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Strength and Durability Study of Geopolymer Concrete by using GGBS, Rice Husk Ash

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***Abstract*— A study is underway regarding OPC-free cement; this is a recently introduced product that is not reliant on Portland cement clinker. The issue is how to make the people who are running the factor to be environmentally friendly constrain themselves. The alternative, which is mainly composed of fly ash, sodium silicate and either potassium or sodium hydroxide (NaOH or KOH), is called geopolymer. The future and perhaps a long time ahead scarcity of flyash might be the outcome of the California coal-generated power plants resining that are brought about by the cleaner energy production outlines. Consequently, the manufacturers of Portland cement and the consumers of river sand have generated more output, in an effort to satisfy the continuously rising cement demand that is being utilized in the construction sector. The river sand is getting scarce and costly because of the illegal mining of the river sand and CO2 emissions are increasing because of the bond production. The given document is mainly focused on the introduction of environmentally-friendly alternatives to bond and river sand.**

In addition, this study has a goal of finding out whether it is possible to incorporate additional pozzolanic ingredients into the geopolymer concrete. In order to achieve a set of objectives, the first was the experiment on the replacement of flyash by granulated impact heater slag (GGBS) and rice husk fiery debris (RHA) in the geopolymer concrete, secondly, river sand was substituted with M-sand. The M25 and M30 concrete mix design was designed based on the new regulations and the Indian standard code (IS 10262).

Solid blocks and tube-shaped samples of GGBS, RHA and M-sand were obtained by the change ratios of the three materials with one another and tested on their compressive strength and splitting tensile strength capability. The different mixture components in which GGBS and RHA are the main components are: 100%GGBS+0%RHA (M0), 95%GGBS+5%RHA (M1), 90%GGBS+10%RHA (M2), 85%GGBS+15%RHA (M3), and 80%GGBS+ 20%RHA (M4). The scientists could extensively experiment with the different properties of the battery of tests they applied to compressive, elastic, flexural and durability of the samples of geopolymer concrete by changing GGBS and RHA ratios.

***Index Terms*— Geopolymer, GGBS, Rice husk ash, compressive strength, durability and concrete.**

I. Introduction

Fly ash fiery remnants based geopolymer is the folio in this research; instead of Portland or any other water-driven bond glue, making concrete.

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Free coarse and fine aggregates as well as other unreacted components can be made into geopolymer concrete with or without admixtures with the assistance of fly ash as a binder [1].
Similar to ordinary Portland cement concrete, a large part of geopolymer concrete, approximately 75-80 per cent of mass, is aggregates. The aggregates and other non-reactive minerals are cemented together by a geopolymer glue that is prepared by dissolving silicon and aluminium in low calcium fly ash in a reacting mixture of sodium hydroxide and sodium silicate [2].Section A. The studies objectives.

A. Purposes of the study project.

- The molarity of a sodium hydroxide (NaOH) solution is varied and the material properties of geopolymer concrete based on GGBS prepared, tested, and investigated in this study [3].
- to construct anything using geopolymer concrete as opposed to old concrete.
- To create a blend proportioning method of manufacturing rice husk ash.

II. LITERATURE SURVEY

Jamdade P.K et.al (2014): The encouragement of the use of fly ash recycled out of coal as a material to substitute traditional concrete was one of the primary focuses. There is an experiment conducted by experts who tried to use geopolymer concrete to minimize stress and alleviate heat. This is because its compressive quality is greatly improved between a time span of 12 to 24 hours at 60 degrees celsius. Research evidence has shown that the most appropriate temperature to be used in polymerisation is 90 degrees Celsius. Geopolymer solid yields much better results in a much lesser period as compared to regular cement. The relieving temperature of the geopolymer concrete and compressive strength has also been increased.
Krishnan L et.al (2014): Led, who is an alternative to Portland bond, thinking that the geopolymer invention could be a good fit to the solids business. This study aimed at producing a cementious material that would not produce carbon dioxide. One of those materials that do not lead to such negative effects is geopolymer concrete. Specifically a very large quantity of carbon dioxide is released in the process of producing a conventional Portland cement.

III. MATERIALS AND PROPORTIONS USED

A. Coarse aggregates

A locally available size of rock stone, pulverised (10 mm in size) was used as a locally available size of coarse aggregate. The coarse fraction of the aggregate between 10 mm and 4.75 mm was used as the main experimental research [4]. The characteristics of the coarse aggregates were determined according to IS: 2386-1963.

B. Fine aggregates

The experiment was conducted using sand found at the local creek, the sand is 4.75 mm thick. The character of the fines in total was decided as per May be: 2386-1963.

C. RHA

In the world, 20 percent of the total 649.7 million metric tonnes of rice produced per year is transformed to a rural store known as rice husk. The air pollution is also contributed by the pollution of the partially consumed husk provided by the processing factories, when it is used as a fuel. There is the push to use the material as another solidifying agent so as to do away with the issue of pollution.

D. GGBS

Figure 1. GGBS

To begin with, the crude product is sprayed with water in order to cool the highly heated residue at a fast rate, which extinguished the flaming residues of the heater in liquid form. This operation satisfies the requirements of IS 12089:1987 (fabricating detail for granulated slag used in Portland Slag Cement) as per the standard by cutting and changing the slag to unshaped granules (glass). According to Rashida A. Jhumarwala [5], the slag is ground to the desired fineness in the form of granules to obtain [1]GGBS the sample of GGBS is illustrated in the next Figure 1.

E. Alkaline solution

The soluble arrangement was done using a mixture of sodium silicate and sodium hydroxide.

F. Sodium hydroxide

The most common soluble geopolymerizing activator is sodium hydroxide (NaOH) or potassium hydroxide (KOH) mixed with sodium silicate (Na2SiO3) or potassium silicate (K2SiO3) [6]. The kind and concentration of the Pozzolanic material greatly influence how it dissolves in the salt solution. This is white, powerful, highly caustic, soluble salt that is offered in a variety of forms such as pellets, drops, granules and ready-to-use solutions and is commonly kept in a variety of concentrations [7]. Figure 2 illustrates the process of preparing a sodium hydroxide solution by dissolving approximately half of the weight of water in it in water.

Figure 2. Preparation of NaOH solution

G. Silicate

Porous concrete and other mixtures of stones are mainly found in the various products which are most commonly produced using sodium silicate with the chemical formula of Na2(SIO2). In case of having more Ca(OH)2 (portlandite) in the material, then there will be a synthetic reaction hence permanently binding the silicates to the surface and therefore rendering it waterproof and maintaining its solidity [8].

H. Admixture

The sulphonated napthalene polymer is a good plasticiser in the form of Conplast SP430, a dark coloured fluid that can be readily dispersed in water, and which may be employed to render clean geopolymer concrete useful,

I. MIX DESIGN

For M30 Grade Concrete-1:0.77:2.4

IV. Experimental Investigations

Production of Fresh Concrete and Casting.

There are also Portland cement concrete processes which are rather old and which can be applied to the manufacturing of geopolymer cement. At the laboratory, the crushed fly fiery remains was again mixed with the totals and mixing of geopolymer concrete is illustrated in the below Figure 3. The sums were raised by means of submerged surface dry conditions [9]. A Strength of Geopolymer concrete.

Figure 3. Mixing of Geopolymer concrete

A. Curing of Geopolymer concrete

Surrounds are typically restored with low-calcium fly ash geopolymer concrete. The chemical reactivity of geopolymer binder is greatly enabled by environmental factors. It was reported that the compressive strength of geopolymer concrete is influenced by reducing the temperature and the recovery period. The time taken in the recovery period was twelve to twenty four hours [10]. Section B. How to cure test specimens.

B. Curing of Test Specimens

Following the throwing, geopolymer solid specimens were eased very rapidly. The two forms of curing that have been used in this investigation are that of restoring the grill and the ambient relieving. To revive the test samples to be used in the oven relieving, we put the samples in the oven, and to revive the samples to be used in the ambient relieving, we put the samples at room temperature. Broiler-relieved of the samples: The samples were put in the stove at 60 C and at 100 C during 24 hours [11]. To prevent a sudden shift of the environmental conditions, specimens that were stored in the moulds were left to rest at least six hours following the relieving time [1].C. Tests on concrete to be carried out.

C. Tests to be conducted on concrete

Below is a list of the numerous tests conducted on new as well as hardened concrete of grades M25 and M30.
Recent concrete evaluations
Cone test for slump
Compaction factor test.
Strong compression Longevity

V. RESULTS AND ANALYSIS

A. Concrete Workability

Cone of Slump Exercise

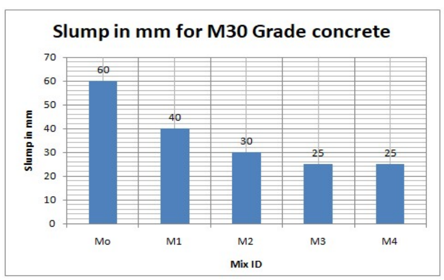

Figure 4 Comparison of slump cone values

Figure 4 above indicates the change in the values of slump cone test in M30 grade concrete. The slump value of M0 to M4 fix in M30 grade concrete becomes lower.

Compaction Factor Test

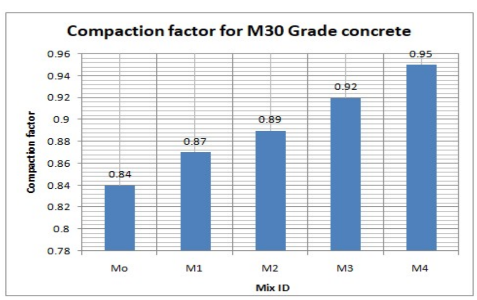

Figure 5. Comparison of comparison values

Figure 5. above illustrates the change in values of compaction factor test of M30 grade concrete. Compaction factor value rises between M0 to M4 fix in M30 grade concrete.

B. Compressive strength of concrete

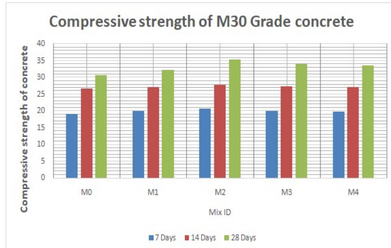

Figure 6 Compressive strength of compressive concrete

The Figure 6 above indicates the change in compressive strength of 7days, 14days and 28 days curing. M2 mix was found to have the best value of compressive strength.

C. Durability of concrete

Acid attack

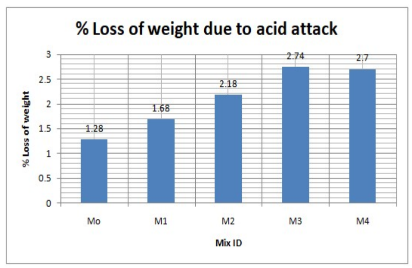

Figure 7 Percentage loss of weight due to acid attack

The table below (figure 7) depicts the percentage analysis of weight loss outcomes of the acid attack test on M30 grade concrete, which shows that the percentage of weight loss decreases as the mix changes to M0 to M4.

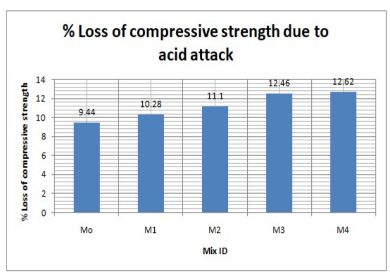

Figure 8 Percentage loss of compressive strength due to acid attack

Figure 8 shows the percent decrease in compressive strength as a result of the acid test attacks on the M30 grade concrete which is a measure of the percent loss in compressive strength as a result of the change in the mix values of M0 to M4.

Alkaline attack

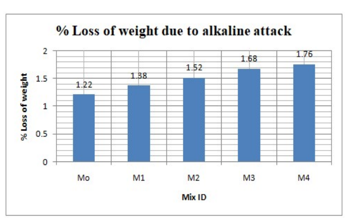

Figure 9 Percentage loss of weight due to alkaline attack

Figure 9 demonstrates the percentage weight loss caused by the alkaline attack test on M30 grade concrete, showing the percentage weight loss due to acid attack increases with the mixtures M0, M1, M2 and M3.

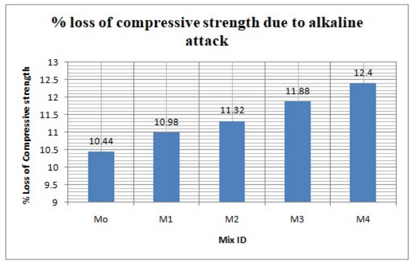

Figure 10 Percentage loss of strength due to alkaline attack

Figure 10 shows that the percentage loss of strength of M30 grade concrete, due to alkaline attack tests, exhibits an increase in percentage loss of strength due to acid attack within the mix range M0 to M4.

V. Conclusion

Considering the outcomes of the experiment stated above, please take into account the following points.
At room temperature, the physical characteristics of a geopolymer cement are generally virtually identical, whereas the properties of a conventional concrete could be different. It is also approximated that the entire setting of the solid samples of a geopolymer can take up to 72 hours without reopening (Shaik, 2016).
When the percentage of RHA rises to 20% in M25 Grade concrete, the slump value decreases by 80mm to 30mm, and again the percentage of RHA also increases to 20% RHA, the value of slump decreases by 25mm.
When the RHA content varies between 0-20, the compaction factor of M2 Grade concrete rises between 0.82 and 0.94 and that of M30 Grade concrete rises between 0.84 and 0.95.
M2 mix was the strongest at 7, 14 and 28 days compressive strength.
The maximum values of Split Rigidity of 7, 14 and 28 days were recorded as 13.44, 12.6 and 11.92 respectively in M25 and M30 cement tests.
The maximum flexural strength of M25 Grade concrete was 19.84, 13.43, and 9.70 after 7, 14, and 28 days, respectively, whereas that of M30 Grade concrete was 13, 10.43, and 12.16. The higher the percentage of GGBS and RHA, the greater is the resistance of the cement to corrosive, alkaline and sulphate attacks.
The GGBS can be converted to geopolymer concrete through the employment of a binding phase that is effective in connecting the structures of the fine and coarse particles. As a result, these compounds can be considered to be environmentally friendly. In addition, a higher mass ratio of sodium silicate to sodium hydroxide leads to a higher rigidity in compression, flexure and splitting.
A higher molarity of sodium hydroxide solution enhances compressive strength of geopolymer concrete made using GGBS. The compressive strength of fly ash based geopolymer concrete is improved by the mass ratio of sodium silicate and sodium hydroxide.

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