M-SAND, An Alternative To The River Sand In Construction Technology

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Abstract— A few alternatives have come up for the industry to bank on of which manufactured sand or M-sand, as it is called, is found to be the most suitable one to replace river sand. M-sand has caught the attention of the construction industry and environmentalists alike for its quality and the minimum damages it causes to nature. Usage of M-Sand can drastically reduce the cost since like river sand, it does not contain impurities and wastages is nil since it is made with modern technology and machinery. Once the M-sand becomes more popular in the construction industry, the demand for river sand and illegal sand mining would come down, 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. In the present study, a comparison of the Compressive strengths of River Sand and M-sand is done with the hundred percent replacement of river sand by M sand.

Index Terms— M-Sand, Compressive strength, fine aggregate

1 INTRODUCTION

Natural Sand is being used as fine aggregate in concrete making and is preferred as fine aggregate. It is mostly mined from the river beds and indiscriminate mining of sand has reportedly causing damages to the environment. We also see that dependency on this source has led to high material costs also. Now there is high scarcity of natural sand. Due to this shortage of good quality natural sand and heavy dependency on this, for concrete manufacturing, there has been seen usage of poor quality natural sands for construction. Thus it becomes almost obligatory to find alternatives to natural sand and evaluate these alternatives for use in concrete production. Out of the many available alternatives, crushed stone sand has emerged as the most easily available material. This material is available at all the crushing units as a by-product during production of 20mm and 10mm size aggregates. Another form of crushed stone sand is manufactured sand (M sand), which is better in terms of quality and fulfils the requirements of suitable material for use in concrete. M sand is manufactured by any of the methods- by crushing of coarse aggregates (20mm& 10mm) in separate sand plants or using 3 stage VSI crushers. Then this material is further processed either by washing with water or dry sieving, if required to improve the grading and reduce fine powder content. This comparison study gives an insight into the various characteristics of fine aggregates playing role in making good pumpable concrete along with other important hardened concrete properties.

2 PROBLEM DEFINITION

Excessive instream sand-and-gravel mining causes the degradation of rivers. Instream mining lowers the stream bottom, which may lead to bank erosion. Depletion of sand in the streambed and along coastal areas causes the deepening of rivers and estuaries, and the enlargement of river mouths and coastal inlets. It may also lead to saline-water intrusion from the nearby sea. The effect of mining is compounded by the effect of sea level rise. Any volume of sand exported from streambeds and coastal areas is a loss to the system.

Excessive instream sand mining is a threat to bridges, river banks and nearby structures. Sand mining also affects the adjoining groundwater system and the uses that local people make of the river.

Instream sand mining results in the destruction of aquatic and riparian habitat through large changes in the channel morphology. Impacts include bed degradation, bed coarsening, lowered water tables near the streambed, and channel instability. These physical impacts cause degradation of riparian and aquatic biota and may lead to the undermining of bridges and other structures. Continued extraction may also cause the entire streambed to degrade to the depth of excavation.

Sand mining generates extra vehicle traffic, which negatively impairs the environment. Where access roads cross riparian areas, the local environment may be impacted. To evaluate and compare in detail various properties of 2 different kinds of fine aggregates for use concrete. To study the effect of various parameters of these fine aggregates on concrete properties (in Fresh and hardened state).

Following fine aggregates samples were taken from available sources

- Natural River Sand
- Manufactured Sand (M sand)

This study covers testing of some physical and chemical parameters of fine aggregates and their effects on concrete properties –workability, setting time & compressive strength and also durability tests on concrete with M. sand.

3 MATERIAL STUDY

3.1 Manufactured Sand or M SAND

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

- Why Manufactured Sand is Used?

Manufactured sand is an alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the word.

Due to the depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Another reason for use of M-Sand is its availability and transportation cost.

Since manufactured sand can be crushed from hard granite rocks, it can be readily available at the nearby place, reducing the cost of transportation from far-off river sand bed.

Thus, the cost of construction can be controlled by the use of manufactured sand as an alternative material for construction. The other advantage of using M-Sand is, it can be dust free, the sizes of m-sand can be controlled easily so that it meets the required grading for the given construction.

Manufactured Sand is produced by feeding hard stones of varying sizes to primary and secondary crushers (Jaw crusher and Cone crusher), for size reduction and these crushed stones are further crushed in Vertical Shaft Impact (VSI) crusher to reduce the particle size to that of sand. The VSI crusher by its unique design and action of attrition produces well-shaped fine aggregate particles that are cubical and angular. The process of attrition also enables the reduction of surface roughness of the fine aggregate particles to some extent.

During the production processes, it is ensured that sand stockpiles are not contaminated with weathered/highly altered rock or with clay and other contaminants. Crushing of multiple source rocks into a single sand stockpile is also not be permitted unless it can be demonstrated that such a process is under blending control and produces a consistent product.

- Screening and Washing

With built-in process of different stages of screening, Manufactured Sand plants ensure proper grading for better particle size distribution. By washing, the percentage of micro fines (passing 75 micron) is controlled below 15% by weight. The washing facility also provides keeps the Manufactured Sand in wet or partially wet condition. This will help to reduce the water absorption rate by Manufactured Sand during concrete manufacturing and hence better workability and workability retention.

3.2 RIVER SAND

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type; i.e., a soil containing more than 85 percent sand-sized particles by mass.

The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, or SiO_2), usually in the form of quartz. The second most common type of sand is calcium carbonate, for example, aragonite, which has mostly been created, over the past half billion years, by various forms of life, like coral and shellfish. For example, it is the primary form of sand apparent in areas where reefs have dominated the ecosystem for millions of years like the Caribbean.

Sand is a non-renewable resource over human timescales, and sand suitable for making concrete is in high demand

4 TESTS CONDUCTED:

4.1 Specific Gravity

Specific gravity is the ratio of the density of a substance to the density of a reference substance; equivalently, it is the ratio of the mass of a substance to the mass of a reference substance for the same given volume. *Apparent* specific gravity is the ratio of the weight of a volume of the substance to the weight of an equal volume of the reference substance. The reference substance is nearly always water at its densest (4°C) for liquids; for gases it is air at room temperature (25°C). Nonetheless, the temperature and pressure must be specified for both the sample and the reference. Pressure is nearly always 1 atm (101.325 kPa)

Pycnometer method is used for the determination of specific gravities of Cement, Fine Aggregate, and Coarse Aggregate. Observed values of the same are tabulated in Table 1.

4.2 Sieve Analysis

A sieve anal**ysis** (or gradation test) is a practice or procedure used to assess the particle size distribution (also called *gradation*) of a granular material. The size distribution is often of critical importance to the way the material performs in use. A sieve analysis can be performed

on any type of non-organic or organic granular materials including sands, crushed rock, clays, granite, feldspars, coal, soil, a wide

range of manufactured powders, grain and seeds, down to a minimum size depending on the exact method. Being such a simple technique of particle sizing, it is probably the most common.

Table 1: comparision of Specific Gravities of River sand

	FINE AGGREGATE		COARSE
	M-SAND	RIVER SAND	AGGREGATE
Observed Specific Gravity	2.48	2.64	2.57
	2.49	2.67	2.60
	2.47	2.64	2.60
AVG. SG	**2.48**	**2.64**	**2.60**

and Manufactured Sand.

Table 2: Comparison of sieve Properties of River Sand and Manufactured Sand.

Properties	River Sand	M-Sand	Advantages of M-SAND
Shape	Spherical particle	Cubicle particle	Higher Cohesion and Compressive Strength
Gradation	Cannot be controlled	Cannot be controlled	Reduction in Voids and Higher strength
Particle Passing 75micron sieve	Up to 3% (IS 383-1970)	up to 15% (IS 383-1970)	Increased paste strength
Clay and Organic Impurities	Likely to be present(retard the setting time &comp. strength)	absent	Better concrete quality
Grading Zone IS 383	Mostly conforms to zone II and zone III	Manufactured to conform to zone III	Zone II ideal for concrete

4.3 Compressive Strength

Compressive strength or compression *strength* is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate. In other words, compressive strength resists compression (being pushed together), whereas tensile strength resists tension (being pulled apart). In the study of strength of materials, tensile strength, compressive strength, and shear strength can be analyzed independently.

Some materials fracture at their compressive strength limit; others deform irreversibly, so a given amount of deformation may be considered as the limit for compressive load. Compressive strength is a key value for design of structures.

Compressive strength is often measured on a universal testing machine; these range from very small table-top systems to ones with over 53 MN capacity. Measurements of

compressive strength are affected by the specific test method and conditions of measurement. Compressive strengths are usually reported in relationship to a specific technical standard.

4.4 Split Tensile Strength

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete.

The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack.

	COMPRESSIVE STRENGTH(KN/m²)				SPLITN TENSILE STRENGTH	
SPECIMEN	MORTAR CUBES		CONCRETE CUBES		CYLINDERS	
GRADE	1:4		M20		M20	
TIME	7 days	28 days	7 days	28 days	7 days	28 days
M SAND	24.07	29	25.77	32.3	1.98	2.4
	25.79	29.2	28	32.44	1.84	2.54
	25.79	31.2	24.88	33.4	2.02	2.5
AVERAGE	25.22	29.8	26.21	32.71	1.95	2.48

Table 3: Comparison of Compressive & Split tensile Strength Properties of River Sand and Manufactured sand.

4.5 Flexural Strength

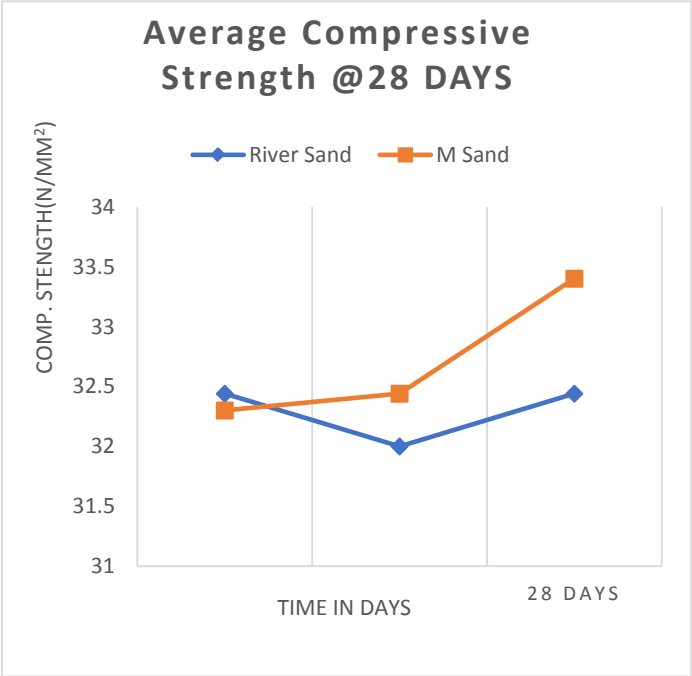
Flexural strength, also known as modulus of rupture, or bend strength, or transverse rupture strength is a material property, defined as the stress in a material just before it yields in a flexure test. The flexural strength represents the highest stress experienced within the material at its moment of yield.

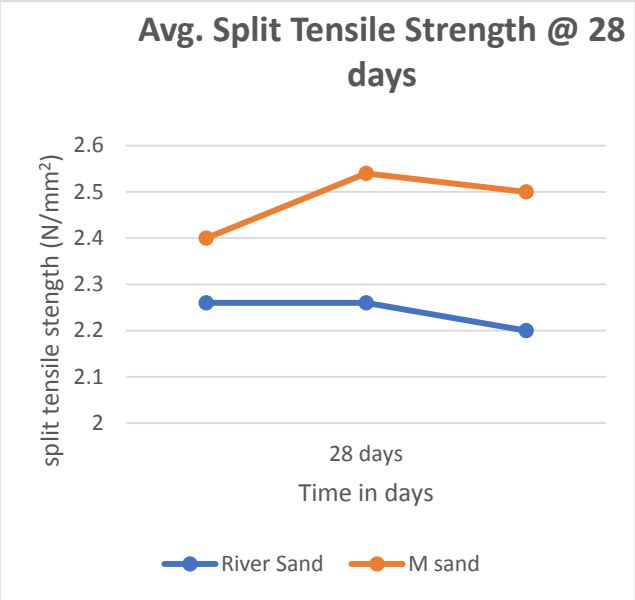
Table 3: Comparison of Flexural Strength Properties of River Sand and Manufactured sand.

	FLEXURALSTRENGTH (N/mm²)	
SPECIMEN	BEAMS	
GRADE	M20	
TIME	7 days	28 days
RIVER SAND	3.64	4.89
	3.66	4.92
	3.6	4.96
AVERAGE	3.63	4.92

	FLEXURAL STRENGTH (N/mm²)	
SPECIMEN	BEAMS	
GRADE	M20	
TIME	7 days	28 days
M SAND	3.74	4.98
	3.72	5.02
	3.76	4.96
AVERAGE	3.74	4.99

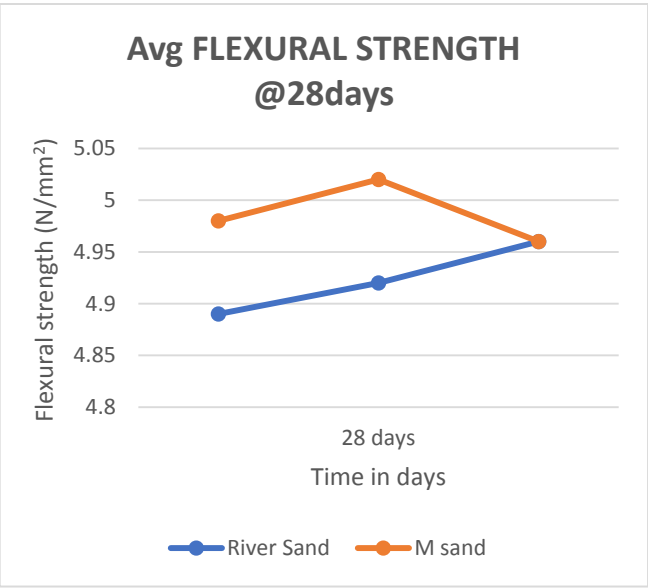
5. GRAPHICAL REPRESENTATION





5 Conclusion

The study on compressive strength of M Sand and River sand will clearly indicates that the M Sand offers same property of River Sand. The various Tests like specific Gravity, Compression Strength test, Flexure Test, spilt tensile strength test will gives same or greater value than River sand. The most important durability test has to be conducted to analyse the cracking effect of M Sand. The M Sand Mortar cubes also have similar property and gives same workability and strength while plastering. Therefore M sand can be effectively used in Construction As a replacement of River Sand. And to preserve the Water bodies for future, and to Promote the Eco-friendly construction processes.



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