

EXPERIMENTAL STUDY OF COMPRESSIVE STRENGTH OF CONCRETE WITH PARTIAL REPLACEMENT OF NATURAL SAND WITH MANUFACTURED SAND

Swastik S. Shinde¹, Swanand R. Kadam², Avinash A. Waychal³

¹Assistant Professor, Dept. of Civil Engineering, Sanjay Ghodawat Institutes, Maharashtra, India.

²Assistant Professor, Dept. of Civil Engineering, Sanjay Ghodawat Institutes, Maharashtra, India.

³Assistant Professor, Dept. of Civil Engineering, Sanjay Ghodawat Institutes, Maharashtra, India.

Abstract - Manufactured sand is a term used for aggregate materials less than 4.75mm and which are processed from crushed rock or gravel. Due to booming of construction activities in our country, natural sand resources are increasing depleted and its costs is becoming increasing high. This project was, therefore, conducted to study the influence that manufactured sand have in compressive strength of concrete, and to access the prospects of using manufactured sand as replacement of natural sand. The results of the hardened properties of the mixes have shown that concrete mixes with partial proportions of manufactured and natural sand achieved a higher compressive strength at all test ages. It can therefore, be concluded from the finding of this study that when the availability of natural sand is scarce or in cities where the price of natural sand is as expensive as manufactured one, manufactured sand concrete mix is a viable and better alternative to the use of natural sand.

Key Words: Manufactured sand, Compressive strength, Bulking of sand, Fines, Workability.

1. INTRODUCTION

It is generally known that, the fundamental requirement for making concrete structures is to produce good quality concrete. Good quality concrete is produced by carefully mixing cement, water, and fine and coarse aggregate and combining admixtures as needed to obtain the optimum product in quality and economy for any use.

Good concrete, whether plain, reinforced or prestressed, should be strong enough to carry superimposed loads during its anticipated life. Other essential properties include impermeability, durability, minimum amount of shrinkage, and cracking.

The environmental impact is attributed to the non-renewable character of the natural resources, the environmental impact on neighborhood, land use conflicts, high energy consumption needed for aggregate production and the potential environmental or health impact of materials produced due to leaching of heavy metals,

radioactivity and to special mineral suspects to have hazardous health effects. Therefore, due to the above-mentioned facts, looking for viable alternatives to natural sand is a must. One possible alternative material that can be used as a replacement for natural sand is the use of manufactured sand. Due to the forecast shortfall in the supply of natural sands and the increased activity in the construction sector, it is apparent that time will come, when manufactured sand may play a significant role as an ingredient in concrete production

1.1 Objectives

The general objective of this study work is to study the influence of manufactured sand on the compressive strength of concrete and to compare the result with that of concrete produced using natural river sand.

The specific objectives of this study are:

1. To study background information on manufactured sand.
2. To find out the optimum quantity of sand required.
3. To draw conclusions and give recommendations based on the research findings and indicate areas for further study

1.2 Manufactured Sand

The term-manufactured sand is used for aggregate materials having dimensions less than 2.36 mm that are processed from crushed rock or gravel and intended for construction use. The term sand refers to relatively small particles and there are some variations of sand with regard to particle size.

The crushing process caused the manufactured sand to have an irregular particle shape. These fine particles and irregular shape of the aggregate have detrimental effects on the workability and finish of the concrete. These negative effects have given manufactured sands a poor reputation in the construction industry. However this study reveals that in some other practical areas, these fine particles can be utilized to increase the compressive strength of the concrete

When it is required to construct a major structure, the supply of high quality aggregate for concrete, both coarse and fine, are of extreme importance. The growing shortage and price rise of the natural sand is also a question that a construction industry shall think about. Now looking for viable alternatives to natural sand is a must and not a necessity. Due to short of supply of natural sands and the increased activity in construction sector, the time has come, for manufactured sand to play a significant role as an ingredient in concrete.



Fig -1: Manufactured sand production site

2 TEST RESULTS

Table -1: Tests on material properties of sand

TESTS	NATURAL SAND	MANUFACTURED SAND
BULK DENSITY	1611.11 Kg/m ³	1922.15 Kg/m ³
BULKING OF SAND	15.61%	10.50%
SPECIFIC GRAVITY	2.6	2.86

2.1 Mix Calculations

The mix calculations per unit volume of concrete shall be as follows

a) Volume of concrete = 1 m³

b) Volume of cement = [weight of cement/specific gravity of cement]

= [394.32/2.94] x [1/1000] = 0.134 m³

c) Volume of water = [197.16/1] x [1/1000] = 0.197 m³

d) Volume of all in aggregates (d) = [a - (b + c)]

= 1 - (0.134 + 0.197) = 0.669 m³

e) Mass of coarse aggregates = d x Volume of CA x specific gravity of CA

= 0.669 x 0.64 x 2.86 x 1000 = 1224.54 kg

f) Mass of fine aggregates = d x Volume of FA x specific gravity of FA

= 0.669 x 0.36 x 2.60 x 1000 = 626.19 kg

2.2 Mix proportions

Cement = 394.32 kg/m³

Water = 197.16 kg/m³

Fine aggregate = 626.19 kg/m³

Coarse aggregates = 1224.54 kg/m³

Water cement ratio = 0.50

Aggregates are assumed to be in SSD. Otherwise corrections are to be applied while calculating the water content. Necessary corrections are also required to be made in mass of aggregates.

Hence the ratio is **1:1.58:3.10:0.5**

Table-2: Overall results of Workability of Concrete.

Description of the mix	Slump obtained in mm	Compaction Factor
Reference mix (R)	105	0.97
20%	105	0.96
40%	95	0.95
60%	80	0.95
80%	75	0.94
100%	55	0.90

2.3 Overall results of compressive strength of concrete by partial replacement with manufactured sand.

Table -3: Compressive strength for 7-days

Description of the mix	Compressive strength	% increase or decrease of Compressive strength with respect to reference mix
Reference mix (R)	10.60	-
20%	11.73	+10.66%
40%	14.96	+41.13%
60%	17.94	+69.24%
80%	15.44	+45.66%
100%	16.50	+55.66%

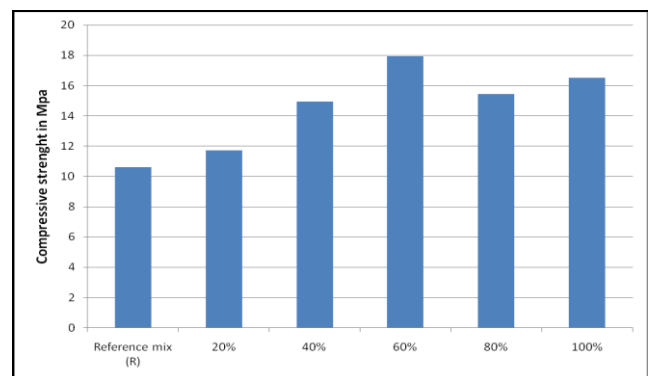


Chart -1: Compressive strength for 7-days

Table -4: Compressive strength for 14-days

Description of the mix	Compressive strength	% increase or decrease of Compressive strength with respect to reference mix
Reference mix (R)	25.75	-
20%	30.56	+18.67%
40%	31.32	+21.60%
60%	35.83	+39.14%
80%	31.17	+21.04%
100%	32.23	+25.16%

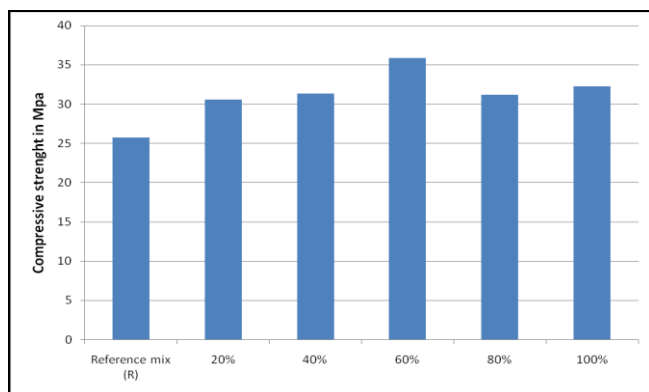


Chart -2: Compressive strength for 14-days

Table -5: Compressive strength for 28-days

Description of the mix	Compressive strength	% increase or decrease of Compressive strength with respect to reference mix
Reference mix (R)	32.34	-
20%	37.33	+15%
40%	37.36	+16%
60%	42.23	+31%
80%	38.93	+20%
100%	42.86	+32%

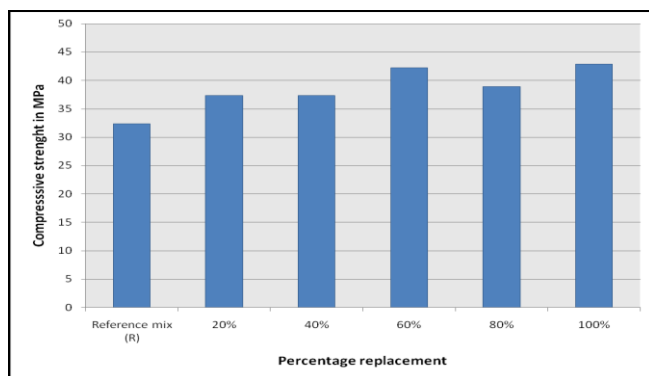


Chart -3: Compressive strength for 28-days

4. CONCLUSIONS

The use of manufactured sand in producing concrete was studied and the following conclusions were made:

1. The results of the hardened properties of the mix have shown that the concrete mix with proportion of manufactured and natural sand achieved a higher compressive strength almost at all tested age of concrete.
2. The test results showed that mix proportion, the manufactured sand with 60%MS+40%NS was capable of achieving a higher compressive strength than the natural sand control mix. It can be concluded that the use of manufactured sand for high strength concrete production is more useful. However, special cares have to be taken to ensure that the concrete mix achieves a suitable finish.
3. Manufactured sands are made by crushing aggregate to sizes appropriate for use as a fine aggregate. During the crushing process the manufactured sand have irregular shapes and more fine particles contributing to improved compressive strength, compared to natural sand control mix.
4. Manufactured sand offers important economic advantages in regions where the availability of natural sand is scarce or in cities where transportation cost is high
5. The use of manufactured sand in the construction industry helps to prevent unnecessary damages to the environment and provide optimum exploitation of the resources.

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BIOGRAPHIES

Prof. Swastik Suresh Shinde,
Dept. of Civil Engineering,
Sanjay Ghodawat Institutes,
Maharashtra, India



Prof. Swanand R Kadam,
Dept. of Civil Engineering,
Sanjay Ghodawat Institutes,
Maharashtra, India



Prof. Avinash A Waychal,
Dept. of Civil Engineering,
Sanjay Ghodawat Institutes,
Maharashtra, India