Replacement of Fine Aggregate by M-Sand

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Abstract

Shortage of good quality natural sand due to depletion of resources and limitation due to environmental considerations has made concrete manufacturers to look for suitable alternative fine aggregate. One such alternative is "manufactured sand". Workability strength and durability of concrete with manufactured sand as replacement to natural sand in proportions of 0%, 5%, 10%, 15%, 20% and 25% is studied. The experiments were conducted on M20 concrete grade. Slump cone test is conducted to determine workability on fresh concrete. Compressive strength test and split tensile strength tests are conducted on hardened concrete by casting cubes and cylinders respectively. Compressive strength and split tensile strength tests were conducted to determine strength of concrete. The 15% replacement of natural sand by manufactured sand showed an increase in strength in both compressive strength test and split tensile strength test.

Keywords: M-Sand, Concrete, Coarse aggregate

I. INTRODUCTION

A composite material that consists essentially a binding medium, such as a mixture of Portland cement and water, within which are embedded particles or fragments of aggregate, usually a combination of fine and coarse aggregate.

Concrete is by far the most versatile and most widely used construction material worldwide. It can be engineered to satisfy a wide range of performance specifications, unlike other building materials, such as natural stone or steel, which generally have to be used as they are. Because the tensile strength of concrete is much lower than its compressive strength, it is typically reinforced with steel bars, in which case it is known as reinforced concrete.

A composite material is made up of various constituents. The properties and characteristics of the composite are functions of the constituent materials properties as well as the various mix proportions. Before discussing the properties of the composite, it is necessary to discuss those of the individual constituents as well as the effects of the mix proportions and methods of production.

II. OBJECTIVES OF THE PRESENT STUDY

1) To determine the effect of replacement of sand by M- Sand on properties of concrete.
2) 2.To study the suitability of M-sand by replacing natural sand with 0%, 5%, 10%, 15%, 20%, and 25% M-sand.
3) To study workability of fresh concrete.
4) To study compressive strength and split tensile strength of hardened concrete.

III. MATERIALS AND METHODOLOGY

A. *Materials Used*

The various materials used in experimental investigation of concrete and method of experiments conducted on materials of concrete and experimental investigation on concrete and their properties.

1) Concrete:

Concrete is a composition of material from coarse granular material such as coarse and fine aggregate mixing in a hard matrix of material that is cemented that fills the space of aggregate particles with an additive and bind them together (Saidi,2007). It has

been known widely in function for building foundations, architectural structures, walls, pavements and most of it in the construction industry. It is important to identify the amount of each material mixing in production of concrete.

2) Cement:

Cement is a material that has a cohesive and adhesion properties that enable binding chunks of rock into one cohesive body. There are dissimilar cases of cement made at factory for specific purposes and to conform to the specific demands. When the void between the aggregates is minimized, then the need for cement to fill the empty space can be reduced to maintain the workability and the strength of concrete. And so, the optimal mixing ratio of aggregates will produce a concrete with minimal quantity of cement contain. Therefore, the lower water and cement quantity of water and cement ratio (w/c) constant, would result a more durable concrete.

3) Coarse Aggregate:

Coarse aggregate can be defined as inert granular materials such as gravel, crushed stone and sand. Coarse aggregate is one of the essential ingredients apart of water and cement in concrete production. It consists about 60 to 75 percent of total concrete production Coarse aggregate comes from particles greater than 4.75mm but commonly in a range between 9.5mm to 37.5mm.

4) Fine Aggregate

Locally available river sand conforming to Grading zone II of IS: 383 –1970. Clean and dry river sand available locally will be used. Sand passing through IS 4.75mm Sieve will be used for casting all the specimens.

5) Manufactured Sand (M-Sand):

Manufactured sand confirming to Zone – II as per IS: 383-1970 is used. It was tested as per Indian standard specification. The manufactured sand used, is brought from Ambika crusher Gejjenhalii, Shivamogga district.

Fig. 1: Cement

Fig. 2: Coarse Aggregate

Fig. 3: Fine Aggregate

Fig. 4: Manufactured Sand

B. Methodology

1) Mix Design

Mix design is a process of selecting suitable ingredients for the concrete and determining their proportion which would produce, as economically as possible, as concrete that satisfies the job requirement. The proportioning of the ingredients of concrete is an a important phase of concrete technology as it ensure quality and economy, in pursuit of the goal obtaining concrete with desired performance characteristics.

Table - 3.1
Mix Proportion

Cement	*Fine aggregate*	*Coarse aggregate:*	*Water/Cement Ratio*
1	*1.82*	*2.96*	*0.53*

IV. RESULTS AND DISCUSSION

A. Tests on Materials

1) Cement

Ordinary Portland cement (OPC cement) of 43 grade is used confirming to IS: 8112-1989. It was tested as per Indian standard specification. Following are the basic tests conducted on cement and the values obtained are within the allowable limits.

Table - 4.1
Detailed Description of Test on Cement

Particulars	*Test method*	*Experimental Outcome*	*Standard as per IS:8112-1989*
Specific Gravity	*Density bottle method*	*3.15*	*3.0-3.15*
Setting time (minutes)	*Vicat's apparatus*		
Initial setting time	*Needle is 1 mm square section*	*30 minutes*	*Which isn't lower than 30 min*
Final setting time	*Needle is 1mm square section with 5mm dia attached*	*240minutes*	*Which is isn't more than 600 min*
Fineness of cement	*Fineness by sieving*	*5.33%*	*<10%*

2) Coarse Aggregates:

Locally available crushed granite coarse aggregate has been used. The present work having maximum size 20mm coarse aggregate used. Accordingly, tests have been carried out as per procedure given in IS 2386 (PART3)-1963

Table - 4.2
Detailed Description of Test on Coarse Aggregate

Physical Properties	*Coarse Aggregate test result*
Specific Gravity	*2.6*
Impact test	*6.9%*
Water Absorption	*0.50%*
Angularity Number	*9.84*

3) Fine Aggregates:

Locally available river sand has been used. The present work having maximum size 4.75mm fine aggregate used. Accordingly, tests have been carried out as per procedure given in IS 2386 (PART3)-1963.

Table - 4.3
Detailed Description of Test on Fine Aggregate

Physical Property	*Fine Aggregate test result*
Specific Gravity of Sand	*2.50*
FM	*2.54*
Grading Zone	*II*
Water Absorption	*1%*

4) Manufactured Sand (M-Sand):

Manufactured sand confirming to Zone – II as per IS: 383-1970 is used. It was tested as per Indian standard specification.

Table - 4.4
Detailed Description of Test on Manufactured Sand

Physical Properties	*Manufactured Sand result*
Specific Gravity	*2.5*
Fineness modulus	*2.75*
Water Absorption	*0.26%*

B. Compressive Strength Test Results

Following table gives the compressive strength test results of concrete produced by replacing the F.A. by M-Sand.

Table - 4.5
Average Strength of cubes for 3, 7 & 28 days

Test at days	*0% M-sand*	*5% M-sand*	*10% M-sand*	*15% M-sand*	*20% M-sand*	*25% M-sand*
3 days	*11.35*	*11.90*	*12.05*	*12.98*	*12.20*	*11.80*
7 days	*18.50*	*19.10*	*19.75*	*19.80*	*19.30*	*19.05*
28 days	*27.44*	*27.85*	*28.30*	*28.95*	*28.00*	*27.60*

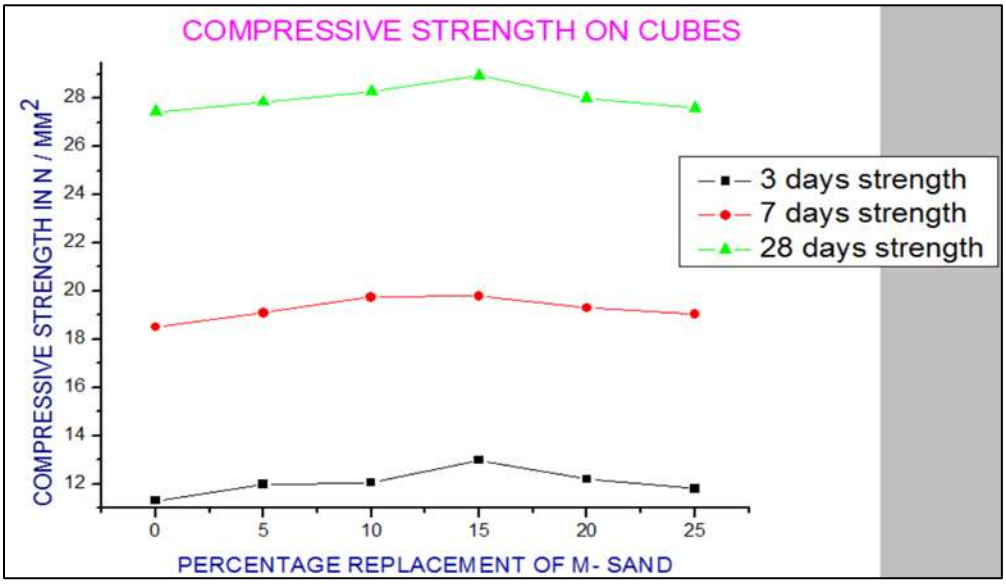

Fig. 5: Compressive Strength Result

C. *Split Tensile Strength Test Results*

Following table gives the split tensile strength test results of concrete produced by replacing the F.A. by M-SAND.

Table - 4.6
Average Strength of cylinders for 3, 7 & 28 days

Test at days	*0% M-sand*	*5% M-sand*	*10% M-sand*	*15% M-sand*	*20% M-sand*	*25% M-sand*
3 days	*0.690*	*0.758*	*0.888*	*0.950*	*0.792*	*0.780*
7 days	*1.3*	*1.45*	*1.53*	*1.73*	*1.66*	*1.55*
28 days	*2.85*	*2.93*	*3.05*	*3.23*	*3.10*	*3.00*

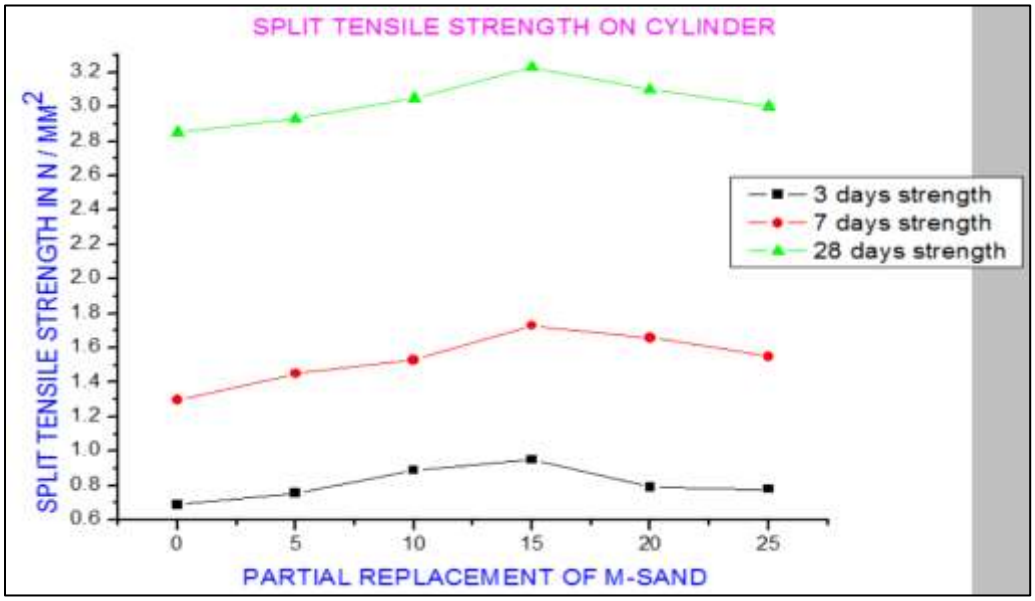

Fig. 6: Split Tensile Strength Result

V. CONCLUSIONS

From the present investigation, the following conclusions were drawn.

1) Manufactured sand is a best alternative for natural river sand in terms of strength and durability.
2) Replacement of 15% Natural River sand by manufactured sand yielded good compressive strength for M20grade concrete.

3) Replacement of 15% Natural River sand by manufactured sand yielded good split tensile strength for M20 grade concrete.
4) Replacing natural sand by manufactured sand induces higher strength in concrete than the conventional concrete.
5) Better control over gradation and free from impurities.
6) Shape of the aggregates may be maintained and desired zone can be achieved.
7) Hardness and strength better than natural river sand.

REFERENCES

[1] Celik T and Marar K, 1996, Effects of crushed stone dust on some properties of concrete, Cement Concrete Research, vol.26, pp.1121–1130.
[2] Hiroshi Uchikawa, 1996, the influence of microstructure on the physical properties of concrete, vol.26, pp.101-111.
[3] Persson and Fletcher, 1998, effect of particle size and shape on the grain size distribution using image analysis, vol.1 pp.968
[4] Hudson, B. P., Manufactured Sand for concrete, The Indian concrete Journal, May 1997, pp.237-240
[5] Kim, 2001,prototype laser scanner for characterizing size and shape of the aggregate vol.40, pp.273
[6] Ahn, N and Fowler, D.W, 2002, the Effects of High Fines on the Properties of Cement Mortar and Concrete. In Proceedings of the International Center for Aggregates Research 9th Annual Symposium, pp.22–25.
[7] Quiroga, P.N, 2003, Concrete mixtures with high microfines, vol.103,pp.258– 264.
[8] Mark James Krinke, the effect of admixtures in concrete containing manufactured sand2004, vol.2, pp.37-40
[9] ShewaferawDinku Belay, (2006), hardened properties of the concrete mixes with partial replacement of natural sand by manufactured sand, pp.17.
[10] Syamprakash V, 2007, ready mixed concrete using manufactured sand as fine aggregate, 32nd conference on our word in concrete and structures, singapoor.
[11] Gerry Huber and Bob McGennis, 2008, how to increase voids in mineral aggregate, the superpave asphalt research programme 2008.
[12] Chris hartwiger and Patrick O'Brien, 2008, making sense of manufactured sand, Newsletter article, January 6, 2008.
[13] Sven-Henrik norman, 2008, sand solutions: replacing natural sand in concrete, special report, pp.24-26.
[14] Saeed Ahmad and Shahidmahmood, 2008, effect of crushed and natural sand on the properties of fresh and hardened concrete, pp.25-27.
[15] Tony Thomas, 2009, manufactured sand-a sustainable solution, boral ACM, PP.1-21.
[16] Mahendra R chitlange and Prakash S pajgade, 2010,strength appraisal of artificial sand as fine aggregate, in SFRC asian research publishing network journal of engineering and applied science, vol.5, pp. 34-38
[17] Shanmugapriya T, 2012, optimization of partial replacement of natural sand by M-sand in high performance concrete, international journal of engineering sciences and emerging technologies, vol.2, pp.73-80.
[18] NimithaVijayaraghavan, 2013, effect of manufactured sand on compressive strength and workability of concrete, vol.2, pp. 229-232.

Reference of Code Practice

[19] IS: 456-2000 Plain And Reinforced Concrete code of practice.
[20] IS: 10262-2009 recommended guidelines for concrete.
[21] IS: 383-1970 recommended guidelines for test on aggregates.
[22] IS: 8112-1989 recommended guidelines for test on cement.