EXPERIMENTAL STUDY ON CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH GGBS AND FINE AGGREGATE WITH STEEL SLAG

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Abstract - Significant development in Infrastructures leads to production of concrete is more compare to all material. Cement and aggregates both are significant ingredients in concrete. In manufacture of cement, large amount of carbon dioxide is released so it causes global warming. Usage of river sand in great demand causes depletion of natural resources, some industrial waste can be used partially to resolve these problems. The utilization of waste material from the industries has been continuously emphasized in the project work. The present work is to use GGBS (Ground granulated Blast furnace slag) and steel slag as combined replacement for ordinary Portland cement and river sand respectively. M20 grade of concrete with W/C 0.5 is carried out with five percentage of cement replacement by GGBS i.e, 5%, 10%, 15%, 20%, and 25%, along with the steel slag varied as 0%, 10%, 20%, 30%, 40%. For all mixes compressive strength are determined at 7 and 28 days of curing. The optimum strength of concrete mix is obtained for the represent of 15% GGBS and 30% steel slag.

Key Words: Steel slag, GGBS Concrete aggregates, OPC, Compressive strength,

1. INTRODUCTION

Concrete plays a critical role in the design & construction of the nation's infrastructure. Almost three quarters of the volume of concrete is composed of aggregates. To meet the global demand of concrete in the future, it is becoming a more challenging task to find suitable alternatives to natural aggregates for preparing concrete. The continues use of Natural Sand leads to the depletion of river beds results into the ecological imbalance. Availability of natural aggregates is getting depleted & also it becoming costly, therefore the replacement of natural sand by the waste industries by-products (Mineral admixtures) has been continuously emphasized during recent years. Natural sand is replaced by slag sand in various percentage. As a construction material, concrete is the largest production of all other materials. Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. The increase in demand for the ingredients of concrete is met by partial replacement of materials by the waste materials which is obtained by means of various industries. When the metal is smelted to satisfaction, the slag is skimmed from the top and disposed of in a slag heap to age. Aging material is an important part of the process, as it needs to be exposed to the weather & allowed to break down slightly before it can be used. In this experimental investigation an attempt is made to study the effect of partial replacement of cement with GGBS & fine aggregate by steel slag in the mechanical properties of M_{20} grade concrete.

1. Materials and Methodology

1.1.Cement

Ordinary Portland Cement (OPC) of 43 grade with brand name Ultra-Tech confirming to (IS 8112-1989) standards were used to cast the specimens. To know the quality of selected cement, few tests have been conducted in the Laboratory.

Table 1: Test results on cement

Sl. No	Name	Experimental value	IS 8112-1989 specified limits
1	Normal consistency	30%	-----
2	Initial setting time	58 mins	!< 30mins
3	Final Setting Time	270 mins	!>600mins
4	Specific Gravity	3.12	3.1 to 3.25
5	Fineness of cement (Sieving method)	5.67%	!> 10%
6	Soundness (Le Chatelier's Apparatus)	2 mm	Maximum of 10mm

1.2 Fine Aggregate (FA)

The sand used for experimental investigation was River Sand and was confirmed to grading zone II as per IS: 383-1970. The sand was sieved through 4.75 mm sieve to remove any particle greater than 4.75 mm.

Table 2: Test results of Fine Aggregate

Sl .No.	Test	Value
1	Specific Gravity	2.58
2	Water Absorption	0.8%
3	Fineness Modulus	2.92

1.3 Coarse Aggregate (FA)

Crushed Stone maximum size of 20 mm and down, 12.5 mm and down has been used as coarse aggregate. The coarse aggregate used as 20 mm graded aggregate as per IS: 383 - 1970 specification.

Table 3: Test results of Natural Coarse Aggregate

Sl. No.	Test	Experimental Value
2	Specific gravity	2.64
3	FM	5.85
4	Water absorption	0.6%

1.4 STEEL SLAG

Steel slag aggregates (basic oxygen furnace slag) obtained by M/s JSW Iron and Steel Industry, Bellary India, having a maximum aggregate size of 4.75 mm was used. Its specific gravity was 2.585.

1.5 GGBS

The GGBS is the granular material formed when molten iron blast furnace slag is rapidly chilled by immersion in water. It is a granular product with very limited crystal formation, is highly cementitious in nature and ground to cement fineness, and hydrates like port land cement. which is used passes, 90% through 90 micron sieve. The aim of this work is to ascertain the performance of concrete mix containing GGBS as replacement of OPC and to compare it with the plain concrete mix of 20 grades. GGBS used in this work is from JSW Cement Company. Its specific gravity was 3.11.

1.6 Water

Portable tap water available in the 1aborotary with Ph va1ue of 7.0 + or – 1 and confirming to the requirements of IS 456-2000 was used for mixing concrete and also for curing the specimens

1.7 Casting

The basic tests are conducted on various materials like OPC43 grade cement, GGBS, fine aggregate, coarse aggregate and steel slag to check their suitability for making concrete. The mix proportions of concrete are modified for using GGBS and steel slag as a partial replacement of Cement and Fine aggregate respectively. The cubes were cast by replacing cement with 0%, 5%, 10%, 15%, 20% and 25% GGBS Similarly replacing Fine aggregate with 0%, 10%, 20%, 30% and 40% Steel slag. Specimens are cast as per mix design (M20) and the compressive strength tests are conducted after proper curing of cubes (150mm x 150mm x 150mm), From the studies, optimum results are found out and compared with the control concrete cubes.
Making of quality concrete cubes (150x150x150 mm) requires special care at every stage like Preparation of moulds, Batching, Mixing, Placing, Compacting, Curing, De-moulding, Testing.

Table 4: Mix Calculations (1 : 1.850402 : 3.996358)

w/c ratio	Cement (kg/m3	Fine aggregate (kg/m3)	Coarse aggregates (kg/m3)		Water (kg/m3)
0.5	320.92	592.66	20 mm	12.5 mm	160.146
			640	640	

2 TESTS FOR SPECIMENS

2.1 Compressive Strength Test

This test is carried to check the compressive strength of concrete at 7 and 28 days. After surface drying, the cubes were turned by 90 degrees from casting position to have smooth surface contact on the cleaned bearing surface of the testing machine. The axis of the specimen was carefully alingned with the center of the thrust of spherically seated plate. The load was applied without shock and incresed continous1y unti1 the resistance of specimen to incresing loads decreses and no greater 1oad cou1d be sustained. This test is conducted by using 3000kN (CTM). The cube was placed in the CTM and the load is given at a constant rate of 140kg/cm2, till the specimen fails and the corresponding load noted as ultimate load. The cube compressive strength

is computed by using standard formula. The obtained results are presented in the next chapter.

3. RESULTS AND DISCUSSION

3.1 Compressive strength

Present experimenta1 investigation consists test resu1ts of compressive strength test. The test were conducted as per the standard specifications i,e minimum three specimens were tested for each test and the average value is tabulated, The test results as presented in this chapter are discussed with apropriate graphical representation. The cubes were cast by replacing cement with 0%, 5%, 10%, 15%, 20% and 25% GGBS Similarly replacing Fine aggregate with 0%, 10%, 20%, 30% and 40% Steel slag. Specimens are cast as per mix design (M20) and the compressive strength tests are conducted after proper curing of cubes, From the studies, optimum results are found out and compared with the control concrete cubes. The Concrete cubes of different replacement proportion were subjected to Compressive strength test and all results obtained all tabulated then plotted the corresponding graph to analyse the variation of strength.

Table 5: Compressive Strength of Concrete

Sl. N0	Mix (GGBS+Steel slag)	Compressive Strength (N/mm2)	
		7days	28days
1	Convectional	27.25	34.95
2	0+10	27.70	35.40
3	0+20	27.80	35.55
4	0+30	**28.14**	**35.70**
5	0+40	25.92	32.22
6	5+0	27.84	35.70
7	5+10	28.58	35.11
8	5+20	28.84	35.40
9	5+30	**29.03**	**35.84**
10	5+40	26.21	31.70
11	10+0	28.14	35.25
12	10+10	28.44	35.40
13	10+20	28.55	35.99
14	10+30	**28.88**	**36.14**
15	10+40	25.92	32.59
16	15+0	28.29	35.85
17	15+10	28.44	36.36
18	15+20	28.73	36.44
19	15+30	**29.17**	**36.66**
20	15+40	26.66	33.33
21	20+0	26.36	32.14
22	20+10	26.81	32.88
23	20+20	26.96	33.17
24	20+30	**27.52**	**33.47**
25	20+40	25.77	31.25
26	25+0	32.14	30.22
27	25+10	32.88	31.25
28	25+20	33.17	31.70
29	25+30	**33.47**	**32.29**
30	25+40	31.25	30.36

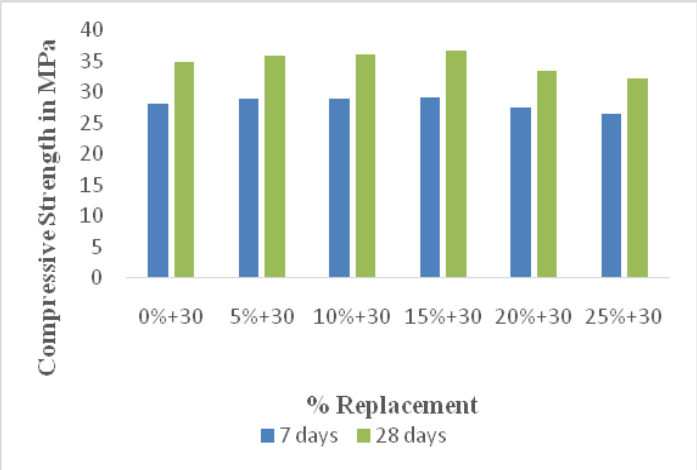

Fig 1 : Varying % Replacement of GGBS with cement & highest value of 30% replacement of steel slag with sand at 7 days and 28 days

From the above Table 5 and Fig 1 represents the comparison of 7 and 28 days compressive strength of concrete with Replacement of GGBS with cement 0% and replacement of steel slag with River sand 30%, similarly 5%, 10%, 15%, 20%, and 25% replacent of GGBS with cement and 30% steel slag replacement with sand. It was found to be compressive strength of concrete has greater strength when 15% GGBS replacement cement and 30% steel slag replacement with fine aggregate Compared to conventional Concrete.

4 CONCLUSIONS

After completion of this project it is concluded that, 0% GGBS Replacement with cement and 10%, 20%, 30% & 40% Replacement steel slag with sand, It was found to be compressive strength of concrete has greater strength when 0% GGBS replacement with cement and 30% steel slag replacement with fine aggregates.

Similarly, 5%, 10%, 15%, 20% & 25% GGBS Replacement with cement and 10%, 20%, 30% & 40% replacement steel slag with sand, It was found to be compressive strength of concrete has greater strength when 5%, 10%, 15%, 20% & 25% GGBS replacement with cement and 30% steel slag replacement with fine aggregates.

We observe From the experimental results that it is clear that the concrete made with 15% GGBS replacement with cement and 30% steel slag replacement with River sand shows higher compressive strength than the other mixes. So it is concluded that 15% GGBS Replacement with cement and 30% steel slag Replacement with River sand is optimum value of compressive strength results.

Hence, it can be recommended that the GGBS and Steel Slag can be satisfactorily utilize as Combined partial replacement for cement and Natural sand respectively in Concrete.

Eco friendly and mass utilization of waste material is possible in construction by using Steel Slag as partial replacement material for partial replacement in concrete.

SCOPE FOR FURTHER STUDY

The further research work can be carried out on following topics below

1. The same experimental work can be carried out on other higher grades of Concrete.
2. Flexure , shear and torsional strengths can be computed
3. Tests on durability can be computed.
4. Behavior of strengths for different aspect ratio can be studied. .

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