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# Role of Geopolymer Concrete with GGBS in Rigid Pavements

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***Abstract:*** ***In modern construction concrete is very expensive and popular material where cement is the main composite. Every year we are producing billion tons of concrete. Production of cement is responsible for too much of $CO_2$ production, in other words it is also responsible for global warming. Mostly India is facing the problem of pollution.***
***Researchers have done a great job and found many ways to replace cement. For making geopolymer concrete by products of different industries may be used like. Fly ash, rice husk. In this investigation geopolymer concrete is prepared with GGBS. GGBS is a by-product of steel industry. It holds the coarse and fine aggregates in the matrix.***
***In this investigation geopolymer concrete is prepared with GGBS and advantages and disadvantages are also investigated. It was an observation that it has good results over other concrete. GGBS is a good replacement of cement and it will help in reducing the production of CO2. as a result of this global warming can be reduced.***
***Keywords: GGBS, Slag, Aggregates, Slump, Geo Polymer***

## I. INTRODUCTION

GGBS is generally produced during the production of steel. Generally, limestone, iron ore, coke are put into a kiln for the production of iron. At a temperature of 1600oC slag is produced approximately 40% lime (CaO) & 30-40% SiO2 it is cementitious in nature. It hydrates like cement. It can also resist some chemical attacks. Molten iron is removed and slag contains residue have siliceous and aluminous properties. Now molten iron slag in water produces granulate slag. Rapid cooling is done to get granulated Slag.

We have lack of study for Geopolymer concrete with GGBS for Rigid pavements. All the literature which we found, tested the strength and behavior of concrete with fly ash, Glass, Red Mud, Foundry Sand. But the study with GGBS is Limited. All studies are done to check and find different parameters. Our study is to check the suitability of GPC with GGBS for rigid pavements. The following objectives are considered for the present study:

*1)* To study the engineering properties of GPC with GGBS.
*2)* To develop a mix without OPC.
*3)* To know the effect of GGBS based GPC on environment.
*4)* To know the suitability of GPC for Rigid Pavements.
*5)* To identify the technique for preparation of workable mix.

India is a developing country and it is very important to control the pollution and also to get the new construction material. India is leading in steel production and production of GGBS is in good quantity. An increase in use of GPC with GGBS will help in Reduction of OPC base concrete for various work and GOI is also making ALL WEATHER ROADS uses of this concrete for rigid pavement will help min saving resources of country and saving of environment. Our focus of study is to test the behavior and strength parameters for rigid pavements. This can be done in limited amount because the machines which are used for production of GPC with GGBS are same as in case of any other concrete.

## II. CONTENT

The material used for making Geopolymer concrete were GGBS as source material aggregates (CA+FA), Alkaline solution, Admixtures and potable water. GGBS (Ground Granulated Blast Furnace Slag) is a byproduct of steel industry and it includes all the constituents that an OPC has but the concentration is different. GGBS on GPC increases the strength of the concrete and it also makes the concrete curable at room temp. The aggregates are the most important constituent of the concrete and it provides good compressive strength to concrete. For our experiment work we used coarse and fine aggregates.

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Fig: Fine Aggregates

We have performed some tests on the samples prepared by following standard codes they are presented as in the table below

| S.No. | TEST PERFORMED | IS CODE FOLLWED |
|---|---|---|
| 1. | SLUMP | IS: 1199-1959 |
| 2. | COMPRESSIVE STRENGTH | IS: 516-1959 |
| 3. | FLEXURAL STRENGTH | IS: 516-1959 |
| 4. | SPLIT STRENGTH | IS: 5816-1999 |

It is one of the important materials for making geopolymer concrete. It generally makes the environment of high pH. It also helps to accelerate the reactions. There are many chemicals which are used as alkaline activator.
Generally, all the activators are used in a requirement ratio. Some of the alkaline activator solutions are NaOH, KOH, $NA_2SiO_3$, $K_2SiO_3$. We have these alkaline activator solutions but for our investigation we have used the Sodium Hydroxide and Sodium Silicate. In this investigation commercial grade is adopted 97%-99% pure. Generally, Sodium Hydroxide was available in the form of pellets, flakes. All these things are used to make the solution of required molarity. for example, solution with concentration 10M is considered as 10x40=400 grams of NaOH solids in the solution of 1 liter.

Sodium Silicate Properties

| S.No. | Characteristics | Actual Value | Specified Value |
|---|---|---|---|
| 1. | Color | Light gray | Clean |
| 2. | Water | 55.36% | 55-57% |
| 3. | Density | 51.76 | 51-54 |
| 4. | $SiO_2$ | 31.2% | 30-33 |
| 5. | $Na_2O$ | 14.23 | 13-15 |
| 6. | Total Solids | 44.56 | 44%min |

Geopolymer is a good construction material and also it may help us to reduce the pollution in environment. It is developed in recent period so we have lack of IS codes for its preparation. Some studies have been done before experimental investigation to know the character of the strength in the Geopolymer concrete. After getting satisfactory result we have precede our work.

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## III. SAMPLE PREPARATION

For primary study we are using hand mixing process. All the materials weighted and mixed carefully. After this AAS were mixed but it was not workable hence, to increase the work ability we adopted to add some more amount of water. When the mix was uniform, we filled the cubes carefully. Every care has been taken to fill the cubes such as cleaning, compaction and vibration. To avoid the voids problem vibration is done and sample was filled in the three layers. All the cubes were prepared at room temperature. After 24 hours of casting molds were opened. Application of water is done on samples. After that they were placed for 7 days open to sky in sunlight.

Fig Dry Material

Fig Mixing

Fig Mixing water

Fig Sample Filling

Fig Finish

## IV. PRELIMINARY STUDY RESULTS

After 7 days of curing all the samples were tested using CTM. As the lake of codes for this particular concrete we are taking codes of Ordinary Portland Cement concrete. And we found the compressive strength which is presented in the table below:

Compressive Strength of Trial Mix

| S.No. | MIX No. | SAMPLES | AVERAGE STRENGTH (MPa) |
|---|---|---|---|
| 1. | MIX 1 | 3 | 41.28 |
| 2. | MIX 2 | 3 | 49.93 |

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## V. CONCLUSION

This report presents a little bit understanding to the geopolymer concrete based on GGBS, higher the amount of the alkaline activator higher will be the strength. Generally, heat cured concrete gives more strength. As it is new concrete and it is new concept for use in structural concrete so new methods can be here to mix the concrete which must be adopted. Based on experimental observations, the following conclusions are drawn.

*A.* There was marginal improvement in the workability of concrete with the addition of GGBS in place of cement.
*B.* The compressive strength of Geo polymer concrete cube increases up to a molarity of 16.
*C.* GGBS shows a pozzolanic behaviour.
*D.* The increment in molarity resulting in higher compressive strength in the concrete mix.
*E.* Mixture becomes hard after 18 minutes so better to use it within 12-14 minutes.
*F.* We found strength maximum of 16M but some other molarity has also good results. As per the requirement we can use them.
*G.* If we talk about the strength, it generally gains strength in first week then increment in strength slowly and slowly takes place.

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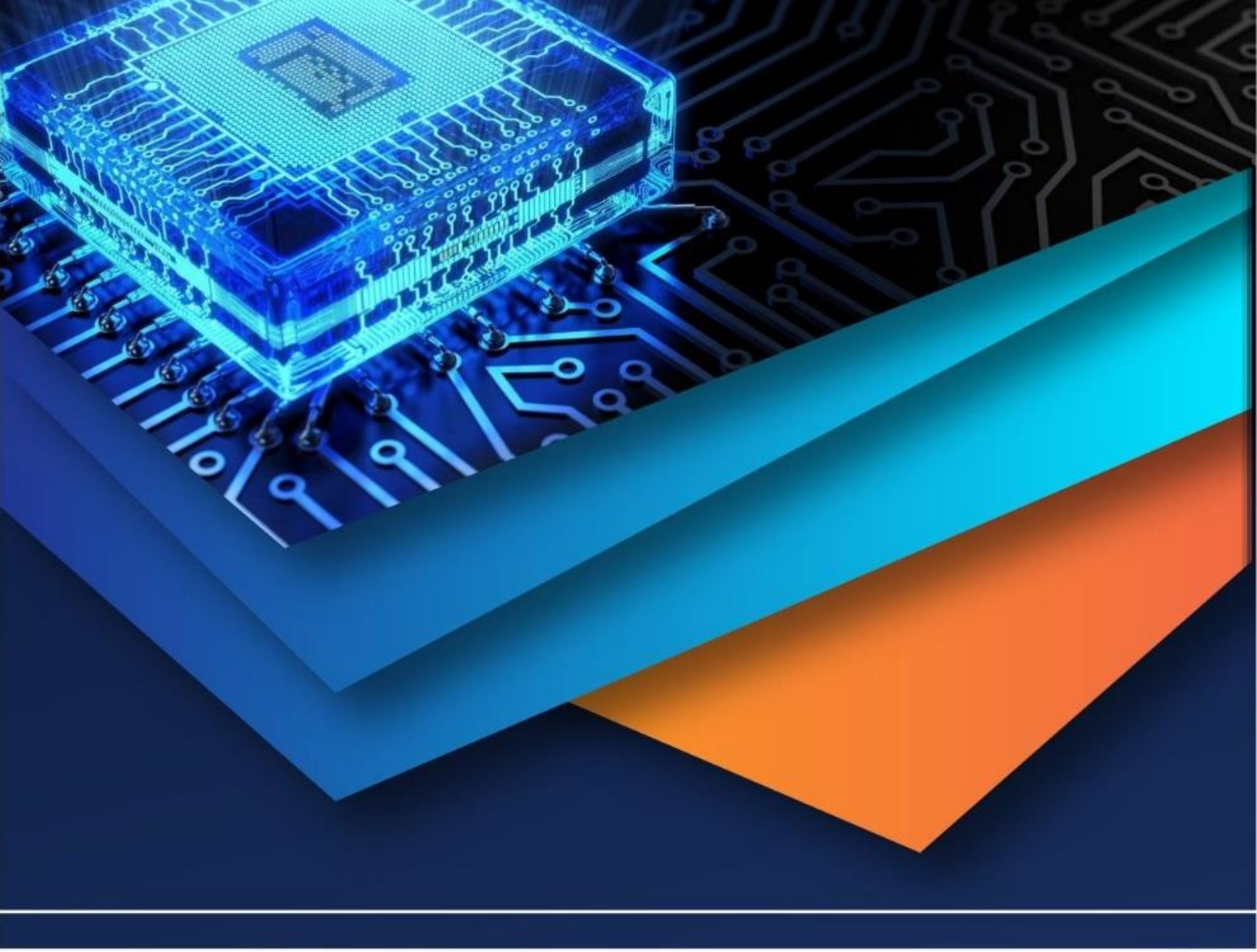

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