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Experimental Study on Bentonite Clay Powder with Silica Fume and GGBS as Partial Replacement of Cement in M40 Grade Concrete

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***Abstract*— Concrete Is A Composite Construction Material Composed Mainly Of Cement, Fine Aggregate, Coarse Aggregate And Water. The Main Ingredient In The Conventional Concrete Is Portland Cement. The Amount Of Cement Production Emits Approximately Equal Amount Of Carbon Dioxide Into The Atmosphere. Cement Production Is Consuming Significant Amount Of Natural Resources. To Overcome The Above Ill Effects, The Advent Of Newer Material And Construction Techniques And In This Drive, Admixture Has Taken Newer Things With Various Ingredients Has Become A Necessity. The Addition Of Pozzolanic Materials With OPC A Century Old Practice Is An Alternative In The Construction Industry. In This The Alternative Materials Selected For Cement Are Silica Fume, GGBS And Bentonite Clay. These Materials Are Partially Replaced By Cement. In This Study The Fresh And Hardened Properties Of Concrete With Partial Replacement Of Cement Studied.**

Keywords—Bentonite clay, Silica fume, GGBS

I. INTRODUCTION

Now a days the world is witnessing the construction of very challenging and difficult structures, concrete being the most important and widely used structural material is called upon to possess very high strength. The main ingredient in the conventional concrete is Portland cement. The amount of cement production emits approximately equal amount of carbon dioxide into the atmosphere. Cement production is consuming significant amount of natural resources. To overcome the above ill effects, the advent of newer material and construction techniques and in this drive, admixture has taken newer things with various ingredients has become a necessity. The addition of pozzolanic materials with OPC a century old practice is an alternative in the construction industry.

Silica fume, also known as micro silica, 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.

Ground-granulated blast-furnace slag (GGBS or GGBFS) is obtained by quenching molten iron slag (a by product of iron and steel making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder.GGBS is used to make durable concrete structures in combination with ordinary Portland cement and/or other pozzolanic materials. Two major uses of GGBS are in the production of quality improved slag cement, namely Portland Blast furnace cement (PBFC) and high-slag blast-furnace cement (HSBFC), with GGBS content ranging typically from 30 to 70%; and in the production of ready mixed or site-batched durable concrete. Concrete made with GGBS cement sets more slowly than concrete made with ordinary Portland cement, depending on the amount of GGBS in the cementitious material, but also continues to gain strength over a longer period in production conditions.

Bentonite is an absorbent aluminum phyllosilicate, impure clay consisting mostly of montmorillonite. Bentonite is available in powder and solution form, which can replaces cement up to 40% of cement used in the concrete. Bentonite presents strong colloidal properties and its volume increases several times when coming into contact with water, creating a gelatinous and viscous fluid. The ionic surface of Bentonite has the useful property in making a sticky coating on sand grains.

Fig.1 Bentonite Clay

II. SCOPE AND OBJECTIVE

A. *Scope of the study*

Scope of this study is to

- During the process of manufacturing of cement environmental pollution is the major issue due to emission of CO_2. So it has become our necessity to find an alternate material for cement.

- Another scope is to find out that how effectively we can use bentonite clay as a replacement of cement in high strength concrete.
- Determine the fresh state and hardened state properties of M40 grade concrete with silica fume, GGBS and bentonite clay as partial replacement of cement.

B. *Objectives*

This study is focusing on partial replacement of cement with silica fume, GGBS and bentonite clay. It is intended to test M40 mix.

- To study the fresh state and hardened state properties of M40 with different percentages of bentonite clay (5%, 10% and 15 %) as partial replacement of cement.
- To study the fresh state and hardened state properties of M40 with 10% silica fume as partial replacement of cement.
- To study the fresh state and hardened state properties of M40 with 50% GGBS as partial replacement of cement.
- To study the fresh state and hardened state properties of M40 with 10 % silica fume and different percentages of bentonite clay (5%, 10% and 15 %) as partial replacement of cement.
- To study the fresh state and hardened state properties of M40 with 50 % GGBS and different percentages of bentonite clay (5%, 10% and 15 %) as partial replacement of cement.
- To compare these results with control mix (M40).

III. METHODOLOGY

The methodology adopted for the present experimental investigation is as follows:

A. Review of literatures.

B. Selection of materials.
•Cement (Ordinary Portland Cement 53 grade), Blast Furnace Slag, Silica fume, Bentonite clay, Coarse Aggregate, M Sand as fine aggregate, Super Plasticizer(Master Glenium Sky 8233).

C. Determination of material properties.
•Cement:-Specific gravity, initial setting time, final setting time, standard consistency
•Blast furnace slag:- Physical and chemical properties, specific gravity
•Silica fume:- Physical and chemical properties, specific gravity
•Bentonite clay:- Physical and chemical properties, specific gravity
•Fine aggregate:- Specific Gravity, water absorption, sieve analysis, bulk density and percentage of voids
•Coarse Aggregate:-Specific gravity, water absorption, sieve analysis, aggregate crushing value

D. Select suitable grade of concrete – M40 here.

E. Design the control mix (M40) with IS 10262:2009.

F. Design mixes (M40) using silica fume, GGBS and bentonite clay as partial replacement of cement.

- M40 mixes with different percentages (5%, 10% & 15%) of bentonite clay.
- M40 mixes with 10% Silica fume and different percentages (5%, 10% & 15%) of bentonite clay.
- M40 mixes with 50% GGBS and different percentages (5%, 10% & 15%) of bentonite clay.

G. Laboratory tests of fresh concrete.

- Slump test and compaction factor tests were conducted on fresh concrete.

H. Place the specimens for 3days, 7 days and 28 days curing.

I. Tests of hardened concrete specimens.

- Study of hardened state properties by conducting tests for Compressive strength, splitting tensile strength and flexural strength.

IV. MATERIAL CHARACTERIZATION

A. *Cement*

OPC 53 grade (Dalmia) cement was used.

TABLE.1 PROPERTIES OF OPC CEMENT

Standard Consistency	35%
Initial Setting Time	240 min
Specific Gravity	3.125
Fineness	5%

B.Fine Aggregate

As per table 4 of IS 383-1970 the fine aggregate belongs to zone II.

TABLE.2 PROPERTIES OF FINE AGGREGATE(M SAND)

Specific Gravity	2.69
Water Absorption	1.5%
Bulk Density	1.225 kg/l
%Voids	54.44%
Water Content	2.23%

C. Coarse Aggregate

TABLE.3 PROPERTIES OF COARSE AGGREGATE

Specific Gravity	2.67
Water Absorption	0.8%
Bulk Density	1.324 kg/l
%Voids	50.412%
Aggregate Crushing Value	28.66%

D. Silica Fume

Specific gravity of silica fume was obtained as 2.73.

E. GGBS

Specific gravity of GGBS was obtained as 2.93.

F. Bentonite Clay Powder

Specific gravity of Bentonite clay powder was obtained as 2.285

D. Super Plasticizer

TABLE.4 PROPERTIES OF SUPER PLASTICIZER

Colour	Light brown
Relative Density	1.08 ± 0.01 at 25°C
pH	>6
Chloride ion content	< 0.2%

V. MIX DESIGN

Different mixes used in this study are given below:

TABLE.5 VARIOUS MIXES WITH SPECIFICATION ID

Mix	**Specification ID**
Control Mix	CM
10% Silica Fume	SF 10
50% GGBS	GG 50
10% Silica Fume + 5 % Bentonite Clay	SB 5
10% Silica Fume + 10 % Bentonite Clay	SB 10
10% Silica Fume + 15 % Bentonite Clay	SB 15
50% GGBS + 5 % Bentonite Clay	GB 5
50% GGBS + 10 % Bentonite Clay	GB 10
50% GGBS + 15 % Bentonite Clay	GB 15
5 % Bentonite Clay	BC 5
10 % Bentonite Clay	BC 10
15 % Bentonite Clay	BC 15

TABLE.6 MIX PROPORTIONS FOR VARIOUS MIXES (kg/m^3)

Mix	**OPC**	**S.F**	**GGBS**	**B.C**	**FA**	**CA**	**Water**	**SP**
CM	415	-	-	-	802	1098	178	1.24
SF10	373	36	-	-	801	1097	178	1.23
GG50	207	-	196	-	801	1097	178	1.21
BC5	394	-	-	15	801	1097	178	1.23
BC10	373	-	-	30	801	1097	178	1.21
BC15	352	-	-	45	801	1097	178	1.19
SB5	352	36	-	15	801	1097	178	1.21
SB10	332	36	-	30	801	1097	178	1.20
SB15	311	36	-	45	801	1097	178	1.18
GB5	187	-	196	15	801	1097	178	1.19
GB10	166	-	196	30	801	1097	178	1.18
GB15	145	-	196	45	801	1097	178	1.16

VI. RESULTS AND DISCUSSIONS

TABLE.7 SLUMP TEST AND COMPACTION FACTOR TEST RESULTS

Specification ID	Slump	Compacting Factor
CM	110	0.91
SF 10	95	0.89
BC 5	100	0.91
BC 10	95	0.89
BC 15	90	0.91
GG 50	105	0.90
SB 5	95	0.89
SB 10	90	0.86
SB 15	85	0.84
GB 5	100	0.90
GB 10	95	0.88
GB 15	90	0.86

From Table.7 it is found that the slump value and compacting factor decreased with increase in amount of bentonite clay powder. It further decreased as the silica fume (10%) added to the concrete. But there was no effect in workability as the GGBS (50%) added to the concrete.

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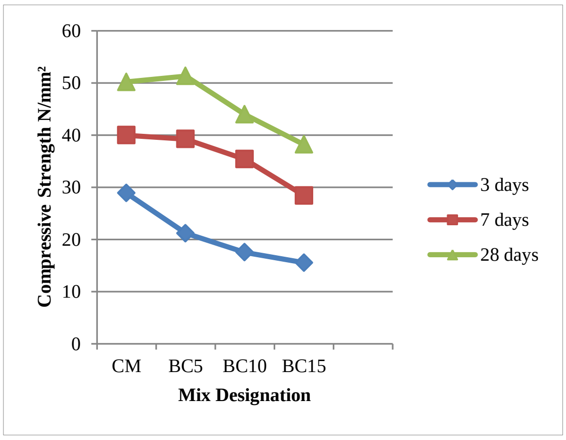

Fig.2 Compressive Strength of CM and BC mixes

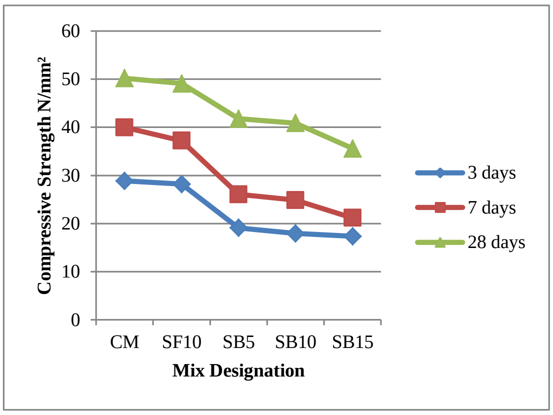

Fig.5 Compressive Strength of CM and 10% Silica Fume with different percentage BC

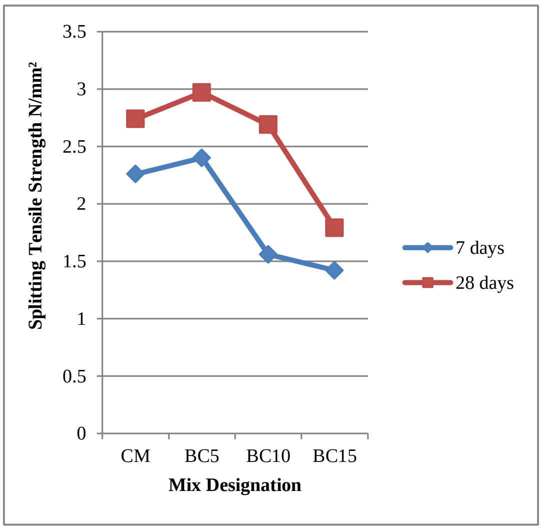

Fig.3 Splitting Tensile Strength of CM and BC mixes

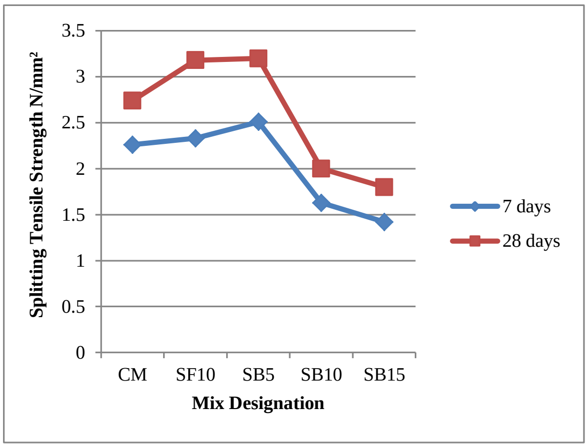

Fig.6 Splitting Tensile Strength of CM and 10% Silica Fume with different percentage BC

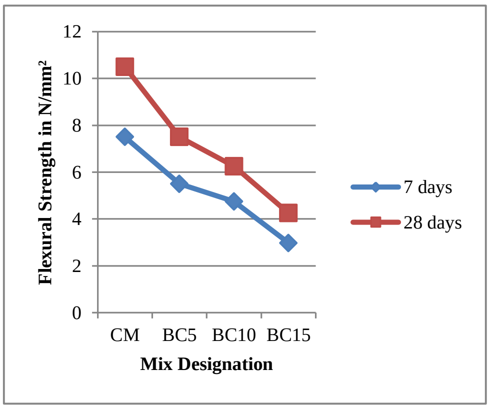

Fig.4 Flexural Strength of CM and BC mixes

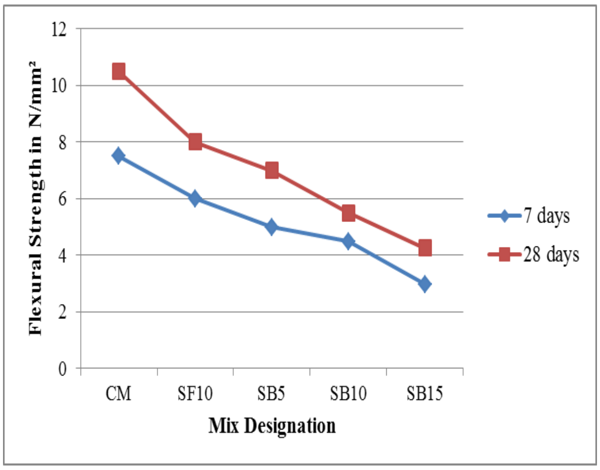

Fig.7 Flexural Strength of CM and 10% Silica Fume with different percentage BC

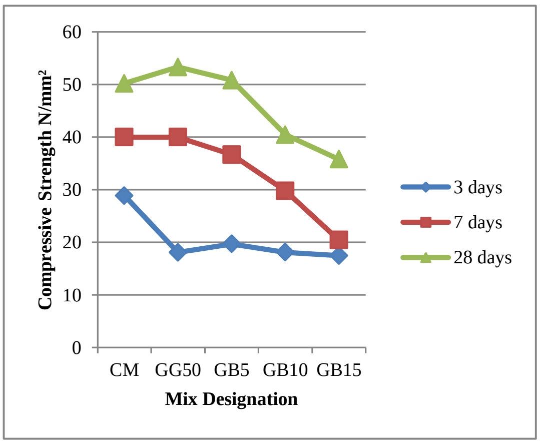

Fig.8 Compressive Strength of CM and 50% GGBS with different percentage BC

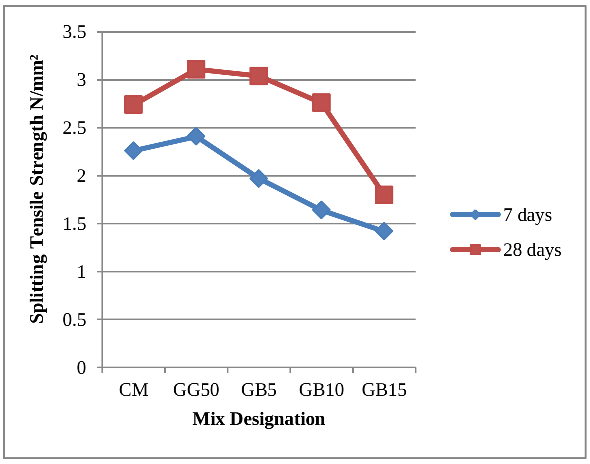

Fig.9 Splitting Tensile Strength of CM and 50% GGBS with different percentage BC

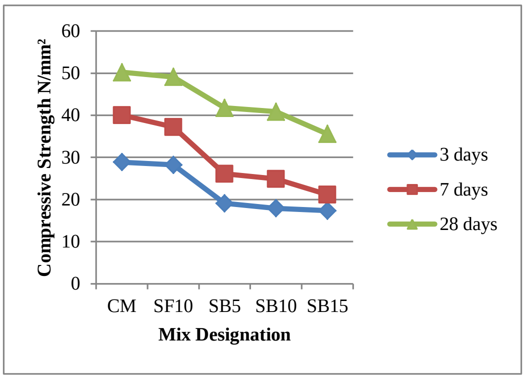

Fig.10 Flexural Strength of CM and 50% GGBS with different percentage BC

VII. CONCLUSIONS

Workability of concrete was found to be decreased with the increase in bentonite clay powder. It further decreased as the silica fume (10%) added to the concrete. But there was no effect in workability as the GGBS (50%) added to the concrete. 5% of cement can be effectively replaced with bentonite clay powder. In the case of 10% silica fume with various percentages of bentonite clay powder there is no significant effect in compressive strength and flexural strength but in SB5 splitting tensile strength is higher than control mix. Cement in concrete can also effectively partially replaced by 50% GGBS with 5% bentonite clay.

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REFERENCES

[1] Prof. M. S. Shetty, "Concrete technology".

[2] IS: 12269-1989, "Specification for ordinary Portland cement 53 grade", Bureau of Indian standards", New Delhi.

[3] IS: 516-1959, "Methods of test for strength of concrete", Bureau of Indian standards, New Delhi.

[4] Tahir Kemal Erdem and Onder Kirca, "Use of binary and ternary blends in high strength concrete", construction and building materials, volume 22, issue 7, July 2008.

[5] Obilade, I . O, "Properties of ternary blended cement concrete containing Rice Husk Ash (RHA)and Saw Dust Ash (SDA)", The International Journal Of Engineering And Science (IJES) , Volume 3, Issue 8, Pages 22-27, 2014.

[6] Sudarsana Rao.H unchate, Sashidhar. Chandupalle, Vaishali .G. Ghorpode and Venkata Reddy.T.C, "Mix Design of High Performance Concrete Using Silica Fume and Superplasticizer", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 3, Issue 3, March 2014.

[7] Verma Ajay, Chandak Rajeec and Yadav R.K. "Effect of micro siica on the strength of concrete with ordinary Portland cement" Reaserch journal of Engineering Science ISSN 2278-9472 vol.1(3), 1- 4, Sept (2012).

[8] T. Shanmugapriya, Dr. R. N. Uma "Experimental Investigationon silica Fume as partial replacement of Cement in High Performance Concrete". (IJES) , 2013.

[9] Reshma Rughooputh and Jaylina Rana "Partial Replacement of Cement by Ground Granulated Blast furnace Slag in Concrete", Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS) 5(5): 340-343, Scholarlink Research Institute Journals, 2014.

[10] Chaithra H L, Pramod K, Dr. Chandrashekara A, "An Experimental Study on Partial Replacement of Cement by GGBS and Natural Sand by Quarry Sand in Concrete", International Journal of Engineering Research & Technology, Volume. 4 - Issue. 05, May 2015

[11] Dhivyana r,"An Experimental Study on Concrete Using Bentonite and Steel Slag", National Conference on Research Advances in Communication, Computation, Electrical Science and Structures (NCRACCESS-2015).

[12] [12] M. Karthikeyan, P. Raja Ramachandran, A. Nandhini, R. Vinodha "Application on Partial Substitute of Cement by Bentonite in Concrete", International Journal of ChemTech Research, Vol.8, No.11 pp 384-388, 2015.