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Laboratory Study of OPC mixed with Blast Furnace Slag

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ABSTRACT
The blast furnace slag is a by-product of the iron manufacturing industry. In the manufacturing of pig iron, hematite and limestone are heated, limestone breaks and then forms quick lime with the liberation of carbon dioxide. This quick lime then reacts with impurities and forms slag known as Ground Granulated Blast Furnace Slag or GGBS. It is one of the construction industry's most commonly used pozzolanas. Pozzolanas are siliceous or siliceous/alumina materials possessing the ability to form cementitious compounds when mixed with lime.
Partial substitution of blast furnace slag for cement whenever feasible because of the replacement of cement with blast furnace slag of the order of 10% to 25% can be made giving equal or better concrete strength and durability. The blast furnace slag facilitates placement of the concrete at lower slumps while maintaining excellent workability.
When Portland cement is mixed with water most of the cement forms insoluble cementitious compounds; calcium hydroxide is formed as a part of the reaction. When blast furnace slag is introduced into concrete, it reacts with the calcium hydroxide to form additional cementitious compounds. In a properly proportioned mix, blast furnace slag can improve many of the properties of concrete including workability and consolidation, flexural and compressive strength, pumpability and decreased permeability.

KEYWORDS: *Ground Granulated Blast Furnace Slag (GGBS), Pozzolana, Experiments on blended cement with different proportions of slag and comparison with the standard results.*

I. INTRODUCTION

1.1 Pozzolana:

Pozzolanas are materials containing reactive silica(in amorphous form) which in themselves possesses little or no cementitious value but which combines with lime in finely divided form in the presence of water to produce cementing compounds. The combination is a chemical reaction, similar to that taking place in the setting of cement.
Recent usage of Pozzolana can be given as:
a) In finely ground form as a mixture in Ordinary Portland Cement up to 35 percent, to make pozzolana portland cement(PPC). For this purpose it must be ground finer than cement.
b) The material is added separately as a replacement, or admixture up to 20 percent of fine aggregate in lime and cement mortar to improve grading and to use the pozzolanic properties. The fineness of the material is not as important as for use as pozzolana.
c) Mixed as a fine powder to fat lime to produce hydraulic lime from fat lime.
Pozzolanas enable the free lime in cement to set by means other than by carbonation
(Without the presence of air) and to add to the strength of cement. The term pozzolana was given to such material in honor of the place Pozzolini in Italy, where it was recently found that romans had built hydraulic structures by mixing lime and the local volcanic ash, thus producing hydraulic lime which can set under water.

1.2 Ground Granulated Blast Furnace Slag:

From slow cooling of the slag obtained from the blast furnace, we get crystalline materials which can be crushed and used as aggregates. Rapid cooling of slag produces amorphous glassy pellets with about 35% silica which when ground to fine powder can form a pozzolanic material. It can chemically react with free lime to produce cementing materials.

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In the production of cement, limestone and clay are heated to a high temperature of 1500 ˚C in a kiln. These material fuse and form clinker which is

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further crushed to form cement. This process requires high energy input (850 kcal per kg of clinker) and implies the extraction of large quantities of raw materials from the earth (1.7 tons of rock to produce 1 tons of clinker). On the other hand the production of one tons of cement generates 0.55 tons of chemical CO_2 and requires an additional 0.39 tons of CO_2 in fuel emissions, accounting for a total of 0.94 tons of CO_2. In geopolymer concrete, the use of GGBS as the binder replaces the cement hence being a key for the sustainable development.

1.3 Objective if the Study:

In this study the experimental investigation is done on use of Ground Granulated Blast Furnace Slag (GGBS) with Ordinary Portland Cement (OPC).

The aim of the study is to mix Blast Furnace Slag with OPC and compare the properties of cement by carrying different tests related to cement.

In the production of cement the limestone and clay is heated to a high temperature of about 1500 ˚C in a kiln. These material fuse and form clinker which is further crushed to form cement. Thus this process is very costly and emit large amount of fly ash and carbon dioxide to the environment. Thus in geo-polymer concrete the use of GGBS as the binder replaces the cement thus it is a key for the sustainable development.

1.4 Chemical Composition:

The chemical composition of blast furnace slag is similar to that of cement clinker.

Cao	30-45%
SiO_2	17-38%
Al_2O_3	15-25%
Fe_2O_3	0.5-2.0%
MgO	4.0-17.0%
Mno_2	1.0-5.0%

The quality of slag is governed by IS 12089 of 1987. The chemical composition of a slag varies considerably depending on the composition of the raw materials in the iron production process. Silicate and aluminate impurities from the ore and coke are combined in the blast furnace with a flux which lowers the viscosity of the slag. In the case of pig iron production the flux consists mostly mixture of limestone and forsterite or in some cases dolomite. In the blast furnace the slag floats on top of the iron and is decanted for separation. Slow cooling of slag results in an unreactive crystalline material consisting of an assemblage of Ca-Al-Mg silicates. To obtain a good slag reactivity or hydraulicity, the slag melt needs to be rapidly cooled or quenched below 800 °C in order to prevent the crystallization of merwinite and melilite. To cool and fragment the slag a granulation process can be applied in which molten slag is subjected to jet streams of water or air under pressure. Alternatively, in the pelletization process the liquid slag is partially cooled with water and subsequently projected into the air by a rotating drum. In order to obtain a suitable reactivity, the obtained fragments are ground to reach the same fineness as Portland cement.

II. DISCUSSION:

Based upon the various laboratory tests on cement when blast furnace slag is mixed with it in different proportions the following conclusions can be made:

- The fineness of blast furnace slag is quite high as compared to the Ordinary Portland Cement. When blast furnace slag is added to the Ordinary Portland Cement the fineness of the cement increases considerably.
- The standard consistency of cement mixed with the blast furnace slag is comparatively less than that of ordinary Portland cement. Since the fineness of blast furnace slag is higher than that of ordinary Portland cement the water required is very less and hence the consistency of blended cement is less than that of OPC.
- The use of blast furnace slag in cement influence the initial and final setting time of cement. It increases the initial setting time while the final setting time of cement decreases considerably.Blast Furnace Slag can also be used as the performance improver in the cement.
- In case of compressive strength, blast furnace slag blended cement imparts more strength when it is added within a certain limit.
- The experiments conducted by adding various proportions of blast furnace slag with ordinary portland cement recommends that the **appropriate range of blast furnace slag in cement is 10-25%.**

III. CONCLUSION:

The following conclusions are drawn based on the study and experimental work on samples of cement with Blast Furnace Slag:

- Pozzolanas are material containing reactive silica which is themselves possess little or no cementitious value but which combine with lime in finely divided form in the presence of water to produce cementitious compounds.
- Now-a-days pozzolana are used as finely ground form as mixture in ordinary portland cement up to 35% to make the pozzolana

portland cement. For theses purpose it must be ground finer than cement. The material is added separately as a replacement or admixture up to 20% of fine aggregate in lime and cement mortar to improve grading and to use pozzolanic properties. The fineness of material is not as important for use as a pozzolana. It is mixed as a fine powder to fat lime to produce hydraulic lime from fat lime.

- The blast furnace slag is a by-product of the iron manufacturing industry. In the manufacturing of pig iron, hematite and limestone are heated, limestone breaks and then forms quick lime with the liberation of carbon dioxide. This quick lime then reacts with impurities and forms slag known as **Ground Granulated Blast Furnace Slag or GGBS.**

REFERENCES:

[1]. U.S. Federal Highway Administration. "Ground Granulated Blast-Furnace Slag". Retrieved 2007-01-24.
[2]. Civil and Marine Company. "Frequently Asked Questions". Retrieved 2007-01-24.
[3]. EnGro Corporation Ltd. "Ground Granulated Blastfurnace Slag (GGBS)". Archived from the original on 2007-01-22. Retrieved 2007-01-24.
[4]. Construct Ireland. "Ground Granulated Blastfurnace Slag (GGBS)". Retrieved 2008-02-21.
[5]. Ecocem. "Ground Granulated Blastfurnace Slag (GGBS)". Retrieved 2013-05-27.
[6]. PinchaTorkittikul; and ArnonChaipanich; Cement and Concrete Composites, 32, 2010, 440-449.
[7]. A. Juan, C. Medina, M. Ignacio Guerra, J. M. Morán, P. J. Aguado, M. I. Sánchez de Rojas M. Frías and O. Rodríguez, "Re-Use of Ceramic Wastes in Construction," In: Wunderlich, W. (ed.) Ceramic Materials. Rijeka, Croatia: Sciyo, 2012, pp. 197-211.
[8]. C. Medina, M. Romero, J. Muran del Pozo and J. Valdes, "Use of Ceramic Wastes in Structural Concretes," 1st Spanish National Conference on Advances in Materials Recycling and Eco – Energy, Universidad de Leon, Spain, 2009, pp. 137-139.
[9]. Santhamarai, RM; DevadasManoharan, P; and Gopinadh, D; Construction and Building Materials, 25, 2011, 2413-2419.
[10]. HanifiBinici; Construction and Building Materials, 21, 2007, 1191-1197.

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