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AN EXPERIMENTAL INVESTIGATION ON PROPERTIES OF CONCRETE PRODUCED 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%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100% strength characteristics such as shear strength and Impact 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 of 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: Aggregate, Cement,Manufactured sand, Natural sand.

I. 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 of 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 form 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 andalso 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. .[4]

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 VastuShashtra the building material must be free from traces of human body or animal body. The river sand containsbones 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.

II. 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.

III. MATERIALPROPERTIES

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.[5]

IV. TEST ON CONCRETE

4.1 Shear strength : The following procedure is adopted to conduct the shear strength test. Place the specimen centrally on the compression testing machine and load is applied continuously and uniformly. [6] The specimen is of L shape having dimensions as shown in fig.3 The load is increased until the specimen fails and record the maximum load carried by each specimen during the test. Note the type of failure and appearance of crack. Computation of the shear strength was as follows**.** [7]

Failure load = [PL1 / (L1 + L2)]

Shear strength = (Failure load / A) X 1000 Where, P = Load in kN A = Area of shear surface = 60 x 150 mm^2. L1 = 25 mm, L2 = 25 m

4.2 Impact strength

For impact test strength,[8]cylindrical specimens of 150mm diameter & 60mm height were prepared. Drop weight test was adopted for testing impact specimen.shown in fig.6, The specimens were kept in the Schrader's

impact testing machine and a hammer weighing 4.54 kg was dropped from a height of 457mm. Number of blows required to cause first crack and final crack were noted down. The final failure is defined as the opening of cracks in the specimen sufficiently so that pieces of concrete are touching at least three out of the four positioned lugs on the base plate. These numbers of blows were converted into impact energy by the following formulae. [9]

Impact energy = W*H*N. Where W = weight of the hammer = 45.4 N. H = height of the fall =0.457 m. N = number of blows required to cause first crack and final crack .All test results are shown in table no.

V. FGURES AND TABLES

TABLE 1 Properties of Natural and manufactured sand and course aggregate.

Properties	Fine aggregate		Course aggregate
	Natural sand	Manufactured sand	
Specific Gravity	2.61	2.82	2.94
Fineness Modulus	2.81	2.91	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 sand
	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 Shear and Impact test results and percentage increase and decrease of results.

% Replacement of natural sand by manufactured sand	Average Shear strength in MPa	Percentage Increase & decrease of shear Strength w.r.t. reference mix	Average impact strength for first crack in N-m	Percentage Increase & decrease of impact Strength of first crack w.r.t. reference mix	Average impact strength for final crack in N-m	Percentage Increase & decrease of impact Strength of final crack w.r.t. reference mix
0%	3.39	-	1109.56	-	1132.23	-
10%	3.47	2.35	1563.0	40.86	1576.82	39.27
20%	3.55	4.71	1928.55	73.81	1824.95	61.18

30%	3.72	9.73	3147.73	183.69	3159.59	179.05
40%	3.81	12.38	3337.42	200.78	3357.18	196.51
50%	3.98	17.40	5009.10	351.45	4049.08	257.61
60%	**4.54**	**33.92**	**5977.36**	**438.71**	**6006.98**	**430.54**
70%	4.23	24.77	2139.98	92.86	2163.69	91.09
80%	4.15	22.41	1780.35	60.45	1798.14	58.81
90%	4.05	19.46	1555.09	40.14	1570.85	38.73
100%	3.68	8.55	1406.91	26.79	1461.77	29.10

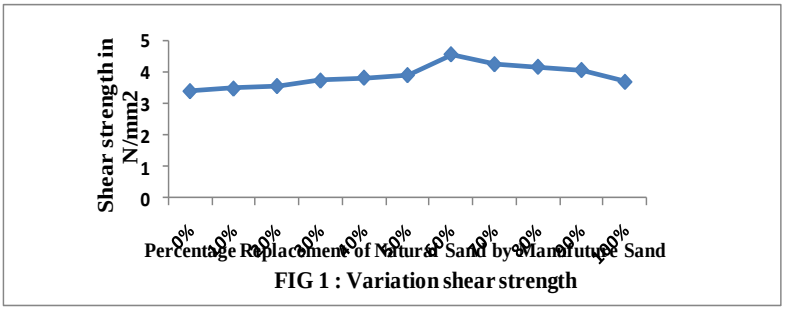


FIG 1 : Variation shear strength

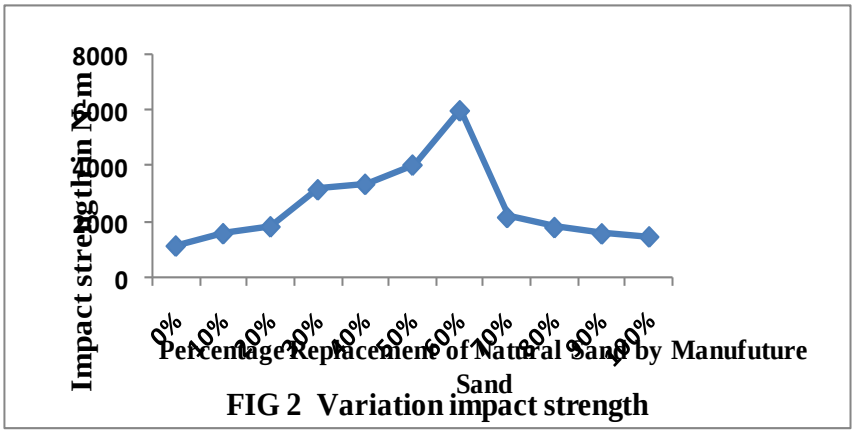


FIG 2 Variation impact strength

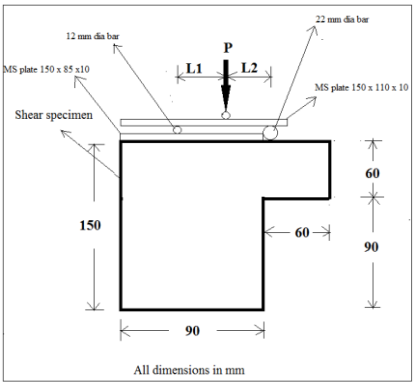
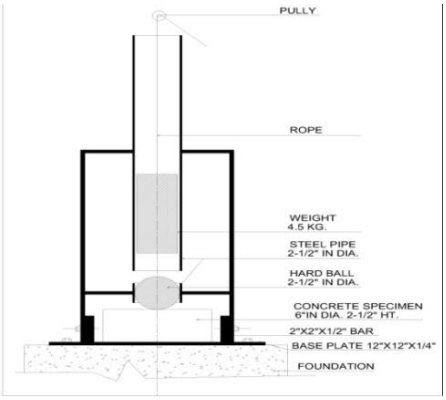


FIG 3 Shear test

FIG 4 Shear test specimen



IG 5 Impact test

FIG 6 Impact test machine with Impact specimen

VI. DISCUSSION ON RESULTS

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 **33.92%.**

It has been observed that the impact strength of concrete with replacement of natural sand by manufactured sand goes on increasing up to 60% replacement. Afterwards the impact strength starts decreasing. i.e. the maximum impact strength can be obtained by replacing

60% natural sand by manufactured sand. The percentage increase in the impact strength at 60% replacement of natural sand by manufactured sand is found to be **430.54%.**

VII. CONCLUSIONS

When replacement of natural sand by 60% artificial sand results in producing the concrete of higher shear and impact strength as compare to reference mix.

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

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