Study on Utilization of Blast Furnace Slag in Concrete

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Abstract— One such type of by-product from the iron smelting industry is iron slag, which is formed from the blast-furnaces of iron industry. This blast furnace slag is used to make a cementitious material by grinding it into a fine powder, which is called Ground Granulated Blast Furnace Slag or GGBS. The same blast furnace slag is used to make a glassy granular product (GBFS) which can be used as fine aggregate. GGBS has cementitious properties and can be very useful in the design and development of high quality cement paste/mortar and concrete. GGBS cement is accessorial to concrete, within the concrete manufacturer's batching plant in conjunction with Portland cement, aggregates and water. Growing ecological limitations to the use of sand from river beds leads to search for alternatives mainly near the larger urban areas. This has brought in brutal strains on the accessibility of sand forcing the construction business to look for substitute building materials without compromising the strength criteria of concrete. Granulated blast furnace slag is one of the promising sustainable solutions as they are obtained as solid wastes generated while production of iron. Hence it eliminates the solid waste disposal problem and other ecological issues. Present experimental work explores the opportunity of using GBFS as replacement of natural sand in concrete and GGBS as replacement of cement in concrete. In our experiments it was found that both GGBS can be used successfully to partially replace cement in concrete by 55%.
Key words: Blast Furnace Slag, GGBS, GBFS, OPC

I. Introduction

The Ordinary Portland Cement (OPC) is one of the most important ingredients used for the production of concrete. Unfortunately, production of cement involves emission of large amounts of carbon-dioxide gas into the atmosphere, which is a major contributor for greenhouse effect and the global warming. The search for any such material, which can be used as an alternative or as a supplement for cement should lead to global sustainable development, lowest possible environmental impact and lowest possible cost. The waste material which is having pozzolanic property are the most suitable to fill up this role.

II. Methodology

This section deals with the different materials used in the experiment. The different materials for making concrete cube for the compressive tests are Cement, Coarse aggregate, Fine aggregate, GGBS, GBFS and Water. Cement used in this study is ordinary Portland cement of grade 53. Mix design is done by IS 10262: 2009, and grade of concrete is used is M30. Coarse and fine aggregate used is crushed aggregate and sand respectively. 15*15*15 cm concrete cube is casted and curing is done in clean water at room temperature, after 7 and 28 days of curing compressive strength test is performed on concrete cubes. Designation of concrete mix is given in table 1.

S.No	Specimen	% Replacement Of Cement By GGBS
1	A1	10.0
2	A2	20.0
3	A3	25.0
4	A4	30.0
5	A5	35.0
6	A6	40.0
7	A7	45.0
8	A8	50.0
9	A9	55.0

Table 1: Designation of Concrete Mix

III. Result & Discussion

In the first sample the concrete is made with traditional ingredients only i.e. cement, fine aggregate, coarse aggregate, and water. The GGBS content of this sample is 0%. The compressive strength was conducted at 7 days and 28 days of wet curing. These tests were conducted to check if the mix design so created is actually at par with the needed design strength. The compressive strength test showed satisfactory results and hence eight different concrete samples were casted with 10%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, and 55% GGBS content respectively. The test samples with 10%, 20%, and 25% did not show any significant variation in compressive strength of concrete, the strength was found satisfactory, hence they are not discussed here. The samples A4 to A9 with GGBS content of 30%, 35%, 40%, 45%, 50%, and 55% respectively showed significant variation in the 7 days and 28 days compressive strength of concrete and are discussed in this thesis. The pie charts of sample A4 to A9 showing percentage content of ingredients are shown for deeper understanding. Average strength of the samples all together. We can see that only sample A6, A8 and A9 were the only ones which reached or crossed the design mean strength. In the three passed samples we see that the average mean strength of sample A6 is the highest. But sample A9 is also a potent concrete specimen. Figure 5.8 show the variation in compressive strength for different percentage of GGBS in the concrete specimens. It can be seen from the curve that with increase in percentage of GGBS maximum strength is attained at 40%.

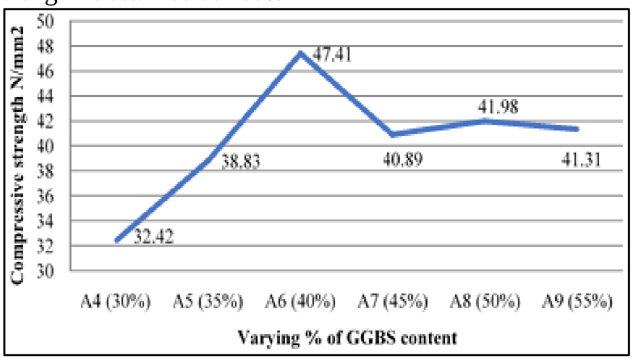

Fig. 1: Compressive Strength of Concrete

IV. CONCLUSION

In the study it was observed that the 7 days compressive strength of sample in which the cement was replaced by 30% of GGBS was satisfactory but when the same sample was subjected to compression test after 28 days of curing, the sample failed to exhibit strength. The average strength of the six samples with 30% of GGBS subjected to compression test at 28 days of curing could not reach the design target strength of 38.25N/mm^2. But on the other hand sample A6 (40% GGBS) showed the best results in the 28 days compression test. The average strength of the sample was 47.41 N/mm^2. Also it has been observed that samples with 50% & 55% of GGBS were found to be satisfactory.

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