

Partial Replacement of Cement Using GGBS A Sustainable Approach-A Review

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ABSTRACT: GGBS is a by-product in pig iron manufacture, has been found to be an ideal material to replace ordinary Portland cement used in concrete and it improves the durability of concrete. GGBS slag is obtained by quenching molten iron slag from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. In this project, it is proposed to study the Economical, Eco-Friendly, and Strength aspects.

KEYWORDS: GGBS, OPC, Replacement of Cement, Environmental pollution, compressive strength.

I. INTRODUCTION

Concrete is typically an enormous individual material element in the built environment. If the concrete can be reduced without decreasing the performance or increasing the cost, significant environmental and economic benefits may be realized. Concrete is mainly comprised of Portland cement, aggregates, and water.

Although Portland cement on average comprises only 12% of the concrete mass, it accounts for around 93% of the total concrete and 6% to 7% of the worldwide CO₂ productions. If concrete is mixed with ground granulated blast furnace slag as a fractional replacement for Portland cement, it would provide environmental and economic profits and the required workability, durability, and strength necessary for the design of the structures. Some of the recent studies in various parts of the world have revealed that ground granulated blast furnace slag concrete can protect the steel reinforcement more capable so that it can resist corrosion, and thus the structure as a whole. GGBS concrete is a type of concrete in which a part of the cement is transformed by ground.

Granulated blast furnace slag, which is an industrial excess. Thus the implementation of GGBS concrete can reduce corrosion in an effective way. Furthermore, it can lead to the more durable structure without the considerable increase in cost.

Ground granulated blast furnace slag from modern thermal power plants generally does not require handling prior to being incorporated into concrete and is therefore considered to be an —environmentally free input material. When used in concrete, ground granulated blast furnace slag is a cementations material that can act as a partial replacement for Portland cement without significantly compromising the compressive strength.

II. APPLICATION

GGBS is used to make long-lasting concrete in combination with ordinary Portland cement. Two major uses of GGBS are in the production of quality superior 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 slowly but surely than ordinary Portland cement concrete. Depending on the amount of GGBS in the cementations material, but also continue to gain

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 6, Issue 4, April 2017

strength over a longer period in production conditions. The GGBS concrete produces lower heat of hydration and lower rise in temperature and avoid cold joints easier, but may also change construction schedule where the fast setting is required.

III. LITERATURE REVIEW

A. Kamran Muzaffar Khan (2004)

Study the comparison of conventional concrete and concrete having GGBS mixed at 25 % and 50% comparison was totally made on the compressive test, fineness, setting time; soundness and chemical property of cement GGBS. Water cement ratio varied for different cubes. Cube having ratio 1:2:4; 1:1.5:3 had W/C ratio of 0.65 and cube with ratio of 1: 1.25:2.5; 1:1:2 had W/C ratio of 0.45. An important statement made author is that there is a cost reduction of up to 50% when used GGBS. GGBS obtained was further pulverized using pulverized

B. Yasutaka SAGAWA Daisuke Yamamoto(2009)

Another advantage using GGBS apart from cost reduction and eco-friendly is it reduces chloride diffusion coefficient from 1/5th to 1/10th and also improves chloride resistance with the specific area of 6000 cm²/g and W/B ratio smaller than 45%.

WHEN USED GGBS IT IS EXPECTED THAT CORROSION IN STEEL BAR'S WON'T OCCUR FOR 100 YEAR'S.

The study claims that Japanese rarely use GGBS for the bridge because strength gained at an early stage is less. In this research, normal strength concrete and high strength concrete were examined by a change in W/C ratio. GGBS was examined against strength and chlorine ion diffusion by migration test Material used were OPC; GGBS4000 & GGBS6000; washed sand crushed stone(20mm) & water reducing & air entering agent (sulphuric acid); Alkali ether; Polycarboxylic Acid as chemical admixtures. Water to binder ratio was kept varying from 35%-65%.

C. Prof. Dr. Ke. A. Palaniappan(2013)

Along with the use of GGBS, this study also uses alkaline liquid for binding material. Liquid used in this study for polymerization are solutions of sodium hydroxide (NaOH) and Sodium Silicate (Na₂SiO₃) customized curing (chemical) of specimen of size 150mm*150mm*150mm (cylinder) & 500mm*100mm*100mm (Beam) Were carried out at 650C in oven & results were compared with conventional concrete percentage GGBS varied between 17%-20% with alkaline activations like NaOH used was between 1.5-2.5 & Na₂SiO₃ was 4-6%.

D. S. Arivalagan,(2014)

S. Arivalagan study an effort to understand the strength of GGBS when used as a replacement of cement at the various percentage of replacement. Author does a replacement of 20%, 30% & 40% of OPC (43 Grade). Research also divides GGBS in three group as per Chinese study i.e. S75, S90 & S105, and states minimum required surface area for each grade

S75 requires 3000 cm²/g

S90 requires 4000 cm²/g

S105 requires 5000 cm²/g

It reviews that Silica Fume, PFA are other materials that can replace cement, to achieve higher performance & sustainable concrete. The material used to perform a test where OPC 43Grade, River sand (zone II) & Crushed blue granite stones of nominal size 12.5 mm (M35 Mix) and Water cement ratio of 0.41.

E. M. Ramalekshmi, R. Sheeja, R. Gopinath (2014)

The author of this project study the experimental behavior of GGBS replaced reinforced concrete mix of M25 was designed and GGBS replaced was 50%, 60%, 70% and 80%.

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A set of 45 cubes has lasted nine pieces of cubes for each level of percentage and conventional concrete gave pieces tests were conducted at 7th day, 14th and 28th day respectively. Once the compression of the above was tested, percentage giving max value was tested on beam and column for constant axial load and reverse lateral loading. Max w/c ratio adopted was 0.5 for moderate exposure condition.

F. Prof. M. V. Nagendra (2014)

The author research says that the strength characteristics of M20 grade concrete with a replacement of cement by GGBS with 30%, 40% and 50% and compare with the conventional concrete. At present artificial sand is used to replace natural sand, so study area extends to find the best percentage of replacement by using both crush and natural sand.

G. Thavasumony D, Thanappan Subash, Sheeba D

This research is focused on reducing cracks that are tended to be formed by high strength. GGBS, when used with OPC & other Pozzolanic material, gives high ultimate strength and strength enhancing CSH. It has been observed that GGBS showed double 24-day strength over a period of 10-12 days.

This research compared PCC & GGBS used concrete, clean river sand & crushed rock 20 mm along with OPC. GGBS was Replace from 10%-60%.

IV. CONCLUSION

- Low W/C ratio will ultimately result in increase of compressive strength.
- WHEN USED GGBS IT IS EXPECTED THAT CORROSION IN STEEL BAR'S WON'T OCCUR FOR 100 YEAR'S
- CO₂ emission reduced.
- Reduce cement consumption which ultimately proves to be economical & eco- friendly.
- GGBS have a smooth surface than conventional concrete.
- Gains low early strength and gains high strength over a longer period in production conditions.
- GGBS would be used to make durable concrete along with OPC & Pozzolanic material.
- Load carrying capacity of GGBS Concrete when tested under beam column increased by 6.6% (50% replacement)
- Loss of weight due to chloride attack in orthodox concrete is 1.02% whereas GGBS Concrete Loss of weight observed was 0.963%.
- Degree of workability was normal for 40% replacement.
- Reduce cement consumption which ultimately proves to be economical & eco-friendly.
- It reduces chloride diffused coefficient by from 1/5th to 1/10th below 45% W/B ratio. GGBS 60000 had smaller coefficient than GGBS 4000.
- Appreciable increase in workability was noted with increases in percentage of GGBS. Therefore less water cement ratio can be adopted to keep slump constant
- Low W/C ratio will ultimately result in increase of compressive strength
- If water reducers are used no effect on compressive strength.

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 6, Issue 4, April 2017

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