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STRENGTH PROPERTIES OF SELF COMPACTING CONCRETE WITH GLASS FIBERS AND REPLACEMENT OF FINE AGGREGATE WITH QUARRY ROCK DUST

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ABSTRACT: ***Self Compacting concrete is high – performance concrete which flow under its own weight to fill form work and self consolidates without any mechanical vibration. Such concrete can accelerate the placement, reduce the labor requirements needed for consolidation & finishing.Concrete plays major role in construction industry. It is made of coarse aggregate, fine aggregate mixed with cement and water. But River sand is high in cost and rare material. Due to increase in its usage depletion of sand deposits is occurring. Quarry Rock Dust (QRD), a by-product from crushing process during quarrying is substitute materials for the natural river sand. In general, concrete is strong in compression & weak in tension. In this research, to increase the Tensile property of Concrete, Glass Fibers are added with dosage of 1kg per m^3 of concrete. In this investigation, an attempt is made to introduce the QRD in a percentage variation and to quantify the optimum usage of QRD in replacement to Natural Sand for Fiber Reinforced Self Compacting Concrete (FRSCC). Compressive Strength & Split Tensile Strength Tests were conducted to study the Mechanical Properties of FRSCC for the replacement of Natural Sand with QRD.***

Key words: Self Compacting Concrete, Quarry rock dust, high-performance concrete, glass fibers, compressive strength, split tensile strength.

1. INTRODUCTION

Concrete plays unique position in construction industry. It is made of coarse aggregate and fine aggregate which is mixed with cement and water. Materials are at the heart of the construction industry. By the advanced construction materials, it shows the development of structures and methods. The major building construction work is of concrete.
For concrete compaction reasons are:

- Removal of entrapped air by maximum density.
- Completely used in form work and steel reinforcement.

The final structure consists not only strength but also good looking and finish. By the compaction of concrete external force be reduced then it leads to the development of Self Compacting Concrete.SCC is a high-performance concrete that can flow under its own weight to completely fill form work and self consolidates without any mechanical vibration. It was dense reinforcement maintains homogeneity without compaction. There is no change in SCC accomplished in property, strength, stability. In steel structures it is fully reinforced with self compacting property. They fill it completely in the frame work. Since last 5 years in US usage of SCC increased. Now-a-days in precast industry it takes first place. High Performance Concrete was defined as a concrete with high durability due to low water-cement ratio.

There are two main methods for making SCC which are Powder method and Admixture method. Compressive strength, Split tensile strength, Bond strength, Modulus of elasticity are the properties of SCC. The main difference between normal concrete and SCC concrete are connected to the behaviour in fresh state. Durability and creep are long-term performance of SCC. It leads to greater shrinkage values due to high sand.

Different methods has developed to verify fresh SCC. Following are the methods consists of Slump-flow test, Funnel test, U Type & Box Type tests, T50 Test, J-Ring test, Orimet test and GTM Screen Stability Test. The properties of fine aggregate greater than coarse aggregate. The paste consists of particle size <0.125. Composite material contains cement, mortar, dicrete uniformly fibres is known as Fiber Reinforced Concrete. Meshes, woven fabrics and rods are not to be discrete fibers. Fibers consists of steel fibers, glass fibers, synthetic fibers and natural fibers.

2. EXPERIMENTAL STUDY

2.1.MATERIALS

In this investigation the materials utilized were FA, QRD and coarse aggregate, glass fiber, SP, water. The sand acquire from Hundri river near Kurnool used as fine aggregate in this investigation. Our sand is confirmed to Zone-II which is passed on 4.75mm sieve & retained on 150µ sieve are used. The coarse aggregate tested for specific gravity it is 2.82, fineness modulus of coarse aggregate is 4.07. For preparation of Concrete and Curing purpose we used Potable Water. QRD brought from the premises of Vulindakonda mandal of Kurnool City. Superplasticizer CONPLAST SP 430 is used. Glass Fibers used are Cem-FIL anti-crack high dispersion glass fibers which are manufactured SAINT GOBAIN GLASSWARES PVT LTD. Glass Fibers is taken as 1Kg per m^3 of concrete.

Table: 1.1 : Properties of Quarry Rock Dust

S.NO	PROPERTY	VALUE	REQUIREMENTS AS PER IS 383
1	Fine Aggregate	QRD	-
2	Specific Gravity	2.62	2.6-2.8
3	Water Absorption	0.58%	Should not be > 1% for construction
4	Density	1650 kg/cum	-
5	Fineness Modulus	2.91	2.6-2.9

2.2.MIX PROPORTIONS

In this research work, M_{40} grade of concrete was selected. NAN-SU MIX DESIGN Method was used. The mix proportions that adopted was 1: 1.46: 1.61: 0.39.

Table: 2.2 : Table of Quantities per m^3 of Concrete Mix

Dosage of QRD	Cement	Fine Aggregate	Coarse Aggregate	Amount of QRD	Water	SP	Fly Ash
%	Kg	Kg	Kg	Kg	Lit	Lit	Kg
0	543.82	795.76	873.94	0.0	212.14	5.44	100
20	438	636.62	873.94	159.15	212.14	5.60	105
40	423	477.46	873.94	318.30	212.14	5.80	120
60	413	318.30	873.94	477.46	212.14	5.00	130
80	403	159.15	873.94	636.12	212.14	6.10	140
100	393	0.0	873.94	795.76	212.14	6.20	150

2.3.Mixing, testing, casting and curing

Mixing process was prepared. Tests has to be conducted on the Fresh Concrete to confirm it as a Self Compacting Concrete; i.e., passing ability, filling ability & segregation resistance tests. The moulds used for the concrete

cubes are made up of cast iron with dimensions of 150 mm X 150 mm X 150 mm for Compressive Strength studies. The moulds are used of size 150 mm diameter X 300 mm height for Split Tensile Strength studies. They were cured for 28 in curing pond. After completion of curing period, specimens were removed from water and sent for testing.

3. RESULTS AND DISCUSSION

This section discusses the results of fresh concrete and mechanical properties of SCC.

Table:3.1Results of fresh concrete- without fiber:

DESIGNATION	SF	TSF	VF	TVF	LB
Units / QRD %	Mm	Sec	Sec	Sec	H_2/H_1
0	780	2.1	4.2	6.3	1.0
20	754	3.3	6.2	7.1	0.98
40	726	3.7	6.8	7.7	0.92
60	688	4.1	7.4	8.8	0.90
80	662	4.6	9.8	12.1	0.88
100	630	5.8	12.8	15.4	0.82

Discussion:

For the SCC mix without Glass Fibers, with the increase of Dosage of QRD, the SCC Flow properties are decreasing to some extent. For the 100% replacement of Sand with QRD; SCC Flow properties are not achieved successful.

Table 3.2:Results of fresh concrete – with fiber:

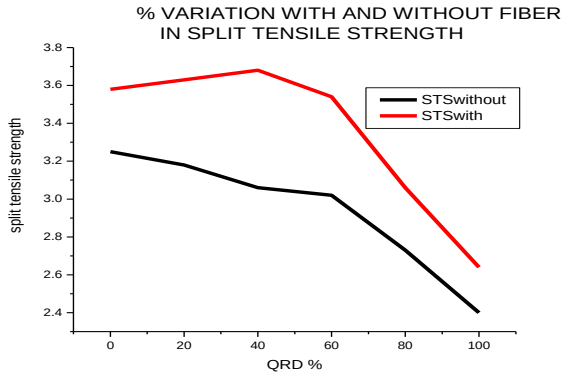
DESIGNATION	SF	TSF	VF	TVF	LB
Units / QRD %	Mm	Sec	Sec	Sec	H_2/H_1
0	768	2.4	4.2	6.4	0.98
20	740	3.5	6.8	7.6	0.94
40	702	4.2	7.2	8.6	0.90
60	664	4.9	8.1	10	0.82
80	640	5.9	10.1	12.6	0.81
100	602	6.3	12.2	16.2	0.76

Discussion: For the SCC mix with Glass Fibers i.e., FRSCC, with the increase of Dosage of QRD, the SCC Flow properties are decreasing. For 100% QRD Dosage, Slump Flow is not achieved. For the dose of upto 60% QRD; SCC Flow Properties holds good.

Table 3.3: Compressive & Split Tensile Strength Test Results:

S.NO.	DOSAGE OF QRD IN %	COMPRESSIVE STRENGTH (MPa)		SPLIT TENSILE STRENGTH	
		WITHOUT FIBER	WITH FIBER	WITHOUT FIBER	WITH FIBER
1	0	47.93	48.34	3.25	3.58
2	20	48.37	49.48	3.18	3.63
3	40	49.04	51.12	3.06	3.68
4	60	47.03	48.56	3.02	3.54
5	80	45.09	46.27	2.73	3.06
6	100	43.31	44.31	2.40	2.64

Discussion: The above table presents the strength criteria for Cube & Cylinder specimens with respective to Compressive Strength & Split Tensile Strength. It can be observed that QRD dosage was increased. The optimum replacement of Natural Sand with QRD is upto 40%; at this dose, SCC Flow properties & Strength criteria holds good.



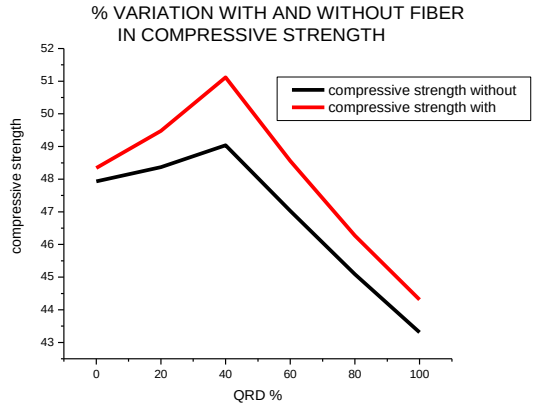
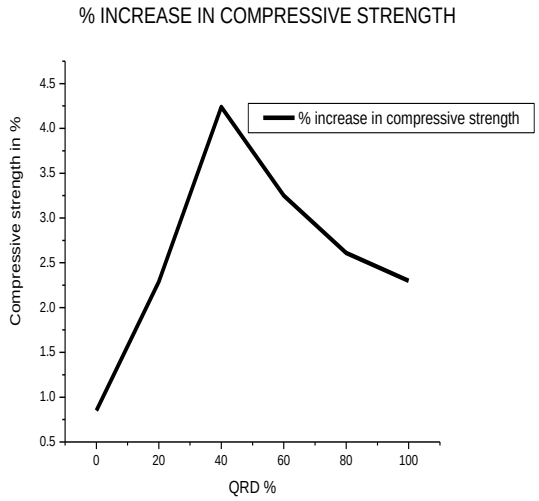
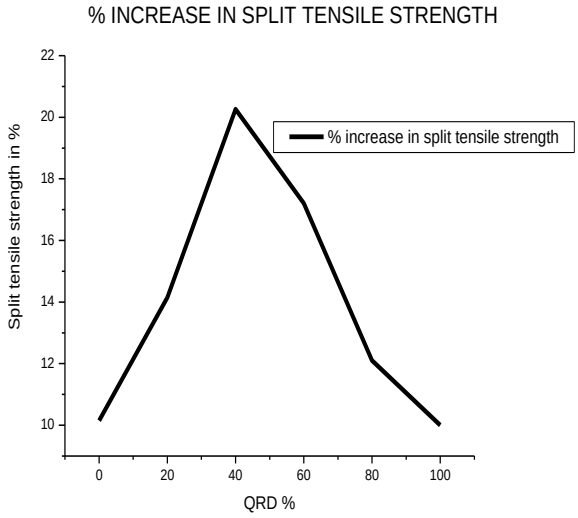


Table 3.4: %ge increase of strength with Glass Fibers:

S.NO	Dosage of QRD in %ge	%ge Increase in Compressive Strength with Fibers	%ge Increase in Split Tensile Strength with Fibers
1	0	0.85	10.15
2	20	2.29	14.15
3	40	4.24	20.26
4	60	3.25	17.21
5	80	2.61	12.10
6	100	2.30	10.00

Discussion: For every increase in QRD dose, percentage increase in strength in compression and Split Tensile Strength were calculated. From table it shows that Compressive Strength increases to maximum of about 4% & Split Tensile Strength is increased to maximum of about 20% at 40% replacement of Natural Sand with QRD. Therefore, it can be stated that; at 40% QRD dose, Strength criteria hold good.





4. CONCLUSIONS

Based on the results of this investigation, following conclusion can be obtained:

- Conventional Fine Aggregate i.e., Sand is replaced with Quarry Rock Dust and based on the test results, the optimum dose is found.
- The Replacement dosage is made at a variation of 20% interval.
- The optimum replacement of Sand is found to be 40% from the study.
- The Target Mean Strength is achieved mostly at 40% replacement of Sand with QRD in FRSCC.
- At this dose, by the use of Glass Fibers, there is a significant increase in Split Tensile Strength. Increment 20% is observed. Increment in Compressive Strength is above 3%.
- Due to presence of Glass Fibers in SCC, Strength results are more predominant compared to normal SCC mix.
- Relation between Split Tensile Strength & Compressive Strength is established.
- Failure occurs in specimens with fiber by splitting no removal of fibers in any specimens.

5. REFERENCES

- Nan Su., et al., "A simple mix design method for Self Compacting Concrete"; Journal of Cement and Concrete Research 31 (2001) pp1799 – 1807.
- M.L.V.Prasad and P.Rathish Kumar, "Comparative Study of Glass and Polypropylene Fiber Reinforced Self Compacting Concrete(FRSCC)", National Conference on Emerging Trends in Civil Engineering for Infrastructure Development(ETC-ID 2008), Raipur, February - 2008.
- Dubey Sanjay Kumar et al., "Development of Self Compacting Concrete by use of Portland Pozzolana Cement, Hydrated Lime and Silica Fume" ISCA Journal of Engineering Sciences, Vol. 1(1), 35-39, July (2012)
- D.L.N.B. Jayawardane et al., "Physical and Chemical Properties of Fly Ash based Portland Pozzolana Cement", Civil Engineering Research Exchange Symposium.
- Alvin Harison et al., "Effect of Fly Ash on Compressive Strength of Portland Pozzolona Cement Concrete", Journal of Academia and Industrial Research (JAIR) Volume 2, Issue 8 January 2014
- Liana iure et al., "The Future Concrete: Self-Compacting Concrete", Universitatea Tehnică „Gheorghe Asachi" 2010
- Dhiyaneshwaran, S. et al., "Study on Durability Characteristics of Self-Compacting Concrete with Fly Ash", Jordan Journal of Civil Engineering , Volume 7, No. 3, 2013
- Mohammed Karem et al., "Evaluation Of Using Glass Fiber On Properties Of Self-Compacting Concrete", Journal of Kerbala University, Vol. 11, 2013.
- A. Deepak Raj et al., "Experimental Methods on Glass Fiber Reinforced Self

Compaction Concrete", IOSR Journal of Mechanical and Civil Engineering Volume 11, Issue 2 Ver. IV (Mar- Apr. 2014).

- P.A. Ganeshwaran et al., "Evaluation Of Mechanical Properties Of Self Compacting Concrete With Manufactured Sand And Fly Ash", International Journal Of Civil Engineering And Technology (IJCIET), Volume 3, Issue 2, July-December (2012).
- M.V.Rama Raju et al., "Study of Properties of SCC using 'Quarry Dust' and 'Fly Ash", International Journal of Engineering Sciences Research-IJESR, Vol 02, Issue 04; August-September 2011
- K.S. Johnsirani et al, "Experimental Investigation on Self Compacting Concrete Using Quarry Dust", International Journal of Scientific and Research Publications, Volume 3, Issue 6, June 2013.
- Anil Banchhor et al., "Advantages of using Fly Ash in Concrete PPC or site mixing of OPC and fly ash site", The Associated Cement Companies Li mited, Cement House, 121, M. K. Road, Mumbai.
- C. I. Goodier, "Development of self-compacting concrete", Proceedings of the Institution of Civil Engineers, Structures & Buildings, November 2003.
- Shahana Sheril P.T. "Self Compacting Concrete Using Fly Ash and Glass Fibre", International Journal of Engineering Research & Technology (IJERT)Vol. 2 Issue 9, September – 2013 ISSN: 2278-0181.
- M Mazloom et al., "Relation Between The Workability And Strength Of Self-Compacting Concrete", 35th Conference on "Our World In Concrete & Structures": 25 - 27 August 2010, Singapore.
- T. Noguchi et al., "Rheological Approach to Passing Ability between Reinforcing Bars of Self-Compacting Concrete".
- M.S.SHETTY., - "CONCRETE TECHNOLOGY".
- "EUROPEAN GUIDELINES FOR SELF COMPACTING CONCRETE" – May 2005.
- IS:383-1970 "Specification for Coarse & Fine aggregates from natural resources"
- IS: 516-1959 "Methods of tests for strength of concrete".
- IS: 5816 "Method of test for splitting tensile strength".
- IS: 1489 (Part 1) "PORTLAND POZZOLANA CEMENT – Its Specifiations".
- Sai Kumar K. et al., "Quarry Rock Dust as a replacement of Fine Aggregate – State-of-Art Report", A National Level Conference on 'Innovations in Green Building Technology – IGBT- 2014', Institution of Engineers (India) at Nagpur.