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Experimental Investigation Of Polypropylene Fibre Reinforced Self Compacting Concrete With Quarry Dust

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ABSTRACT

The materials such as ordinary Portland cement, river sand, quarry dust, coarse aggregate, fly ash, silica fume, Super plasticizer, Polypropylene fiber and locally available potable water were used in the present work. All these materials were tested using the relevant standard methods prescribed by Bureau of Indian standards. The SCC-QD and SCC-RS binary as well as ternary blended mixes are tested for filling ability, passing ability and segregation resistance as per the guidelines prescribed by EFNARC. Further, the mechanical properties of hardened SCC such as compressive strength, split tensile strength and flexural strength have also been evaluated. Also, the durability characteristics of SCC-QD mixes such as sorptivity, chloride resistance, sulphate resistance, and acid resistance have been studied. It is evident that 20% of FA or 15% of SF is the optimum percentage to replace the cement to impart maximum strength to SCC-RS mixes. However, in the case of SCC-QD mixes, 30% of FA or 5% of SF is the optimum percentage to replace the cement to provide maximum strength to concrete. Among the binary blended SCC, the QD-FA30 mix has exhibited highest strength of 58 MPa, followed RS-SF15 mix with 52 MPa. In the case of ternary blended mixes , the QD-SF15-FA10 mix yielded maximum strength of 50 MPa. Further, all SCC-QD mixes exhibited remarkably low sorptivity and thereby higher durability than control mix. Also, among all the SCC-QD mixes, binary blended SCC-QD-SF mixes have demonstrated relatively low sorptivity and higher durability than other mixes. It is followed by ternary blended SCC – QD and binary belnded SCC-QD-FA.

Key words: Polypropylene fiber; sorptivity; , silica fume.

1.0 INTRODUCTION

Ordinary Portland Cement (OPC) is the most commonly used material as a binder for making concrete. The fine aggregate is an essential component of concrete. River courses and flood plains are the only sources of fine aggregate to use in construction industry. The inherent qualities of sand in terms of durability and sorting made it as most suitable material as fine aggregate (Kondolf et al., 2002). The ever growing demand for concrete has increased demand for sand resulting in fast depletion of natural sand resources. Further, consistent supply of river sand cannot be guaranteed. Several attempts were made for the past three decades to assess the potential of quarry dust and its effect on characteristics of both fresh and hardened concrete. It is a by- product from the stone crushers and available abundantly in many areas at low cost. It is generally considered to be a refuse material, and thereby causes disposal problem. If it is consumed as fine aggregate in concrete, certainly address theenvironmental problems (Raman et al 2007). Moreover, the incorporation of quarry dust offsets the cost of production of concrete. Hence, effect usage of quarry dust as a ine aggregate in concrete, will convert the refuse as a valuable resource for making concrete (Illangovan, et.al, 2008 and Nataraja, et.al, 2001). Presently, quarry dust is being used for various areas of construction industry and also to produce different types of building materials (Radhikesh et.al, 2010).The utilization of well graded, fines free quarry dust was accepted as fine aggregate in the western countries for the past few years (Manasseh Joel, 2010; Hudson, 1997).

The plain cement concrete is inherently brittle and weak in tension. The concrete tensile strength has been improved with the embedded reinforcement. Incorporation of fibre in concrete is another possible way to enhance tensile strength of concrete. Asbestos fibres have been used in concrete as early as beginning of nineteenth century. The concept of fibre reinforced concrete came into limelight in 1950s. Later, it has been realized the need for an alternative to asbestos due to its associated health risks. Subsequently, various types of fibres such as steel, carbon, glass and synthetic fibres (polypropylene fibres) have become popular to produce the fibre reinforced concrete composites during 1960s.

It has been reported the distribution of more fibre in tension zone of the beam has ubstantially increased ultimate strength than the beam with uniform distribution (Sri Ravindra and Tam, 1984). It was reported that beam with hybrid fibre has demonstrated remarkably higher flexural performance in post-cracking zone than beam with mono fibre (Guodong and Hannant, 1992; Yao and Li, 2003; banthia and Gupta, 2004; Eswari, et.al, 2006). Later, Stroeven (2000). Vengala et a1. (2017) reported that incorporation of fine fly ash has improved compressive strength of SCC by about 38% at the age of 28 days. However, volume of paste in SCC must be in the range of 0.43 and 0.45 to impart maximum compressive strength.

The present work entitled “Experimental and numerical investigation of polypropylene fiber reinforced self-compacting concrete with quarry dust as fine aggregate To arrive at the optimum mix proportion for making the polypropylene fiber reinforced self-compacting concrete made with quarry dust as fine aggregate and study the properties of fresh self-compacting concrete such filling ability, passing ability and segregation resistance of polypropylene fibre reinforced self-compacting concrete.

2.0 MATERIALS AND METHODS

The materials such as cement, fly ash, silica fume, river sand, quarry dust, coarse aggregate, water, polypropylene fibre and super plasticizer were used in this work. The mix proportions, preparation of test specimens and methodology adopted for evaluating the workability, strength, durability, structural performance of fibre reinforced SCC incorporated with quarry dust, finite element, ANN and Regression modeling are included.

Ordinary Portland Cement (OPC) of 53 Grade, conforming to IS: 12269-1987 was used in the present work. Fly ash is an industrial by-product, originating due to combustion of pulverized coal in thermal power plant. It is basically a refuse material obtained from Electro Static Precipitator (ESP).It is having less than 10% lime (CaO). The Class F fly ash having specific gravity of 2.27, obtained from Ennore thermal power plant, Chennai to use in the present work. Locally available coarse aggregate of maximum size 12.5 mm conforming to well grade aggregate as per IS: 383-1970 was chosen for the present investigation.

It is essential to use chemical admixtures to impart required workability to SCC. The admixtures used for SCC are mainly superplasticisers and viscosity modifying agents. The superplasticiser improves the workability of mix without addition of water, whereas, viscosity modifying agents helps to reduce segregation of SCC mix. The Modified polycarboxylic ether based superplasticiser (Con Xl – PCE (VMA blended)) was used in this study. It is a product of Don Chemicals Ltd having a specific gravity of 1.222. This superplasticizer increases workability, cohesion and aids pumping by reducing friction between the particles.

2.1 MIX PROPORTIONING OF SCC

In this work, the following mix codes are used to understand the mix composition. The capital letters in the mix code such as FA and SF designates fly ash and silica fume respectively. Also, suffix numeral indicates the amount of mineral admixtures in the mix. Further, the letter RS, QD and PPF in the mix represent river sand, quarry dust and polypropylene fibre respectively. Moreover, mix code with letter CM is taken as control mix. The design mix was obtained using guidelines prescribed by ENARC. Several trials were made by varying the quantities of coarse aggregate, fine aggregate, fly ash, silica fume and super plasticizer to develop a M 30 grade SCC mix. Based on the available literature, 0.1% of polypropylene fibre was used in the present work. The details of SCC mixes incorporated with river sand and quarry dust as fine aggregate are furnished in Table 1. The durability studies were carried on only SCC mixes with 100% quarry dust as fine aggregate.

Table 1 Mix properties of concrete.

Mix code	Cement (Kg/m^3)	Fly ash (Kg/m^3)	SF (Kg/m^3)	F.A (Kg/m^3)	C.A (Kg/m^3)	Water (Kg/m^3)	S.P (Kg/m^3)
CM(RS)	536	---	---	836	772	192	4.82
RS-FA10	472	52	---	836	772	189	4.72
RS-FA20	411	103	---	836	772	185	4.62
RS-FA30	352	151	---	836	772	181	4.52
RS-SF5	506	---	27	836	772	192	4.80
RS-SF10	477	---	53	836	772	191	4.70
RS-SF15	448	---	79	836	772	190	4.74
RS-SF20	419	---	105	836	772	188	4.71
RS-SF5-FA30	325	150	25	836	772	180	4.50
RS-F10-FA20	355	102	51	836	772	183	4.57
RS-F15-FA10	378	50	76	836	772	181	4.54

2.2 MECHANICAL PROPERTIES OF HARDENED SCC

The mechanical properties of SCC such as compressive strength has been evaluated in the present work. The compressive strength of SCC was determined using concrete cubes having 150 mm dimensions as per IS: 516-1959. Three specimens foreach mix were tested at the age of 3, 7 and 28 days. Totally, 198 cube shave been tested using compression testing machine (Fig. 3.8). All the precautions prescribed by specified by IS: 516-1959 have been followed while carrying out the test. The load at which the specimen failed has been recorded.

3.0 RESULTS AND DISCUSSIONS

Compressive Strength Totally, 198 cubes have been tested for compressive strength of SCC-RS and SCC-QD binary and ternary blended concrete and the results are furnished in Table2.

Table 2 Compressive Strength of SCC- RS Blended Concrete.

S. No	Mix code	Compressive Strength (MPa)		
		3 days	7 days	28days
1	CM (RS)	18	35	40
2	RS-FA10	22	36	43.2
3	RS-FA20	25	38	45.5
4	RS-FA30	17	34	42.6
5	RS-SF5	24	37	43.2
6	RS-SF10	26	39	46.3
7	RS-SF15	27	42	52.2
8	RS-SF20	16	32	36.8
9	RS-SF5-FA30	18	28	34
10	RS-SF10-FA20	21	36	44.5
11	RS-SF15-FA10	23	37	48.2

It is evident from the results that 20% of FA or 15% of SF are the optimum percentage to replace the cement to impart maximum compressive strength to SCC- RS blended concrete (fig.1). It is almost in conformity with the results reported by Mohammed (2011). However, it has been made clear that the SCC with 30% of Fly ash has yielded maximum compressive strength.

Among all SCC-RS mixes, RS-SF15 binary blended mix has exhibited maximum compressive strength of 52.2 MPa at the age of 28 days. It is about 35.5% more than control mix. But, the RS-FA20 mix has yielded only 45.5 MPa compressive strength. It is just 13.5% higher than control mix. However, the SCC-RS-SF15-FA10 strength than QD-SF binary blended concrete. At the same time, it has yielded 19 % higher compressive strength than the control mix.

Further, it is evident from the fig.2 that the QD-FA binary blended concrete mixes have shown remarkably higher compressive strength than the RS-FA binary blended concrete mixes. The compressive strength of QD-FA binary blended mixes is 5.32 to 36.15% higher than RS-FA binary blended mixes depending on the fly ash present in the mix. But, all the QD-SF binary blended mixes have exhibited remarkably less compressive strength than RS-SF binary blended mixes. It varies from 6.94 to 30 % depending on the SF content present in the mix. However, the compressive strength of QD ternary blended mixes is almost same or very marginally higher than RS ternary blended SCC mixes

Table 3: Compressive Strength of SCC- QD Blended Concrete.

S. No	Mix code	Compressive Strength (MPa)		
		3 days	7 days	28 days
1	CM (QD)	19.0	25.5	42.00
2	QD -FA10	23.5	28.0	45.50
3	QD- FA20	21.5	28.5	48.30
4	QD -FA30	22.0	29.0	58.00
5	QD- SF5	19.5	26.0	40.20
6	QD- SF10	22.2	28.3	38.20
7	QD- SF15	25.0	27.2	36.00
8	QD- SF20	25.8	26.2	30.00
9	QD- SF5-FA30	20.0	28.2	35.00
10	QD- SF10-FA20	25.0	29.0	45.00
11	QD- SF15-FA10	30.0	34.8	50.00

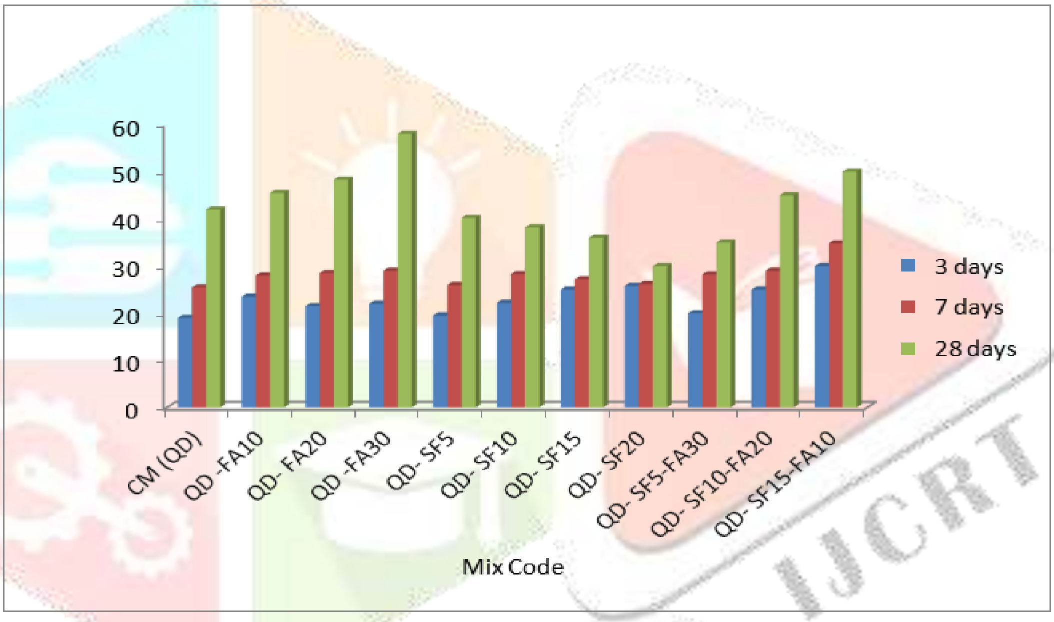

Fig. 1: The Compressive Strength of SCC-QD Blended Concrete.

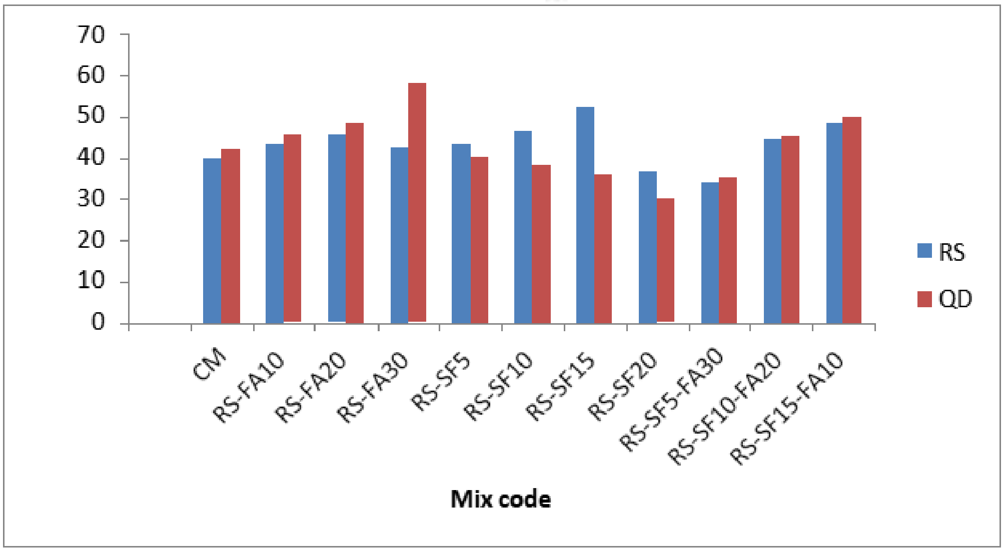

Fig. 2 The Compressive Strength of SCC-RS and SCC-QD mixes.

CONCLUSIONS:

All the SCC mixes satisfy the workability as specified by EFNARC. Also, all SCC-RS blended mixes have shown relatively higher workability than SCC- QD mixes. The more fines present in quarry dust reduced the workability of SCC-QD mixes. In addition, SCC-FA binary blended and SCC -FA-SF ternary mixes have demonstrated higher workability than control mixes. Also, increase in FA content enhanced the workability of the mixes due to its low specific surface area and spherical shape. However, SCC-SF binary blended mixes yielded relatively less workability than control mix and also SCC-FA mixes. It is due to very high specific surface area of SF.

REFERENCES

1. Ahsan.P and Stephen JF. Fatigue Behavior of Steel-Fiber-Reinforced Concrete Beams, Journal of Structural Engineering, 141(4), p.401- 411, 2014.

2. Amin MM, Jamaludin SB, Pa, FC, Chuen, KK. „Effects of Magnesium Sulfate Attack on Ordinary Portland Cement (OPC) Mortars"", Portugaliae Electrochimica Acta, 2008; 26,p. 235–242.

3. Anjali HJ, Urmila RK. Effect of Quarry dust and Fly ash Mix on strength properties of M40 grade Concrete, International Journal of Engineering Research and General Science May-June 2015; 3(3): Part-2.

4. Antonio FB, Gabriel OR. Analysis of Reinforced Concrete Structures using ANSYS Nonlinear Concrete Model, Computational Mechanics 1998; 13(2): 1–7.

5. Aoude H. Response of Steel Fiber-Reinforced Concrete Beams with and without Stirrups, ACI Structural Journal 2012; 109(3):359–368.

6. ASTM C1585-2013, „Standard test method for measurement of rate of absorption of water by hydraulic-cement concretes"", American Society of Testing of Materials, West Conshohocken, PA.

7. ASTM C267 (01)-2012, „Standard test methods for chemical resistance of mortars, grouts, and monolithic surfacing and polymer concretes"", American Society of Testing of Materials, West Conshohocken, PA.

8. Azad AK. Chloride diffusion in concrete and its impact on corrosion of reinforcement, Available from 2011, https://eprints.kfupm.edu.sa.

9. Bakhtiyari S, Allahverdi A, Rais-Ghasemi M, Ramezanianpour AA, Parhizkar T, Zarrabi BA. "Mix design, compressive strength and resistance to elevated temperature (500°C) of self-compacting concretes containing limestone and quartz fillers", International Journal of Civil Engineering 2011;9(3) pp.215- 222,

10. Banthia N, Gupta, R. Hybrid Fiber Reinforced Concrete (HyFRC): Fiber Synergy in High Strength Matrices, Materials and Structures 2004; 37(10):707–716.

11. Banthia N, Nandakumar N. Crack Growth Resistance of Hybrid Fiber Reinforced Cement Composites, Cement and Concrete Composites 2003; 25(1):3–9.

12. Barzin M, Li C.Y. Mechanical Properties of Hybrid Cement-Based Composites, Materials Journal 1996; 93(3):284–292.

13. Bentur A, Mindess S. Concrete Beams Reinforced with Conventional Steel Bars and Steel Fibres: Properties in Static Loading, International Journal of Cement Composites and Lightweight Concrete 1983;5(3):199–202.

14. Bhattacharya .A, Indrajit R, Julio FD. Effects of Aggregate Grading and Admixture/Filler on Self-consolidating Concrete the Open Constructing and Building Technology Journal 2008; 2:89–95.

15. Bishara A.G. Some Aspects of Dynamic Response of Rectangular Reinforced Concrete Beams, ACI Publication 1982; SP75:235–252.

16. Choubey U. Cyclic Response of Latex Modified Reinforced Concrete Beams, Journal of Structural Engineering 2006; 33(5):407–412.

17. Chowdhury S, Kadam S, Keskar SV. Impact of fine aggregate particle size on rheology and compressive strength of mortar for SCC, Indian Concrete Journal 2011; 85(4):51–59.

18. Chris H, Patrick O. Making Sense of Manufactured Sand, Newsletter Article, January 6, 2008.

19. Corradi M, Khurana R, Magarotto R. Low fines content self-compacting. 5th International RILEM Symposium of Self-Compacting Concrete 2007; 2:839– 844.

20. Desayi, P. and Krishnan, S., Equation for the stress-strain curve of concrete, ACI J., 61(1964)345-350.

21. Dhiyaneshwaran S, Ramanathan P, Basker I, Venkatasubramani R. Study on Durability Characteristics Of Self-Compacting Concrete with Fly Ash, Jordan Journal of Civil Engineering 2013;7(3):342–353.

22. Dinakar P, Babu KG, Santhanam M. Durability properties of high volume fly ash self compacting concretes. Cem Concr Compos 2008; 30(10):880–6.

23. Dumne S. M. Effect of Superplasticiser on Fresh and Hardened Properties of Self-compacting Concrete Containing Fly Ash, American Journal of Engineering Research Volume-03, pp-205-211,2014

24. Dwarakanath HV, Nagaraj TS. Deformational Behavior of Reinforced Fiber Reinforced Concrete Beams in Bending, Journal of Structural Engineering 1992; 118(10):2691–2698.

25. EFNARC. Specification and guidelines for self-compacting concrete. European Federation of Producers and Applicators of Specialist Products for Structures, 2002.