EFFECT OF M-SAND REPLACEMENT ON MECHANICAL AND DURABILITY PROPERTIES OF HSC WITH SILICA

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Abstract: This project is related on the use of Silica fume as a substitution of cement and 100% m-sand as fine aggregate. Concrete is the most widely utilized material in the construction industry and will hold good for years. But in the recent years, the concrete industry is facing a big challenge mainly due to the cement which is a vital component. In order to improve the durability properties many types of special concretes such as High Strength Concrete, High Performance Concrete, Fiber Reinforced Concrete, Self Compacting Concrete, etc. High Strength Concrete mixes were made with cement replaced by silica fume in proportions of 0%, 5%, 10% and 15%. For each mix, cement was replaced by silica fume and fine aggregate was replaced by 100%M-Sand

Key words: Concrete, Silica fume, High strength concrete, Aggregates

1. Introduction:

Concrete is an important structural material in human history. Concrete holds the credit of being the most widely utilized man-made material in the construction industry and will hold good for many years. The credit goes to the properties of concrete like excellent strength, durability, less maintenance costs and use in many structural applications. Thus, CO_2 emission from cement production industries increases 100%by 2020. Concrete being the most important structural material has become a choice for a variety of structural applications like houses, industrial structures, highways, bridges and water retaining structures. This is mainly due to the easy availability of the ingredients of concrete. HPC has gained importance in the recent times mainly due to its optimized performance characteristics against the different exposure conditions.

Manufactured Sand is produced by crushing rock deposition sto produce a fine aggregate which is generally more angular andhas rougher surface texture than naturally weathered sand particles. The production of M-Sand also generates high percentages of micro-fines, particlesthatpassthe75micronsieve, ranging from 5% to 20%.

2. LITERATUREREVIEW

Francois De Larrard& Thierry Sedran (2002) proposed a mix proportioning for high performances concrete considering packing density and segregation ability of dry packing particles.

Kadri& Duval (2009) and Cong et al (1992) conducted the studies on the influence of silica fume on the hydration heat of concrete. Portland cement was replaced by silica fume in 1030% by mass with water-cementitious materials (w/cm) ratios varying between 0.25 and 0.45.

Joshi (2001) studied method adopted for designing and optimizing the M60 grade HPC in the construction of along bridge connecting Bandra Worlisea link at Mumbai. He concluded that target strength of 74Mp a could be achieved

Basu(2001)discussed the use of silica fume based HPC in the construction of Indian NPP containment structures. The laboratory test results of hardened HPC mixesusedinKaigaAtomicPowerProjectunits1&2

Robert & Hasbi (2001) had undertaken a research work based on HPCof grade M75 where SF was added at 10% by weight of cement to ensure durability of the structure. They found 28 days compressive strength of HPC varied from79.6 to 81.3MP a indicating good control of concrete quality.

3. EXPERIMENTAL INVESTIGATION

3.1 Cement

Ordinary Portland cement of C53grade (Conforming to the requirements of IS: 12269) was used in all these investigations. This cement, in general, also confirms to the provisions of Type I cement as per ASTM. The characteristics of the cement used in the present investigation were presented in theTable3.1

Table 3.1: Characteristics of the cement

1	Standard consistency (%)	33
2	Specific Gravity	3.15
3	Setting Time	-
	initial (min.)	160
	Final (min.)	247

3.2 Silica fume

The American Concrete Institute (ACI) defines silica fume as || very fine non- crystalline silica produced in electric arc furnaces as a by-product of the production of elemental silicon or alloys containing silicon

Table 3.2: Properties of Silica fume

Properties	Results
Physical Properties :	
Specific gravity	2.
Surface area, m2/kg	20,000
Size, micron	0.
Bulk density, kg/m	57
Fineness modulus	<3
Chemical Properties, (%)	
SiO_2	9
Al_2O_3	0.5-

3.3 River sand

River Sand that is available in nearby locality has been used as fine aggregate. Other foreign matter present in the sand has been separated before use. The specific gravity of sand used in this investigation is2.60. Properties of rivers and are shown in table3.3

Table 3.3: Properties of River sand

Material	Specific gravity	Fineness modulus
River	2.6	2.9

3.4 M-Sand

M-Sand that is available in nearby locality has been used as fine aggregate. Other foreign matter present in the sand has been separated before use. The m-sand was sieved through 4.75mm sieve to avoid the presence of pebble sand organic matter. The specific gravity of m-sand used in this investigation is 2.90. Combined grading curves was presented in Table 3.4

Table3.4:DetailsofcombinedgradingcurvesQuarry Dust

S.No	IS Sieve size	Weight Retained in grams	Cumulative Weight Retained	Cumulative % Weight Retained	% of Weight Passing	% Passing as per IS 383-1970
1	10mm	0	0	0	100	100
2	4.75mm	7	7	0.35	99.65	90-100
3	2.36mm	132	139	3.95	93.05	75-100
4	1.18mm	754	893	44.65	55.35	55-90
5	600mi- crons	394	1287	64.35	35.65	35-50

6	300mi- crons	406	1693	84.65	15.35	8-30
7	150mi- crons	156	1849	92.45	7.55	0-10
	Total	2000		290.4		

3.5 Coarse Aggregate

Well graded and good quality crushed granite stone was chosen as coarse aggregate. The different size fractions of coarse aggregate (20mm down graded and 12.5mm downgraded) were taken in order to get a dense concrete. Combined grading curves were presented in Table3.5

Table 3.5: Details of combined grading curves 20mm downgraded

S.No	IS Sieve size	Weight Retained in grams	Cumulative % Weight Retained	Cumulative % Weight Retained	% of Weight Passing	% Passing as per IS 383-1970
1	40Mm	0	0	0	100	100
2	20mm	65	65	3.25	96.75	95-100
3	10mm	1300	1365	68.25	31.75	25-55
4	4.75mm	625	1990	99.5	0.5	0-10
5	2.36mm	10	2000	100	0	—
6	1.18mm	0	2000	100	0	—
7	600 mi- crons	0	2000	100	0	—
8	300 mi- crons	0	2000	100	0	—
9	150 mi- crons	0	2000	100	0	—
	Total	2000		**671**		

4. MECHANICAL AND DURABILITY PROPERTIES

4.1 Compressive Strength Test

The compressive strength tests on concretes were carried out in compressive strength testing machine and the capacity of them achine was3000kN. The size of the specimen was 100mm cube. The test was performed at different ages like7, 28, and 56 days.

4.2 Tensile strength Characteristics

Cylinders of 100mm diameter and 200mm height were used for splitten sile strength and this test was carried out in the same compressive strength testing machine at the age of 28days.

4.3 Flexural Strength Test

The standard sizes of beam specimen were 10x10x50 cm. The beam moulds conform to IS: 10086-1982.Compacting of concrete will be done by vibration as per IS: 5161959. The specimensweredemouldedafter24hoursofcastingand were transferred to curing tank where in they were allowed to cure for 28 days.

4.4 Water absorption

This study was done to know the relative porosity or permeability characteristics of the concrete sand was carried out according to ASTMC642-82 at 28days. The specimens used for this test were 100mm cube cured in water for 28days. The concrete cubes were cleaned by light scrubbing to remove any loose material and the initial weights were taken (w1).The cubes were dried in a hot air oven at105^{0}c and changes in the weights were measured at regular intervals.

Formu; a

4.5 Moisturemigration

Studies were also performed on 100mm cubes. Before drying the surface of the cubes were thoroughly cleaned with a wire brush to remove all loosed posits. It was observed that if these were not fully removed and the surface was not cleaned the moisture migrates very rapidly through the absorption of the porous loose deposition top.

4.6 Acid attack studies

Concrete is easily deteriorated by the aggressive action of chemical substances which could result in the disruption, cracking or desolution. These aggressive ions, particularlysulfateschemicallyreactwiththehydratedC3Acompound present in the concrete and form set tringite(3CaOAl2O33CaSO432H2O).

5. RESULTS AND DISCUSSION

Table 5.1: Strength characteristics of concretes

Sl. No.	Name	Compressive strength (Mpa)			
		7Days	28Days	56Days	of cylinderfor 28 days
1	C-1	58.5	84.5	85.5	74.41
2	SF0M	51.5	81.166	82.5	69.63
3	SF5M	59.83	86.833	88	75.58
4	SF10M	62.166	89.166	90.83	78.35
5	SF15M	51.16	80.833	81	68.39

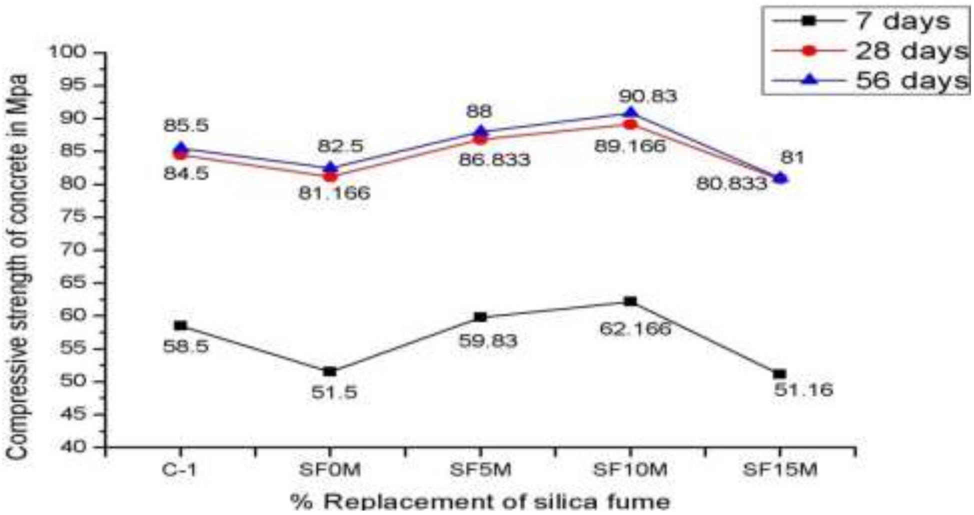

Table 5.2: 28 days Split tensile Strength of concrete

Sl. No.	Name	Split tensile Strength (Mpa)
		28Days
1	C-1	6.50
2	SF0M	6.15
3	SF5M	6.90
4	SF10M	7.69
5	SF15M	6.10

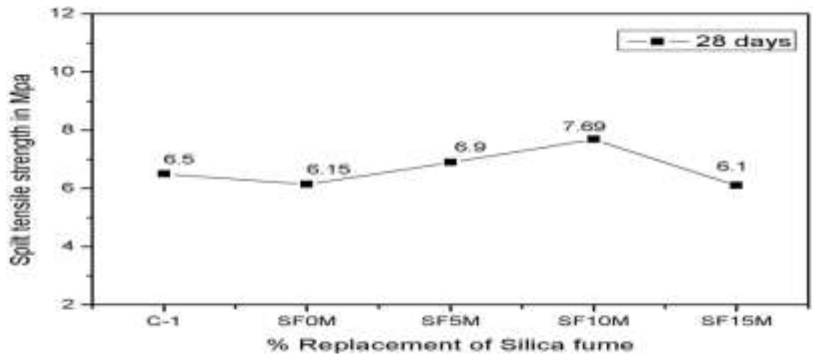

Table 5.3: 28 days Flexural Strength of concrete

Sl. No.	Name	Flexural Strength (Mpa)
		28Days
1	C-1	10.2
2	SF0M	9.8
3	SF5M	10.575
4	SF10M	10.94
5	SF15M	10.1

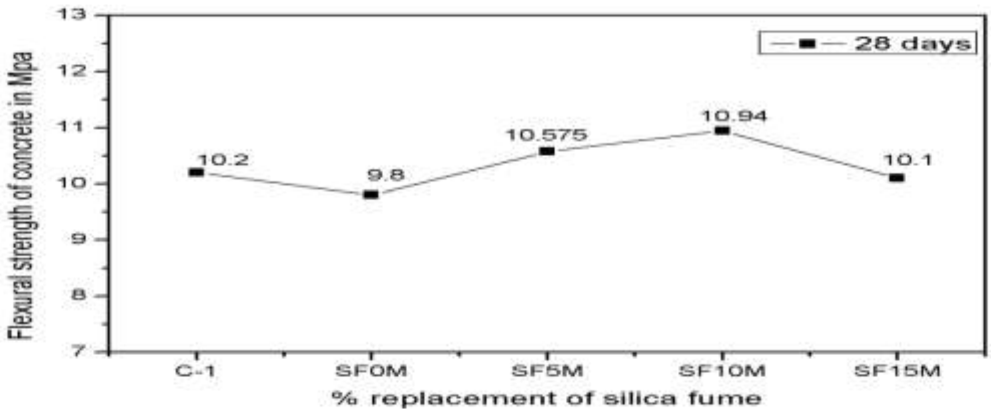

Table 5.4: Absorption characteristics of Silica fume concrete

SI. No	Name	Initial Weight	Water absorption (%) /Time(hrs)						Final Weight
		(gms)	0	0.5	6	24	48	72	(gms)
1	C-1	2435		1.20	1.35	2.35	2.85	3.17	2512
2	SF0M	2441		0.86	1.10	1.86	2.56	2.95	2513
3	SF5M	2505		0.78	0.94	1.65	2.35	2.56	2569
4	SF10M	2535		0.65	0.90	1.57	2.20	2.33	2594
5	SF15M	2548		0.96	1.10	2.05	2.76	3.05	2624

Table 5.5: Assessment criteria for absorption (CEB, 1989)

Absorption (%@30 min)	Absorption rating	Concrete Quality
<3.0	Low	Good
3.0 to 5.0	Average	Average
>5.0	High	Poor

Table 5.6: Moisture migration characteristics of Silica fume concrete

SI. No	Name	Initial Weight (gms)	Moisture migration (mm)/Time (hrs)						Final Weight (gms)
			0	0.5	6	24	48	72	
1	C-1	2465		15	20	25	28	31	2495
2	SF0M	2490		13	15	22	25	28	2535
3	SF5M	2520		11	13	23	25	26	2560
4	SF10M	2500		9	11	20	22	23	2535
5	SF15M	2560		13	16	20	24	27	2605

Table 5.7: Effect of acid attack on concrete investigated

SI. No	Name	Initial Weight (gms)	Immersion period (5%H2SO4) Weight loss (%)		
			7 Days	14Days	28 Days
1	C-1	2465	0.54	1.96	3.60
2	SF0M	2490	0.44	1.60	3.40
3	SF5M	2520	0.60	1.10	2.94
4	SF10M	2500	0.35	0.95	2.65
5	SF15M	2560	0.50	1.24	3.10

Conclusions

- The mix of 10% silica fume with 100% M-Sand achieved a maximum compressivestrengthattheageof28days.
- The splitten sile strength of mix10% silica fume with100% M-Sand was found to be maximum. Splitten sile strength of concrete is increases with increase in silica fume upto10%
- There is decrease in flexural strength with the100% M-Sand and increases with increase in silica fume percentage up to 10%. The mix of 10% silica fume with100% M-Sand achieved a maximum flexural strength.
- Thus from the above conclusions, High strength Concrete with addition of silica fume significantly improves the strength of the properties of concrete. Maximum strength has been achievedat10% replacement of silica fume with 100% m-sand.

  Durability Performance of HSC

- The moisture migration and saturated water absorption values reduced when coarse M-Sand was used. The HSC specimens with 10% silica fume and M-Sand tested for sorptivity and saturated water absorption exhibited 30% and 18% reduction at 28days respectively in comparison with control concrete mix.
- When subjected to accelerated exposure under sulpuric acid, the mix incorporating M-Sand was found to have more resistance to the impact of sulphates compared to control concrete mix. Thus, with mix of 10% silica fume and100%M-Sandissuitableforadverseenvironmentalconditions.

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