Biased Replacement of Cement Using GGBS – A Sustainable Approach

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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 resilience of concrete. GGBS slag is obtained by quenching molten iron slag from a blast furnace in water or steam, to manufacture smooth as glass, coarse merchandise that is then dried and ground into a fine particles In this project, it is projected to study the wealth, Eco-Friendly and Strength aspects*

Keywords- GGBS, OPC, Replacement of Cement, Environmental pollution, compressive strength

I. INTRODUCTION

Concrete has been the major appliance for providing stability and dependability in infrastructure since the days of Greek and Roman empire. Concrete is the most world widely used construction material. The increase in demand of concrete more the new method and materials are being developed for production of concrete. Concrete is a mixture of cement, water, and aggregates with or without chemical admixtures. The most important part of concrete is the cement. Use of cement alone as a binder material produces large heat of hydration[2]. Since the production of this raw material produces lot of CO2 emission. The carbon dioxide emission from the cement raw material is very harmful to the environmental changes. Nowadays many researchers have been carried out to reduce the CO2. The effective way of reducing CO2 emission from the cement industry is to use the industrial by products or use of supplementary cementing material such as Ground Granulated Blast Furnace Slag (GGBS), Fly Ash (FA), Silica Fume (SF) and Metakaolin (MK). In this present experimental work an attempt is made to replace cement by GGBS to overcome these problems[14].

GROUND GRANULATED BLAST FURNACE SLAG (GGBS):

Ground Granulated Blast Furnace is a byproduct from the Blast furnace slag is a solid waste discharged in large quantities by the iron and steel industry in India. These work at a temperature of about 2732 Fahrenheit and are fed with a cautiously controlled mixture of iron – ore, coke and limestone. The iron ore is minimized to iron and remaining materials from slag that floats on top of the iron. At times the slag is tapped off as a molten liquid and if it is to be used for the production of GGBS it has been quickly quenched in outsized volumes of water. The quenching optimizes the cementitious properties and produces granules similar to coarse sand. This granulated slag is then dried and ground to a fine powder. The recycling of these slags will become an significant measure for the environmental fortification. Iron and steel are basic materials that underpin modern civilization, and due to many years of research the slag that is generated as a byproduct in iron and steel production is now in use as a material in its own right in various sectors. The primary constituents of slag are lime (CaO) and silica (SiO2). Portland cement also contains these constituents. The primary constituent of slag is soluble in water and exhibits an alkalinity like that of cement or concrete. Meanwhile, with the development of steel industry, the disposal of such a material as a waste is definitely a problem and it may cause severe environmental hazards.

Advantages of GGBS: The major use of GGBS is in ready mixed concrete. The technical benefits, which GGBS imparts to concrete, including

- Enhanced workability, production, placing and compaction are easier.
- Lower premature age temperature rise, reducing the risk of thermal cracking in large pours.
- High resistance to chloride ingress, plummeting the risk of reinforcement deterioration
- Soaring resistance to attack by sulphate and other chemicals.
- Considerable sustainability profit.
- Elimination of the risk of damaging internal reactions such as ASR.

OBJECTIVES:

- To study literature and present advances in GGBS
- To study and test the property of raw material Such as Cement, Aggregate and GGBS
- To test the mix for slump, compression up to 60^{TH} day of curing.
- Analysis and interpretation of result obtained

II. LITERATURE REVIEW

Kamran Muzaffar Khan (2004)

Study the contrast 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 powdered using pulverizer

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.[1]

The thesis claims that Japanese use GGBS once in a blue moon for the bridge because strength gained at an early phase 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 dispersion. Material used were OPC; GGBS4000 & GGBS6000; washed sand crushed stone(20mm) & water reducer & air entering agent (sulphuric acid); Alkali ether; Poly carboxylic Acid as chemical admixtures.[14]

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 650cin 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%.

S. Arivalagan,(2014)

Author made an attempt to know the strength of GGBS when used as a replacement of cement at the diverse 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 least 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.

III. MATERIALS AND METHODS

Cement

Ordinary Portland cement of 43 grade (Ramco) conforming to IS 8112-1989 is used. Table 1 shows the test results of basic properties of cement

Ground Granulated Blast Furnace Slag

GGBS was collected from JSW cement limited, vidyanagar Bellary. Table 3 shows the test results of basic properties of GGBS. TABLE 4: BASIC PROPERTIES OF GGBS

Water

Ordinary portable water is used in this investigation both for mixing and curing.

Super plasticizer (SP)

PCE based super plasticizer. Generally known as water reducer, was used to enhance the workability of concrete.

Concrete Mix Design

Different mix proportions were made for each mix with water- cement ratio of 0.35 and super plasticizer of 0.1% of cement content.

Batching of Materials

Weight batching and machine mixing are adopted in this study for concrete production. The percentage replacement of ordinary cement by GGBS and their material weight are shown in Table 3

Fine aggregate

Artificial sand of size below 4.75mm conforming to zone II of IS 383-1970 is used as fine aggregate. Table 2 shows the test results of basic properties of fine aggregates.

Coarse Aggregate

Natural crushed stone with 20mm down size is used as coarse aggregate. Table 2 shows the test results of basic properties of coarse aggregates

Table no 1: Raw Material Testing

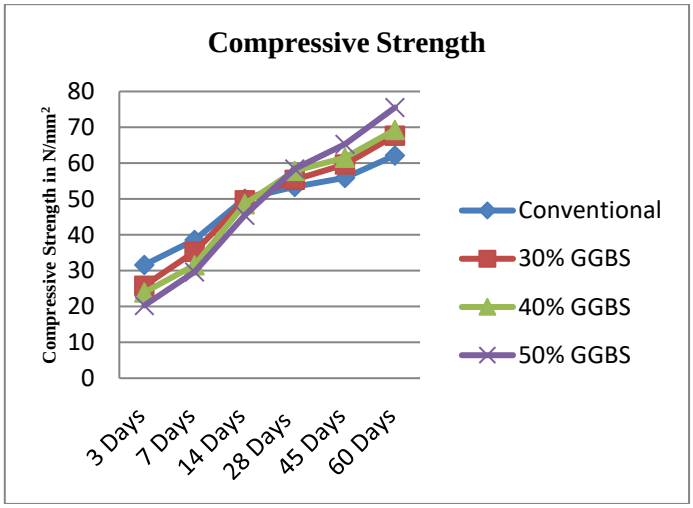
Test	Results
Specific gravity (FA)	2.74
Fineness Modulus (FA)	4.48
Silt content	3.33%
Flakiness index	8.5%
Elongation index	8.9%
Fineness modulus (CA)	14.89%
Specific gravity(CA)	2.74
Aggregate crushing value	7.16%
Aggregate impact value	5.14%

Table no 2: Mix Proportion

Mix no	% replacement	GGBS	Cement	FA	CA	Water	Admixture	W/C Ratio
1			429	817.6	1128.49	150	4.29	0.35
2	30	141.6	330.04	796.35	1099.72	150	4.72	0.35
3	40	188.18	283.2	748.02	1032.98	150	4.72	0.35
4	50	236	236	748.02	1032.98	150	4.72	0.35

IV. RESULTS AND DISCUSSIONS

- The compressive strength of concrete was determined at The age of 3,7,14, 28, 45 and 60 days as presented in graph.
- It was observed that concrete made by using GGBS offered more workability thanConventional concrete as GGBS material is finer than cement
- Keeping in mind strength aspect, GGBS concrete developed low early strength as compared to conventional concrete but it showed increase in strength from 14th day of curing
- Surface of GGBS concrete was more smooth and glossy as compared to conventional concrete and also it shows variation in color of concrete produced with increase in percentage replacement



Graph no 1: Compressive strength of mix

Table no 3: Compressive Strength of mix

Test Day	Conventional Concrete Mean Strength	30% GGBS Mean Strength	40% GGBS Mean Strength	50% GGBS Strength
3 Days	31.61	25.82	23.95	20.30
7 Days	38.56	35.31	31.50	29.67
14 Days	50.09	49.67	48.62	45.5
28 Days	53.42	55.35	57.85	58.38
45 Days	55.87	59.64	61.58	65.29
60 Days	62.17	67.70	69.31	75.54

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