Experimental Investigation on SFRC Beams Using M-Sand

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Abstract- This paper describes the experimental study of fiber reinforced concrete with Manufactured Sand (M-Sand) in addition of crimped steel fibers. Due to high global consumption of natural sand, sand deposit is being depleted and causing serious threat to environment. Since river/natural sand has become a scarce commodity and hence the use of alternatives has become necessary. To overcome the difficulties due to excessive sand mining, M-Sand is used a fine aggregates. Manufactured sand is a very good alternative to natural sand as it is uniform in size, produced from gravel crushes in controlled conditions. The present trend in concrete technology is towards increasing the strength and durability of concrete to meet the demands of modern construction. The demand for high strength and crack resistant concrete led to the development of fiber reinforced concrete. In the present work we study the behaviour of fiber reinforced concrete with m-sand when natural sand is completely replaced with m-sand and fibers of various percentages 0.5%, 1%, 1.5%, & 2% are added.

Indexed Terms- Concrete, Crimped Steel Fibers, Fiber Reinforced Concrete, M-Sand.

I. INTRODUCTION

Concrete plays a major role in the construction industry and a large quantum of concrete is being utilized. River sand, which is one of the constituent used in the production of conventional concrete, has become expensive and also a scarce material. River sand becoming a scare commodity and hence exploring alternatives to it has become imminent. Depletion of the virgin natural river sand is the main issue concerning the construction industry. And also, the biggest challenge. The objective of the present study is to examine the suitability of M-Sand as fine aggregate in concrete and an attempt is made to evaluate the effect of the steel fibres on concrete grade of M-25 prepared by *M-Sand*.

Stone crushed in require grain size is called M-Sand. Manufacturing of M-Sand process involves three stages, crushing of stones in to aggregate by vertical shaft impact (vsi), then fed to Rotopactor to crush aggregate into sand to required grain size. Screening is done to eliminate dust particles and washing of sand eliminates very fine particles present within. The end product will satisfy all the requirements of IS: 383-1970 and can be used in concrete. The formation of cracks is the main reason for the failure of the concrete. To increase the tensile strength of concrete, many attempts have been made. One of the successful and most commonly used method is providing steel reinforcement. Steel bars, however, reinforce concrete against local tension only. Cracks in reinforced concrete members extend freely until encountering rebar. Thus need for multidirectional and closely spaced steel reinforcement arises. That cannot be practically possible. Fibre reinforcement gives the solution for this problem so to increase the tensile strength of concrete a technique of introduction of fibres in concrete is being used. These fibres act as crack arrestors and prevent the propagation of the cracks. These fibres are uniformly distributed and randomly arranged in the concrete mass. This concrete is named as Fibre Reinforced Concrete. In this present study fully replacement of natural sand by M-sand and using different percentage of steel fibres had taken in both concrete mix M-25.

II. REVIEW OF LITERATURE

1) A Siddharth Anand, Mohammad Afaque Khan, et.al, 2016

Considered that Steel fibers had effect on compressive, tensile strength, flexural strength, and modulus of elasticity and ultrasonic pulse velocity of steel fiber self-compacting concrete. The content was (0 – 1.5 %) steel fiber by volume of mix. All fiber mixes performed for tensile strength, and flexural strength relative to plain mix at all curing ages. The strength increased as the fiber content increased. The results indicated that the workability reduced with the increase of steel fiber content. The steel fiber content of 1.5% by Vol. of mix had better effect on hardened properties but worst on fresh properties of SCC. As well as 0.75% and 1% steel fiber content will be sufficient for achieving satisfying performance in fresh and hardened properties of SCC.

2) S. C. Patodi, C. V. Kulkarni (2012)
The authors found that matrix having 0.3% of recron and 0.7% of steel fiber volume fraction was found:

- More balanced in terms of strength and post – peak ductility.
- Best resistance against impact and maximum toughness.
- For overall better performance.
- Advantages in improving concrete properties.

3) S. Sharmila et al. (2013)
The authors indicated that:

- The effect of adding hybrid fibres influence the behavior of beams by increasing the ductility characteristics by 80% and energy absorption characteristics by more than 160%.
- Instead of adding single fibre, the combination of different types of fibres (Hybrid fibres) increases the energy absorption capacity substantially.

4) Zoran J. Grdic et al. (2012)
The authors concluded that:
Abrasive resistance of concrete is reduced with the increase of water/cement ratio from 0.5 to 0.7 which is reflected in the increase of the value of abrasion resistance rate.

The addition of fibers increases tensile strength across the entire range of water/cement factors from 0.5 to 0.7 in respect to the benchmark concrete.

The concretes with high compressive and tensile strength (at bending) have higher abrasive resistance, so these parameters may serve as indicators of the abrasive–erosive resistance of concrete.

The polypropylene fibrillated fibers proved better in respect to the monofilament fibers in terms of abrasive– erosive resistance of concrete.

5) Kiran. M. Mane, et.al, 2017.
Has worked on The strength and workability of concrete with manufactured sand.

The main part of work has to study the effect of percentage replacement of manufactured sand by natural sand as 0%, 20%, 40%, 60%, 80% and 100% respectively on workability of concrete and the strength characteristics such as compressive strength, shear strength, of concrete was carried out.

It has M30 grade concrete with 0.45 water cement ratio.

It has been observed that any percentage replacement of natural sand to manufactured sand it will reduce workability.

The results of in the compressive strength has 60% replacement of natural sand by manufactured sand is found to be 1.52% and shear strength of concrete 60% replacement of natural sand by manufactured sand has21.95%.

III. CONSTITUENTS OF MATERIALS

The materials to be used are Cement, M-Sand, Coarse aggregate, Steel fiber, Admixture (Super Plasticizer) and Water.

A-CEMENT:
We will be using most commonly used type of cement that is OPC, Ordinary Portland Cement 43 grade conforming to I.S. – 12269- 1987.

B-FINE AGGREGATES:
For fine aggregates we will be using M-Sand and conforming to IS: 383.

C-COARSE AGGREGATE:

Coarse aggregate of nominal size of 20mm down are chosen and tests to determine the different physical properties as per IS 383-1970.

D-STEEL FIBERS:
Additionally, a commercial crimped steel fibre with a length and a cross section of 50mm and 0.5 mm respectively, and with an equivalent aspect ratio 100 will be added into the both mix. Taking into account the workability problem (balling and clumping of fibres) of composites associated with the addition of fibers and cost effectiveness, maximum dosage of fiber in concretes was limited to 2%.

E- ADMIXTURES:
An admixture is defined as a material, other than the cement, water and aggregate, used as an ingredient of concrete and is added to the batch immediately during mixing. An admixture CONPLAST SP430 of FOSROC will be used. It is based on Sulphonated Naphthalene Polymers and supplied as a brown liquid instantly dispersible in water. Its specific gravity is 1.2 to 1.225 at 300C temperature. It is non-flammable. CONPLAST SP430 complies with IS: 9103:1999 and IS2645:1975

F-WATER:
Water is an important ingredient of concrete as it initiates the chemical reaction with cement. Ordinary potable water will be used throughout the investigation as well as for curing concrete specimens.

SPECIFICATIONS OF CEMENT:

SL NO.	TESTS	RESULTS
1	Normal Consistency	32%
2	Initial Setting Time	38 MINUTES
3	Final Setting Time	158 MINUTES
4	Specific Gravity	3.05
5	Finness	2%

SPECIFICATIONS OF COARSE AGGREGATE:

SL NO.	TESTS	RESULTS
1	Specific gravity	2.70
2	Water Absorption	1%
3	Size	20mm
4	Bulk Density	Loose 1.44 Compact 1.53

SPECIFICATIONS OF FINEAGGREGATE:

SL NO.	TESTS	RESULTS
1	Specific gravity	2.40
2	Water Absorption	1.14%
3	Bulk Density	Loose 1.61 Compact 1.71

SPECIFICATIONS OF STEEL FIBERS:

Sl no.	Tests	Results
1	Equivalent dia	0.5 mm
2	Aspect ratio	100
3	Length	50 mm
4	Packing	20 kg/bag
5	Type of Fibers	Crimped

SPECIFICATIONS OF SUPER PLASTICIZER:

Sl no.	Tests	Results
1	Water Reduction	More than 12
2	Appearance	Brown Liquid
3	Specific Gravity	1.20

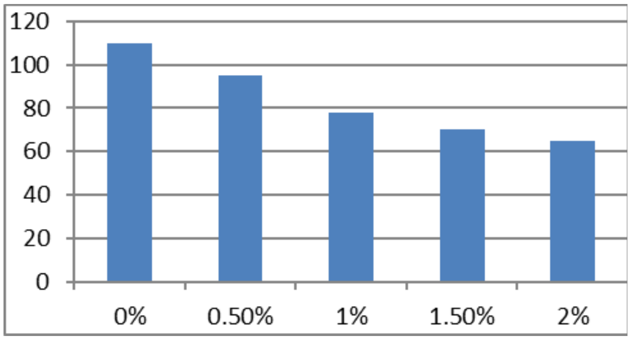
MIX DESIGN:
The mix design as per 10262:2009 for M25 grade concrete with 0.47 water cement ratio. Concrete mixes are prepared by full replacement of Natural sand with M-Sand and addition of various percentages steel fibers.

TESTS ON CONCRETE:

1) TESTS ON FRESH CONCRETE
   a) SLUMP CONE TEST

RESULTS OF SLUMP CONE TEST:

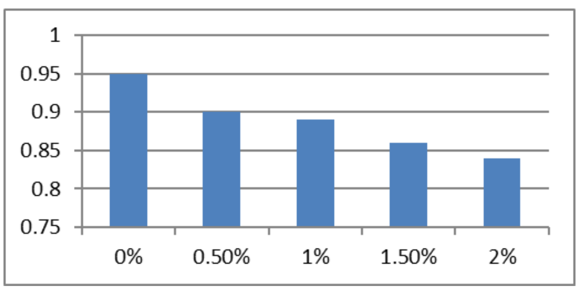
Steel Fibers	Slump value
0 %	110 mm
0.5%	95 mm
1%	78 mm
1.5%	70 mm
2%	65 mm



b) COMPACTION FACTOR

RESULTS OF COMPACTION FACTOR:

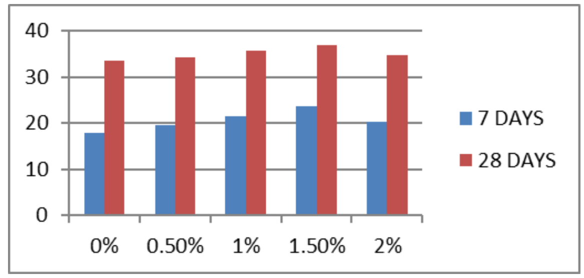
Steel Fibers	Compaction factor
0 %	0.95
0.5%	0.90
1%	0.89
1.5%	0.86
2%	0.84



2) TESTS ON HARDENED CONCRET

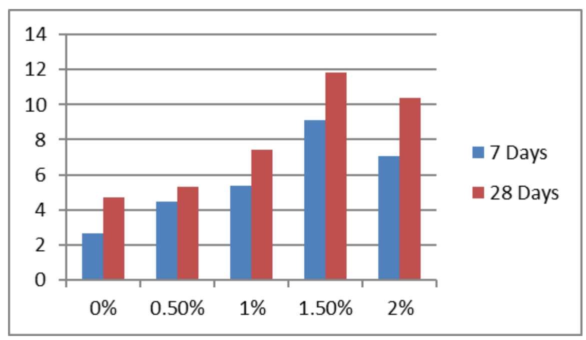
a) COMPRESSIVE STRENGHT

COMPRESSIVE STRENGTH		
Steel Fibers	7 Days	28 Days
0 %	17.9	33.5
0.5%	19.6	34.2
1%	21.4	35.6
1.5%	23.7	36.9
2%	20.4	34.8



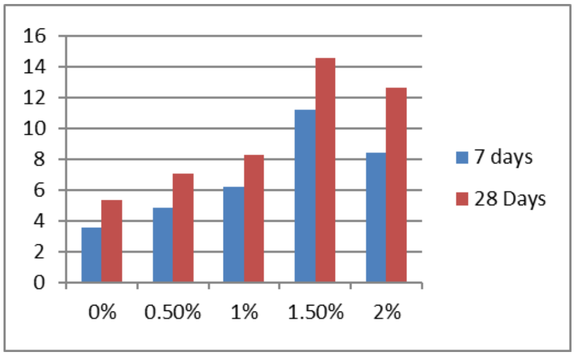
b) SPLITING TENSILE TEST:

SPLITING TENSILE TEST		
Steel Fibers	7 Days	28 Days
0 %	2.65	4.71
0.5%	4.44	5.32
1%	5.38	7.44
1.5%	9.12	11.85
2%	7.08	10.4



c) FLEXURAL STRENGTH:

FLEXURAL STRENGTH		
Steel Fibers	7 Days	28 Days
0 %	3.55	5.35
0.5%	4.85	7.05
1%	6.22	8.3
1.5%	11.2	14.55
2%	8.4	12.6



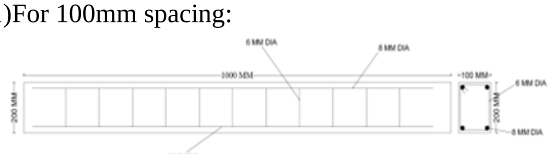
CASTING OF BEAMS:
The beams are designed for M25 grade Concrete and Fe415 HYSD Steel bars. The size of the beam specimen is 100mmX200mmX1000mm reinforced with 2 Nos of 8 mm dia bars in tensile zone,2 Nos of 8 mm dia bars in Compression Zone and 6mm dia 2 legged stirrups at 100mm and 150mm spacing c/c are provided. The effective depth of beam is calculated as 180mm by taking 20mm clear cover for Beams.

REINFORCEMENT DETAILS:

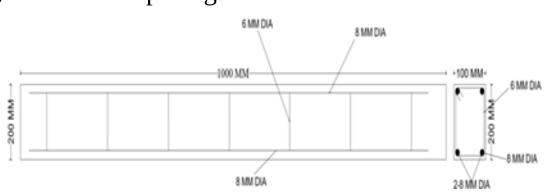
Diagram of reinforcement details:

1 % Steel Reinforcement

1)For 100mm spacing:



2)For 150mm spacing:



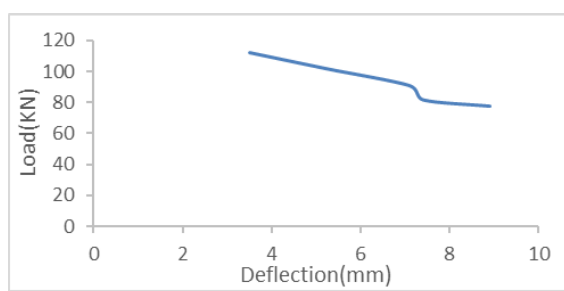
PROCEDURE FOR CASTING OF BEAMS:

- Inspecting the correct internal dimension of the mould to be as specified (i.e. 100x200x1000mm).
- Oiling the internal surface of the mould.
- The materials such as cement , M-sand , coarse aggregates , steel fibers , water and superplasticizer are weighed and measured accordingly.
- The reinforcements are placed inside the mould with effective coverings in the sides and bottom.
- Dry mixings of cement M-sand and coarse aggregates is done for approximate 5 minutes until uniform colour was visible
- Steel Fiber were added uniformly over the dry mix and these were mixed for another 5 minutes,
- Now water was added to the dry mix in 3 parts.
- Superplasticizer conplast 430 was added to the mix and ensure that the mixing was done thoroughly.
- The concrete mix was now poured into the mould in 3 layers and each layer was tamped with tamping rod to ensure no air voids are present.
- Scraping off the excess material and leveling of the top surface.
- The specimen is kept inside the mould for 24 hours setting of concrete.
- After 24 hours the specimen is removed from the mould .
- The specimen is kept for curing, the method of curing adopoted is surface curing with the help of gunny bags.

TABULAR COLUMN FOR TESTING OF BEAMS:

1% steel @ 100mm spacing c/c

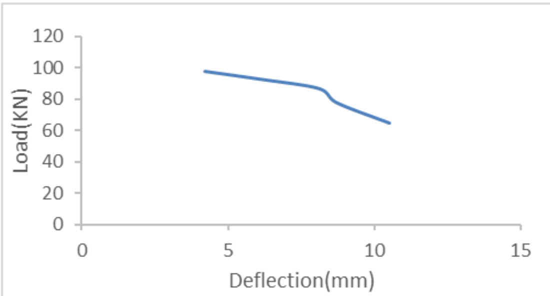
% of Steel Fiber	Load (KN)	Deflection(mm)	Shear strength
0	78	8.9	3.9
0.5	82	7.4	4.1
1	91	7.1	4.55
1.5	102	5.2	5.1
2	112	3.5	5.6



1% Steel @ 150mm spacing c/c

% of Steel Fiber	Load (KN)	Deflection(mm)	Shear strength

0	65	10.5	3.25
0.5	78	8.7	3.9
1	87	8.1	4.35
1.5	93	6.1	4.65
2	98	4.2	4.9



CONCLUSION

- Slump value and compaction factor value decreases as fibers ratio increases.
- The Compressive Strength of FRC increases as Fiber percentage increases up to 1.5% by 10%.
- The Split Tensile Strength increases as the Fiber percentage increases up to 1.5% of increase by about 150%.
- Similarly, flexural strength also increases by an increase in the percentage of steel fibers by about 150% for 28 days.
- FRC beams also shows the improvement in load carrying capacity by increase in steel fiber content. The ultimate load in increased by 43% for 100mm stirrups spacing.
- Similarly, beams with 150mm stirrups spacing also show an improvement in load-carrying capacity by 50%.
- The deflection of the beams with 100mm stirrups spacing and 150mm spacing shows a decrease in deflection by 50%.
- FRC beams show the better improvement in shear strength by increase in percentage of steel fibers.
- As the percentage of steel fibers increase then the load vs deflection gradually decreases.

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