EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OF CEMENT USING MICRO-SILICA

Ramesh.J

Assistant Professor, Prince Shri Venkateshwara Padmavathy Engineering College, Chennai, Tamil Nadu, India

ABSTRACT

Concrete is the most undisputed construction material in the world. In concrete, scientist have found many special type of concrete which they have replaced cement, river sand, gravel and even water. Method of concreting also have changed a lot, but in environmental factors and in strength factors only. Strength is most important factor in concrete as strength factor explains the nature of the concrete. In today's concrete history, durability is a question mark which our engineers doesn't satisfy as the time lack and problems of construction. Pores are the main reason for reduction of strength of concrete. Reduction of pores can increase the strength as well as the durability of the concrete, so use of micro silica in replacement of cement is been adopted in this project. Micro-silica is a fine material than the cement, which is 10 times less diameter than the cement. Instead of using large amount of replacement material, Micro-silica overcomes by using small amount of replacement giving strength than the expected level. This paper explains that, according to the Indian standards, M50 is allowable grade and for higher strength with low replaceable material we can obtain greater strength using Micro-silica.

Keyword : *- Micro silica, Compressive Strength, Flexural strength, Split tensile strength*

1. INTRODUCTION

Concrete is the single most material used in this world as it serves as a remarkably good building material. Concrete has a number of performance characteristics that can improve the sustainability performance of a building or structure. Concrete is composed of cement (mostly opc, ppc, psc), fine aggregate (sand), coarse aggregate (gravel or crushed stone), and sometimes chemical admixtures. The concrete solidifies and hardens through a chemical process called hydration. The water reacts with the cement, which bonds the other components together, creating a robust stone-like material.

The demand for the construction materials has been rising with the increasing need for housing both in rural and urban areas. In order to overcome such problems, the main focus is to find new alternatives for the construction materials. This in turn should reduce the cost of construction and should increase the strength of the conventional concrete. Ceramic powder, silica fume, fly ash, Ground Granulated Blast furnace Slag and other suitable materials are employed in replacing cement in concrete. The main aim of this study is to analyze the effect of using MICRO-SILICA in the replacement of cement employed in concrete. Cement is replaced using Micro-silica, for different percentages and their behavior, properties are examined carefully.

2. EXPERIMENTAL INVESTIGATION

2.1 Materials

2.1.1 Micro silica

Silicon is not found in nature, and is normally produced from silica (SiO2) and carbon (C) Ideally, the following reaction is intended.

$$SiO_2 + 2C = Si + 2CO$$

Where

- SiO2 is normally quartz.
- C is a mix of coal, coke and wood chips.

Production take place in large electric smelting furnaces at temperatures > 2000^oC

This is how microsilica is produced. However, the chemistry is much more complex than the simplified.

$$SiO_2 + 2C = Si + 2CO$$

A number of side-reactions are involved, with silicon carbide and the (unstable) gas SiO as important intermediate products. In practice, some of the SiO-gas escapes from the furnace and reacts with air.

$$SiO + ½O_2 = SiO_2$$

This is microsilica. Of the quartz added to the furnace, 10 - 25% ends up as microsilica.

2.1.2 Aggregates

Aggregates are inert materials which are mixed with binding material such as cement or lime for manufacturing of mortar or concrete. Aggregates are used as filler in mortar or concrete in order to reduce their cost. The aggregates generally comprises of both fine and coarse aggregates. The aggregates of standard specifications were used in this study.

2.2 Mix design

In this study PPC confirming to IS 1489-1991 (part 1) with a specific gravity of 2.91 was employed. No other additives were added. The water cement ratio was taken as 0.35. The mix proportion was found as listed in table.

Table -1: Proportion of Materials for Cement Replacement

Mix	%replacement	Volume of cement (kg/m^3)		Volume of fine aggregate (kg/m^3)	Volume of coarse aggregate (kg/m^3)
		cement	Micro silica		
0	0	450	0	674	1118
1	7.5	416	33.75	676	1125
2	15	383	67	674	1112

2.3 Mixing and Casting of Concrete Cubes

The mixing duration is a major parameter to attain a homogeneous mix with uniform consistency of concrete. Initially the source material and aggregates were mixed in the pan in dry condition and then required quantity of water is added. Cubes were casted in moulds of size 150x150x150 mm. 6 cubes were casted for each mix. Beams were casted in moulds of size 500x100x100 mm. 4 beams were casted for each mix. Cylinders were casted in moulds of size 200 x 100 mm. 4 cylinders were casted for each mix.

2.4 Curing of Concrete

After the concrete was casted, they were demolded after 24 hours followed by curing in the ambient condition. The curing period was taken as 14 and 28 days.

3. RESULTS AND DISCUSSION

3.1 Compressive Strength

The average strength of concrete was tested after 14 and 28 days of curing. The compressive strength was found to decrease with increase in percentage of replacement but the workability was found to be good. The average compressive strength was shown in the following figure. The combined mix showed 7.5% increase in the final compressive strength.

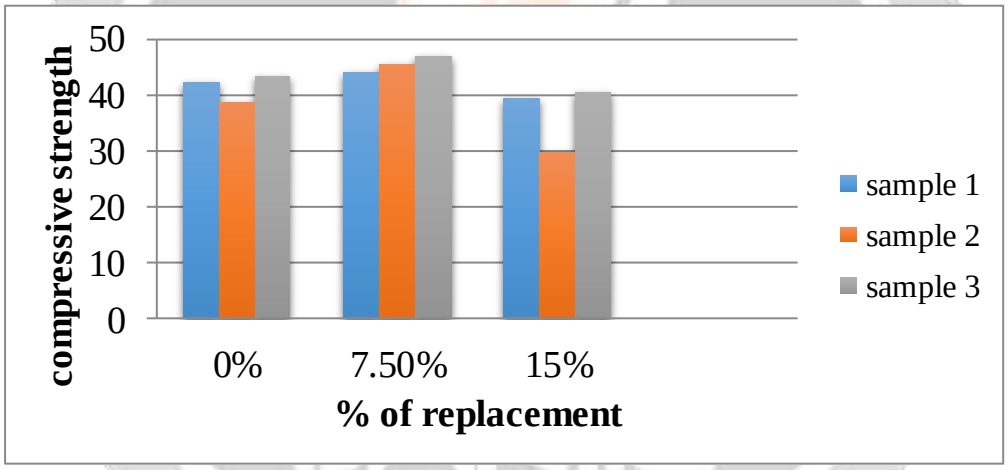

Chart -1: 14 days compression strength of concrete

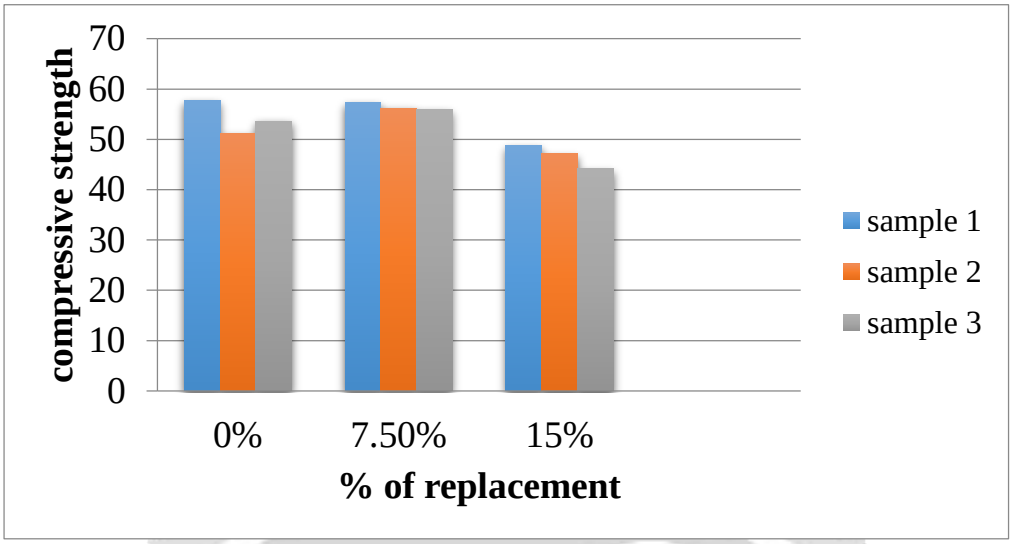

Chart -2: 28 days compression strength of concrete

3.2 Flexural strength

The average strength of concrete was tested after 14 and 28 days of curing. The Flexural strength was found to increase with increase in percentage of replacement but the workability was found to be good. The average compressive strength was shown in the following figure. The combined mix showed 7.5% increase in the final compressive strength.

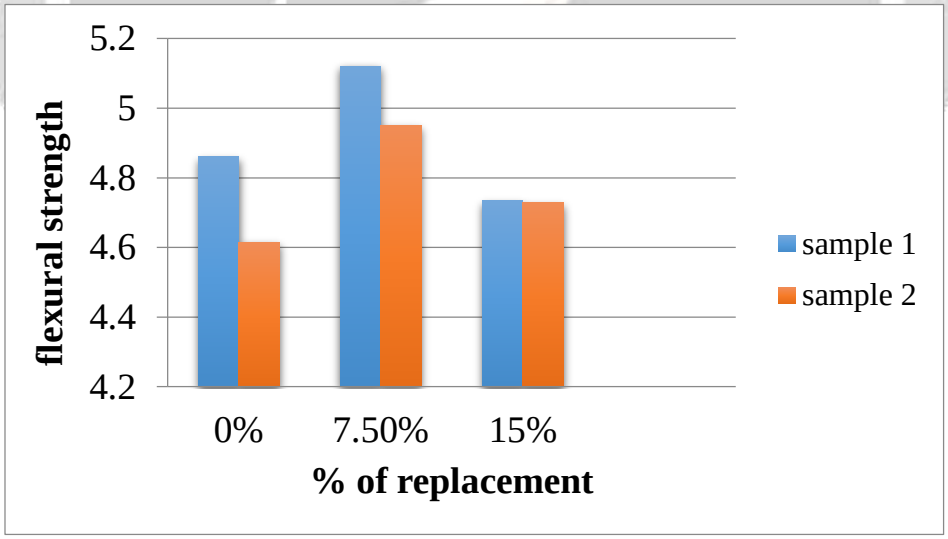

Chart -3: 14 days flexural strength of concrete

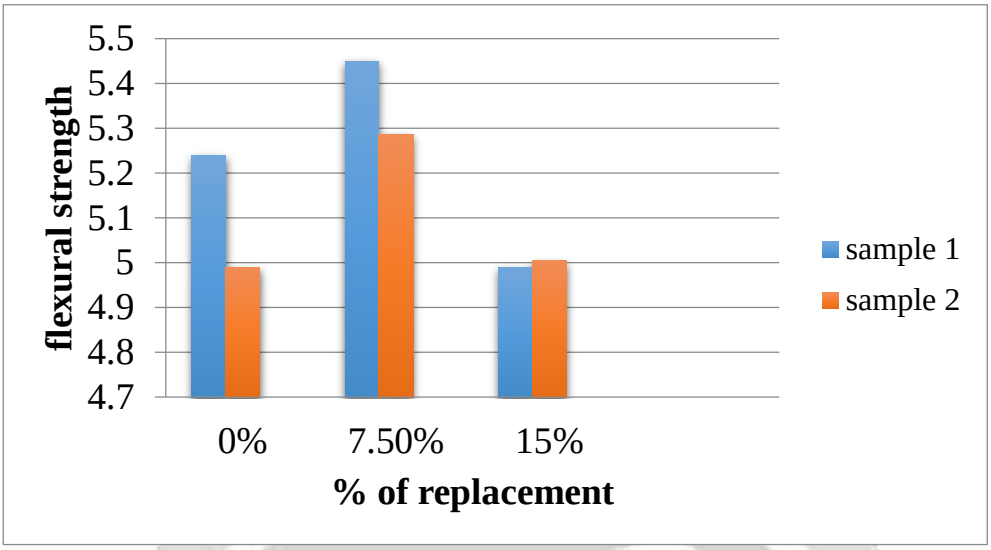

Chart -4: 28 days flexural strength of concrete

3.3 split tensile strength

The average strength of concrete was tested after 14 and 28 days of curing. The split tensile strength was found to increase with increase in percentage of replacement but the workability was found to be good. The average compressive strength was shown in the following figure. The combined mix showed 7.5% increase in the final compressive strength

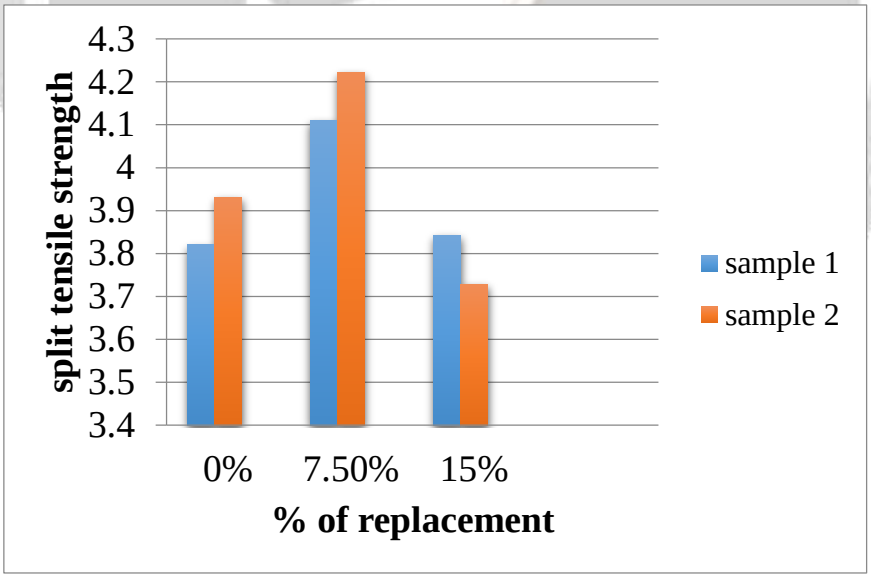

Chart -5: 14 days split tensile strength of concrete

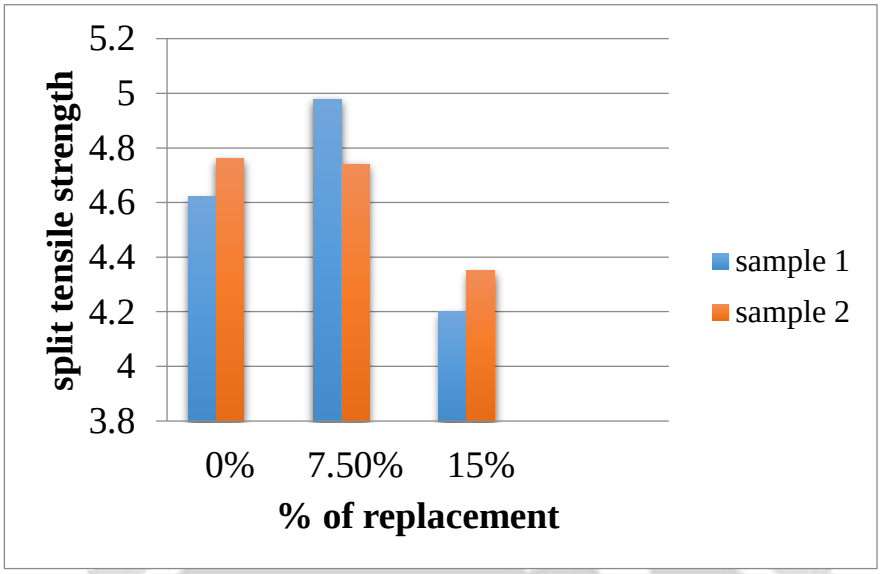

Chart -6: 28 days split tensile strength of concrete

4. CONCLUSIONS

In this project titled as "Partial replacement of cement using Micro-silica" we adopted different types of solutions and effects of the replaced material. Since micro-silica is a fine powder concluded from the tests conducted, a theoretical study has been made on them as they can reduce the pores content due to their size lesser than the cement material, as such strength is obtained in higher rate than the conventional concrete with experimental reviews.

A suggestions are been made from the experimental investigation that use of micro-silica can increase the durability of the concrete than the conventional concrete. According to Indian standards, the tests are conducted and the project has been successfully completed with better results.

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