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STUDY OF HIGH STRENGTH TERTIARY BRAND CONCRETE WITH VARYING CONTENTS OF MICRO SILICA

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Abstract - *Concrete is the most important engineering material in construction industry because of its inherent strength properties. However, the addition of some other materials may change the properties of concrete. With increase in trend towards the wider use of concrete for pre-stressed concrete and high rise buildings there is a growing demand of concrete with higher compressive strength. Micro-silica, also called as silica fumes is produced in electric arc furnace as a by-product of the production of elemental silicon's or alloys containing silicon. The mineral admixtures with pozzolanic properties such as fly ash (FA), silica fume (SF), ground blast-furnace slag (GGBS) and metakaolin (MK) are commonly used as a partial substitution of Portland cement during construction. These admixtures are often added to modify the physical and chemical properties of cementitious mixes, performances and engineering properties of the concrete. In comparison to ordinary Portland cement, the collection of GGBS as a by-product requires less energy and it produces less greenhouse gases. Thus, GGBS blended concrete is a more environmentally friendly concrete compared to OPC concrete. This paper presents the study of variation of contents of micro silica in the mix consisting of cement, GGBFS (ground granulated blast furnace slag), and micro silica. Micro silica is used in three percentages 0%, 7%, and 10% and the compressive strength test of cubes is being conducted.*

Key Words: compressive strength, cementitious content, GGBFS, Micro silica, pozzolanic.

1. INTRODUCTION

Fly ash, ground granulated blast-furnace slag, silica fume, and natural pozzolans, such as calcined shale, calcined clay or metakaolin, are materials that when used in conjunction with Portland or blended cement, contribute to the properties of the hardened concrete through hydraulic or pozzolanic activity or both. Supplementary cementitious materials are added to concrete as part of the total cementitious system. They may be used in addition to or as a partial replacement of Portland cement or blended cement in concrete, depending on the properties of the materials and the desired effect on concrete. Traditionally, fly ash, slag, calcined clay, calcined shale, and silica fume were used in concrete individually. Today, due to improved access to these materials, concrete producers can combine two or more of these materials to optimize concrete properties. Mixtures using three cementitious materials, called ternary mixtures, are becoming more prominent.

2. MATERIAL

Ground granulated blast furnace slag (GGBS) is a by-product from the blast-furnaces used to make iron. These operate at a temperature of about 1,500 degrees centigrade and are fed with a carefully controlled mixture of iron-ore, coke and limestone. The iron ore is reduced to iron and the remaining materials form a slag that floats on top of the iron. This slag is periodically tapped off as a molten liquid and if it is to be used for the manufacture of GGBS it has to be rapidly quenched in large volumes of water. The quenching optimises the cementitious properties and produces granules similar to coarse sand. This 'granulated' slag is then dried and ground to a fine powder.

Silica fume, also known as microsilica, is an amorphous (non-crystalline) polymorph of silicon dioxide, silica. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production and consists of spherical particles with an average particle diameter of 150 nm. The main field of application is as pozzolanic material for high performance concrete. Silica fume is an ultrafine material with spherical particles less than 1 μm in diameter, the average being about 0.15 μm.

Cement, type of cement is important mainly through its influence on the rate of development of compressive strength of concrete. The choice of the type of cement depends upon the requirements of performance at hand. The most commonly used cement is ordinary Portland cement. Variation in the cement quality will cause the compressive strength to vary more than any other single material.

2.1 Tests on material

The materials required and determining their various properties has been carried out in this phase. The Constituents of concrete viz. cement, fine aggregate, and

coarse aggregate are procured and their various properties are determined.

Table -1: Properties of Cement

Property	Average value for OPC used in present investigation	Standard value for OPC
Specific gravity	3.15 (standard)	3.15
Fineness (%)	4	<10%
Consistency (%)	30	-
Initial setting time (min)	78	>30
Final setting time (min)	380	>600

Table -2: Test results of physical Properties of Coarse Aggregate

Sr. No.	Property	Average value
1	Specific Gravity	2.88
2	Water absorption	0.97%
3	Moisture content	-
4	Type	Crushed
5	Maximum Size	20 mm

Table -3: Test results of Physical Properties of Fine Aggregate

Sr. No.	Property	Average value
1	Specific Gravity	2.67
2	Water absorption	1.23%
3	Moisture content	-
4	Fineness Modulus	4.97
5	Type	Natural Sand

2. MIX PROPORTIONS

Mix proportions are determined for the proposed grade of concrete (M60) by partially replacing cement with GGBFS and micro silica.

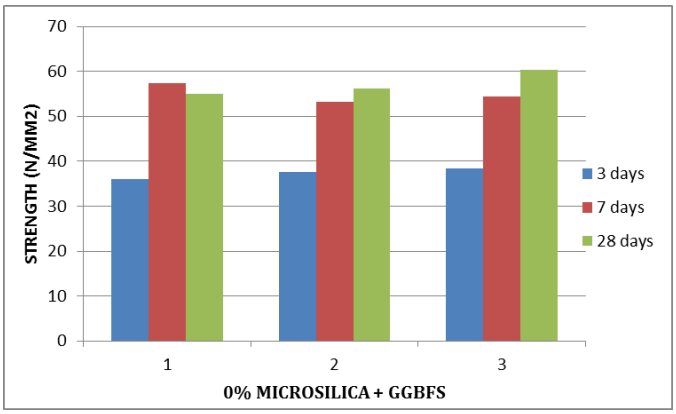
Table -4: Mix proportion for 1m3

Mix components	Mix 1 (micro silica 7%)	Mix 2 (micro silica 10%)	Mix 3 (micro silica 0%)
Cement	402	405	450
GGBFS	110	110	100
Micro silica	38	55	-
20mm	820	820	820
10mm	350	350	350
River sand	276	276	276
Artificial sand	414	414	414
Water content	135	135	135
Admixture	205 gm (9 cubes)	145gm (9 cubes)	209gm (9 cubes)

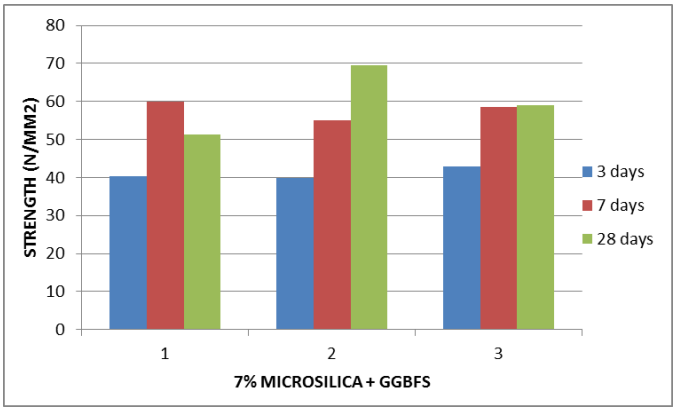
4. RESULTS AND DISCUSSION

The test was carried out on number of specimens prepared by using different contents of the materials. In the mix cement was partially replaced by GGBFS and micro silica, where the percentage of micro silica is varying (0%, 7% and 10%). Test was carried out at 3, 7, 28 days and results were obtained.

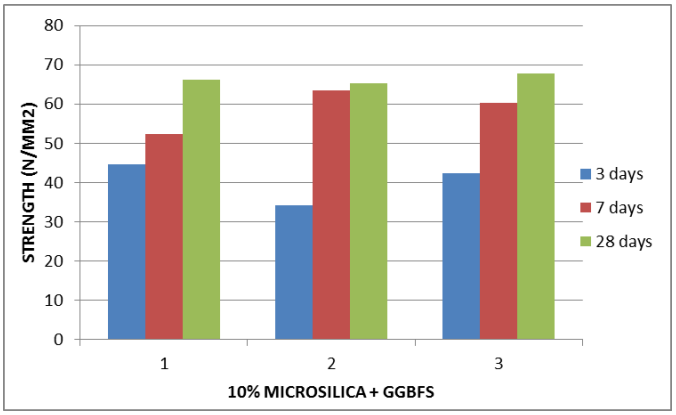
a) 0% micro silica



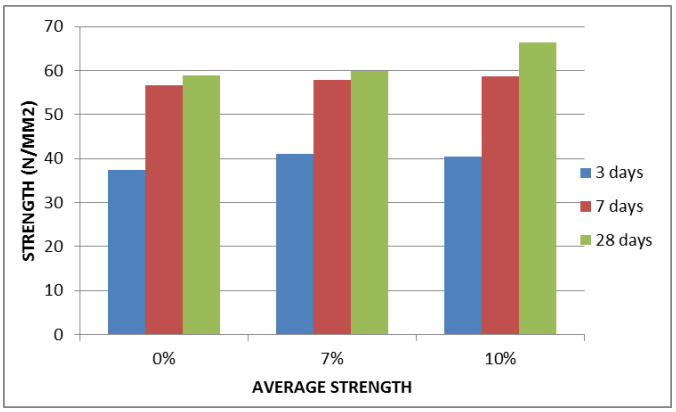
b) 7% micro silica



c) 10 % micro silica



d) Average strength



This study gives the results for the mix tested by conducting compressive strength test on the cubes (150x150x150 mm). Silica fume has strong effects in compressive strength of concrete for 3, 7 and 28 days of age. Graph a, b, c shows the variation of strength for 0%,7%,10% micro silica for 3,7,28 days. The variation of compressive strength for different replacement levels of OPC by silica fume for 3, 7 and 28 days is shown in graph(d), which shows the average strength for variable proportions of micro silica. For 28 days concrete it was observed that maximum compressive strength (66.43 N/mm^2) was exhibited which possess, 10% micro silica, 20% GGBFS and 70% cement.

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