Physical Properties of High Strength Self Compacting Concrete using Silica fume and Quarry dust

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***Abstract*— A liquefied combination suitable for crammed reinforcement is High strength self-compacting concrete (HSSCC). It should possess a good equilibrium between the deformability and rightness. HSSCC with diverse materials other than those used universally like firmed basalt, Quartz sand, Quartz powder etc., Exploration is conceded on mechanical properties of Concrete. A simple mix design for SCC was designed by EFNARC and IS guidelines and offered description on HSSCC has been used for deception the trial mix. As per IS guidelines the fresh concrete properties of the trial mixes checked and the one which gives the greatest potency has been used in the present work. Slump flow, V-funnel, U-Box L-Box tests are chequered beside the specifications known by IS guidelines for qualifying HSSCC properties. This venture presents the results of mechanical properties of high strength self-compacting concrete with quarry dust, silica fume and super plasticizer.**

***Keywords*— Self Compacting Concrete, Admixtures, Quarry dust, Slica Fume, Strength parameters.**

I. INTRODUCTION

Concrete is considered a brittle material, primarily because of its low tensile strain capacity and poor fracture toughness. For a long time, concrete was considered to be very durable material requiring a little or no maintenance. [1].Self-Compacting Concrete (SCC) has had a remarkable impact on the concrete construction industry, especially the precast concrete industry [2]. SCC can be described as a high-performance material which flows under its own weight without requiring vibrators to achieve consolidation by complete filling of formworks even when access is hindered by narrow gaps between reinforcement bars. Concrete with reduced environmental impact has been produced in Denmark for some years [3]. Self-compacting concrete is otherwise called as a self-flow concrete that has very low resistance towards the flow and high deformability. Utilization of SCC has been generally expanded in the construction area. It can be successfully placed without vibration [4]. SCC is defined by two primary properties: Ability to flow or deform under its own weight and the ability to remain homogeneous while doing so [5]. The use of SCC shortens the construction period, since SCC allows faster placement and less finishing time, leading to improved productivity. Being able to build with green concrete the potential environmental benefit to society is huge [5]. High strength self-compacting concrete acquire sufficient workability, very high strength and durability properties. Efforts are being made in the field of concrete technology to extend self-compacting concrete with special considerations [6]. Recently a new term “high strength self-compacting concrete” is used for concrete mixture which possess high workability, high strength, high density and low permeability.

The high performance concrete called high strength self-compacting concrete has denser microstructure with low inborn “porosity” and “permeability”, because of lower water cement ratio and use of mineral admixture in concrete [7]. Usually high strength self-compacting concrete mixture have a high cement content that enhance the heat of hydration and may cause increased shrinkage that result in a prospective of cracking and low durability [6,7]. To beat these problems cement can be replaced by pozzolanic material which can reduce heat of hydration and hence shrinkage. SCC mix always contains a powerful super plasticizer which necessary for producing a highly fluid concrete mix, while powder materials are essential to maintain sufficient stability of the mix, hence reducing bleeding, segregation and settlement [8]. High strength self-compacting concrete having proceed viscosity and workability can easily fill the mould without the necessity of using vibrators. High volume of mineral crushed is necessary for a proper self-compacting concrete design. An attempt was made to develop high strength self-compacting concrete by using silica fume, Quarry Dust and admixtures in concrete to certain proportions. Consumption of SCC has been generally expanded in the construction area [7,8]. It can be successfully placed without trembling.

This project presents the durability characteristics of high strength self-compacting concrete by partially replacing cement by and silica fume and fine aggregate by quarry dust. The cement was replaced with 20% Silica Fume and 20% of Quarry Dust. Water-cement ratio was kept constant for all the mixtures. The Objectives of study is to investigate producing high strength self-compaction concrete and inspect the physical properties strength [5]. A range of test such as, Compressive strength, Tensile Strength and flexural strength were conducted and check their physical properties against IS. One way to increase concrete flowing ability is minimizing the voids among particles of the powder mixture poised with cement, silica fume and other fine components.

II. METHODOLOGY

Statistics was collected from the study area, review of literature and secondary source of information. The main aim is to identify materials and check the parameter of materials using study. Material parameters are mainly used for design the mix as per code practices. Mix design can be calculated from the procedure for practice the specimen. Fresh concrete will be casted and cured. Finally, specimen will be tested to get results

Fig.1. Methodology

III. MATERIAL PROPERTIES AND EXPERIMENTAL PROGRAMME

The objectives of the experimental study are given below. To study the compressive, flexural strength and split tensile strength behavior at 7days and 28, days form 60 grade High Strength Self Compacting Concrete Mix.

A) Cement

Ordinary Portland cement of 53 grades available in local market is used in the investigation. The cement used has been tested for various proportions as per IS 4031 – 1988 and found to be confirming to various specifications of IS 12269-1987.

Table I Properties of Cement

Standard Consistency	Specific gravity	Initial setting time in minutes	Final setting time in minutes
32.5%	3.14	34	554

B) Coarse Aggregate

A River gravel was used as coarse aggregate with minimum size of 16mm.

Table II Properties of Fine Aggregate

Size	Fineness modulus	Water absorption	Specific Gravity
Passing through 4.75mm	3.45	1.1%	2.62

C) Water

As per IS: 456-200 Portable water is used for concreting Water to be used for mixing and curing should be liberated from harmfulmaterials. In this investigation, tap water was used for both mixing and curing purposes.

D) Silica Fume

It is an ultrafine powder obtained from the alloys of silicon and ferrosilicon invention and consists of particle diameter of 150 nm with average spherical particles. It should have the high level of fineness have the possessions of good cohesion and improved resistance to segregation. It should be successful in eliminating bleeding.

Table III Physical Properties of Silica Fume

Particle size	Bulk Density	Specific Gravity	Specific Surface
Less than 1 micro meter	480 to 720 kg/m3	2.2	15000 to 3000 m2/kg

Table IV Chemical Properties* Of Silica Fume

SiO2	Al2 O3	Fe2O3	CaO	Loss of Ignition
91.03	0.39	2.11	1.5	4.05

E) Quarry dust

During quarrying behavior it is obtained as a byproduct. Quarry dust is the smaller aggregate particles. Hence was sieved and then used for the replacement of fine aggregate.

Table V Physical Properties of Quarry Dust

Finess Modulus	Absorption	Maximum Size	Specific Gravity
4.3	0.6	4.75mm	2.63

F) Super plasticizer

In this investigation super plasticizer- Master Glenium SKY 8233.It is an admixture based on modified poly carboxylic ether. This has been principally developed for applications in high strength concrete where the high strength and utmost durability is required. It is free of chloride & low alkali. It is compatible with all types of cements.

IV. MIX PROPORTIONS

Mix proportions were arrived at for M60 grade of high strength self-compacting concrete. Trial mix based on the formulated mix design procedure by adding 0.5 lit of water with water-cement ratio of 0.29. A total of four trial mixes were arrived at. The quantities of dissimilar materials necessities per m^3 of M60 grade of high strength self-compacting concrete is done as per mix design.

Table VI Mix Proportions

Mix	Cement kg/m³	F.A kg/m³	C.A kg/m³	Water litre/m³	SF kg/m³	QD kg/m³	Water ml
HSSCC	511.5	773.5	1044.5	143	102.3	102.3	816

V. EXPERIMENTAL INVESTIGATIONS

This chapter presents workability mechanical properties are carried out on the test specimen and strength-related properties of high strength concrete. To produce high strength, concrete a substantial reduction in water cement ratio is required.

V.1TESTS ON FRESH CONCRETE

G) Slump Flow Test:

Flow ability of self-compacting concrete is obtained from the slump flow test. This test is done to assess the horizontal free flow of concrete in the horizontal surfaces. Filling ability is assessed by this method. At site, it can be used. After lifting the cone to the concrete reaching a diameter of 50 cm is measured as a time at T50cm. The deformation rate or viscosity of the self-compacting concrete is measured in T50cm and results were tabulated. The value should confirm to EFNARC Guide lines.

H) L-Box Test:

Passing ability of self-compacting concrete is obtained from the L-Box test. In L-Box test, fresh concrete is filled in the vertical section. The gate is lifted, then the concrete flow into the horizontal section. The vertical section represents h1 (mm) is height of the concrete and at the end of horizontal section represents h2 (mm). Blocking ratio is represented by ratio of h2/h1 and the result were tabulated and the value should confirm to EFNARC Guide lines

I) V-Funnel Test:

Filling ability self-compacting concrete is obtained from the V-Funnel test. In this test, V-Funnel is completely filled with fresh concrete and trap door is closed at the bottom of V-Funnel. From opening the trap door and complete emptying the funnel V-Funnel time is measured. Again the concrete is filled in V-Funnel and kept for 5 minutes, and then trap door is opened. V-Funnel time is measured again. V-Funnel time at T5min and the result were tabulated and the value should confirm to EFNARC Guide lines.

Table VII Slump Flow, L-Box & V-Funnel Values

Mix Code	Slump Flow (mm)	L-box (h2/h1)	V-Funnel time (s)
HSSCC01	675	0.94	9.0
HSSCC02	690	0.96	9.3
HSSCC03	680	0.92	9.2
HSSCC04	680	0.98	9.3

Fig.2.Slump and V-funnel test

V.2. TESTS ON HARDENED CONCRETE

i) Compressive Strength Test:

The cube compressive strength results at the 28 days for different replacement levels such as 20% of silica fume and quarry dust of cement and fine aggregate respectively. Three specimens were casted for each mix and average value was taken. They were tested on compressive testing machine as per IS 516:1959.Compressive strength = P/A

Where,

P = Maximum load in N applied to the specimen

A = Cross sectional area of the specimen in mm2

Fig.3. Cube under Compression Test

Table VIII Compressive Strength Results for 7th & 28th days

Mix Code	Percentage replacement of SF & QD	7 Days Compressive Strength (N/mm2)	28 Days Compressive Strength (N/mm2)
HSSCC01	10	47.17	67.33
HSSCC02	20	49.34	69.14
HSSCC03	30	48.08	67.86
HSSCC04	40	47.57	67.53

ii) Split Tensile Strength:

It is an indirect test to determine the tensile strength of cylindrical specimens. It was carried out in compression testing machine as per IS 5816:1999. Three specimens were casted for each mix and average value was taken.

F = 2P/ LD
Where,
P = Load in N
L = Length of the specimen in mm
D = diameter in mm

Fig.4. Specimen under Split Tensile Test

Table IX Split Tensile Strength Results for 7th Day& 28th Day

Mix Code	Percentage replacement of SF & QD	7 Days Split Tensile Strength (N/mm2)	28 Days Split Tensile Strength (N/mm2)
HSSCC01	10	5.02	5.70
HSSCC02	20	5.40	5.96
HSSCC03	30	5.30	5.80
HSSCC04	40	5.30	5.60

VI. CONCLUSION

It is to be observed that considerable increases in Compressive Strength has been obtained by using 20% of silica fume and quarry dust in concrete when compared to conventional concrete. Using silica fume and quarry dust 20% by weight of cement and fine aggregate respectively shows good result of water absorption. It was observed that the workability tests performed in this investigation were as per EFNARC guidelines. The tests were slump flow, L-box, V-funnel.

A. The use of mineral admixtures improves the performances of high strength SCC in fresh state and also avoids the use of VMAs.
B. At the water/cement ratio of 0.23, slump floe test, V-funnel test, and L-box test results were found satisfactory, i.e. passing ability; filling ability and segregation resistance are well within the limits as per the EFNARC.
C. The results of hardened properties of HSSCC such as compressive strength have shown that higher strength is obtained.
D. The presence of Silica fume and Quarry dust improved both early ages and long term compressive strength of HSSCC.

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