Effect on Rheological Properties of Concrete Using Manufactured Sand

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Abstract: **A few choices have come up for the industry to bank one of which manufactured sand or M-sand, as it is called, is discovered to be the most appropriate one to supplant river sand. M-sand has grabbed the eye of the construction industry and environmentalists alike for its quality and the base harms it causes to nature. Utilization of M-Sand can radically lessen the expense since like river sand, it doesn't contain impurities and wastages are nil since it is made with present day modern technology and machinery. When the M-sand turns out to be more famous in the construction industry, the interest for river sand and illegal sand mining would descend, A very much handled produced sand as a half or full substitution to river sand is the need of great importance as a drawn-out arrangement in Indian concrete industry until other suitable alternative fine aggregate is created. In the current examination, a correlation of the Compressive qualities of River Sand and M-sand is finished with the hundred percent substitution of river sand by M sand.**

Keywords: **Manufactured sand (M-sand); water cement ratio (W/C); Ground Granulated Blast Furnace Slag (GGBS).**

I. INTRODUCTION

In many countries, sources of natural sand for use as an aggregate in construction are becoming scarce, as sandpits are exhausted and environmental legislation prevents dredging. In recent years, under the pressure of environmental protection and the need for flood control digging natural sand is restricted or even forbidden (Yamei and Lihua, 2017) and concrete is the absolute most generally utilized development material on the planet today. Hence, numerous alternatives materials are being proposed for concrete production from construction materials and demolition waste. Therefore, the rapid development construction market needs a large number of fine aggregates.

As a result, the cost of concrete production is currently on the increase due to the recent recession in the world economy. Conventional construction materials are becoming expensive (Karthik et al. 2017).

One possible source of construction fine aggregate is sand that has been manufactured from the crusher dust that results when coarse aggregate is produced in hard rock quarries. Coarse aggregate creation commonly yields 25% to 45% smasher dust contingent upon the parent rock, crushing equipment, and crushing conditions. By product of coarse aggregate means crusher dust, undergo further processing to provide the majority of the sand required by the construction industry.

However, compared to natural sand crusher dust tend to have inferior shape and texture properties as well as poor grading and unfamiliar mineralogical compositions all of which affect the properties of fresh and hardened concrete (Pilegis et al. 2016).

II. LITERATURE REVIEW

*Ding et al***.** presented 186 groups compressive strength tests data of concrete with M-Sand in different curing ages and 262 groups compressive strength tests data of M-Sand at 28 days. The test data was cubic compressive strength at 28 days ranged from 25.0 MPa to 84.6 MPa with a watercement ratio (W/C) as 0.30–0.70, the sand ratio of 30–46%, P.O.32.5, P.O.42.5 and P.O.52.5 cement in the density of 2871–3134 kg/m3, coarse aggregate with a maximum particle size of 20–31.5 mm, M-Sand with limestone powder content of 0–20% and fineness modulus of 2.60–3.40.

Karthik et al. used bamboo strips as reinforcement in concrete that was made with supplementary cementitious materials and partial replacement of river sand with M-sand. The cement was partially replaced by a 25% combination of admixtures such as fly ash and Ground Granulated Blast Furnace Slag (GGBS). In alignment with standard requirements, concrete samples such as cubes, cylinders, and beams were produced and tested at stipulated periods and the following conclusions were investigated.

1. From the morphological (FTIR and SEM) qualities of bamboo dust inspected, it was reasoned that bamboo is a pliable strengthening material having some obvious rigidity, which makes it appropriate as a substitute for steel. Because of its emphatically fortified particles, bamboo can be an excellent material for members subjected to compression and bending.
2. Partial replacement of cement with fly ash and GGBS in concrete containing wholly M-Sandas fine aggregate yielded a promising compressive strength. Although their values were low relative to the reference concrete, it can form a good material for some structural applications. Yet the materials were better than the reference concrete in terms of split

tensile strength.

3. Under flexural loading, the performance of BRC made with alternative materials (fly ash, GGBS, and m-sand) was significantly low compared to BRC with reference materials. Perhaps a poor bonding of bamboo with concrete with alternative material can be a factor because bamboo on its own has good strength and ductility. In addition, BRC made with reference materials yielded more flexural strength than the SRC, thus representing a 6.5% strength gain.

Pilegis et al. presented a laboratory study in which manufactured sand produced in an industry-sized crushing plant was characterized with respect to its physical and mineralogical properties. The influence of these characteristics on concrete workability and strength, when manufactured sand completely replaced natural sand in concrete, was investigated and modeled using artificial neural networks (ANN). The results showed that the manufactured sand concrete made in this study generally requires a higher water/cement (w/c) ratio for workability equal to that of natural sand concrete due to the higher angularity of the manufactured sand particles Water decreasing admixtures can be utilized to make up for this if the produced sand doesn't contain dirt particles. At a similar w/c proportion, the compressive and flexural strength of made sand concrete exceeds that of natural sand concrete.

Yamei and Lihua investigated the particle shape parameters of natural sand and limestone manufactured sand. The results showed that compared with the natural sand, the manufactured sand was more 19.0% in lengthwise ratio, less 11.5% in flatness ratio, more than 0.3% in convexity ratio, more than 0.2% in fullness ratio, less 19.3% in particle shape parameters, and less 14.8% in sphericity. Therefore, the natural sand was more close to the sphere shape and more smooth, while the M-Sand was more slim, flat, and rough. When slump and the cement dosage were at the same time, manufactured sand concrete was larger water usage and less air content, but the compressive strength was greater than natural sand concrete.

Zhao et al. presented 755 groups splitting tensile strength test data of concrete with M-Sand in different curing ages ranged from 1 day to 388 days. Raw materials of M-Sand were the ordinary silicate cement, the admixture consisted of fly ash, slag and silica fume, the crushed stone, and the manufactured sand. The cement compressive strength and tensile strength at 28 days ranged in 35.5–63.4 MPa and 6.9–10.8 MPa, respectively. The max. grain size of crushed stone ranged from 12mm to 120mm. The fineness modulus of manufactured sand was 2.2–3.55. As these studies were done based on different codes, different maximum particle sizes of 0.075 mm and 0.160 mm were defined for stone powder in manufactured sand. The contents of stone powder with a particle size of 0–0.075 mm ranged in 0–21.8%, whereas those with a particle size of 0-0.160 mm varied in 0-40%. The water-binder ratio W/B = 0.24–1.00, while the water-cement ratio MW/mc = 0.30-1.43. The sand ratio was 24–54%. The compressive strength of M-SAND at 28 days ranged from 10.1–96.3 MPa, the slump of fresh M-SAND varied from 10 mm to 260 mm, the curing time of specimens ranged from 1 day to 388 days.

Kumars and Kotian compared the compressive strengths of River Sand and M-Sand was done with the hundred percent replacement of river sand and M sand. The results showed that the M Sand offers the same property as the River Sand. The various Tests like specific Gravity, Compression Strength test, Flexure Test, spilt tensile strength test also given the same or greater value than River sand. Thivya and Aarthi (2019) determined the concrete's strength and durability by using M-Sand and Quarry Dust as sand and comparing it with the conventional mix. A wide range of 28 days of healing was considered the design mix in the study of M40 grade concrete with full replacement of M-Sand and Quarry Dust respectively have been considering for investigation. The compressive strength (cube), split tensile strength (cylinder), and flexure strength (beam) testing of concrete. The following conclusions have been investigated.

1. The fine aggregate replacement with M-Sand and Quarry Sand was more cost economical.
2. The compressive strength of 28 days for M40 concrete mix with 100% River sand replacement by M-sand yield compressive strength of 63.56 N/mm².
3. 100% replacement was reasonable where there was a low workability requirement. And where there was a high workability requirement, partial replacement can be made keeping in view the strength and economy.
4. For big projects like highways, establishing a plant leads to the economy as they require a large amount of fine aggregate.

III. MATERIALS USED AND THEIR PROPERTIES

In this present investigation materials used are Cement, Fine aggregate (M-Sand and natural Sand**)**, Coarse aggregate.

3.1. Cement

Ordinary Portland Cement (Ultratech cement) available in local market will be utilized in this investigation. The cement will be tested on different properties as per IS: 4031-1988 and will found confirmation to different specifications as per IS: 12269-1987. Cement will be bought from the same source throughout the research work.

3.2. Fine Aggregate (Manufactured Sand)

Manufactured sand (M-Sand) is a substitute for river sand for concrete development. Manufactured sand is produced from hard granite stone by crushing. The crushed sand is of cubical shape with grounded edges, washed and graded as a construction material. The size of manufactured sand (M-Sand) is under 4.75mm.

3.3. Coarse Aggregate

Coarse aggregate with crushed annular granite metal of an average size of 20mm. It will be free from dust, clay particles, organic matter etc. The coarse aggregate with different properties will be used as per IS: 383-1970.

3.4. Water

Water utilized for mixing and healing will be clean and free from harmful volumes of oils, acids, alkalis, salts, organic materials or other materials. Versatile water will be utilized for blending just as curing of concrete as prescribed in IS: 456-2000.

IV. EFFECT OF MANUFACTURE SAND ON THE MECHANICAL PROPERTIES– AN EXPERIMENTAL STUDY

4.1. Experimental program

The experimental program was intended to look at the mechanical properties i.e. compressive strength, split tensile strength, and flexural strength of concrete with M25 and M30.

4.2. Mix Proportions:

Concrete mixes were designed to a compressive strength of M25 and M30 grades with a water-cement ratio (W/C) of 0.49 and 0.43 respectively as per IS code 10262-2019.

Table 1: Properties of M-Sand.

S. No	Materials	Quantities in Kg/m3	
		M25	M30
1	Cement	392	447
2	Water	192	192
3	Fine aggregate	664	624
4	Coarse aggregate	1129	1117
5	Water cement ratio	0.49	0.43

The Samples of standard cubes (100 mm x 100 mm x 100 mm) standard cylinders of (150mm Día x 300mm height) and standard beams of (100mm x 100mm x 500mm) were cast.

4.3. Mechanical Properties:

4.3.1 Compressive Strength:

The compressive strength M25 and M30 grade concrete, M-sand concrete at 28 days is introduced in Table 2. The consequences of compressive strength were introduced in Table 2 and figure1. The test was done adjusting to IS 516-1959 to get the compressive strength of concrete at 7 days and 28 days. The cubes were tested in a Compression Testing Machine (CTM) of capacity. The compressive strength is up to 24.53, 29.03MPa and 33.23, 38.96MPa at 7 and 28 days. The greatest compressive strength is seen at 28 days is 5.44% (M25) and 1.72% (M30). The compressive strength at the age of 28 days.

Table 2: Compressive Strength.

S.No	Concrete Mix	Compressive Strength N/Mm²	
		7days	28 days
1	M25(N-S)	20.46	31.53
2	M30(N-S)	25.53	38.30
3	M25(M-S)	24.53	33.23
4	M30(M-S)	29.03	38.96

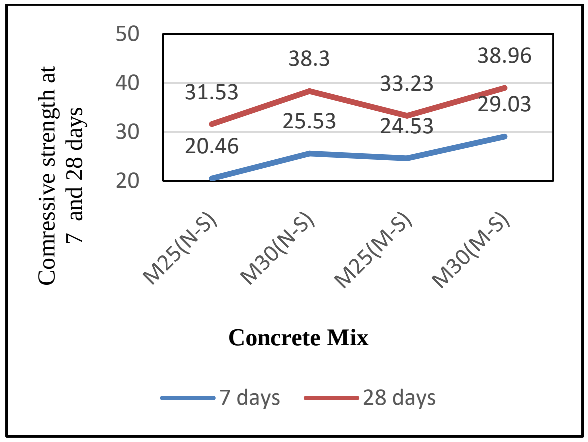


Figure 1: Compressive Strength at 7 days and 28 days.

4.3.2. Flexural Strength:

The results of the flexural strength of concrete replaced M-Sand was introduced in table 3 and figure 2. The test was done adjusting to IS 516-1959 to get the flexural strength of concrete at the time of 14 and 28 days. The beams were tested utilizing the Universal Testing Machine (UTM). The greatest increment in flexural strength is seen as 3.90 and 4.75MPa at 28 days is 1.30%(M25) and 9.95%(M30). The flexural strength at the age of 28 days of concrete continuously increased regarding traditional sand.

Table 3: Flexural Strength in MPa at 28 days.

S.NO	Concrete Mix	Flexural Strength N/Mm²	
		14days	28 days
1	M25(N-S)	3.02	3.85
2	M30(N-S)	3.67	4.32
3	M25(M-S)	3.34	3.90
4	M30(M-S)	3.79	4.75

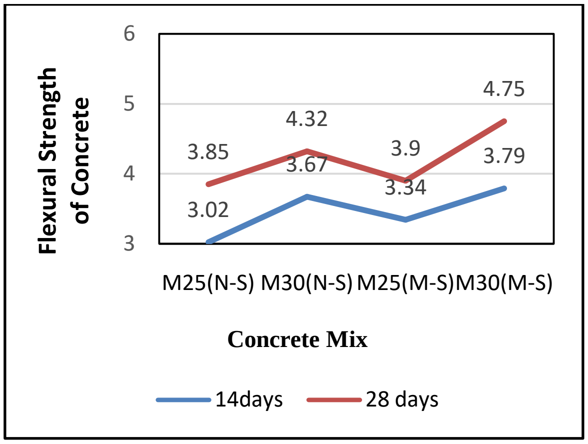


Figure 2: Flexural Strength of Concrete.

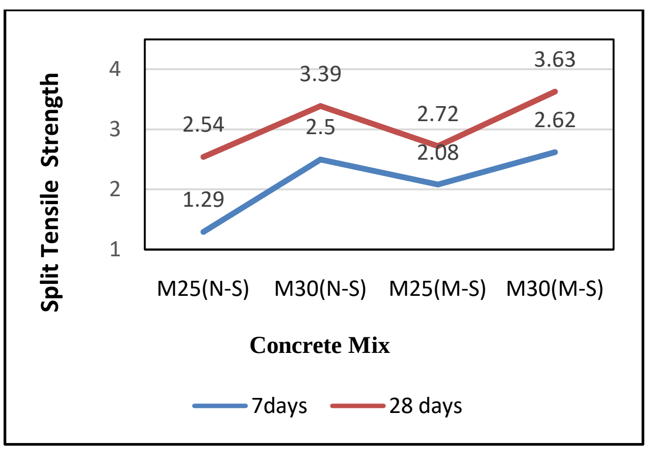
4.3.3. Split Tensile Strength:

The results of Split Tensile Strength were introduced in Table 4 and figure 3. The test was completed adjusting to IS 516-1959 to acquire split tensile strength of concrete at the age of 28 days. The cylinders were tested utilizing a Compression Testing Machine (CTM) of limit 2000KN. The increase in strength is 2.72 and 3.63MPa at age of 28 days.

Table 4: Split Tensile strength in MPa at 28 days.

S.No	Concrete Mix	Split Tensile Strength N/Mm²	
		7days	28 days
1	M25(N-S)	1.29	2.54
2	M30(N-S)	2.50	3.39
3	M25(M-S)	2.08	2.72
4	M30(M-S)	2.62	3.63

Figure3: Split Tensile strength at 28 days.



V. CONCLUSION AND FUTURE WORK

Based on the findings and then analysis, the following conclusions have been arrived. The cubes of concrete have been cast at 100 percentage if M-Sand content. The ratio of water cement for this work was taken as 0.49 and 0.43. cubes were tested for 7 days, 14 days and 28 days to resolve M25 and M30 concrete's compressive strength drawn from the current investigation.

1. The fine aggregate replacement with M-Sand with river Sand is more cost economical.
2. With 100% replacement of natural sand with manufacture sand, the strength criteria can be fully established.
3. The compressive strength of 28 days for M25 and M30 concrete mix with 100% River sand replacement by M-sand yield compressive strength of 33.23 and 38.96 N/mm².
4. For big projects like highways, establishing a plant leads to economy as they require large amount of fine aggregate.
5. The most extreme increment in compressive strength is 5.44% (M25) and 1.72% (M30), flexural strength is 1.29% and 9.95% and Split tensile strength is 6.16% and 6.68% respectively.

Future Work

i. M-Sand improves the compressive and split elasticity. In this way, M sand can be viably utilized in Construction as a substitution of the River Sand and to protect the Waterbodies for the future, and to advance the Eco-accommodating development measures.

ii. Study various physical and chemical properties of different raw materials of manufacture sand will be investigated which has been collected from different crusher plants.

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