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Research Paper

EFFECTS OF MANUFACTURED SAND ON COMPRESSIVE STRENGTH AND WORKABILITY OF CONCRETE

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A huge amount of concrete is consumed by the construction industry. About 35% volume of concrete is comprised of sand. A good quality concrete is produced by careful mixing of cement, fine and coarse aggregates, water and admixtures as needed to obtain an optimum quality and economy. Generally cement and coarse aggregates is factory made products and their quality and standards can be easily controlled and maintained. Water used for mixing of concrete is usually tap water. The fine aggregates or sand used is usually obtained from natural sources specially river beds or river banks. Now-a-days due to constant sand mining the natural sand is depleting at an alarming rate. Sand dragging from river beds have led to several environmental issues. Due to various environmental issues Government has banned the dragging of sand from rivers. This has led to a scarcity and significant increase in the cost of natural sand. There is an urgent need to find an alternative to river sand. The only long term replacement for sand is manufactured sand.

Keywords: Manufactured sand/Artificial sand, Natural sand, Compressive strength, Workability

INTRODUCTION

The main cause of concern is the non-renewable nature of natural sand and the corresponding increasing demand of construction industry. Therefore looking for an alternative to river sand has become a necessity. The cheapest and easiest alternative to natural sand is manufacturing sand by crushing rocks/stones in desired size and grade by suitable method. Sand produced by such means is known as manufactured/ crusher/artificial sand.

This paper presents the results of experimental investigation of partial and full replacement of natural sand by manufactured sand. The main aim of the paper is to compare the compressive strength and workability of concrete with manufactured and natural sand in varying proportions. The results show that concrete with manufactured sand shows higher

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compressive strength whereas workability decreased with increasing proportion of manufactured sand.

LITERATURE REVIEW

Shanmugapriya *et al.* (2012) concluded from experimental researchers that compressive and flexural strength of concrete can be improved by partial replacement of cement by silica fume and manufactured sand for natural fine aggregates. They suggested that optimum replacement of natural sand by manufactured sand is 50%.

Saeed Ahmad *et al.* (2008) have found that compressive strength of various mix ratios increased from 7% to 33% whereas workability decreased from 11% to 67% with increasing proportion of manufactured sand.

Shyam Prakash *et al.* (2007) says that manufactured sand satisfies the requirements fine aggregates such as strength, gradation, shape angularity. It is also possible to produce manufactured sand falling into the desired grade. They say that the mechanical properties of manufactured sand depend upon the source of its raw material, i.e., parent rock. Hence the selection of the quarry is very important to quality fine aggregate.

Mahendra R Chitlange *et al.* (2010) experimentally proved that due to addition of steel fiber to natural sand concrete and manufactured sand concrete there is a consistent increase in flexural and split tensile strength whereas there is only a marginal rise in compressive strength.

EXPERIMENTAL INVESTIGATION

Materials

Cement: Ordinary Portland cement of 53 Grade conforming to IS 8112 -1989 9, and the specific gravity of cement was found to be 3.15. The physical properties of cement are given in Table 1.

Table1: Physical Properties of Cement

Component	Results	Requirements
Fineness m^2/kg	1.63%	<10%
Initial setting time, minutes	135 mins	Minimum 30mins
Final setting time. Minutes	315 mins	Maximum 10 h
Standard consistency	30%	
Soundness	5.53 mm	Maximum 10mm

Fine Aggregate

Natural Sand: Locally available River sand having bulk density 1.71 kg/m^3 was used and the specific gravity is 2.65. The Fineness modulus of river sand is 5.24.

Manufactured Sand: M-Sand was used as partial replacement of fine aggregate. The bulk density of Manufactured sand was 1.75 kg/m^3, specific gravity and fineness modulus was found to be 2.73 and 4.66, respectively.

The percentage of particles passing through various sieve were compared with natural sand and it was found to be similar.

Coarse Aggregate: Crushed angular aggregate with maximum grain size of 20 mm

and downgraded was used and having bulk density 1.38 kg/m^3. The specific gravity and fineness modulus was found to be 2.82 and 8, respectively

Water: Fresh portable water, which is free from acid and organic substance, was used for mixing the concrete.

Mix Proportions and Mix Details

Concrete mix design in this investigation was designed as per the guidelines specified. Table 3 shows the mix proportions of Concrete (kg/m^3). Concrete mixtures with different proportions of manufactured sand for natural sand ranging from 0% to 100% were casted.

EXPERIMENTAL PROCEDURE

Compressive Strength

The specimen of standard cube of (150 mm x 150 mm x 150 mm) was used to determine the compressive strength of concrete. Three specimens were tested for 3, 7 and 28 days with varying proportion of manufactured sand replacement. The constituents were weighed and the materials were mixed in a mixer. The mixes were compacted with the help of taping rod. The specimens were de molded after 24 h, cured in water for 3, 7 and 28 days, and then tested for its compressive strength as per Indian Standards.

Table 2: Mix Proportions

Proportion / Materials	100% Natural Sand (0% Manufactured Sand	50% Natural Sand +50% Manufactured Sand	100% Manufactured Sand (0% Natural Sand)
Cement+ fly ash + micro silica	1	1	1
Coarse aggregate			
20 mm	1.69	1.41	0.88
10 mm	1.56	1.3	0.81
Fine aggregate	3.25	1.79	1.69
Water	0.28	0.28	0.28

Table 3: Table Showing Compressive Strength Readings

Proportion	100% Natural Sand (0% Manufactured Sand	50% Natural Sand +50% Manufactured Sand	100% Manufactured Sand (0% Natural Sand)
3 days	35.35 mpa	35.39 mpa	49.39 mpa
7 days	52.35 mpa	46. 59 mpa	59.21 mpa
28 days	70 mpa	72.96 mpa	74.92 mpa

Figure 1: Compressive Strength Of Concrete With Varying Proportion Of Manufacture Sand

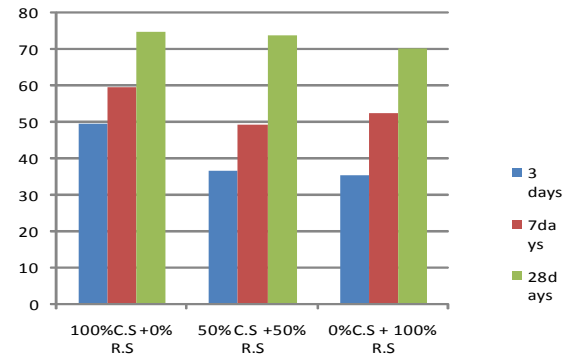
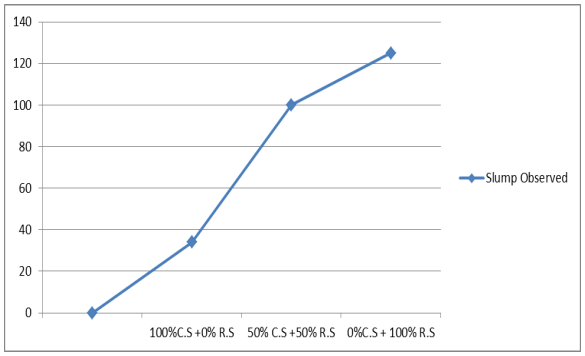


Table 4: Table Showing Slump Values

Mix	Slump (mm)
100% natural sand (0% manufactured sand	125
50% natural sand + 50% manufactured sand	100
100%manufactured sand (0% natural sand)	34

Figure 2: Workability Of Concrete With Varying Proportion Of Manufactured Sand



Workability

The workability of the mixes was determined using a slump cone test having same water cement ratio for all the three mixes.

RESULTS AND CONCLUSION

1. All the mixes of concrete formed by replacement of natural sand by manufactured sand when compared to reference mix i.e., 0% replacement, reveal higher compressive strengths.
2. In 50% replacement with admixture the compressive strength increases by 5.7%.
3. In 100% replacement of natural sand by crushed sand, the compressive strength increases by 7.03%, which is maximum.
4. Concrete mix becomes harsh with increase in proportion of manufactured sand.
5. Results show that the river sand can be fully replaced by manufactured sand.

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