

MANUFACTURED SAND, A SOLUTION AND AN ALTERNATIVE TO RIVER SAND IN CONCRETE MANUFACTURING

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ABSTRACT

Scarcity of good quality Natural River sand due to depletion of resources and restriction due to environmental consideration has made concrete manufactures to look for suitable alternative fine aggregate. One such alternative is “Manufactured sand”. Though manufactured sand has been in use in concrete manufacturing in India, the percentage of its contribution is still very negligible in many parts of the country. Except in Kerala and in some pockets in Southern and Western India, real processed manufacture sand is not available and this makes manufacturing of good quality of concrete very difficult. The application of concrete meeting the specification is of paramount importance, to ensure construction of durable R.C.C. structure. Hence durable concrete covers and bears the responsibility of sustaining the entire R.C.C. structure throughout its service life. A well processed manufactured sand as partial or full replacement to river sand is the need of the hour as a long term solution in Indian concrete industry until other suitable alternative fine aggregate are developed.

Key words: manufactured sand, fine aggregate, concrete, compressive strength, workability

INTRODUCTION

With the world wide decline in the availability of construction sands along with the environmental pressures to reduce extraction of sand from rivers, the use of manufactured sand as a replacement is increasing. With the ban on sand mining implemented by different states, and with the increasing demand for river sand for construction works, many civil engineers have expressed the need to promote use of manufactured sand in the construction industry. As per reports, manufactured sand is widely used all 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.

There is a need for 'clean sand' in the construction from the point of view of durability of structures. Indiscriminate mining and quarrying is posing threat to the environment. As the demand for Natural River sand is surpassing the availability, has resulted in fast depletion of natural sand sources. Manufactured sand is the answer for this problem especially when some states have already banned the use of river sand for construction. This sand has been defined well in IS 383-1970, under clause 2.0.

There is a need to study shape characteristics of manufactured sand, effect of micro fines on concrete characteristics such as modulus of elasticity, shrinkage, creep etc. concrete mix proportioning by resorting to particle packing approach is the need of the hour when it comes to use of manufactured sand as a replacement to natural river sand.

some of the study's findings from Dr. C.S. Viswanatha, Chief Executive, Torsteel Research foundation in India has concluded that compared to concrete made from natural sand, high-fines concrete generally had higher flexural strength, improved abrasion resistance, and higher unit weight and lower permeability due to filling the pores with microfines

IMPACT OF USING MANUFACTURED SAND ON CONCRETE PROPERTIES

Increase in strength characteristics of concrete has been observed as compared to concrete made with natural river sand is mainly due to denser particle packing and silt free nature as compared to river sand. International centre for aggregate research (ICAR) has conducted extensive research on the use of manufactured micro fines, upto 17%, in concrete with promising results. ICAR 102 studied the uses of micro fines in Portland cement concrete and determined the effects of higher amount of crusher fines on fresh and hardened concrete properties. The amount of fines passing the No. 200 sieve (75 μ m) ranged from 7.4 to 16.7%.

Researchers concluded that, compared to concrete made from natural sand, high fines concrete generally had higher flexural strength, improved abrasion resistance, and higher unit weight and lower permeability due to filling the pores with micro fines. There is no appreciable difference in dry shrinkage in concrete made with manufactured sand as compared to river sand.

Manufactured sand is more angular and has rougher surface texture than naturally weathered sand particles. Aggregate that is more angular will have more water demands compared to river sand. Increase in water demand has to be compensated by the increasing cement content to maintain the same water cement ratio. Their particle size distribution helps in higher packing density which enhances the durability of the concrete.

Mr. Vijay K. Kosaraju. Executive Director of Robo Silicon limited concluded that manufactured sand is anytime better than river sand. The particle shape is cubical, which is almost closer to rounded river sand. The gradation what we get generally won't be available in any river sand. It is also a proven fact, that the compressive strength of any grade of concrete is much more than the concrete where river sand is used.

NATURAL SAND VS MANUFACTURED SAND

The sand from river due to natural process of attrition tends to possess smoother surface texture and better shape. It also carries moisture that is trapped in between the particles. These characters make concrete workability better. However, silt and clay carried by river sand can be harmful to the concrete. Another issue associated with river sand is that

of obtaining required grading with a fineness modulus of 2.4 to 3.1. It has been verified and found, at various locations across south India, that it has become increasingly difficult to get river sand of consistent quality in terms of grading requirements and limited silt / clay content. It is because we do not have any control over the natural process.

In case of manufactured sand, the process of attrition through VSI and washing makes the crushed stone sand particles good enough to be compared shape and surface texture of natural sand. With well-designed screening system the required grading (Zone II) and fineness modulus (2.4 to 3.1) can also be achieved consistently in the case of manufactured sand. It must be noted that properly processed manufactured sand can improve both compressive strength and flexural strength through better bond compared to river sand.

PROPORTIONING OF CONCRETE MIXES USING MANUFACTURED SAND

Concrete mix proportions chosen should be such that the concrete is of adequate workability for the placing condition of the concrete and we can properly be compacted with the means available. In hardened state concrete shall have required strength, durability and surface finish. Fine aggregate is one of the important constituents of concrete. As natural sand deposits become depleted near some areas of metropolitan growth, the use of manufactured sands as a replacement fine aggregate in concrete receiving increased attention. Designers, specifiers, contractors and material suppliers need to understand the effects of manufactured sand characteristics on concrete water demand and concrete durability. IS 383 – 1970 (reaffirmed 2007) recognize manufacture sand as ‘Crushed stone sand’ under clause 2. Typical properties of manufactured sand shown in table 1.

TABLE: 1 MIX PROPORTION FOR PUMPING CONCRETE USING MANUFACTURED SAND

Mix Designation	Aggregate Max. size (mm)	Suggested Mix proportion C:FA:CA	Water Cement ratio (max)	Cement Content (Kg/cu.m)	Dosage of admixture per bag of cement	Compressive strength (N/sq.mm) 7days 28days
M25	20	1:2.18:3.78	0.50	320	600 ml	23.8 33.0
M30	20	1:2:3.47	0.50	340	550 ml	27.5 40.0
M35	20	1:1.71:2.98	0.44	380	600 ml	30.6 45.0
M40	20	1:1.75:2.83	0.41	400	650 ml	34.9 50.5
M45	20	1:1.56:2.62	0.40	420	600 ml	44.7 55.6
M50	20	1:1.48:2.60	0.34	450	600 ml	45.2 65.0
M55	20	1:1.48:2.55	0.34	450	600 ml	50.2 68.0
M60	20	1:1.38:2.32	0.34	475	600ml	54.2 69.9

NOTE:

Admixture used is CONPLAST SP 430, manufacturer M/s Fosroc Chemicals (India) Pvt. Ltd (In case of M 55 & M 60 grades dosage of admixture is to be considered as per bag of cementitious material.).

RESULTS

The test results from the Institute for Construction Material and Technologies PVT LTD (ICOMAT) is shown in table.2, table.3, table.4 and table.5

TABLE: 2, SIEVE ANALYSIS DATA

IS SIEVE	% OF PASSING OF RIVER SAND SAMPLE	% OF PASSING OF M-SAND SAMPLE
4.75 mm	100.00	100.00
2.36 mm	99.70	90.70
1.18 mm	89.00	66.20
600μ	60.90	39.80
300μ	17.70	25.50
150μ	3.10	9.90
Fineness modulus	2.30	2.68

TABLE: 3, WET SIEVE TEST TO FIND THE % OF MICROFINES

SAMPLE	TEST	RESULT	REMARKS
RIVER SAND	Material finer than 75 μ (%)	2.4	Finer than 75 μ shall not exceed 3 % for uncrushed aggregate as per IS 383 – 1970
MANUFACTURED SAND	Material finer than 75 μ (%)	2.0	Finer than 75 μ shall not exceed 3 % for uncrushed aggregate as per IS 383 – 1970

TABLE: 4, WATER ABSORPTION TEST

River Sand from Karur	1.75%
Manufactured sand ,Karur	1.96%

SAMPLE	TEST	TEST CONDUCTED	RESULT	REMARK
RIVER SAND	SOUND-NESS TEST	SODIUM SULPHATE (%)	5.79	The aggregate values shall not exceed 10% (5 cycles) by weight for aggregate when tested with sodium sulphate. As per IS 383 – 1970
		MAGNESIUM SULPHATE (%)	7.64	The aggregate values shall not exceed 15% (5 cycles) by weight for aggregate when tested with magnesium sulphate. As per IS 383 – 1970
MANUFACTD SAND	SOUND-NESS TEST	SODIUM SULPHATE (%)	1.6	The aggregate values shall not exceed 10% (5 cycles) by weight for aggregate when tested with sodium sulphate. As per IS 383 – 1970
		MAGNESIUM SULPHATE (%)	2.0	The aggregate values shall not exceed 15% (5 cycles) by weight for aggregate when tested with magnesium sulphate. As per IS 383 – 1970

TABLE-5, SOUNDNESS TEST

NOTE:

- Soundness test is conducted to verify the ability of aggregate to with stand long term effect of alternate wetting & drying and or freezing & thawing.

ORGANIC IMPURITIES TEST

Both river sand and manufactured sand are found to be free of organic impurities.

ALKALI SILICA REACTIVITY TEST

Both river sand and manufactured sand showed much lower expansion compared to the limit of 0.1% that qualifies them as innocuous material.

PARTICLE SIZE VERIFICATION

The shape of river sand tends to be good. However, manufactured sand particles match the shape of river sand very closely. The shape verification test was done by sieving respective fine aggregate particle through 4.75 mm sieve and retained at 2.36 mm sieve. The particle between the size 4.36 mm and 2.36 mm are verified visually for their shape. This method considered suitable especially on field, as it is quick and easy. The same method can be used to verify the shape of the particle between 2.38 mm 1.18 mm, too.

DISCUSSION

WORKABILITY

- 1) The mix with Ms Sand as 100% fine aggregate gives initial workability of 170mm, which is much higher than that of the mixes with 100% river sand (RS) and crusher dust.
- 2) Higher fineness modulus, particles grading, shape, texture and control of microfines have contributed to better workability of manufactured sand. The good physical properties of manufactured sand has enabled in reduction of free water as well.
- 3) The river sand particles have better shape and texture, lower fineness modulus and silt content have contributed to the reduced workability of just 100mm, which is much lower than that of the standard mix with 100% MS.

COMPRESSIVE STRENGTH

- 1) The standard mix with 100% manufactured sand has exhibited much higher compressive strength 53 MPa.
- 2) The standard mix with 100% of river sand has exhibited compressive strength of 49MPa, 7.5% lower than that of manufactured sand.
- 3) The improved properties of MS by the entire process of manufacturing could have resulted in reduced surface area and better particle packing. This contributed to the better binding effect with the available cement paste and improved the compressive strength.

CONCLUSION

1. Proportioning the concrete mix for type of job in hand is an essential part of any quality assurance plan. This can be done effectively with proper understanding of properties of constituent material of concrete.
2. It is important to consider the gradations recommended by ASTM for fine aggregate.
3. The bulk specific gravity (BSG) and absorption capacity are the physical properties that are required to make the calculation of a mix design and can also be used to evaluate the consistency of a source of material.
4. The effect on the use of manufactured sand on early age and long term volumetric properties, such as shrinkage and creep respectively, are not available and should be studied.

5. Further research work is needed to explore the effect of manufactured sand on high performance concrete.
6. The fresh properties of concrete are certainly affected by the use of manufactured sand, but the hardened properties such as flexural strength & compressive strength do not seem to be greatly affected by the gradation.
7. Their particle size distribution helps in higher packing density which enhances the durability of the concrete.
8. Research findings concluded that, compared to concrete made from river sand, high fines concrete generally had higher flexural strength, improved abrasion resistance, and higher unit weight & lower permeability due to fillings the pores with micro fines.

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