

# Experimental Study on Mechanical Properties of High Strength Concrete with Manufactured Sand and Admixtures

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**ABSTRACT:** Now a day's high strength and high performance concrete are being widely used all over the world in high rise buildings, long span bridges and in some special structures. Hence an experimental investigation was made on the mechanical properties of high-strength concrete of grade M40 at 28 days using manufactured sand and admixtures like silica fume & super plasticizer. After testing the materials and finding the mix proportion, the specimens were casted by using standard cubes (150mm x 150mm x 150mm), standard cylinders (150mm diameter x 300mm height) and Standard prisms (150mm x 150mm x 750mm) moulds. The mechanical properties viz., compressive strength, flexural strength and splitting tensile strength of high strength concrete with various replacement of manufacture sand viz., 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100% were tested on 7, 14 and 28 days of the curing period and the results were compared with control concrete. It was identified that the 50% replacement of river sand by M-sand is optimum. The investigations revealed that the use of waste material like silica fume improved the mechanical properties of high strength concrete which is otherwise hazardous to the environment and thus may be used as a mineral admixture.

**KEYWORDS:** High strength concrete (HSC), M40, silica fume, super plasticizer.

## I. INTRODUCTION

Concrete is a major construction material which is used worldwide because of its strength properties. Concrete is composed of an inert matrix of sand, gravel, crushed rock, or other aggregates held together by a harden paste of hydraulic cement and water. The strength of concrete depends upon the strength of these components, their deformation properties, and the adhesion between the paste and aggregate surface [1]. The construction of high rise buildings, long span bridges and special structures using high strength concrete (HSC) have been increased in recent years. As per Indian Standard recommendations any concrete possesses a 28 day compressive strength more than 35MPa is termed as high strength concrete. But elsewhere in the International forum the high strength label is applied to concrete having strength 40MPa or above. Hence many experimental investigations were made on the high strength concrete (HSC) in order to reduce the concrete volume and to achieve high strength. Thus an experimental study was conducted using manufactured sand and admixtures to achieve the same.

The manufactured sand (M-Sand) was chosen to reduce non-renewable fine aggregate (river sand) usage in concrete and the admixtures (silica fume and super plasticizers) were used to increase the strength of the concrete as proved by experimental investigations. Thus the aim was to find the effective proportion of the M-Sand as replacement of river sand for the concrete of grade M40 at 28 days based on the compressive, split tensile and flexural strength properties.

## II. MATERIAL AND MIX PROPORTION

In the design of high strength concrete, the selection of proper ingredients, evaluating their properties and understanding the interaction between different materials plays a major role in performance of the concrete. The ingredients used are Cement (OPC grade 53), Silica fume (0.12 to 0.2 micron in size), Natural sand, M-Sand, coarse aggregate, super plasticizer (Conplast SP430).

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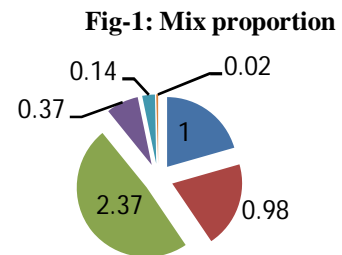
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Initially the materials were tested and the properties were found as: (i) **Cement**– specific gravity (3.15); Fineness modulus (2.83); initial setting time (40 min) and final setting time (320 min), (ii) **natural river sand** - specific gravity (2.65); fineness modulus (2.44) and Bulk density = 1600 kg/m<sup>3</sup> (iii) **M-sand** - specific gravity (2.45) and fineness modulus (3.05), (iv) **coarse aggregate** - specific gravity (2.71); fineness modulus (5.51) and Bulk density = 1691 kg/m<sup>3</sup>, (v) **super plasticizer (chemical admixture)**- specific gravity (1.20 to 1.22), (vi) **silica fume (mineral admixture)** - specific gravity (2.1 to 2.3). By using the test results and following IS code the mix proportion of the concrete for M40 grade was calculated as given in table-1 and shown in figure-1.

### III. EXPERIMENT AND RESULTS

For the replacement of river sand, the chosen M-sand percentages were ranging from 10 to 100% and also a control using 0% replacement were taken. Before casting specimens for testing the strength properties, fresh concrete tests were conducted for the entire M-sand ratio for its slump nature. After confirming their workability, the suitable

Table-: Mix Design Ratio						
Materials	Cement	Aggregate		Water	Admixture	
		Fine	Coarse		Mineral	Chemical
<b>Mix ratio</b>	1	0.98	2.37	0.37	0.14	0.02
<b>Quantity(kg/m<sup>3</sup>)</b>	492	483	1168	183	67	9.84



specimens were casted.

Table-2: Compressive strength of the concrete				
S.no	% Replacement of sand by M-sand	Compressive strength (MPa)		
		7 days	14 days	28 days
1	0	36.09	46.40	51.55
2	10	36.70	47.20	52.44
3	20	38.26	49.20	54.66
4	30	40.36	51.89	57.66
5	40	41.06	52.80	58.66
6	50	42.61	54.80	60.88
7	60	40.13	51.60	57.33
8	70	38.89	50.00	55.55
9	80	37.01	47.60	52.88
10	90	35.77	46.00	51.11
11	100	34.22	44.00	48.88

Table-3: Splitting tensile strength of the concrete				
S.no	% Replacement of sand by M-sand	Splitting tensile strength (MPa)		
		7 days	14 days	28 days
1	0	2.92	3.75	4.17
2	10	2.99	3.83	4.26
3	20	3.04	3.90	4.34
4	30	3.12	4.01	4.46
5	40	3.15	4.05	4.50
6	50	3.37	4.33	4.82
7	60	3.28	4.21	4.68
8	70	3.19	4.10	4.56
9	80	3.13	4.03	4.48
10	90	3.02	3.88	4.32
11	100	2.87	3.69	4.10

**Compressive test:** The cube moulds of size 150mm were used for casting specimens. Nine specimens for each proportion were casted and it was kept in curing tanks. After curing periods of 7, 14 and 28days, three specimens for each curing period was tested for its compressive strength and their average compressive strength was shown in the table-2 and represented by figure-2.

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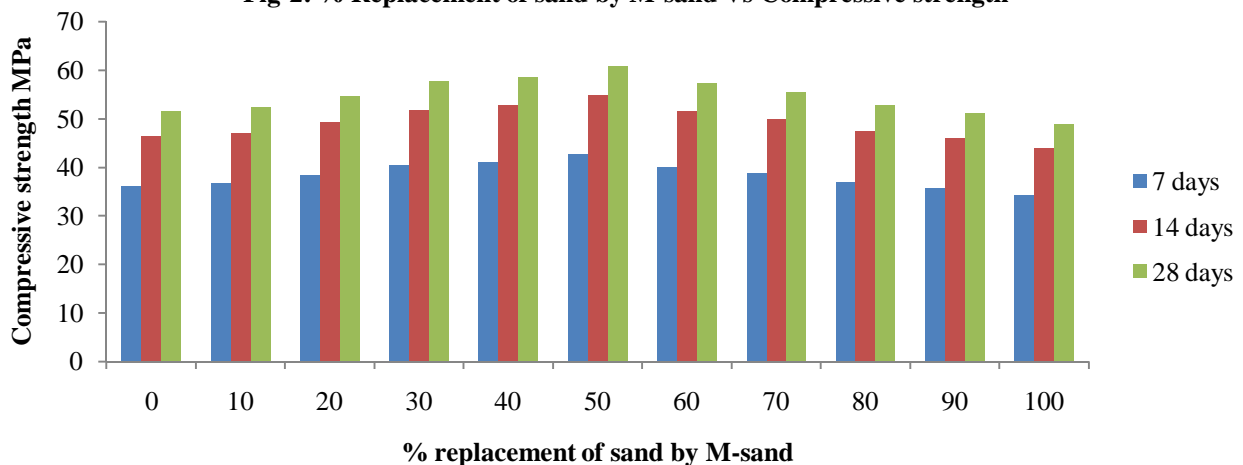
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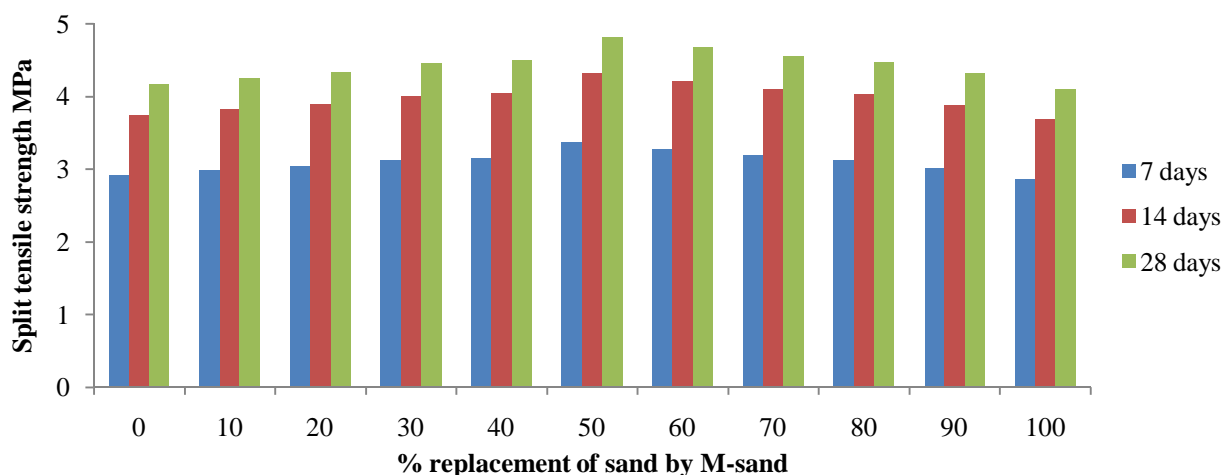
**Splitting tensile strength test:** Similar to compressive strength, the splitting tensile strength of the specimens was tested. The specimens used were casted by using cylindrical moulds of dia.150mm and length 300mm. the results were tabulated in table-3 and the graphical representation was shown in figure-3.

**Flexural strength test:** The tests were carried out conforming to IS 516-1959 to obtain the flexural strength of M40 grade concrete. Three standard prism specimens were cast for each replacement level and tested under two-point loading. The experimental results of flexural strength with OPC mix case is shown in table-4 and their graphical representation by figure-4.

**Fig-2: % Replacement of sand by M-sand Vs Compressive strength**



**Fig-3: % Replacement of sand by M-sand Vs Split tensile strength**

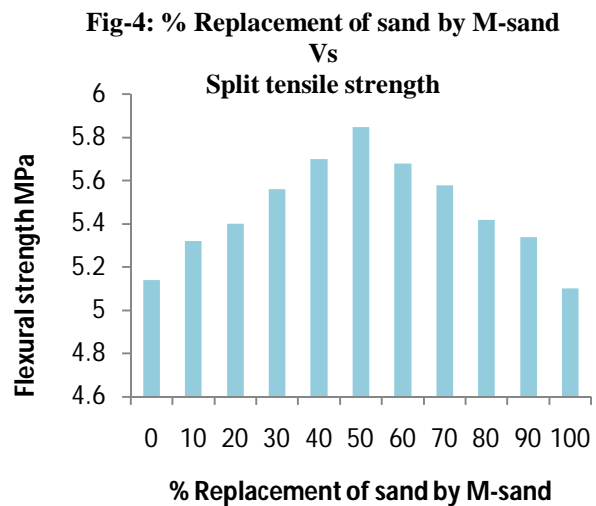


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S.no	% Replacement of sand by M-sand	Flexural strength (MPa)
1	0	5.14
2	10	5.32
3	20	5.40
4	30	5.56
5	40	5.70
6	50	5.85
7	60	5.68
8	70	5.58
9	80	5.42
10	90	5.34
11	100	5.10



## IV. DISCUSSION AND CONCLUSION

From the results of the above experimental investigation it was identified that sand replacement up to 50% with manufactured sand leads to increase in compressive strength, splitting tensile strength and flexural strength, for M40 grade. Beyond 50% there was a decrease in compressive strength, tensile strength and flexural strength for 28 days curing period. It was observed that the compressive strength, splitting tensile strength and flexural strength of M40 grade concrete was increased by 15.32%, 2.56% and 12.13% respectively over controlled concrete. Therefore the optimum replacement level of manufactured sand is 50% for M40 grade of concrete. Manufactured sand is much cheaper than natural sand therefore considering it is very important in economical point of view.

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