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Experimental Investigation on Concrete Compression Member with GGBS

Roshini P[1], N Sellakkannu[2]
[1]*Pg Student, JCT College of Engineering and Technology* [1]
[2]*Assistant Professor, JCT College of Engineering and Technology Civil Department, Anna University*

Abstract*: The increasing search for an alternative sustainable and eco-friendly construction material has led to research on various replacement materials in concrete that have properties similar to that of cement. The concept of partial replacement of cement which is capable for sustainable development is characterized by application of industrial wastes to reduce consumption of natural resources and energy and pollution of the environment. GGBS 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. Ground Granulated Blast Furnace Slag (GGBS) was partially replaced as 0%, 10%, 20%, 30%, and 40% in place of cement in concrete. Concrete are made for M -30 mix and the cubes, cylinders and prisms are casted for 7, 14 & 28 days of ages and based on the testes conducted on these specimens the 30% replacement is found to be the optimum percentage of replacement of GGBS in concrete. In this study the comparison of conventional RCC column and 30% GGBS RCC column are analysed. The columns are casted for 28 days of curing and tested. It is found that normal M30 grade concrete fails to sustain the compressive strength as compared to the M30 grade concrete prepared by partial replacement of cement by GGBS.

***Keywords*: GGBS, Sustainable and Eco-Friendly, Super plasticizer, Concrete compression member, Compressive strength.**

I. INTRODUCTION

Concrete is primarily comprised of Portland cement, aggregates, and water. Cement plays a great role in the production of concrete and is the most expensive of all other concrete making materials. In addition, there is environmental concern in the production of cement. The ground granulated blast furnace slag is a waste product from the iron manufacturing industry, can protect the steel reinforcement more efficiently, 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 replaced by ground granulated blast furnace slag, which is an industrial waste. Thus the implementation of GGBS concrete can minimize corrosion in an effective way. Moreover it can lead to much durable structure without considerable increase in cost. Ground granulated blast furnace slag from modern thermal power plants generally does not require processing 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 cementeceous material that can act as a partial substitution for Portland cement without significantly compromising the compressive strength. Columns are the basic parts of many engineering structures. The columns majorly take the axial loads and try to resist the bending caused due to the applied axial loads.

A. Applications

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 cementeceous material, but also continues to gain strength over a longer period in production conditions. This results in lower heat of hydration and lower temperature rises, and makes avoiding cold joints easier, but may also affect construction schedules where quick setting is required.

II. MATERIALS INVESTIGATION

A.Cement

The Ordinary Portland cement of 53-grade was used in this study conforming to IS: 12269-1987. The specific gravity of cement is 3.15. The initial setting time is found as 35 minutes and the Standard consistency of cement was 31%.

B.Fine Aggregate

The river sand is used as fine aggregate conforming to the requirements of IS: 383-1970. Having specific gravity of 2.60 and fineness modulus of 2.76 has been used as fine aggregate for this study.

C. Coarse aggregate

Locally available crushed blue granite stones conforming to graded aggregate of nominal size 12.5mm as per IS 383-1970. Having specific gravity of 2.64 and fineness modulus of 5.54.

D. GGBS

Ground Granulated Blast furnace Slag (GGBS), a co-product produced simultaneously with iron, molten blast furnace slag is cooled instantaneously by quenching in large volumes of cold water, known as granulation, to produce Granulated Blast furnace Slag.

Table –I
Chemical Composition of GGBS

Chemical Composition	Percentage (%)
SiO2	34.06
Al2O3	18.8
CaO	32.4
MgO	10.75
SO3	0.85
Fe2O3	0.7
S	0.65
MnO	0.49
Na2O	0.31
K2O	0.98
Cl	0.008

Table –II
Physical properties of GGBS

Physical Properties	GGBS
Colour	White powder
Consistency	*30%*
Specific gravity	2.9

E. Water

Potable clean water was used in the present investigation for both casting and curing of concrete conforming as per IS: 456-2000.

F. Super plasticizer

Super plasticizer (Fosroc Conplast SP430 DIS, Sulphonated Naphthalene Formaldehyde) was used in the present investigation.

III.EXPERIMENTAL INVERSTIGATION

A. Compressive Strength test

The compressive strength of 150mm x150mm x 150mm size cubes were tested for 7, 14 & 28 days. The M30 mix ratio of 1: 1.84: 3.05:0.40 which gave better results when compared to the control mix.

The concrete mixture with 30% GGBS achieved highest compressive strength at end of curing day with all variations in comparison to plain concrete mixture. Hence the optimum value is achieved for 30% GGBS.

B. Split Tensile Strength test

The Split tensile strength of cylinders of 150mm diameter and 300mm long was carried out for 7, 14 & 28 days. The concrete mixture with 30% GGBS achieved highest tensile strength at end of curing day with all variations in comparison to plain concrete mixture. Hence the optimum value is achieved for 30% GGBS.

C. Flexural Strength Test

The Flexural strength of concrete prisms of 100mm x100mm x 500mm were tested for 7, 14 & 28 days. The concrete mixture with 30% GGBS achieved highest flexural strength at end of curing day with all variations in comparison to plain concrete mixture. Hence the optimum value is achieved for 30% GGBS.

D. Compressive Strength test of column

Totally 4 columns are casted. Out of these columns, 2 columns are conventional and another 2 columns are GGBS replaced column. The size of column is 600mm x100mm x100 mm. the size of main rod is 12mm. The lateral ties are 8mm should be used. The cover thickness is 20mm. The M30 grade concrete should be used to make the column. The plywood mould is made for casting the column. Before starting the casting work of column the mould is well cleaned and oiled throughout the mould. Based on above test results the optimum percentage of GGBS replaced with cement is concluded as 30%. Based on this percentage the column is casted. The Figure 1 shows the Longitudinal and cross section detailing of compressive member and the Figure 2 shows the casted columns.

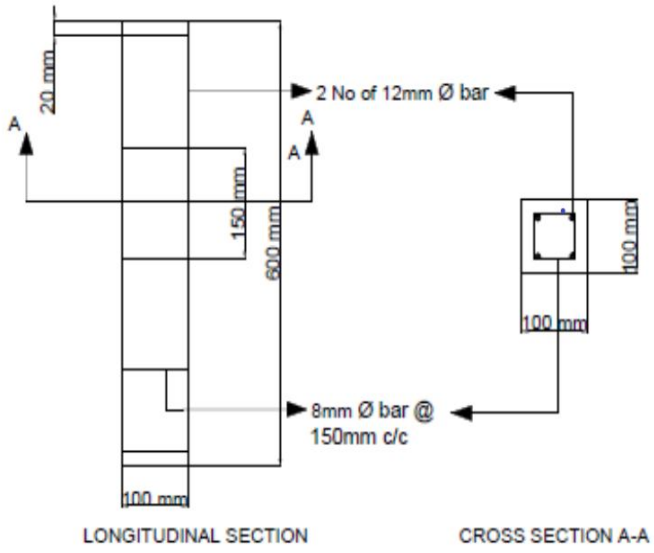

Fig1: Longitudinal and cross section detailing of compressive member

Universal Testing Machine having load carrying capacity of 1000KN is used for testing the columns. Base plates of 25 mm were providing at top and bottom faces of specimen to transfer a uniform distribution of load over the column. For each load increments the deformation and buckling were recorded. All specimens were subjected to load up to failure. Thus load carrying capacity of each column would be calculated by applying load.

Fig2: Casted Columns

Fig3: Compressive Strength test of column

Table –III
Load carrying capacity & Deflections of columns

Sl.No.	Type of column	Sample No.	Ultimate Load (KN)	Ultimate Deflection (mm)
1	Conventional Column	1	212	6.2
		2	205	5.8
		Avg	208.5	6.0
2	GGBS Replaced Column (30%)	1	230	5.1
		2	235	4.9
		Avg	232.5	5.0

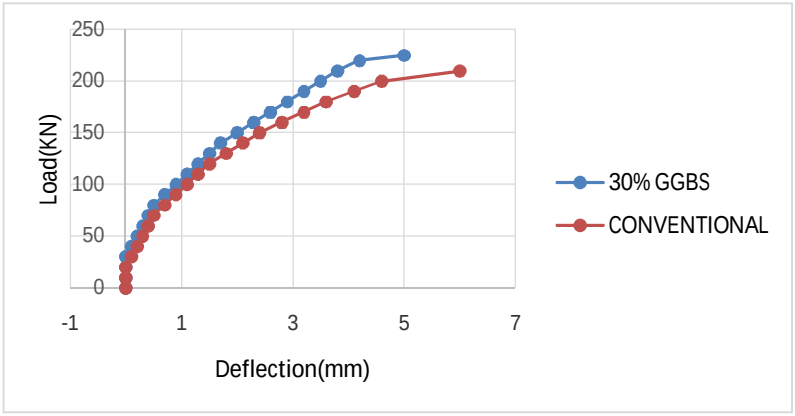

Fig4: Comparison of load vs. deflection curve for conventional and GGBS columns

From the load deflection curve it was found that axial load carrying capacity of a GGBFS column enhance good load carrying capacity when compared with conventional column.

IV. CONCLUSIONS

The GGBS replaced column gives the strength more than the conventional column. The GGBS replace column gives load carrying capacity more than the conventional column and also the deflection is reduced than the conventional column. The concrete mixture with 30% GGBS achieved highest compressive, split tensile, flexure strength at end of curing day with all variations in comparison to plain concrete mixture. Hence the optimum value is achieved for 30% GGBS. The 30% replacement of cement with GGBS gives optimum result but after that the strength got slowly decreases. Results of this investigation suggest that GGBS could be very conveniently used in structural concrete.

Use of GGBS reduces the amount of cement content as well as heat of hydration in a mortar mix. Thus, the Construction work with GGBS concrete becomes environment friendly and also economical. GGBS can beUsed as substitute for cement which will reduce the cost of cement in concrete and also reduce the Consumption of cement. Therefore it is safe to replace the cement with 30% GGBS considering the strength.

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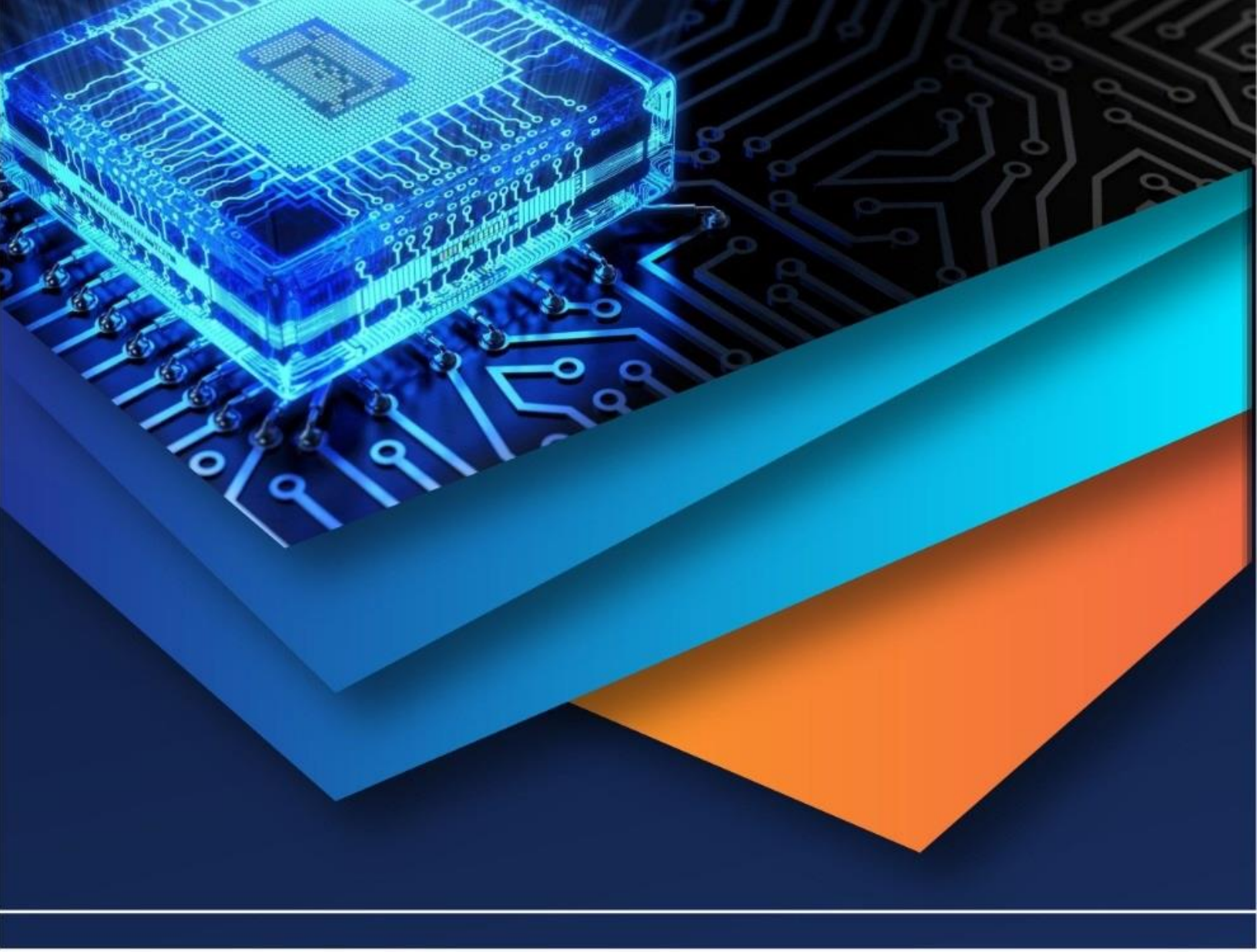

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