Test Study on Concrete by Partial Replacement of Cement with GGBS

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Abstract: A Composite material of the solid that having its remarkable physical and mechanical quality, which chiefly helps the business, likes development. The current investigation is done in two stages in an underlying blend of M30 grade concrete, and part of the way supplanted from concrete to GGBS by 0%, 2%, 4%, and 6% analyses are utilized to locate the greatest substitution rate and accomplished the solid strength attributes. This work is experimented that the GGBS based material have achieve to improve in length intended to 30% substitution of cement at the period of 7, 14, and 28 days. As far as cost is concerned, the expense of GGBS in the market, including bundling and moving, is multiple times not exactly of OPC. In this way, the incomplete substitution of OPC in cement by GGBS isn't just practical yet also encourages environmentally-friendly removal of the waste slag into a valuable item produced in enormous amounts from the iron and steel enterprises. The ideal strength was accomplished with the blend of 6% of GGBS with concrete.

Keywords: GGBS, Concrete, Cement, Sieve analysis, M20 Blends.

1. Introduction
The GGBS to be a consequence of assembling iron, and the measures of iron and slag acquired are of a similar order. Those glossy grinds are dehydrated with the ground to the necessary size is called GGBS [15].

1.1 Objective of the task
The fundamental targets of this examination are,
• The execution of cement by incomplete substitution of concrete.
• The compressive strength and split elasticity of cement for 7 days and 28 days relieving.
• The most streamlined blend of GGBS, based cement [5].

2. Methodology
This section manages different investigations that were done on plain concrete a lot with CSA. The pressure test is led on blocks of standard measurements separately. Because of the consequence of the research center's tests, ends are drawn [11].

2.1 The Tests Are
1. Test on Compression.
2. Split tensile test.
3. Flexural test.
In solid official up the material, the help of fine total, coarse total, concrete, and water proportion.

2.2 Methodology Flow Chart

![Flow Chart Image]

**Figure 1:** Workflow of Proposed GGBS systems

2.3 Compression Test
Adding and supplanting the coarse total with GGBS in cement. The substitution of GGBS keeps an eye on the shifting of solidarity in the pressure test. Compression is characterized as packing the solid, which demonstrated the strength of cement. Figure 1 shows workflow of Proposed GGBS systems

2.4 Split Tensile Test
The split tensile is characterized as the pliable of cement up to the most extreme scope of solidarity in properties. In this test, adding GGBS along these lines, the split tensile fluctuates the worth. The split tensile test knows this in GGBS.

2.5 Flexural Test
The flexural strength is characterized as the twisting in cement. It is one of measure the concrete strength. In this test, adding GGBS changing the worth. This is known as a flexural test in GGBS.

3. Literature review
RHA and CRP (crushed rock powder) as Substitution Materials and Carbon dioxide effect as soothing of cement [1]. This exploration was led to examine Crushed Rock Powder (CRP) impact like well total and incomplete supplanting of concrete with admixtures exposed to various water, carbon dioxide, and air relieving periods.

Fractional supplanting of characteristic waterway sand with squashed stone sand in solid creation”, the utilization of squashed stone sand because a halfway substitution of stream sand in cement was examined [2]. The successful normal sand (R.S.) substitution ran somewhere in the range of 0 to 60
percent among the most excellent outcomes accomplished on 20 percent substitution and pinnacle compressive strength and backhanded elasticity estimations \(23.2 \text{ N/mm}^2\) besides \(1.42 \text{ N/mm}^2\) separately be gotten. Modulus of elasticity of cement expanded starting \(22 \text{ K.N. /mm}^2\) toward \(23 \text{ K.N/ mm}^2\) with 20 % substitution of normal sand. Likewise, the circuitous elasticity expanded from \(1.28 \text{ N/mm}^2\) to \(1.42 \text{ N/mm}^2\) with 20 % waterway sand substitution. The pillar diversion went among 0.25 mm also 0.4 mm, by the most reduced avoidance record at 20 % CRS is the most noteworthy redirection of 0.4 mm among the control blend (0 percent CRS) [7].

“Effective use of smasher dust in solid utilizing Portland pozzolana concrete ”(2013). There is different quarry dust extents that the cement mortar cube was concentrated such as (CM 1:1, CM 1:2, and CM 1:3) [6]. The test results indicated that quarry dust expansion for a fine to the coarse aggregate proportion of 0.6 was created to improve the compressive properties just as elastic modulus [3].

4. Materials properties
The properties of the materials utilized, specifically concrete, fine total, coarse total, and GGBS, are considered.

4.1 Cement
Concrete be a binder, a material utilizes for enlargement to sets, solidifies moreover clings to various materials, restricting them simultaneously [4]. Concrete is occasionally utilized, thus far, rather than to bind sand along with rock (aggregate) mutually. Concrete is used with well aggregate to make mortar in favor of stonework or rock and sand aggregate to distribute concrete.

4.2 Specific Gravity of Concrete
Apparatus required:
- Le Chatelier flask or specific gravity bottle 100ml limit.
- Balance fit for weighing precisely up to 0.1gms.

4.3 Procedure
Weight a spotless and dehydrated Le Chatelier jar, otherwise explicit gravity bottle among the plug (W1). Spot on the example of concrete up to half of the container around 50 grams as well as weight with its stopper (W2). Add kerosene (polar fluid) concrete in the bottle plow it is regarding half full. Keep mixing with include further lamp oil plow it's blush through the graduated imprint. Dehydrated the outside and gauge (W3). Ensnared air might exist using void siphon if accessible void the flask clean it tops off with clean lamp oil with the graduate imprint wipe dry the exterior and weigh (W4).

4.4 Calculation
Specific gravity = \(\frac{(W2-W1)}{(W2-W1) - (W3-W4)} \times 0.94\)

 Whereas,
W1- Weight of empty flask
W2- the weight of flask + cement
W3- Weight of flask + cement + GGBS
W4- Weight of flask + GGBS
0.94 = Specific gravity of cement = 3.15

4.5 Initial setting time
Initial setting time is the time slipped using involving the minutes so as the water is added to the material to glue begins its elasticity.

4.6 Procedure
Take around 400 grams of concrete example and blend it with 0.85 occasions the water needed to create a concrete paste of typical consistency. Start the stopwatch the second the water is added to the
concrete. Spot the Vi cat's form loaded up with the glue of standard consistency with the glass plate at the base in the Vi cat mechanical assembly with the marker set to 0-0 when the tip of the underlying set needle fixed in the needle holder contacts the outside of the paste in shape [8]. Speedy delivers the needle to permit it to infiltrate into the paste and note the obstruction offered from the lower part of the shape. Rehash the cycle by rapidly delivering the needle at regular intervals until the protection from infiltration is 5mm to 7mm from the lower part of the shape. At that point, note down the underlying setting time. When the needle neglects to infiltrate 5mm to 7mm from the lower part of the shape, it is noted as 32 minutes [9]. Tests were led to locating the particular gravity, consistency; setting time, adequacy, and compressive strength of OPC, and the outcomes are arranged in the Table 1. This table likewise analyzes the outcomes acquired and the prerequisite according to I.S.: 8112-1989.

4.7 Fine Aggregate

Aggregates be dormant granular materials like sand, rock otherwise squashed stone to a finished result inside their right. They are similar to the rudimentary resources are elementary fixings in cement. Aggregate, which corresponds to 60 to 75 percent of cement volume, is alienated into 2 individual classes – fine also coarse aggregate. Fine aggregate, comprises common sand or squashed stone with most particles going through a 9.5mm filter. Fine aggregate, comprises of regular sand or else sand with mainly particles going throughout a 3/8-inch sieve [10]. Very well aggregate is standard sand that have been washed and sieved to eliminate particles bigger than 5mm. The code to be referred to understand the specifications for fine aggregates is I.S.: 383:1970 [12].

### Table 1: Fine aggregate Of Sieve analysis

| Sieve size (mm) | Retained Weight (gms) | % of wt. retained | Cumulative % of wt. | Cumulative wt. of retained (gms) | % of passing |
|-----------------|-----------------------|------------------|---------------------|--------------------------------|-------------|
| 4.75            | 0                     | 0                | 0                   | 0                              | 100         |
| 2.36            | 42.3                  | 2.13             | 2.13                | 42.5                           | 97.87       |
| 1.18            | 153                   | 7.65             | 9.78                | 195.5                          | 90.22       |
| 0.60            | 585                   | 29.25            | 39.03               | 780.5                          | 60.97       |
| 0.425           | 663.5                 | 33.18            | 72.20               | 1444.0                         | 27.80       |
| 0.30            | 0                     | 0                | 72                  | 1444.0                         | 27.80       |
| 0.15            | 350.5                 | 17.53            | 20                  | 1794.5                         | 10.27       |
| 0.090           | 164.5                 | 8.23             | 89.73               | 1959                           | 2.05        |
| 0.075           | 10                    | 0.5              | 97.95               | 1969                           | 1.55        |
| Pan             | 8                     | 0.40             | 98.45               | 1977                           | 1.15        |

**Fineness modulus of fine aggregate** = sum of cumulative % retained / 100 = 580.32/100 =5.80

### Table 2: Fine aggregate for Specific gravity test

| Sl. No. | Observation                              | Readings (gms) |
|---------|------------------------------------------|----------------|
| 1       | The pycnometer empty weight (W1)         | 0.29           |
| 2       | Pycnometer + sand (W2)                   | 0.29           |
| 3       | Pycnometer+sand+ water (W3)              | 1779.5         |
| 4       | Pycnometer +water (w4)                   | 1960.5         |

4.8 Course aggregate

Development coarse aggregate, or basically "aggregate," is a common cataloging of common to intermediate grained individual concrete used in construction, together with, slag, reused concrete,
squashed stone, geo-manufactured aggregate and sand rock. Size of the coarse aggregate = 20mm [13]. Table 2 shows Fine aggregate for Specific gravity test and Sieve analysis of coarse aggregate are discussed in Table 3.

### Table 3: Sieve analysis of coarse aggregate

| Sieve size (mm) | Retained Weight (gms) | % of Retained Weight | Cumulative weight retained (gms) | Cumulative % retained | % of passing |
|-----------------|------------------------|----------------------|---------------------------------|----------------------|--------------|
| 25              | 0                      | 0                    | 0                               | 0                    | 0            |
| 20              | 662.5                  | 33.13                | 662.5                           | 33.13                | 66.87        |
| 12.3            | 1308.5                 | 65.43                | 1971                            | 98.55                | 1.45         |
| 10              | 28.5                   | 1.43                 | 1999.5                          | 99.98                | 0.02         |
| 6.3             | 0                      | 0                    | 0                               | 0                    | 0            |
| 6.75            | 0                      | 0                    | 0                               | 0                    | 0            |
| Pan             | 0                      | 0                    | 0                               | 0                    | 0            |

### Table 4: Specific gravity of coarse aggregate

| SL. No. | Observations                              | Weight-in grams |
|---------|-------------------------------------------|-----------------|
| 1       | The empty weight of the Pycnometer (W1)   | 629             |
| 2       | Pycnometer + Sand (W2)                    | 829             |
| 3       | Pycnometer+sand + water (W3)              | 1784.5          |
| 4       | Pycnometer+ water (W4)                    | 1660.5          |

4.9 GGBS (Ground Granulated Blast Furnace Slag)

Flash furnace slag is a by-product acquired to assembling iron pig; a produce formed using a blend with the earthy constituent of iron ore through the limestone flux at high temperature in the blast furnace (about 1500c). The physical and chemical properties of GGBS are given in tables. Table 4 explains about Specific gravity of coarse aggregate.

4.10 Summary

The Feasibility of position granulated flash furnace slag as limited substitution of cement as fine aggregate is studied. The replacement of 10%, 20%, and 30% is added. The mechanical properties of GGBS concrete are studied by casting concrete cubes, cylinders, and beams GGBS concrete test study is discussed in Figure 2.
5. Conclusion

- This work experiential with the aim of GGBS based concrete include to achieve an increase in length meant by 30% substitute of cement at the age of 7, 14 and 28 days.
- The substitution of concrete by GGBS expands the compressive strength as well as diminishes the concrete substance, which declines in the emanation of CO2.
- The most enhanced blend of GGBS based cement is discovered to be 30% from both compressive and part rigidity of cement.
- As far as cost is concerned, the expense of GGBS in the market, including bundling and moving, is multiple times not exactly of OPC.
- In this way, the incomplete substitution of OPC in cement by GGBS isn't just practical yet also encourages environmentally-friendly removal of the waste slag into a valuable item produced in enormous amounts from the iron and steel enterprises. The ideal strength was accomplished with the blend of 6% of GGBS with concrete.

6. Scope of the future work

This exploration was proposed to look at the impact by slag of copper increases inside cement also RCC components for M20 blends. A similar expression can be stretched out to advanced evaluations of cement blends through differing water/cement proportions [14].
- Ground granulated blast furnace slag could be efficiently replaced in constructing bricks, hollow blocks, and pathway blocks.
- While GGBS have a superior shear strength value that could be used for soil stabilization.
- GGBS was replaced as a fine aggregate in real as well as RCC members, which can be tested for mechanical performances.
References

[1]. RHA and CRP (crushed rock powder) as Substitution Materials and Carbon dioxide effect as soothing of cement (2010) by D.S.Rajendra Prasad International diary of Innovative Research in Engineering and Management.

[2]. Fractional supplanting of common stream sand with squashed stone sand in solid creation, (2013)by Manguriu, G.N., Karugu, C.K., oyawa, W.O., Abuodha, s.o. what's more, mulu5, International diary of inventive exploration in Engineering executives

[3]. Dr. A.D. Poofale, Syed Raziuddin Quadri2 " Effective utilization of crusher dust in concrete using Portland pozzolana cement "( 2013) International journal of innovative research in Engineering and Management

[4]. Prakash and A. Sivakumar “Characteristic studies based on the mechanical properties of quarry dust addition in conventional cement “(2011) International journal of innovative research in Engineering and Management.

[5]. Vijayalaxmi D., Ajay H.A., Ranjith A., Sandhya D.S. "Experimental investigation on Elastic properties of concrete incorporating GGBFS" (2015) – IJIREM.

[6]. ACI Committee 211.4R "Guide for selecting properties for high - performance concrete (material) with Portland cement and fly ash “(2001”) International journal of innovative research in Engineering and Management.

[7]. Dr. Eswaramoorthi (2013) “Experimental study on durability characteristics of High-performance concrete “(2004) International journal of innovative research in Engineering and Management.

[8]. Guppreetsingh (2012) “strength and durability studies of concrete containing waste foundry sand “ (2012) – IJIREM.

[9]. Ondova. M, “The study of the properties of fly ash based concrete composites with various chemical admixtures “(2012) – IJIREM.

[10]. Elavenil S. and Samuel Knight G.M, "Behaviour of steel fiber reinforced concrete beams and plates under static load "(2007) - IJIREM.

[11]. Gorantla Rajkiran,” An Experimental Study on the Properties of Concrete by Partial Replacement of Cement with Egg Shell Powder (ESP) and Rice Husk Ash (RHA),” (2020) – IJAST.

[12]. Prof. Shaheen S. Gupta," A Review Paper on Uses of Mount Crushed Rock as Replacement of Fine Aggregate in Concrete,”(2020) - (IRJET).

[13]. Vikas Srivastava,” Stone Dust in Concrete: Effect on Compressive Strength,” (2015) International Journal of Engineering and Technical Research (IJETR).

[14]. T.V. S. Vara Lakshmi,” A Study on Preparing Of High-Performance Concrete Using Silica Fume and Fly Ash," (2016) - (IJES).

[15]. S.k.Sirajuddin, T.Venkat Das.” Experimental Investigation on Properties of Concrete by Partial Replacement of Cement with GGBS and Fine Aggregate with Quarry Dust,” (IJRTE).