International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

# COPY RIGHT

2017 IJIEMR. Personal use of this material is permitted. Permission from IJIEMR must be obtained for all other uses, in any current or future media, including reprinting/republishing this material for advertising or promotional purposes, creating new collective works, for resale or redistribution to servers or lists, or reuse of any copyrighted component of this work in other works. No Reprint should be done to this paper, all copy right is authenticated to Paper Authors

IJIEMR Transactions, online available on 1st August 2017. Link :
http://www.ijiemr.org/downloads.php?vol=Volume-6&issue=ISSUE-5

Title: Comparison of Normal Concrete and GGBS Concrete.

Volume 06, Issue 05, Page No: 2334– 2338.

Paper Authors

*** N.ANUSHA, KOPPERAPU NIVEDITHA.**

* Dept of Structural Engineering, Siddhartha Institute of Technology and Sciences.

USE THIS BARCODE TO ACCESS YOUR ONLINE PAPER

To Secure Your Paper As Per UGC Guidelines We Are Providing A Electronic Bar Code

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

# COMPARISON OF NORMAL CONCRETE AND GGBS CONCRETE

***N.ANUSHA,**KOPPERAPU NIVEDITHA**

*PG Schoar, Dept of structural Engineering, Siddhartha Institute of Technology and sciences.
**Assistant Professor , Dept of Structural Engineering, Siddhartha Institute of Technology and Sciences.

## ABSTRACT

Today's construction industry, use of concrete is going on increasing rapidly. Cement is major constituent material of the concrete which produced by natural raw material like lime and silica. Once situation may occurs there will be no lime on earth for production of cement. This situation leads to think all people working in construction industry to do research work on cement replacing material and use of it. Industrial wastes like Ground Granulated Blast Furnace Slag (GGBS) show chemical properties similar to cement. Use of GGBS as cement replacement will simultaneously reduces cost of concrete and help to reduce rate of cement consumption. This study report of strength analysis of GGBS concrete will give assurance to encourage people working in the construction industry for the beneficial use of it. This research work focuses on strength characteristics analysis of M20 grade concrete with replacement of cement by GGBS with 20%, 30%, 40% and 50% and compare with plain cement concrete. Now days crush sand is used to replace natural sand, so study area extends to find best percentage of replacement by using both crush and natural sand.

## 1. INTRODUCTION

Concrete has basic naturally, cheaply and easily available ingredients as cement, sand, aggregate and water. After the water, cement is second most used material in the world. But this rapid production of cement creates two big environmental problems for which we have to find out civil engineering solutions. First environmental problem is emission of $CO_2$ in the production process of the cement. We know that $CO_2$ emission is very harmful which creates lots of environmental changes. 1 tone of carbon dioxide is estimated to be released to the atmosphere when 1 tone of ordinary Portland cement is manufactured. Peoples working in the environmental field creates awareness in the public about the energy sources like petrol, diesel are limited in earth crest and for future generation we have to save it or we have to find alternative energy sources. But the peoples working in the construction field are having the same awareness about the lime consumption? This is second environmental problem related to consumption of lime. As there is no alternative binding material which totally replace the cement so the utilization of partial replacement of cement is well accepted for concrete composites.In order to fulfill its commitment to the sustainable development of the whole society, the concrete of tomorrow will not only be more durable, but also should be developed to satisfy socioeconomic needs at the lowest environmental impact. So the problem is related to environment, problem is related to cost minimization but structural engineer will give the solution by proper analysing the properties of concrete made by using industrial waste material. GGBS means the ground granulated blast furnace slag is a by-product of the manufacturing of pig iron. Iron ore, coke and Lime-stone are fed into the furnace and the resulting molten slag floats above the molten iron at a temperature of about $1500^{o}C$ to $1600^{o}C$. The molten slag has a composition close to the chemical composition of Portland cement. 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 ground granulated blast furnace slag (GGBS).

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

## 2. METHODOLOGY

The study work is to analyse strength properties of partially replaced GGBS concrete. The tests of concretes are carried out as per IS code for this proposed investigation work. For successful investigation, tests have to be performed on normal concrete and on GGBS concrete with proportion 20%, 30%, 40%, 50% cement replacement. The comparative report prepare before arriving at the final conclusion of plain concrete and GGBS concrete with crush sand and natural sand.

Following methodology will be followed for proposed work:

- Collection of review of journals and articles to get idea of research work conducted on proposed subject of work.
- Studying the properties of cement with GGBS by conducting tests as per BIS such as standard consistency test, initial and final setting time test.
- Mix design of concrete is done for preparation of concrete as per IS10262:1983.
- Tests on fresh concrete conducted at the time of casting work of different specimens required for proposed work.
- UTM is used to conduct the tests. Test procedure used as per IS 516.

1. Compression test- For this test cubes of standard size of 150mm x 150mm x 150 mm used.
2. Flexural tensile strength- It is measured by testing beams under central point load of size 100mm x 100mm x 150mm.

- Analysis is carried out with test result comparison of GGBS concrete with normal concrete.

## 3. PROPERTIES OF INGREDIENTS

### Cement

The cements used in this experimental works are ordinary Portland cement. All properties of cement are tested by referring IS Specification for Ordinary Portland cement. Test results are presented in Table 1.

Table 1. Physical Properties of Cement (Confirming to IS 12269 – 1987)

| Sr. No. | Description of Test | Results |
|---|---|---|
| 01 | Fineness of cement | 1 % |
| 02 | Specific gravity | 3.15 |
| 03 | Standard consistency of cement | 30 % |
| 04 | Setting time of cement<br>a) Initial setting time<br>b) Final setting time | <br>135 minute<br>288 minute |
| 05 | Soundness test of cement (with Le-Chatelier's mould) | 1.5mm |

### GGBS

The chemical composition of blast furnace slag is similar to that of cement clinker.

Table 2. Chemical composition of GGBS

| Sr. No. | Chemical formula | Percentage |
|---|---|---|
| 01 | Cao | 30-45% |
| 02 | SiO2 | 17-38% |
| 03 | Al2O3 | 15-25% |
| 04 | Fe2O3 | 0.5-2.0% |
| 05 | MgO | 4.0-17.0% |
| 06 | Mno2 | 1.0-5.0% |
| 07 | Glass | 85-98% |

Results are shown in Table 7 & 8 and graphical presentation between compressive strength and percentage GGBS volume fraction is shown in Figure 1.

The compressive strength of specimen was calculated by the following formula:

$$f'_c = \frac{P}{A} \qquad (1)$$

Where,

Table 3. Physical Properties of Cement

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

| Sr. No. | Description of Test | Results |
|---|---|---|
| 01 | Fineness of cement | 1 % |
| 02 | Specific gravity | 3.15 |
| 03 | Standard consistency of cement | 30 % |
| 04 | Setting time of cement<br>c) Initial setting time<br>d) Final setting time | 135 minute<br>288 minute |
| 05 | Soundness test of cement (with Le-Chatelier's mould) | 1.5mm |

Water

Potable water available in laboratory is used for mixing and curing of concrete.

Tests on aggregates

Natural sand from river confirming to IS 383-1970 is used. Various tests such as specific gravity, water absorption, impact strength, crushing strength, sieve analysis etc. have been conducted on CA and FA to know their quality and grading. The above said test results are shown in Tables 4 &5. Crushed black trap basalt rock of aggregate size 20mm down was used confirming to IS 383-1970.

Table 4. Physical Properties of Fine Aggregate (sand)

| Sr. No. | Property | Results |
|---|---|---|
| 01 | Particle Shape, Size | Round, 4.75mm down |
| 02 | Fineness Modulus | 3.17 |
| 03 | Silt Content | 1.67% |
| 04 | Specific Gravity | 2.6 |
| 05 | Bulking of Sand | 4.16% |
| 06 | Bulk Density | 1793 Kg/m$^3$ |
| 07 | Surface Moisture | Nil |

Table 5. Physical Properties of Course Aggregate (20mm)

| Sr. No. | Property | Results |
|---|---|---|
| 01 | Particle Shape, Size | Angular, 20mm. |
| 02 | Fineness Modulus of 20mm aggregates | 6.87 |
| 03 | Specific Gravity | 2.9 |
| 04 | Water Absorption | 0.55% |
| 05 | Bulk density of 20mm aggregates | 1603 Kg/ mm$^3$ |
| 06 | Surface Moisture | Nil |

Mix Design for M20 grade concrete Then the mix proportion as per IS becomes 10262:1985-

Table 6. Mix design proportion

| Cement | F.A. | C.A. | Water |
|---|---|---|---|
| 383.2 | 553.98 | 1313 | 191.6 |
| 1 | 1.45 | 3.42 | 0.5 |

## 4. TESTING OF SPECIMENS

$P_c$ = Failure load in compression, kN A = Loaded area of cube, mm$^2$

Flexural test on plain concrete and GGBS: Standard beams of size 100 x 100 x 500 mm were supported symmetrically over a span of 400 mm subjected central point's loading till failure of the specimen.

Experimental flexural strength:

Maximum experimental flexural strength of the beam specimen was computed by the following equation from theory of strength of materials. The flexural strength of concrete beam specimen was calculated as:

$F_b = 3P \times a/bd^2$ if (2)

a<20 Where,

$F_b$=flexural stress, MPa,

b=measured width in cm of the specimen,

d=depth in mm of the specimen.

l=length in mm of the span on which the specimen was supported and

p=maximum load in kg applied to the specimen.

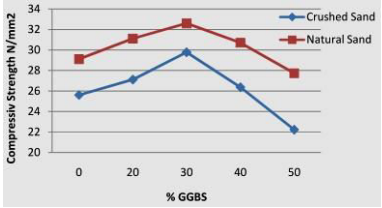
## 5. RESULT

Table 7. Compressive strength of M20 concrete over different percentage GGBS for 28 days using cement as OPC & Natural sand

| Sr. no. | % of the GGBS | Compressive strength of GGBS concrete in N/mm$^2$ | Compressive strength of P.C.C. N/mm$^2$ | Percentage increased in compressive strength |
|---|---|---|---|---|
| 1 | 20 | 31.11 | 29.11 | 6.87 |
| 2 | 30 | 32.59 | | 11.95 |
| 3 | 40 | 30.7 | | 5.46 |
| 4 | 50 | 27.74 | | -4.71 |

Table 8. Compressive strength of concrete over different percentage GGBS for 28 days using cement as OPC & Crush sand

| Sr. no. | % of the GGBS | Compressive strength of GGBS concrete in N/mm$^2$ | Compressive strength of P.C.C. N/mm$^2$ | Percentage increased in compressive strength |
|---|---|---|---|---|
| 1 | 20 | 27.11 | 25.61 | 5.86 |
| 2 | 30 | 29.78 | | 16.28 |
| 3 | 40 | 26.37 | | 2.97 |
| 4 | 50 | 22.22 | | -13.24 |




Compressive strength of cubes are determined at 28 days using compression testing machine (CTM) of capacity 2000 KN. Flexural testing

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

setup of UTM machine of capacity 40 tones was used to determine the flexural strength of beams.

4.1 Compressive strength test on cube:

A cube compression test was performed on standard cubes of plain and GGBS of size 150mm x 150mm x 150 mm at 28 days of immersion in water for curing.

Table 10. Flexural strength of concrete over different percentage GGBS for 28 days using cement as OPC & Crush sand

| Sr. no. | % of the GGBS | Flexural strength of GGBS concrete in N/mm² | Flexural strength of P.C.C. N/mm² | Percentage increased in Flexural strength |
|---|---|---|---|---|
| 1 | 20 | 3.45 | 3.01 | 14.62 |
| 2 | 30 | 3.58 | | 18.94 |
| 3 | 40 | 3.44 | | 14.29 |
| 4 | 50 | 3.12 | | 3.65 |

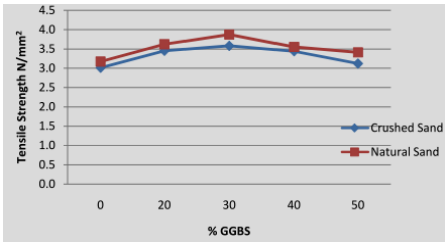



Figure 2. Flexural strength of GGBS concrete with Crushed sand and Natural sand for M20 grade

## 6. CONCLUSIONS

1. The plain cement concrete prepared by OPC cement and natural sand of M20 grade. The maximum compressive strength achieved is 32.59pa at 30% of GGBS replacement and those achieved for 20%, 40%, and 50% of concrete is 31.11Mpa, 30.7Mpa and 27.74Mpa respectively as compare to 29.11 Mpa of strength of plain cement concrete for 28 days. The plain cement concrete prepared by OPC cement and crushed sand of M20 grade. The maximum compressive strength achieved is 29.78pa at 30% of GGBS replacement and those achieved for 20%, 40%, and 50% of concrete is 27.11Mpa, 26.37Mpa & 22.22Mpa respectively as compare to 25.61Mpa of strength of plain cement concrete for 28 days.

Figure 1.Compressive strength of GGBS concrete with Crushed sand and Natural sand for M20 grade

Table 9. Flexural strength of M20 concrete over different percentage GGBS for 28 days using cement as OPC & Natural sand

| Sr. no. | % of the GGBS | Flexural strength of GGBS concrete in N/mm² | Flexural strength of P.C.C. N/mm² | Percentage increased in Flexural strength |
|---|---|---|---|---|
| 1 | 20 | 3.62 | 3.17 | 14.20 |
| 2 | 30 | 3.87 | | 22.08 |
| 3 | 40 | 3.55 | | 11.99 |
| 4 | 50 | 3.41 | | 7.57 |

4.
5.
6. O'Connell, Martin; McNally, Ciaran; Richardson, Mark G, Experimental Investigation on Strength of High Performance Concrete with GGBS and Crusher Sand, Construction and Building Materials, Volume 27, Issue 1, February 2012, Pages 368–374
7. Mahesh Patel, P. S. Rao, T. N. Patel (2013) Experimental Investigation on Strength of High Performance Concrete with GGBS and Crusher Sand, Indian journal of research. Volume 3 , May 2013, 114- 116
8. Mr. Bennet Jose Mathew, Mr. M Sudhakar, Dr. C Natarajan (2013) Strength, Economic and Sustainability Characteristics of Coal Ash –GGBS Based Geopolymer Concrete, International Journal Of Computational Engineering Research (ijceronline.com) Vol. 3 Issue. 1
7. A.H.L. Swaroop, K. Venkateswararao, Prof P Kodandaramarao, Durability Studies On Concrete With Fly Ash & Ggbs. International Journal of Engineering Research and Applications (IJERA), ISSN: 2248-9622 Vol. 3, Issue 4, Jul-Aug 2013, 285-289

The flexural strengths achieved are 3.17Mpa, 3.62Mpa, 3.87Mpa, 3.55Mpa and 3.41Mpa at 0%, 20%, 30%, 40%, and 50% for GGBS concrete respectively for M20 grade concrete of OPC cement and natural sand. This report shows that tensile strength also give good performance for 20%, 30 % and 40% replacement which is more than normal plain concrete.

2. The flexural strengths achieved are 3.01 Mpa, 3.45 Mpa, 3.58Mpa, 3.44Mpa and 3.12 Mpa at 0%, 20%, 30%, 40%, and 50% for GGBS concrete respectively for M20 grade concrete of OPC cement and crushed sand. This report shows that tensile strength also give good performance for 20%, 30 % and 40% replacement which is more than normal plain concrete.

## REFERENCESE.

Condren and S. Pavía, A comparative study of the moisture transfer properties and durability of PC and GGBS mortars. Int .Conf. Concrete Platform. M I Russell and PA M Basheer Eds. Queen's University, Belfast, 2007, p 469-478.Pazhani.K., Jeyaraj.R, Study on durability of high performance concrete with industrial wastes, ATI - Applied Technologies & Innovations Volume 2, Issue 2, August 2010 p. 19-28

1. K. Suvarna Latha, M V Seshagiri Rao, SrinivasaReddy. V, Estimation of GGBS and HVFA Strength Efficiencies in Concrete with Age, International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, Issue-2(2012), 212-225.

N.ANUSHA
M.TECH (Structures)
Siddhartha institute of technology& science

KOPPERAPU NIVEDITHA
Assistant professor,
Structurul Engineering, Siddhartha institute of technology and sciences, Narapalli.

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org