Experimental Study on Concrete By Using GGBS As Partial Replacement of Fine Aggregate

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Abstract- *Today the environmental problems are very common in India due to generation of industrialization. Due to industrialization enormous by –products are produced and to utilize the product is the main challenge faced in India. GGBS is one of the abundant material extracted from iron industries and the compressive strength of GGBS concrete was revised. The result confirm the use of GGBS reduce the pollution problem and land fillings. The experimental work has carried out to study the effects of fine aggregate has been replaced by GGBS in the range of 10%, 20%, 30%, 40% and 50% for M20 mix.*

Keywords- Compressive strength, GGBS-Ground Granulated Blast Furnace Slag, Manufactured sand, OPC-Ordinary Portland Cement, and Tensile strength.

I. INTRODUCTION

The advancement in concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. Nowadays large amount of slag generated from various Iron and Steel Plants. This waste, cause a great impact on environment and to human beings. This paper conveys the use of GGBS (Ground Granulated Blast Furnace Slag) and its feasibility in use of it as a partial replacement to sand (or Fine Aggregate). After the molten iron tapped off, the remaining molten slag, which mainly consists of siliceous and aluminous residues, is then rapidly water- quenched, resulting in the formation of a glassy granulate. This granulate is dried and ground to the required size which is known as ground granulated blast furnace slag (GGBS). Ground Granulated Blast Furnace Slag is the most common industrial by–product produced by the industry. The slag varies according to the cooling process removed from furnace and their chemical composition varies with the manufacture process.

One of the main goals of sustainable solid waste management is to maximize the ability of recycling and reuse of metals and plastics. The concrete industry focused on research in reusing waste material from industries to make partial or fully replacement of aggregate in concrete mix. It reduce the demand of natural resources and hence reduce the landfill space.

II. MATERIAL PROPERTIES

CEMENT:

OPC (Ordinary Portland Cement) 53 Grade of ACC confronting to IS 269:1967, IS 4031:(I)1988 and IS 4031-(IV)-1988 adopted in this work. Test conducted on Cement are as follow,

CEMENT OPC 53 GRADE

Table I: Cement

PARTICULARS	PERMISSIBLE VALUES	TEST RESULTS	IS CODE
FINENESS TEST	≤10%	7%	IS 4031-(I)-1988
CONSISTENCY TEST	26-34%	32%	IS 4031-(IV)-1988
INITIAL SETTING TIME	30 mins	30 mins	IS 269 – 1967
FINAL SETTING TIME	600 mins	600 mins	IS 269 – 1967

COARSE AGGREGATE:

The aggregates used are locally available. The aggregate used are 20mm size. The coarse aggregate is tested for their suitability for the experiment. The test conducted on aggregate are as in Table II.

Table II: Coarse aggregate

SL.NO	TEST	TEST RESULTS
1.	Size of aggregate	20mm
2.	Crushing value	20.55%
3.	Impact value	11.76%
4.	Abrasion value	18.4%
5.	Flakiness index	36.65%
6.	Elongation index	45.2%

FINE AGGREGATE:

Fine aggregate is natural sand which has been washed and sieved to remove particles larger than 5 mm. Sand consists of small angular grains of silica.

Table III: Fine aggregate

SL.NO	TEST	RESULT	IS REQUIREMENT
1.	FINENESS MODULUS	4.7%	As per IS 383:1970 Max. 3.2
2.	MOISTURE CONTENT	7.5%	-

MANUFACTURED SAND (M-Sand):

Manufactured sand confirming to Zone – II as per IS: 383-1970 is taken. It was tested as per Indian standard specification. The manufactured sand used, is brought from the nearby area.

Table IV: Test on Manufactured Sand

Physical Properties	Manufactured Sand result
Specific Gravity	2.6
Fineness modulus	2.95
Water Absorption	0.28%

Figure 1: M-Sand

GGBS:

Ground Granulated Blast Furnace Slag which is a by-product of iron manufacturing industry is an mineral admixture for use in concrete. This granulated material then further ground to less than 45 micron is called GGBS.

Figure 2: GGBS

Table V: Physical Properties of GGBS

Sl.No	Property	Value
1.	Normal consistency	30%
2.	Initial setting time in min	55mins
3.	Final setting time in min	540mins
4.	Specific gravity	2.98
5.	Fineness of cement by sieve	8%

Chemical Composition of GGBS:

Silicate and aluminate impurities from the ore and coke are combined in the blast furnace slag with a flux which lowers the viscosity. In the case of pig iron manufacturing the flux consider mostly of a mixing of limestone and for sterilite.

Table VI: Chemical Composition of GGBS

Components	Percentage
Calcium Oxide	34 to 43%
Silicon Dioxide	27 to 38%
Aluminium Oxide	7 to 12%
Magnesium Oxide	7 to 15%
Iron	0.2 to 1.6%

Table VII: Test results of GGBS

TEST	RESULT	IS REQUIREMENT
FINENESS MODULUS	3.51%	As per IS 383:1970 Max. 3.2

CONCRETE MIX DESIGN:

In the study, M20 grade with nominal mix as per IS 456-2000 was used. The concrete mix proportion is 1: 1.5: 3 by weight and a water cement ratio of 0.45.

III. RESULTS AND DISCUSSION:

Workability test results:

SLUMP TEST

Table VIII: SLUMP CONE VALUE

w/c ratio	Slump value in cm
0.38	0
0.4	2.5
0.42	3.2
0.44	5
0.46	7

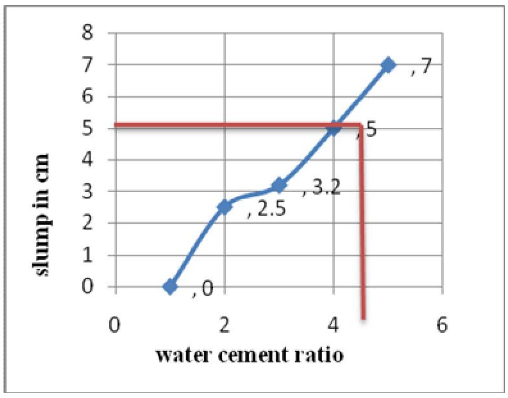

Figure 3: Slump cone test

CUBE

Table IX: Test results of compressive strength

Sl. no	Curing days	Average Compressive Strength in N/mm²					
		Control concrete	GGBS concrete				
			10%	20%	30%	40%	50%
1.	7	17	18.3	19.8	21.5	22.8	7.5
2.	28	22.8	24.4	24.9	26.1	27.0	9.4

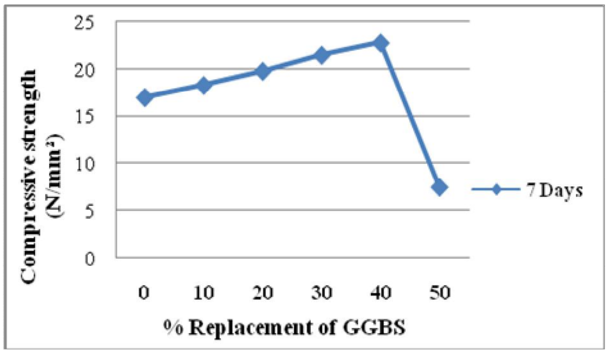

Figure 4: Result of 7 days

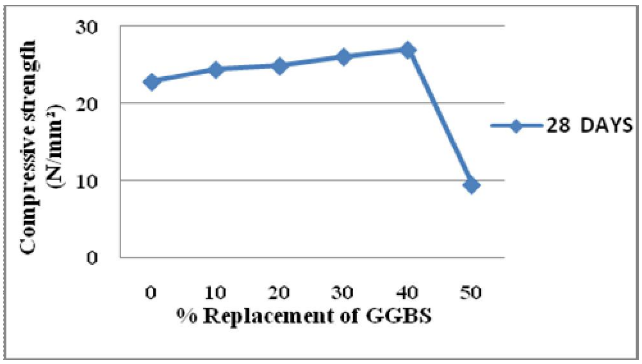

Figure 5: Result of 28 days

The value variation of compressive strength of cubes for the partial replacement of Fine aggregate with GGBS increased values in the order of after 28 days 24.4, 24.9, 26.1, 27.0 for 10%, 20%, 30% and 40% GGBS proportions replacements respectively.

CYLINDER

Table X-Test results of spilt tensile strength

Sl. no	Curing days	Average Spilt Tensile in N/mm²					
		Control concrete	GGBS concrete				
			10%	20%	30%	40%	50%
1.	28	2.73	3.1	3.7	4.2	4.5	2.8

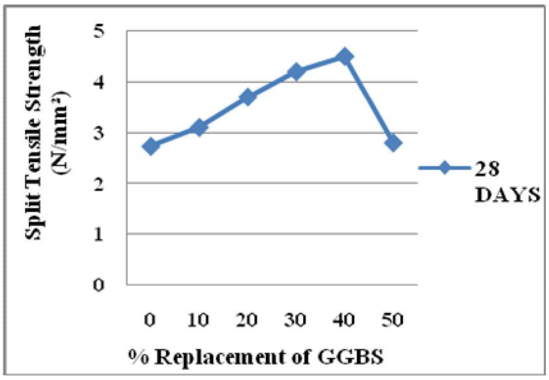

Figure 6: Result of 28 days

The value variation of spilt tensile strength of cylinder for the partial replacement of Fine aggregate with GGBS increased values in the order of after 28 days 2.73, 3.1, 3.7, 4.2, 4.5 for 10%, 20%, 30% and 40% GGBS proportions replacements respectively.

PRISM

Table XI- Test results of flexural strength

Sl. no	Curing days	Average Flexural Strength in N/mm²					
		Control concrete	GGBS concrete				
			10%	20%	30%	40%	50%
1.	28	1.92	1.57	1.57	0.67	1.69	2.36

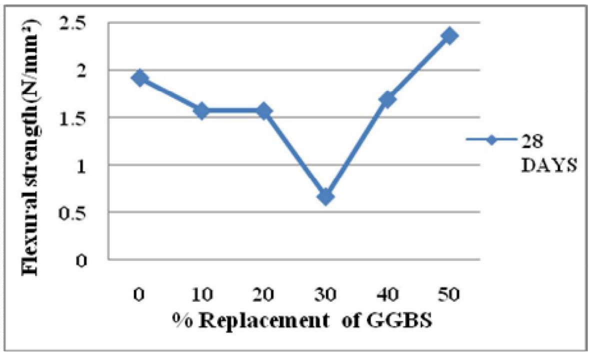

Figure 7: Result of 28 days

The value variation of flexural strength of cylinder for the partial replacement of Fine aggregate with GGBS increased values in the order of after 28 days 24.4, 24.9, 26.1, 27.0 for 10%, 20%, 30% and 40% GGBS proportions replacements respectively.

IV. CONCLUSION

The concrete was prepared for the M20 grade concrete with partial replacement of fine aggregate by GGBS with various percentages of 10%, 20%, 30% and 40% and 50%. The specimens were casted for 7days and 28 days then tested. The results are presented below.

From the above results following conclusion were made

1. The compressive strength for partial replacement of fine aggregate with GGBS increased in the order of 24.4, 24.9, 26.1, 27.0 for 10%, 20%, 30% and 40% partial replacements respectively and decreased by 1 3% for 50% partial replacement with respect to control specimen.
2. The split tensile strength for partial replacement of fine aggregate with GGBS increased in the order of 2.73, 3.1, 3.7, 4.2, 4.5 for 10%, 20%, 30% & 40% partial replacements respectively and decreased by 9.75% for 50% partial replacement with respect to control specimen.
3. The flexural strength for partial replacement of fine aggregate by GGBS increased in the order of 1.57, 1.57, 0.67, 1.69, 2.36 for 10%, 20%, 30% , 40% & 50% partial replacements respectively and with respect to control specimen.
4. The maximum compressive strength, spilt tensile strength for partial replacement of fine aggregate with GGBS be achieved by 40% is found to be greater than the conventional concrete.
5. The maximum flexural strength for partial replacement of fine aggregate with GGBS be

achieved by 50% is found to be greater than the conventional concrete.

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