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# Experimental Study on Partial Replacement by GGBS and Ceramic Waste in Concrete

R. Sanjay Kumar[1], P. Vinodh Kumar[2], R. Vinodh Kumar [3]
[1] *(Civil Engineering, Aarupadai Veedu Institute of Technology / Vinayaka Missions University, Chennai, India)*
[2,3] *(Civil Engineering, Meenakshi College of Engineering / Anna University, Chennai, India)*

**Abstract:** The use of concrete leads to more emission of $CO_2$, by using ground granulated blast furnace slag(GGBS) leads to reduce the emission of $CO_2$. The reuse of wastages in construction site leads to waste management. The present paper is an effort to measure the strength of ground granulated blast furnace slag (GGBS) and ceramic waste at various replacement levels and evaluate its efficiencies in concrete. Cement with GGBS and Ceramic waste with coarse aggregate replacement has emerged as a major alternative in conventional concrete and has its economical and eco-friendly benefits. This research under went by partially replacing cement and coarse aggregate by various percentages for M35 grade of concrete at different ages. The replacement in material will improves in high compressive strength, low heat of hydration, resistance to chemical attack, better workability, good durability and cost-effectiveness.

**Keywords:** Ceramic Waste, Compressive strength, Flexural strength test, GGBS, M35 grade concrete, Split tensile strength test

## 1. Introduction

### 1.1 Basics

Many countries are witnessing a rapid growth in the construction industry which involves the use of natural resources for the development of the infrastructure. Natural resources are depleting worldwide and the generated wastes from the industry are lot more increasing. The sustainable development for construction involves the use of non-conventional and innovative materials, and recycling of waste materials in order to compensate the lack of natural resources and to find alternative ways for conserving the environment. Aggregates are the main component for preparation of concrete and it can be replaced partially with artificial aggregates generated from industrial wastes and artificially manufactured aggregates. In this study an attempt has been made to identify the various properties necessary for the design of concrete mix with the waste as aggregate in a systematic manner. Broken waste has been used as coarse aggregate with the replacement of conventional coarse aggregate.

### 1.2 Objective of the Study

- To study the experimental behavior of M35 grade concrete by partial replacement of cement and coarse aggregate with GGBS and Ceramic Waste respectively
- To study the material behavior based on the different materials used in the concrete
- To study and analyze all the test results using various parameters

## 2. Material study

### 2.1 Selection of materials

The properties of material used for making concrete mix were determined in laboratory under controlled conditions as per relevant IS codes of practice. The material characterization was carried out for all the major ingredients of concrete which include cement, coarse aggregates, fine aggregates, and water. The purpose of the characterization is to check their acceptability as per relevant Indian standards so as to enable an engineer to design a concrete mix for a particular strength. The properties of the various materials used in this study, are discussed in the succeeding sub-sections.

#### 2.1.1 Material used

The materials such as cement, fine and coarse aggregate, GGBS and Ceramic waste

Fig 1 Cement, Sand and Gravel

Fig 2 GGBS, Ceramic waste used in this project

## 2.2 Mix proportions

**TABLE 1 MIX PROPORTION**

| Cement (kg/m$^{3}$) | Water Cement Ratio (liter/m$^{3}$) | Fine Aggregate (kg/m$^{3}$) | Coarse Aggregate (kg/m$^{3}$) | Admixture (kg/m$^{3}$) |
|---|---|---|---|---|
| 1 | 0.45 | 1.6 | 2.907 | 0.003 |
| 454.5 | 204.5 | 727.2 | 1321.23 | 1.3635 |

### 2.3 Specifications of Specimens

The Specimens were tested for 7 and 28 days of curing. The specimens were prepared according to the following schedule.

**Table 2 Specifications of Specimens**

| S.NO | Specimen | NOs | Experiment |
|---|---|---|---|
| 1 | Cube(150x150x150mm) | 10 | Compressive Strength test |
| 2 | Cylinder(height=300mm,dia=150mm) | 10 | Split tensile strength test |
| 3 | Prism(100x100x500mm) | 10 | Flexure strength test |

## 3. Experimental study

Based on the different mix proportion, batching process in carried out in order to initiate the casting of concrete. Then the mould is prepared with oil coating and filled with concrete mixes respectively. Compaction and screening the top layer is done side by side for every concrete mixes. After casting of every concrete, it is kept for 24 hours in room temperature for setting purpose. Then the concrete with different mix proportions are dropped on water for curing. Thus the concrete is evaluated on 7$^{th}$ and 28$^{th}$ day respectively and the strength of the concrete is determined.

### 3.1 Flow Table Test

The Flow Table test is carried out for all mix proportion such as Conventional Concrete, 30% and 35% of cement replaced with GGBS respectively, 15% and 20% of Coarse Aggregate replaced with Ceramic waste respectively. Thus the value attained is not exceeded than 38mm, so that the mix proportion of all concrete is efficient to use.

**Table 3 Flow Table Test**

| S.NO | Description | | Flow spread(cm) |
|---|---|---|---|
| 1 | M35 Conventional concrete | | 23 |
| 2 | GGBS | 30% | 17 |
| | | 35% | 20 |
| 3 | Ceramic waste | 20% | 19 |
| | | 25% | 22 |

### 3.2 Slump Cone Test

The Slump Cone test is carried out for all mix proportion such as Conventional Concrete, 30% and 35% of cement replaced with GGBS respectively, 15% and 20% of Coarse Aggregate replaced with Ceramic waste respectively. Thus the value attained gives the consistency of the concrete of different mix proportions and it can be used effectively.

**Table 4 Slump Cone Test**

| S.NO | Description | | Slump cone value(cm) |
|---|---|---|---|
| 1 | M35 Conventional concrete | | 27 |
| 2 | GGBS | 30% | 26 |
| | | 35% | 25.5 |
| 3 | Ceramic waste | 20% | 25 |
| | | 25% | 24.3 |

### 3.3 Compressive strength test

Fig 3 Compressive Strength Test

**Table 5 Compressive Strength Test**

| S. No | MIX | % of Replacement | Average Compressive strength at 7 days | Average Compressive strength at 28 days |
|---|---|---|---|---|
| 1 | $C_0$ | Conventional Concrete M35 grade | 27.66 | 51.2 |
| 2 | $G_1$ | 30% of GGBS | 30.4 | 53.6 |
| 3 | $G_2$ | 35% of GGBS | 29.25 | 48.3 |
| 4 | $C_1$ | 15% of Ceramic waste | 31.55 | 54.22 |
| 5 | $C_2$ | 20% of Ceramic waste | 28.03 | 40.11 |

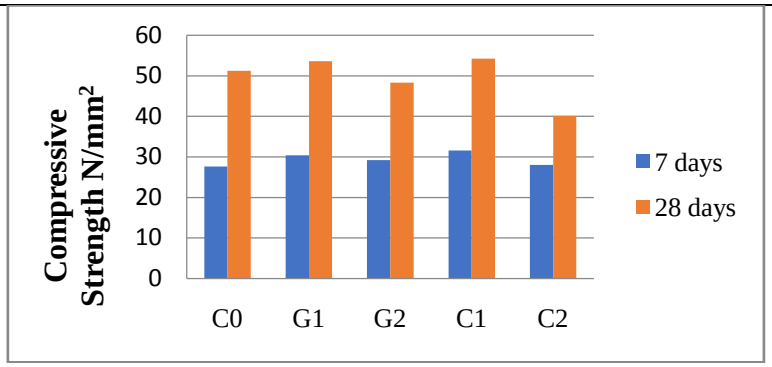


Fig 4 Chart of Compressive strength test

### 3.4 Split tensile strength test

Fig 5 Split tensile Strength Test

**Table 6 Split Tensile Strength Test**

| S. No | MIX | % of Replacement | Average Compressive strength at 7 days | Average Compressive strength at 28 days |
|---|---|---|---|---|
| 1 | $C_0$ | Conventional Concrete M35 grade | 2.78 | 4.16 |
| 2 | $G_1$ | 30% of GGBS | 2.97 | 4.35 |
| 3 | $G_2$ | 35% of GGBS | 2.85 | 4.28 |
| 4 | $C_1$ | 15% of Ceramic waste | 3.89 | 4.63 |
| 5 | $C_2$ | 20% of Ceramic waste | 3.50 | 4.38 |

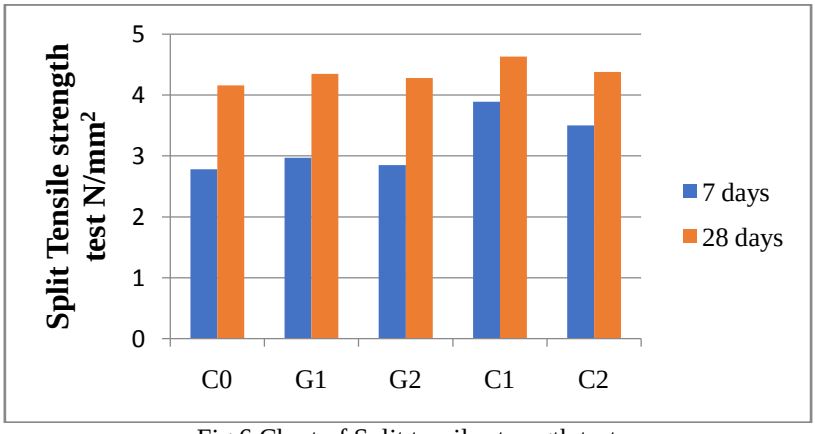


Fig 6 Chart of Split tensile strength test

**3.5 Flexure strength test**

Fig 6 Flexure Strength Test

**Table 7 Flexure Strength Test**

| S. No | MIX | % of Replacement | Average Compressive strength at 7 days | Average Compressive strength at 28 days |
|---|---|---|---|---|
| 1 | $C_0$ | Conventional Concrete M35 grade | 3.85 | 5.42 |
| 2 | $G_1$ | 30% of GGBS | 3.98 | 5.86 |
| 3 | $G_2$ | 35% of GGBS | 3.92 | 5.79 |
| 4 | $C_1$ | 15% of Ceramic waste | 4.17 | 5.92 |
| 5 | $C_2$ | 20% of Ceramic waste | 4.03 | 5.84 |

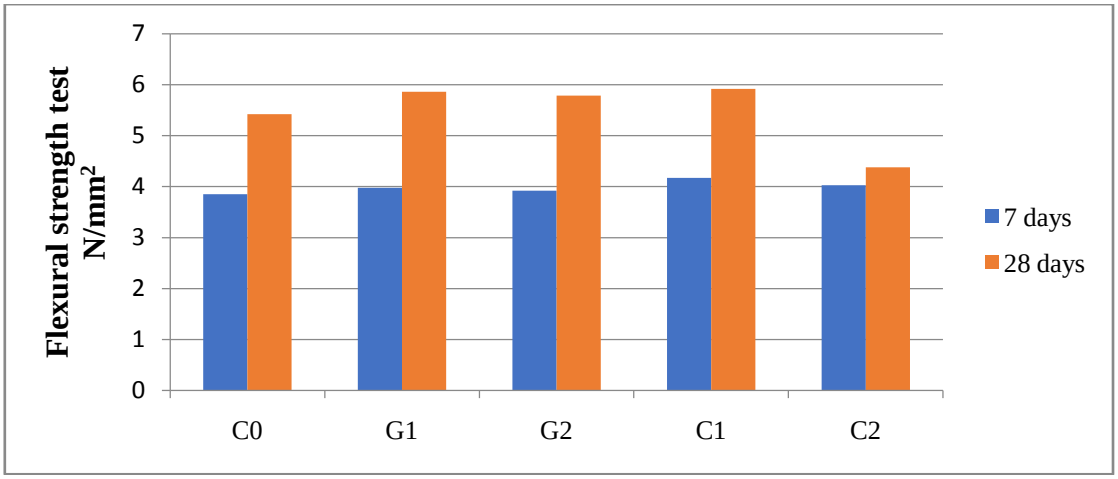


Fig 7 Chart of Split tensile strength test

## 4. Conclusion

The conclusions drawn from the study and summarized below are applicable to the characteristics of the material used and the range of parameters investigated

- In this study the five mixtures were cast as at 15%, 20%replacement of coarse aggregate by ceramic waste aggregate and 30%, 35% replacement of cement by GGBS and compared with conventional concrete (M35) mix.
- The analysis of the experimental result shows that replacing 15% of coarse aggregate by ceramic waste and replacing 30% cement by GGBS respectively, increases the efficiency and durability of the concrete when compressed with other concrete mixes
- And in comparison of both effective mixes the compressive strength, split tensile strength and flexure strength of 15% of coarse aggregate replaced with ceramic waste is 1.5%, 6.5%, 1.0% higher than the

30% of cement replaced with GGBS respectively. Therefore 15% of cement replaced with GGBS is more effective to use

- We conclude that ceramic waste aggregate could be replaced for aggregates and GGBS with Cement respectively in concrete production.
- Therefore it is safe to replace the coarse aggregate with 15% Ceramic waste and cement with 30% GGBS considering the strength respectively.
- Use of GGBS reduces the amount of cement content as well as heat of hydration in a mortar mix. Thus, the Construction work with GGBS concrete becomes environment friendly and also economical.
- GGBS can be used as substitute for cement which will reduce the cost of cement in concrete and also reduce the Consumption of cement.

## References

[1]. Am cheng, Ram Huang, Jiann-KuoWu,Cheng-Hsin Chen "Influence of GGBS on durability and corrosion behavior of reinforced concrete" Materials Chemistry and Physics Volume 93,Issues 2-3,October 2005 , Pages 404-411

[2]. Amit J. Gujarati Mitul K. Monpara Jugal Mistry (2017)" Effect of Partial Replacement of Fine and Coarse Aggregate (10mm) with Ceramic Waste on the Properties of Concrete" International Journal for Scientific Research & Development| Vol. 5, Issue 10, 2017

[3]. Amitkumar D. Raval, Dr.Indrajit N. Patel, Prof. Jayeshkumar Pitroda (2013) "Ceramic Waste : Effective Replacement Of Cement Forestablishing Sustainable Concrete" International Journal of Engineering Trends and Technology (IJETT) - Volume4 Issue6- June 2013

[4]. Fernando Pacheco-Torgal (2010) "Compressive strength and durability properties of ceramic wastes based concrete" Materials and Structures DOI 10.1617/s11527-010-9616-6

[5]. Rama Rao.B Anuradha.C.H (2016) "Partial Replacement of Waste Foundry Sand by Fine Aggregate and Waste Ceramic Tiles by Coarse Aggregate in Concrete" International Journal for Scientific Research & Development| Vol. 4, Issue 09, 2016

[6]. Senthamarai.RM P.Devadas Manoharan(2005)"Concrete with Ceramic Waste aggregate" Cement and Concrete Composites Volume 27,Issues 9-10,October-November 2005, Pages 910-913

[7]. Seshu.D.R & Ramesh.K "Constitutive behaviour of confined fibre reinforced concrete under axial compression" cement and concrete composites, 2003, pp 343-350.

[8]. Syed Asif Ali, Shaik Abdullah (2014) "Experimental Study on Partial Replacement of Cement by Fly ash and GGBS" IJSRD - International Journal for Scientific Research & Development| Vol. 2, Issue 07, 2014

[9]. Topcu.I.B and Canbaz.M, (2007) "Utilization of Crushes Ceramic waste as Aggregate in Concrete" Iranian Journal of Science & Technology, Transaction B, Engineering, Vol. 31, No. B5, pp 561-565,Printed in The Islamic Republic of Iran,

[10]. Wattanasiriwech.D, Saiton.A, Wattanasiriwech.S (2009) "Paving blocks from ceramic tile production waste" Journal of Cleaner Production 17 1663-1668.