EXPERIMENTAL INVESTIGATION ON MECHANICAL PROPERTIES OF CONCRETE CONTAINING QUARTZ POWDER AND SILICA FUME WITH STEEL FIBRE

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Abstract - *Over the years, Concrete has become considerably more complex. There is a need to replace a part of cement by some pozzolanic material to reduce the consumption of cement. In this study the effect of silica fume, quartz powder and steel fiber on M-40 grade concrete has been studied. Cement is replaced with silica fume at 10% by weight of cement. Simultaneously fine aggregate is replaced by quartz powder of about 20% by weight fraction and also Fibers were added in concrete to improve the mechanical properties. The test results of fibrous concrete for 7days, 28days were compared with conventional concrete and concrete without addition of steel fiber.*

Key Words: Quartz Powder, Silica Fume, Steel Fiber, Compressive Strength.

1. INTRODUCTION

In recent years the construction was well developed in the world. Concrete plays a main role in construction Field. During cement production, it emits lot of Carbon-di-oxide and it affects the environment as well as demand for cement increases day by day. The use of supplementary cementitious materials and additives designed to enhance the properties of concrete has grown significantly. Also by using these supplementary materials we can reduce the demand for cement and natural sand. The primary focus of this development has been on the achievement of improving the mechanical properties of concrete by replacing supplementary materials. Here cement is replaced by silica fume and fine aggregate by quartz powder. In addition to this steel fibers were also incorporated in concrete.

Deepak.S, Vijay.G, Vinothkumar.R, and Gokulakannan.P (2017) carried out a study on concrete by partial replacement of glass powder and quartz Powder in cement with Steel Fiber. In their study the replacement of 5% Quartz Powder and also Glass powder in cement by 22%, 25%, 30% in additional of 1% steel fiber increases the compressive strength of the concrete [1].

T.Subramani and S.B. Sankar Ram (2015) studied the properties of concrete using cement with Glass Powder. They have found increase in compressive strength of concrete by replacing Glass powder of 10%. There was also marginal improvement in the split tensile strength [2].

Paulson Joseph and C.K Savinth [2017] Kumar had done a comparative study on effects of Quartz Powder and Textile Sludge on strength of concrete. When cement is replaced by textile sludge alone the compressive strength value decreases as the percentage increases [3].

Abdul ghaffar, Amit S. Chawhan and Dr.R.S. Tatwawadi (2014) carried out a study on Steel Fiber Reinforced concrete. The workability of concrete significantly reduced as the Fiber dosage rate increases [4].

T.Chandra Sekhara reddy and J.K. Elumalai (2014) studied the macro mechanical properties of Ultra High Strength Concrete using Quartz Sand and Silica Fume. This study compared the compressive strength of concrete with Normal Curing and Heat treatment [5].

Milind V. Mohod (2012) studied about the performance of steel fiber concrete. it has been observed that with the increase in fiber content up to the optimum value increases the strength of concrete [6].

Shende.A.M, Pande.A.M, and Gulfam Pathan.M (2001) carried out study on steel fiber reinforced concrete for M-40 grade. With addition of steel fiber of varying percentage they found increase in 28 days compressive strength [7].

2. Properties of Materials:

Cement:

The Ordinary Portland 53 grade Cement according to as per IS 12269:1987 [8] was used as a binding material in this experimental work. The properties of the cement were tested and the values are given in the table 1

Table -1: Properties of Cement

S.No	Description	Values Obtained
1	Normal Consistency	30%
2	Specific Gravity	3.15
3	Initial setting time	40 minutes
4	Final setting time	340 minutes

Silica Fume:

Silica Fume of particle size 15 µm was used in this study which confirms according to as per IS 15388:2003[9] and it brought from Cido agencies, Coimbatore. The specific gravity of silica fume was found as 2.63.

Quartz powder:

The crushed quartz powder used in the experiment is in a form of white powdered quartz flour, which replaces fine aggregate from the conventional concrete. The fineness of the quartz powder is 200 mesh which is equivalent to 74 microns. The specific gravity of quartz powder is 2.6.

Fine Aggregate:

Natural river sand collected from nearby area used as fine aggregate. The properties of sand were found in the laboratory as per procedure given in IS 383:1970 [10] and values were given in table 2

Table -2: Properties of Fine and Coarse aggregate

S.No	Property	Fine aggregate	Coarse aggregate
1	Specific gravity	2.75	2.8
2	Water absorption	1.5%	2.0%
3	Fine modulus	2.89	5.96
4	Size of aggregate	4.75 mm	12,20 mm

Corse Aggregate:

The coarse aggregate comprising of sizes 12mm, 20mm was used. The properties of coarse aggregate were found in the laboratory as per procedure given in IS 383:1970 [10] and values were given in table 2.

Steel fiber:

Crimped Steel fiber having an aspect ratio of 100 was chosen with length of 50mm, diameter of 0.5 mm was used.

Super Plasticizer:

In order to increase the strength and workability of quartz concrete. Sulphonated naphthalene polymer based super plasticizer CONPLAST SP 430 was used in this study. Having specific gravity 1.145 as per IS 9103:1999[11].

3. Experimental Investigation:

Mix proportioning:

As per the guidelines given in IS 10262:2009[12] mixture proportion of M-40 grade concrete was arrived. The conventional concrete was denoted as CC. Cement was replaced by Silica Fume about 10% and fine aggregate by quartz powder about 20%. Both Mixes were denoted as QC and QFC. In QSFC steel fibers are added about 1% by volume of cement. The detailed mixture proportion is given in Table 3.

Table -3: Mix design proportion

Ingredients	Mix ID		
	CC	QC	QSFC
Material	Kg/m^3	Kg/m^3	Kg/m^3
Cement	383	345	345
Silica fume	-	38	38
Quartz powder	-	151	151
Fine aggregate	753	602	602
Coarse aggregate	1229	1229	1229
Steel fiber	-	-	1.915
Super plasticizers	1.915	1.915	1.915
Water	153	153	153
w/c ratio	0.4	0.4	0.4

Casting of specimens:

150x150x150mm concrete cube specimens were casted to study quality and strength of concrete at curing age of 7, 28 days. 150mmØ X 300mm length cylinder and 500x100x100mm beam specimens were casted to study the split tensile strength and flexural of concrete respectively at 7 and 78 days. Based on the material proportions for corresponding mixtures, concrete were made and casted the specimens after 24 hours, specimens are demoulded from moulds, then kept in the curing tank filled with potable water. Curing process was carried out up to the required curing age. At the age of testing, specimens were taken out from water and dried in room temperature and tested the specimens. Specimens were tested as per procedure given in IS 516:1959[13].

3. Result and Discussion:

A. Compressive Strength:

The cube specimen of size 150x150x150 mm was used to carry out compressive strength test as per IS 516:1959[13]

at the age of 7days, 28days. Average of three specimens is taken for each test mixes. Specimens are tested after fully dried. Tested results are tabulated in Table 4.

Table -4: Compressive Strength results at 7 & 28 days

MIX ID	Compressive Strength (Mpa)	
	7 days	28 days
CC	28.5	46.8
QC	33.3	53.3
QSFC	38.5	60

From the figure 1, it is observed that the 7days, 28 days compressive strength of concrete reached maximum value attained at QSFC. Compressive testing images are shown in figure 2.

Figure-1: Compressive Strength of 7, 28 days (Mpa)

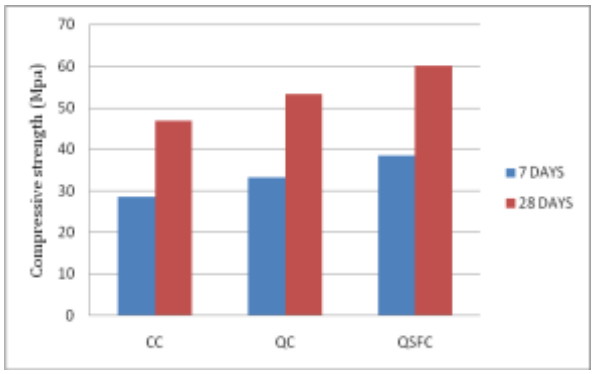

Figure-2: Testing of Specimen

B. Split Tensile Strength:

The cylinder of size 150mmØ X 300 length used to carry out Split tensile test and it is done with compression testing machine by placing a cylindrical specimen horizontally between the loading surfaces of a plate. The loading is applied to the cylinder till failure occurs. These strengths are found at the curing age of 28days as per IS 5816:1999[14].Tested results are tabulated in Table 5.

Table -5: Tensile Strength of concrete at 28 days

MIX ID	Tensile Strength of concrete at 28 days (Mpa)
CC	2.83
QC	3.1
QSFC	3.6

From the figure 3, it is noted that there is an increase in tensile strength at 28 days in QC and QFC compared to CC mix. The failure of tensile strength specimen is shown in figure 4.

Figure-3: Split Tensile Strength at 28 days (Mpa)

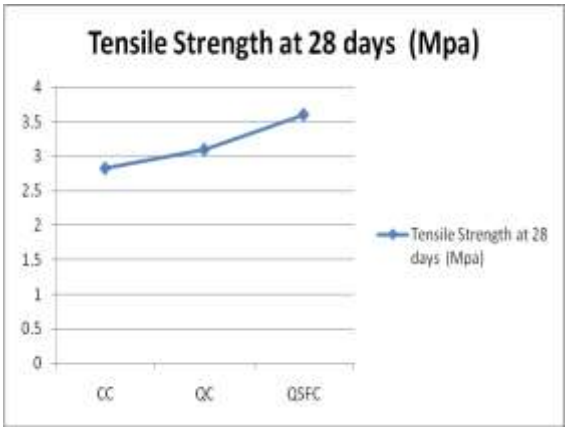

Figure-4: Testing of Specimen at laboratory

B. Flexural Strength:

Flexural strength result of concrete is obtained at curing age of 28 days as per IS 516:1959[13]. The prism of size 100x100x500 mm was used to find out the flexural strength of concrete. The flexural strength is shown in Table 6.

Table -6: Flexural Strength of concrete at 28 days

MIX ID	Flexural Strength of concrete at 28 days (Mpa)
CC	5.1
QC	6
QSFC	7.5

From the figure 5, it is observed that there is an increase in flexural strength at 28 days in QFC compared to CC mix. The failure pattern of flexural strength specimen is shown in figure 6.

Figure-5: Flexural Strength at 28 days (Mpa)

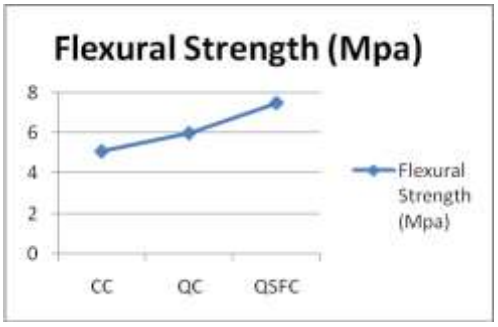

Figure-6: Flexural Strength Test

4. CONCLUSIONS

- From this experimental work it is concluded that, by partially replacing the cement with Silica Fume and sand with Quartz Powder will increase the strength up to certain percentage.
- Addition of admixture to Quartz concrete gave highest compressive strength of 60Mpa for M40 grade concrete as compared to CC having 28days compressive strength of 46.8Mpa.
- The combination of 10% silica fume in cement and 20% Quartz powder in fine aggregate in concrete with addition of steel fiber showed the maximum strength in compressive strength, split tensile strength, flexural strength test

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