EXPERIMENTAL STUDY OF SELF-COMPACTING CONCRETE AND CONVENTIONAL CONCRETE BY REPLACING NATURAL SAND WITH ARTIFICIAL SAND

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ABSTRACT

Self-Consolidating Concrete often known as self compacting concrete is becoming more widely used in construction in recent years due to its favourable attributes, such as productivity improvements, reduced labour costs, improved work environment and safety. Fine Aggregate is one of the important ingredients of concrete. River sand is commonly used as fine aggregate in making concrete. However dredging of sand from river beds is hazardous to the environment. This has made the Government to restrictions on the use of river sand in construction. Such cases lead use of crushed sand as an alternative to river sand. Especially on the environmental aspects.This paper presents the result of a study that investigated the influence of properties of fresh and hardened self-compacting concrete as substitutes to natural sand. The experimental work is mainly concerned with the study of mechanical properties like compressive strength, split tensile strength and flexural strength of concrete then the results are compared with the natural sand concrete.

Keywords - Natural Sand, Artificial Sand, SCC, Compressive Strength, Flexural Strength, Split Tensile Strength

I. INTRODUCTION

Making concrete structures without vibration have been done in the past, Mass concrete and shaft concrete can be successfully placed without vibration. But the above concrete are generally of lower strength and difficult to obtain consistent quality European Federation of national trade associations representing producers and applicators of specialist building products (EFNARC), has drawn up Specification and Guidelines for self-compacting concrete to provide a framework for design and a use of high quality SCC, during 2002 [9] Natural sand is excavated from river bed impacts on environment in many years 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.[4] Due to limited supply of natural sand, cost is very high and its consistent supply cannot be guaranteed. Under these circumstances use of crushed fine aggregates becomes unavoidable [4]. A SCC (self-compacting concrete) is a concrete that flows and sets up in the most complex and scrapped forms under the effect of its own weight. It is important to note that the material should not undergo any form of segregation and should have qualities similar to those of conventional vibrated concrete [5] Artificial sand is a process controlled crushed fine aggregate produced from quarried stone by crushing or grinding and classification to obtain a controlled gradation product that completely passes the 4.75 mm sieve. Artificial sand generally contain more angular particles with rough surface textures and flatter face than natural sand that are more rounded as a result of

weathering. Over the time some investigations have shown that angular particles, rough surface of artificial sand influences the workability and finish ability in fresh concrete. The artificial sand have to satisfy the technical requisites such as workability, strength and durability of concrete and hence it has become necessary to study these properties in order to check the suitability and appropriate replacement level of artificial sand in comparison with the natural sand for producing concretes in an economical way [3]

II. RESEARCH METHODOLOGY

Construction of durable concrete structures requires skilled labor for placing and compacting concrete. Therefore, there is need to render the durability of the concrete structures to be independent of the quality of the construction worker. [10] 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. [1] When rock is crushed and sized in a quarry the main aim has generally been to produce coarse aggregates and road construction materials meeting certain specifications. Generally, this process has left over a proportion of excess fines of variable properties, generally finer than 5-mm size. The premixed concrete industry has for some time tried to find ways to utilise this material as a controlled replacement of natural sand. In order to do this it has been recognised that provided the material is appropriately processed and selected from suitable materials then a sand replacement can be produced to meet the highest quality concrete specification Natural sands improve workability of fine aggregate, Blending is effective in controlling some adverse properties, Ability to supply market demand [7] Another advantage when sand and aggregates are manufactured is that quarries can be kept in the near vicinity to its place of end-use, thereby shortening transport distances, followed by less pollution and increased employment opportunities for the locals. It is anticipated that in the future aggregate production from crushed rock will increase and production from natural sand and gravel deposits will decrease. [6]

III. EXPERIMENTAL STUDY

3.1 Test Material

3.1.1 Cement

Ordinary Portland Cement (OPC) Ultratech – 53 grade confirmng to be 12269-1987 was used. The physical properties are shown in Table 1.

No	Property	Value
1	Fineness m^2/Kg	225
2	Initial setting time (Min)	30
3	Final setting time(Min)	600
4	Soundness (mm)	10
5	**Compressive strength (MPA)**	
	a) 3 days	27
	b) 7 days	37
	c) 27 days	53

Table1. Physical Properties of Cement

3.1.2 Fine Aggregate

Natural sand obtained from the river and normally available in the market was used. The artificial sand obtained from local crusher was used. The sieve analysis details are given in table 2. The physical properties of natural and artificial sands are listed in table 3. Both types of fine aggregates are confirming to zone II of IS 383-1970.

IS Sieve Size	Percentage Of Passing	
	Natural sand	Artificial sand
4.75	91.5	65.86
2.36	80.1	25.86
1.18	48.7	7.98
600 µ	28.75	5.66
300 µ	3.85	3.54
150 µ	0.4	0
F.M	3.46	4.91

Table2. Sieve Analysis of Fine Aggregate

Sr. No.	Property	Natural Sand	Artificial Sand
1	Particle Shape, Size	Round, 4.75mm down	Angular, 4.75mm down
2	Fineness modulus	3.46	4.91
3	Specific Gravity	2.576	2.730
4	Bulk Density	1793 kg/m^3	1865 kg/m^3
5	Surface Moisture	Nil	Nil

Table3. Physical Properties of Fine Aggregate

3.1.3 Coarse Aggregate

Crushed natural rock stone aggregate of nominal size up to 12.5 mm and aggregate passing 10 mm were used. The aggregates are proportioned by trial in the mixes. The physical properties of these coarse aggregates are listed in table5. The sieve analysis details of 12.5 mm coarse aggregate are shown in table4.

IS Sieve Size	Percentage Passing
16mm	98.56
12.5mm	72.24
4.75mm	23.68
2.36mm	0.18
1.18mm	0.08
600 µ	-
300 µ	-
150 µ	-
F.M	7.05

Table4. Sieve Analysis of Coarse Aggregate

Sr. No.	Property	Coarse Aggregate
1	Particle Shape, Size	Angular, 20mm down
2	Fineness modulus	6.87
3	Specific Gravity	2.603
4	Water absorption	1.14%
5	Bulk Density	1585 kg/m^3
6	Surface Moisture	Nil

Table5. Physical Properties of Coarse Aggregate

3.1.4 Superplasticizer

A High Performance Superplasticiser mainly composed of acrylic acid and water, making it eco friendly.

Sr No		
1	Visual Appearance	Pale Brown Viscous Liquid
2	(23ºC) Density	1.09±0.02
3	pH (23ºC)	Acidity(1:10) 6+ 0.5
4	(%) Solid Content	40.0±2.0
5	(0˚C,24hours) Stability	No Crystallization

Table6. Properties of FXP-40

3.2 Concrete Mix Design

Concrete mixes were designed in accordance with IS 10262-1982 and IS 456-2000 by assuming good degree of quality control and moderate exposure conditions and EFNARC 2002 Guidelines. The mixes are designed for M25 concret. For comparison of behavior of natural and artificial sand, the natural sand was sieved and used in the same proportion as the percentages of fractions observed in artificial sand. All other Ingredients of concrete i.e. cement, coarse aggregate, water cement ratio were kept same. To achieve desired workability super plasticizer was used as admixture in the percentage of cement weight. The adopted mixes proportions by weight batching method are summarized in table7.

Materials	Natural Sand CC	Natural Sand SCC	Artificial Sand SCC
Cement	438.44	580	580
Natural Sand	535	1158.85	-
Artificial Sand	-	-	1158.85
Coarse Aggregate	1137.76	948.15	948.15
Water	197.3	170	170
Superplasticizer	-	2%	2%
w/c Ratio	0.45	0.293	0.293
Cement/Aggregate Ratio	1:3.81	1:3.63	1:3.63

Table7. Concrete Mix Proportions

3.3 Specimen Details

There were two series. Conventional concrete with fine aggregate as natural sand and self compacting concrete with fine aggregate as artificial sand and each series comprised of three beams. For each series three beams (150mm x 150mm x 1000mm), three cubes (150 mm x 150 mm x 150 mm) and three cylinders (150 mm diameter and 300 mm height) were cast as control specimens. Specimens were cured for 7 days.

Fig.1 Artificial Sand Concrete Sample

3.4 Testing

Testing was carried out on 3 beams of both series for flexure. For flexural strength beams were simply supported on constant effective span of 900 mm under two point concentrated symmetrical loads for both series. All the beams were having constant overall span and width of 1000 mm and 150 mm respectively.

Fig.2 Flexural Test on Beam

Fig.3 Compressive Test on Cube

Fig.4 Split Tensile Test on Cylinder

The beams were kept on universal testing machine. The beams were tested under gradually applied two point loading on Universal Testing machine (UTM) as shown in Fig. 1 for flexural strength. Ultimate load and modes of failure of beam were noted. Compressive strength and Split tensile strength are carried out on cubes and cylinders respectively, tested under compression testing machine.

3.5 Results

Compressive Strength of Concrete

Grade of Concrete	Avg. 7 days Strength in Mpa		
	Natural Sand CC	Natural Sand SCC	Artificial Sand SCC
M25	35.51	38.37	43.55

Table8.

Split Tensile Strength of Concrete

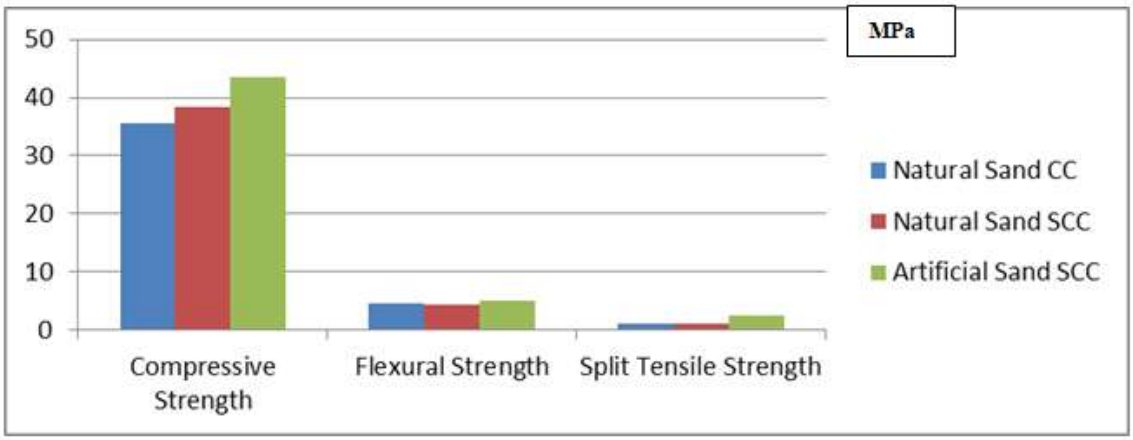
Grade of Concrete	Avg. 7 days Strength in MPa		
	Natural Sand CC	Natural Sand SCC	Artificial Sand SCC
M25	1.008	1.128	2.479

Table9.

Flexural Strength of Concrete

Grade of Concrete	Avg. 7 days Strength in MPa		
	Natural Sand CC	Natural Sand SCC	Artificial Sand SCC
M25	4.64	4.31	5.04

Table10.



Graph-1. Tests Results

IV. CONCLUSION

1. SCC with 100% Natural Sand Concrete is more workability than SCC with 100% Artificial Sand.
2. Fresh properties of SCC with Natural Sand gives better result than SCC with Artificial Sand.
3. Artificial sand SCC requires extra dose of superplasticizer than River sand SCC for similar workability.
4. Compressive strength of artificial sand SCC is more than River sand SCC.
5. Flexural strength of artificial sand SCC is more than River sand SCC.
6. Split tensile strength of artificial sand SCC is more than River sand SCC.
7. From the result it is observed that as that 100% replacement with Artifial sand is possible.

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