Impact Factor (SJIF): 3.632

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 3, Issue 4, April-2016

Effect of combination of micro silica and fly ash in high performance concrete

Umang K. Patel[1], Prof. Himesh Bhavani[2]

[1] PG Student, M.E. (Civil) Infrastructure Engineering, L.D.R.P. Institute of Technology & Research, Gandhinagar
[2]Faculty , Department of Civil Engineering, L.D.R.P. Institute of Technology & Research, Gandhinagar

Abstract — Concrete is the most widely used construction materials in civil engineering industry because of its high structural strength and stability. Concrete is most important engineering material. By adding or replacing of some of material may change the properties of concrete. Studies have been carried out to investigate the possibility of utilizing a broad range of materials as partial replacement materials for cement in the production of concrete.

This present research work is mainly focused on one of such method in which Micro silica is used to improve the compressive of concrete. It gives the brief information regarding how exactly Micro silica affects strength and durability parameters like compressive strength and workability of concrete.

In these theses in concrete mixture, cement is first replaced by fly ash by 15%, 17.5%, 20% and for every % of Fly ash, micro silica should be use as filler material by 5%, 8%, 10% replacement of cement. By limiting the content of fly ash and micro silica whatever gives better result than normal concrete in terms of strength, workability and durability. The grade of concrete M50 tested for various percentage of replacement to obtain result.

Keywords- Concrete, Environmental, High performance concrete, Micro Silica, Fly ash, Workability, Compressive strength.

I. INTRODUCTION

Micro Silica is an extremely reactive pozzolanic material. It is a by-product obtained from the manufacture of silicon or Ferro-silicon. It is extracted from the flue gases from electric arc furnaces. Micro Silica particles are very fine with particle sizes about hundred times smaller than those of average size of OPC particles. It is a densified powder or is in the form of water slurry. The standard specifications of Silica Fume are defined in ASTM 1240. It can be used successfully for the structures where high strength is needed or significantly reduced permeability to water is the major concern. Silica fume used in this study was taken from Green Field Projects. Extraordinary procedures are required to be adopted for handling, placing and curing concrete with these very fine Micro Silica particles.

Fly Ash (FA) class F, known also as pulverized- fuel ash, is the by-product obtained by electrostatic and mechanical means from flue gases of power station furnaces fired with pulverized coal. The similarity of FA to natural pozzolans of volcanic origin has encouraged the use of FA in conjunction with Portland cement in making the concrete. FA is complicated in its chemical and phase compositions. It consists of heterogeneous combinations of glassy and crystalline phases. However, wide ranges exist in the amounts of the three principal constituents- SiO2 (25 to 60%), Al2O3 (10 to 30%), and Fe2O3 (5 to 25%). FA can be categorised into two classes, i.e. Class F and Class C, according to ASTM C 618-99 (1999). If the sum of these three ingredients is 70% or greater, the FA is categorised as Class F. However, as Class C, FA generally contain significant percentages of calcium compounds reported as CaO, the sum of the three constituents just mentioned is required only to be greater than 50%.

II. CHEMICAL ANALYSIS

Sr No	Parameter	Result (%)
1	Silica (As SiO2)	94.34
2	Alumina (As Al2O)	0.071
3	Alkali (As K2O)	0.40
4	LOI at 950 C	0.70
5	Moisture	0.70
6	Sieve Analysis	0.85
	Retained on 325BSS Mesh	

Table 2.1: Chemical Content in Micro Silica

Sr No	Parameter	Result (%)
1	SiO2	53.36
2	Al2O3	26.49
3	Fe2O3	10.86
4	Cao	1.34
5	Na2O	0.37
6	K2O	0.80
7	TiO2	1.47
8	MgO	0.77
9	P2O5	1..43
10	SO3	1.70
11	LOI	1.39

Table 2.2: Chemical Content in Fly Ash

III. EXPERIMENTAL STUDIES AND METHODOLOGY

Details of the materials used, the methods adopted in preparing the test specimens and the different test procedures are discussed here. The experimental program consisted of five main stages.

Stage 1: Selection of Material:

In this stage Fly Ash and Micro Silica is selected based on results obtained from literature review.

Stage 2: Mix Proportions:

Replaced the cement by Fly Ash by 15%, 17.5% and 20% and also further replaced it by Micro Silica by 5%, 8% and 10% in M50 grade of concrete. The mix proportions of various materials of concrete are as per IS-CODE.

Stage 3: Experimental Investigation:

Laboratory investigations for determination of mechanical properties of Concrete like workability by slump test, compressive strength.

Stage 4: Performing the statistical analysis of results obtained from experimental investigation.

Graph and chart are developed from the result obtained from the compressive strength at 7 and 28 days and. Compare the Result of the test.

Stage 5: Give the Conclusion based on the analysis from the experiments.

Give the conclusion based on effect of Fly Ash and Micro Silica on the concrete strength using in different proportion.

.

- **Mix Proportion of Concrete:**

Table 3.1: Mix Design For M50 Grade of Concrete with Fly ash 15%, 17.5% and 20% Replacement

Sr No.	**Material**	**As per Design Mix(Kg /M3)**		
		F.A 15 %	**F.A 17.5%**	**F.A 20%**
1	Cement	450	441	427.2
2	Fly Ash	84	93	106.8
3	Micro Silica	0	0	0
4	20 mm	732	732	732
5	10 mm	370	370	370
6	River Sand	671	671	671
7	Water	176.22	176.22	176.22
8	Admixture	6.408	6.408	6.408
9	Total weight of material	2489.63	2489.63	2489.63

Table 3.2: Mix Design For M50 Grade of Concrete with Replacement of Fly Ash 15% & Micro Silica 5%, 8% and 10%

Sr No.	**Material**	**As per Design Mix(Kg /M3)**		
		F.A 15 % & M.S 5%	**F.A 15% & M.S 8%**	**F.A 15% & M.S 10%**
1	Cement	427.2	411.18	400.5
2	Fly Ash	80.1	80.1	80.1
3	Micro Silica	26.7	42.72	53.4
4	20 mm	732	732	732
5	10 mm	370	370	370
6	River Sand	671	671	671
7	Water	176.22	176.22	176.22
8	Admixture	6.408	6.408	6.408
9	Total weight of material	2489.63	2489.63	2489.63

Table 3.3: Mix Design For M50 Grade of Concrete with Replacement of Fly Ash 17.5% & Micro Silica 5%, 8% and 10%

Sr No.	Material	As per Design Mix(Kg /M3)		
		F.A 17.5 % & M.S 5%	F.A 17.5% & M.S 8%	F.A 17.5% & M.S 10%
1	Cement	413.85	397.83	387.15
2	Fly Ash	93.45	93.45	93.45
3	Micro Silica	26.7	42.72	53.40
4	20 mm	732	732	732
5	10 mm	370	370	370
6	River Sand	671	671	671
7	Water	176.22	176.22	176.22
8	Admixture	6.408	6.408	6.408
9	Total weight of material	2489.63	2489.63	2489.63

Table 3.4: Mix Design For M50 Grade of Concrete with Replacement of Fly Ash 20% & Micro Silica 5%, 8% and 10%

Sr No.	Material	As per Design Mix(Kg /M3)		
		F.A 20 % & M.S 5%	F.A 20% & M.S 8%	F.A 20% & M.S 10%
1	Cement	400.50	384.48	373.80
2	Fly Ash	106.8	106.80	106.8
3	Micro Silica	26.7	42.72	53.40
4	20 mm	732	732	732
5	10 mm	370	370	370
6	River Sand	671	671	671
7	Water	176.22	176.22	176.22
8	Admixture	6.408	6.408	6.408
9	Total weight of material	2489.63	2489.63	2489.63

IV. TEST RESULTS

Table 4.1: Cube Test Result of M50 Grade with 15% Fly ash replacement

Sr No.	Identification	Slump Test (mm)	Weight of Cube (gram)	Cube Strength (KN)		Result (N/mm2)	Average Result(N/mm2)
				7 Days	28 Days		
1	U/1 Fly Ash : 15% Micro Silica : 0%	Initial: 190	8639	925.0		41.11	41.34
2			8530	949.0		42.17	
3			8667	917.0		40.75	
4		30 min: 140	8764		1375.5	61.13	59.05
5			8663		1261.0	56.05	
6			8770		1349.0	59.97	

Table 4.2: Cube Test Result of M50 Grade with 15% Fly ash 5% Micro Silica replacement

Sr No.	Identification	Slump Test (mm)	Weight of Cube (gram)	Cube Strength (KN)		Result (N/mm2)	Average Result(N/mm2)
				7 Days	28 Days		
1	U/2 Fly Ash : 15% Micro Silica : 5%	Initial: 185	8724	1235.5		54.91	49.88
2			8618	1049.0		46.62	
3			8868	1083.0		48.13	
4		30 min: 130	8490		1513.5	67.26	65.64
5			8720		1456.0	64.72	
6			8804		1461.0	64.94	

Table 4.3: Cube Test Result of M50 Grade with 15% Fly ash 8% Micro Silica replacement

Sr No.	Identification	Slump Test (mm)	Weight of Cube (gram)	Cube Strength (KN)		Result (N/mm2)	Average Result(N/mm2)
				7 Days	28 Days		
1	U/3 Fly Ash : 15% Micro Silica : 8%	Initial: 175	8761	1355.5		60.24	58.98
2			9230	1248.0		55.46	
3			8862	1378.0		61.24	
4		30 min: 130	8628		1722.5	76.56	73.72
5			8528		1594.0	70.84	
6			8626		1659.5	73.76	

Table 4.4: Cube Test Result of M50 Grade with 15% Fly ash 10% Micro Silica replacement

Sr No.	Identification	Slump Test (mm)	Weight of Cube (gram)	Cube Strength (KN)		Result (N/mm2)	Average Result(N/mm2)
				7 Days	28 Days		
1	U/4 Fly Ash : 15% Micro Silica :10%	Initial: 150	8854	1213.0		53.91	47.93
2			8778	985.0		43.77	
3			8816	1038.0		46.13	
4		30 min: 120	8906		1386.0	61.59	63.07
5			8918		1367.0	60.76	
6			8728		1504.5	66.86	

Table 4.5: Cube Test Result of M50 Grade with 17.5% Fly ash replacement

Sr No.	Identification	Slump Test (mm)	Weight of Cube (gram)	Cube Strength (KN)		Result (N/mm2)	Average Result(N/mm2)
				7 Days	28 Days		
1	U/5 Fly Ash : 17.5% Micro Silica: 0%	Initial: 180	8430	995.0		44.22	44.66
2			8593	974.0		43.28	
3			8750	1045.0		46.48	
4		30 min: 130	8710		1391.5	61.84	62.47
5			8805		1453.0	64.57	
6			8580		1372.5	61.00	

Table 4.6: Cube Test Result of M50 Grade with 17.5% Fly ash 5% Micro Silica replacement

Sr No.	Identification	Slump Test (mm)	Weight of Cube (gram)	Cube Strength (KN)		Result (N/mm2)	Average Result(N/mm2)
				7 Days	28 Days		
1	U/6 Fly Ash : 17.5% Micro Silica :5%	Initial: 200	8960	982.0		43.64	53.44
2			8947	1295.0		57.55	
3			8846	1330.0		59.13	
4		30 min: 160	8556		1565.0	69.54	69.40
5			8370		1547.5	68.79	
6			8730		1572.0	69.87	

Table 4.7: Cube Test Result of M50 Grade with 17.5% Fly ash 8% Micro Silica replacement

Sr No.	Identification	Slump Test (mm)	Weight of Cube (gram)	Cube Strength (KN)		Result (N/mm2)	Average Result(N/mm2)
				7 Days	28 Days		
1	U/7 Fly Ash : 17.5% Micro Silica: 8%	Initial: 200	9049	950.0		42.22	46.16
2			8811	1147.5		51.0	
3			8898	1018.0		45.26	
4		30 min: 180	8850		1289.0	57.29	61.54
5			9205		1413.0	62.80	
6			8670		1452.0	64.53	

Table 4.8: Cube Test Result of M50 Grade with 17.5% Fly ash 10% Micro Silica replacement

Sr No.	Identification	Slump Test (mm)	Weight of Cube (gram)	Cube Strength (KN)		Result (N/mm2)	Average Result(N/mm2)
				7 Days	28 Days		
1	U/8 Fly Ash : 17.5% Micro Silica: 10%	Initial: 190	9049	1057.5		47.00	45.38
2			8811	970.0		43.11	
3			8898	1036.0		46.04	
4		30 min: 145	8518		1461.0	64.93	60.51
5			8308		1312.0	58.32	
6			8767		1311.0	58.28	

Table 4.9: Cube Test Result of M50 Grade with 20% Fly ash replacement

Sr No.	Identification	Slump Test (mm)	Weight of Cube (gram)	Cube Strength (KN)		Result (N/mm2)	Average Result(N/mm2)
				7 Days	28 Days		
1	U/9 Fly Ash :20% Micro Silica: 0%	Initial: 170	8420	860.0		38.22	40.75
2			8638	947.5		42.11	
3			8583	943.0		41.92	
4		30 min: 135	8779		1306.5	58.06	56.59
5			8820		1359.0	60.41	
6			8642		1154.0	51.03	

Table 4.10: Cube Test Result of M50 Grade with 20% Fly ash 5% Micro Silica replacement

Sr No.	Identification	Slump Test (mm)	Weight of Cube (gram)	Cube Strength (KN)		Result (N/mm2)	Average Result(N/mm2)
				7 Days	28 Days		
1	U/10 Fly Ash :20% Micro Silica: 5%	Initial: 180	8432	1144.0		50.86	47.63
2			8462	1021.0		45.38	
3			8502	1049.5		46.65	
4		30 min: 125	8601		1434.0	63.73	62.67
5			8638		1331.0	59.16	
6			8457		1465.0	65.12	

Table 4.11: Cube Test Result of M50 Grade with 20% Fly ash 8% Micro Silica replacement

Sr No.	Identification	Slump Test (mm)	Weight of Cube (gram)	Cube Strength (KN)		Result (N/mm2)	Average Result(N/mm2)
				7 Days	28 Days		
1	U/11 Fly Ash :20% Micro Silica: 8%	Initial: 160	8315	993.0		44.12	42.57
2			8690	838.0		37.25	
3			8763	1042.5		46.34	
4		30 min: 110	8700		1214.0	53.96	59.12
5			8785		1293.5	57.48	
6			8905		1483.0	65.92	

Table 4.12: Cube Test Result of M50 Grade with 20% Fly ash 10% Micro Silica replacement

Sr No.	Identification	Slump Test (mm)	Weight of Cube (gram)	Cube Strength (KN)		Result (N/mm2)	Average Result(N/mm2)
				7 Days	28 Days		
1	U/12 Fly Ash :20% Micro Silica: 10%	Initial: 170	8488	935.0		41.56	38.76
2			8605	896.0		39.82	
3			8438	785.0		34.90	
4		30 min: 130	8560		1134.0	50.41	53.83
5			8710		1266.5	56.29	
6			8498		1233.0	54.79	

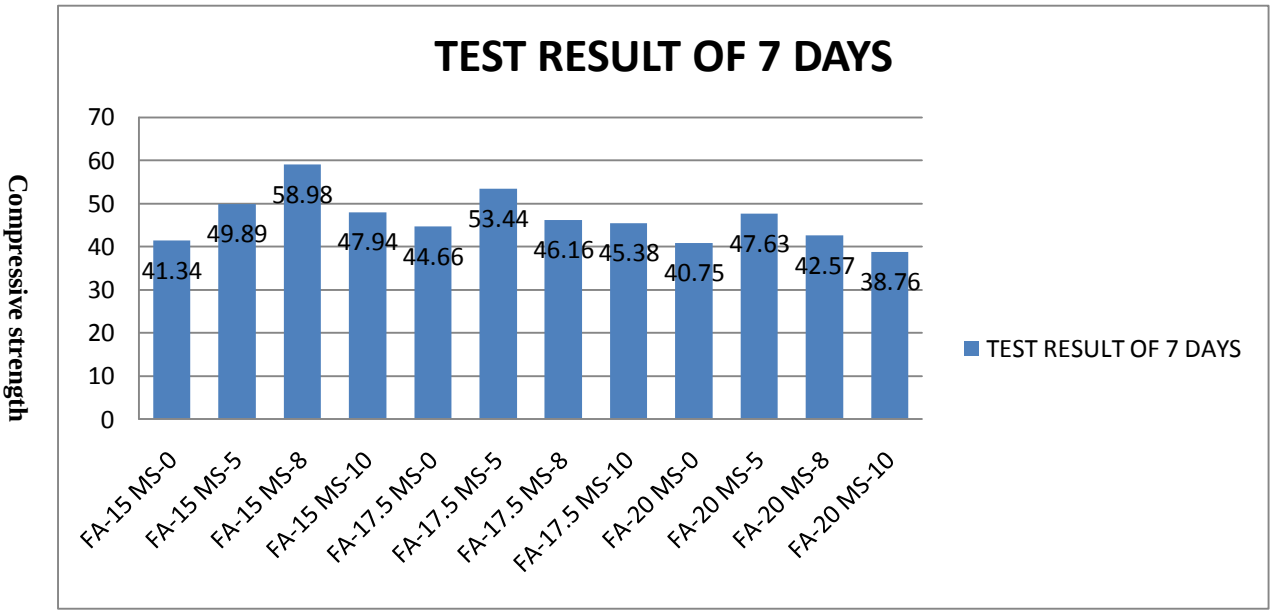

Fig 4.1: Graphical representation of Compressive strength at 7 days

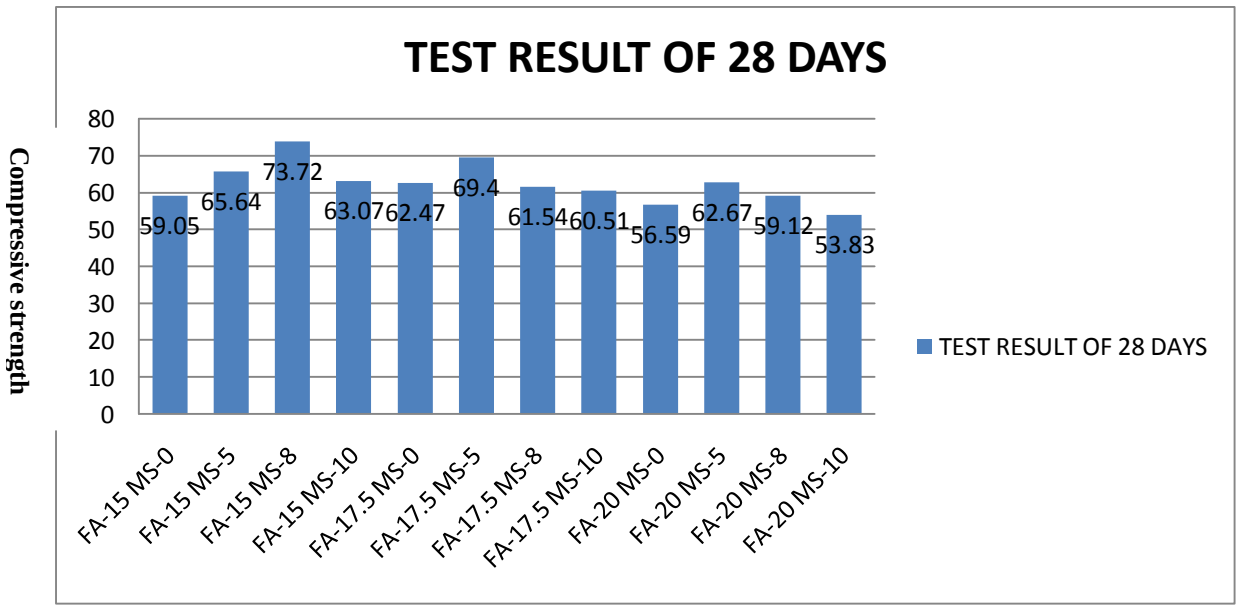

Fig 4.2: Graphical representation of Compressive strength at 28 days

V. CONCLUSION

- **Results for Compressive Strength for only Fly Ash**:
  The compressive strength of concrete for cubes, all mixes at 7 and 28 days of curing. Only 6 cubes were casted for various percentage replacements of cement by Fly Ash. The result shows that the Compressive strength of concrete at 15%, 17.5% & 20% fly ash replacement are respectively 59.05 KN/mm2, 62.47 KN/mm^2 & 56.59 KN/mm^2. From above them highest result, i.e. 62.47 KN/mm^2 at 17.5% of Fly ash replacement by weight of cement.

- **Results for Compressive Strength for Combination of Micro Silica and Fly Ash**:
  The result shows that the Compressive strength of concrete at various combination of fly ash and micro silica. From all of them highest result, i.e. 73.72 KN/mm^2 at combination of 15% fly ash and 8% Micro Silica replacement by weight of cement.

REFERENCES

[1] Amar Devendra Shitole, Sandhya Mathapati "The Use of Micro-Silica to Improve the Compressive and Flexural Strength of Concrete" International Journal of Mechanical and Production Engineering, Volume- 2, Issue-8, August 2014

[2] Anil Kumar, Poonam, Ashok K. Gupt "Experimental Investigation of Influence of Micro Silica on High Strength Concrete Properties" International Journal of Engineering Research and Applications (IJERA), National Conference on Advances in Engineering and Technology, March 2014

[3] Upadhyay Siddharth P., M. A. Jamnu. "Effect on Compressive strength of High Performance Concrete Incorporating Alccofine and Fly Ash" International Journal of Innovative Research and Development 3.2 (2014)

[4] Nayak Praveen, H. S. Narasimhan, Raghunandan V. Kadaba. "Hardened properties of concrete made with Micro silica and Alccofine–A performance optimization based comparative study." International Journal of Engineering Research and Development 10.8 (2014): 01-04

[5] Madhusudhan T. "Utilization of micro silica as partial replacement of OPC & SRC in concrete" International Refereed Journal of Engineering and Science Volume 3, Issue 3(March 2014), PP.67-73

[6] Patil Shreekedar A, Kumbhar P. D "Study On Effect of Mineral Admixtures in Mix Proportioning of HPC"International Journal of Research in Advent Technology Volume 1, Issue 5, December 2013

[7] Verma, Ajay, Rajeev Chandak, and Rk Yadav. "A review for characterization of silica fume and its effect on concrete with pozzolanic Portland cement."International Journal of Scientific & Engineering Research 4.1 (2013).

[8] Dhagat Aditya, and Manav Mittal. "Effect of MicroSilica and fly ash on the strength of concrete" International Journal of Scientific & Engineering Research, Volume 4, Issue 8, August 2013

[9] Mr. Sarath S, Mr. R Vandhiyan, Dr.E B Perumal Pillai "Corrosion Properties of Concrete Containing Micro Silica" International Journal of Advancements in Research & Technology, Volume 2, Issue4 (April 2013)

[10] Ajay, Verma, Chandak Rajeev, and R. K. Yadav. "Effect of micro-silica on the strength of concrete with ordinary Portland Cement." Res. J. Eng. Sci 1 (2012): 1-4.

[11] http://www.howconcreteworks.com/properties_of_concrete.html

[12] Shetty, M. S. Concrete Technology (ME). S. Chand, 2005.

[13] Neville, Adam M. Properties of concrete. 1995

[14] Indian standard code IS 12269:1987 "Specification for 53 grade ordinary Portland cement "

[15] Indian standard code IS 10262:2009 "Concrete mix proportioning guide lines"

[16] Indian standard code IS 1199:1959 "Methods of sampling and analyses of concrete"

[17] Indian standard code IS 516:1959 "Methods of test for strength of concrete"

[18] Indian standard code IS 456:2000 "Code of Practice for Plain and reinforced concrete"