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EXPERIMENTAL STUDY ON USE OF GROUND GRANULATED BLAST FURNACE SLAG AND WASTE FOUNDRY SAND IN CONCRETE

Tanuja Rani[1], Abhilesh Kant Sharma[2]

[1]PG Student, M.Tech. Structural Engineering Department of Civil Engineering, Sri Sai University, Palampur, India
[2]Assistant Professor, Department of Civil Engineering, Sri Sai University, Palampur, India

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ABSTRACT-*There are so many waste materials generated from manufacturing processes and due to scarcity of space for land filling the waste causes environmental problems. So to reduce these problems we have to use such type of materials in our construction work which reduces the consumption of natural resources and also gives better results than that of conventional concrete. The current research is focused around the use of foundry sand and ground granulated blast furnace slag in concrete to check their compressive strength. In this research work Waste Foundry Sand is replaced with 20%, 40% and 60% of fine aggregate. Then with the optimum value of foundry sand i.e. 20% is added in concrete and cement is replaced with GGBS with varying proportions i.e. 30%, 40% and 50%. For this work we use M30 grade of concrete. The water cement ratio is constant for all mixes i.e. 0.42. The compressive strength of concrete mix at 7th and 28th day of curing is determined along with the workability property of fresh concrete. The test results showed a good performance for concrete and enhancement in the strength with the use of these waste materials.*

Keywords: Waste Foundry Sand, Ground Granulated Blast Furnace Slag, Compressive strength.

I. INTRODUCTION

Concrete is the important part of construction whose manufacturing composed of components such as cement, aggregates, water and admixtures. In the construction material, concrete is used to meet all the requirements such as strength, workability, durability and fire resistance. As we know that growth of industrialization is increased day by day, due to which large amount of waste is also produced this is a major drawback to dispose securely. Hence to control this problem the reuse or recycle of the waste can also be done. Hence the waste generated by the industries and agriculture field can be used as a substituent construction material, so that protection of natural resources can be easily done and disposal of harmful waste can be reuse and reduced.

In present, due to rising construction work, the need of raw material such as aggregates etc. also raise with the increase in demand of concrete. So this is based upon the reuse of the WFS and GGBS in concrete. Both the materials used in this investigation study are waste generated by the factories. If these waste materials are found appropriate for construction work then the structure would be cost effective and problem of disposal of wastes would be lowered.

II. METHODOLOGY

Present investigation is to study the consumption of cement can be reduced significantly if GGBS and also reduction of sand by WFS used as partial replacement without compromising performance characteristics of concrete including durability. A total of 42 concrete specimens were casted and cured in controlled conditions in laboratory and then were tested at curing ages of 7 and 28 days to obtain their strengths. Nominal mix proportion of 1:1.44:2.4 was used to prepare concrete mixes. The cube size of 150*150*150 mm is used make specimens for various mixes. The quantity of material should be mixed as per the requirements of mix design. Slump test was done on fresh concrete and then fill the moulds by proper compaction with temping rod. The tests were performed on concrete after 7 and 28 days for compression strength test. Then all the results of replacement of WFS and GGBS with fine aggregate and cement were compared with conventional concrete. These results were compared with each other for better understanding of effects of reuse of WFS and GGBS on concrete. To reduce their hazardous effect on environment there should be proper utilization of this kind of waste in concrete.

III. EXPERIMENTAL PROGRAM

A. Material Used

1) Cement

Cement used in this study was PPC and it is free from lumps. This cement is formed by synthesizing ordinary Portland cement with pozzolanic in a right proportion. Pozzolanic reaction takes a simply acid and base reaction between $Ca(OH)_2$ and silicic acid H_4SiO_4. This reaction can be represented as

$$Ca(OH)_2 + Pozzolana + H_2O \rightarrow C\text{-}S\text{-}H\ gel$$

The initial setting time of PPC is not less than 30 minutes and final setting time is not more than 10 hours. The various test on cement are performed as per IS: 1489 (Part 1). Before use of the cement properties are investigated in the laboratory.

2) Fine Aggregates

Fine aggregates are those inert materials, which binds all ingredients together in concrete or mortar. In this work river sand was used which is made up of crushed aggregates. Particles of sand is passed from 4.75mm sieve and retained over 75µ is known as fine sand. Fine aggregate also helps to increase workability of concrete.

3) Coarse Aggregates

Locally available coarse aggregates having maximum size of 20mm and 10mm were used in this present research work. Testing of these aggregates was done as per IS: 383-1970. The 20mm size aggregates are sieved with 20mm sieve then using 10mm sieve for 10mm size aggregate and all are retained over 4.75 size sieve. Then they were washed to remove dust, impurities and then dried to surface dry condition.

4) Waste Foundry Sand

Waste foundry sand is the waste product which is generated by metal casting industries. Foundry sand mainly used to cast or form molds and cores.. Waste foundry sand is a by-product of iron and non- iron casting process. Waste foundry sand is non- hazardous in nature. In this work Waste foundry sand is collected from Bhoparai Metals Pvt. Mohali, Punjab, India.

Figure 1WFS

5) Ground Granulated Blast Furnace Slag

The GGBS used in this research work is obtained from ECOGEN Industry Pvt. Ltd. Dehradun. GGBS reduces the effect of heat of hydration in concrete so greater the percentage of GGBS, the greater will be the effect on concrete properties. GGBS is used to make durable concrete structures in grouping with ordinary Portland cement or other pozzolanic materials.

Figure 2 GGBS

6) Water

Water in the laboratory supplied by the University through tap was used for all mixes. The water was clean and free from acid, oils, salts and other harmful substances. Same water was also used for curing purpose.

7) Super Plasticizer

RHEOPLAST-SP-450, high range water reducing super plasticizer for concrete, mortars based on selected Synthetic sulphonated naphthalene formaldehyde condensates. It was used as a water- reducing admixture up to 20-30%and it improves the workability of concrete. Rheoplast- SP 450 has been specially formulated to give higher early and ultimate strength to the concrete.

IV. MIX DESIGN

In present study M30 grade of cement concrete was designed as per IS: 10262- 2009. In this study firstly the fine aggregates are replaced with Waste Foundry sand with varying ratio of 20%, 40% and 60% in the concrete. Then by knowing the optimum value of strength with waste foundry sand in concrete we add GGBS which replace the cement (PPC) with different proportions i.e. 30%, 40% and 50% and the value of WFS is constant i.e. 20%. For all the mixes the water cement ratio is constant i.e. 0.42. The replacement percentage was done by volume of total fine aggregates and total cement derived from the mix design.

Table 1 Mix proportion of M30

Unit of batch	Water	Cement	Fine aggregates (Kg)	Coarse Aggregates (Kg)
Volume in Cubic meter	197	470	678	1128
Ratio of materials	0.42	1	1.44	2.4

Table 2 Mix proportion with GGBS and WFS

Sr. No.	GGBS	WFS	Cement	F.A	C.A	Water
1.	30%	20%	329	542	1128	138
2.	40%	20%	282	542	1128	118
3.	50%	20%	235	542	1128	98.7

V. TESTS AND RESULTS

A. Effect on Workability

Normally concrete slump value is used to find the workability, which indicates the w/c ratio, but also there are so many other factors which affect the slump value such as methods, dosage and admixture etc. The slum value in which fine sand is replaced by WFS in different proportions (20%, 40% and 60%) and the mix having WFS constant i.e. 20% and varying proportions of GGBS (30%, 40% and 60%) in place of cement in the concrete is discussed in table.

Figure 3 Workability test

Table 3 Slump value with WFS in concrete mix

Sr. No.	Mixture	Slump Value
1.	Conventional concrete	145mm
2.	20% of WFS	90mm
3.	40% of WFS	25mm
4.	60% of WFS	0

Table 4 Slump value with WFS and GGBS in concrete (with super plasticizer)

Sr. No.	Mixture	Slump Value (mm)
1.	Conventional concrete	145
2.	20% WFS + 30% GGBS	105
3.	20% WFS + 40% GGBS	52
4.	20% WFS + 60% GGBS	0

B. Effect on Compressive strength

The test is performed after 7 and 28 days of curing to determine the compressive strength of concrete as per IS: 516-1959. For every proportion, 3 cubes were casted and average values are taken for their compressive strength.

Table 5 Compressive strength of concrete

Sr. No.	Replacement Percentage	7 Days	28 Days
1.	FS0 (Conventional concrete)	19.3	34.67
2.	FS1 (20% WFS)	21.77	36.22
3.	FS2 (40% WFS)	18.89	33.11
4.	FS3 (60% WFS)	14.66	28.88
5.	FG1 (20% WFS + 30% GGBS)	22.67	37.56
6.	FG2 (20% WFS +40% GGBS)	24.22	38.89
7.	FG3 (20% WFS + 50% GGBS	20.22	33.55

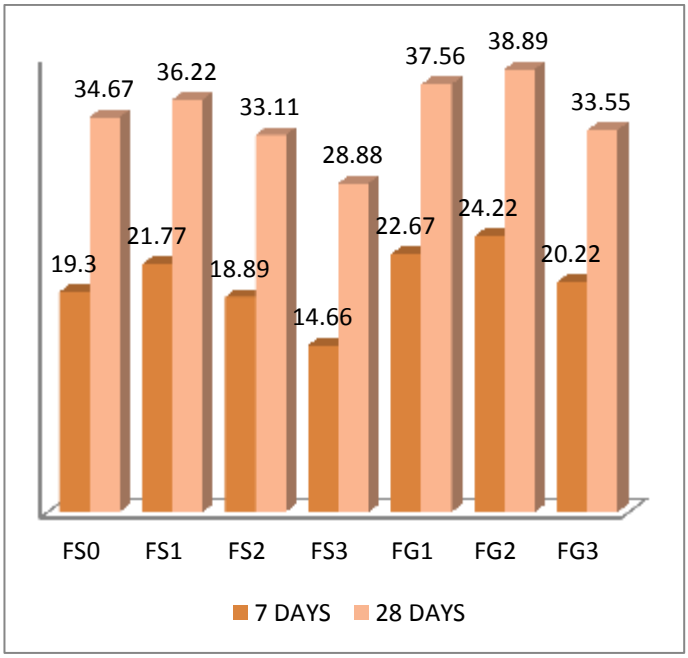

Figure 4 Compressive strength

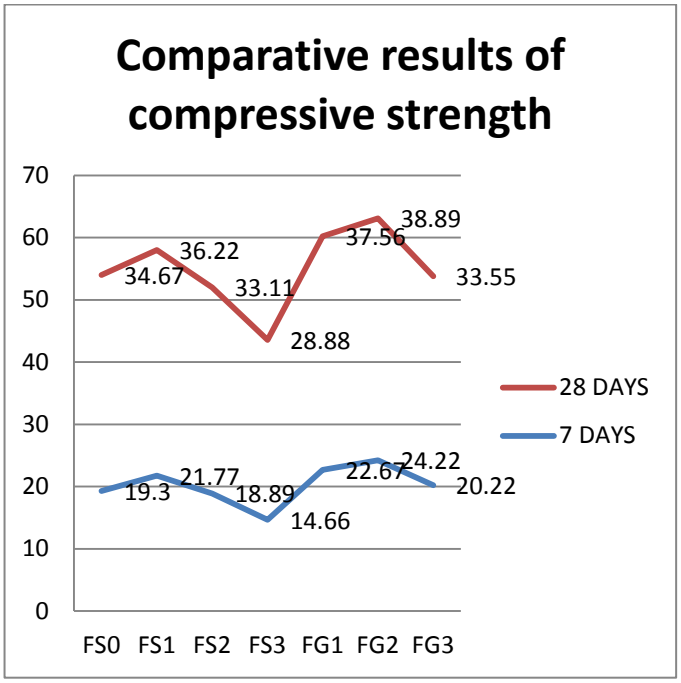

Figure 5 Comparative result of compressive strength

VI. CONCLUSIONS

In this research importance of GGBS as cement replacing material, whereas WFS as fine aggregate replacing material has been discussed. Durability and strength property such as compressive strength is studied in present study by replacing cement and fine aggregate. The following major conclusion can be drawn from this study:

1) The workability decreases as the amount of Foundry sand is increases in the concrete.
2) At 20% replacement of WFS in concrete shows the maximum compressive strength after 7 and 28 days of curing.
3) The fineness modulus of GGBS is lower than that of PPC, which makes the concrete denser and gives smooth finishing to the specimens.
4) The maximum compressive strength of cubes, when 20% of fine aggregate is replaced with WFS and 40% cement is replaced with GGBS.
5) Slight reduction in strength is observed when the percentage of GGBS is 60% and foundry sand is 20% in concrete.

6) 12.17% increment in the compressive strength found in 20% replacement of fine aggregate with WFS and 40% replacement of cement with GGBS at 28 days when compared to conventional concrete. And the strength decreases by 3.23% when fine aggregate is replaced with 20% of WFS and cement with 60% of GGBS.

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