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PARTIAL REPLACEMENT OF CEMENT WITH MICROSILICA

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ABSTRACT: Concrete is the most important engineering material and the addition or replacement of some of the materials may change the properties of the concrete. Micro silica is an amorphous type of silica dust mostly collected in bag house filters as by-product of the silicon and Ferro-silicon production. The paper summarizes important physical and chemical properties of micro silica and uses those results for an evaluation of micro silica from a Healthy Safety and Environment (HSE) standpoint. Micro silica consists of spherical particles with an average particle size of 150nm and a specific surface area of typically 20 m3/g. More than 500,000 MT of micro silica are sold to the building industry world-wide and are used in fiber cement, concrete, oil-well drilling, refractories, and even in polymer. The use of micro silica had major impact on industries , ability to routine and commercial produces silica fume modified concrete of flow able in nature but yet remain cohesive, which in turn produces high early and later age strength including resistant to aggressive environments. This is an experimental study on nature of micro silica and its influence on the properties of fresh concrete. The partial replacement of cement by micro silica the strength parameters of concrete have been studied. First the strength parameters of concrete without any replacement were studied then strength parameters by partial replacement with silica fume have been studied by placing cube and cylinder of concrete on compression testing machine (CTM). Micro silica were used to replace by 10%, 13%, 15% of cement. The results showed that partial replacement of cement by micro silica had significant effect on the compressive strength of cube and split tensile strength of cylinder. The strength of concrete increases rapidly as we increase the micro silica and optimum value of compressive strength is obtained at 13% replacement. After 13% replacement it starts decreasing under uniform load condition of 3 to 4 KN and split tensile strength increases up to 13% and then starts decreasing under the uniform load of 2KN.

I. INTRODUCTION

Micro Silica

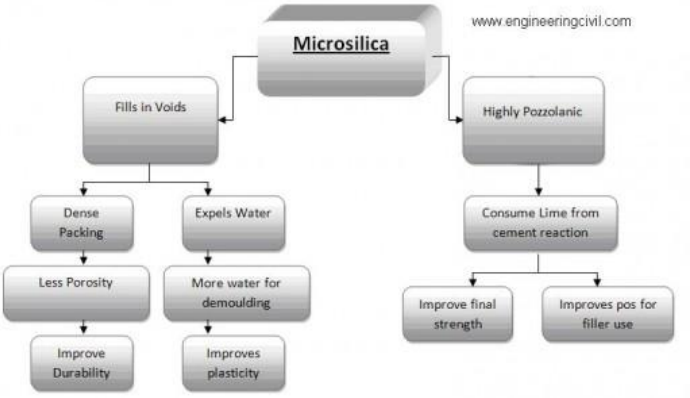
Mineral additions which are also known as mineral admixtures have been used in Portland cement for many years. There are two types of additions which are commonly mixed into the Portland clinker or blended directly with cement these days. They are crystalline, also known as hydraulically inactive additions and pozzolanic, which are hydraulically active additions. Silica fume is very reactive pozzolans, while it is used in concrete because of its fine particles, large surface area and high SiO2 content. Silica fume is much fined separated silica obtained as a by-product in industry. It is used as an admixture in the concrete mix and it has significant effects on the properties of the resulting material. Simultaneously, silica fume can be also utilized in production of refectory and porcelain, to increase intensity and durability. In addition, it can improve the overall performance of the material as filler used in coating resin, paint, rubber and other high molecular materials. This review paper discusses the effects of silica fume on the concrete properties such as strength, modulus, ductility, permeability, chemical attack resistance, corrosion, freeze-thaw durability, creep rate. Characterisation of silica fume as well as its physical and chemical properties will also be reviewed in this paper.

How Micro Silica Improves Concrete

Finer than fly ash, this pozzolans increases strength and density, reduces concrete permeability Since micro silica particles are only about 1 to 100 the size of cement grains, the material may be hard to batch and ship. These handling problems may be overcome by mixing micro silica with water (and sometimes other admixtures) in a slurry which replaces part of the normal concrete mixing water. Densification and palletization have also been tried to simplify the mixing and handling.

Micro silica Concrete Applications

Because of the pozzolanic and micro filler effect of micro silica, its use in concrete can improve many of its properties opening up a wide range of applications including



Materials used in the Present Work

The materials used in the present investigation are:

Cement – OPC 53 grade conforming to IS 12269 –1987

Fine aggregate – natural sand – IS383 – 1970

Coarse aggregate – crushed 20mm maximum size –IS383 – 1970

Micro silica
Portable water
Super plasticizer -B233

II. TEST ON MATERIALS

TESTS ON CEMENT	VALUES
Standard consistency	30%
Initial setting time	37 Min
Final stetting time	9 hours
Fineness modulus	2.67%
Compression strength	50MPa
Soundness	2mm
Specific gravity	3.157

Table 2.1 Test results of cement

Test conducted on materials	Fine aggregate	Coarse aggregate
Specific gravity	2.61	2.7
Bulk density	1.64 gm/cc	1.52 gm/cc
Moisture content	1.04%	0.92%

Table 2.2 Test result of materials

III. CONCRETE MIX DESIGN

Mix Ratio

Cement	Coarse Aggregate	Fine Aggregate	Water
383kg/m^3	1150kg/m^3	691.8kg/m^3	192kg/m^3

IV. EXPERIMENTAL METHODOLOGY

Tests on Fresh Concrete

4.1 Workability tests

- Slump test
- Compaction factor test

4.2 Tests on Hardened Concrete

- Compression Test
- Flexural strength
- Split Tensile Strength

V. TEST RESULT AND ANALYSIS

a. Compression Test Results

For 3 days:

Sl. No	Sample Name	Percentage of Replacement	Weight of sample	Peak load	Compressive Strength
1	C1	0	8.4	200	8.8
2	C2	0	8.24	193	8.5
3	C3	0	8.3	185	8.4
4	R1	10	8.49	250	11
5	R2	10	8.29	300	13.3
6	R3	10	8.32	290	12.8
7	S1	13	8.61	350	15.5
8	S2	13	8.55	370	16.4
9	S3	13	8.36	400	17.7
10	M1	15	8.35	238	10.5
11	M2	15	8.33	250	11.1
12	M3	15	8.25	220	9.7

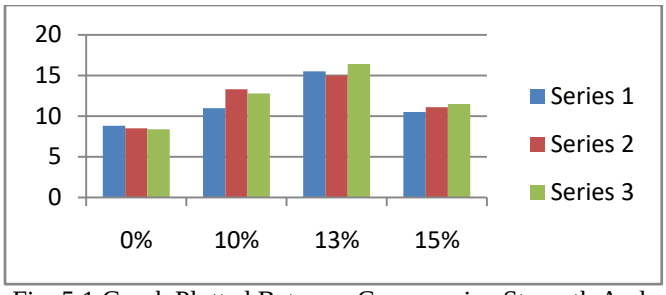
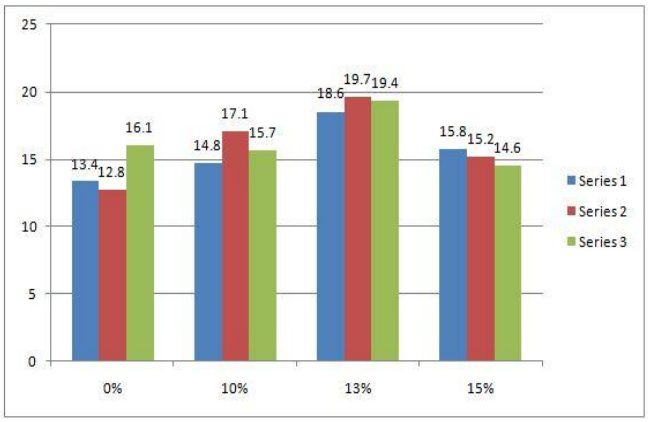


Fig: 5.1 Graph Plotted Between Compressive Strength And Replacement

For 7 days:

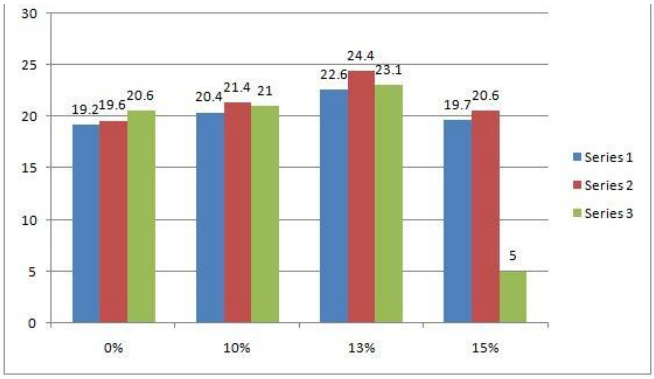
Sl. No	Sample name	Percentage of replacement	Weight of sample	Peak load	Compressive strength
1	C4	0	8.6	303	13.4
2	C5	0	8.2	290	12.8
3	C6	0	8.4	361	16.1
4	R4	10	8.6	333	14.8
5	R5	10	8.41	385	17.1
6	R6	10	8.54	354	15.7
7	S4	13	8.37	445.3	19.7
8	S5	13	8.23	437	19.4
9	S6	13	8.43	420	18.6
10	M4	15	8.39	356.3	15.8
11	M5	15	8.43	343.5	15.2
12	M6	15	8.46	330	14.6



5.2 Graph Between Compressive Strength And Replacement For 7days

For 28days

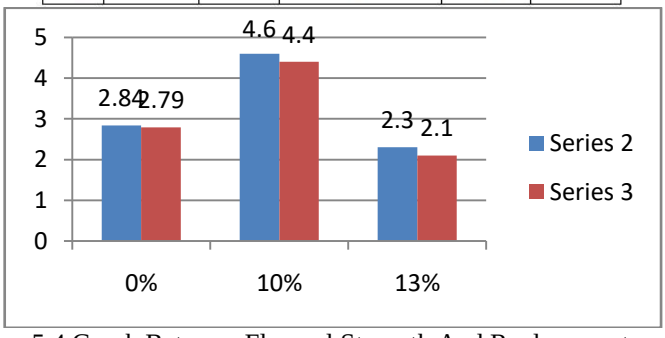
Sl. No	Sample name	Percentage of replacement	Weight of sample	Peak load	Compressive strength
1	C7	0	8.2	434	19.2
2	C8	0	8.5	441	19.6
3	C9	0	8.35	452	20.6
4	R7	10	8.5	460	20.4
5	R8	10	8.65	485.4	21.4
6	R9	10	8.63	473	21.0
7	S7	13	8.23	509	22.6
8	S8	13	8.28	520	23.1
9	S9	13	8.3	550	24.4
10	M7	15	8.56	443.5	19.7
11	M8	15	8.63	455	20.2
12	M9	15	8.6	465.4	20.6



5.3 Graph Between Compressive Strength And Replacement For 28days

b. Flexural Strength Test Results

S No	Sample Name	No. of days	% of Replacement	Weight of Sample	Flexural Strength
1	b1	3	0	12.55	1.24
2	b2	3	0	12.24	1.32
3	b3	7	0	11.83	1.42
4	b4	7	0	11.79	1.48
5	b1	28	0	11.9	2.84
6	b2	28	0	11.6	2.79
7	b3	3	10	12.37	2.68
8	b4	3	10	12.64	2.74
9	b1	7	10	9.94	3.84
10	b2	7	10	9.5	3.63
11	b3	28	10	12.25	4.6
12	b4	28	10	11.86	4.4
13	b1	3	13	10.22	1.3
14	b2	3	13	9.2	0.7
15	b3	7	13	11.78	1.28
16	b4	7	13	11.86	1.34
17	b5	28	13	11.5	2.3
18	b6	28	13	11.3	2.1

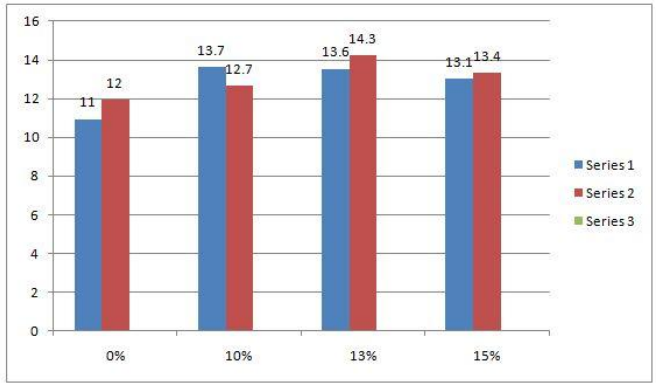


5.4 Graph Between Flexural Strength And Replacement

C. Split Tensile Strength Test Results

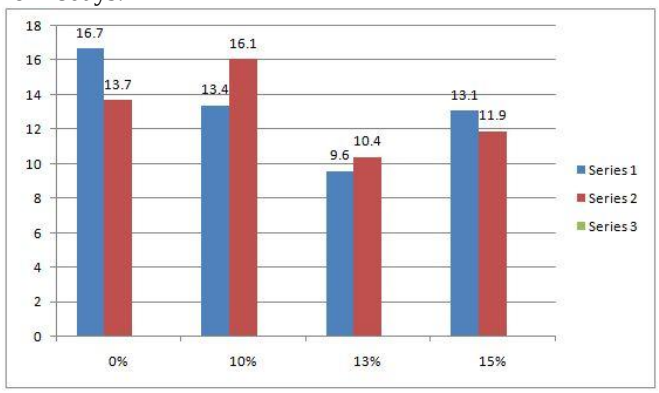
S.No	Sample Name	No.of days	Percentage of Replacement	Weight of Sample	Peak load	Split Tensile Strength
1	Cy1	7	0	12.69	195.8	11
2	Cy2	7	0	12.7	213.4	12
3	Cy3	28	0	12.28	296.4	16.7
4	Cy4	28	0	12.52	242.6	13.7
5	Cy5	7	10	12.45	256.1	11.3
6	Cy6	7	10	12.61	225.6	12.7
7	Cy7	28	10	12.4	237.8	13.4
8	Cy8	28	10	17.62	285.4	16.1
9	Cy9	7	13	12.54	241.9	13.6
10	Cy10	7	13	12.63	242.5	14.3
11	Cy11	28	13	12.72	117.6	9.6
12	Cy12	28	13	11.78	184.6	10.4
13	Cy13	7	15	11.6	231.7	13.1
14	Cy14	7	15	11.12	237.4	13.4
15	Cy15	28	15	12.53	231.9	13.1
16	Cy16	28	15	11.62	211.4	11.9

For 7 days



5.5 Graph Plotted Between Split Tensile Strength And Replacement For 7 Days

For 28days:



5.6 Graph Showing Split Tensile Strength Results For 28days

VI. CONCLUSION

Achievement of Objectives

• In this project, the review and research of current usage to the use of scrap as aggregate in the concrete was discussed into different sectors, such as constructions, industries, applications, recycling process, previous research and investigation.

• Total of four batches of concrete mixes required by the scope of the project.

• The investigation and laboratory testing on replaced scrap concrete specimens such as compression test, tensile test, and flexural test. However, not all the specimens had achieved to the high strength as per requirement.

• All the result for the tests was recorded in an appropriate manner. Moreover, result of each test was analysed in detail. All of this was discussed in previous chapters.

Conclusion

1. Cement replacement up to 10% with silica fume leads to increase in compressive strength, for M20grade of concrete. From 15% there is a decrease in compressive strength for 7 and 28 days curing period.
2. It was observed that the compressive strength ofM20 grade of concrete is increased from 16.15% to29.24% and decrease from 23.98% to 20.22%.
3. The maximum replacement level of silica fume is10% for M20 grade of concrete.
4. The use of micro silica in high strength concrete leads to

economical and faster construction.
5. Due to use of the micro silica in a OPC concrete the life of that concrete is increase 4-5 times than the OPC concrete.
Thus we can conclude that to reduce the environmental pollution and heat we can replace cement by industrial wastes like silica fume.

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