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Study of M_{50} grade concrete using silica fume, quartz powder and crimped steel fibres

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Abstract : The project defines strength properties of M50 concrete with silica fume, quartz powder and crimped steel fibre. In this study we used concrete mix with silica fume of 10%, 20%, 30% and keeping quartz powder 5% with addition of crimpled steel fibre of 1%, 2%,3% by weight of cement. The basic test conducted on cement are fineness, specific gravity, normal consistency, soundness, initial setting & final setting time. The test conducted on green concrete are slump, compaction factor & on hardened concrete are compressive, split tensile, flexural & durability test. The assessment between normal concrete and partially replaced concrete is has to be done. Mix design carried out for M50 grade concrete as per IS 10262-2009

Key words: Silica fume, quartz power, crimped steel fibre.

1. INTRODUCTION

Nowadays, various types of construction work concrete used due to its easy availability and good durability. It has long been considered a durable and sustainable material that requires less maintenance during its useful life. In order to meet the requirements of building, concrete takes an important role in achieving high strength early.

The less and tolerable existence of customary concrete under the distinctive kinds of climatic conditions regular concrete has significant insufficiencies like low bond quality, low elasticity, high vulnerability and moreover advance cracks. Silica fume is most generally used mineral admixtures in HPC. Adding to the concrete mix will imparts the workability, strength & impermeability of concrete which intern rises the Comprehensive Strength. One of the most practices of micro silica in conventional concrete is because of its physical and chemical properties. Since it is a very fine highly reactive pozzolana. Micro silica is usually whitish or grayish color non-crystalline powder, fairly Similar to OPC. It is a active pozzolana material due to its fine particle and high purity of sio2 [99.5%] content. Quartz Powder is made by breaking mineral quartz lumps to different sizes. quartz powder has high silica content when contrasted with natural sand and has immaterial or no Impurities. quartz Sand is exceedingly impervious to both mechanical and compound weathering.

To prevent shrinkage cracks and to achieve high tensile strength durability concrete small steel fibers are added during the mixing of concrete with an aspect ratio 50, and thus it improves concrete properties.

Hereafter the replacement of micro-silica, quartz powder with addition steel fibers in normal concrete improved the properties such as flexural strength, tensile strength, toughness, brittleness, corrosion resistance, low permeability,high impact resistance & ultimately increased life of the structure. Also it reduces the cost of construction and use of these materials in concrete reduces environment pollution upto some extent.[15]

2. LITERATURE REVIWE

Kumar & Dhaka In this project Silica fume used as partial replacement of concrete and investigated its effects on concrete. Silica fume is replaced 0, 5, 9, 12&15% by weight of cement and determined compressive, tensile & Flexural strength of concrete for 7 & 28 days. The strength and durability is increases when % of silicafume is increased at all stages compared to normal concrete.

Pratapraj NR et.al Studied partial replacement of silica fume with addition to the coir(jute) fibre of length 5cm & dia. of 1mm . Silica fume is replaced 5, 10, 15% and jute fibre added 0.5, 1% by weight of cement. As the % of silicafume and coir fibre increases the compressive strength is also increased.

Srivastava et.al He shown that replacement of silica fume in concrete there is decrease in workability howerer in some cases it is increased. With various % of silica fume increased the compressive strength of concrete 6-57% wrt normal concrete & there is no change in tensile and flexural and tensile strength when compared with normal concrete.

KamalRahmani et.al Founded the use of micro and nano-silica in concrete to improve abrasion resistance and compressive-strength.

Vikas srivastav et.al In this study the silica fume and metkaolin are added in concrete and observed that the concrete is improved by resistance to permeability and cracks. And found that optimum dosage of silica found 15% by wt.of cement and metkaoline dosage was 6%.

H.Katkhuda, B.Hanaynehand, N.Shatarat In this project they varied w/c ratio from 0.25-0.42 and replaced silicafume 0, 5, 10, 20, 25 & 30% for compressive, split, tensile strength examined as silicafume % increased there in increase in strength

3. OBJECTIVE OF THE PROJECT

i. The main purposes of this investigational work is to study the effect of industrial byproduct like silica fume in the Concrete on its several properties.
ii. To discover the effects of micro silica & quartz powder on Compressive, Split Tensile and flexural strength of the concrete.
iii. Evaluation of test Results of conventional concrete with partial replace concrete.
iv. To ascertain the behavior of M_{50} with silica fume, thereby, examining the changes of properties like strength and durability.
v. but it is not constant due to different w/c ratio. Based on these results relation between split, compressive & flexural strength of silica fume concrete.

4. MATERIAL USED

4.1 CEMENT: In this project work we used Ultra tech Ordinary Portland Cement of 53 Grade which is brought from Balaji hardware, Kalaburagi, Karnataka

TABLE NO: 01 Shows the physical properties of cement tested in the laboratory

SL.No	Properties	Test result
I.	Fineness	3.4%
II.	Soundness	1mm
III.	Initial setting time	40 min
IV.	Final setting time	180min
V.	Specific gravity	3.1
VI.	Std. consistency	33%

4.2 SILICA FUME Silica fume is waste coming from manufacture of silicon metal or ferrosilicon in electric arc furnaces. In this project work we gray colour silica fume of average particle size 0.15 micro meter which is brought from from walter enterprises, Mumbai

TABLE NO: 02 Shows the chemical and physical properties of silica fume

PROPERTIES	UNIT	STANDARD	RESULTS
Appearance	-	Gray	-
Sp, surface area	m^2/g	200±15	198
PH value		3.7-4.5	4.31
Sio_2	Wt.%	>99.8	99.92
Moisture	Wt.%	<.5	0.08
Tamped density	g/l	Approx..30	30
Chlorides	Ppm	≤5	Complies
Iron	Ppm	≤5	complies

4.3 QUARTZ POWER The most common existing mineral in the Earth's continental crust is quartz. In this project work we used quartz powder of average particle size 10 micro meter which is brought from Parth minerals, Gujarat.

TABLE NO: 03 Shows the chemical composition of quartz powder

SL.no	PARAMETER	% BY WEIGHT
I.	SiO_2	99.22
II.	Al_2O_3	0.0024
III.	Fe_2O_3	0.0024
IV.	TiO_2	0.002
V.	Cao	0.056
VI.	Mgo	0.152
VII.	Na_2O_3	0.006
VIII.	K_20	0.005
IX.	Ignition loss	0.490

4.4Fine Aggregate: In our project work local available River sand is used which is brought from shahbad dist.Kalburagi, Karnataka

TABLE NO: 04 Shows the Test results of Natural Sand

SL.No	Test	Results
I.	Fineness modulus	3.71 (Zone-II)
II.	Specific gravity	2.61
III.	Water absorption	1.4%

4.5 Coarse Aggregate: In this project work we used 20mm down size coarse aggregate which is brought from Lahoti stone crushers, Kalaburagi.

TABLE NO: 05 Shows the Test results of coarse aggregate

SL.No	Test	Results
I.	Fineness modulus	6.42
II.	Specific gravity	2.7
III.	Impact value	16.4%

4.6 CRIMPED STEEL FIBRES In this project work we used Crimped steel fibres of leggth 50mm and diameter of 1mm which is brought from walter enterprises, Mumbai

TABLE NO : 06 Properties of crimpled steel fibre

Sl.no	Properties	Dimension
I.	Length	50mm
II.	Diameter	1mm
III.	Aspect ratio	50

5. EXPERIMENTAL INVESTIGATION

Present investigation consists total no of cubes casted for compressive strength is 36 no's for conventional concrete 9 and partially replaced 27 no's, 24 no's of beams for flexural test and 24 no's cylinder for split tensile test, these specimen is Cured in a fully Immersed water for 3 days 7 days & 28 days for Compression test, 7 days and 28 days specimen is cured for Split Tensile Test and Flexural Test. For durability of concrete water absorption 12 no's of cube casted and Cured.

C.C = Conventional concrete
Mix-1 = 10% silicafume+5%quartz powder+1% fibre
Mix-2 = 20% silicafume+5%quartz powder+2% fibre
Mix-3 = 30% silicafume+5%quartz powder+3% fibre

Table no 07 Shows the Test on Concrete

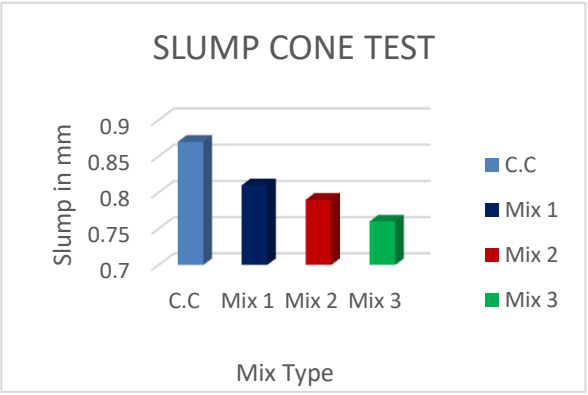
Fresh Concrete	Hardened Concrete
Slump Cone Compaction Factor	Compressive, Split Tensile, Flexural Strength Water Absorption for Durability.

6. RESULTS AND DISCUSION

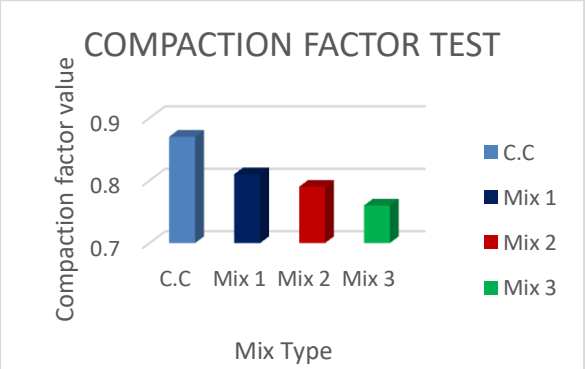
6.1 SLUMP CONE AND COMPACTION FACTOR TEST

Table 08 Shows The Result of Slump Cone and compaction factor value.

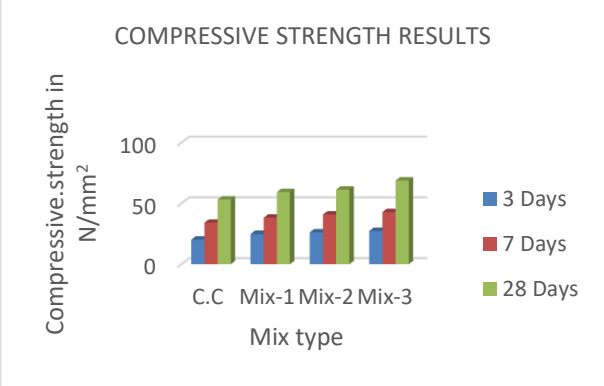
SL No.	Concrete Type	Obtained Slump Value (mm)	Compaction factor Value
I.	Conventional concrete	85	0.87
II.	Mix 1	83	0.81
III.	Mix 2	80	0.79
IV.	Mix 3	75	0.76



Graph 01 Shows The Slump Cone Value



Graph 02 Shows The Compaction Factor Value



Graph: 3 Shows Compressive Strength results for various mix

6.2 COMPRESSIVE STRENGTH TEST: In this test a specimen size 150X150X150mm were casted and cured for 3, 7 and 28days. After curing with respected days we test specimen in a UTM (universal testing machine) compression test carried under as per IS 516-1959 codal recommendation can be obtained by-

$$fc = \frac{P}{A}$$

Where:-

fc = compressive-strength

P = Failureload

A = c/s area

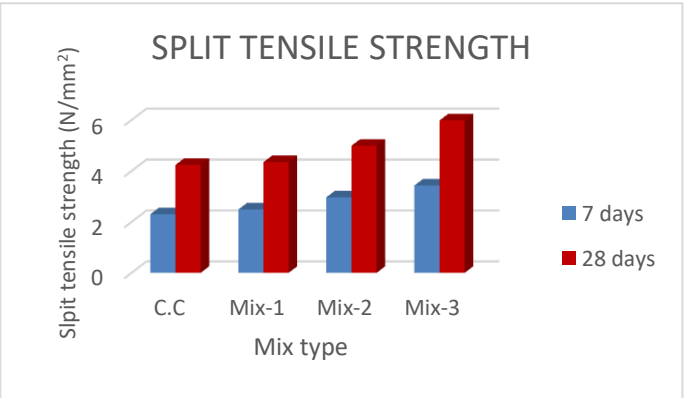
TABLE NO: 09 **Shows the test results of compression strength**

CONCRETE TYPE	**AVG.COMPRESSION STRENGTH (N/mm²)**		
	3DAYS	**7DAYS**	**28DAYS**
Normal concrete	20.26	34.16	53.16
MIX-1	24.90	38.23	59.30
MIX-2	26.20	40.83	61.30
MIX-3	27.3	42.86	68.83

6.3 Split Tensile strength test A concrete cylinder of size 150mm (diameter) x 300mm (height) were casted and tested under universal testing machine(UTM).

TABLE NO: 10 **Shows the split-tensile test result**

TYPE OF CONCRETE	**AVG. SPLIT TENSILE STRENGTH STRENGTH (N/mm²)**	
	7DAYS	**28DAYS**
Normal concrete	2.30	4.24
MIX-1	2.49	4.35
MIX-2	2.97	4.99
MIX-3	3.43	5.98



Graph:4 Shows the split-tensile Strength results for various mix

6.4 Flexural strength test:

Flexural strength test for different mix and different curing period 7days and 28 days carried on the prism of 100X100X500mm casted and cured.

TABLE NO: 14 **Shows the test results of flexural-strength**

TYPE OF CONCRETE	**AVG.FLEXURAL STRENGTH (N/mm²)**	
	7DAYS	**28DAYS**
Normal concrete	2.57	4.60
MIX-1	2.97	4.99
MIX-2	3.10	5.25
MIX-3	3.61	6.24

Graph: 5 Shows the Flexural-Strength results for various mix

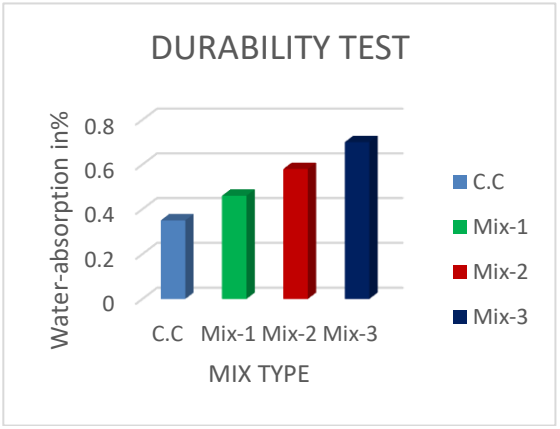
6.5 DURABILITY TEST, WATER ABSORPTION

The calculation of water absorption test given below

$$\% \text{ of water absorption} = \frac{W2 - W1}{W1} X\ 100$$

TABLE NO: 15 **Shows the test results of durability-test**

SL. No	Grade of Concrete	Type of Concrete	Dry wt.grams (W_1)	Wet wt.grams (W_2)	% age of Water Absorption
I.	M_{50}	Conventional Concrete	8490	8520	0.35
II.		Mix-1	8485	8525	0.46
III.		Mix-2	8460	8510	0.58
IV.		Mix-3	8467	8527	0.70



Graph: 6 Shows durability-test result

7. CONCLUSIONS

i. At 3 days, by comparing strength of normal concrete, concrete with 30% Silica fume, 5% Quartz powder +3% crimped fibre (Mix-3), the combination i.e. with Mix-3 achieves maximum strength of 27.3 N/mm² which is 34.7% more than that of normal concrete.

ii. At 7 days, by comparing strength of normal concrete, concrete with 30% Silica fume, 5% Quartz powder +3% crimped fibre (Mix-3), the combination i.e. with Mix-3 achieves maximum strength of 42.86N/mm² which is 11.9% more than that of normal concrete 28 days, by comparing to normal concrete, concrete with30% Silica fume, 5% Quartz powder +3% crimped fibre (Mix-3), the combination i.e. with Mix-3 achieves

maximum strength of 68.83N/mm² which is 29.87% more than that of normal concrete.

iii. At 7 days, by comparing split tensile strength of normal concrete, concrete with 30% Silica fume, 5% Quartz powder +3% crimped fibre(mix-3), the combination i.e. with Mix-3 achieves maximum strength of 3.43N/mm² which is 49.1% more than that of normal concrete.

iv. At 28 days, by comparing split tensile strength of normal concrete, concrete with 30% Silica fume, 5% Quartz powder +3% crimped fibre(Mix-3), the combination i.e. with, Mix-3 achieves maximum strength of 5.986N/mm² which is 41.1% more than that of normal concrete.

v. At 7 days, by comparing flexural strength of normal concrete, concrete with 30% Silica fume, 5% Quartz powder +3% crimped fibre(Mix-3), the combination i.e. with Mix-3 achieves maximum strength of 3.61N/mm² which is 40.4% more than that of normal concrete.

vi. At 28 days, by comparing flexural strength of normal concrete, concrete with 30% Silica fume, 5% Quartz powder +3% crimped fibre(Mix-3), the combination i.e. with, Mix-3 achieves maximum strength of 6.24N/mm² which is 35.6% more than that of normal concrete.

vii. In water absorption durability test, concrete with 30% Silica fume, 5% Quartz powder +3% crimped fibre(Mix-3) absorbs water 50% more than normal concrete due to presence of silica.

7.1 FUTURE SCOPE OF PROJECT STUDY:

i. In my limited study the micro silica is replace up to a 30% by weight of cement which will gives the better results.

ii. The micro silica and quartz powder with different percentages for further work can be used as replacement materials in various percentages for making high strength & durable concrete.

iii. The micro silica with quartz powder enhances the durability properties of concrete which can be utilized for further study.

iv. The additional of steel fiber to concrete can improve its tensile & flexural properties of concrete.

v. Use of plasticizers or additives to check strength of concrete by various proportions of mixing.

vi. Study on detail durability properties of concrete like acid attack, sulphate attack, alkali aggregate reaction.

vii. Add different types of fibres to study the strength characteristic of concrete.

8 REFERENCES

[1]. High Tech Concrete: Where Technology and Engineering Meet", Springer Nature, 2018

[2]. Aditya Dhagat, Manav Mittal; effect of microsilica and fly ash on the strength of concrete International Journal of Scientific & Engineering Research, Volume 4, Issue 8, 2013

[3]. Adanagouda1, Dr.H.M.Somasekharaiah: "Experimental Investigation on Strength Characteristics of Fly Ash Based High Performance Concrete with Steel Fiber and Polypropylene fiber" 'International journal of innovative research in science, engineering and technology' vol. 4, issue 9, september 2015

[4]. Amit Rana. "some studies on steel fiber reinforced concrete". international journal of emerging technology and advanced engineering.(jan 2013)

[5]. Amarkhail. "Study on effect of silica fume on high strength concrete for workability" 'International journal of advanced engineering, management and science (IJAEMS) volume 3, Issue 3, March 2017

[6]. Alok Kumar "A research paper on partial replacement of cement in M_{30} concrete from silica fume and flyash" 'SSRG international journal of civil engineering volume 3 Issue 5 may 2016

[7]. Syed Rahemath Peer Quadri, Rohan S Gurav, Dr. Shreenivas Reddy Shahpur, Maneeth P. D, Brij Bhushan.S." Experimental Investigation on Partial Replacement of Natural Sand by Industrial Steel Slag with an Addition of Steel Fiber in Cement Concrete," International Journal for Scientific Research & Development| (IJSRD)- Vol. 4, Issue 6, 2016

[8]. Md. Salman Quraishi, Maneeth P D, Brijbhushan S,"Effect ofM40 Concrete With Partial Substitute of OPC With Micro Silica & Replacement of Fine Aggregate With 50% Manufactured Sand Along With addition of Steel Fiber", International Research Journal of Engineering and Technology (IRJET)- Volume: 04 Issue: 07 | July-2017, pp. 3063-3072

[9]. IS -10262:2009 code book for concrete mix design.