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Experimental Investigation Manufactured Sand as a Partial Replacement Material of Fine Aggregate in Self-Compacting Concrete

KEYWORDS: self compacting concrete, Manufactured sand, Super-plasticizer

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ABSTRACT *Self-Compacting Concrete(SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. In the work, an attempt has been made to make a comparative study on the fresh and hardened state properties of M30 and M40 grades of plain concrete mixes to self compacting concrete with the replacement of River sand by Manufactured sand.This paper presents an Experimental Investigation on Strength aspects like Compressive, Flexural and Split Tensile Strength of Self-Compacting Concrete and Workability tests (slump, L-box, U-box, V-Funnel, J-ring and T50) are carried out. The methodology adopted is that Manufactured sand are replaced by 0 %, 25%, 50%, 75%, 100%, for river sand and performance is measured and compared.This research outcome is very bene ficial and economical to the Community.*

INTRODUCTION

Concrete is a widely used construction material around the world, and its properties have been undergoing changes through technological advancement. Numerous types of concrete have been developed to enhance the different properties of concrete. So far, this development can be divided into four stages. The earliest is the traditional normal strength concrete which is composed of only four constituent materials, which are cement, water, fine and coarse aggregates. At the way to achieve the high compressive beginning, reducing thewater cement ratio was the easiest way to achieve the high compressive strength.

Thereafter the fifth ingredient a water reducing agent or super plasticizer was indispensable. The chemical admixture is said to be any material that is added in a small quantity (i.e., less than 5%) to the concrete mixture which enhances the properties of concrete in both the fresh and hardened state. But now a day the cost of sand has been increasing beyond imagination which is resulting in the increase in concrete cost. This is because demand for sand is more than its supply to overcome this problem the experiment on concrete by partial replacement of river sand by manufactured sand in self compacting concrete. We can reduce the cost of concrete and enhance the strength of concrete also M-sand can reduce ecological imbalance in nature. To study the mechanical properties of both SCC and manufactured sand as a replacement material in various percentages to the mix. A study has been done on the compressive, flexural and split tensile strength with these various mix Self-compacting mixes are designed to have fresh properties that have a higher degree of workability than convectional concrete. Workability is a way of describing the performance of concrete in the plastic state and for SCC, workability is often characterized by the following properties:

- Filling ability: ability to fill formwork under its own weight.
- Passing ability: ability to overcome obstacles like reinforcement.
- Stability: homogeneous composition of concrete during and after placing concrete

Table 1 Typical Acceptance Criteria for SCC

Method	Unit	Typical ranges of values	
		Minimum	Maximum
Slump flow by Abram's cone	Mm	650	800
T50cm Slump Flow	Sec	2	5
V-Funnel	Sec	8	12
L-Box	h1/h2	0.8	1.0
U-Box	(h2-h1) mm	0	30
J- ring	Mm	0	10

OBJECTIVES

1 .For Design mixes for self compacting concrete mixed with Manufactured sand in various Percentages and to study its Fresh and Hardened state concrete properties.

2. To compare the Compressive Strength at the ages of 7and 28 days, Split Tensile Strength and Flexural behavior of Self Compacting Concrete at 28 days for M30 and M40 Grades of Concrete Mixes.

MATERIAL PROPERTIES

CEMENT

Ordinary Portland cement of 53 grade was used and tested for physical and chemical properties and found to be conforming to various specifications as per IS: 12269-1987.

Table 2 Physical Properties of Cement

Sl No	Tests on cement	Observations
1	Specific gravity	3.10
2	Normal consistency	30%
3	Initial setting time	38 min
4	Compression strength 7 Days 28 days	 29 N/mm2 52 N/mm2

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FINE AGGREGATE

Locally available river sand which is free from organic impurities is used sand passing through 4.75mm sieve and retained on 150 micron IS sieve is used in this investigation. River sand confirming to IS: 2386-1975 is used.

Table 3 Properties of fine Aggregate

Property	Value
Specific Gravity	2.7
Fineness modulus	2.74
Bulk density	1690

MANUFACTURED SAND

Manufactured sand confirming to IS: 383-1970 is used.. Which is confirms to Zone II The physical properties of fine aggregate like specific gravity, bulk density, gradation and fineness modulus is tested in accordance with IS: 2386-1975.

Table 4 Properties of Manufactured sand

Properties	Observations
Fineness Modulus	2.72
Specific Gravity	2.68
Bulk Density (Kg/m^3)	1688

COARSE AGGREGATE

The crushed coarse aggregate of 20 mm maximum size rounded obtained from the local crushing plant; (Bidadi, Karnataka) is used in the present study. The physical properties of coarse aggregate like specific gravity, bulk density, gradation and fineness modulus are tested in accordance with IS : 2386-1975.

Table 5 Properties of Coarse Aggregate

Properties	Observations
Fineness Modulus	4.98
Specific Gravity	2.75
Bulk Density (Kg/m3)	1530

ADMIXTURE: CONPLAST SP 430

Conplast SP 430 is an admixture of a new generation made from the Forsoc Company. The product has been primarily developed for applications in high performance concrete where the highest durability and performance is required. Conplast SP 430 is free of chloride & low alkali. It is compatible with all types of cements.

Table 6 Mix Proportions for M30 Grade Concrete

Mix Designation	Cement kg/m3	Manufactured sand kg/m3	Fine Aggregate kg/m3	Coarse Aggregate kg/m3	W/C Ratio	Super plasticizer
SCC 1	462.93	0		754.36	0.45	2.77
SCC 2	462.93	691.50	230.50	754.36	0.45	2.77
SCC 3	462.93	461.00	461.00	754.36	0.45	2.77
SCC 4	462.93	230.50	691.50	754.36	0.45	2.77
SCC 5	462.93	922.00	0	754.36	0.45	2.77

Table 7 Mix Proportion for M40 Grade

Mix Designation	Cement kg/m3	Manufactured sand kg/m3	Fine Aggregate kg/m3	Coarse Aggregate kg/m3	W/C Ratio	Super plasticizer
SCC 6	595.50	0	884.57	723.98	0.35	3.57
SCC 7	595.50	221.14	663.42	723.98	0.35	3.57
SCC 8	595.50	442.28	442.28	723.98	0.35	3.57
SCC 9	595.50	663.42	221.14	723.98	0.35	3.57
SCC 10	595.50	884.57	0	723.98	0.35	3.57

EXPERIMENTAL RESULTS

Fresh State Properties

The fresh state properties like slump flow, V-funnel test, L-box test U-box test and J-ring test has been carried out to determine the flow ability and pass ability. And the test results has been tabulated in the table below

Table 8 Workability Test Results

Sl No.	Mix Designation	Slump Flow 650-800mm		V-Funnel 8-12 S	L-Box Ratio 0.8-1.0	U-Box (H2-H1)	J-Ring Mm
1	SCC 1	680	4	8	0.86	19	8
2	SCC 2	665	4	8	0.85	23	8
3	SCC 3	660	4	9	0.85	21	7
4	SCC 4	657	3	10	0.86	24	6
5	SCC 5	652	4	9	0.86	17	10
6	SCC 6	715	4	10	0.95	18	10
7	SCC 7	704	3	8	0.95	15	9
8	SCC 8	698	3	9	0.9	27	5
9	SCC 9	690	4	9	0.9	19	7
10	SCC 10	685	4	10	0.9	22	8

SPECIMEN DETAILS

The specimens casted are

a) Cubes of 150mm×150mm×150mm size
b) Cylinder of 150mm dia×300mm length
c) Prism of 100mm×100mm×500mm size

HARDENED STATE PROPERTIES

Fig 1: Split tensile strength test

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Fig: 2. Flexural Strength test

Test Results

The compressive strength of cubes Split tensile strength of cylinder and flexural strength of prism are tabulated below.

Table 9 Compressive Strength of M30 grade concrete

% of Manufactured sand	Compressive strength N/mm2	
	7 days	28 days
0%	29.6	41.8
25%	28.4	39.8
50%	31.6	44.0
75%	28.9	36.6
100%	24.9	33.0

Table 10 Compressive Strength of M40 grade concrete

% of Manufactured sand	Compressive strength N/mm2	
	7 days	28 days
0%	31.0	45.6
25%	32.0	43.5
50%	36.8	49.6
75%	30.2	41.5
100%	29.2	36.5

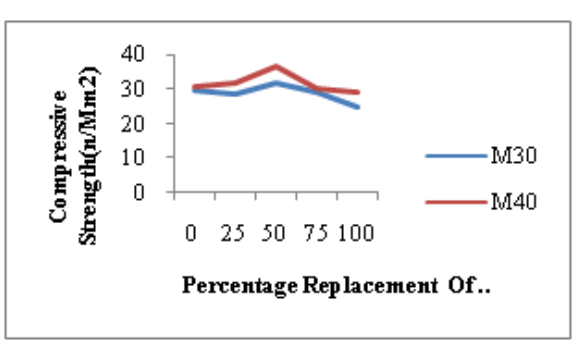

Fig: 3. Compressive Strength of 7 Days

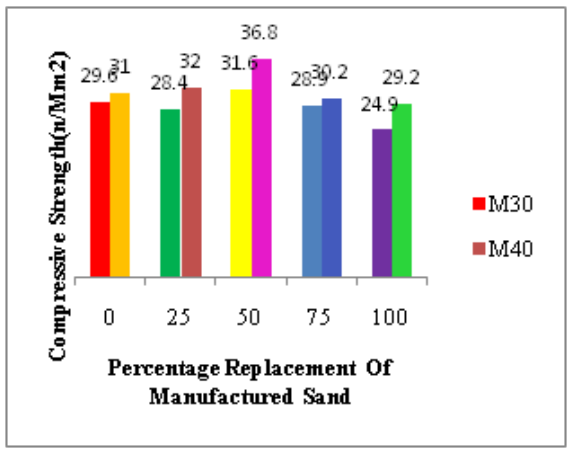

Fig: 4 Compressive Strength of 7 Days

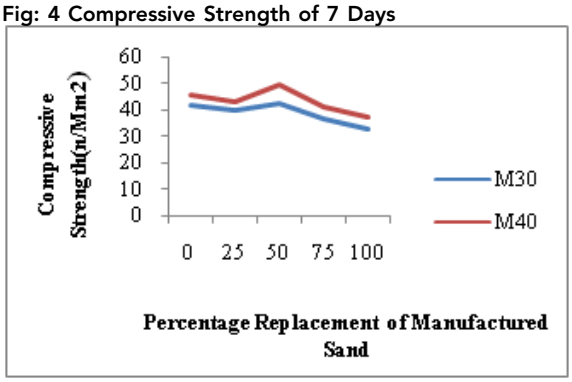

Fig: 5.compressive strength of 28 Days

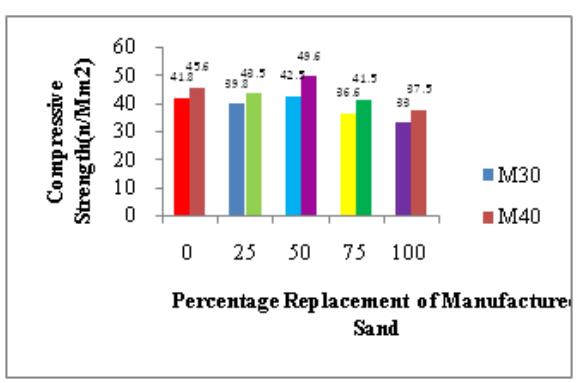

Fig: 6 Compressive Strength of 28 Days

Table 11 Split Tensile Strength of Concrete

% of Manufactured sand	Split Tensile strength N/mm2	
	M30 Grade	M40 Grade
0%	3.10	3.47
25%	3.43	3.86
50%	3.91	4.30
75%	3.8	4.05
100%	3.48	3.62

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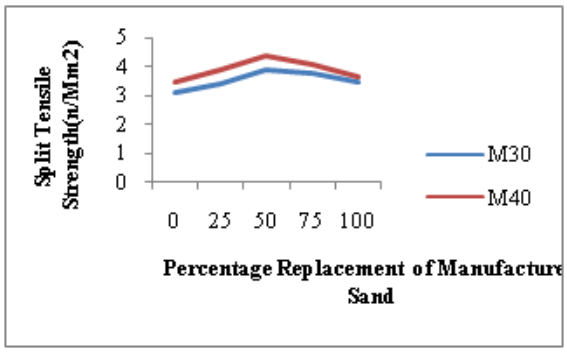

Fig: 7 Split tensile Strength of 28 Days

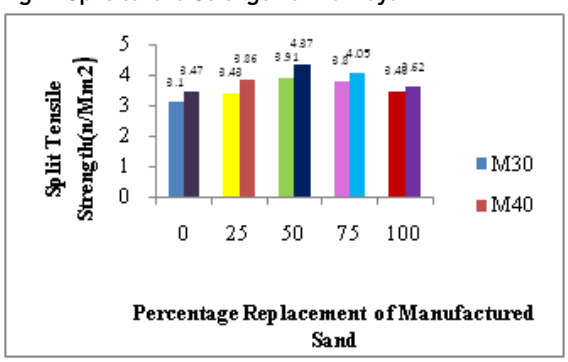

Fig: 8 Split tensile Strength of 28 Days

Table 12 Flexural Strength of Concrete

% of Manufactured sand	Flexural strength N/mm2	
	M30 Grade	M40 Grade
0%	3.06	3.21
25%	3.58	5.21
50%	6.2	7.44
75%	5.0	6.53
100%	4.26	5.3

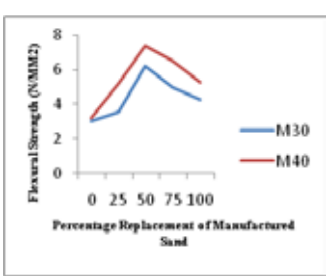

Fig 9 Flexural Strength of 28 Days

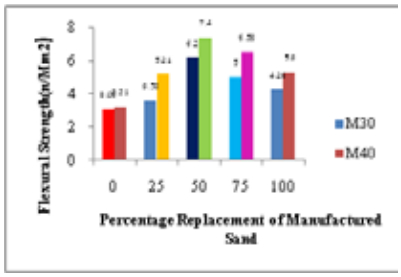

Fig: 10 Flexural Strength of 28 Days

CONCLUSION

1. M-sand is a well graded material and falls within the grading limits specified by BIS Guidelines IS: 383-1970 code for getting zone II Sand classification.
2. Both M30 and M40 grade mixes when converted to SCC mix as per guidelines given in EFNARC satisfies the desired requirement criteria in slump, Compressive strength, Split tensile, Flexural strength test.
3. Both M30 and M40 grade mixes when converted to SCC mix as per guidelines given in EFNARC satisfies tests value of slump, L-box, U-box, V-Funnel, J-ring and T50.
4. The cube compressive strength of SCC at 28 days for M30 and M40 mixes is either more or close to the target compressive strength. Which may be due to Cubes with SCC attaining more degree of compaction than normal cubes prepared according to standard test procedure.
5. Compressive strength of SCC is optimum at 50-50 mix of river sand and M-sand for both M30 and M40 grade mixes.
6. 19% reduction in compressive strength between 100-0 and 0-100 proportion mix(RS:MS) of River sand and M-sand for M30 grade mix ,was observed.
7. 21% reduction in compressive strength between 100-0 and 0-100 proportion mix (MS:RS) of River sand and M-sand for M40 grade mix, was observed.
8. Split tensile strength is optimum for 50-50 proportion of river sand and M-sand.
9. 6% increase in split tensile strength of 100-0 and 0-100 proportion (MS:RS) of River sand and M-sand for M40 grade mixes, was observed.
10. There is about 14% increase in split tensile strength of 100-0 and 0-100 proportion(MS:RS) of River sand and M-sand for M30 grade mixes, was observed.
11. Flexural strength is optimum for 50-50 proportion of River sand and M-sand.
12. There is about 39% increase in flexural strength of 100-0 and 0-100 proportion of River sand and M-sand for M30 grade mixes, was observed.
13. There is about 65% increase in flexural strength of 100-0 and 0-100 proportion(MS:RS) of River sand and M-sand for M30 grade mixes, was observed.

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