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The Impact of Manufactured Sand (M-Sand) as Partially and Fully Replacement of Fine Aggregate in Concrete

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ABSTRACT

This, research work was to study the potential of M-sand as compared to river sand in concrete, here M-sand is replaced by river sand 0%,45%,50%,55% and 100% in the concrete mix, Mix design is designed as per IS Standards. In this research a mix 1:2.32:2.82 (M20) was considered. The test specimen was casted for 7days, 28 days and 90days. The performance of M-sand was determined by several experiments such as slump test, impact strength test, flexural Strength, and compressive strength test. The results attained from each test states that as M-sand increases the slump value decreases. flexural strength, compressive strength and impact test of concrete at 7 days, 28 days and 90 days is greater at 100% and 50% replacement of M sand by river sand.

1. Introduction

This paper is an extension of work originally presented in conference IEEE 5th International Conference on Engineering Technologies & Applied Sciences, 22- 23 Nov 2018, Bangkok Thailand [1]. In the world, fine aggregate, probably natural sand, composes up to 30% of the volume of concrete, it is around 4 billion tons sand is required to meet annual necessity of concrete production [2]. Increasing in excavation of river sand from riverbeds leads to serious threat to environment [3]. Due to the limiting resources of river sand, alternatively M sand can be used. [1]–[10]. The Manufactured sand is produced by crushing the rocks [5] [10].

The impact of M-Sand on the concrete properties:

Higher split tensile strength, higher compressive strength, & higher flexural strength can be attained by the 50% substitution of of fine aggregate by M Sand [5], [6],[10]. It is due to the angular in shape of M sand gives good bonding between cement and aggregate. Gradual increase in strength can be obtained by 50% replacing river sand by M sand. [4]. Gained higher strength at 60% by substituting the river sand by M sand at various proportions such as 0%, 20%, 40%, 60% and 80% [14]. The concrete flexural strength increased up to 2% and 4.3% by 25% and 100% incorporation of river sand by M sand[15]. Compared to the air curing and standard moist curing, the membrane curing will give the good strength in both river sand and M sand. Addition of Super Absorbent Polymer leads to a significant increase of mechanical properties of the concrete [16].

The M sand properties are very much similar to river sand so nowadays, instead of river sand, M sand can be used in place of river sand[11] , by utilizing M sand in alternative of river sand the workability of concrete will decreases[12], the workability can be gained by adding water reducing admixtures [16].

It was observed that if river sand is completely replaced by M sand, M sand has greater resistance to loss in strength as compared to river sand, if specimen is immersed in chemicals. The Combined replacement of M sand and Marble powder upto 25% by river sand increased the concrete strength [17].

Compressive strength increased by approximately 10% for 28 days of curing, when river sand fully substituted by M sand [2]. It has been recorded that the compressive Strength enhance up to 50% incorporation of river sand by M-sand sand and introduction of 2% to 6% waste plastics [18].

The 100% incorporation of natural sand by M sand, it helps in increase in paste volume as compare to river sand, which is useful to produce self-compacting concrete. Increase in paste volume is

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due presence of high fines in M sand, which increases the water demand also [19].

Manufactured sand is suitable as alternative for river sand at affordable cost. It will act as cohesive cement mortar. It helps environment to maintaining the economical balance [3] [19].

2. Objective

- To inspect the properties of M-sand
- To examine the impact of M-sand on fresh and hard properties of concrete.
- To investigate the comparison of the, flexural Strength, compressive strength and Impact sstrength achieved by the cubes and beams in river sand and M-sand.

3. Materials and Its Properties

3.1. Cement

In this research Ordinary Portland Cement (53 grade) was used. As per IS: 8112-1989 Cement Properties are determined as tabulated in Table 1.

Table 1: Cement Properties

Properties		Result	IS code Requirement
Specific gravity		3.05	
Standard consistency		31%	
Setting time	Initial(Minutes)	33 min	30 minimum
	Final(Minutes)	380 min	600 maximum
Compressive strength (MPa)	7 days	32	33
	28 days	46	43

3.2. Fine Aggregates

The river sand was collected from the Mangalore local area which is excavated from riverbeds. The sieve analysis of river sand is tabulated in Table 2 and shown in Figure 3.

Table 2: Sieve analysis of river sand

SL No	Sieve Designation	Percentage Passing	Grading Limits for Zone II Sand (IS383)
1	4.75 mm	99	90-100
2	2.36 mm	87.8	75-100
3	1.18 mm	54.6	55-90
4	600 micron	37.6	35.59
5	3000 micron	12.6	8-30
6	150 micron	6.4	0-10
7	75 micron	2	0-10

From the sieve analysis test the river sand and M-sand fineness value are 3 and 3.45 respectively, both falls under zone-2, it shows the M-sand properties is similar to river sand, M-sand is slightly coarser as compared to river sand. The sieve analysis of M sand is shown in Table 3 and Figure 4

Table 3: Sieve analysis of M- Sand

SL No	Sieve Designation	Percentage Passing	Grading Limits for Zone II Sand (IS383)
1	4.75 mm	100	90-100
2	2.36 mm	91	75-100
3	1.18 mm	61.2	55-90
4	600 micron	48.3	35.59
5	300 micron	27.4	8-30
6	150 micron	13.8	0-10
7	75 micron	3.8	0-10

3.3. Coarse Aggregate

The 20mm down size crushed stone is used in this research. Table 4 and Figure 5 shows the Coarse aggregate sieve analysis.

Table 4: Sieve analysis of Coarse Aggregate

SL No	Sieve Designation	Percentage Passing	Gradation requirement as per IS 383-1970 for grade II	Remark
1	40	100	100	As per IS 383 the sample confirms the graded aggregate
2	20	98	95-100	
3	10	46	25-50	
4	4.75	0.8	1-10	

3.4. Mix Design

In this research work a mix design 1:2.32:2.82 (M20) is considered.

Table 5: Mix Design

Mix Design	Cement (kg/m^3)	Aggregate (kg/m^3)		w/c Ratio	Water (l)
		Fine	Coarse		
1:2.32:2.82	358	829.67	1009.96	0.55	197

4. Fresh Properties of Concrete

4.1. Slump test

The workability of concrete was estimated by using slump test. Figure 6 and Table 6 shows that slightly decrease in the slump value as M sand increases.

Figure 1: Slump test

Table 6: Slump test

Percentage of M Sand	Slump Value (mm)
0%	102
45%	100
50%	99
55%	100
100%	99

5. Hard properties of Concrete

5.1. Compressive Strength test

The tests were carried out on 150mm* 150mm*150mm size of cubes. The outcomes is displayed in Figure 8.

Figure 8 shows the compressive strength for results for 7days, 28 days and 90 days curing, it is detected that the compressive strength increased for 100% and 55% of replacement of M Sand by river sand, 100% and 55% incoporation of M sand can be advised to use as fine aggregate.

Figure 2: Compressive strength test

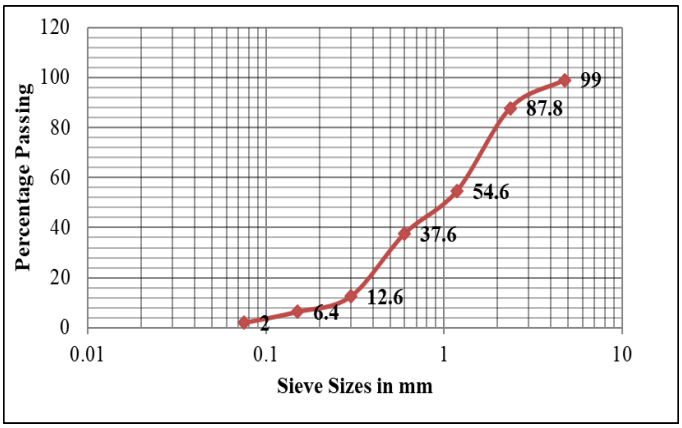


Figure 3: Sieve analysis of River Sand

5.2. Flexural strength test

The tests were carried out on beams of width 150 mm length 150 mm and 70 mm thickness. Figure 9 shows the flexural strength for results 7days, 28 days and 90 days curing, it is observed that the flexural strength increased for 100% and 55% of incorporation of M Sand by river sand, 100% and 55% incorporation of M sand can be advised to use as fine aggregate.

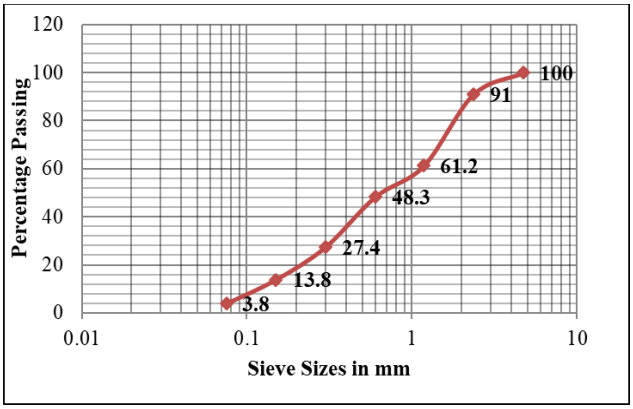
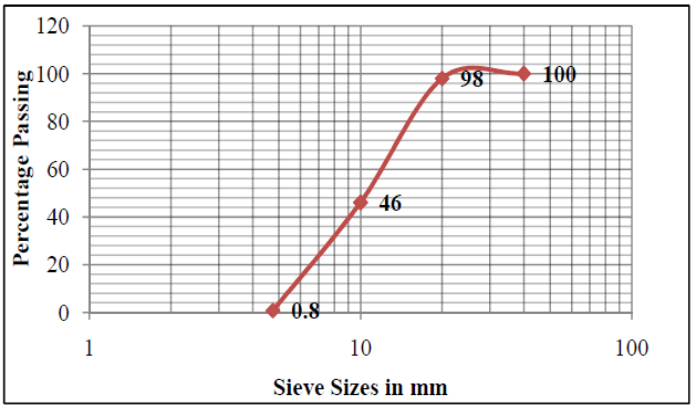


Figure 4: Sieve analysis of M Sand



5.3. Impact Test Results

Figure 10 shows the variation in impact test results of the concrete specimen prepared by replacing natural sand by M-sand at the percentages of 0%, 45%, 50%, 55% and 100%. Results shows that energy consumption in 55% and 100% replacement

shows increase in energy consumption that is about 47.99% and 40% for initial crack, 48.38% and 38.7% for ultimate failure when compare to 0% replacement. It can be concluded that 100% and 55% substitution of river sand by M sand has a threshold values for an optimal performance in energy adsorption and crack resistance.

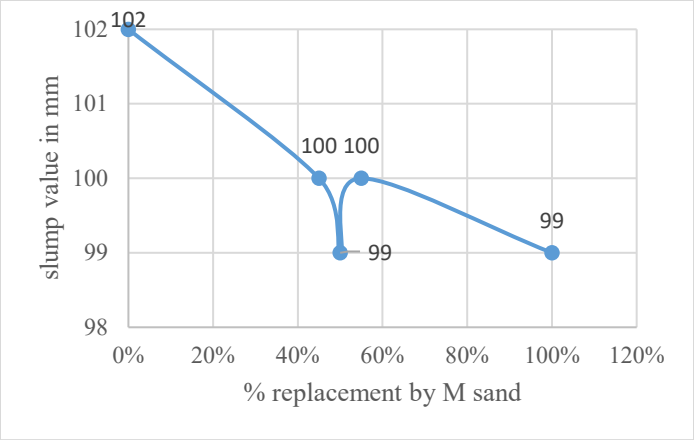


Figure 6: Slump test graph

Figure 6: Flexural strength test

Figure 7: Impact test on concrete

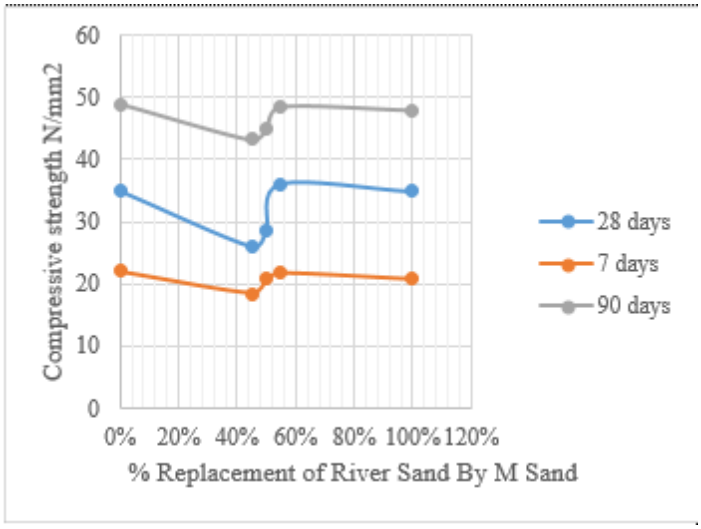
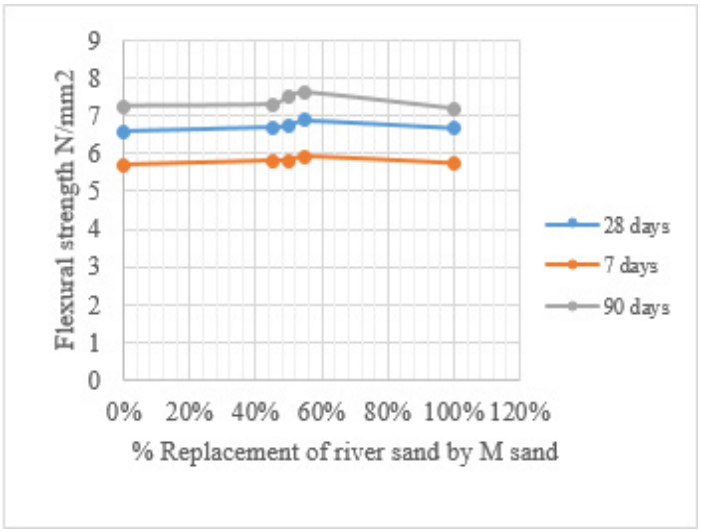


Figure 8: Compressive strength test graph



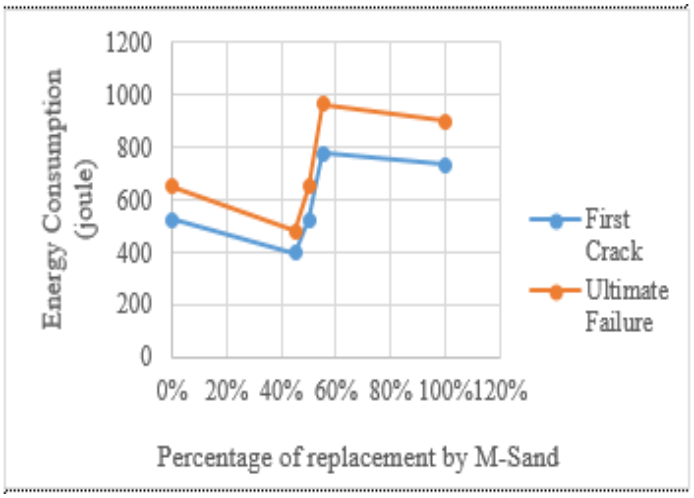


Figure 10: Variation in Energy Consumption for M20 grade Concrete Specimen

Conclusion

M-sand and River sand fineness value are 3 and 3.45 respectively, both falls under zone-2, it shows the M-sand

properties is similar to river sand, M-sand is slightly coarser as compared to river sand.

By 100% and 55% incorporation of M sand by river sand concrete can achieve higher flexural strength and compressive strength of concrete at 7 days, 28 days and 90 days.

Concrete can achieve optimal performance in energy adsorption and crack resistance by 100% and 55% substitution river sand by M-sand.

An incorporation of 100% and 55% of M sand can be advised to use as fine aggregate to enhance the strength of Concrete.

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