Durability Properties of Blast Furnace Slag (BFS)-Modified Concrete

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Abstract*: Mineral admixtures are being used today almost in all concretes partially, to improve workability, engineering properties and also to enhance durability of the concrete. These are industries by-products. This paper discusses, blast furnace slag (BFS) was used to study durability properties; namely, initial water absorption, final water absorption and acid attack. To examine the above mentioned properties, M30 concrete was chosen. The BFS content was varied from 0% to 30% by volume of cement with an interval of 10%. In acid attack, specimens were cured in H_2SO_4 solution about 3% concentration, the corresponding weight losses (%) were evaluated for curing periods of 7, 14 and 28 days. The durability properties of the BFS-modified concrete have been improved when BFS content increased up to 20% advantageously. Weight loss was also decreased.

Keywords— Concrete, BFS, Water absorption and Acid attack.

I. INTRODUCTION

A study was conducted on fly ash-modified polymer concrete. In addition to mechanical properties, Young's modulus (E) of the concrete was also improved. According to the test results, both the strength and durability properties of the concrete improved up to a fly ash content of 15% [1].

An experimental study was conducted on fly ashes which are available in India, and insulin on concrete. The engineering properties and durability properties improved effectively. The micro cracks in the concrete were also reduced. Finally, low calcium fly ash-modified concrete gave better improvement of durability properties of concrete [2].

Improvement of corrosion resistance of cementitious mortor was studied. The corrosion resistance was evaluated in terms of 90 days ponding, water absorption, macro cell corrosion, impressed voltage, weight loss and rapid chloride ion penetration. According to the test result, the corrosion resistance of the concrete improved advantageously [3].

An experiment was conducted on durability properties of fly ash (FA)-modified concrete. In view of experimental test results, the low permeability voids and low $Ca(OH)_2$ of the concrete observed [4].

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A study was conducted on rice husk ash (RHA)- and marble powder (MP)-modified concrete. The experimental test results showed that mechanical properties as well as durability properties improved advantageously [5].

An experiment was conducted on corrosion resistance of RHA-modified concrete. According to the test results, the durability properties improved advantageously [6].

A study was conducted on durability properties of RHA-modified concrete. According to the test results, the properties of RHA-modified concrete improved. The optimum content of RHA was taken as 30% for M30 and M40. While for M50, RHA content was 20%. The permeable voids of the concrete were reduced when RHA content increased. At higher grades of concrete, the coefficient of permeability reduced [7].

A study was conducted on Engineering and durability properties of metakaolin-modified concrete. The engineering properties were estimated for the basic curing periods. The inner-structure of the metakaolin-modified cement motor was examined by SEM and XRD picture. According to the test results, the engineering and durability properties improved effectively [8].

A study was conducted on the durability of metakaolin-modified concrete. Concrete specimens were cured in Na_2SO_4 solution of 5% concentration, durability properties were evaluated after the curing period of 18 months. SO_4 resistance of metakaolin-modified concrete was improved. According to the test results, the durability properties of metakaolin-modified concrete improved advantageously [9].

A study was conducted on chloride penetration of both metakaolin-modified and fly ash-modified concretes. According to the test results, the durability properties of the concrete improved effectively [10].

A study was conducted on strength properties of high performance metakaolin-modified concrete (HPC). The concrete was exposed to HCl solution. It had been concluded that the strength of high performance metakaolin-modified concrete improved effectively [11].

A study was conducted on Engineering and durability properties of SF-modified concrete. The properties of the concrete were improved when compared with conventional concrete. According to test results, the SF-modified concretes gave superior durability properties [12].

A study was conducted on Engineering and durability properties of both FA- and SF-modified concretes. An optimum content of both FA and SF in this study was 10%. According to the test results, the properties of the concrete improved advantageously [13].

A study was conducted on durability properties of high strength SF-modified concrete. The SF content was varied as 0%, 5%, 10%, 15%, 20%, and 25%, with and without super-plasticizer. The properties of silica fume-modified cement mortor improved effectively. In durability criteria, the optimum content of SF content was 15% [14].

A study was conducted on workability and durability of FA based SF-modified concrete. According to the test results, the durability properties of SF-modified FA based concrete improved advantageously [15].

A study was conducted on engineering properties of GGBS-modified concrete. The GGBS content was varied from 10% to 40%, the slump of GGBS-modified concretes were improved. According to the test results, the strength properties were decreased at 56 days. The properties of the concrete improved for a GGBS content of 30% when compared with conventional concrete [16].

A study was conducted on durability of GGBS-modified concrete. According to the test results, the properties of the concrete improved advantageously [17].

A study was conducted on Engineering and durability of GGBS-modified concrete. The GGBS content was varied as 30%, 40% and 50. According to the test results, the properties of concrete increased. The specimens were immersed into H_2SO_4 and HCl of 1% and 5% concentration respectively. The durability properties were improved effectively [18].

II. EXPERIMENTAL PROGRAM

Materials used

The usual construction materials such as binder, sand, coarse aggregate and water were used in the preparing the specimens for durability tests. In this experiment, GGBS and metakaolin were used to study durability properties. Tests on the material were performed to identify basic properties.

Basic properties of cement such as specific gravity, consistency, initial and final setting times were calculated and their values are 3.15, 33%, 86 minutes and 254 minutes respectively. The specific gravities of sand and coarse aggregate were found to be 2.55 and 2.65 respectively.

The acidic nature of water was found to be in permissible limit to use in concrete making.

The specific gravity of GGBS and metakaolin were calculated as per IS 1723 and the values were 2.77 and 2.60 respectively.

Durability tests performed

To evaluate the performance of concrete in durability criteria some tests were conducted viz., water absorption and resistance to acid attack.

III. RESULTS AND DISCUSSIONS

WATER ABSORPTION

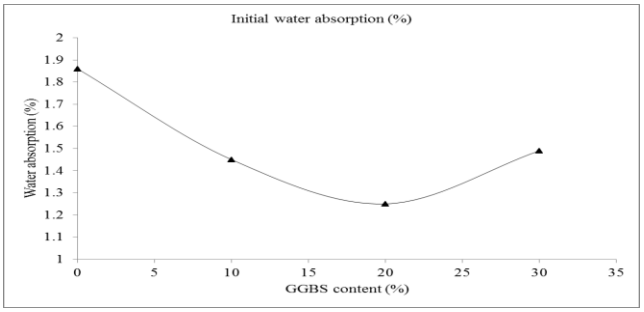

Figure 1 Initial water absorption

Figure 1 prescribes the effect of initial water absorption (%) with BFS content (%). When BFS content increased from 0% to 30%, initial water absorption was decreased. For instance, When BFS content increased from 0% to 30%, initial water absorption was decreased from 1.86% to 1.49%. The maximum decrement of initial water absorptions at BFS content of 20%.

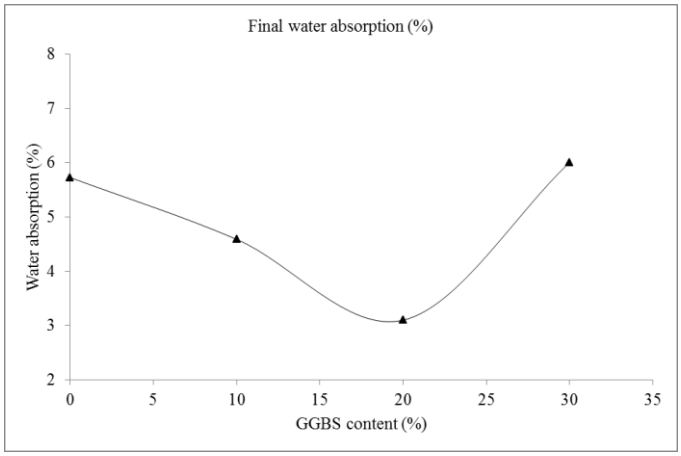

Figure 2 Final water absorption

Figure 2 prescribes the effect of 96 hours of final water absorption (%) with BFS content (%). The final water absorption was increased from 5.73% to 6.01% when BFS content increased from 0% to 30%. But, the final water absorption was decreased from 5.73% to 3.10% when BFS content increased up to 20% and thereafter it increased at higher content of BFS (%).

ACID ATTACK

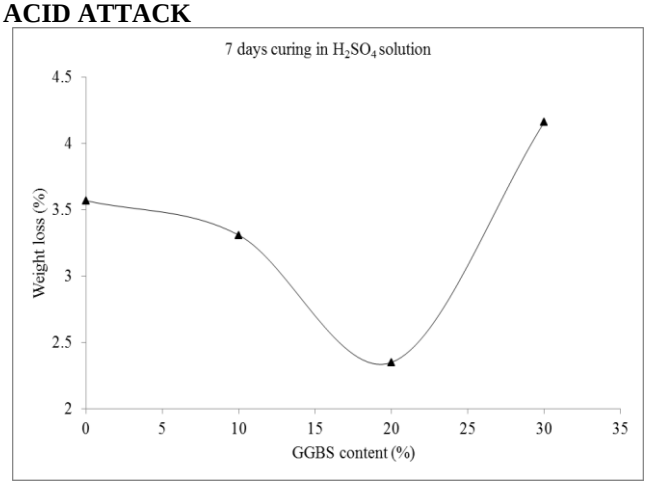

Figure 3 the effect of weight loss (%) with the BFS content (%) (7 days)

Figure 3 prescribes the effect of weight loss (%) with the BFS content (%) at 7 days curing in H_2SO_4 solution. The weight losses (%) of specimens were calculated. The weight loss (%) was decreased from 3.57% to 2.35% when the BFS content increased from 0% to 20%. Thereafter, it increased at high content of BFS.

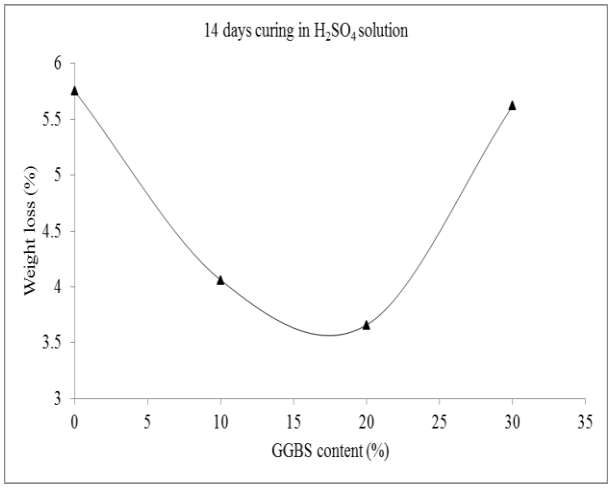

Figure 4 the effect of weight loss (%) with the BFS content (%) (14 days)

Figure 4 prescribes the effect of weight loss (%) with the BFS content (%) at 14 days curing in H_2SO_4 solution. When the BFS content increased from 0% to 20%, the weight loss (%) was decreased from 6.71% to 3.62%. Thereafter, it increased at higher content of BFS (%).

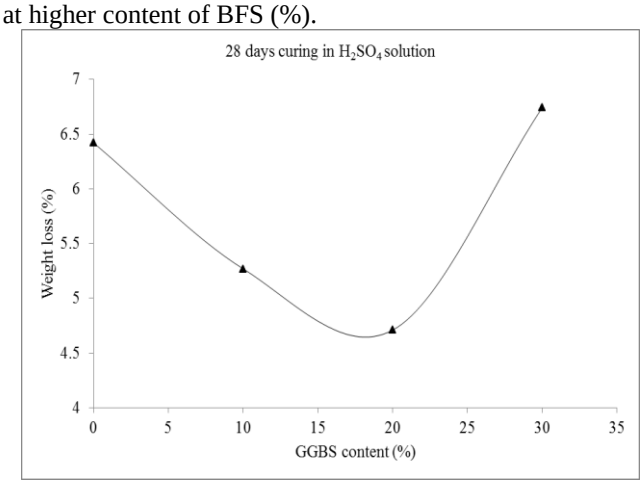

Figure 5 the effect of weight loss (%) with the BFS content (%) (28 days)

Figure 5 prescribe the effect of weight loss (%) with the BFS content (%) at 28 days curing in H_2SO_4 solution. The weight loss (%) was decreased from 6.42% to 4.71% when the BFS content increased from 0% to 20%. Thereafter, it increased at higher content of BFS (%).

IV. CONCLUSIONS

- The decrement of initial water absorption was about 20% when the BFS content increased from 0% to 20%.
- For 96 hours of final water absorption, the reduction was about 46% when the BFS content increased from 0%to 20%.
- The weight loss of the concrete subjected to 3% H_2SO_4 solution was decreased with the increase in BFS content (%). The decrement of weight losses was about 34%, 46% and 27% for curing periods of 7, 14 and 28 respectively when BFS content (%) increased from 0% to 20%.

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