Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 12, December-2019

Shear Strength of Crushed Sand Self Compacting Concrete

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***Abstract*:- Fine Aggregate is one of the important ingredients of 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 leads use of crushed sand as an alternative to river sand, due to angular shape and rough texture it gives better bond strength. Compaction of normal concrete is impossible at the place of dense reinforcement where needle vibrator can not reach, at that place Self Compacting Concrete is effective to reach at every corner of formwork, and get compact by its self weight. In design of structures, shear strength of concrete is very important for calculating the quantity of shear reinforcement. Shear strength of concrete depends upon Compressive strength. In this present work an attempt is made to study the shear strength of River Sand Self Compacting Concrete with varying the percentage of shear reinforcement by 0 %, 0.25 % and 0.50 % at shear plane of Push-off specimen. Load-deflections variations of SCC with River sand and SCC with Crushed sand are also studied. For compressive and shear test of 100 mm ×100mm cube and 150 mm ×150 mm × 450 mm push-off specimen were used. In this experimental study it is observed that the shear strength of CSSCC becomes more than RSSCC at same w/c ratio.**

Keywords-Self-Compacting Concrete, Crushed sand, River sand, Fly ash, Shear strength, Compressive strength, Shear reinforcement etc.

I. INTRODUCTION

Self compacting concrete (SCC) was first developed in 1988, to achive durable concrete structures. The creation of durable concrete structures requires adequate compaction by skilled workers. However the gradual reduction in the number of skilled workers in Japan construction industries has led to reduction in the quality of construction work. The necessity of SCC was praposed by Okamura in 1986. Studies to develope SCC including a fundamental study on the warkability of concrete have been carried out by Ozawa in 1989.

Currently India has taken a major initiatives on developing the infrastructure such as express highways, power project and industrial structures etc. to meet the requirements of globalization, in the construction of buildings and other structures concrete plays the rightfull role, but use of large quantity of concrete, has become highly expensive and scarce. In the backdrop of such a fleak atmosphear, there is large demand for alternative materials from industrial waste. In concrete sand is a non-excludable material, but natural sand is expensive due to the excessive cost of transportation from natural resources. Also government restrict to draw sand from river by considering enviornmental problems. As, these constraints make the availability and use of river sand less attractive, a substitute or alternative product to river sand need to be found out.

In such a situation the Crushed sand can be an economic alternative to the river sand. Crushed sand can be defined as residue tailing or other non-valuable waste material after the extraction and processing of rocks to form coarse particle greather than 4.75 mm. The particle shape of crushed sand is more angular with a rougher surface texture, that why it can be gives bettor bonding, so strength of concrete get increases than that of natural sand. problems of durability of concrete and non availibility of river sand,one solution on that problems is Self Compacting Concrete with crushed sand.

II. EXPERIMENTAL PROGRAM

SCC mixes with w/c of 0.35, 0.41 and 0.47 using river sand and crushed sand. Fly ash content of 25 %, 29 % and 33 % was consider for RSSCC and CSSCC with w/c 0.35, 0.41 and 0.47 respectively. For each mix cubes of 100 × 100 ×100mm and shear specimen of 150 ×150 × 150 mm were cast. Percentage of shear reinforcement was 0 %, 0.25 % and 0.50 % for each mix.

III. MATERIALS

3.1 Cement

The cement used in this experimental work is “53 grade Ordinary Portland Cement”. Properties of cement are tested as per IS 12269 – 1987 [33]. Test results are presented in Table 1.

3.2 Aggregates

Natural sand from Wardha river and Crushed sand from locally available Vertical Shaft input (VSI) crusher is used. Various tests such as specific gravity, water absorption, moisture content, sieve analysis etc. have been conducted as per IS 2386. The test results are presented in Table (2) and (3). Crushed well graded aggregate black trap basalt of size 10mm was used, and confirming the requirement of IS 383-1970 as coarse aggregate.

3.3 Water

Potable laboratory tab water was used for mixing of SCC.

3.4 Super Plasticizer

Poly-carboxylate ether based Super plasticizer Sika ViscoCrete 10R, Brownish color is used as high range water reducing admixture in the experimental work. They satisfy the requirement of IS 9103- 1999 (Amended 2003).

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Table 1: Properties of Cement

Properties	Results
Fineness	2.9 %
Specific Gravity	3.15
Standard Consistency	30 %
Setting Time a) Initial b) Final	 110 (min) 248 (min)
Soundness	3.0 (mm)

Table 2: Physical Properties of Aggregates

Properties	Results		
	F. A. (River)	F. A. (Crushed)	C. A.
Particle Shape	Rounded	Cubical	Angular
Particle Size (mm)	4.75	4.75	10
Fineness Modulus	2.683	2.873	6.0
Specific Gravity	2.63	2.88	2.6
Silt /Dust Content	3.3 %	8.6 %	Nil
Surface Moisture	Nil	Nil	Nil
Water absorption	1.43 %	1.94 %	2.84 %
Bulk Density	1723 kg/m^3	1810 kg/m^3	1620 kg/m^3

Table 3: Sieve Analysis of Aggregates

Sieve Size	% Passing		
	F.A. (River)	F.A. (Crushed)	C. A.
10 mm	100	100	100
4.75 mm	100	100	0.00
2.36 mm	96.3	92.2	--
1.18 mm	70.7	59.2	--
600 µ	46.6	35.7	--
300 µ	14.9	17.0	--
150 µ	3.2	8.6	--
F. M.	2.683	2.876	6.03

3.5 Viscosity Modifying Agent

Biopolymer based Viscosity Modifying Agent Sika ViscoCrete 4R, Brownish color is used as viscosity modifying admixture in the experimental work.

3.6 Fly ash

Fly Ash of Sifiya thermal power plant Amravati is used in concrete in dry powder form. Color of Fly ash is light gray.

IV. MIX PROPORTIONS OF SCC

The mix proportions was same for River Sand Self Compacting Concrete (RSSCC) and Crushed Sand Self Compacting Concrete (CSSCC), only Dosage of Admixture and VMA was changed according to workability of concretes for satisfy the Fresh properties of SCC as per EFNARC Specifications. Proportions of ingredients are given in Table - 4.

Table 4: Quantities per 1 cum of RSSCC and CSSCC

Materials	Proportion by weight (kg/m^3)		
	Mix-1	Mix-2	Mix-3
Cement	400	450	500
Fly Ash	132	130	120
F. A.	885	792	800
C. A.	81	742	800
Water	188	185	175

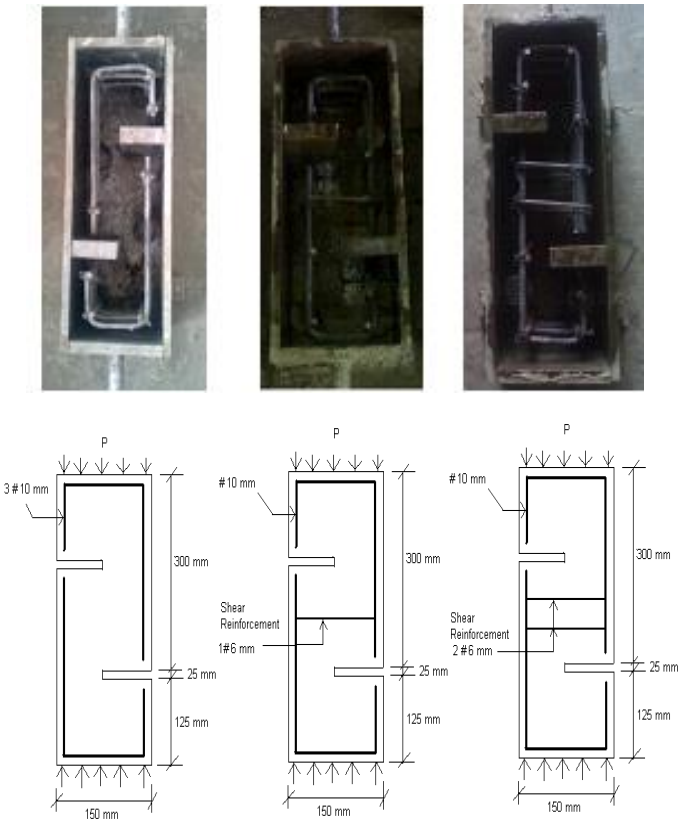

Figure 1: Reinforcement Details of 0 %, 0.25 % and 0.50 % Shear Reinforced Push-off Specimens

V. TEST PROCEDURE

Compressive test was carried out as per I.S. 516-1975. For compression test total 18 specimens of size 100 x 100 x 100 mm cube were used. For compressive test, compression testing machine of capacity 3000 kN were used. And rate of loading was kept 1.5 kN/sec. For Shear test total 54 numbers of push-off specimens were cast. After 28 days water curing test were performed using Universal Testing Machine (UTM) of capacity 40 tons, and for measuring deflection, use dial gauge of capacity 20 mm of least count 0.01mm.

VI. TEST RESULTS

Compressive and Shear strength of River Sand Self Compacting Concrete (RSSCC) and Crushed Sand Self Compacting Concrete (CSSCC) for w/c ratio 0.47, 0.41 and 0.35 are given in Table-5 and variation of shear strength with respect to Compressive strength of RSSCC and CSSCC are shown in figure-2.

Table 5: Compressive and Shear strength of RSSCC and CSSCC

W/C	Types of SCC	Comp. Strength (MPa)	Shear Strength (MPa)		
			Sr- 0 %	Sr- 0.25 %	Sr- 0.50 %
0.47	RSSCC	38.33	5.755	6.453	8.197
	CSSCC	40.00	6.278	7.150	9.592
0.41	RSSCC	47.00	6.627	7.674	9.069
	CSSCC	51.00	7.325	8.371	9.766
0.35	RSSCC	55.00	7.325	8.720	9.941
	CSSCC	62.67	7.848	9.418	10.464

Sr = Percentage of Shear Reinforcement

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 12, December-2019

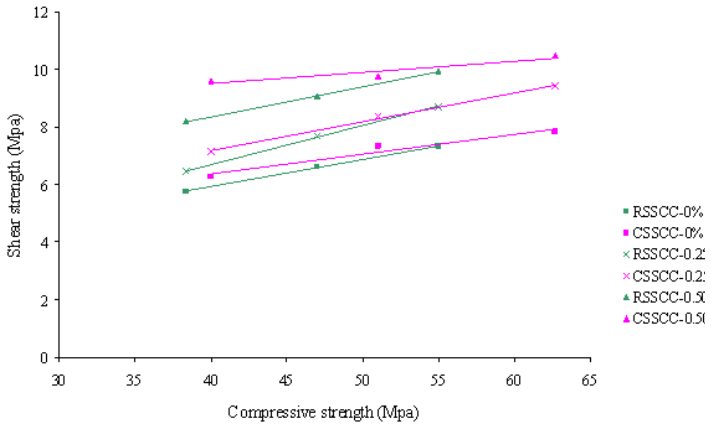

Figure 2: Variation of Shear Strength with Respect to Compressive Strength

VII. LOAD VERSES DEFLECTION

Deflection was measure at the time of testing at interval of 400 kg, and Load verses Deflections of 0 %, 0.25 % and 0.50 % shear reinforced specimens of RSSCC and CSSCC at w/c 0.47, 0.41 and 0.35 was measured.

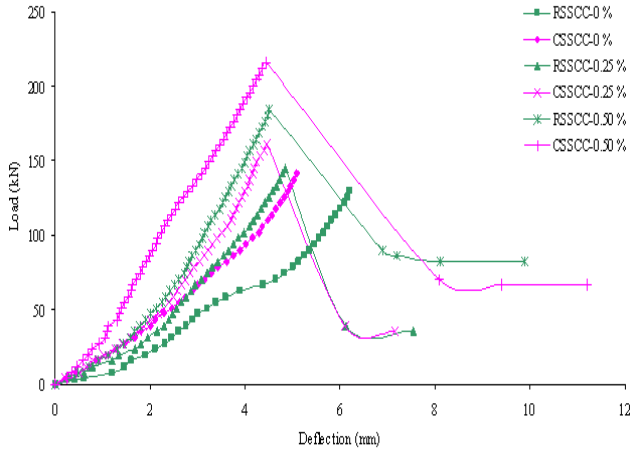

Figure 3: Variation Load-Deflection of Push-off Specimen with w/c 0.47.

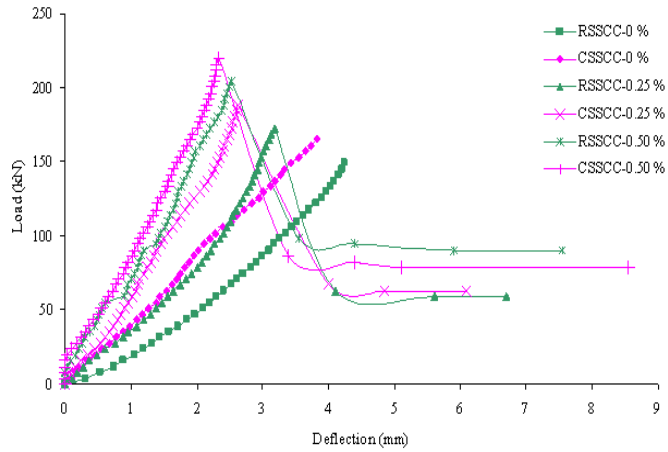

Figure 4: Variation Load-Deflection of Push-off Specimen with w/c 0.41

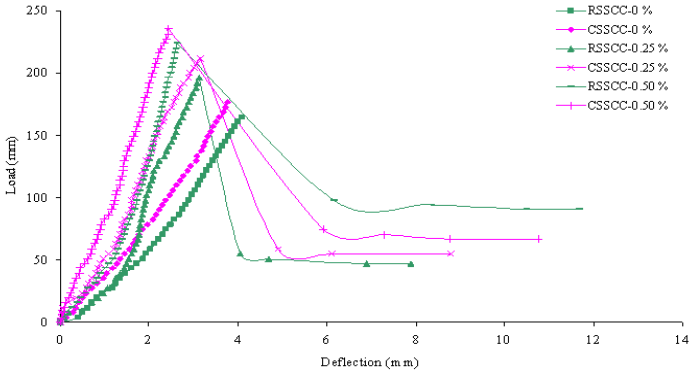

Figure 5: Variation Load-Deflection of Push-off Specimen with w/c 0.35

VIII. RESULTS AND DISCUSSION

The shear strength of CSSCC occurs more than RSSCC at same w/c ratio and percentage of shear reinforcement. Rough surface of crushed sand gives bettor interlocking with other materials in concrete, that's why RSSCC gives more strength than that of RSSCC. The figure (2) shows that the difference between shear strength of CSSCC and RSSCC get decreases when increase the compressive strength of concrete. In shear the failure of 0 % shear reinforced push-off specimen is sudden failure but the failure of 0.25 % and 0.50 % shear reinforced push-off specimen is ductile manner, after failure the load get decreases up to certain limit and after that it remain constant but deflection continuously get increase. Load carrying capacity get increase when increasing the percentage of shear reinforcement at shear plain. The shear reinforcement is across the shear plane that's why it contributes to resist the load, (increase the load resisting area) and load carrying capacity get increase.

Figure (7), (8) and (9) show that the deflections occurs in 0 % shear reinforced push-off specimen is more at minimum load, but in 0.25 % and 0.50 % shear reinforced push-off specimen deflection occur is less at same loading. The rate of gaining shear load at minimum deflection is get increases when percentage of shear reinforcement gets increase. Deflections get decreases at same loading when increasing the percentage of shear reinforcement. The area under the curve goes increases when increasing the percentage of shear reinforcement. The area under the curve of 0.50 % shear reinforced push-off specimen is more than that of 0 % and 0.25 % shear reinforced push-off specimen at same w/c. The area under the curve represents the durability of that concrete. Furthermore the area under the curve is large; the durability of that concrete is high. Shear strength of RSSCC and CSSCC at 0.25 % and 0.50 % shear reinforcement, observed to be increased by 12.121 %, 42.424 % and 13.889 %, 52.78 % than that of 0 % shear reinforcement at w/c 0.47. Shear strength of RSSCC and CSSCC at shear reinforcement 0.25 % and 0.50 % observed to be increased by 15.790 %, 36.842 % and 16.667 %, 33.324 % than 0 % shear reinforcement at w/c 0.41 respectively. Shear strength of RSSCC and CSSCC at shear reinforcement 0.25 % and 0.50 % observed to be increased by 19.048 %, 35.714 % and by 20 %, 33.333 % than that of 0 % shear reinforcement at w/c 0.35. The shear strength increases in CSSCC at 0 % shear reinforcement by 9.088 %, 10.533 %, 7.140% at w/c at W/C

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 12, December-2019

0.47, 0.41 and 0.35 respectively. In same above W/C but % age of Shear reinforcement is 0.25 %, the Shear strength increases in CSSCC by 10.801 %, 9.083 % and 8.005 %. Shear strength increases of CSSCC at 0.50 % Shear reinforcement by 17.018 %, 7.686 %, and 5.261 % at W/C 0.47, 0.41, and 0.35 respectively

IX. CONCLUSION

The Crushed sand Self compacting concrete gives more shear strength than that of River sand Self compacting concrete at same w/c ratio and percentage of shear reinforcement.

The Crushed sand self compacting concrete gives more load at minimum deflection than that of River sand self compacting concrete. The rate of increment of load carrying capacity of CSSCC is more than RSSCC.

Area under the curve is more in CSSCC than that of RSSCC.

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