



“AN EXPERIMENTAL INVESTIGATION ON PROPERTIES OF CONCRETE CONTAINING MANUFACTURING SAND AND FOUNDRY SAND WITH DIFFERENT CURING METHODS”

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Abstract : The effect of water cement ratio on fresh and hardened properties of concrete with partial replacement of natural sand by manufactured sand and foundry sand was investigated. Concrete mix design of M30 (4350 psi) grade was done according to Indian Standard code (IS: 10262). Concrete cube specimens were tested for evaluation of compressive strength. Workability was measured in terms of slump, compacting factor and vee bee consistometer. The concrete exhibits excellent manufactured strength with 25% replacement of natural sand and for foundry sand strength with 25% replacement of natural sand by using the deep curing method so it can be used in concrete as viable alternative to natural sand. This paper puts forward the applications of manufactured sand and foundry sand as an attempt towards sustainable development in India. It will help to find viable solution to the declining availability of natural sand to make eco-balance.

IndexTerms - Manufactured sand, Foundry sand, Natural curing, Accelerated curing.

I. INTRODUCTION

Conventionally concrete is mixture of cement, sand and aggregate Properties of aggregate affect the durability and performance of concrete so fine aggregate is an essential component of concrete. The most commonly used fine aggregate is natural river or pit sand. Fine and coarse aggregate constitute about 75% of total volume. It is therefore, important to obtain right type and good quality aggregate at site, because the aggregate form the main matrix of concrete or mortar.

The global consumption of natural sand is very high, due to the extensive use of concrete, In general, the demand of natural sand is quite high in developing countries to satisfy the rapid infrastructural growth, in this situation developing country like India facing shortage in good quality natural sand. Particularly in India, natural sand deposits are being depleted and causing serious threat to environment as well as the society Increasing extraction of natural sand from river beds causing many problems, loosing water retaining sand strata, deepening of the river courses and causing bank slides, loss of vegetation on the bank of rivers, exposing the intake well of water supply schemes, disturbs the aquatic life as well as affecting agriculture due to lowering the underground water table etc are few examples.

Amnon and Hadassa (2006) studied the effect of high levels of fines content on concrete properties. Hudson B.P. (1997) has taken a review of various tests in his article manufactured sand for concrete, Ilangoan et.al (2006) studies the strength and behaviour of concrete by using crushed rock dust as fine aggregate, they investigated the possibility of using crushed rock as 100% replacement for sand with varying compacting factors. Nagraj TS (2000) studied the proportioning concrete mixes with rock dust as fine aggregate Safiuddin et al (2007) carried investigation on utilization of quarry waste fine Aggregate in concrete mixtures.

On this basis, manufactured sand offers viable alternative. 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 graves from which natural fine aggregate had been removed.

The main objective of the present work was systematically study the effect of water cement ratio and percentage replacement of manufactured sand and foundry sand by natural sand as 0% 25%, 50% ,75% and 100% respectively with different curing methods on the strength propertied of concrete. The study was carried out on M30 grade concrete with 0.42 water cement ratio. Manufactured

sand and Foundry 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 investigates the concrete produced manufactured and foundry sand.

II. MATERIALS AND METHODS

Aggregate: Coarse aggregate (20mm [60%] and 10mm [40%]) was used, which was manufactured from locally available rock. Summary of material properties were presented in Table I according to Indian Standard. Locally available river sand as fine aggregate (4.75mm to 75 micron) was used. Manufactured sand and Foundry sand was used for partial replacement to natural sand. Sieve analysis and material properties were presented in Table 1 and 2 according to Indian Standards.

Cement: The cement used was 53 grade (Ordinary Portland Cement).

Table 1: Physical Properties of Fine Aggregates

Characteristic	Value	As per IS
Specific Gravity	2.38	2.5 – No limit
Bulk Density	1613 kg/m ³	Min 1200kg/m ³ Max 1750kg/m ³
Fineness Modulus	2.7	2.3 – 23

Table 2: Physical Properties of Coarse Aggregate

Characteristic	Value	As per IS
Specific Gravity	2.76	2.5 - 3
Total Water Absorption	1.83%	2%
Fineness Modulus	7.3	6 – 7.5

III. EXPERIMENTAL WORK

The compressive strength and workability (slump and compacting factor) were studied on concrete with partial replacement of natural sand by manufactured sand and foundry sand. Table 3 presents the M30 grade concrete mix design for concrete and six trial mix series used on partial replacement of natural sand by manufactured sand and foundry sand. All of the experiments were performed in normal room temperature. The concrete ingredients namely coarse aggregate, fine aggregate and cement were first mixed in dry state, then calculated amount of water was added and mix it thoroughly to get a homogeneous concrete mix. Workability of fresh concrete was determined by the slump and compacting factor test according to Indian standards.

Compressive strength was measured on 150mm x 150mm x 150mm cubes that were cured in deepwater curing and accelerated curing for 7, 14 and 28 days and it tested at 28 day's on compression testing machine.

Table 3. Concrete Mix Design for M30 Grade

Materials (kg)	Cement	Water	Sand	Coarse Aggregate
Total Quantity for 1m ³	420	210	800	1500
Proportion	1	0.42	1.90	3.57

Table 4. Workability of Fresh Concrete

Replacement Level	Slump (mm) M-Sand	Slump (mm) F-Sand	Compacting Factor-M Sand	Compacting Factor-F Sand
0%	85	85	0.94	0.94
25%	75	65	0.91	0.90
50%	60	50	0.89	0.86

IV. RESULTS AND DISCUSSION

Fresh Concrete

- **Workability Slump Results** – The control mix (0% replacement) exhibited the highest slump value of 85 mm, indicating good workability. With increasing replacement levels, the slump value decreased progressively for both M-sand and foundry sand mixes. At 25% replacement, both M-sand and foundry sand showed a moderate slump of 70 mm, indicating acceptable workability. At 50% and 75% replacements, the slump dropped significantly to 50 mm and 25 mm, respectively. This shows reduced flowability and increased stiffness of the concrete mix.
- **Compacting Factor Results** - The control mix had a compacting factor of 0.965, suggesting very good compaction properties. With increased replacement, the compacting factor gradually decreased, indicating reduced ease of compaction. For M-sand, compacting factors ranged from 0.958 (25%) to 0.928 (75%). For F-sand, compacting factors ranged from 0.958 (25%) to 0.928 (75%).

Hardened Concrete

Table 5. Test Results of Concrete 28 days for Deep water curing.

%Replacement of natural sand by M sand	Compressive Strength Mpa	%Replacement of natural sand by F sand	Compressive Strength Mpa
Mix 1 (0%)	34.50	Mix 1 (0%)	32.48
Mix 2 (25%)	37.00	Mix 2 (25%)	36.27
Mix 3 (50%)	35.46	Mix 3 (50%)	35.60
Mix 4 (75%)	32.17	Mix 4 (75%)	34.20

Table 8. Test Results of Concrete for Accelerated curing

%Replacement Level	Manufacturing sand (Mpa)	Foundry sand (Mpa)
Mix 1 (0%)	36.58	35.84
Mix 2 (25%)	37.80	36.15
Mix 3 (50%)	39.20	34.60
Mix 4 (75%)	36.00	32.92

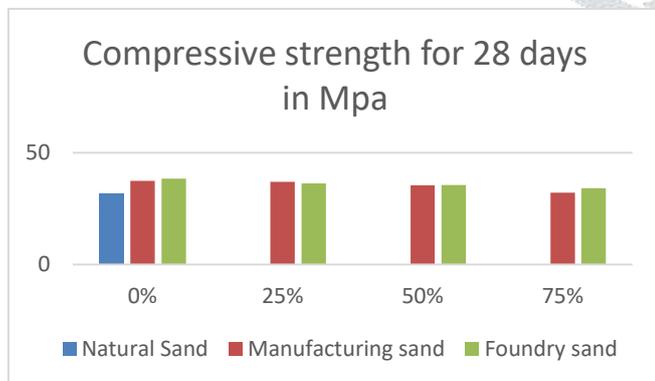


Fig 1: Variation in compressive strength of concrete in 28 days for deep water curing

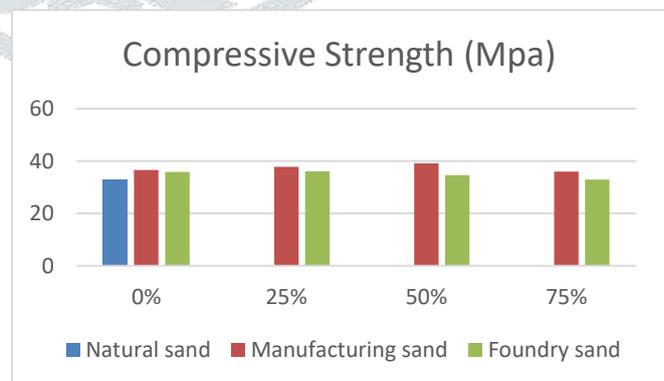


Fig 2: Variation in compressive strength of concrete in for Accelerated curing

The study investigated the compressive strength of M25 grade concrete using Manufactured Sand (M-sand) and Foundry Sand (F-sand) as partial replacements for natural river sand at varying levels (0%, 25%, 50%, and 75%).

- For 28-day deep water curing, both M-sand and F-sand showed decreasing trends with increasing replacement percentage. However, F-sand consistently gave higher strength values compared to M-sand across all replacement levels. The highest strength was observed in the control mix (0%) for both sands, with 38.48 MPa for F-sand and 37.50 MPa for M-sand.
- Under accelerated curing conditions, M-sand exhibited a gradual increase in compressive strength, peaking at 50% replacement (39.20 MPa), while F-sand showed a slight increase at 25% but then a decline with further replacement, reaching a low of 32.92 MPa at 75%.

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