Effect of Crushed Quartzite on Self Compacting Concrete

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Abstract: ***Self-Compacting Concrete (SCC) is one of the modern techniques in the concrete research. The SCC is able to flow and fill the most restacked places to the form work without vibration. For SCC, super plasticizer is used in order to improve high mobility. There are several methods for testing SCC properties in fresh state the most frequently used tests are slump flow test, L-box, V funnel test. In recent days the demand for river sand is increasing due to lesser availability. In India the conventional concrete is produced using natural sand obtained from river beds as fine aggregate. Decreasing natural resources poses the environmental problem and hence State Government restrictions on sand quarrying result in scarcity and significant increase in its cost. This project presents the properties of SCC, mixed with quartzite as fine aggregate. This project aims to focus on the possibility of using industrial by-product like crushed quartzite. The usage of this crushed quartzite is proposed as partial replacement of fine aggregate in the production of SCC. Strengths properties such as Compressive strength, Tensile strength, Split Tensile Strength of SCC is determined at the age of 28 days with normal curing.***

Keywords: Self compacting concrete, Crushed Quartzite, Super Plasticizer

1. Introduction

The development of self-compacting concrete (SCC) also referred to as „Self-Consolidating Concrete" has recently been one of the most important developments in construction industry. SCC is a special concrete that can settle into the heavily reinforced, deep and narrow sections by its own weight, and can consolidate itself without necessitating internal or external vibration, and at the same time maintaining its stability without leading to segregation and bleeding. SCC demands a large amount of powder content compared to conventional vibrated concrete to produce a homogeneous and cohesive mix. The common practice to obtain self-compactibility in SCC is to limit the coarse aggregate content and the maximum size and to use lower water–powder ratio together with new generation super plasticizer (SP). During the transportation and placement of SCC Due to flow ability property of SCC it causes segregation, bleeding problems in form work placing condition to which can be overcome by providing the necessary viscosity to SCC, which is usually supplied by increasing the fine aggregate content by limiting the maximum aggregate size by increasing the powder content or by utilizing viscosity modifying admixtures (VMA). One of the disadvantages of SCC is its cost, associated with the use of chemical admixtures and use of high volumes of Portland cement. One alternative to reduce the cost of the SCC is to use of mineral additives such as limestone powder, natural pozzolans, fly ash and slag, which are finely divided materials added to concrete as separate ingredients either before or during mixing . As these mineral additives replace part of the portland cement, the cost of SCC will be reduced especially if mineral additive is an industrial by-product or waste. It is well established that the mineral additives, such as fly ash and slag, may increase the workability, durability and long-term properties of concrete. Therefore, use of these types of mineral additives in SCC will make it possible, not only to decrease the cost of SCC but also to increase its long-term performance. To assess the effectiveness of Fly ash in SCC some of the parameters like chemical composition, hydraulic reactivity, and fineness have been carefully examined earlier It was seen that among these, the reactive glass content and fineness of Fly Ash alone will influence the cementitious/pozzolanic efficiency or its reactivity in concrete composites significantly

In India the conventional concrete is produced using natural sand form river beds as fine aggregate. Decreasing natural resources poses the environmental problem and hence State Government imposing restrictions on sand quarrying, resulted in scarcity and significant increase in its cost. Digging sand from river beds in excess quantity is hazardous to the environment. If deep pits are dug in river beds affect the ground water level so In order to fulfill the requirement of fine aggregate, some alternative material must be found. The cheapest and the easiest way of getting substituent for natural sand is obtained from Quartzite quarry. Concrete made with Crushed Quartzite as replacement of natural sand in concrete can attain more or less same compressive strength. In this paper the fresh and mechanical properties of SCC is evaluated by partially replacing Cement with Fly ash and fine aggregate with Crushed Quartzite..

2. Review of Literature

Halit Yazici[2]had studied the effect of silica fume(SF), fly ash on properties of concrete. Cement has replaced with a Class C fly ash (FA) in various proportions from 30% to 60%. Test results indicate that SCC could be obtained with a high-volume FA. Ten percent SF additions to the system positively affected both the fresh and hardened properties of high-performance high-volume FA SCC.

Prajapatikrishnapal, Chandak Rajeev[6] had studied the properties of self compacting concrete, mixed with fly ash. The test results for acceptance characteristics of self-compacting concrete such as slump flow; V-funnel and L-Box are presented. Further, compressive strength at the ages of 7, 28 days was also determined. They concluded that addition of fly-ash in SCC increases filling and passing ability of concrete, Increase in fly ash, super plasticizer content in SCC reduced water demand and increased/reduced compressive strength of concrete.

J.Guru Jawahar[3] had studied the effect of coarse aggregate blending on short term mechanical properties of concrete. Their investigation mainly focused on finding the unit weight, compressive strength, modulus of elasticity(MOE) and split tensile strength(STS) of SCC mixes with different coarse aggregate blending(20mm and 10mm)(60:40 and 40:60) and coarse aggregate content (28% and 32%). They concluded that the coarse aggregate blending did not affect the compressive strength of SCC mixes, but it affected the unit weight, MOE and STS of SCC mixes.

J.Guru Jawahar[4] had studied the micro and macro level properties of Class F fly ash blended SCC after 28,56,112 days of curing. SEM analysis and X-RAY analysis were carried out to study the micro properties .Results revealed that the pozzolanic action of class F fly ash improved the micro level properties with age and reducing the micro cracking width and also enhanced the macro level properties.

Mucteba Uysal[5]had studied the effectiveness of various mineral admixtures in producing SCC. For this purpose, fly ash (FA), granulated blast furnace slag (GBFS), limestone powder (LP), basalt powder (BP) and marble powder (MP) were used. It was concluded that among the mineral admixtures used, FA and GBSF significantly increased the workability of SCC.

Anthony Nkem Ede[1]They had made attempts enhance the flow-ability of SCC by replacement of cement with varying dosage of limestone and super-plasticizer. To validate the improvement of SCC fresh properties, slump test is used to assess workability, L-box test for passing ability and V-funnel test for filling ability. Test results analyzed with statistical tools confirmed that the workability and rheological properties of SCC can be improved through the adoption of various dosages of limestone powder.

3. Materials Used

In the present investigation materials used are
1. Ordinary Portland cement 53 Grade
2. Fly Ash as partial replacement to cement
3. Crushed Quartzite as partial replacement to Fine Aggregate.
4. Naturally available River sand as fine aggregate
5. Crushed Granite as coarse aggregate of size not greater than 12.5 mm
6. Master Glenium Sky super plasticizer(poly carboxylate based)
7. Water

4. Material Properties

(1) Ordinary Portland Cement (OPC) 53 grade conformingtoIS12269:1987 is used in this work. The properties of used cement were

TYPE	Ordinary Portland Cement
Normal consistency	32%
Specific Gravity	3.13
Compressive strength	55.6 Mpa

(2) Fly Ash brought from Rayalaseema Thermal Power Plant having specific gravity 2.2

(3) Thephysical propertiesoffineaggregate (riversand) were.

Specific gravity – 2.65	Water absorption – 1%
Fineness modulus – 2.68	Maximum nominal size – 4.75 mm

(5)Thephysical propertiesofCoarseaggregate (Crushed granite) were

Specific gravity - 2.72	Water absorption(%) – 0.3%
Fineness modulus - 4.6	Maximum nominal size – 12.5 mm

(6) Thephysical propertiesofreplaced fineaggregate (Crushed Quartzite) were.

Specific gravity – 2.71	Water absorption – 1%
Fineness modulus – 3.12	Maximum nominal size – 4.75 mm

(7) Master Glenium Sky Super plasticizer (poly carboxylate based) having specific gravity 1.03

5. Mix Proportioning

The mix proportion is a key factor to be considered to achieve SCC. Though the SCC was first developed in 1980‟s there is no standard mix design adopted or developed to achieve SCC. The European Federation Of Specialist Construction Chemicals and Concrete systems (EFNARC) provide the guideline for development of SCC. But no method of mix design specifies the grade of concrete in SCC except Nan Su et al method. In this work mix design is developed based on the EFNARC guidelines. In this work Fly Ash used as a mineral additives which replaces cement and water-powder ratio of 0.4 is maintained constant throughout the experiment. First cement is replaced with Fly ash in proportions of 10,20,30& 40 fresh and hardened properties were checked.

By taking the optimum mix from the results and keeping that percentage of Fly Ash constant, partially replacing Fine aggregate with Crushed Quartzite is done in proportions of 10.20,30,40 & 50. In present work at 30% replacement with Fly ash gives the optimum results and for a mix with 30% Fly Ash and partially replacing River sand with Crushed Quartzite Gives Comparatively Better Strength. The mix proportions are tabulated below.

MIX PROPORTION FOR 1 m^3 OF SCC

Mix Designation	Mix Proportions	CEMENT (kg)	Fly Ash (kg)	WATER (litres)	F.A River Sand(kg)	F.A Crushed Quartzite (Kg)	C.A (kg)	S.P (litres)
M0	100% C	500	-	200	897	-	733	4.6
M1	90% C + 10% FA	450	50	200	894	-	723	4.6
M2	80% C + 20% FA	400	100	200	884	-	715	4.6
M3	70% C + 30% FA	350	150	200	875	-	707	4.6
M4	60% C + 40% FA	300	200	200	864	-	700	4.6
M5	70% C+30% FA + 10% CQ	350	150	200	787.7	87.5	707	4.6
M6	70% C +30% FA+ 20% CQ	350	150	200	700	175	707	4.6
M7	70% C +30% FA + 30% CQ	350	150	200	612.1	268.29	707	4.6
M8	70% C+30% FA+ 40% CQ	350	150	200	524.7	357.72	707	4.6
M9	70% C+30% FA + 50% CQ	350	150	200	437.5	437.5	707	4.6

(C- Cement, FA – Fly ash, CQ – Crushed Quartzite)

6. Testing Procedures

6.1 Fresh properties

Slump flow, V-funnel, L-box, were used to test the workability and passing ability, of SCC. Workability of the SCC was controlled through the slump flow test such that slump flow diameters of all of the mixtures were designed to be in the range of 650-800 mm as to satisfy the EFNARC limitation . For this, trial batches were produced for each mixture till the desired slump flow was obtained by adjusting the dosage of the superplasticizer. Flowability of the mixtures was inspected through the V-Funnel test. L-box test was carried out as an indication of passing ability, or the degree to which the passage of concrete through the bars is restricted. Slump flow, L-box, and V-funnel tests were performed according to the procedure recommended by EFNARC committee. The results of fresh properties for each mix were tabulated below

Fresh properties of SCC

MIX ID	Slump (mm) (650-800 mm)	T_{500} (sec) (2-5 sec)	V-Funnel(sec) (6-12 sec)	T_5 (sec)	L-box (0.8-1.0)
M0	640	5	13	15	0.75
M1	670	4	9	11	0.82
M2	690	3.5	8	12	0.86
M3	720	2.8	7	10	0.86
M4	740	2.3	7	8	0.89
M5	720	3.0	8.5	10	0.86
M6	730	3.8	8	11	0.86
M7	730	3.5	7.3	9	0.92
M8	740	3.0	6.8	9	0.96
M9	780	2.O	5.0	7.0	1.2

6.2 Hardened Properties

Compressive strength of SCC were measured by means of a compression testing machine. The test was conducted on three 150 mm cubes at the ages of 28 days normal water curing and the average of them was reported herein. Splitting tensile strength of the SCCs was determined on 150 mm dia and300 mm height cylinder specimens at 28 days. The splitting tensile strength reported in the study was the average of two cylinders. Flexural strength of the SCC wae determined on 500 mm x 100 mm x100 mm beam specimens. The test was conducted on one beam specimen after 28 days of normal water curing. Test results were tabulated below

Hardened properties of SCC

MIX ID	Compressive strength (MPa)	Split tensile strength (MPa)	Flexural strength (MPa)
M0	33.00	2.57	7.6
M1	34.66	2.8	7.73
M2	36.88	2.97	7.95
M3	38.96	3.225	8.25
M4	34.22	2.54	7.95
M5	39.87	3.22	8.25
M6	40.56	3.24	8.27
M7	41.18	3.25	8.28
M8	41.77	3.30	8.30
M9	42.07	3.38	8.34

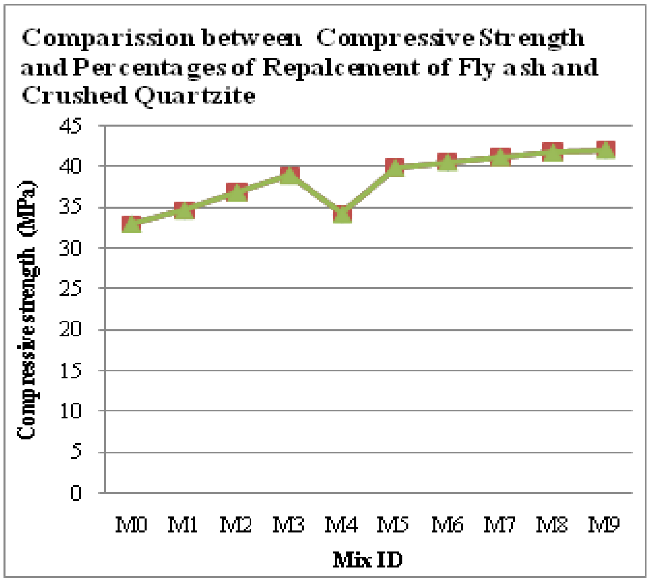

Figure 1: Mix ID vs Compressive Strength

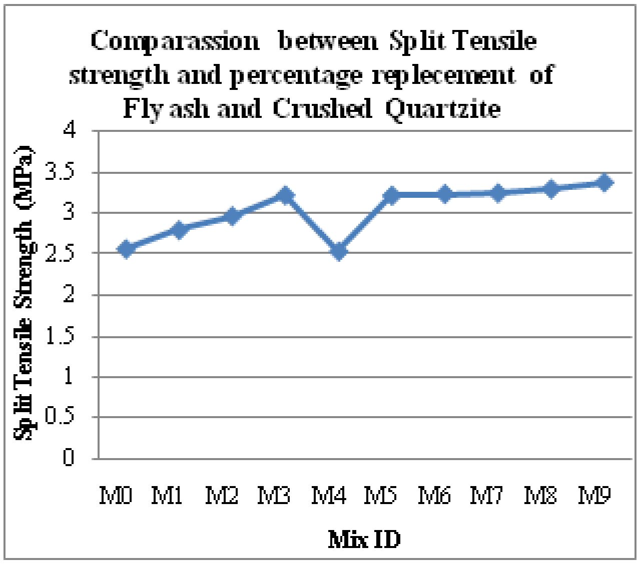

Figure 2: Mix ID vs Split Tensile Strength

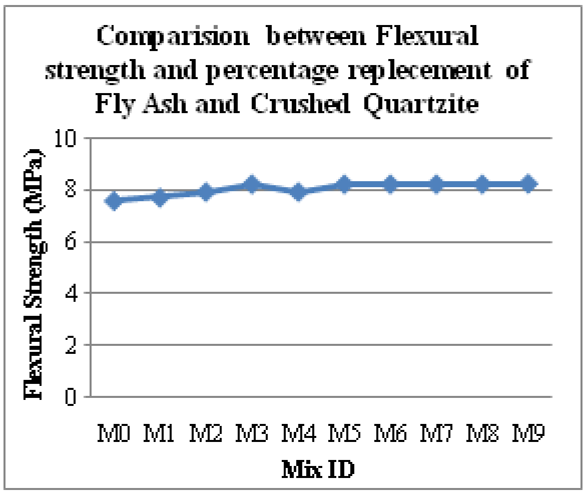

Figure 3: Mix ID vs Flexural Strength

7. Conclusions

This paper had presented experimental results of an investigation on feasible use of Fly ash as mineral admixture and replacement of Crushed Quartzite as Fine aggregate in SCC. Based on the results of this present study, the following Conclusions can be drawn

1) In preliminary stage, replacement of Fly Ash as Mineral Admixture gives good results in Fresh Properties of Concrete (i.e Satisfy the fresh Properties limits prescribed in EFNARC)
2) The Compressive strength, Split Tensile Strength and Flexural Strength shows with the replacement of 30% Fly ash as Mineral admixture gives the maximum strength among 10%,20%30% and 40 % of Fly ash Mixtures.
3) While replacement of 10%,20%.30% & 40% Crushed Quartzite as Fine Aggregate had Positive Effect on Fresh Properties. 50% replacement of Crushed Quartzite had Negative Effect on Fresh properties.
4) The Hardened Properties shows with the replacement of 30% of Fly ash as mineral admixture and 10% to 50% Crushed Quartzite as Fine Aggregate does not affect the Strength Properties.
5) The Strength Properties are slightly increased, except Mix $M_4$when compared with the M_0 mix.

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