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Comparative study on mechanical properties of ultra high strength concrete using natural sand and manufactured sand

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ABSTRACT

The development of concrete technology and demand on high strength construction material leads to the development of Ultra High Strength Concrete. Nowadays getting natural sand has become expensive and lead to many environmental impact. To overcome these impact M-sand can be used which is more economical. This paper presents the development of UHSC using different fine aggregate such as Natural sand and Manufactured sand (M-sand). It is proposed to determine and compare the mechanical properties of UHSC containing natural sand and M-sand. The mechanical properties such as compressive strength, split tensile strength and flexural strength of UHSC were investigated and evaluated by studying the effect of using M-sand and natural sand. The UHSC specimens were prepared with natural sand and M-sand as a fine aggregate.

Keyword: Ultra High Strength Concrete, Natural sand, M-sand, Mechanical properties.

INTRODUCTION

In concrete technology many improvements have been occurring in past few years. Sustainable use of concrete materials have facilitated improvements in mechanical properties of concrete. Now a days, to produce high strength concrete researchers using silica fume as pore fillers, super plasticizer as water reducing admixture and M-sand as fine aggregate in concrete. Combining ordinary Portland cement, silica fume, high range water reducer and water produces Ultra high strength concrete which is also known as reactive powder concrete. RPC represents one of the most recent technological leaps in the construction industry. The concrete with compressive strength greater than 100MPa is called as Ultra-High Strength Concrete (UHSC). Ultra-High Strength Concrete is a concrete with constituent materials which include Portland cement, silica fume, fine aggregate, coarse aggregate, high-range water reducer and has an extremely low water to cement ratio (i.e. less than 0.26). Ultra high strength concrete is regarded as the promising material for structure like pre stressed or precast concrete members.

[1] Srinivas Allena and et al., had given the Ultra-High Strength Concrete Mixtures Using Local Materials and concluded that Compressive strength of fibre reinforced UHSC was greater than the compressive strength of plain UHSC. [2] The author Nageh N. Meleka and et al., had given the Ultra high strength concrete could be produced effectively using cheap available materials such as Cement, Fine aggregate, silica fumes, super plasticizer, steel fibers. [3] The author G.Venkatesan et al., had given an intensive study on Ultra High Strength Concrete using Cement, Fine aggregate, Coarse Aggregate, Water, Silica fume, Super plasticizer, w/b ratio of 0.18. [4] The author Mani Kandhan.K.U and et al., proposed that

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high strength concrete using M-sand and Natural sand as fine aggregate by casting of cubes and cylinders for determining compressive and split tensile strength respectively and concluded that concrete using M-sand gives strength higher than concrete using Natural sand. [5] The author Priyanka A et al., had given the effect of replacement of natural sand by manufactured sand by comparing the properties of cement mortar using manufactured sand and natural sand with different mortar mix proportion. Thus concluded that manufactured sand has a potential to provide alternative to natural sand and helps in maintaining the environment as well as economical balance. [6] The author M.Adams Joe et al., had given an experimental investigation on the effect of M-sand in high performance concrete by casting concrete cubes with various percentage of natural sand replaced by M-Sand were tested. They concluded that compressive strength increases up to 50% replacement of M-Sand. [7] Meghashree and et al., suggested about that the physical properties between natural sand and manufactured sand and have been similar properties.

MATERIAL USED

Cement

The ordinary portland cement of grade 43 is used for the investigation. The material properties of cement is determined as per IS 12269:1987, ASTM C150/C150M-17.

Table 1 Properties of Cement

S.No	Test conducted	Result
1	Normal consistency (%)	26
2	Initial setting time (minutes)	30
3	Final setting time (minutes)	340
4	Specific gravity	3.1

Fine aggregate

The fine aggregate used was M-sand and natural sand from local sources. The properties of fine aggregate is determined as per IS: 2386 (Part I) – 1963, IS: 383-1970, IS: 460-1962.

Table 2 Properties of Fine Aggregate (M-sand)

S.No	Test conducted	Result	
		Natural sand	M-sand
1	Specific gravity	2.64	2.71
2	Water absorption (%)	1.745	1.165
3	Bulking (%)	3.99	2.95
4	Fineness	2.97	2.78

Coarse aggregate

The coarse aggregate that was broken stones of hard granite drawn from quarries in and around Coimbatore of size 12mm is used. The properties of coarse aggregate is determined as per IS 383:1970, ASTM C33, IS: 2386 (Part I) – 1963, IS: 460-1962.

Table 3 Properties of Coarse Aggregate

S.No	Test conducted	Result
1	Specific gravity	2.78
2	Fineness modulus	9.2
3	Impact value (%)	4.86
4	Crushing value N/mm^2	2.5
5	Water absorption (%)	0.6
6	Abrasion value (%)	4.12

Silica fume

It is a very fine non- crystalline Sio2. It is a by-product of producing silicon metal or Ferro silicon alloys. It is made at a temperature approximately about 2000 ºC. It acts as an excellent pore filling material. It can be used in proportions of 5-10% of cement content in a mix. Depending on its chemical proportion the specific gravity of silica fume varies from 1.3-1.4. The particle size ranges lies between 5.3 mm to 1.8 mm.

Super plasticizer

This is high range water reducer. The strength of concrete increases when the water binder ratio decreases. The super plasticizer used here is Master glenium sky 8233 with Specific gravity of 1.08. **MASTER GLENIUM SKY 8233** is an admixture of new generation based on modified poly carboxylic ether. It is free from chloride & low alkali. It is compatible with all types of cement.

Mix ratio and experimental procedure

For ultra-high strength concrete the chosen grade of concrete was M130. The mix proportions used in this study was given in table. The same mix ratio was used for both natural sand and M-sand. The specimens were cast using natural sand and M-sand as fine aggregate by the following mix design. Then their mechanical properties such as compressive strength split tensile strength and flexural strength were tested for comparative study. For compressive test, cube moulds of size 100mm x 100mm x100mm were used for casting specimens. Similar, for splitting tensile strength, cylindrical moulds of dia.150mm and length 300mm specimens and for flexural test prism of size 100mm x 100mm x 500mm specimens were used for casting and the specimens was kept in curing tanks.

Table 4 MIX RATIO

Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Silica fume (kg)	Super plasticizer (liters)	W/C ratio
1	0.714	1.429	0.1	0.0143	0.2

RESULT AND DISCUSION

Compressive strength

The compressive strength test on cubes were determined after7, 14 and 28 days of curing as per standards.

Table 5 Compressive test results for natural sand

S.No	Age at testing (days)	Compressive Strength (N/mm^2)
1	7	90.21
2	14	124.6
3	28	138.28

Table 6 Compressive test results for M-sand

S.No	Age at testing (days)	Compressive Strength (N/mm^2)
1	7	88.33
2	14	121.7
3	28	135.86

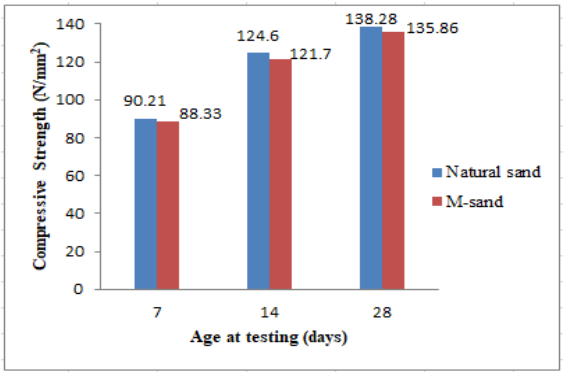

Figure 1 Compressive strength of UHSC using natural sand and M-sand

Flexural strength

The Flexural strength test on cylinder were determined after7, 14 and 28 days of curing as per standards.

Table 7 Flexural test results for natural sand

S.No	Age at testing (days)	Flexural Strength (N/mm^2)
1	7	3.83
2	14	5.2
3	28	5.89

Table 8 Flexural test results for M-sand

S.No	Age at testing (days)	Flexural Strength (N/mm^2)
1	7	3.4
2	14	4.68
3	28	5.21

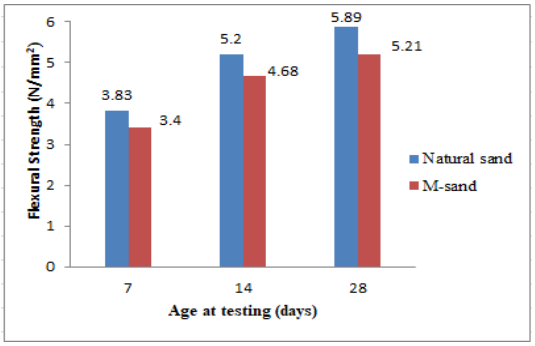

Figure 2 Flexural strength of UHSC using natural sand and M-sand

Split tensile strength

The Split Tensile strength test on cylinder were determined after7, 14 and 28 days of curing as per standards.

Table 9 Split Tensile test results for natural sand

S.No	Age at testing (days)	Split Tensile Strength (N/mm^2)
1	7	5.9
2	14	8.19
3	28	9.1

Table 10 Split Tensile test results for M-sand

S.No	Age at testing (days)	Split Tensile Strength (N/mm^2)
1	7	5.56
2	14	7.83
3	28	8.7

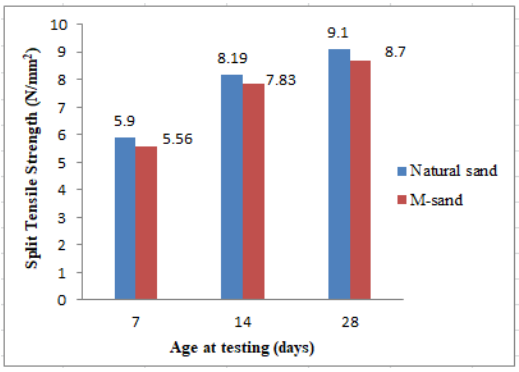

Figure 3 Split tensile strength of UHSC using natural sand and M-sand

CONCLUSION

Cube, cylinder and prism of M130 grade have been casted with natural sand and M-sand as fine aggregate and tested for compressive strength, split tensile strength and flexural strength. The comparative study on mechanical properties of Ultra High Strength Concrete (UHSC) using natural sand and M-sand have been determined.

Based on the experimental investigation, the following result have been determined

1. The difference in the compressive strength of UHSC using natural sand is more than M-sand. But the difference in compressive strength is very less (i.e. 2-3 N/mm^2).
2. As per mix design the compressive strength of UHSC for both natural sand and M-sand were found to be greater than 130 N/mm^2.
3. It is determined that using M-sand as fine aggregate will not affect the compressive strength of concrete and it will be more economical than natural sand.

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