INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume3, Issue5)
Available online at www.ijariit.com

Partial Replacement of Cement with GGBS in Concrete

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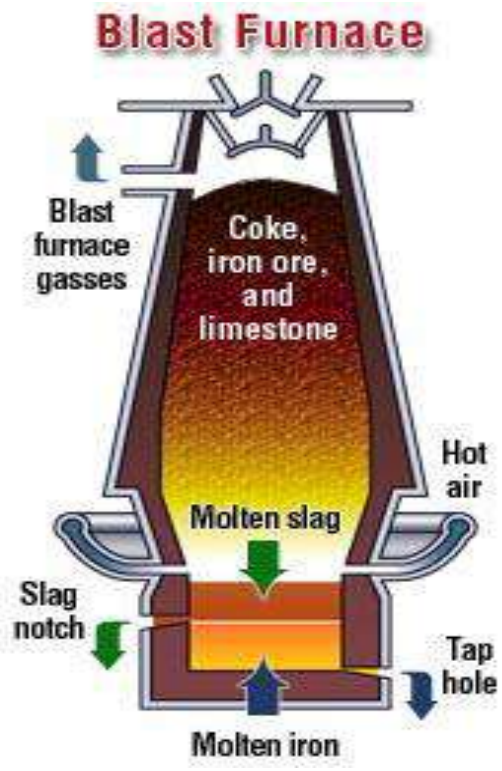
Abstract: In this present construction era concrete is the most used construction material in the world. Concrete is consumed widely that it is second most consumed material after the water in terms of per-capita consumption. As the pollution is increasing and the environmental sustainability is affected, researchers are seeking for other materials to reduce the consumption of cement. GGBS is one of these supplementary materials used to replace with cement to reduce the consumption of the cement.

Keywords: GGBS, High-Performance Concrete.

INTRODUCTION

The blast furnace slag is a by-product of the iron manufacturing industry. Iron ore, coke, and limestone are fed into the furnace and the resulting molten slag floats above the molten iron at a temperature of about 1500ºC to 1600ºC. The molten slag has a composition of about 30% to 40% SiO_2 and about 40% CaO, which is close to the chemical composition of Portland cement.



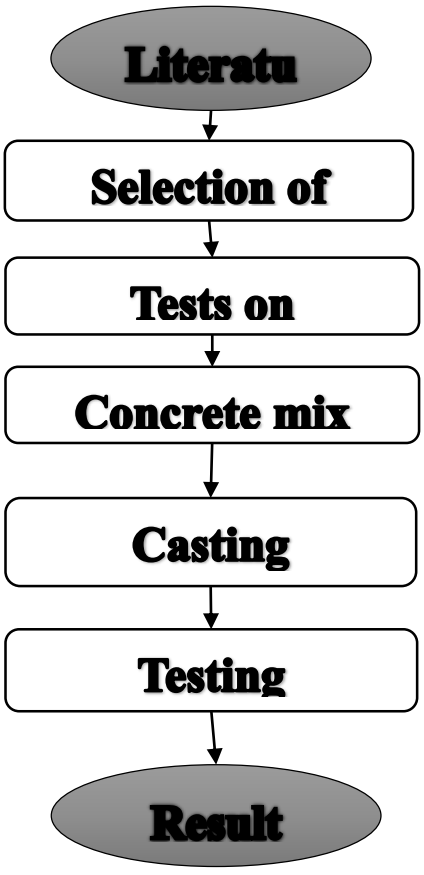
Advantages

- Durable concrete structures can be made with the combination of GGBS and ordinary Portland cement.
- Portland Blast furnace cement (PBFC) and high-slag blast-furnace cement (HSBFC) are produced from the GGBS.

LITERATURE REVIEW

- **Er. Kimmi Garg, Er. Kshipra Kapoor** studied and experimented, it is proved that GGBS can be used as an alternative material for cement, reducing cement consumption and reducing the cost of construction. Use of industrial waste products saves the environment and conserves natural resources.
- **Vinayak Awasare, Prof. M. V. Nagendra** made a study work to analyse strength properties of partially replaced GGBS concrete. The flexural strengths achieved are 3.01Mpa, 3.45Mpa, 3.58Mpa, 3.44Mpa and 3.12Mpa at 0%, 20%, 30%, 40%, and 50% for GGBS concrete respectively for M20 grade concrete of OPC cement and crushed sand. This report shows that tensile strength also gives good performance for 20%, 30 % and 40% replacement which is more than normal plain concrete.
- **Yasutaka SAGAWA, Daisuke Yamamoto and Yoshikazu HENZAN** in a study concluded that the specimens which include normal-strength concrete and high-strength concrete by changing W/B from 65% to 35% were examined. The effectiveness of GGBS on chloride ion diffusion coefficient was investigated by migration test. Moreover, the application of GGBS which has the surface area of 6000 cm2/g for bridge superstructures was presented.
- **D. Suresh and K. Nagaraju** in a review concluded that the movement of moisture of GGBS mixes, probably due to the dense and strong microstructure of the interfacial aggregate/binder transition zone is probably responsible for the high resistance of GGBS mix to attack in aggressive environments such as silage pits. GGBS is a good replacement for cement in some cases and serves effectively but it can't replace cement completely. But even though it replaces partially it gives very good results and a greener approach to construction and sustainable development which we are engineers are keen about today.

METHODOLOGY



Materials Used

- Cement
- Fine Aggregate
- Coarse Aggregate
- GGBS
- Water
- **Cement**

Ordinary Portland cement (OPC) of 53 grade was used in which the composition and properties are in compliance with the Indian standard organization.

Cement Chemical Composition of Cement

S.No	Chemical Composition	Limits (%)
1	CaO	61-67
2	SiO_2	19-23
3	Al_2O	2.5-6
4	Fe_2O_3	0-6
5	SO_3	1.5-4.5

Physical Properties of Cement

S.No	Property	Result
1	Brand of cement	53 grade OPC
2	Standard consistency	35%
3	Initial setting time (in mins)	30
4	Final setting time (in mins)	600
5	Specific gravity	3.15

Fine Aggregate

The aggregate which passes through 4.75 mm IS sieve and retain on 75 microns IS sieve are known as fine aggregates. Fine aggregate is basically sands won from the land or the marine environment. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 9.5mm sieve. As with coarse aggregates, these can be from Primary, Secondary or Recycled sources.

Sand (Fine Aggregate)

Physical Properties of Fine Aggregate

Property		**Result**
Fineness modulus		2.72
Specific gravity		2.613
Bulk density (Kg/m^3)	Loose	1585
	Compact	1690

Coarse Aggregate

The aggregates which pass through 75mm IS sieve and retain on 4.75mm IS sieve are known as coarse aggregates.

Coarse Aggregate

Physical Properties of Coarse Aggregate

Property		**Result**
Fineness modulus		6.15
Specific gravity		2.625
Bulk density (Kg/m^3)	Loose	1475
	Compact	1532

GGBS

Chemical Composition of GGBS

Chemical	Constituent Portland	GGBS
CaO	65%	40%
SiO_2	20%	35%
AI_2O_3	5%	10%
MgO	2%	8%

Physical Properties of GGBS

Colour Off	White powder
Bulk density (loose)	1.0–1.1 tonnes/m^3
Bulk density (vibrated)	1.2–1.3 tonnes/m^3
Relative density	2.85–2.95
Surface area	400–600 m^2/kg

Water

Water plays an important role in concrete production (mix) in that it starts the reaction between the cement, pozzolanic and the aggregates. It helps in the hydration of the mix. In this research, the water used was distilled water.

Water

EXPERIMENTAL PROCEDURE

Mixing of Concrete

Mixing of concrete was carried out by machine. Machine mixing is not only efficient but also economical. Before the materials are loaded in to drum about 25 percent of the total quantity of water required for mixing is poured into the mixer drum and to prevent any sticking of cement on the bodies or at the bottom of the drum.

Mixing of Concrete

Moulds

The concrete is cast into cube molds of size 150mm×150mm.

Mould

Curing of specimen

After casting the molded specimens are stored in the laboratory at a room temperature for 24 hours. After this period the specimens are removed from the molds and immediately submerged in clean, fresh water of curing water tank. The specimens are cured for 28 days in present investigation work.

Curing

RESULTS AND DISCUSSION

The compressive strength of the cubes at different days with different GGBS combination and the slump value and compaction factor is given.

Slump Cone Test

The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete, and therefore the ease with which concrete flows. It can also be used as an indicator of an improperly mixed batch.

Slump Cone Test

Slump test

Mix	**Slump Value (mm)**
Normal Concrete	61
20 % GGBS	63
40 % GGBS	57

Compaction Factor Test

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS: 1199 – 1959. The apparatus used is Compacting factor apparatus. Procedure to determine the workability of fresh concrete by compacting factor test.

Compaction Factor test

Compaction Factor

Mix	**Compaction Factor**
Normal Concrete	0.92
20 % GGBS	0.93
40 % GGBS	0.91

COMPRESSIVE STRENGTH TEST

Compression Testing Machine

A Compression testing machine (CTM), is used to test the compressive strength of materials. The set-up and usage are detailed in a test method, often published by a standards organization. This specifies the sample preparation, fixturing, gauge length (the length which is under study or observation), analysis, etc.

Compression-Testing Machine

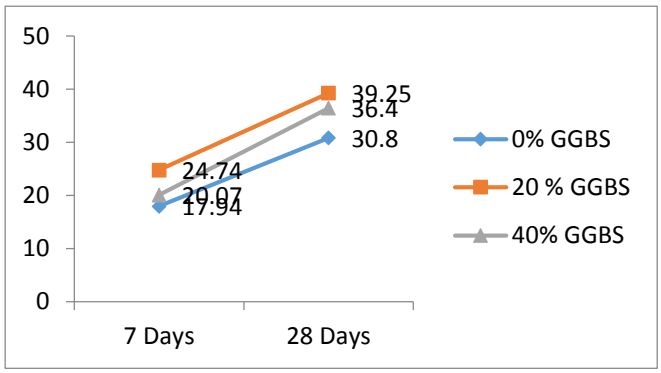
COMPRESSIVE STRENGTH RESULTS

Compressive Strength Results

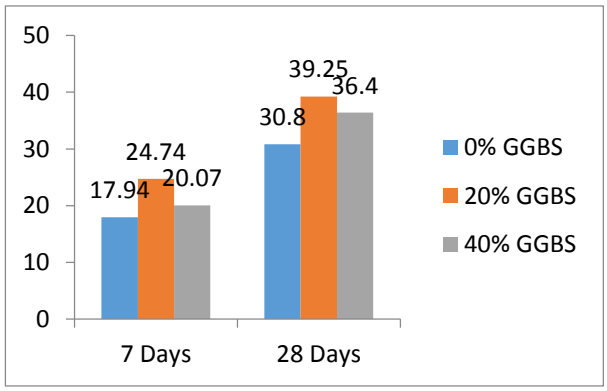
% Replacement of Cement with GGBS	Compressive Strength at 7 days	Compressive Strength at 28 days
0% (Normal concrete)	17.94	30.8
20%	24.74	39.25
40%	20.07	36.4

The above Table 5.1 gives the compressive strength of the concrete when the cement is replaced with GGBS at the proportions of 0%, 20%, 40% with cement after the curing period of 7 Days and 28 Days.

Graph for Comparison of Strength Acquired



Bar Graph for Comparison of Strength Acquired



CONCLUSIONS

1. Durability and service life are improved by preparing High-Performance Concrete.
2. With the addition of 40% of GGBS as a replacement of Cement for an M25 grade of concrete, there is an increase in the strength compared to the normal concrete.
3. As GGBS is partially replaced with the cement, the consumption of the cement is reduced and also the cost of construction is reduced.
4. Thus the workability is improved by the partial replacement of the GGBS with cement.

REFERENCE

[1] Santosh Kumar Karri, G. V. Rama Rao, P. Markandeya Raju "*Strength and Durability Studies on GGBS Concrete*", SSRG International Journal of Civil Engineering (SSRG - IJCE), V2 (10), 34-41 October 2015. ISSN: 2348 – 8352. www.internationaljournalssrg.org/IJCE/index.html. Published by: Seventh Sense Research Group.

[2] Mojtaba Valinejad Shoubi, Azin Shakiba Borough, and Omidreza Amirsoleimani. (2013). . . "*Assessment of the Roles of Various Cement Replacements in Achieving Sustainable and High-Performance Concrete*". International Journal of Advances in Engineering and Technology, 6 (1): 68-77.

[3] Martin O. Connell, Ciaran McNally, and Mark G. Richardson. (2012). "*Performance of Concrete Incorporating GGBS in Aggressive Wastewater Environments*. *Construction and Building Materials*", 27 (1), 368-374.

[4] "*European Journal of Scientific Research ISSN 1450-216X Vol.88 No-1*" October 2012, pp.155163@Euro journals Publishing, Inc. 2012 http://www.europeanjournalof scientific research.com.

[5] Aveline Darquennes, Stephanie Staquet, and Bernard Espion. (2011). "*Behaviour of Slag Cement Concrete under Restraint Conditions*". European Journal of Environmental and Civil Engineering, 15 (5), 787-798.

[6] Elsayed, A.A. (2011). "*Influence of Silica Fume, Fly Ash, Super Pozz and High Slag Cement on Water Permeability and Strength of Concrete*". Jordan Journal of Civil Engineering, 5 (2), 245-257.

[7] Reginald B. Kogbara, and Abir Al-Tabbaa. (2011). "*Mechanical and Leaching Behaviour of Slag-Cement and Lime-activated Slag Stabilized/Solidified Contaminated Soil*". The science of the Total Environment, 409 (11), 2325-2335.

[8] Peter W.C. Leung, and Wong, H.D. (2010). "*Final Report on Durability and Strength Development of Ground Granulated Blast Furnace Slag Concrete*". Geotechnical Engineering Office, Civil Engineering and Development Department, the Government of Hong Kong.

[9] Pazhani .K., Jeyaraj .R —"*Study on durability of high-performance concrete with industrial wastes ATI - Applied Technologies & Innovations"* Volume 2 | Issue 2 | August 2010 |pp. 19-28

[10] Ashish Kumar dash et al —"*Effect of pozzolanas on fiber Reinforced concrete*" 2010

[11] Venu Malagavelli et. al. —"*High-performance concrete with GGBS and robot sand*" International Journal of Engineering Science and technology vol. *2(10),* 2010, 5107-5113.

[12] Hanifi Binici, Huseyin Zengin et al. —R*esistance to sodium sulphate attack of plain and blended cement containing corncob ash and ground granulated blast furnace slag Scientific Research and Essay*" *Vol.4 (2), pp. 098-106*, February 2009.

[13] M. Shariq, J. Prasad et al —"*Strength development of cement mortar and concrete incorporating GGBFS Asian journal of civil engineering (building and housing) " vol. 9, no. 1* (2008)Pages 61-74.

