (100 \times 150)$

$= 1.1$

Check for shear stress

Shear stress, $\tau_v = (V_u / bd)$ Eq.6

$= (21.53 \times 10^3) / (100 \times 150)$

$= 1.59\ N/mm^2$

Refer table 19 of IS 456-2000 code and read out the permissible shear stress are

$\tau_c = 0.70 N/mm^2$

$\tau_v > \tau_c$, shear reinforcement are required.

Balance shear, $V_{us} = V_u - (\tau_c \times bd)$

$= 21.53 \times 10^3 - (0.7 \times 100 \times 150)$

$= 12.08$ kN

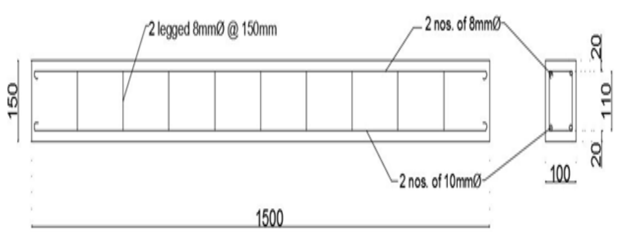
Spacing, $S_v = (0.87 f_y A_{sv} d) / V_{us}$

$S_v = 0.87 \times 415 \times 100.5 \times 150 / 12.08 \times 10^3$

$= 450mm\ S_v$

$< 300mm$

Hence provide 2 legged 8mm diameter bars at 150mm c/c spacing.



All Dimensions in mm

Fig 3.5 Reinforcement Details

SPECIMENS CASTED

The wooden formworks required for casting the reinforced beam are fitted and the required reinforcement is being tied up as per the beam calculation. The covers are being provided to avoid the formworks contact with reinforcement. The formwork and reinforcement details provided are shown in the figure below.

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Fig 3.6 Casted Specimen

Beam Specimen	No. of Beams
SCC control beam	2
25% of M-Sand	2
25% of M -Sand and 0.2% of S.F	2
25% of M- Sand and 0.4% of S.F	2
25% of M- Sand and 0.6% of S.F	2

EXPERIMENTAL SETUP & TESTING PROCEDURE

The tests were carried out in 50T Beam Loading Frame Machine (Model) with necessary fixtures as per ASTM C D 293 (Standard test method for flexural strength of concrete using single beam with centre point loading) with two steel rollers, on which the specimen was supported, and these rollers were mounted at a distance of 200mm from centre on both sides which have the bearings of 150mm. The type of loading is two points loading. A load cell with 50T capacity was mounted on the plate fixed at the top of the rollers. The distance between loads as well as between load and support are kept L/3. LVDT is placed at the bottom centre of the beam to deflection. Then the load is applied to observe the load deflection behavior and crack pattern. From the observation readings, the graph of Load versus Deflection is to be plotted.

Design Load

Theoretical load arrived : 18 KN

Expected load capacity of beam with 25% M Sand : 18 to 20 KN

Expected load capacity of beam with 25% M Sand and S.F : 20 to 30 KN

Fig 3.7 Loading Frame Setup

RESULT AND DISCUSSION

GENERAL

In this chapter the experimental results of the control beams and beams replaced by 25% of M-Sand and various proportion of Steel fiber (0.2%, 0.4%, 0.6%) are being compared. Their behavior throughout the test is described using mechanically obtained data on deflection behavior and the load carrying capacity. All the beams are tested for their ultimate strengths and flexural strength of the beams.

LOAD V_s DEFLECTION RESULTS

The Beam of SCC with control mix, M-Sand and with Steel fiber for M30 grade concrete is kept in 28 days and taken out from curing cleaned completely. By placing the beam in the support load V_s deflection curve is obtained.

SCC Control Beam

SCC control beam is the control mix of above said M_{30} mix proportion without any replacement of River Sand. The load V_s deflection curve of control beam is shown in the table below.

Fig 4.1 SCC control Beam

Load (KN)	Deflection(mm)
0	0
1.7	3
3.1	4.7
4.3	6.4
5	8.6
5.6	12
6.2	15.4
7.4	17.5
9.1	18.8
10.5	19.9

Table 4.1 Load V_s Deflection for SCC Control Beam

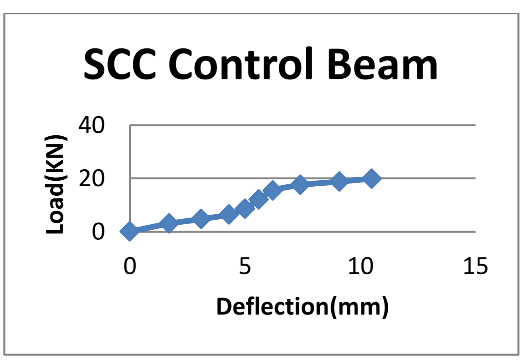

Fig 4.2 Load V_s Deflection Curve for SCC Control

SCC control Beam which were being tested under the loading frame lead to flexural crack failure and the average ultimate load if found to be 19.9 kN. The averagedeflection of the beam is 10.5 mm which has been shown in fig 4.2.

SCC beam with 25% of M-Sand

SCC beam of 25% of M-Sand is replaced with Fine Aggregate weight with M_{30} mix proportion of SCC. The load V_s deflection curve of M-Sand with 25% replaced beam is shown in the table below

Loads (KN)	Deflection (mm)
0	0
2	36
3.8	4.7
5	6.4
5.8	8.6
6.2	12
6.9	18.3
8.1	21.2
9.5	23.4
11.4	24.2

Table 4.2 Load V_s Deflection for 25% M-sand

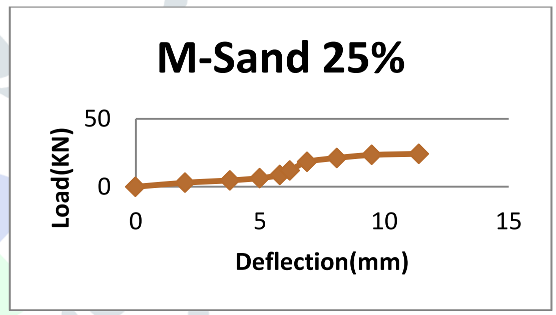

Fig 4.3 Load V_s Deflection Curve of 25% M-sand

The average ultimate load if found to be 24.2 kN. The average deflection of the beam is 11.4 mm which has been shown in fig 4.3

SCC beam with 25% of M-Sand and 0.2% Steel Fiber.

SCC beam of 25% of M-Sand is replaced with Fine Aggregate weight with M_{30} mix proportion of SCC and added with 0.2% Steel Fiber

Loads (KN)	Deflection (mm)
0	0
3	4
3.8	4.7
4.8	6.3
5.5	10
5.8	13.4
Loads (KN)	Deflection (mm)
6.4	16.6
7.7	18.9
9.4	20.6
11.4	24.9

Table 4.3 Load V_s Deflection for 25% of M-Sand and 0.2% Steel Fiber.

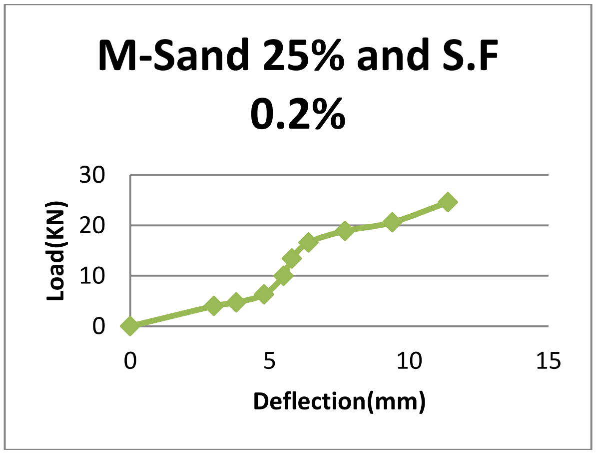

Fig 4.4 Load V_s Deflection Curve for 25% M-sand and 0.2% Steel Fiber

SCC beam with 25% of M-Sand and 0.4% Steel Fiber.

Loads (KN)	Deflection(mm)
0	0
1.8	3
2.9	5
4	7
4.9	11
5.7	17
6.2	23.1
7.8	27.9
8.8	29.4
11.9	34.4

Table 4.4 Load V_s Deflection for 25% of M-Sand and 0.4% Steel Fiber.

SCC beam of 25% of M-Sand is replaced with Fine Aggregate weight with M_{30} mix proportion of SCC and added with 0.4% Steel Fiber.

The load V_s deflection curve of M-Sand with 25% replaced beam is shown in the table above.

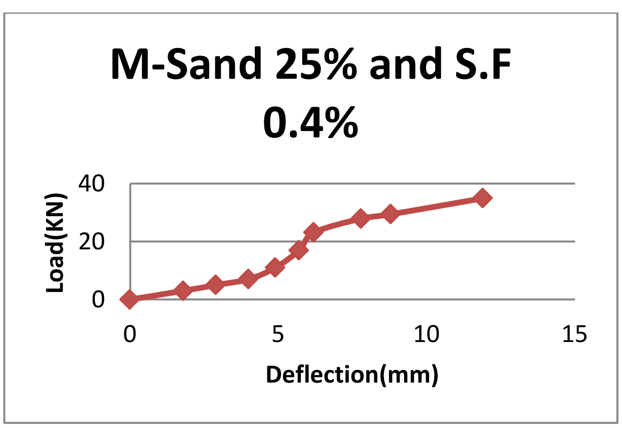

Fig 4.5 Load V_s Deflection Curve for 25% M-sand and 0.4% Steel Fiber.

SCC with 25% of M-Sand and 0.4% Steel Fiber Beam which were being tested under the loading frame lead to flexural crack failure and the average ultimate load if found to be 34.4 kN.

The average deflection of the beam is 11.9 mm which has been shown in the fig 4.5

SCC beam with 25% of M-Sand and 0.6% Steel Fiber.

SCC beam of 25% of M-Sand is replaced with Fine Aggregate weight with M30 mix proportion of SCC and added with 0.4% Steel Fiber.

The load V_s deflection curve of M-Sand with 25% replaced beam is shown in the table below.

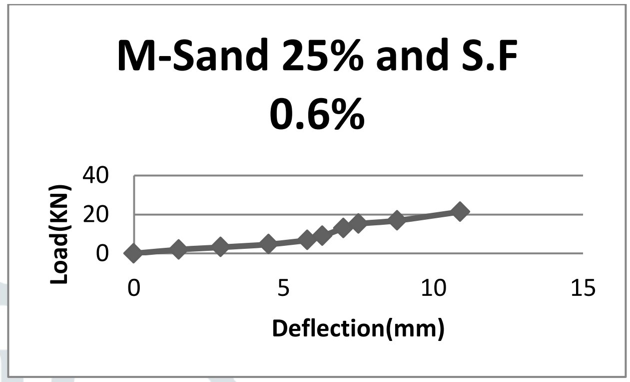

Fig 4.6 Load V_s Deflection Curve for 25% M-sand and 0.6% Steel Fiber.

Load(KN)	Deflection(mm)
0	0
1.5	2
2.9	3.2
4.5	4.7
5.8	6.9
6.3	9
7	13
7.5	15.2
8.8	16.9
10.9	21.4

Table 4.5 Load V_s Deflection for 25% of M-Sand and 0.6% Steel Fiber.

SCC with 25% of M-Sand and 0.2% Steel Fiber Beam which were being tested under the loading frame lead to flexural crack failure and the average ultimate load if found to be 21.4kN. The average deflection of the beam is 10.9mm which has been shown in the fig 4.6

Ultimate Load

The graphs obtained provides a clear variation that the load bearing of the SCC 25% of M-Sand with 0.4% of Steel fiber beam is being increased due to the added fiber gives additional strength to the concrete. The crack being developed can be restricted to minimum by the addition of polypropylene Fiber. Also the initial load bearing of the beam is increased. The variation of the Ultimate load is being shown in the bar chart below.

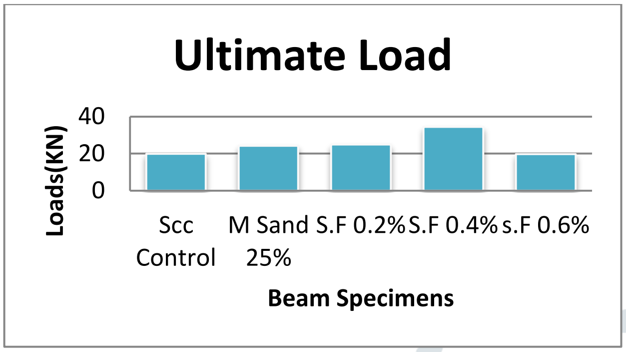

Fig 4.7 Variation of Ultimate Load

Flexural Strength

Flexural strength is also known as modulus of rupture, it represents the highest stress experienced within the beam at its moment of rupture. Most of the material fails under tensile stress before they fail under compressive stress, so the maximum tensile stress value that can be sustained before the beam fails is its flexural strength. It was obtained by formula,

$$R = Pl/bd^2$$

Where,

b = width of specimen (mm)

d = failure point depth (mm)

l = supported length (mm)

p = max. Load (N)

Specimen	Flexural strength (N/mm^2)
SCC control beam	10.61
25% of M-Sand	12.90
25% of M.S and 0.2% of S.F	13.28
25% of M.S and 0.4% of S.F	18.34
25% of M.S and 0.6% of S.F	10.50

Table 4.6 Flexural Strength of Beams

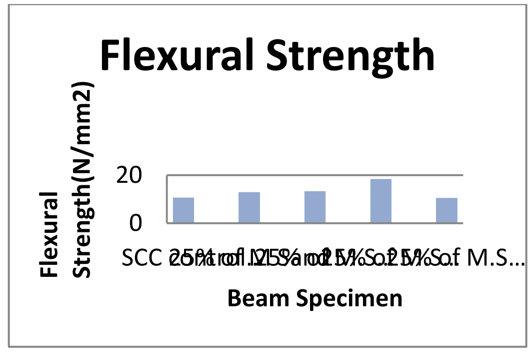

Fig 4.8 Variation of Flexural Strength

LOAD, DEFLECTION AND FLEXURAL STRENGTH COMPARISON

The comparison results of the SCC control, M-Sand beams and various proportions of M-Sand Steel Fiber beams are obtained and shows that beam with M-Sand 25% of 0.4% 0f Steel Fiber is higher strength. The load vs deflection and Flexural strength are being shown below.

Specimen	Ultimate Load (KN)	Max. Deflection (mm)	Flexural Strength (N/mm^2)
SCC control beam	19.9	10.5	10.61
25% of M-Sand	24.2	11.4	12.90
25% of M.S and 0.2% of S.F	24.9	11.4	13.28
25% of M.S and 0.4% of S.F	34.4	11.9	18.34
25% of M.S and 0.6% of S.F	19.7	10.9	10.50

Table 4.7 Load, Deflection and Flexural Strength Comparison

CONCLUSION

GENERAL

In this project the study on flexural strength of SCC beam with M-Sand and Steel Fiber beams are cast and tested in loading frame. The ultimate load, Deflection and flexural strength are obtained from the testing results and the results are summarized and the following conclusions are made.

CONCLUSION

Based on the experimental results from this project the following conclusions are made.

1. The study of properties of SCC gives favorable results with Flow ability and Passing ability of concrete for M_{30} grade mix proportion.
2. Compressive strength and split tensile strength of SCC while replaced with 25% of M-Sand which gives increase in value compare with control concrete.
3. The experimental results of all the control beams are compared with the partially replaced M-Sand with Steel Fiber Beams.
4. Their behavior throughout the test is described using mechanically obtained data on deflection behavior and the load carrying capacity.
5. All the beams are tested for their ultimate strengths and flexural strength is obtained.
6. It was observed that 25% replacement of M-Sand with 0.4% of S.F beam has 14.5% higher strength compare to SCC control beam.

7. By using M-Sand the amount of Fine Aggregate used for concrete will be reduced by 25%.
8. Availability of M-Sand is in Quarry. During scarcity of River Sand only the cost of M-Sand will be costlier.
9. By adding Steel fiber with 0.2% and 0.4% the initial shrinkage is reduced and the load carrying capacity is increased with 55% and 14.6% respectively compare to SCC replaced with M-Sand beams.
10. The beam replaced with 25% of M-Sand and 0.4% Steel fiber are obtained good strength and gives cost effective compare to other obtained results.

REFERENCES

[1] IS:12269-1987,*Indian standard specification for 53 grade ordinary Portland cement (first reprint 1993), Bureau of Indian standards,* New Delhi.

[2] IS:383-1970,*Indian standard specification for coarse and fine aggregate from natural sources for concrete(second revision),* Bureau of Indian standards, New Delhi.

[3] IS:2386(part I)-1963,*Indian standard Methods of test for aggregate for concrete part I particle size and shape (Eleventh reprint),* Bureau of Indian standards, New Delhi.

[4] IS:2386(part III)-1963, *Indian standard Methods of test for aggregate for concrete part III specific gravity, Density, voids, Absorption and Bulking(Eighth Reprint March 1997),* Bureau of Indian standards, New Delhi.

[5] Self-Compacting Concrete - Procedure for Mix Design, ParatibhaAggarwal, RafatSiddique, YogeshAggarwal, Surinder M Gupta, Leonardo Electronic Journal of Practices and Technologies, Issue 12, Page 15, June 2008.

[6] Mix Design Procedure for Self Compacting Concrete, KrishnaMurthy.N, NarasimhaRao A.V, Ramana Reddy I .V, IOSR Journal of Engineering (IOSRJEN), Volume 2, Issue 9, Page 33, September 2012.

[7] A Simple Tool For Self Compacting Concrete Mix Design, J. Guru Jawahar, C. Sashidhar, I.V. Ramana Reddy and J. Annie Peter, International Journal of Advances in Engineering & Technology, Volume 3, Issue 2, Page 550, May 2012.

[8] Experimental Investigation Manufactured Sand as a Partial Replacement Material of Fine Aggregate in Self-Compacting Concrete, Indian journal of applied research,Volume:4, Page no:236, August 2014.

[9] Experimental investigation on Self-Curing Self- Compacting Concrete by Replacing Natural Sand by M- sand and Coarse aggregates By Light Weight Aggregate for M-40 Grade Concrete, International Journal of Scientific and Research Publications, Volume 4, page no:1, August 2014.

[10] Effect of Different Type of Steel Fiber and Aspect Ratio on Mechanical Properties of Self Compacted Concrete, International Journal of Engineering and Innovative Technology, Volume 2, page no:184, July2012.

[11] Self-Compacting Concrete - Procedure for Mix Design, Leonardo Electronic Journal of Practices and Technologies, page no:15, June2008.

[12] Experimental Investigation Of Mechanical And Durability Properties Of Self Compacting Concrete With Fly Ash And M-Sand, NationalConference on Research Advances in Communication, Computation, Electrical Science and Structures, Page no:11,2015.