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# STRENGTH PROPERTIES OF CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT AND SAND WITH GRANITE SLUDGE & GGBS

Sunil R[1], Sanjay S J[2], Dr. B K Narendra[3]

[1,2]*Asst. Professor,* [3]*Professor and Principal,*
*Department of civil engineering, B.G.S.I.T, B.G Nagar*

***Abstract-*** *Now a day's high strength and high performance concrete are being widely used all over the world. Most applications of high strength concrete have been in high rise buildings, long span bridges and in some special applications in structures. Traditionally, the basic ingredients of concrete include Cement, Fine aggregate and Coarse aggregate. In general, Ordinary Portland cement is utilized in the creation of civil structures. This OPC can be replaced by Granite Sludge and costs lower than OPC. Similarly, another important ingredient of concrete is Fine aggregate i.e., river sand which is a highly scarce resource. To meet the growing applications for the river sand, Ground Granulated Blast furnace Slag (GGBS) which is readily available that can be utilized in the construction activity. The present investigation deals with the development of concrete when the cement and river sand are replaced by Granite Sludge and GGBS in various proportions. This study mainly focuses on the discussion of strength and workability characteristics of concrete, when the cement is replaced by Granite Sludge partially in various proportions, together with the replacement of river sand by GGBS in various proportions. Cubes are casted for each proportion and tests are conducted for obtaining the compressive strength of concrete. The obtained results are discussed and finally conclusions are made accordingly.*

***Keywords-*** *Compressive strength, Workability, Slump test, Granite sludge, GGBS*

## I. INTRODUCTION

The construction industry relies heavily on conventional materials such as cement, coarse aggregate and fine aggregate (sand) for the production of concrete. The high and increasing cost of these materials greatly hindered (prevent) the development of shelter and other infrastructural facilities in developing countries. These arises the need for engineering consideration of the use of cheaper and locally available materials to meet desired needs and enhance self-efficiency and head to an overall reduction in construction cost for sustained development. Attempts have equally been made by various researchers to reduce the cost of constituents in concrete and hence total construction cost by investigating and ascertaining the usefulness of materials which could be classified as agricultural or industrial waste. Some of these wastes include granite sludge, GGBS, slag etc. Improved the mechanical properties of high strength concrete which is hazardous to the environment and thus may be used as a partial replacement of cement and sand.

GGBS and granite sludge is used in concrete to reduce the cost of construction. The mix design of concrete was done according to Indian standard guidelines [IS 10262-2009] for M20 grade concrete. In the present investigation, the quantities of cement is replaced with different percentages of granite sludge 10%, 20%, 30% & 40% and also the quantities of sand is replaced with different percentages of GGBS 20%, 40%, 60% & 80%. The design strength and workability of the concrete, water demand and relative cost of granite sludge and GGBS as compared to fine aggregate and cement. Various laboratory studies such as workability, compressive strength test were conducted on these mixes and are compared with ordinary concrete without granite sludge and GGBS. Test on hardened concrete were done on 7$^{th}$, 14$^{th}$ and 28$^{th}$ days of casting.

### 1.1 Materials

#### 1.11 Cement

The most commonly available Portland cement of 43 grade cement confirming to IS:12269-1987(ultratech) was used for the project. Cement was bought from the same source through the project work. While storing cement, all possible contact with moisture was avoided. The properties of cement are shown in Table 1.

| Sl.no | Properties | Results |
|---|---|---|
| 1. | Initial setting time | 35min |
| 2. | Normal consistency | 39% |
| 3. | Specific gravity | 3.1 |
| 4. | Fineness | 5% |

Table 1: Physical Properties of cement

**1.12 Ground Granulated Blast furnace Slag (GGBS)**

GGBS is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder.

| **Sl. No.** | **Chemical formula** | **Composition (%)** |
|---|---|---|
| 1 | Cao | 40 |
| 2 | $Sio_2$ | 35 |
| 3 | $Al_2o_3$ | 12 |
| 4 | $Fe_2o_3$ | 0.2 |
| 5 | Mgo | 8.2 |
| 6 | Others | 5 |

Table 2: Chemical composition of GGBS

**1.13 FINE AGGREGATE**

Normally concrete are prepared by mix design. In this study, altogether different combination of material is used in the preparation of concrete. Concrete has reported in this study are prepared with different combination of the selected ingredients to suit the requirement as a concrete. Sand is one of the main ingredients in the preparation of concrete. In this study, sand to some extent is replaced by granite sludge.

The sand used in this investigation is depending on the proportion of the ingredients selected for the concrete was made from an external source. For this purpose, locally available sand was used, which confirmed to Zone 2 as per IS: 383-1987. The proper fine aggregate are shown in table 3.

| Sl. No | Properties | Result |
|---|---|---|
| 1. | Specific gravity | 2.6 |
| 2. | Grading zone | ZONE II |

Table3: Properties of fine aggregate

**1.14 COARSE AGGREGATE**

20mm size of coarse aggregate is used in the project. However, the nominal size of coarse aggregate used for the concrete manufacturing can vary depending on size of the concrete member and the presence of reinforcement. The grading, shape and texture of aggregates largely influence concrete workability. Namely, the amount of water required for target workability is related to the nominal size of the coarse aggregate, the shape, texture and cleanliness of particles of fine and coarse aggregates, and the grading of coarse aggregates. In India, fine and coarse aggregates shall meet the requirements of IS 383.

**1.15 GRANITE SLUDGE**

Granite sludge used in the present study was taken from granite cutting factory, Jigani Industrial area Bangalore. The granite sludge was air dried, sieved through 4.75mm and stored in the bins before being used for making paver blocks.

## II. METHODOLOGY

**2.1 MIX DESIGN**

The concrete mix is designed for M20 grade and the considered degree of workability is medium. The mix design is carried out according to the IS 10262:2009 for the conventional concrete. The obtained mix proportion is 1:1.5:3 with water - cement ratio of 0.45.

**2.2 REPLACEMENT OF CEMENT AND FINE AGGREGATE**

GGBS and Granite Sludge is used in concrete to reduce the cost of construction. The mix design of concrete was done according to Indian standard guidelines [IS 10262-2009] for M20 grade concrete. In the present investigation, the quantities

of cement is replaced with different percentages of granite sludge 10%, 20%, 30% & 40% and also the quantities of sand is replaced with different percentages of GGBS 20%, 40%, 60% & 80%. The design strength and workability of the concrete, water demand and relative cost of granite sludge and GGBS as compared to fine aggregate and cement. Various laboratory studies such as workability, compressive strength test were conducted on these mixes and are compared with ordinary concrete without granite sludge and GGBS. Test on hardened concrete were done on $7^{th}$, $14^{th}$ and $28^{th}$ days of casting.

**FOR GRANITE SLUDGE**

- Series-A consists of 0% granite sludge
- Series-B consist of 10% granite sludge
- Series –C consist of 20% granite sludge
- Series –D consist of 30% granite sludge
- Series –E consist of 40% granite sludge

**FOR GGBS**

- Series-A consists of 0% GGBS
- Series –B consist of 20% GGBS
- Series –C consist of 40% GGBS
- Series –D consist of 60% GGBS
- Series –E consist of 80% GGBS

**2.3 CONCRETE MIXES**

Four concrete mixes were prepared. The control mix (CM) A consisted of 100% OPC. In mixes B, C,D and E the cement was partially substituted with 10%, 20%,30% and 40% of Granite sludge by weight respectively. The fine aggregate content of 100% in mix A and partially replaced by mixes B,C,D and E in 20%,40%,60% and 80% of GGBS for all mixes. The British method also known as the 'DoE method' was used for the mix design process. This method of design comprises of tables and charts available at the Building Research Establishment (BRE). The target strength of all mixes was 50 N/mm2 and the target slump was 135-155 mm. The proportions of materials for each concrete mix are shown in Table 4

| Sl. No | Materials | Quantity(kg/m3) |
|---|---|---|
| 1. | Cement (OPC) | 438 |
| 2. | Fine aggregate | 588 |
| 3. | Coarse aggregate | 960 |
| 4. | Water | 197 |

. Table 4: Quantity of materials for $1m^3$.

| Sl.No | Series | Cement | GS | Sand | GGBS | CA | Water |
|---|---|---|---|---|---|---|---|
| 1. | A | 438 | - | 588 | - | 960 | 197 |
| 2. | B | 394.20 | 43.8 | 470.40 | 117.60 | 960 | 197 |
| 3. | C | 350.40 | 87.6 | 352.80 | 235.20 | 960 | 197 |
| 4. | D | 306.60 | 131.40 | 235.20 | 352.80 | 960 | 197 |
| 5. | E | 262.80 | 175.20 | 117.60 | 470.40 | 960 | 197 |

Table 5: Weight of cement, sand, granite sludge, GGBS, coarse aggregate and water used in the present study from A to E series for $1m^3$ in Kg

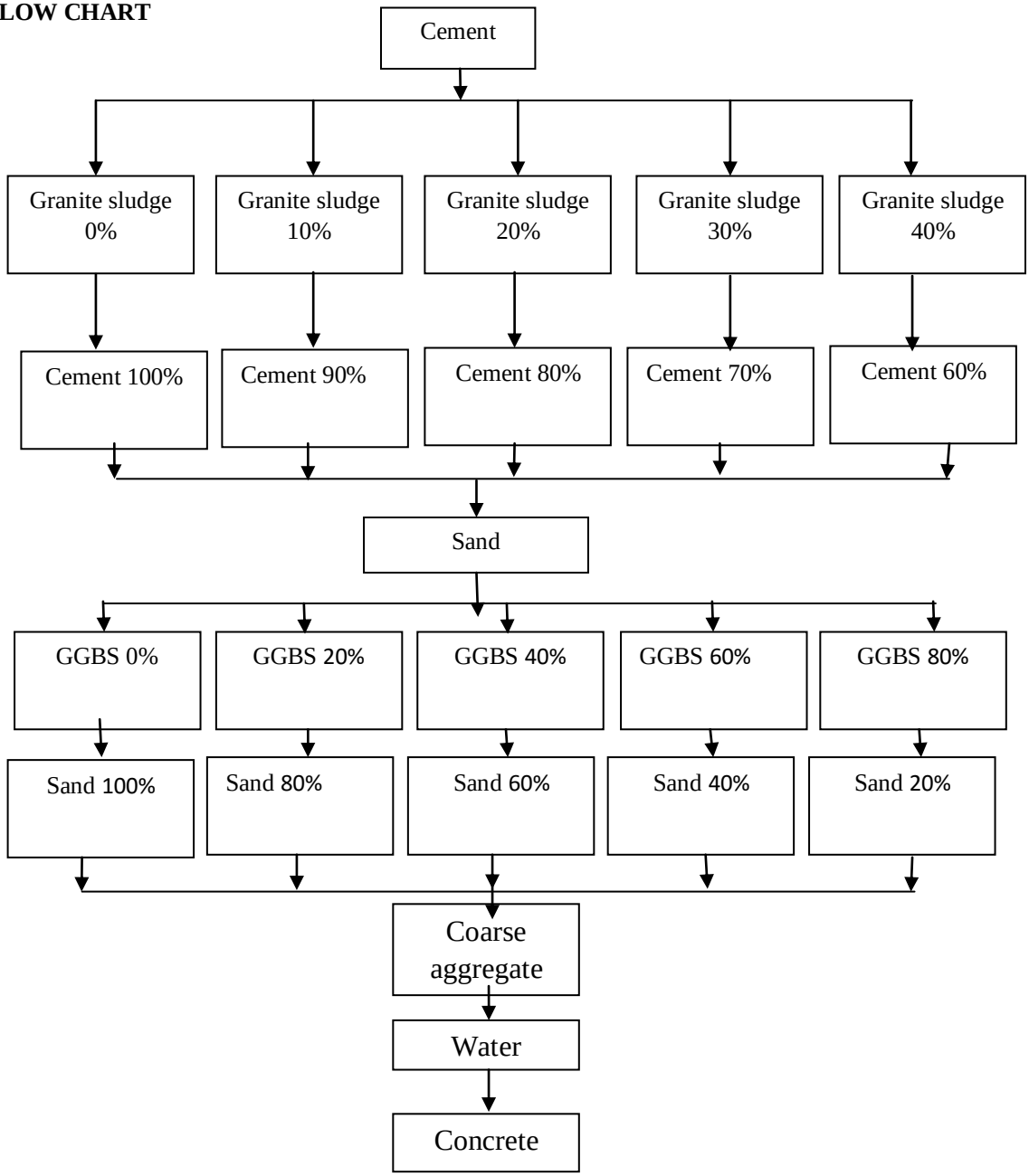
| Sl.No | Series | Cement | GS | Sand | GGBS | CA | Water |
|---|---|---|---|---|---|---|---|
| 1 | A | 14 | - | 18 | - | 30 | 6 |
| 2 | B | 12.6 | 1.4 | 14.4 | 3.6 | 30 | 6 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | C | 11.2 | 2.8 | 10.8 | 7.2 | 30 | 6 |
| 4 | D | 9.8 | 4.2 | 7.2 | 10.8 | 30 | 6 |
| 5 | E | 8.4 | 5.6 | 3.6 | 14.4 | 30 | 6 |

Table 6: Weight of cement, sand, granite sludge, GGBS, coarse aggregate and water used in the present study from A to E series for 9 cubes in Kg

**2.4 FLOW CHART**



## III. RESULTS AND DISCUSSIONS

### 3.1 Effect of different proportions of GGBS and GS on the concrete blocks

Concrete blocks prepared with different mix proportion used in the present study were tested on compressive strength for a period of 7 days, 14 days and 28 days. The test results has been tabulated in the following Table 7.

| Sl.No | Series | 7 Days | 14 Days | 28 Days |
|---|---|---|---|---|
| 1. | A | 11.26 | 18.03 | 27.25 |
| 2. | B | 10.37 | 19.45 | 26.37 |
| 3. | C | 11.26 | 20.21 | 26.96 |
| 4. | D | 12.15 | 21.65 | 27.55 |
| 5. | E | 10.81 | 20.35 | 23.25 |

Table 7 Compressive strength at 7, 14 and 28 days

Fig 5. Show the plot of compressive strength versus time of ageing for the concrete blocks for various proportion of GGBS and GS. It can be observed that same strength of concrete up to the proportion of 60%GGBS and 30% granite sludge replacement. After increasing the proportion of GGBS and GS the compressive strength of the concrete gets decreased. This may be due to the increase in fines in form of GGBS and GS.

The test results discussed with graph as shown in following.

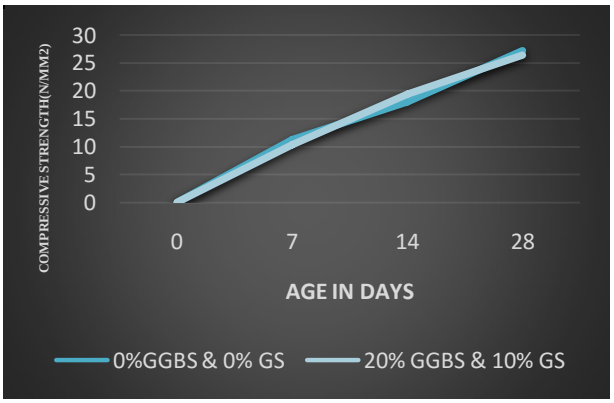



Fig1. Compressive strength versus A & B series

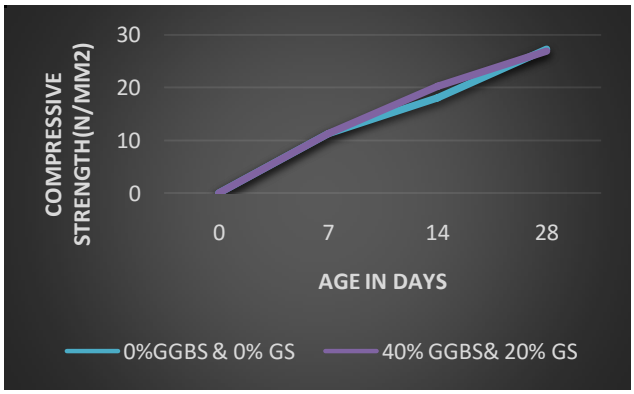



Fig. 2 Compressive strength versus A & C series

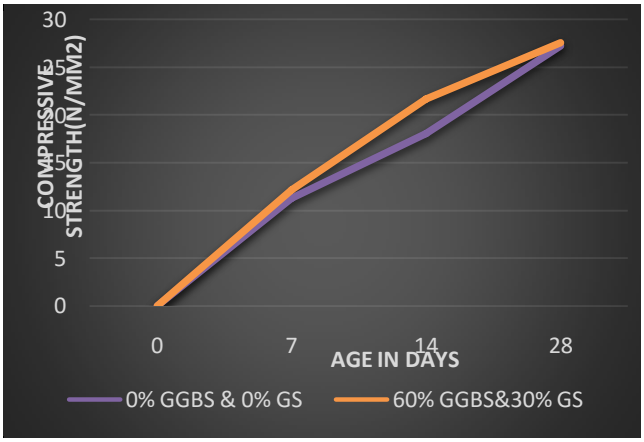



Fig 3 Compressive strength versus A & D series

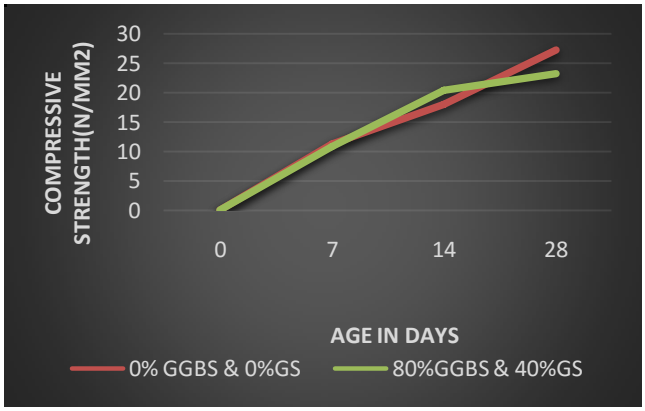



Fig 4 Compressive strength versus A & E series

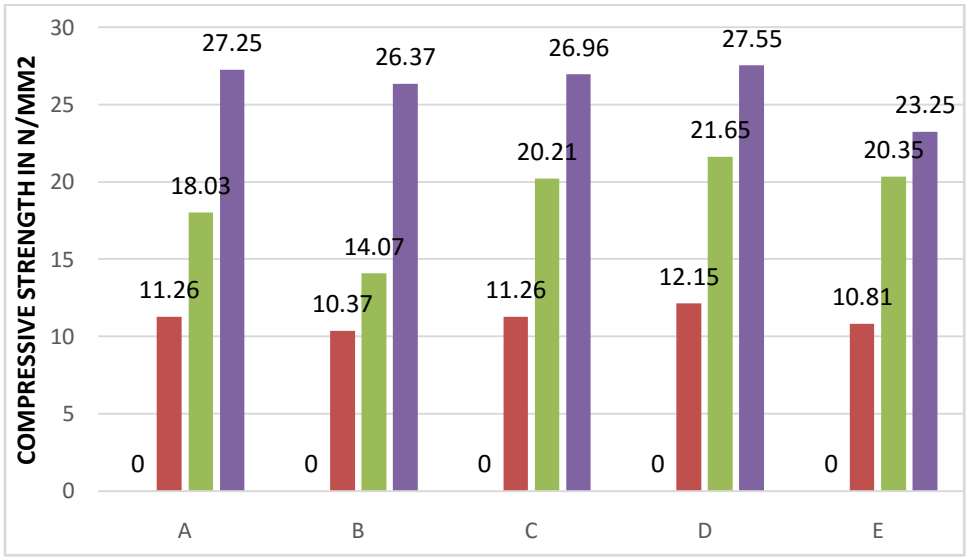



Fig 5 Compressive strength versus all series

## IV. CONCLUSIONS

Based on this experimental study, it can be concluded that

1. Concrete blocks prepared with 30% Granite sludge & 60% GGBS have observed to be yielded good engineering properties required for a concrete blocks. The observed compressive strength at 28 days of ageing is observed to be 27.55 MPa.
2. We can replace Granite Sludge upto 40% by cement increases the compressive strength but there will be decrease in strength when GGBS is replaced sand by 80%.

## REFERENCES

[1] Atul Dubey, Dr. R. Chandak, Prof. R.K. Yadav (2012) - "Effect of blast furnace slag powder on compressive strength of concrete" – *International Journal of Scientific & Engineering Research*, Vol.3, Issue 8, August.

[2] Chitlange, M.R., Pajgade,P.S., and Nagarnaik, P.B. (2008) – "Experimental Study of Artificial Sand Concrete" - *First International Conference on Emerging Trends in Engineering and Technology, IEEE*, Computer Society, pp.1050-1054.

[3] Mrs. VeenaG.Pathan, Mr. Vishal S.Ghutke and Mr. GulfamPathan (2012) – " Evaluation of Concrete Properties using Ground Granulated Blast Furnace Slag" – *International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET)*, Vol.1, Issue 1, November.

[4] M. Sai Lakshmi, Dr. B. S. R. K Prasad, V. Mallikarjuna and S. Krishna Rao (2013)- "Strength And Workability Characteristics Of High Performance Concrete With Partial Replacement Of Cement And Sand With GGBS & Robosand"- *International Journal of Engineering Research & Technology (IJERT)*, ISSN: 2278-0181 Vol. 2 Issue 8, August - 2013

[5] Sachin Balkrishna Kandekar, Amol Jagannath Mehetre, Vijayshree A. Auti (2012) – " Strength of concrete containing different types of Fine Aggregate" – *International Journal of Scientific and Engineering Research (IJSER)*, ISSN 2229- 5518, Vol.3, Issue 9 , September.

[6] T. Shanmugapriya, R.N. Uma (2012) – "Optimization of Partial Replacement of M-Sand By Natural Sand in High Performance concrete with Silica fume" – *International Journal of Engineering Sciences & Emerging Technologies (IJESET)* , Vol.2, Issue 2, pp:73-80.

[7] Vinayak R.Supekar and PopatD.Kumbhar (2012) – "Properties of concrete By Replacement of Natural Sand with Artificial Sand" – *International Journal of Engineering Research & Technology (IJERT)*, ISSN 2278-0181, Vol.1, Issue 7, September.