Investigation on Compression, Flexural Strength of Concrete with Manufactured Sand & Micro Silica

Madhusudhan T
(Research scholar JJT University)

***Abstract:*-This paper presents the Mix designs of C20, C35 C40, C50 grade of concrete prepared with the combination of OPC, Micro silica and Manufactured sand. Cubes were tested for compressive strength & flexural strength at 7 days, , 28days for above grades . Various tests were conducted on coarse aggregate and fine aggregate to determine specific gravity, bulk density, and fineness modulus of aggregate, The Water cement ratio is kept as per workability requirement. The compressive strength and flexural strength of concrete shall compare for the Mixes with and without Micro silica & manufactured sand**

Key words: OPC, Micro silica, M-sand, SP (Super plasticizer)

I. INTRODUCTION

1.1. Micro silica

The term micro silica is the one normally used to describe the very fine powder which is extracted from exhaust gasses of silicon and ferrosilicon smelting furnaces and utilized in Concrete to improve the properties of the concrete. Other terms for the same product are silica fume, condensed silica fume (CSF) and silica flour.

The main purpose of incorporating the material in concrete is to make use of the very fine and reactive particles to produce a denser cement matrix. The Micro silica particles have a pozzolanic reaction with calcium hydroxide from the hydration of the cement, thereby increasing the total product of hydration and reducing the amount of calcium hydroxide. When properly used, Micro silica increases the strength and reduces the permeability of the concrete providing a more durable product. A small quantity of micro silica can be effective in a concrete mix, a typical dosage being in the range 5 to 10% by weight of the cement

The OPC cement concrete with small percentage of micro silica shall give good performance for Freeze-thaw condition, reinforcement protection, and sulphate resistance, reduced aggregate reactivity.

1.2. M-Sand

Demand for crushed fine aggregates for making concrete is increasing day by day because natural sand cannot meet the rising demand of construction sector. Natural sand takes flexural millions of years to form and is not repleneshible .. Because of its limited supply the cost of natural sand has sky rocketed and its consistent supply cannot be guaranteed. Under the circumstances use of crushed fine aggregates becomes inevitable. However many people in India have doubts about quality of concrete / mortars when crushed fine aggregates are used. Crushed fine aggregates have been regularly used to make quality concrete for decades in India and abroad. Natural sand in many parts of the country is not graded properly and has excessive silt on other hand crushed sand does not contain silt / organic impurities and can be produced to meet desired gradation and fineness as per requirement.

II. OBJECTIVE

The main objective of this paper is to develop the concrete mix designs by using OPC concrete with micro silica and M-sand and evaluation of compressive strength & flexural strength of low and high grade concrete

2.1 Methodology

Generally by using M-sand the following disadvantages shall observed while making concrete

1. Concrete does not give adequate workability
2. Concrete tends to set quickly
3. Concrete tends to segregate
4. Concrete gives lower strength
5. Concrete has Honeycombs
6. Concrete surface shows irregular shaped voids

The above draw backs can be eliminated by selecting the appropriate dosage of plasticizer, cementious material, grading of M-sand and adjusting the water cement ratio

In the present experimental mix designs the W/C ratio and dosage of plasticizer increased for mixes with micro silica and manufactured sand to eliminate the above drawback

III. LITERATURE REVIEW

Nimitha et al.(2013) proved that permeability of concrete is very less for mixes with 100% M-sand concrete. Prof. R. S. Deotale et al. (2014), find that an addition of 10% fly ash considerably increase the compressive strength for all grades of concrete with 50% of M-sand. T. Shanmugapriya et al. (2012) proved that that 50% replacement of natural sand by M-sand with the combination of 5% micro silica increases the compressive strength by 18.8%when compared to similar mixes without micro silica and M-sand. V. Syam Prakash (2007) proved that by using M-sand as replacement of natural sand with uses of plasticiser in concrete mixes adequate workability can be maintained for ready mix concretes for the grade M-20and M-25. Priyanka A. Jadhav et al.(2012) conducted experimental investigation on the properties of concrete containing manufactured sand and proved that the maximum increase of strength in compression, split tensile and flexural shall be 12.61%,11.44%,14.60% at 60% of replacement of conventional sand with M-sand. Dr .S.Elavenil et al (2013), studied mix designs of M-20 to M-sandM-60 made with M-sand .Investigations were carried on various properties of M-Sand ie. Gradation, organic impurities, alkali silica reactivity, particle size, soundness etc, Investigations concluded that , Higher fineness modulus, particle grading shape, control of microfines in fine aggregate shall contribute to better workability with M-Sand concrete mixes.

IV. EXPERIMENTAL PROGRAMME

4.1. Concrete specification

Grade of concrete: C-20, C-35, C-40, C-50

Workability: 100±25 mm

Durability: Extreme climate

4.2. Material Properties

4.2.1. Cement:

A) OPC:
Ordinary Portland cement complies with BS EN 197-1:2000 CEM-1class-42.5N& it also conforms to specification of ASTM C 150-99a type 1

PHYSICAL TEST		OPC		
REQUIREMENT		Specification		Test Results
		Max	Mn	
Specific Surface Air Permeability Test (M^2 /Kg)		-----	---	320
Setting Time	Initial (Minutes)	---	60	168
	Final (Minutes)	----	----	202
Soundness Le Chatelier Expansion (mm)		10.00	---	1.5
Soundness Autoclave Expansion (%)				
Compressive Strength: Mortar Prisms				
At 3 days N/mm^2		---	10.0	20.2
At 7 days N/mm^2		----	----	30.4
At 28 days N/mm^2		----	----	45.0
CHEMICAL TESTS				
Silica (SiO_2) %		---------	-------	20.75
In soluble Residue (IR %)		5	---------	0.31
Alumina (AI_2O_3) %		--------	---------	4.12
Ferric Oxide (Fe_2O_3) %		--------	---------	4.33
Lime (CaO)%		--------	--------	62.50
Magnesia (MgO) %		5.00	-------	2.70
Sulphur Trioxide (SO_3) %		3.50	-------	2.58
Loss on ignition (LOI) %		5.00	-------	2.00
Chloride (Cl) %		0.10	---------	0.01
Alkalies (Na_2O+0.658 K_2O) %		0.60	---------	0.50
Tricalcium Silicate (C_3S) %		---------	---------	55.51
Dicalcium silicate (C_2S) %		---------	--------	17.61
Tricalcium aluminate (C_3A) %		---------	--------	3.59
Lime saturation Factor (LSF) %		102	66	92.16
Alumina Modulus (AM) %		-------	0.64	0.95

Table.4.2.1

4.2.2. Microsil [R] Physical and chemical **Properties**

Analysis	EN 13263 1,2	ASTM C1240	Typical
SiO_2 %	Min 85	Min 85	90-97
Free Si %	Max 0.4	------------	0.14
Free CaO %	Max 1.0	-------------	<0.1
SO_3 %	Max 2.0	------------	0.25
Na_2O eq %	To report	To report	0.5
Cl %	Max 0.3	------------	0.3
Loss on ignition %	Max 4.0	Max 6.0	2.0
Specific surface (BET)(m^2/g)	15-35	Min 15	23
Pozzolanic Activity Index Normal curing (28 days)	Min 100	------------	110
Pozzolanic Activity Index Normal curing (7days)	-------------	Min105	115
Bulk Density (Kg/m^3)			
Undensified	-----------	To report	350-650
densified		To report	150-170
H_2O %	-------------	Max 3%	0.3
> 45 µm %	------------	Max 10.0	1.2
P^H	-------------	-------------	7.5
Brightness			45

Table.4.2.2

4.2.3. Aggregate Physical & Chemical Properties

S,No	Property	FA(River sand)	FA(M-sand)	CA (10mm)	CA(20mm)
1	Specific gravity	2.68	2.58	2.81	2.81
2	Water absorption by %	1.7	1.1	0.7	0.7
3	Fineness modulus	2.68	2.8	------	----
4	Grading Zone	BS882-1992	ASTM	BS882-1992	BS882-1992 Spec
5	Soundness of aggregate Weighted percent loss	2	0.7	<1	<1
6	Chemical Analysis of aggregate				
	a) acid soluble chloride%			0.01	0.01
	b) acid soluble sulphate so_3 %			0.02	0.0
7	Organic impurities	Absent		--------	-------------
8	Potential Alkali Reactivity a) Dissolved silica as Sio_2 mmol/L b) Reduction in alkalinity mmol/L	 18 135		 16 110	16 110
9	Clay lump & Friable particles of aggregate %	0.04		----------	-------------
10	Aggregate Impact value %			14%	14%
11	Losangels Abrasion value			16%	16%
12	Ten percent fines value			290 KN	290 KN
13	Flakiness index			16%	16%
14	Elongation Index			24	24

Table.4.2.3

4.3. Gradation of Aggregates

4.3.1 Gradation of Fine Aggregate

A) River Sand

Sieve Analysis

BS Sieve Size In (mm)	Cumulative % Retained	Cumulative % passing	BS 882 -1992. Spc limit	
			Lower	Upper
10	0	100	100	
5	0.72	99.28	100	
2.36	22.2	77.8	60	100
1.18	40.8	59.2	30	90
0.600	62.74	37.26	15	54
0.300	76.6	23.4	5	40
0.150	90.3	9.7	0	10
0.075	96.7	3.3	0	4

Table 4.3.1(A)

B) M-Sand

BS Sieve Size In (mm)	Cumulative % Retained	Cumulative % passing	ASTM C33 Manufactured sand and blends	
			Min	Max
9.5	0	100	100	100
4.75	3.6	96.4	80	100
2.36	19.2	80.8	60	100
1.18	38.5	61.5	40	85
0.600	54.8	45.2	20	60
0.300	78	22	10	45
0.150	97.1	2.9	0	30
0.075	97.1	2.9	0	18

Table 4.3.1(B)

4.3.2 Gradation of Coarse Aggregate (20mm)

Sieve Analysis

BS Sieve Size In (mm)	Cumulative % Retained	Cumulative % passing	BS 882 -1992. Spc limit	
			Lower	Upper
37.5	0	100	100	
20	1	99	85	100
14	42.75	57.25	0	70
10	84.941	15.1	0	25
5	99.72	0.3	0	5
2.36	99.72	0.3		
1.18	99.72	0.3		
0.600	99.72	0.3		
0.300	99.72	0.3		
0.150	99.72	0.3		
0.075	99.72	0.3		

Table 4.3.2

4.3.3.Gradation of Coarse Aggregate (10mm)

Sieve Analysis

BS Sieve Size In (mm)	Cumulative % Retained	Cumulative % passing	BS 882 -1992. Spc limit	
			Lower	Upper
14	0	100	100	
10	0.80	99.2	85	100
5	85.83	14.2	0	25
2.36	99.8	0.2	0	5
1.18	99.8	0.2		
0.600	99.8	0.2		
0.300	99.8	0.2		
0.150	99.8	0.2		
0.075	99.8	0.2		

Table 4.3.3

5. MIX DESIGN

Mix	Description of concrete	Characteristic Strength	Component of Materials in $1m^3$ concrete batch Kg/m^3								
		N/mm^2	Cement Kg	Micro silica Kg	Water lt	FA Kg		CA Kg		SP kg/m^3	W/C ratio
						NS	MS	20 mm	10 mm		
A_1	C-20/20	20	250	-----	135	990	-----	783	335	3.5	0.54
A_2	C-20/20	20	232	18	150	990	------	783	335	4	0.6
A_3	C-20/20	20		18	150	-----	990	783	335	4	0.6
B_1	C-35/20	35	380	-----	150	815	-----	830	310	4.5	0.39
B_2	C-35/20	35	353	27	160	810	----	830	310	4.5	0.41
B_3	C-35/20	35	353	27	160	---	815	830	310	6	0.41
C_1	C-40/20	40	420	-----	163	773	-----	790	320	5.5	0.38
C_2	C-40/20	40	390	30	173	773	-----	700	320	5.5	0.41
C_3	C-40/20	40	390	30	173	---	773	700	320	6.5	0.41
D_1	C-50/20	50	450	-----	153	710	-----	610	475	5.5	0.34
D_2	C-50/20	50	418	32	163	710	-----	610	475	5.5	0.36
D_3	C-50/20	50	418	32	163	---	710	610	475	7	0.36

Table 5.1

RESULTS & DISCUSSION

Researchers proved that micro silica replacement as cementious material in the concrete shall give good strength when micro silica used in the proportion 5% to 10% weight of cementious material. Present experimental study 7% of microsilica by weight of cementious material is used

Grade of Concrete	Mix	Compressive Strength		Flexural Tensile strength	
		7days N/mm^2	28 days N/mm^2	7days N/mm^2	28 days N/mm^2
C-20/20	**A_1**	17	25	3.5	5
	A_2	22	29	3.8	5.9
	A_3	21	27	3.7	4.9
C-35/20	**A_1**	28	42	4.5	5.40
	A_2	37	48	4.9	6
	A_3	35	46	4.5	5.9
C-40/20	**A_1**	30	46	4.7	5.6
	A_2	39	51	5.1	6.2
	A_3	35	54	4.7	6.0
C-50/20	**A_1**	54.1	61	5.5	7
	A_2	60.8	70	5.8	7.8
	A_3	59	69	5.8	6.9

Table 5.2

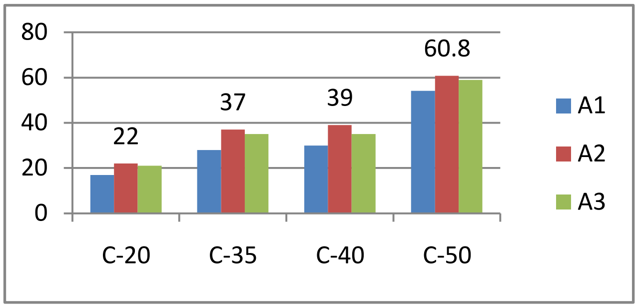

Figure.1

7 Days Compressive Strength

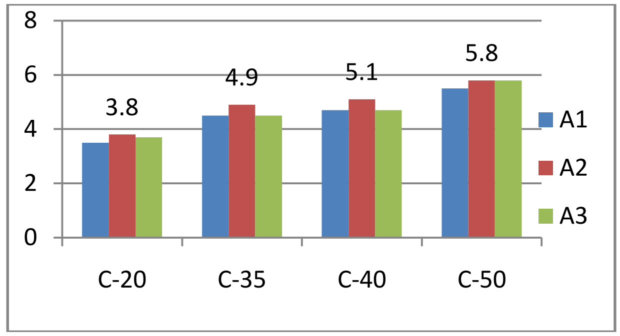

Figure.2

7 Days Flexural Strength

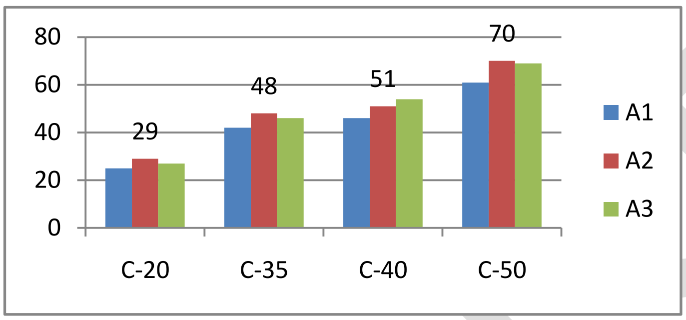

Figure.2

28 Days Compressive Strength

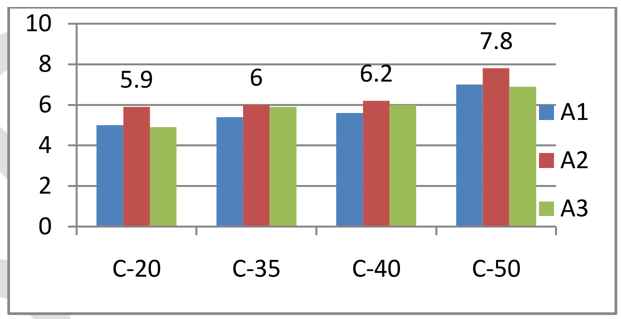

Figure.2

7 Days Flexural Strength

The above results show that the replacement of 7% of cement by micro silica produces higher strength in concrete. The same strength can be obtained in the mixes by replacing the natural sand with M-Sand.

For mixes with Micro silica and M-sand higher dosage of Plasticizer and higher W/C ratio used when it compared to same grade of concrete with natural sand without micro silica

REFERENCES

[1] Effect of Manufactured Sand on Durability Properties of Concrete. (by Nimitha vijayraghavan, Dr.A.S Wayal. American Journal of Engineering 2013Volume-02, Issue-12, pp-437-440)

[2] To Study of Concrete Mix with Partial Replacement of Cement by suitable Pozzolonic Cementitious Material and Sand by Manufactured Quarry Sand.(by Prof R. S. Deotale, Harshavardhan L. Rangari, Prof Swapnil P. Wanjari International Journal of Emerging Technology and Advanced Engineering Volume 4, Issue 3, March 2014)

[3] 3.Optimization of partial replacement of m-sand by natural sand in high performance concrete with silica fume(by

[4] T. Shanmugapriya, R. N. UmaT. International Journal of Engineering Sciences & Emerging Technologies, June 2012Volume 2, Issue 2, pp: 73-80)

[5] Ready mixed concrete using manufactured sand as fine aggregate (by V. Syam Prakash, 32nd Conference on OUR WORLD IN CONCRETE & STRUCTURES: 28 - 29 August 2007, Singapore)

[6] Experimental investigation on the properties of concrete containing MANUFACTURED SAND, (by Priyanka A. Jadhav, Dilip K. KulkarniAN International Journal of Advanced Engineering TechnologyIJAET/Vol.III/ Issue II/April-June, 2012/101-104)

[7] Manufactured Sand, A Solution And An Alternative To River Sand And In ConcreteManufacturing, (by Dr.S.Elavenil, B. Vijaya,
Journal of Engineering, Computers & Applied Sciences (JEC& AS) Volume 2, No.2, ,February 2013)

[8] BS 882 -1992. Spc limit

[9] BS1881: Part 122:2011

[10] 9.. **Microsil** ^{R} Product Information