Research Paper Engineering

A Reviewe on Need of Manufactured Sand in Concrete Constructions As A Replacement To River Sand

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ABSTRACT

The reduced availability of natural sands, particularly along the east coast of India, and the need to better utilise sand-size material generated in the aggregate crushing process, has combined to encourage the development of 'Manufactured Sand'. The crushed rock fine should be processed to have fines content close to the optimum fines content or within a certain recommended range encompassing the optimum fines content. Such knowledge of the optimum fines content would help the quarry operators process the crushed rock fine to produce manufactured sand. With manufactured sand marketed as a material complying with certain recognized specifications, it is then up to the design engineers or concrete producers to specify ordinary crushed rock fine, which is cheaper and should be good enough for normal concrete, or manufactured sand, which is more expensive but should be a better choice for high strength concrete. This paper describes different issues related with manufactured sand.

KEYWORDS Manufactured sand, Crushed rock, Natural sand, High Strength Concrete

INTRODUCTION

Currently India has taken a major initiative on developing the infrastructures such as express highways, power projects and industrial structures etc. To meet the requirements of globalization, in the construction of buildings and other structures concrete plays the rightful role and a large quantum of concrete is being utilized. River sand, which is one of the constituents used in the production of conventional concrete, has become highly expensive and also scarce. In the backdrop of such a bleak atmosphere, there is large demand for alternative material. Natural sand is excavated from river bed impacts on environment in many ways. Due to digging of the sand from river bed reduces the water head, so less percolation of rain water in ground, which result in lower ground water level. There is erosion of nearby land due to excess sand lifting as well as it destroys the flora & fauna in surrounding areas. Due to limited supply of natural sand, cost is very high and its consistent supply cannot be guaranteed. Under these circumstances use of artificial sand becomes unavoidable. As the supplies of suitable natural sand near the point of consumption are becoming exhausted, the cost of this sand is increasing. In addition to this, the turbulence created by dredging sand near the estuaries could damage the fragile ecosystem along the coast [1]. The artificial sand produced by proper machines can be a better substitute to river sand. The sand must be of proper gradation. It should have particles from 150 microns to 4.75 mm in proper proportion. When fine particles are in proper proportion, the sand will have fewer voids. The cement quantity required will be less. Such sand will be more economical. River sand in many parts of the country is not graded properly and has excessive silt and organic impurities and these can be detrimental to durability of steel in concrete whereas manufactured sand has no silt or organic impurities [2]. In general, the demand of natural sand is quite high in developing countries to satisfy the rapid infrastructure 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 [4]. The main cause of concern is the nonrenewable 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 [5]. Mahendra [6] found that the sharp edges of the particles in artificial sand provide better bond with the cement than the rounded part of the natural sand.Presence of other impurities in river sand such as coal, bones, shells, mica, etc. makes it inferior for the use in cement concrete. The decay of these materials, due to weathering effect, shortens the life of the concrete. Thus a replacement material to the natural sand was sought, and artificial sand was identified as a possible substitute material.

GENERAL REQUIREMENTS OF MANUFACTURED SAND

1. All the sand particles should have higher crushing strength.
2. The surface texture of the particles should be smooth.
3. The edges of the particles should be grounded.
4. The ratio of fines below 600 microns in sand should not be less than 30%.
5. There should not be any organic impurities
6. Silt in sand should not be more than 2%, for crushed sand.
7. In manufactured sand the permissible limit of fines below 75 microns shall not exceed 15%.

NATURAL SAND V/S 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 com-

pressive strength and flexural strength through better bond compared to river sand [3].

VASTU IMPACTS OF RIVER SAND

Now-a-days, Vastu-Shastra is more popular, many people consults Vastu while constructing home. As per Vastu-Shastra, the building material must be free from traces of human or animal body. The river sand contains bones of human beings and animals. The shells are also a kind of bone. It is not easy to take out all such things present in the river sand. Hence, the best solution for this is to use manufactured sand of good quality for human well being [2].

PROCESS OF MANUFACTURING ARTIFICIAL SAND

Manufactured Sand is produced by feeding stones of varying sizes into Vertical Shaft Impact (VSI) Crusher. The VSI crusher by means of its unique design and action produces well shaped fine aggregate particles. The process of attrition also enables the removal of surface roughness of the fine aggregate particles to a good extent. When the stones are processed through Vertical Shaft Impact (VSI) Crusher, not only fine aggregates, but the coarse aggregates, another end product, also acquire improved particle shape and reduced surface roughness.VSI Crushers in quarry are sometimes used to convert entire coarse aggregates into fine aggregates. With an inherent process of screening, Manufactured Sand plants ensure better grading of fine aggregates for better particle size distribution. Also some of the plants possess Air Filter System and/or washing facility through which the percentage of micro fines (passing 75 micron) is controlled below 3% by weight. The washing facility provides another benefit of keeping the Manufactured Sand in wet or partially wet condition. This will help to reduce the absorption rate of Manufactured Sand during concrete manufacturing and in turn will contribute to the better workability and workability retention. Test results in South India has shown that if the Manufactured Sand is produced by processing through VSI crusher and washing system, it exhibits much reduced water absorption character in comparison with Crusher Dust (CRF). Fines are removed by (AFT) After Filtering Technology and also by ORTNER system. The process is shown in Fig.1in the form of operations.

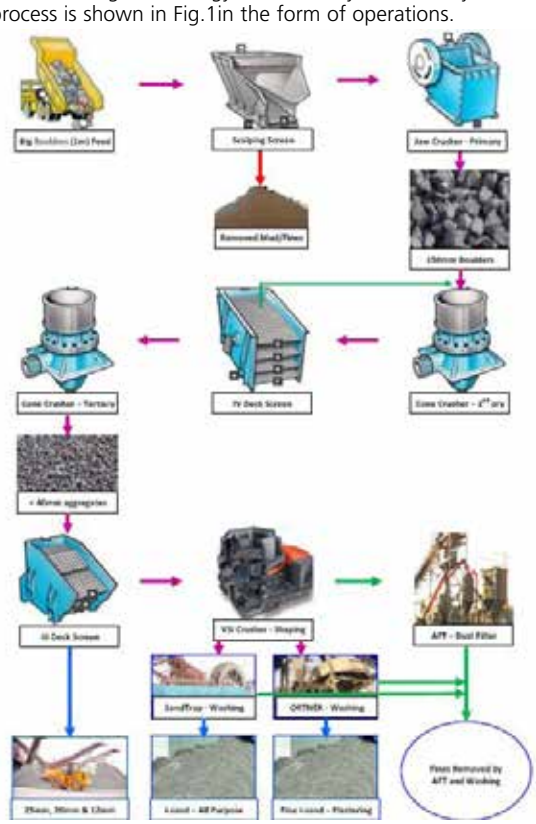


Fig. 1 Process of Manufacturing Artificial Sand

CASE STUDY

A case study of manufactured sand is described below.

RESULTS

The test results from the Institute for Construction Material and Technologies PVT LTD (ICOMAT) are shown in Table.1,2,3 and 4.

SIEVE ANALYSIS TEST OF RIVER SAND AND MANUFACTURED SAND

Table 1 Sieve analysis data

IS SIEVE	% of passing(RiverSand)	% of passing (Manufactured Sand)	Zone II (As per IS:383)
4.75mm	100	100	90-100
2.36mm	99.7	90.7	75-100
1.18mm	89	66.2	55-90
600micron	60.9	39.8	35-59
300micron	17.7	25.5	8-30
150micron	3.1	9.9	0-20

SOUNDNESS TEST OF RIVER SAND AND MANUFACTURED SAND

Table 2 Soundness test data

TEST CONDUCTED	RIVER SAND	ARTIFICIAL SAND	Remarks (AS PER IS:383-1970)
Sodium Sulphate (%)	5.79	1.6	The value shall not exceed 10%
Magnesium Sulphate(%)	7.64	2.0	The value shall not exceed 15%

WATER ABSORPTION TEST

Table 3 Water absorption test result

SR.NO	RIVER SAND	MANUFACTURED SAND	LIMIT AS PER IS 383-1970
1	1.75%	1.96%	2%

WET SIEVE TEST

Table 4 Wet sieve test data

SAMPLE	Test	Result	Remarks
RIVER SAND	% finer than 75	2.4	<3% AS PER IS 383-1970
MANUFACTURED SAND	% finer than 75	2.0	<3% AS PER IS 383-1970

COST COMPARISON OF RIVER SAND AND MANUFACTURED SAND

Table 5 cost comparison between river sand and manufactured sand.

Location-Banglore city.	River Sand	Manufactured sand	Remarks
Market rate	Rs. 1100 per T	Rs. 600 per T	50% cheaper

In concrete- per Cum	Rs.770-880	Rs. 420-480	Saving of rs.350-400
In mortar (1:5) for 100 kgs.	Rs. 198	Rs.156	20% Less

BEHAVIOUR OF MANUFACTURED & RIVER SAND WHEN USED IN CONCRETE

Table 6 shows the behavior of river sand and manufactured sand when used in concrete and remedies to improve properties of concrete.

Table 6 Behaviour of river sand and manufactured sand in concrete

SrNo	Property	River sand	Manufactured sand	Remedies
1	Workability & its retention	Good & Good retention	Less & Less retention	Control of fines & apply water absorption correction, use of plasticisers
2	Setting	Normal	Comparatively faster	Apply water absorption correction, use retarders
3	Compressive strength	Normal	Marginally higher	As shown above
4	Permeability	Poor	Very poor	
5	Cracks	Nil	Tend to surface crack	Early curing & protection of fresh concrete

COMPRESSIVE STRENGTH COMPARISON OF CONCRETE CONTAINING RIVER SAND AND ARTIFICIAL SAND

The test performed by G Sreenivasa, General Manager (Business Development), UltraTech Cement Limited Bangalore to compare compressive strength is shown in Table.7 [2].

Table 7 Compressive strength result

SAMPLE	CEMENT	20mm AGGREGATE	12mm AGGREGATE	WATER CONTENT	COMPRESSIVE STRENGTH AFTER 7 DAYS
RIVER SAND (75 KG)	50 KG	75 kg	37.5 kg	19 Ltrs.	44.1 Mpa
MANUFAC-TURED SAND (70 KG)	50 KG	80 kg	35 kg	19 Ltrs.	48.8 Mpa

CONCLUSION

By keeping in mind the acute shortage of river sand, heavy short coming on quality of river sand, high cost, greater impact on road damages and environmental effects, the Construction Industry shall start using the manufactured sand to full extent as an alternative and reduce the impacts on environment by not using the river sand. The Local Authorities/ PWD/ Government shall put more emphasis on the use of Manufactured sand in Public Construction Works, if possible, shall make mandatory to use Manufactured sand wherever available with immediate effect. Policy should be drafted by the Government on Sand to encourage the major industries of India to set up more no of Sand crushing Units across the all Districts, States to meet the sand requirements of the Construction Industry.

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