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ASSESSMENT OF GROUND GRANULATED BLAST FURNACE SLAG AND STEEL FIBERS BASED RIGID PAVEMENT

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Abstract

This paper represents the laboratory investigation in which the compressive strength and flexural strength of ground granulated blast furnace slag concrete compared with normal concrete of M40 grade and also for increasing flexural strength steel fibers was used. For this study, concrete cubes and beams were produced of six partial GGBS replacement ratios (10%, 20%, 30%, 40%, 50%, and 60%) with constant water-cement ratio (0.4) and cement dose of 500 kg/m^3. To keep a constant workability, super plasticizer was used in concrete. The cubes and beams were tested at the age of 7 and 28 days with continuous water curing condition. The comparison between normal concrete, GGBS concrete and with steel fiber concrete was made. After testing it was found that at 30% GGBS replacement we can get M40 strength of concrete. But flexural strength decreases by increasing percentage of GGBS so that to increase in flexural strength steel fibers of two different aspect ratios was used. Steel fibers were added in concrete by 1% of total weight of concrete with different proportions. Thus the compressive and flexural strength reached up to considerable limit.

1. Introduction

It is a glassy granular material formed during the process of producing iron in a blast furnace and is formed by rapidly chilling the molten material and subsequently grinding it to a fine powder. Ordinary cement concrete pavement possesses a very low tensile strength, limited ductility and little resistance to cracking. Internal micro-cracks are inherently present in the concrete pavement and its poor tensile strength is due to propagation of such micro-cracks, leading to brittle failure of concrete pavement. So there is need of concrete pavement having more tensile strength.

Cengiz Duran Atis, Cahit Bilim in 2007 tested the compressive strength of GGBS concrete in wet and dry condition and reported that dry curing conditions influenced GGBS concrete more than normal concrete and when increasing water- binder ratios concrete becomes more sensitive.

Ilker Bekir Topcu, Ahmet Raif Boga in 2010 tested mechanical properties of concrete. According to their conclusion, the usage of GGBS at the ratio of 25% to replacement in concrete can improved the corrosion resistance of the reinforcement in concrete.

S.E. Chidiac, D.K. Panesar in 2008 found that the compressive strength of concrete increases when 60% GGBS is used, increasing the W/B ratio from 0.31 to 0.38.

2. Experimental program

2.1 Materials

Concrete cubes and beams were casted by using PPC cement, GGBS, coarse aggregate of size 20 mm, fine aggregate and steel fibers with different aspect ratios.

2.2 Concrete mix Design

As per IS 10262:2009 (recommended guidelines for concrete mix design) concrete mix design was made for M40 concrete. At first, when mortar was made, it shows very poor workability. So to improve workability, super plasticizer named AC-Hypercrete was added at a percentage of 0.5% of cementitious materials.

3. Result and discussion

The compressive strength and flexural strength of the concrete

The compressive strength and flexural strength at the age of 7 and 28 days are shown in fig.1and fig. 2. It can been seen that at the age of 7 and 28 days, the compressive strength of normal concrete were 37.7 Mpa and 45.78 Mpa respectively. On the other hand, the flexural strength was found to be 5.4 MPa and 9.0 MPa at the age of 7 and 28 days respectively.

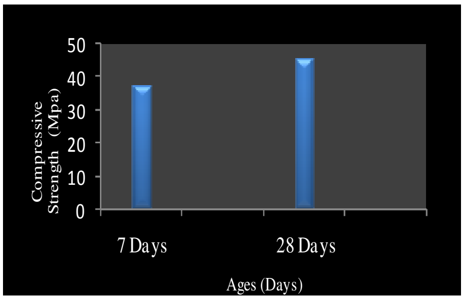

Fig. 1. Compressive Strength at different ages of normal concrete.

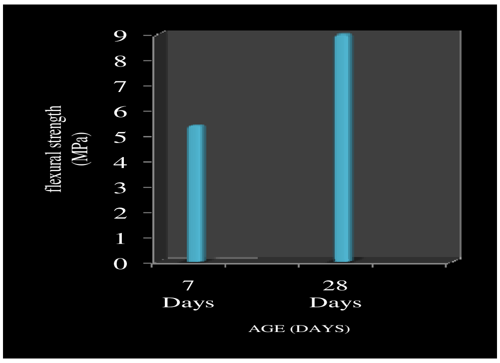

Fig. 2. Flexural Strength at different ages of normal concrete.

In all GGBS mortar, it can be seen that the compressive strength and flexural strength decreases with the increase in percentage of GGBS. The highest compressive strength was found when 30% GGBS replacement as that of M40 concrete. So by choosing this replacement, further investigation started to compare with normal M40 grade of concrete.

Table 1- Compressive strength of concrete cube and flexural strength of concrete beam with different percentage of GGBS

Percentage replacement of GGBS	10	20	30	40	50	60
Age of 7 days (C.S.) MPa	32.08	27.85	27.63	21.78	16.82	12.52
Age of 28 days (C.S.) MPa	44.3	42.96	40.88	34.74	24.44	18.87
Age of 7 days (F.S.) MPa	5.33	5.26	5.33	2.2	1.07	1.2
Age of 28 days (F.S.) MPa	7.86	6.8	6.46	4.93	3.67	2.07

From the table 1, it can be seen that flexural strength was very poor as compare to normal concrete. So it is necessary to increase flexural strength by adding steel fibers. Two types steel fibers having different aspect ratios (i.e. MSH 7530 and MSH 7560) used to check effect on beam. These two types of steel fibers used in percentage ratios. Table 2.gives result by adding steel fibers with different aspect ratios with 30% GGBS replacement.

Table 1- Compressive strength of concrete cube and flexural strength of concrete beam with 30% of GGBS replacement and steel fibers used

Steel Fiber (%)	0.2% 7530 & 0.8% 7560	0.4% 7530 & 0.6% 7560	0.6% 7530 & 0.4% 7560	0.8% 7530 & 0.2% 7560	1% 7530	1% 7560
Age of 7 days (C.S.) MPa	28.87	34.74	27.4	29.33	27.56	28.89
Age of 28 days (C.S.) MPa	40.37	50.37	38.51	39.40	35.85	40.0
Age of 7 days (F.S.) MPa	5.33	5.2	5.33	5.2	4.8	4.73
Age of 28 days (F.S.) MPa	7.33	6.2	6.93	5.86	7.27	7.0

4. Conclusion

From the above experimental work following are the conclusions made for the different percentage of G.G.B.S. and steel fibers in concrete

1) With the increase in steel fibers, the compressive strength of the concrete increases to considerable limit.
2) With the increase in steel fibers, the workability of concrete decreases.

3) With increase in percentage of G.G.B.S the tensile strength of concrete decreases.
4) With maximum thirty percent replacement of G.G.B.S. with cement the strength of concrete is found at considerable limits.
5) To increase tensile strength of concrete maximum percentage of steel fibers is 1% to 1.5% at G.G.B.S. 30% is found.
6) The objective of fibers reinforcement and construction are to build safe, serviceable, economical, durable and aesthetic structures.
7) The primary aim of fiber reinforcement to minimize the probability of failure to an acceptable low value.
8) Structural behavior, failure modes, deformation pattern should be known properly.
9) Fibers can be used in concrete to control the plastic shrinkage cracking and drying shrinkage cracking.
10) They also lower the permeability of concrete thus prevents the corrosion of steel.
11) Chemical attack effect on G.G.B.S. and steel fiber used concrete can be checked.

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