

## **Partial Replacement of Cement by Ground Granulated Blast Slag (GGBS) and Addition of Activated Charcoal Powder.**

S. P.Khedekar, Shubham bonde , Prathamesh Bacchav , Ajay ingle , Sachin kanoje

Department of Civil Engineering,  
All India Shri Shivaji Memorial Society, College Of  
Engineering, Pune

### **Abstract**

*Concrete is a versatile Material. In construction industry the use of concrete is increasing rapidly. Many researches have been made to use waste material as it will eliminate the disposal problems and also reduce the burden on natural resources consumption, pollution. The sustainable development is characterized by application of industrial waste to improve mechanical properties of concrete. The study examines the possibility of using GGBS as a replacement for cement in various percentages like 10%, 20%, 30% and 40% by the weight of concrete and find the optimum replacement percentage. Also use of Activated Charcoal Powder (ACP) in 1%, 2% and 3% by the weight of cement to enhance the properties of concrete. The grade of concrete is M40. Then the optimum of ACP+GGBS was studied and compared with the conventional concrete. Compressive strength test taken for 7 days, 14 days, 28 days, 56 days and 90 days respectively. Split tensile strength test and Flexural strength test taken for 28 days of curing. So it was observed that optimum replacement was at 30% GGBS and optimum addition was at 1% ACP.*

**Key words:** GGBS, ACP, Replacement, Addition, Optimum, Compressive strength, Flexural Strength, Split Tensile Strength.

### **INTRODUCTION :**

The GGBS is a by-product in the manufacture of iron and the amounts of iron and slag obtained are of the same order. Iron ore, coke and limestone are fed into the furnace and the resulting molten slag floats above the molten iron at a temperature of about 1500°C to 1600°C. After the molten iron is tapped off, the remaining molten slag, which consists of mainly siliceous and aluminous residue is then water quenched rapidly, resulting in the formation of a glassy granulate. This glassy granulate is dried and ground to the required size, which is known as GGBS. Activated carbon reduces the presence of pores in conventional concrete, which enhances the performance of concrete. This research will be focused on mechanical properties of concrete and identify the significant parameters which influence the strength of concrete. Utilization of such wastes as cement replacement materials and as addition may reduce the cost of concrete production and also minimize the negative environmental effects with disposal of these wastes.

## MATERIAL PROPERTIES

**Cement:** Out of the total production, Ordinary Portland Cement accounts for about 80-90%. Many tests were conducted to cement some of them are Consistency tests, Se Time tests, Soundness tests, etc.

**Fine Aggregate:** Fine aggregate is locally available, free from debris & soil & crushed sand is used.

**Coarse Aggregate:** The crushed aggregates used were 20 mm nominal maximum size and are tested as per Indian standards and results are within the permissible limit.

**GGBS:** It is a by-product in the manufacture of iron and the amounts of iron and slag obtained are of the same order. Iron ore, coke and limestone are fed into the furnace and the resulting molten slag floats above the molten iron at a temperature of about 1500°C to 1600°C. After the molten iron is tapped off, the remaining molten slag, which consists of mainly siliceous and aluminous residue is then water quenched rapidly, resulting in the formation of a glassy granulate. This glassy granulate is dried and ground to the required size, which is known as GGBS.

**Activated Charcoal Powder :** It is a carbon created from carbonaceous materials like bamboo, coconut husk, willow peat, wood, coir, lignite, coal, and petroleum pitch. Activated carbon can be produced by physical activation or chemical Process

## EXPERIMENTAL METHODOLOGY:

### 1. Sample Collection

- a) Materials are Collected from various Sources. Few of them are taken from the suppliers

### 2. Mix Proportion

- a) The Conventional Concrete of M40 grade with constant Water/Cement ratio of 0.40 was prepared without replacement of cement.
- b) Cement was partially replaced by GGBS with 10%, 20%, 30% and 40% and adding ACP with 1%, 2% and 3%

### 3. Casting

- a) 15 Cubes per sample of size 150 X 150 X 150 mm is casted for Compressive Strength Test.
- b) 3 Beams per sample of size 700 X 150 X 150 mm for Flexural Strength Test and 3 Cylinders for Split Tensile Strength Test and cured these samples for various days.

### 4. Curing

- a) Casted samples were cured in curing tank for curing period of 7 days, 14 days, 28 days, 56 days, and 90 days

## 5. Testing

- a) Compression testing
- b) Flexural testing
- c) Split tensile testing

Mix design proportion for GGBS replacement( $1\text{m}^3$ )m40 Grade Concrete.

Sr	Material	0%	10%	20%	30%	40%
1	Cement	470	423	376	329	282
2	10 mm	461	461	461	461	461
3	20mm	691	691	691	691	691
4	Sand	648	648	648	648	648
5	Water (ltr)	160	160	160	160	160
6	Admixture(ltr)	4.7	4.7	4.7	4.7	4.7
7	GGBS	0	47	94	141	188

## Results:

### 1. Compression testing:

Out of many test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. We carried out compressive strength test on cubes for 7 day , 14day, 28 day, 56 day and 90 days of curing



	0%	10%	20%	30%	40%
7 Days	39.10	40.35	41.90	41.10	39.90
14 Days	46.90	46.40	46.50	47.90	45.90
28 Days	49.25	52.90	52.25	56.20	54.40
56 Days	50.10	53.90	55.70	58.80	55.40

90 Days	49.10	53.55	56.00	59.90	56.40
---------	-------	-------	-------	-------	-------

**Flexural Strength**

The flexural strength of 150mm×150 mm cross, 700mm concrete beam was determined according to BS EN 12390-5:2009: Testing hardened concrete: Flexural strength of test specimens after 28 days of curing. A load was applied on the specimens with an increasing rate until failure of the specimen occurred. Strength is calculated by the following formulae:

1) if  $a < 200$  then  $f_b = 3Pa/bd^2$

2) if  $a > 200$  then  $f_b = PL/bd^2$



	0%	10%	20%	30%	40%
28 Days	5.35	5.81	5.57	6.38	4.80

**Split Tensile Strength:**

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The cylinder used had 150 mm radius and 300mm height. The strength is calculated by using formula

formula  $2P/3.14 DI$

	0%	10%	20%	30%	40%
28 Days	4.38	4.06	4.07	4.63	3.50

**CONCLUSION :**

- From this study, it is concluded that the Combination of GGBS and Activated Charcoal Powder is a good substitute for cement in the concreting works
- Partial replacement of GGBS decrease the environmental pollution such as ground pollution, water pollution etc.

- Partial replacement of GGBS increase the strengths at 10%,20%,30% as well as decrease the strength at 40%,50%.
- It also reduce the cost of construction. Thus the workability is improved by the partial replacement of the GGBS with cement.
- The replacement of cement by GGBS not only increases the compressive strength but also reduces the cement content which eventually decrease in emission of CO<sub>2</sub>.
- Activated carbon due to its structure developed, large surface area, strong adsorption capacity, high mechanical strength, low bed resistance, good chemical stability, easy regeneration, durability and other advantages, received great attention and extensive research, known as 21 centuries one of the most advanced materials.
- Activated carbon reduces the presence of pores in conventional concrete, which enhances the performance of concrete.
- The combination of 30% GGBS and 2% ACP gave higher results for Flexural Strength

## ACKNOWLEDGEMENT

The authors thankfully acknowledge our project guide Prof. S.P. KHEDEKAR, AISSMS COE. and Head of Civil Department Dr. U. R. AWARI, AISSMS COE. for their keen interest, valuable suggestion and their expert guidance.

We would also like to thank staff of RMC plant owned by Ingle Construction Pvt Ltd, Saswad for complete support & cooperation to carry out research.

## REFERENCES :

### Reference books

1. M.S. Shetty. (2019). Concrete technology. India: S. Chand Publishing.
2. John Newman. (2003). Advanced concrete technology. Elsevier Oxford.

### Papers from Journal or transactions

3. Santosh Kumar Karri, G. V. Rama Rao, P. Markandeya Raju "Strength and Durability Studies on
4. GGBS Concrete", SSRG International Journal of Civil Engineering (SSRG - IJCE), V2 (10), 3441 October 2015. ISSN: 2348 – 8352. [www.internationaljournalssrg.org/IJCE/index.html](http://www.internationaljournalssrg.org/IJCE/index.html). Published by: Seventh Sense Research Group.

5. Mojtaba Valinejad Shoubi, Azin Shakiba Borough, and Omidreza Amirsoleimani. (2013). "Assessment of the Roles of Various Cement Replacements in Achieving Sustainable and High Performance Concrete". International Journal of Advances in Engineering and Technology, 6 (1): 68-77.
6. Martin O. Connell, Ciaran McNally, and Mark G. Richardson. (2012). "Performance of Concrete Incorporating GGBS in Aggressive Wastewater Environments. Construction and Building Materials", 27 (1), 368-374.

#### Reports, Standards etc.

7. I.S: 456 – 2000, Indian standard Specification for plain and reinforced concrete – code of practice. (Fourth revision), B.I.S., New Delhi.
8. I.S: 516-1959, Indian Standard Methods of Test for Strength of concrete. Bureau of Indian Standards, New Delhi.
9. I.S: 1199-1959, Indian Standard Methods of Sampling and analysis of concrete. Bureau of Indian Standards,
10. I.S: 1199-1959, Indian Standard Methods of Sampling and analysis of concrete. Bureau of Indian Standards,
11. I.S: 5816: 1999, Methods of tests for splitting tensile strength of concrete.
12. I.S: 383 – 1970, Indian standard specification for coarse & fine aggregates from natural sources for concrete, B.I.S., New Delhi.
13. I.S: 12269-1987, Specification for 53 grade ordinary Portland cement, B.I.S., New Delhi.

#### Internet

[https://en.wikipedia.org/wiki/Activated\\_carbon](https://en.wikipedia.org/wiki/Activated_carbon)

<https://www.cemnet.com/Forum/thread/107986/sell-portland-cement.html>



I.S: 1199-1959, Indian Standard Methods of Sampling and analysis of concrete. Bureau of Indian Standards, New Delhi.

I.S: 2386-1963, Methods of Test for aggregates for concrete - Part 3: Specific gravity, Density, Voids, Absorption and Bulking, Bureau of Indian Standard, New Delhi.

.

.