Effect of Partial Replacement of Cement with GGBS on Properties of Concrete

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***Abstract*- As existence of human is being modernized together with the use of technologies has lead to an increase in the quantity and type of waste being generated. This causes a serious issue of waste disposal. By implementing appropriate industrial waste management an extensive economic & environmental reimbursement can be achieved. But to protect our environment, sustainable development of our society is needed. Taking in view a progress of new technologies to recycle and convert waste materials into reusable materials is vitally essential. However, the current study presents an attempt for beneficial reuses of Ground Granulated Blast Furnace Slag (GGBS), in an effort to provide a compendium of recent and past developments, and update our current state of knowledge. In this study, the workability, compressive strength and flexural strength test for quality concrete mixtures for different percentage of GGBS as replacement of cement are reported. For the same, varying percentage of Cement has been partially replaced by GGBS and its effect in terms of strengths, compressive and flexural, after 7 and 28 days has been discussed.**

Index Terms- Ground Granulated Blast Furnace Slag, Workability Test, Compressive Strength Test, Flexural Strength Test.

I. INTRODUCTION

In present days, concrete has become a vital part of our lives. With every transient date, Concrete is extensively used. From this construction material main constituent is Portland cement. Therefore, as the increasing in the use of concrete, there is increase in manufacturing and consumption of cement. Thus it increases the demand of cement and thereafter the cost of this ingredient. And due to the effect of global warming the temperature on earth is increasing & use of cement releases heat during the process of heat of hydration which will again increase surrounding temperature. However, there was a need to minimize the use of cement in concrete so that the effect of heat of hydration, cost and manufacturing of material is reduced. Taking this point in view a new trend of partial replacement of cement with other non cementious material called as Pozzolana mineral admixtures rises head in field of concrete technology. The present study deals with the same aspect of partial replacement of cement with Ground Granulated Blast Furnace Slag (a pozzolanic material produced in iron manufacturing industry) along with a dose of super plasticizer to have a workable concrete of M25 grade.

II. OBJECTIVE OF EXPERIMENT

This work focus on the performance and durability of Ground granulated blast furnace slag as partial replacement of Portland cement (PC) in concrete. Based on the above, the specific objectives are:

1. Evaluation of strength development of concrete with Ground granulated blast furnace slag as partial replacement of Portland cement.
2. Determination of achieved flexural strength in concrete with GGBS as partial replacement of Portland cement.
3. To study the effective partial replacement of cement with GGBS and provide environment friendly construction material.
4. To analyze effect of GGBS on the properties of fresh concrete especially workability of concrete.
5. To study the durability requirements of the GGBS concrete.

III. RESULTS AND DISCUSSIONS

In this chapter the cause of, using GGBS with partial replacement of cement as 0%, 20%, 40% and 60% for M25 grade of concrete, on workability, compressive strength and flexural strength has been shown in tabular and graphical form. These tests are

performed at 7 and 28 days of curing of concrete. Super-plasticizer is used in all the mixes at 0.5% by weight of cementitious material.

a) Workability of Fresh Concrete:

Table 4.1: Workability Test Result

Mix Proportion	Workability
0%	80 mm
20%	95 mm
40%	110 mm
60%	75 mm

Above result of workability shows the variation in slump height as percentage of GGBS change with use of Superplasticizer of 0.5% of cementious material. The highest and the lowest values slump are found at 40% (110mm) and 60% (75mm) replacement of cement with GGBS respectively. There is 13.64% increase in workability of concrete from 20% to 40% replacement of cement with GGBS. But the workability reduces by 31.82% from 40% to 60% replacement of cement with GGBS. This indicates that there is increase in the workability of concrete upto 40% replacement of cement with GGBS but the workability reduces with further 60% replacement of cement.

b) Compressive Strength Test:

Table 4.2 Compressive Strength Test Results

Partial Replacement of cement (%)	Compressive Strength	
	7 Days	28 Days
0% GGBS	18.25	29.57
20% GGBS	22.05	31.89
40% GGBS	23.80	33.56
60% GGBS	21.39	30.22

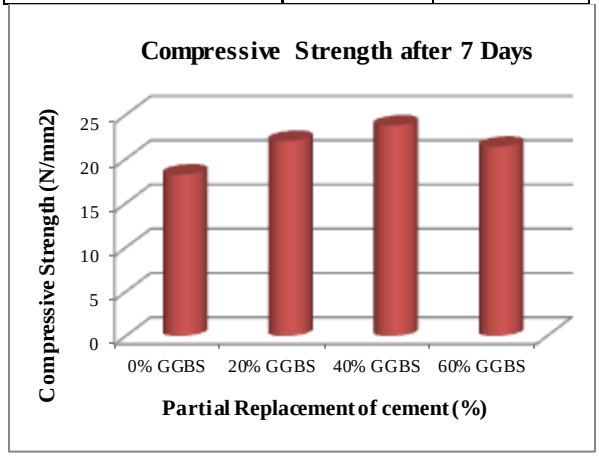

Figure 4.2: Graphical Representation of Compressive strength Test after 7 days

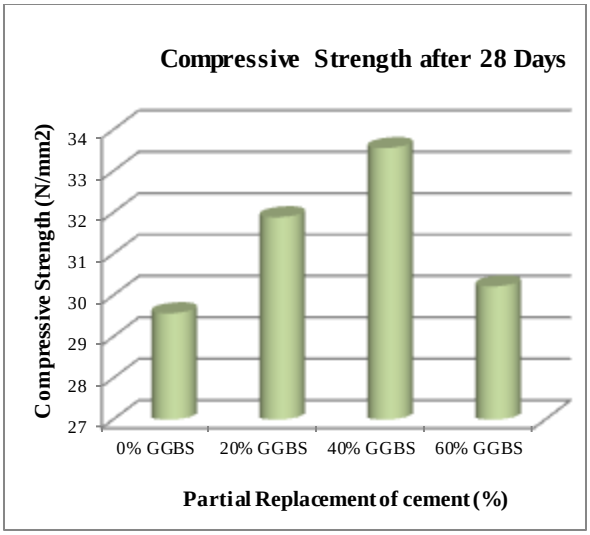

Figure 4.3: Graphical Representation of Compressive strength Test after 28 Days

On observing the strength data provided in Table 4.2, it is found that a maximum compressive strength of 23.8 N/mm^2 is achieved at 7 days and 33.56 N/mm^2 is achieved at 28 days curing period.

The above figures shows the average compressive strengths of the concrete cubes cured to 7 and 28 days corresponding to the values tabulated in table. The compressive strength is observed with 0% replacement of cement (29.57 N/mm^2). Among the partial replacement cubes, the optimum strength is found on 40% replacement of cement with GGBS as 33.56 N/mm^2 at 28 days of curing. There is 11.88% increase in compressive strength of concrete. And for 20% replacement of cement compressive strength after 28 days of curing is 31.89 N/mm.

c) Flexural Strength Test:

d) Table 4.3 Flexural Strength Test Results

Partial Replacement of cement (%)	Flexural Strength	
	7 days N/mm^2	28 days N/mm^2
0% GGBS	3.285	4.731
20% GGBS	3.528	5.102
40% GGBS	3.461	4.982
60% GGBS	2.994	4.835

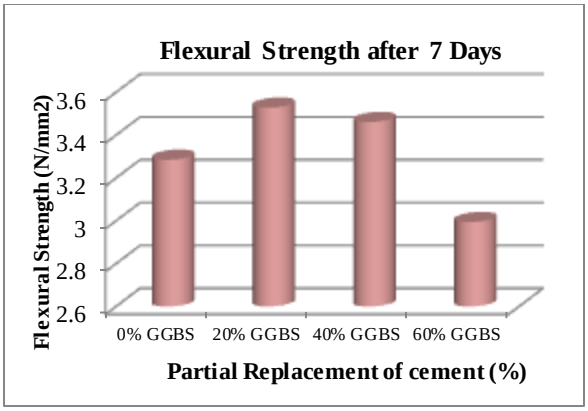

Figure 4.2: Graphical Representation of Flexural strength Test after 7 days

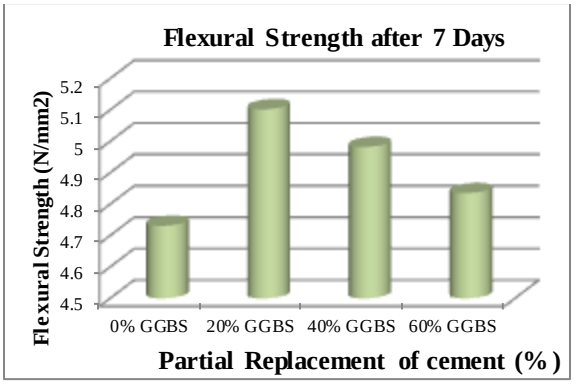

Figure 4.2: Graphical Representation of Flexural strength Test after 28 days

On observing the strength data provided in Table 4.3, it is found that a maximum flexural strength of 3.5 N/mm^2 is achieved at 7 days and 5.1 N/mm^2 is achieved at 28 days curing period.

The above figure shows the average compressive strengths of the concrete cubes cured to 7 and 28 days corresponding to the values tabulated in table. The compressive strength is observed with 0% replacement of cement (4.7 N/mm^2). Among the partial replacement beams, the optimum strength is found on 20% replacement of cement with GGBS as 3.5 N/mm^2 at 7 days and 5.1 N/mm^2 at 28 days of curing. On further observations it has been observed that there is small difference between the flexural strength of 20% and 40% replacement with GGBS.

IV. CONCLUSION

The performed tests on concrete with partial replacement of cement with varying percentage of GGBS show varying results for different GGBS content. Thus, from the results obtained following are the concluded points of the experimental work:

1. For the experimental work performed, the degree of workability of concrete was increase with the addition of GGBS upto 40% replacement level with dose of Superplasticizer. Later on with addition of GGBS at 60% replacement workability decreases.
2. The maximum compressive strength of concrete achieved when cement is replaced with 40% GGBS for all ages. The strength is observed to slightly decrease at 20% replacement of cement with GGBS.
3. The optimum flexural strength of concrete attained when cement is replaced with 20% GGBS at 7 days and 28 days of curing and slightly decrease at 40% replacement of cement with GGBS
4. The replacement of cement by GGBS not only increases the compressive strength but also reduces the cement content which eventually leads to the decrease in emission of Carbon dioxide (CO2) gas.
5. The most optimized mix of GGBS based concrete is found to be 40% from both compressive and flexural strength of concrete .however beyond 40% of replacement the strength decreases
6. As for as cost is concerned the cost of GGBS in the market including packaging and transporting is three time less than that of Ordinary Portland Cement.
7. From the above study result it is proved that GGBS can be used as alternative material for cement reducing cement consumption and also reduced cost of construction use of industrial waste products save the environments and conserves natural resources
8. GGBS is good replacement to cement upto certain percentages and serves effectively but it can't replace cement completely.

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