

STRENGTH AND WORKABILITY OF CONCRETE WITH MANUFACTURED SAND

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Abstract

The fast and vast infrastructural development in India demand huge quantity of natural sand for concrete work. Dwindling sand resources pose environmental problems and hence government restrictions on sand quarrying resulted in scarcity and significant increase in its cost. Sand mining from our rivers becomes objectionable. It has now reached a stage where it is disturbing our river ecosystem of our country from total depth. Hence there is a dearth of quality sand for construction. So there is a need to find some substitute to natural river sand.⁽¹⁾

The main objective of the present work was to systematically 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. The study was carried out on

M30 grade concrete with 0.45 water cement ratio. Manufactured sand can be used as fine aggregate, but it has to satisfy the technical requisites like workability and strength. On this aspect research on concrete with manufactured sand is scarce, so this paper an experimental investigation on properties of concrete produced with manufactured sand.

Keywords: Manufactured sand, natural sand, aggregate, cement.

Introduction

Increase in demand and decrease from natural sources of fine aggregate for the production of concrete has resulted in the need to identify new source of fine aggregate. Due to increased levels of construction expected in the forthcoming years, it is expected that fine aggregates suitable for use in concrete will become scarce or uneconomical to produce. With the expected shortfall in natural sands,

manufactured sands offer a viable alternative to natural sand manufactured sand has to satisfy the technical requisites like workability and strength of concrete. Since the data on this aspect of concrete using manufactured sand is scarce, it is necessary to investigate the concrete produced with manufactured sand. ⁽²⁾

Traditionally, natural sand has been used in all constructions activities till recently. Natural sand is weathered and worn out particles of rocks and is of various grades and sizes depending on the amount of weathering. The main source of natural sand is riverbeds. However, natural sand is slowly and consistently becoming scarce. Moreover, since it is an environmental hazard to extract natural sand from riverbeds, even the government has banned it from time to time. Thus, a technically superior substitute to natural sand is manufactured sand. ⁽³⁾

Manufactured sand is manufactured by granulating good quality stone metal. The particle size and shape and also the overall gradation of crushed sand is controlled in the manufacturing process, which takes place in a fully automated state of the art manufacturing unit. The result is excellent quality sand with consistent gradation. Thus the major drawbacks of natural sand like irregular particle sizes, presence of organic impurities, clays etc. are totally overcome. Manufactured sand is widely used around the world and technicians of major projects around the world insist on the compulsory use of manufactured sand because of its consistent gradation and zero impurity. The use of this sand results in dense and cohesive concrete thus increasing the strength and life of the concrete. Manufactured sand is popularly known by several names such as crushed sand, rock sand, green sand, robo sand, poabs sand, barmac sand, pozzolana sand, and artificial sand.

The term manufactured sand is used for aggregate materials less than 4.75 mm. It is purpose made fine aggregate produced by crushing and screening or further processing i.e. washing, grading, classifying of quarried rock, cobbles, boulders or gravel from which natural fine aggregates have been removed. ⁽⁴⁾

Now days Vastu Shashtra is more popular, followed by so many persons for constructing a house. As per Vastu Shashtra the building material must be free from traces of human body or animal body. The river sand contains bones of human beings and animals. The shells are also one kind of bone. It is not easy to take out all such things present in the river sand. The best solutions for this is to use manufactured sand of good quality.

Methodology:

To find out the suitability of manufacture sand in the production of concrete many experiments have to be conducted. Therefore basically the research is experimental oriented.

Material properties

Properties of manufactured and Natural sand and aggregate are find out and shown in table 1. Details of sieve analysis for natural and manufactured sand are carried out and shown in table 2.

Tests on concrete

Workability test: Workability of mixes was determined using slump, compaction factor, flow table, Vee-Bee test having same water cement ratio for all mixes as per I.S.1199-1959 results are shown in table no. 3.

Strength tests : Compression test was carried out in accordance with I.S.516-1959, shear test was carried out on L

shaped specimen. The test results shown in table no.4

Table 1 Properties of Natural and Manufactured Sand and Coarse Aggregate

Properties	Fine aggregate		Course aggregate
	Natural sand	Manufactured sand	
Specific Gravity	2.60	2.62	2.94
Fineness Modulus	2.9	3.45	4.29
Water absorption	2.43	1.8	0.94

Table 2 Details of sieve analysis for natural and manufactured sand

Sieve Designation	Percentage passing of zone II sand		Grading limit for zone II
	Natural sand	Manufactured sand	
4.75mm	93.8	93.7	90-100
2.36mm	85.2	83.3	75-100
1.18mm	75.7	70.6	55-90
600 micron	42.3	43.4	35-59
300 micron	15.1	12.9	8-30
150 micron	6.9	5.1	0-20

Table 3 Slump, compaction factor, flow and Vee-Bee test results

% replacement of NS by MS	Slump in mm	C.F.	Flow in c.m.	V.B. in Sec.
0	98	0.910	48	7.1
20	90	0.893	47	7.5
40	87	0.889	36	8.4
60	85	0.885	36	8.8
80	80	0.857	32	9.5
100	75	0.840	32	10.1

Table 4 Compression, shear test results and percentage increase and decrease of results.

% Replacement of natural sand by manufactured sand	Average 7 day's Compressive strength in MPa	Average 7 day's shear strength in MPa
0%	28.89	4.1
20%	27.11	4.2
40%	28.89	4.8
60%	29.33	5.0
80%	29.11	4.9
100%	28.67	4.0

Discussion on results

1) It was observed that any percentage replacement of natural sand to manufactured sand will reduce the workability.

The round shape and smooth surface texture of natural sand reduces the inter particle friction in the fine aggregate component so that the workability is higher in natural sand. Manufactured sand particles are angular in shape and their rough surface texture improves the internal friction in the mix. Because of that the workability is reduced.

2) It has been observed that the compressive strength of concrete with replacement of natural sand by manufactured sand goes on increasing up to 60% replacement. Afterwards the compressive strength starts decreasing. i.e. the maximum compressive strength can be obtained by replacing 60% natural sand by manufactured sand. The percentage increase in the compressive strength at 60% replacement of natural sand by manufactured sand is found to be **1.52%**.

3) It has been observed that the shear strength of concrete with replacement of natural sand by manufactured sand goes on increasing up to 60% replacement. Afterwards the shear strength starts decreasing. i.e. the maximum shear strength can be obtained by replacing 60% natural sand by manufactured sand. The percentage increase in the shear strength at 60% replacement of natural sand by manufactured sand is found to be **21.95%**.

4) It has been observed that with 60% replacement of Natural Sand with

Manufactured Sand, it is more economical.

Conclusions:

When replacement of Natural sand by 60% Manufactured sand is done, results in producing the concrete of higher shear and compressive strength as compared to reference mix.

The replacement of Natural sand with Manufactured sand will help in conserving the natural resources of sand and maintain the ecological balance of the nature.

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Fig.1 Flow table test



Fig.2 Compression test on cube



Fig.3 Slump cone test



Fig4 Shear test on L shaped specimen