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Strength and Workability of Self-Compacting Concrete made with M-Sand and Polypropylene Fibers

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Abstract- ***The modern construction industry has seen evolution of various types of concretes to fulfill special requirements without compromising strength and durability, being primary requirements of any concrete. Self-Compacting Concrete (SCC) is a widely acknowledged invention that has revolutionized Construction Technology. The concept of self-compaction was invented in Japan in late 1980s.Some of the typical characteristics of SCC are high flowability, filling & passing ability and segregation resistance. To achieve these characteristics, chemical admixtures, powdered substances and unique design methods are employed. In this study, Nan-Su method of mix design was used to get the mix proportions. Many trials were conducted with slight modifications in the mix proportion to get workable slump. M-sand also called as crushed sand was partially replaced in succession of 10, 20, 30, 40% of river sand to study plastic state and hardened properties. The increasing quantity of M-sand decreased workability, flow and passing abilities, but increased the compressive strength. It was observed that 40% replacement yielded workable mix and higher strength. Polypropylene fibers were incorporated in the optimum replacement (40%) to study their influence on compressive strength at room and elevated temperatures. Fibers were varied in volume fractions of 0.05, 0.1 and 0.15 %.***

Index Terms- **SCC, GGBS, M-sand, Polypropylene Fibers.**

I. INTRODUCTION

Self-Compacting Concrete a is a special concrete that has high flowability and segregation resistance. It can flow and fill the formwork completely without any external compaction (1). Usage of SCC isone of the ways to increase durability of structure independent of quality of construction work (2).In this experimental study, Nan-Su method of mix design was used to arrive at the mix proportions. A series of trials were also conducted with slight modifications to get desired slump flow. It is also observed that partial replacement of river sand by M-sand reduces workability and increases compressive strength (3).In the present study, natural river sand was partially replaced by M-sand (10%, 20%, 30%, 40%). Polypropylene fibers were added in the mix and were varied in volume fraction of 0.05%, 0.1% and 0.15% of concrete. Polypropylene fibers are normally used as temperature and shrinkage reinforcement. Typical properties of polypropylene fibers are density = 0.90 g/cc, Tensile strength = 550 to 690 MPa, Modulus of elasticity=3.4 GPa (4).

II. MATERIALS AND EXPERIMENTATION

- Cement: In this experimental work OPC 43 grade with specific gravity 3.15 was used confirming to (IS: 8112: 2013)
- Fine aggregates: Natural river sand was procured from a local source. Sieve analysis showed that it belonged to Zone II. The specific gravity of sand was 2.65. The water absorption and moisture content of the sample were 4.38 % and 2.25 % respectively. All the tests were conducted in accordance with (IS: 383:1970).
- M-sand: It was obtained from local source. It belonged to zone II. Specific gravity was found to be 2.72. Water absorption was 5%.All the testes were in accordance with (IS: 383: 1970)
- Coarse Aggregates: Locally available 20mm down sized aggregates were used in this experimental work. The specific gravity was 2.78. Water absorption of coarse aggregates was 0.5%. All the tests were conducted in accordance with (IS: 383:1970).
- Mineral admixture: In this experimental work Ground Granulated Blast Furnace Slag (GGBS) was used as filler material. Specific gravity of GGBS was 2.88.
- Water: Potable tap water was used for experimental and curing purpose.
- Super plasticizer: Conplast SP430 which is readily available was used in this experimental study.
- Polypropylene fibers: Virgin polypropylene fibers of company Recron 3S were used in this study. The thickness and length were 25 micron and 12 mm respectively.

In this experimental work SCC of M 30 Grade has been used.Nan-Su method of mix design was used to get mix proportion. A series of trails were conducted to get required workability characteristics.

Table 1: **Mix Proportion of SCC**

Particulars	Quantity(Kg/m^3)
Powder(Cement+GGBS)	440
F.A	980
C.A	750
Water	198
Superplasticizer	6.6

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Regular river sand which has become a scarcity nowadays was partially replaced by M-sand as an alternative in the succession of 10%, 20%, 30%, and 40%. P olypropylene fibers were added to concrete in which 40% replacement of river sand was made with M-sand. Fibers were added in volume fractions of 0.05, 0.1 and 0.15% of concrete.Cube specimens of dimension 150 mm were cast and tested at the end of 7 and 28 days.

TESTING

Various tests conducted on fresh SCC were a) Slump Flow Test b) V-Funnel Test c) U- Box Test d) L- Box Test. These tests were conducted to determine Workability, Filling & Passing abilities. Compressive strength test was conducted on 7 and 28 day cured concrete specimens to determine strength.

III. RESULTS AND DISCUSSION

A. Fresh Properties

Influence of increasing percentage of M-sand on workability were determined. The results are tabulated in Table 2.

Table 2: Workability parameters for various percentage replacement of river sand by M-sand

Test	Reference Mix	Percentage Replacement of Natural Sand by M-sand (%)				EFNARC Limit
	0%	10%	20%	30%	40%	
Slump flow (mm)	690	680	665	640	620	600-800
V-funnel (sec)	6	7	9	12	14	6-12
U-Box (mm)	22	23	25	29	31	0-30
L-Box	0.92	0.90	0.88	0.80	0.78	0.8-1

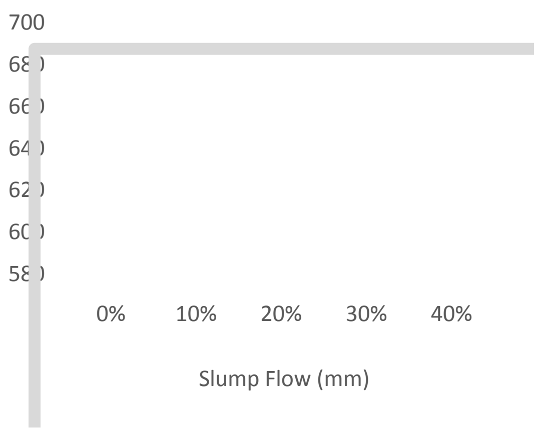

Fig 1: Slump flow variation for percentage replacement of river sand by M-sand

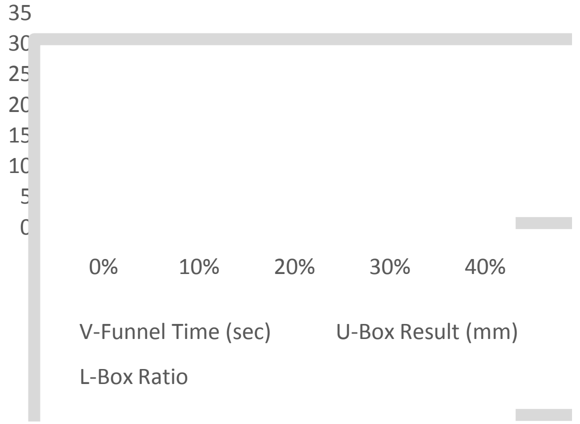

Fig 2: Variation of workability parameters (V-Funnel, U-Box, L-Box) for percentage replacement of river sand by M-sand.

It is observed from Table 2 that all the plastic state properties namely slump flow, filling & passing abilities of SCC continually reduced with increasing percentage replacement of natural sand by M-sand. This may be due to the presence of finer segments in M-sand which possess rock forming elements such as alumina, silica etc. These segments make the mix cohesive and restrict the flow of concrete which decreases the workability, and also, due to its fineness, M-sand has more surface area which demands higher water quantity compared to natural sand.

B. *Compressive Strength*

Table 4: Compressive Strength for percentage replacement of natural sand by M-sand

Percentage Replacement by M-Sand (%)	Compressive Strength (N/mm^2)	
	7days	28days
0(reference mix)	24	38.66
10	24.44	39.55
20	24.44	40
30	25.33	41.33
40	26.66	41.77

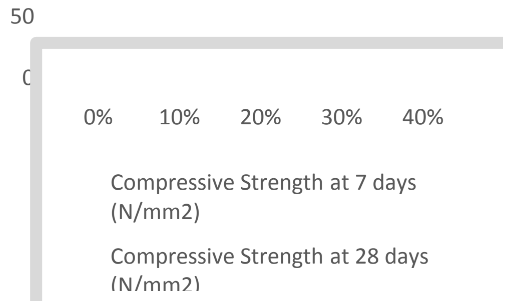

Fig 3: Variation of Compressive strength for percentage replacement of river sand by M-sand.

It is evident from Table 4 that Compressive strength increased with increase in the percentage replacement of river sand by M-sand. Maximum strength was obtained for 40% replacement. The increase in strength may be due to angular shape of M-sand particles and better interlocking. 30% replacement gives high strength with satisfying workability requirements as per EFNARC.

Table 5: Workability parameters for percentage variation of Polypropylene fibers

Test	Reference Mix	Volume Fraction of Polypropylene Fibers			EFNARC Limit
	0%	0.05%	0.10%	0.15%	
Slump flow (mm)	620	610	600	565	600-800
V-funnel (sec)	14	16	20	26	6-12
U-Box (mm)	31	35	38	43	0-30
L-Box	0.78	0.75	0.71	0.65	0.8-1

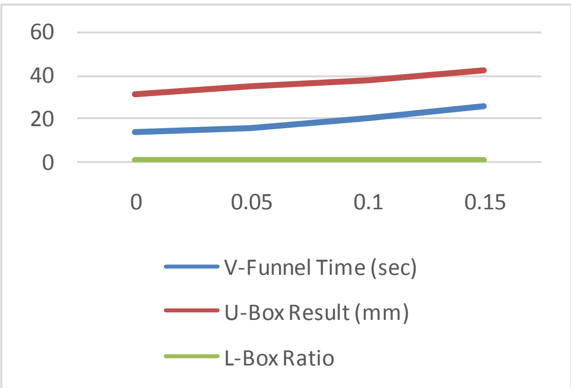

Fig 4. Variation of workability parameters against percentage variation of Polypropylene fibers

It is evident from Table 5 that workability, filling & passing abilities have shown reduction with increase in Polypropylene fiber content.

Table 6: Compressive strength for percentage variation of polypropylene fibers

Percentage of Polypropylene Fibers (Volume Fraction)	Compressive Strength (N/mm^2)
	28days
0	41.77
0.05	42.22
0.1	41.33
0.15	41.33

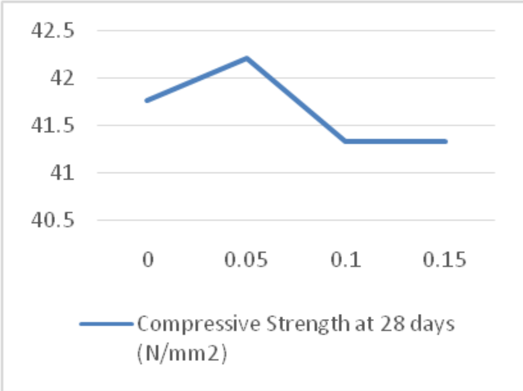

Fig 4: Variation of Compressive strength for percentage variation of polypropylene fibers

From Table 6 it is observed that the inclusion of polypropylene fibers in the concrete has no significant effect on Compressive strength, Marginal increase of 1% was observed for 0.05% fiber volume fraction.

IV. CONCLUSIONS

It was observed that the workability reduced continually with increase in M-sand content in SCC.

It has been observed that Compressive strength increased due to increment in percentage replacement of river sand by M-sand. An increase of 6.90%was observed for 30%replacement of river sand by M-sand for a given mix proportion.

It was observed that workability reduced with addition of Polypropylene fibers. Marginal increase of 1% in Compressive strength was observed for 0.05% fiber volume fraction.

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REFERENCES

[1] Nan-Su, Kung-Chung Hsu and His-Wen Chai “A simple mix design method for self-compacting concrete” Cement and Concrete Technology, Cement and research, 2001, Vol.31, No.12,pp.1799-1807.

[2] Hajime Okamura and Masahiro Ouchi“Self-Compacting Concrete” Journal of Advanced Concrete Technology, 2003, Vol.1, No 1, pp. 5-15.

[3] B.K.Tuljaramsa and V.D.Gundakalle “A Study on Strength Properties of SCC with M-sand”, proceeding of NCRIET-2015 & Indian J. Sci. Res. 2015, Vol.12, No.1, pp. 370-374.

[4] iad Bayasi and Mubarak Al Dhaheri “Effect of Exposure to Elevated Temperature on Polypropylene Fiber Reinforced

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 7, Issue 3, September 2017

Concrete" ACI Materials Journal, 2002, Vol.99, No.1, pp.22-26.

[5] FNARC February 2002: "Specification and Guidelines for Self-Compacting Concrete".

[6] Bureau of Indian Standard "Method of Test for Aggregates for Concrete" IS 2386, Part III, 1963.

[7] Bureau of Indian Standard "Methods of Tests for Strength of Concrete" IS 516:1959.

[8] Bureau of Indian Standard "Plain and Reinforced Concrete-Code of Practice" IS 456:2000.

[9] Bureau of Indian Standard "Specification for Coarse and Fine Aggregates from Natural Sources for Concrete" IS 383:1970.

[10] Bureau of Indian Standard "Specification for ordinary Portland Cement 43 Grade" IS 8112:2013.

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