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# Removing the impurities chloride & alkalies from granulated blast furnace slag

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**ABSTRACT**

***The river sand and manufactured sand forms by the crushed rocks in millions of years. Nowadays, the reduction of river sand and manufactured sand is too fast in our environment because of our rapid construction world. So the GBFS (Granulated Blast Furnace Slag) is used at the place of river sand and manufactured sand but the presence of alkali and chloride in GBFS causes different problems like corrosion in reinforcement, react with external agents, high heat generated during the heat of hydration process and less durability. In this project, the foam separation method is adopted for removing the presence of alkali from GBFS (Granulated Blast Furnace Slag) and balance the pH value of crushed slag just like river sand and manufactured sand. The alkali and chloride remove from crushed slag in the form of bubbles and floats over the surface. The pH value balanced like river sand and manufactured sand. By using the foam separation method, 99% of alkali removed from GBFS (Granulated Blast Furnace Slag). The pH value of GBFS is balanced as equal to the river sand which is approx 7.00. The external effect of rainwater and chemical attacks are protected by removing the alkali from GBFS (Granulated Blast Furnace Slag). The total weight of construction also reduces because of the less value of bulk density of slag i.e. 1200kg/m³. After this method N-A-S-H OR C-A-S-H gel substituted by the C-S-H gel which is the same as well as river sand mix concrete. Also, protect our forest soil and area which places dumped by the Slag and its harmful to the soil nutrients and also for ecosystem.***

***Keywords***: *GBFS (Granulated Blast Furnace Slag), Sodium Lauryl Sulphate, Foam Separation Method, Balance pH Value of Crushed Slag, Protect Natural Sand.*

## 1. INTRODUCTION

The major task of the government and researchers is to use the industrial by-products that influence health and the environment by improper disposal. Preventing the depletion of natural resources and enhancing the usage of industrial by-products resolves so many environmental problems that have become a challenge to the scientists and engineers. For the protection of natural resources and environmental pollution many studies have been conducted which contributes to the economy by using industrial by-products. The two most important by-products of industries are Fly-ash and Slag. In India, the annual production of fly ash is approx 170 million tons out of which around 40% is only being utilized. As per Indian mineral yearbook 2018, blast furnace slag generation was around 200 to 550kg per tone which 15-35% is only being utilized. Hence there is a need to increament of the quantity of use of slag consumption.

There are Three types of slag are first one is air-cooled slag, second one is granulated slag and third one is expanded slag which is depending on the cooling process of slag.
Oxides commonly found in slags :-

- Ferrous Oxide (FeO)
- Ferric Oxide ($Fe_2O_3$)
- Silica ($SiO_2$)
- Alumina ($Al_2O_3$)
- Calcia (CaO)
- Magnesia (MgO)

## 2. OBJECTIVES OF MY PRESENT Work

The main objective of my present work is that remove the presence of Alkalies and Chlorides which causes distortion of building and also reduces the age of building due to reason of corrosion in reinforcement and formation of cracks.

- To find the percentage replacement of river sand and manufacture sand by Granulated Blast Furnace Slag.
- Control the effects of corrosion in reinforcement at the time of using GBFS as fine aggregate.
- Control the formation of cracks during curing process and gain strength as similar that concrete in which using river sand or manufacture sand.

## 3. MATERIALS AND METHODOLOGY

### 3.1 Materials

- Cement
- Crushed GBFS (Granulated Blast Furnace Slag)
- Coarse Aggregate
- Water
- Sodium Lauryl Sulphate

**3.1.1 Cement:** A powder formation substance made by lime and clay, mixed with water to form mortar or mixed with fine aggregate, coarse aggregate and water to make concrete.

**Fig. 1: Cement**

**3.1.2 Crushed GBFS (Granulated Blast Furnace Slag):** There are Three types of slag are first one is air-cooled slag, second one is granulated slag and third one is expanded slag which is depending on the cooling process of slag.
Oxides commonly found in slag:-

- Ferrous Oxide (FeO)
- Ferric Oxide ($Fe_2O_3$)
- Silica ($SiO_2$)
- Alumina ($Al_2O_3$)
- Calcia (CaO)
- Magnesia (MgO)

**Fig. 2: Crushed GBFS**

**3.1.3 Coarse Aggregate:** Coarse aggregates has particle size greater than 0.19 inch and retained by 4.25mm sieve but generally range between 3/7 to 1.5 inches in diameter. Coarse aggregate is using for making the concrete to be harder, stronger and has durable.

**Fig 3: Coarse Aggregate**

**3.1.4 Water:** Water is a natural resource. It is most important for making construction materials and for the process of Heat of Hydration.

**3.1.5 Sodium Lauryl Sulphate:** It is a white crystalline powder form. It is used for food wash, shampoo, shower gel, soap and other daily products. This is used as alkali removal chemical in my project work.


**Fig. 4: Sodium Lauryl Sulphate**

**3.2 Methodology**

**3.2.1 Foam Separation Method –** Foam separation involving sodium dodecyl sulphate could remove a series of alkali metal ions.

**3.2.1 Foam Separation Method:** The pH value of GBFS (Granulated Blast Furnace Slag) is approximate 10. In this method try to remove the Alkalies from the slag and get pH value same as river sand. The river sand has pH value is 7.00. This pH value of river sand is suitable for all type construction and protect from other chemical affects due to presence of Alkalies and others.

In this experiment using the GBFS (Granulated Blast Furnace Slag) is by product of steel plant when the iron ore was melting then the by-product slag was floats over the melted iron. The pH value of slag is 10.61. The bulk density of GBFS (Granulated Blast Furnace Slag) is 1200kg/m³ and the bulk density of river sand is 1680kg/m³.

**Table 1: Table of GBFS Properties**

| GBFS Properties | Value |
|---|---|
| Parameter | % by mass |
| Moisture | 11% maximum |
| Size | 353mm (Maximum)<br>3±1mm (Minimum) |

The temperature of the Slag is 1150-1200°c. The value of lower temperature because of the blast furnace slag does not produce the steel but it produces the by-product which floats over the melted iron ore. The Granulated Blast Furnace Slag is melts at 1150-1200°c and the melting point of iron is 1530°c.

**Table 2: Table of River Sand Properties**

| River Sand Properties | Value |
|---|---|
| Parameter | 9% depends on the casting method |
| Moisture | 12% Natural, 7% Average |
| Size | 0.0725mm to 2.25mm |

To calculate the weight of GBFS (Granulated Blast Furnace Slag) and River Sand needs to determine the volume of their and multiply the volume with their own bulk density.

For example;

The volume of sand and crushed slag is 1m³.

Weight of Sand;

= volume X bulk density of sand

= 1 X 1680

=1680kg/-

Weight of crushed Slag;

= volume X bulk density of slag

=1 X 1200

=1200kg/-

The difference between the weight of 1m³ volume River Sand and Crushed Slag is 480kg/-

- Remove the alkalies as per need of construction and protect by cause of chemical effects in future.

- C-A-S-H gel or N-A-S-H gel formation during the heat of hydration process cause of corrosion and more affected by chemical agents.
- The heat level during heat of hydration is about 70°c which causes cracking in the structure.
- This method is very easy to handle and make the slag construction is durable.
- This method can proof that 99% protect our river sand present in the nature.
- Also protect our forest soil and area which places dumped by the Slag and its harmful to the soil nutrients and also for ecosystem.
- It may have less effect to the industries but more effect our environment in many ways.
- It affects all type construction where it is used.
- Foaming method is more effective and economical.
- Easy to handle.
- After this method N-A-S-H OR C-A-S-H gel substituted by the C-S-H gel which is same as well as river sand mix concrete.
- The total weight of construction is also reduces because of the less value of bulk density of slag i.e. 1200kg/m³.
- The bulk density of Granulated Blast Furnace Slag is 1200kg/m³ less than the bulk density of River Sand which is 1680kg/m³.

**3.3 Requirement for Foaming Test**

**Chemical and Material Required**

- Sodium Dodecyl Sulphate or Sodium Louryl Sulphate
- Crushed GBFS (Granulated Blast Furnace Slag)
- Water
- Beaker Spatula
- Glass Rod
- Circuler measuring glass plate
- Tripod stand
- Sieve
- Flask
- Funnel
- Graduated Cylinder
- Dropper
- Crucible Tongs

**Apparatus Required**

- Mechanical Stirring Machine
- Digital pH Meter
- Thermometer

**Test Procedure**

- Check the pH value of Granulated Blast Furnace Slag before the experiment of foaming separation.


**Fig. 5: pH value of Crushed GBFS**

- After then start the experiment, First of take 10gm of Sodium dodecyl sulphate or Sodium lauryl sulphate powder in a beaker.


**Fig. 6: Sodium Lauryl Sulphate**

- Take 200 ml water in other beaker and filled it in the first beaker in which the Sodium louryl sulphate is already present.
- Stir it by the help of spatula.
- After then take 200gm of crushed GBFS(Granulated Blast Furnace Slag) and slowly filled in the diluted lauryl sulphate and stirring by mechanical stirring machine.

**Fig. 7: Adding GBFS to diluted acid**

- Stir it carefully and watch it continue.

**Fig. 8: Mechanical Stirring Machine**

- After some time the Alkalies removed from GBFS (Granulated Blast Furnace Slag) in the form of bubbles floats over the surface.

**Fig. 9: Alkali in the form of bubble**

- Check the pH value after 24 hours by the help of Digital pH meter.

**Fig. 10: Digital pH Machine**

- The digital pH meter has a digital display in which shows the pH value and the function set in pH.
- The Calebrate set in initial point of value after then the temperature set approximate 27±3°c as well as room temperature.
- The Meter tube attached with wire to the pH display machine.
- This Meter tube set under the beaker after 24 hours and take the reading of pH value of crushed Slag.

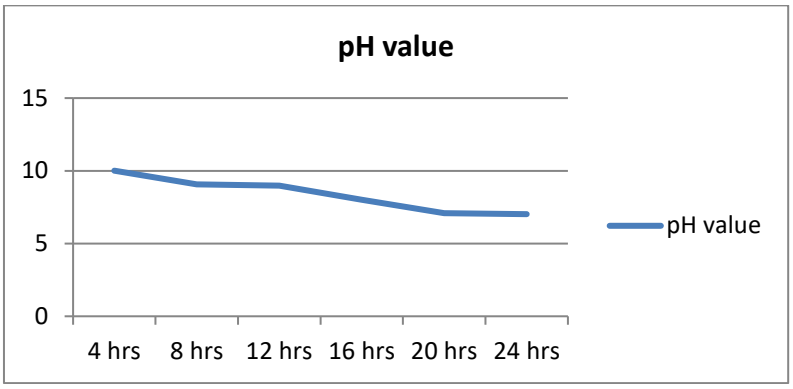
**Fig. 11: Final pH value of GBFS**

## 4. OBSERVATIONS AND RESULT

### 4.1 Observation Table of Foam Separation Test

**Table 3: Observation Table Of Foaming Test**

| Time | pH value |
|---|---|
| After 1 hours | 10.61 |
| After 4 hours | 10.01 |
| After 8 hours | 9.06 |
| After 12 hours | 8.99 |
| After 16 hours | 8.01 |
| After 20 hours | 7.09 |
| After 24 hours | 7.02 |




**Graph. 1: Line Chart on the basis of observation of Foam Separation Method**

### 4.2 Result

The pH value of GBFS (Granulated Blast Furnace Slag) is **7.02** .

## 5. CONCLUSION

- The pH value of GBFS (Granulated Blast Furnace Slag) is **7.02** after 24 hrs. By using foam separation test removing 99% of alkalies from GBFS.
- The excess using of river sand and manufactured sand are saved by using GBFS.
- The pH value of GBFS is balanced as equal to the river sand which is 7.00.
- The external effect of rain water and chemical attacks are protected by removing the alkalies from GBFS.
- The pH value of GBFS (Granulated Blast Furnace Slag) is **7.02** after 24 hours By using Foam Separation Method for removing the alkalies from GBFS and it is work at the place of RS & MS.

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