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Impact Assessment On Manufactured Sand Inducing Polycarboxylic Ether Based Admixture & Carbon Fibre In Smart Concrete

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ABSTRACT

The effect of high performance admixture on fresh and hardened properties of concrete with sector replacement of natural sand by manufactured sand was investigated. Concrete mix design of M25 grade was executed as per the norms in Indian Standard (IS 10262). Concrete cube, cylindrical and beam specimens were assessed for evaluating the compressive, split tensile & flexural strength respectively. The proposed concrete exhibits better strength when on replacing with 50% of natural sand by manufactured sand. This shall be further improved by inducing carbon fibre reinforced polymer CFRP in the concrete possessing five times stronger than steel and mass is lesser in one fourth to steel thus reducing the self-weight of a framed structure effectively and also the tensile strength of a concrete shall be improved. The CFRP sheet has a fibre thickness of 0.176mm which carries an additional imposed load in the range of 5% - 15%. This concept shall be applied in specialized areas pertaining to skyscraper construction, structural repair, strengthening of concrete elements. The performance shall be investigated by creating a simulation using ANSYS multiphysics.

Keywords: Reduction in self-weight, CFRP, Strengthening of concrete elements

I. INTRODUCTION

Concrete significantly represented as a mixture of cement, fine & coarse aggregates. Where the properties of aggregate and admixture affects the durability and performance of concrete. In view towards the current scenario, natural river sand is widely used as fine aggregate in concrete. Proper selection of aggregate has to be ensured as they impart quality and creates the core matrix of concrete. Presently, the consumption of river sand is very extreme due to the extensive use of concrete. The demand gets elevated day by day as we don't follow proper parameters to manage the natural sources resulting in severe depletion of river beds, loss of vegetation at the bank of rivers, exposing of intake structures, collapsing the aquatic life. In view towards the kind of serious threats, advancements had been erupted to proceed with substituent material to natural sand. But the advanced infrastructural growth requires abundant alternative resources without any demand and they shall satisfy the technical requisites of fine aggregate

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II. LITERATURE REVIEW

Martins Polegis indicated that manufactured sand differs from river dredged sand in its physical and mineralogical properties and hence requires a higher water cement ratio for workability equal to that of natural sand in concrete due to high angularity of manufactured sand particles. **Hudson B.P** performed a review of various tests in the manufactured sand for concrete. **Amnon & Hadassa** studied the effect of high level of fines content on the properties of concrete. **Nithyambigai** studied the utilization of flyash leads to reduction in attaining early strength in concrete yet there is an increase in long term strength and also it provides increased workability, reduction in cement content and decreased permeability. **Prashant Muley et al** observed the effect on different volume of fibres from 0% to 1% to the concrete. Results indicated that the fibres enhance the strength in earlier manner and they do not allow splitting of concrete specimens & the occurrence of brittle failure after preliminary crack thereby improving the ductility of the concrete. *In view* towards the above mentioned, it is clear that manufactured sand stands as a viable alternative material to river sand produced by crushing, cleaning, grading, categorizing the identical materials in which river sand shall be considered partially or non-partially

III. RESEARCH SIGNIFICANCE

The ultimate objective is to study the effect of admixture, water-cement ratio of 0.42, 0.45, 0.47, 0.48 & the percentage replacement of manufactured sand by natural sand in constituents of 25%, 50%, 75% & 100% respectively on the strength gain property of concrete. The study was carried out on M25 grade using high performance super plasticizer (Master Glenium Sky 8233) thereby adopting CFRP into concrete having hollow circular pattern via simulation using ANSYS multiphysics and evaluating the performance of it thereby comparing the existing one to determine the output in terms of performance. This kind of research is scarce and hence this article investigates the concrete produced with manufactured sand.

IV. MATERIALS

Aggregates – Coarse aggregate (20mm HBG [60%] and 12.5mm [40%] procured from locally available sources [40mm to 4.75mm] and locally available river sand [4.75mm to 150 microns] as fine aggregate was used to perform the investigation. The fine aggregate corresponds with zone I and the coarse aggregates of 20mm and 12.5 mm corresponds with single sized and graded aggregates as per IS 383-2016. Summary of the material properties for cement were determined in Table 1, Properties of material for fine and coarse aggregates were determined in Table 2 and the sieve analysis were presented in Table 3 according to the Indian Standards

Cement – Portland Pozzolona Cement (Flyash based) [Bharati Manufacturer] was used for this investigation

Admixture – *Master Glenium Sky 8233* – free of chlorides & low alkalies and probably compatible with all types of cements, improving the effectiveness of cement dispersion. Steric hindrance provides a physical barrier between the cement grains and

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thus flowability is achieved with reduced water content.

Table 1: Physical Properties Of Cement

S.NO	TEST CONDUCTED	RESULTS	REQUIREMENTS AS PER IS 1489 (Part – 1) : 1991 R 2009
1	Consistency	30.6 %	Not specified
2	Initial Setting time	160 minutes	Shall not be less than 30 Minutes
3	Final Setting time	315 minutes	Shall not be more than 600 Minutes
4	Fineness	353 sq.m/kg	Shall not be less than 300 sq.m / kg
5	Soundness (By Le Chatlier's Method)	0.6 mm	Shall not be more than 10 Mm

Table 2: Physical Properties of Fine & Coarse Aggregates

S.NO	DESCRIPTION	VALUE
1	Dry rodded bulk density	1.645 kg / lit
2	Loose bulk density	1.547 kg/ lit
3	Specific gravity	2.64
4	Water Absorption	2.50 %

S.NO	DESCRIPTION	VALUE
1	Shape	Angular
2	Dry rodded bulk density	1.595 kg / lit
3	Loose bulk density	1.466 kg/ lit
4	Specific gravity	2.80
5	Water Absorption	0.34 %

Table 3: Details of sieve analysis of Natural sand & M-sand

RIVER SAND

IS SIEVE DESIGNATION	CUMULATIVE PERCENTAGE		SPECIFICATIONS AS PER IS 383 - 2016		
	RETAINED	PASSING	ZONE 1	ZONE 2	ZONE 3
4.75mm	4.4	95.6	90-100	90-100	90-100
2.36mm	13.1	86.9	60-95	75-100	85-100
1.18mm	50.2	49.8	30-70	55-90	75-100
600 microns	79.1	20.9	15-34	35-59	60-79
300 microns	94.6	5.4	5-20	8-30	12-40
150 microns	98.4	1.6	0-10	0-10	0-10

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MANUFACTURED SAND

IS SIEVE DESIGNATION	CUMULATIVE PERCENTAGE		SPECIFICATIONS AS PER IS 383 - 2016		
	RETAINED	PASSING	ZONE 1	ZONE 2	ZONE 3
4.75mm	0.2	99.8	90-100	90-100	90-100
2.36mm	17.5	82.5	60-95	75-100	85-100
1.18mm	49	51	30-70	55-90	75-100
600 microns	69.4	30.6	15-34	35-59	60-79
300 microns	84.1	15.9	5-20	8-30	12-40
150 microns	93.4	6.6	0-10	0-10	0-10

V. EXPERIMENTAL INVESTIGATION

The strength potencies in terms of compressive, split tensile, flexural and workability were studied on concrete with partial replacement of river sand by manufactured sand. This article extends the study towards the implementation of CFRP into the concrete and evaluating the performance of it. Table 4 presents the concrete mix design for M20 grade. Trial mix series [9 sets each] are done for the above mentioned and they were performed at 31°c. The materials were blended in dry state followed by the addition of water and admixture to acquire a homogeneous mixture.

Workability of fresh concrete was determined by the slump cone test according to the Indian Standards. Compressive strength was measured on [0.15m*0.15m*0.15m] cube specimens and split tensile strength was measured on [0.15m*0.3m] cylindrical specimens that were cured in water for 28 days respectively. The specimens are tested on CTM. Flexural strength was measured on [0.23m*0.3m*2m] specimens and they are tested on UTM (1 ton), center point loading shall adopt over the span of 2m and the test results were compared with the reference mix.

Table 4: Concrete Mix Design For M25 Grade

Mix Proportion – *1: 2.29: 3.48*

S. NO	MIX ID	CEMENT CONTENT (Kg/m^3)	WATER (Kg/m^3)	RIVER SAND (Kg/m^3)	M SAND (Kg/m^3)	20 MM (Kg/m^3)	12.5MM (Kg/m^3)	ADMIXT-URE DOSE (ml)
1	1	340	144.9	778.85	0	710.4	474	1700
2	2	340	144.9	598.25	198.85	710. 4	474	1700
3	3	340	153.3	390.47	398	710.4	474	1700
4	4	340	163	197.28	581.57	710.4	474	1700
5	5	340	163.15	0	778.85	710.4	474	1700

Table 5: Workability Of Fresh Concrete

S.NO	MIX I.D	SLUMP IN 10 MIN	SLUMP IN 60 MIN

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1	1	136 mm	106 mm
2	2	150 mm	110 mm
3	3	180 mm	130 mm
4	4	160 mm	130 mm
5	5	150 mm	110 mm

Table 6: Test Results of Concrete

MIX I.D	Compressive Strength (Mpa)	Split tensile Strength (Mpa)	Flexural Strength (Mpa)
1 (0% M-Sand)	38	2.05	5.02
2 (25% M-Sand)	44	3.92	7.52
3 (50% M-Sand)	44	3.97	7.69
4 (75% M-Sand)	32	2.68	5.74
5 (100% M-Sand)	37	3.34	5.86

VI. RESULTS & DISCUSSION

Fresh Concrete

Workability – For heavily reinforced structures, workability shall adhere greater than 100 mm slump. With respect to the effect of admixture, the results were satisfactory (given in Table 5) by adding the exact dosage required for different mix identities. The consumption of water in higher levels by M-Sand will take over using admixtures satisfying the workability requriements.

Hardened Concrete:

Different mix identities revealed that the elevated strength potencies had been achieved as a result of replacing 50% of M-Sand as seen in Table 6 and Fig.1, Fig.2 & Fig.3 respectively.

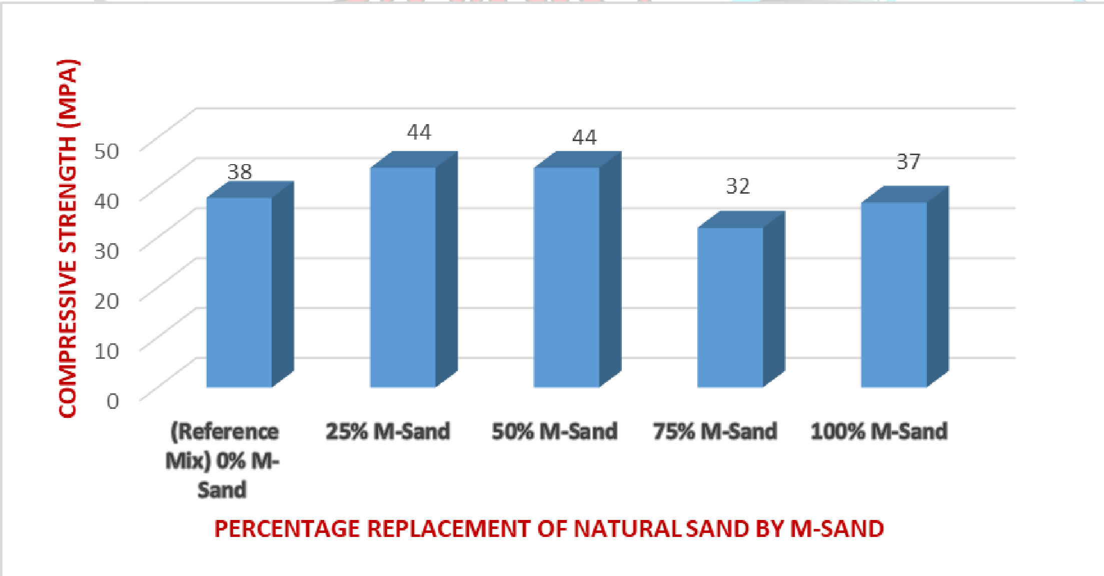

Fig.1 Variation in Compressive strength of concrete

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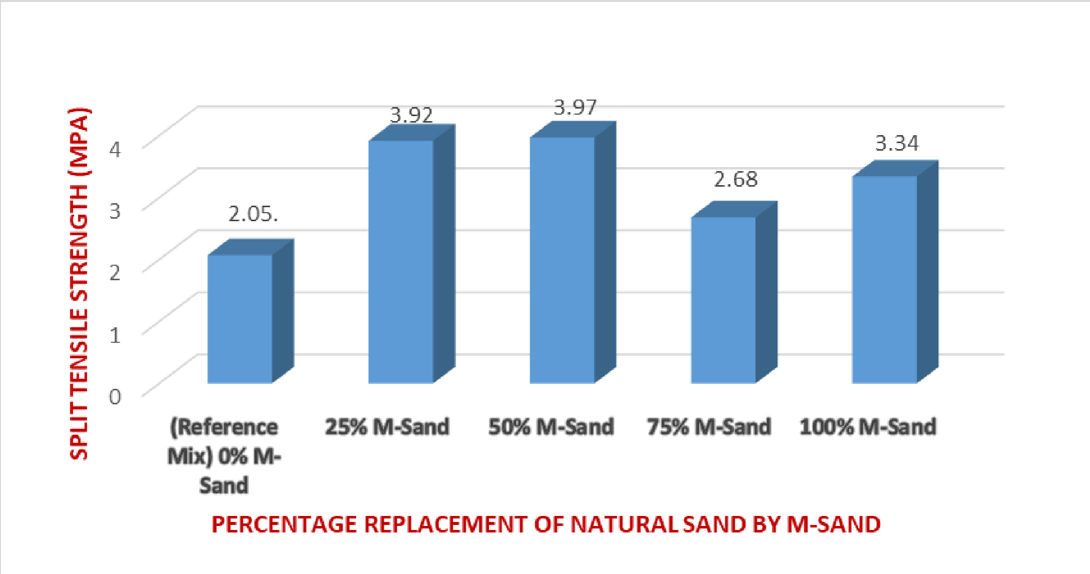

Fig.2 Variation in split tensile strength of concrete

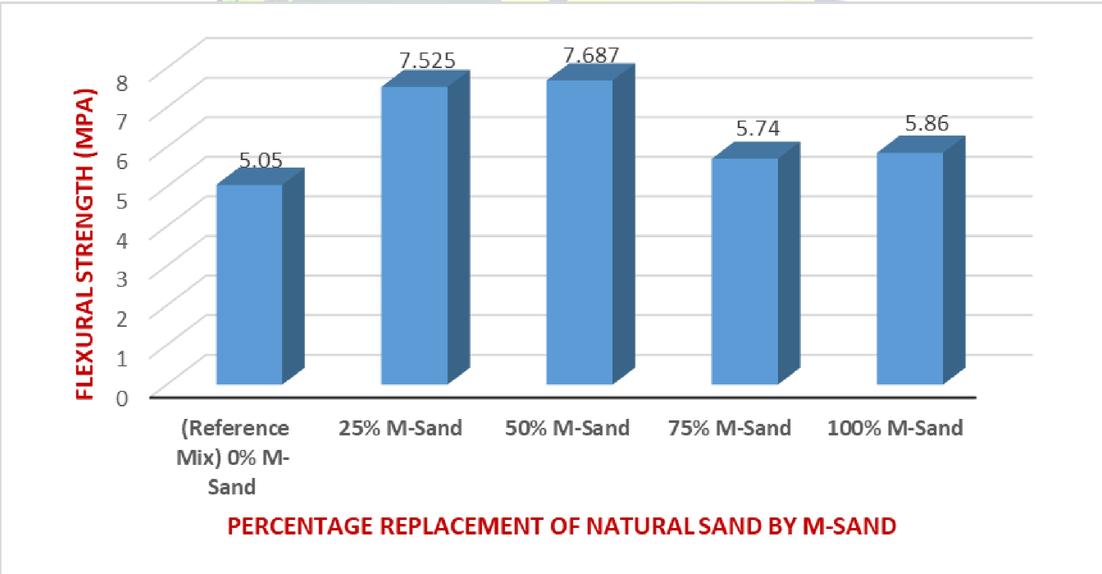

Fig.3 Variation in Flexural Strength of Concrete

Improved tensile and flexural strength shall be achieved if CFRP in hollow section is induced into the component reducing the self-weight of the structure to an extent also

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Fig.4 Blending the concrete mix

Fig.5 Casting cube specimens

Fig.6 Testing of Concrete cube & cylindrical specimens

VII. ANALYTICAL RESPONSE

A simulation model had been created using ANSYS multiphysics where a rectangular beam of 230 mm * 300 mm * 2000 mm had been considered for evaluation. The size of the element had been considered to be 25 mm and the supports are given at the point of eccentricity of about 40 mm where the dimensions of the support are 230 mm * 30mm* 80mm. A concrete beam had been considered as solid 65 and the rebars as Link180, supports and impactor as Solid186. CFRP had been considered for the configuration on the top and bottom faces of the beam The degree of freedom on X,Y,Z is set to be free where the rotation is completely locked for support 1 and Y is set to be free where the rotation is completely locked for support 2.

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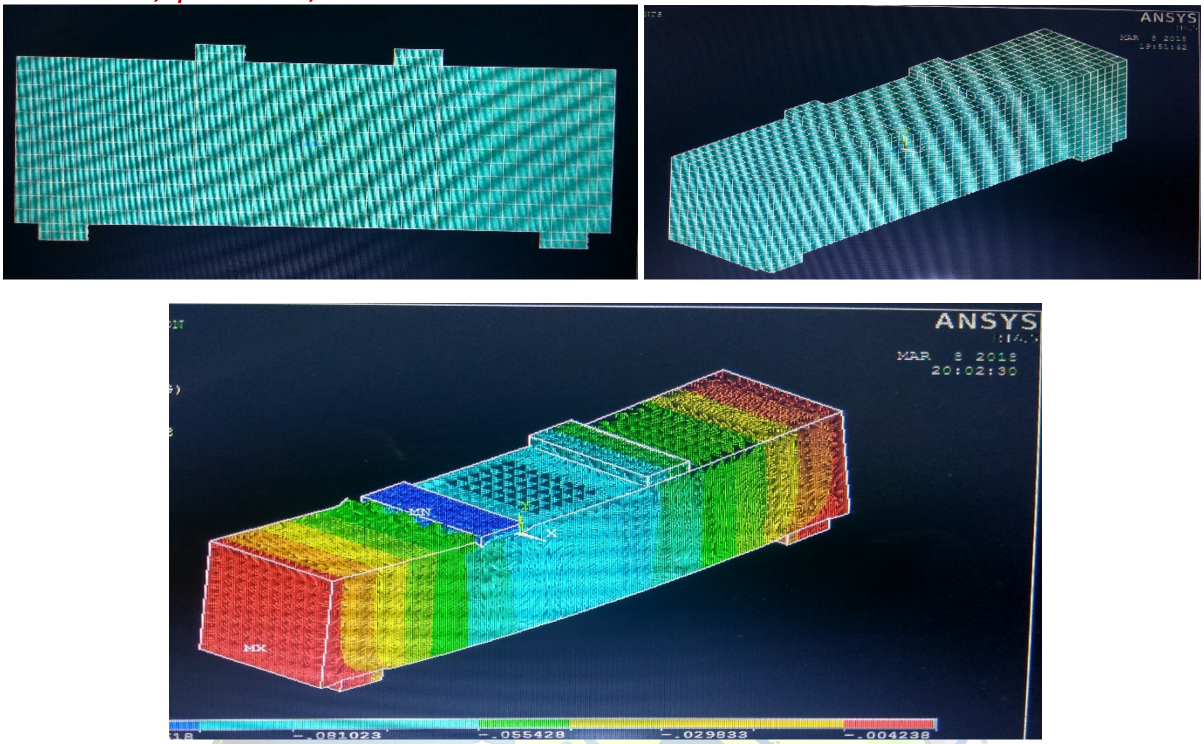

Fig.7 Analytical Response of a CFRP Beam with deflection modes

Table 7: Analytical Test Results Of CFRP in Beams

S.NO	MIX I.D	Flexural Strength (Mpa)
1	1 (0% M-Sand)	8.8
2	2 (25% M-Sand)	10.2
3	3 (50% M-Sand)	12.2
4	4 (75% M-Sand)	14.4
5	5 (100% M-Sand)	15.2

VIII. CONCLUSION

The effect of admixture with partial replacement of manufactured sand on the properties of strength with respect to conventional concrete and proposed concrete identity were studied.

1. The compressive, split tensile and flexural strength of concrete with 50 % replacement of natural sand by manufactured sand and 60-40 ratio of aggregates [20mm & 12.5mm] using high performance super plasticizer reveals higher strength as compared to the reference mix
2. The overall strength of concrete linearly increases from 0%, 25%, 50%, 75%, 100% replacement of natural sand by manufactured sand as compared with the reference mix. The present study exhibits the limitations and necessity to use super plasticizer wherever required in the construction industry.
3. Assessing the performance of the concrete using CFRP as solid circular section (rolled &baked mode) reveals elevated strength potencies when compared to reference identities and

the concept can be utilized to reduce the self-weight of a framed structure and also it has high adaptability towards strengthening of columns subjected to additional imposed loads in future.

4. The study ensures the mode of embedding CFRP into a beam where due to improper placing, its load carrying capacity will be limited.
5. The CFRP will be considered as a cost effective material when it hits the market with a huge production rate

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