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# Strength And Durability Study of Geopolymer Concrete By Using GGBS, Rice Husk Ash, And M-Sand

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**Abstract-** Research for finish OPC free cement is as yet advancing and there is a requirement for creating elective restricting operators which are earth well disposed. One such option is recognized to be geopolymer which frequently comprises of fly fiery remains, sodium silicate, and sodium or potassium hydroxide (NaOH or KOH). Since, many coal based power plants in India have been resigning because of pushed towards cleaner vitality generation and this may prompt shortage of flyash in future.The creation of Ordinary Portland bond and the utilization of typical waterway sand are expanded because of the request of cement in development Industries. The outflow of CO2 increments amid the generation of bond and in the meantime the accessibility of stream sand is likewise getting to be costlier and shortage because of illicit digging of waterway sand. The primary intension of this exploration paper is to center the eco benevolent elective material for the bond and stream sand. Henceforth the goal of this examination is to consolidate other Pozzolanic materials in geopolymer concrete. In accordance with target two Pozzolanic materials granulated impact heater slag (GGBS) and rice husk fiery debris (RHA) were utilized to supplant flyash in geopolymer concrete and the level of M-sand instead of waterway sand. Solid blend plan of M25 and M30 were done in view of Indian standard code (IS 10262) and altered rules. Solid blocks and tube shaped examples were tried for advancing the compressive quality and split elasticity by shifting the rates of GGBS,RHA and M-sand in concrete The rate substitution of GGBS, RHS and M-sand in Geopolymer concrete by utilizing 0%GGBS+0%RHA+0%M-sand,2.5%GGBS+2.5% RHA+5%M-sand, 5%GGBS+5%RHA+10% M-sand, 7.5%GGBS+7.5%RHA+15%M-sand,10%GGBS+ 10%RHA+20%M-sand. The different tests like compressive, elastic, flexural and Durability tests are performed on geopolymer concrete by shifting rates of RHA, GGBS and M-sand.

## I. INTRODUCTION

In this work, fly fiery remains based geopolymer is utilized as the folio; rather than Portland orany other water powered bond glue, to create concrete. The fly fiery debris based geopolymerpaste ties the free coarse totals, fine totals and other un-reactedmaterials together to frame the geopolymer concrete, with or without the nearness of admixtures.

As in the OPC concrete, the totals involve the biggest volume, i.e. around 75-80 % by mass, in geopolymer concrete. The silicon and the aluminum in the low calcium (ASTM Class F) fly cinder are initiated by a mix of sodium hydroxide and sodium silicate answers for frame the geopolymer glue that ties the totals and other un-responded materials.

**Objectives of the study**
The present study deals with the manufacturing and study of properties of Fly ash based Geopolymer concrete by varying the Molarity of Sodium Hydroxide (NaOH) solution.

1. To make a solid without utilizing concrete (i.e. Geopolymer concrete).
2. To build up a blend proportioning procedure to produce Rice Husk Ash based Geopolymer concrete.
3. To research the quality properties (Compressive, split, flexural quality) of Rice Husk Ash based geopolymer concrete.
4. To investigation the solidness properties of geopolymer concrete

## II. .LITERATURE REVIEW

**Jamdade P.K et.al (2014)**
Advanced the utilization of modern waste fly slag as the swap for concrete. Analysts done tests on relieving time, restoring temperature of geopolymer concrete. The compressive quality ascents from 12 hrs to 24 hrs at 60°c. The investigation demonstrates that, for polymerisation the temperature 90°c is very adequat e. Geopolymer solid gives more quality than ordinary cement in least time of relieving. Geopolymer concrete has bigger compressive quality with higher relieving temperature.

**Krishnan L et.al (2014)**
Led considers and inferred that the geopolymer innovation is appropriate for application in solid industry as an elective cover to the Portland bond.. The goal of this examination work was to create a carbon dioxide outflow free cementious material. Geopolymer concrete is such a material, to the point that stays away from such destructive impacts. The discharge of carbon

dioxide amid the creation of conventional Portland bond is especially high.

## III. MATERIALS AND MIX PROPORTIONING

**Coarse aggregates**
Locally accessible pulverized rock stone total of 10mm size was utilized ascoarse total. The coarse total going through 10mm and holding 4.75mm was utilized for exploratory work. The properties of coarse totals were resolved as perIS: 2386-1963.

**Fine aggregates**
The locally accessible stream sand, going through 4.75 mm was utilized in this test work. The properties of fine totals were resolved according to May be: 2386-1963.

**RHA**
Rice husk is a rural buildup which represents 20% of the 649.7 million tons of rice created yearly around the world. The delivered incompletely consumed husk from the processing plants when utilized as a fuel additionally adds to contamination and endeavors are being made to defeat this ecological issue by using this material as a supplementary solidifying material.

*2) Manufactured sand:*

Fabricated sand (M-Sand) is a substitute of waterway sand for solid development. Made sand is delivered from hard rock stone by pounding.
The pulverized sand is of cubical shape with grounded edges, washed and evaluated to as a development material. The extent of produced sand (M-Sand) is under 4.75mm.

**GGBS**

**GGBS-**

Granulated Blast Furnace Slag is acquired by quickly chilling (extinguishing) the liquid fiery remains from the heater with the assistance of water. Amid this procedure, the slag gets divided and changed into formless granules (glass), meeting the prerequisite of IS 12089:1987 (fabricating detail for granulated slag utilized in Portland Slag Cement). The granulated slag is ground to wanted fineness for creating GGBS.

**GGBS**

**Alkaline solution**

A mix of sodium silicate arrangement and sodium hydroxide arrangement was utilized as soluble arrangement.

**Sodium hydroxide**
The most well-known soluble activator utilized in geopolymerisation is a combinationof sodium hydroxide (NaOH) or potassium hydroxide (KOH) and sodium silicate(Na2Sio3) or potassium silicate (K2SiO3). The sort and convergence of salt arrangement influence the disintegration of Pozzolanic material. It is a white strong and exceptionally causticmetallic base and soluble base salt which is accessible in pellets, drops, granules, and as preparedsolutions at various diverse fixations. Sodium hydroxide frames anapproximately half (by weight) soaked arrangement with water.

Preparation of NaOH solution

**Silicate**
Sodium silicate is the basic name for mixes with the equation Na2(SiO2) Concrete treated with a sodium silicate arrangement serves to significantlyreduce porosity in most stone work items, for example, concrete. A synthetic response occurswith the overabundance Ca(OH)2 (portlandite) exhibit in the solid that for all time ties the silicates with the surface, making them undeniably strong and water repellent.

*B. ADMIXTURE*

To secure usefulness of clean Geopolymer Concrete, Sulphonated napthalene polymer based absolutely great plasticizer Conplast SP430 in the state of a dark colored fluid immediately dispersible in water,

**MIX DESIGN**
For M25 Grade Concrete-1:0.78:2.5
For M30 Grade Concrete-1:0.77:2.4

IV EXPERIMENTAL INVESTIGATION

**Manufacture of Fresh Concrete and Casting**

Geopolymer cement can be produced by embracing the traditional systems utilized in the make of Portland bond concrete. In the research facility, the fly fiery remains and the totals were first combined for 3 minutes. The totals were set up in immersed surface dry condition.

Mixing of Geopolymer concrete

***Curing of Geopolymer concrete***

Surrounding restoring of low calcium fly fiery debris based geopolymer concrete is for the most part prescribed. Surrounding relieving generously helps the substance response that happens in the geopolymer glue. Both restoring time and relieving temperature impact the compressive quality of geopolymer concrete. The restoring time differed from 12 to 24 hours.

***Curing of Test Specimens***
In the wake of throwing, geopolymer solid examples were relieved quickly. Two composes ofcuring were utilized in this examination, i.e. Broiler restoring and Ambient relieving. For Oven relieving, thetest examples were restored in the broiler and for encompassing restoring, they were kept underambient conditions for relieving at room temperature. The examples were broiler relieved at 60°C and 100°C for 24 hours in the stove. After the relieving time frame, the test specimenswere left in the molds for no less than six hours so as to stay away from an extraordinary change in the ecological conditions.

**Tests to be conducted on concrete**
Fresh concrete tests
Slump cone test
Compaction factor test
Hardened concrete tests
Compressive strength
Split tensile strength
Flexural strength
Durability

V. RESULTS AND ANALYSIS

Workability of concrete

Slump cone test

| S. no | %GGBS+%RHA+%M-Sand | Slump in mm for M25 Grade concrete | Slump in mm for M30 Grade concrete |
|---|---|---|---|
| 1 | 0%GGBS+0%RHA+0%M-sand (Mo) | 80 | 60 |
| 2 | 2.5%GGBS+2.5%RHA+5%M-sand (M1) | 60 | 40 |
| 3 | 5%GGBS+5%RHA+10%M-sand (M2) | 50 | 30 |
| 4 | 7.5%GGBS+7.5%RHA+15%M-sand (M3) | 50 | 25 |
| 5 | 10%GGBS+10%RHA+20%M-sand (M4) | 30 | 25 |

Compaction factor test

| S. no | %GGBS+%RHA+%M-Sand | Compaction factor for M25 Grade concrete | Compaction factor for M30 Grade concrete |
|---|---|---|---|
| 1 | 0%GGBS+0%RHA+0%M-sand (Mo) | 0.82 | 0.84 |
| 2 | 2.5%GGBS+2.5%RHA+5%M-sand (M1) | 0.85 | 0.87 |
| 3 | 5%GGBS+5%RHA+10%M-sand (M2) | 0.86 | 0.89 |
| 4 | 7.5%GGBS+7.5%RHA+15%M-sand (M3) | 0.90 | 0.92 |
| 5 | 10%GGBS+10%RHA+20%M-sand (M4) | 0.94 | 0.95 |

**Compressive strength of concrete**

| S. no | Mix ID | Compressive strength of M25 Grade concrete | | | Compressive strength of M30 Grade concrete | | |
|---|---|---|---|---|---|---|---|
| | | 7days | 14 days | 28 days | 7days | 14 days | 28 days |
| 1 | 0%GGBS+0%RHA+0%M-sand (Mo) | 16.20 | 22.10 | 29.66 | 19.20 | 26.60 | 30.60 |
| 2 | 2.5%GGBS+2.5%RHA+5%M-sand (M1) | 16.88 | 22.74 | 30.26 | 19.92 | 27.18 | 32.34 |
| 3 | 5%GGBS+5%RHA+10%M-sand (M2) | 17.22 | 23.26 | 32.12 | 20.64 | 27.82 | 35.26 |
| 4 | 7.5%GGBS+7.5%RHA+15%M-sand (M3) | 17.02 | 23.10 | 32.02 | 20.10 | 27.42 | 34.02 |
| 5 | 10%GGBS+10%RHA+20%M-sand (M4) | 16.84 | 22.92 | 30.68 | 19.72 | 27.20 | 33.62 |

### Split tensile strength of concrete

| S. no | Mix ID | Split tensile strength of M25 Grade concrete | | | Split tensile strength of M30 Grade concrete | | |
|---|---|---|---|---|---|---|---|
| | | 7days | 14 days | 28 days | 7days | 14 days | 28 days |
| 1 | 0%GGBS+0%RHA+0%M-sand (Mo) | 3.22 | 3.48 | 3.84 | 3.82 | 4.28 | 4.44 |
| 2 | 2.5%GGBS+2.5%RHA+5%M-sand (M1) | 3.46 | 3.68 | 3.98 | 4.12 | 4.48 | 4.66 |
| 3 | 5%GGBS+5%RHA+10%M-sand (M2) | 3.72 | 3.98 | 4.36 | 4.40 | 4.88 | 5.14 |
| 4 | 7.5%GGBS+7.5%RHA+15%M-sand (M3) | 3.50 | 4.01 | 4.26 | 4.12 | 4.64 | 5.02 |
| 5 | 10%GGBS+10%RHA+20%M-sand (M4) | 3.36 | 3.84 | 4.18 | 4.02 | 4.38 | 4.84 |

### Flexural strength of concrete

| S. no | Mix ID | Flexural strength of M25 Grade concrete | | | Flexural strength of M30 Grade concrete | | |
|---|---|---|---|---|---|---|---|
| | | 7days | 14 days | 28 days | 7days | 14 days | 28 days |
| 1 | 0%GGBS+0%RHA+0%M-sand (Mo) | 4.12 | 4.62 | 4.84 | 4.68 | 4.98 | 5.20 |
| 2 | 2.5%GGBS+2.5%RHA+5%M-sand (M1) | 4.34 | 4.98 | 5.04 | 4.96 | 5.22 | 5.62 |
| 3 | 5%GGBS+5%RHA+10%M-sand (M2) | 4.68 | 5.34 | 5.36 | 5.38 | 5.56 | 5.92 |
| 4 | 7.5%GGBS+7.5%RHA+15%M-sand (M3) | 4.92 | 5.26 | 5.30 | 5.26 | 5.42 | 5.74 |
| 5 | 10%GGBS+10%RHA+20%M-sand (M4) | 5.14 | 5.08 | 5.12 | 5.10 | 5.20 | 5.52 |

### Durability of concrete
### Acid attack and Alkaline attack

| Sl.No | Mix ID | Initial weight of cube after 28days curing in grams | Final weight of cubes after 56days curing in grams | % loss of weight due to acid attack | Compressive strength of cube after 28days curing | Compressive strength of cubes after 56days curing | % loss of compressive strengtl due to acid attack |
|---|---|---|---|---|---|---|---|
| 1 | 0%GGBS+0%RHA+0%M-sand (Mo) | 2340 | 2314 | 1.12 | 24.66 | 22.90 | 7.16 |
| 2 | 2.5%GGBS+2.5%RHA+5%M-sand (M1) | 2256 | 2220 | 1.62 | 25.26 | 23.23 | 8.04 |
| 3 | 5%GGBS+5%RHA+10%M-sand (M2) | 2198 | 2156 | 1.92 | 26.12 | 23.74 | 9.12 |
| 4 | 7.5%GGBS+7.5%RHA+15%M-sand (M3) | 2356 | 2299 | 2.42 | 25.88 | 23.22 | 10.26 |
| 5 | 10%GGBS+10%RHA+20%M-sand (M4) | 2404 | 2351 | 2.20 | 25.44 | 22.80 | 10.42 |

| Sl. no | Mix ID | Initial weight of cube after 28days curing in grams | Final weight of cubes after 56 days curing in grams | % loss of weight due to alkaline attack | Compressive strength of cube after 28days curing | Compressive strength of cubes after 56 days curing | % loss of compressive strength due to alkaline attack |
|---|---|---|---|---|---|---|---|
| 1 | 0%GGBS+0%RHA+0%M-sand (Mo) | 2444 | 2413 | 1.28 | 24.66 | 22.53 | 8.64 |
| 2 | 2.5%GGBS+2.5%RHA+5%M-sand (M1) | 2356 | 2320 | 1.50 | 25.26 | 22.87 | 9.46 |
| 3 | 5%GGBS+5%RHA+10%M-sand (M2) | 2198 | 2156 | 1.94 | 26.12 | 23.31 | 10.74 |
| 4 | 7.5%GGBS+7.5%RHA+15%M-sand (M3) | 2404 | 2350 | 2.26 | 25.88 | 22.92 | 11.42 |
| 5 | 10%GGBS+10%RHA+20%M-sand (M4) | 2384 | 2332 | 2.20 | 25.44 | 22.38 | 12.02 |

### Sulphate attack

| Sl. no | Mix ID | Compressive strength of cube after 28days curing | Compressive strength of cubes after 56 days curing | % loss of compressive strength |
|---|---|---|---|---|
| 1 | 0%GGBS+0%RHA+0%M-sand (Mo) | 24.66 | 19.44 | 21.16 |
| 2 | 2.5%GGBS+2.5%RHA+5%M-sand (M1) | 25.26 | 19.72 | 21.94 |
| 3 | 5%GGBS+5%RHA+10%M-sand (M2) | 26.12 | 20.30 | 22.26 |
| 4 | 7.5%GGBS+7.5%RHA+15%M-sand (M3) | 25.88 | 19.98 | 22.80 |
| 5 | 10%GGBS+10%RHA+20%M-sand (M4) | 25.44 | 19.50 | 23.30 |

### Acid attack

| Sl. no | Mix ID | Initial weight of cube after 28days curing in grams | Final weight of cubes after 56 days curing in grams | % loss of weight due to acid attack | Compressive strength of cube after 28days curing | Compressive strength of cubes after 56 days curing | % loss of compressive strength due to acid attack |
|---|---|---|---|---|---|---|---|
| 1 | 0%GGBS+0%RHA+0%M-sand (Mo) | 2234 | 2205 | 1.28 | 29.60 | 26.80 | 9.44 |
| 2 | 2.5%GGBS+2.5%RHA+5%M-sand (M1) | 2362 | 2323 | 1.68 | 30.34 | 27.22 | 10.28 |
| 3 | 5%GGBS+5%RHA+10%M-sand (M2) | 2420 | 2367 | 2.18 | 31.26 | 27.80 | 11.10 |
| 4 | 7.5%GGBS+7.5%RHA+15%M-sand (M3) | 2448 | 2381 | 2.74 | 31.02 | 27.15 | 12.46 |
| 5 | 10%GGBS+10%RHA+20%M-sand (M4) | 2362 | 2298 | 2.70 | 30.62 | 26.755 | 12.62 |

### Alkaline attack

| Sl. no | Mix ID | Initial weight of cube after 28days curing in grams | Final weight of cubes after 56 days curing in grams | % loss of weight due to alkaline attack | Compressive strength of cube after 56 days curing | Compressive strength of cubes after 56 days curing | % loss of compressive strength due to alkaline attack |
|---|---|---|---|---|---|---|---|
| 1 | 0%GGBS+0%RHA+0%M-sand (Mo) | 2298 | 2270 | 1.22 | 29.60 | 26.51 | 10.44 |
| 2 | 2.5%GGBS+2.5%RHA+5%M-sand (M1) | 2424 | 2391 | 1.38 | 30.34 | 27 | 10.98 |
| 3 | 5%GGBS+5%RHA+10%M-sand (M2) | 2280 | 2245 | 1.52 | 31.26 | 27.72 | 11.32 |
| 4 | 7.5%GGBS+7.5%RHA+15%M-sand (M3) | 2368 | 2328 | 1.68 | 31.02 | 27.33 | 11.88 |
| 5 | 10%GGBS+10%RHA+20%M-sand (M4) | 2410 | 2368 | 1.76 | 30.62 | 26.82 | 12.40 |

### Sulphate attack

| Sl. no | Mix ID | Compressive strength of cube after 28days curing | Compressive strength of cubes after 56 days curing | % loss of compressive strength |
|---|---|---|---|---|
| 1 | 0%GGBS+0%RHA+0%M-sand (Mo) | 29.60 | 24.03 | 18.82 |
| 2 | 2.5%GGBS+2.5%RHA+5%M-sand (M1) | 30.34 | 24.26 | 20.04 |
| 3 | 5%GGBS+5%RHA+10%M-sand (M2) | 31.26 | 24.43 | 21.84 |
| 4 | 7.5%GGBS+7.5%RHA+15%M-sand (M3) | 31.02 | 24 | 22.62 |
| 5 | 10%GGBS+10%RHA+20%M-sand (M4) | 30.62 | 23.33 | 23.80 |

## VI. CONCLUSIONS

From the above trial think about the accompanying ends were made

1. Geopolymer cement tend to demonstrate no noteworthy physical change in its properties at typical working room temperature which is seen in the event of ordinary assortment. The entire setting of Geopolymer solid examples will take upto 72 hours with no thinks back at first glance on which it is solidified.
2. The estimation of droop diminishes from 80mm to 30mm in M25 Grade concrete and 60mm to 25mm with increment in the level of GGBS+RHA+M-Sand from o%GGBS+0%RHA+0%M-Sand to 1o%GGBS+10%RHA+20%M-Sand
3. The estimation of compaction factor increments from 0.82 to 0.94 for M2 Grade concrete and 0.84 to 0.95 for M30 Grade concrete with increment in the rateGGBS+RHA+M-Sandfrom o%GGBS+0%RHA+0%M-Sand to 1o%GGBS+10%RHA+20%M-Sand.
4. The ideal esteem (greatest esteem) of compressive quality was seen at 5%GGBS+5%RHA+10%M-Sand for 7days, 14 days and 28 days.
5. The ideal esteem (most extreme esteem) of Split rigidity was seen at 5%GGBS+5%RHA+10% M-Sand for 7 days ,14 days,28days at rates 0f 13.44%,12.6%,11.92% for M25 review and 13.18%,12,29%,13.61% for M30 review of cement
6. The ideal esteem (most extreme esteem) of Flexural quality was seen at 5%GGBS+5%RHA+10%M-Sand for 7days, 14 days and 28 days at rates of 19.84%, 13.43%, 9.70% for M25 Grade and 13%, 10.43%, 12.16% for M30 Grade concrete The solidness of cement because of corrosive assault, alkalinine assault, sulfate assault increments with increment in the level of GGBS+RHA+M-Sand.
7. The GGBS can be utilized to deliver geo polymeric fastener stage which can tie the total frameworks comprising of fine and coarse total to shape geo polymer concrete. In this way these solid can be considered as eco-accommodating material Compressive, flexural and split rigidities are increments with the Higher the proportion of sodium silicate - to-sodium hydroxide proportion by mass.
8. Higher focus (regarding molar) of sodium hydroxide arrangement resultsin higher compressive quality of GGBS based geopolymer concrete Higher the proportion of sodium silicate-to-sodium hydroxide proportion by mass, higheris the compressive quality of fly cinder based geopolymer concrete

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