North Asian International Research Journal of Sciences, Engineering & I.T.

IRJIF. I.F. : 3.821

ISSN: 2454-7514 Vol. 8, Issue-7 July-2022

Index Copernicus Value: 52.88 Indian Citation Index Thomson Reuters ID: S-8304-2016

NAIRJC A Peer Reviewed Refereed Journal

DOI: 10.5949/NAIRJC_joe_00007.91

STUDY ON THE BEHAVIOUR OF SANDY SOIL USING GROUND GRANULATED BLAST SLAG

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ABSTRACT

Clayey soils are problematic due to the reactions of their minerals, which gives them an exbution of shrink-swell properties. The shrunk-swell property obtains clayey soil as inappropriate material for direct utilization in construction. In underdeveloped nations due to the remarkable development in road infrastructure, soil stabilization has become the most efficient solution in construction industries.To make these soils more workable for construction various methods (mechanical, chemical) and materials have been used. Cement , lime, flyash and ground Granulated blast furnace slag has usually used as stabilizer for developing the engineering properties of soil. The main focus of this review paper is on the utilization of GGBS by product and lime to enhance the geotechnical properties of the clayey soil. Experimental results of different tests like strength, microstructure and compaction of various stabilization and their percentages are evaluated and discussed. Lime and GGBS as local natural and industrial sources implied for chemical stabilization. However, the reduction of waste materials and it's usage in construction has become an area of potential and promise.

KEY WORD: ***GGBS, clayey soils, shrink swell properties , soil stabilization,***

1. INTRODUCTION

Due to differences in moisture content, soft soils involvement significant volume fluctuations. Property built on it suffers noteworthy damage as a result of this. Their volume grows as they absorb water. Although mechanical compaction, dewatering, and earth reinforcement have been found to enhance soil strength, other approaches, such as mixture stabilization, are more beneficial. Lime, cement, fly ash's, and other admixtures are available. Because of the rising cost of cement and environmental concerns associated with its manufacture, cement stabilization is no longer a viable option. Lime is likewise ineffective in sulphate-containing soils. Due to the growth of swelling minerals such as ettringite and Thomasite, the presence of sulphates can increase the swelling behaviour of soil.

I. MATERIAL AND METHOD

Materials used:
In this segment a concise conversation is done on the material utilized in this work.
Different tests performed on this material are likewise examined.

Soil

The Sandy Clayey soil is gotten from Lalru (INDIA). As per Bound together Soil Grouping framework, the dirt was delegated clayey sand with low pliancy (CL). The record and designing still up in the air and are displayed in Part 4.

Ground Granulated Impact Slag

Ground Granulated Impact Heater Slag (GGBS) was obtained from Prepared blend substantial plant of Aditya Birla bunch. The material might be delegated low compressible inorganic sediment (ML).The synthetic arrangement of a slag fluctuates significantly relying upon the piece of the unrefined substances in the in the iron creation process. The fundamental parts of impact heater slag are CaO, Sio2,Al2o3, and MgO. The physical and substance properties of GGBS are displayed in table 1 and 2

Properties	Values
Specific gravity	2.90
Bulk Density(kg/m3)	1220
Surface Area (m2/kg)	416
Insoluble residue (%)	0.14
Loss on ignition (%)	0.19
Moisture Content (%)	0.14

Table 1: Physical properties of GGBS

Composition	Percentage
Sio2	33.77
CaO	33.77
Al2o3	13.24
MgO	8.46
MnO	0.05
Fe2O3	0.65
Sulphide sulphur	2.23
Sulphite sulphur	0.23
Total chloride	0.01

Table 2: Chemical composition of GGBS in percentage

PROCEDURE METHODOLOGY

Atterberg's limit
Plastic limit
Liquid limit
Plasticity index Specific gravity test
Free swelling index
Sieve analysis
Compaction characteristics
Light compaction test
Maximum dry density
Optimum moisture content Strength characteristics.
Triaxial Shear Test
Unconfined compression test
California bearing ratio test

Atterberg Limits

The Atterberg's limits are basic amount of the acute water content of the fine-grained soil, like plastic breaking point and fluid cutoff. As a dry, clayey soil takes on increment measures of water, it attempts influence and unmistakable variety in conduct and consistency. Strong semi-strong plastic fluid

Plastic Limit

As far as possible is deciding plastic constraint of the dirt. As far as possible is characterized as the dampness content where the string falls to pieces at a distance across of 3 mm.PL is Process the normal of the water substance got from the three plastic breaking point tests. As far as possible (PL) is the normal of the three water substance.

Liquid Limit

As far as possible is decide in the lab as the dampness content at which the different sides of a furrow shaped in soil come simultaneously and contact a distance of 2 inch after 25 blows. it is exceptionally interesting to get this to happen esteem precisely, we will run the test more than once until the notch closes 1/2 inch with north of 25 blows. We can plot these outcomes as no of difficulty versus dampness content and introduce the dampness content at 25 blows from the chart.

Specific Gravity

The explanation of the test is to depict the particular gravity of soil passing the 4.75 mm strainer by thickness bottle technique. 50g of test of soil and impact heater slag is taken in every 3 jugs and added water then, at that point, weight of the water + bottle is taken. Then, at that point, every one of the 3 containers are exposed to sand shower, warming is done up to air bubbles are acknowledged in the jug. This is done to eliminate the captured air in the combination; the jug is saved for around 15min with the goal that the temperature comes to 27oC.

Sieve Analysis

This test is execution to control the extent of various grain sizes contain with in a red soil. Strainer examination is performing to decide the dispersion of the coarser, bigger estimated particles. Grain size review gives the grain size appropriation, and it is needed in ordering the dirt.

Proctor Compaction Test

Delegate compaction test is a lab procedure of test is to depict the ideal dampness content at which a given soil type will explicitly. To control the ideal water content at which soil have the option to get to its greatest dry thickness. The dirt is then found and packed in the Delegate compaction shape in three distinct layers where each layer gets 25 blows of the standard mallet. Before addition each layer, the outside of the layers is scratched to confirm a perpetual dispersion of the compaction. Toward the finish of the test, after take out and drying of the example, the dry thickness and water content of the example is decide for each Delegate compaction test. In view of the 3 of results, a chart is arranged between the dry thickness and dampness content. From this diagram, the ideal water content to accomplish the most extreme dry thickness can be found. The dampness content, and dry thickness family members be start by compaction tests according to IS: 2720 (Section VII) 1980. Soil is balanced out with variable level of Impact Heater Slag (0%, 6%, 12%, 18% and 24%) of its dry weight..

Test Procedure

Take roughly 10 lb. (4.5 kg) of air-dried soil in the blending dish, break every one of the irregularities with the goal that it passes (4.75mm sifter) and add approx volume of water to expand the dampness content by around 5%. Clean the shape fix it to the base and take the vacant mass of form append the collar to the shape and inside the form lubed completely. Place the main part of the dirt in the Delegate shape and minimized the layer applying 25 blows. Scratch the layer with a spatula shaping a lattice to guarantee consistency in conveyance of compaction energy to the succeeding layer. Place the subsequent layer, apply 25 blows, place the last piece and apply 25 blows. The last layer ought to guarantee that the compacted soil is simply over the trim of the compaction shape. Separate the collar cautiously without disturbing the compacted soil inside the shape and utilizing a straight edge trim the additional dirt evening out to the form. Decide the heaviness of the shape with the clammy soil, Expel the example and break it to assemble the example for water content assurance ideally from the center of the example. Rehash the interaction with builds water content by 2% until the wt. of shape is diminishes.

Asper IS: 2720 (Section 2) 1973 the dampness content of the compacted still up in the air. From the dry thickness and dampness content relationship, ideal dampness content (OMC), and greatest dry thickness still up in the air. Comparable compaction tests were shown withvarying. Level of Impact Heater Slag (0%, 6%, 12%, 18% and 24%)and the comparing ideal dampness content (OMC) and greatest dry thickness still up in the air. This was finished to concentrate on the impact of BFS content and compactive energy of OMC and MDD.

Triaxial Shear Test Preparation of Test Specimen:-

Remold test might be ready, the dirt which is passes from 4.75mm is blended at determined O.M.C at compacted into shape with three layers and a slender walled tube having a similar inside width is driven into the form. The example ought to be expelled from the cylinder pushing from the state of the art side. The finishes of the example are managed level and typical to its pivot the split shape ought to be gently oiled from inside. The example is then taken out cautiously from the split form so length and breadth are not impacted. The example is then on one of the end covers and the opposite end cap is put on the highest point of the example. The elastic layer is then positioned around the example above and underneath so that water isn't influence the example. The example is prepared to use for the computation of dial check and demonstrating as

Unconfined Compressive Strength Preparation Of Test Specimen:

Remold test might be prepared, the dirt which is passes from 4.75mm by packing the dirt at the needed water content in a shape, and afterward cut by the inspecting tube. The partitioned shape is oiled daintily from inside and the example is then pushed out of the cylinder into the split form and the example is reasonably taken out from the split form. A wire saw might be utilized to manage the closures corresponding to one another a machine or trimmer might be utilized to manage the example to round cross unit. The Examples of tallness 10 cm and measurement 5cm with a volume of 196.34 cubic cm are made.The test is prepared to use for the discover the boundary for unconfined compressive strength. Unconfined pressure trial of soil with impact heater slag rates of 0, 6, 12, 18, furthermore 24% are directed. Relieving time of 0, 3, 7, and 15 days are taken on. An aggregate of 60 UCS tests have been directed with impact heater slag.

II. RESULT

Properties of Soil

The various properties of soil are determined by the following tests

Liquid Limit (ASTM D 4318 – 05)

Plastic Limit (ASTM D 4318 – 10e)

Sieve Analysis (ASTM D 6913)

Specific Gravity (ASTM D 6473)

Standard Proctor Compaction Test (ASTM D 1557)

1. Liquid Limit

The liquid limit of soil sample is shown in Table 3

GGBS	1	2
0	44.06%	46.86%
6	39.10%	43.30%
12	38.12%	44.24%
18	37.08%	42.36%
24	39.02%	41.10%

Table 3: liquid limit of soil sample

2. Plastic Limit

Table 4.2: Plastic limit of soil sample is shown in Table 4

GGBS	1	2
0	33.32%	32.30%
6	32.42%	31.88%
12	29.20%	30.01%
18	27.30%	28.54%
24	23.61	27.95%

Table 4:Plastic limit of soil sample

3 Sieve Analysis

A sieve analysis is a exercise or procedure used assesses the particle size delivery of a granular material.

Table 5: Index properties of soil

Test	Parameters		Symbol	Description
Sieve Analysis	Sand		S	15.01%
	Silt & Clay		M&C	86.44%
Atterberg's Limits	Liquid limit		W_L	76%
	Plastic Limit		W_P	23.01%
	Shrinkage Limit		W_S	5.90%
		IP=WL-WP		53.01%
	Plasticity Index	A-line Equation*	I_P	40.12%
Classification of soil				CH

Free Swell Test			54.15%
UCC	UCS Value	q_u	0.67%
CBR	CBR Value		1.87%

4 Specific Gravity

Specific gravity is defined as the ration of the unit of soil solids unit of water. The specific gravity is wanted for various cunning purposes in soil mechanic e.g. tvoid ratio, density and unit weight.

Various amount of GGBS added tosoil and determine the effect on specific gravity of soil with 0 % to 25% by dry weight of soil.

Table 6:Specific gravity of soil sample

GGBS	Specific gravity
0	2.57
6	2.59
12	2.61
18	2.62
24	2.64

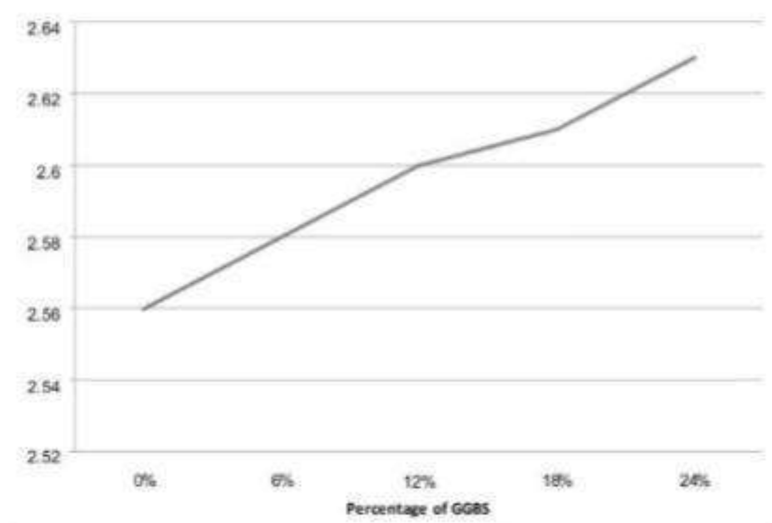

Figure 1.Effects of GGBS on specific gravity of soil

5 Standard Proctor Compaction Test

Compaction is the process of concretion of soil mass by reducing air voids under dynamic loading..

The physical properties of the soil used in this study before the addition of stabilizers are shown in Table 7From this, it can be said that the soil is clay of intermediate compressibility. GGBS (%)

5. Standard Proctor Test

Standard Delegate tests were utilized to start the dry thickness dampness content affiliation and completed the trial of soil with many measures of GGBS added consider the impact of GGBS on ideal dampness content and greatest dry thickness the trial of soil with 0 % to 24% by dry load of soil.

Table 7: Effect of GGBS on OMC and MDD

Blast furnace slag%	Moisture content%	Dry density g/cc
0	15	1.774
6	17	1.779
12	18	1.8
18	15	1.754
24	19	1.812

6. Tri Axial Shear Test

In a triaxial shear test, stress is exerted to an material being tried in a manner which brings about burdens along one hub being not the same as the anxieties in opposite bearings. This is regularly accomplished by setting the example between two equal platens which apply pressure in one (typically upward) course, and applying liquid strain to the example to apply pressure in the opposite bearings. The utilization of various compressive burdens in the test mechanical assembly causes shear pressure to create in the example the heaps can be expanded and diversions checked until disappointment of the example. During the test, the encompassing liquid is compressed, and the weight on the platens is expanded until the material in the chamber fizzles and structures sliding areas inside it, known as shear groups. Soil with different measures of GGBS added to decide the impact on shear boundary of soil with 0 % to 24% by dry load of soil. The consequences of tri hub shear test is displayed in table 8 and graphically addressed in figure 2

Table 8: EFFECT OF GGBS ON SHEAR PARAMETER OF SOIL

GGBS		**Cohesion (C) (kg/cm2)**	**Angle of shearing Resistance in degree**
0		1.45	17.46
6		1.37	18.63
12		1.30	19.43
18		1.20	20.23
24	1.00	21.98	

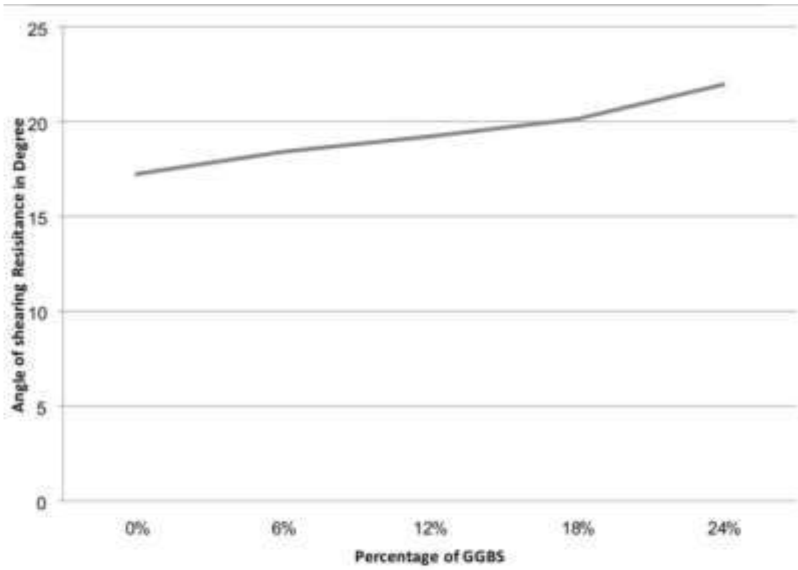

Figure2:Angle of shearing resistance (0% to 24%)

7. Unconfined Compression Test

The unconfined pressure test is by a wide margin the most well known strategy for soil shear testing since it is one of the quickest and least expensive techniques for estimating shear strength. The technique is utilized essentially for soaked, durable soils recuperated from dainty walled testing tubes. The unconfined pressure test is unseemly for dry sands or brittle dirts in light of the fact that the materials would self-destruct without some place where there is horizontal repression. The shearing strength is generally examined through pressure tests in which a hub load is applied to the example and expanded until disappointment happens. The unconfined compressive strength is the heap per unit region at which and unconfined barrel shaped example of soil will come up short in a basic pressure test. In the event that the unit hub pressure power per unit region has not arrived at a most extreme worth up to 20 percent pivotal strain. This test was directed according to of a strong soil falls in pressure and by plotting the pivotal anxiety in the chart, following unconfined qualities are registered according to support. The unconfined compressive strength of the dirt is displayed in table 9and graphically addressed in figure 3

Table 9: EFFECT OF GGBS ON COMPRESSIVE STRENGTH OF SOIL

GGBS	Unconfinedcompressive strength(kg/cm2)
0	1.94
6	1.984
12	2.42
18	2.62
24	2.54

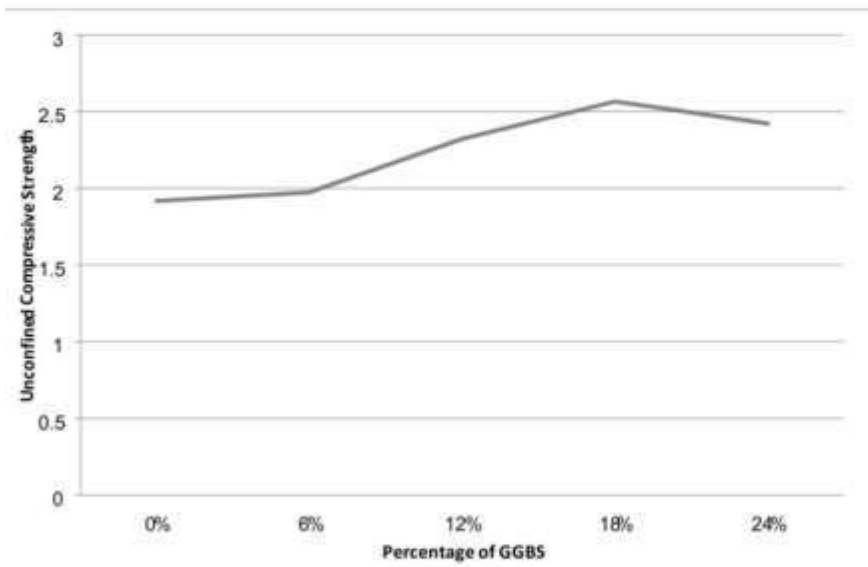

Fig 3:Unconfined compressive strength (0% to 24%)

8. California Bearing Ratio Test

Various amount of GGBS added tosoil to regulate the effect on California bearing ratio test of soil with 0 % to 25% Dry weightsd soil. The effect of GGBs on CBR value for both Unsoaked and soaked soil are shown in Table 10and 11The graphical representation of CBR values are shown in Figure 4and 5

Table 10: EFFECT OF GGBS ON C B R VALUE FOR UNSOAKED SOIL

GGBS	CBR in %at2. 5mm penetration	CBR in%at 5mm penetration
0	4.38	4.15
6	4.88	4.45
12	5.68	5.33
18	5.78	5.35
24	6.45	6.15

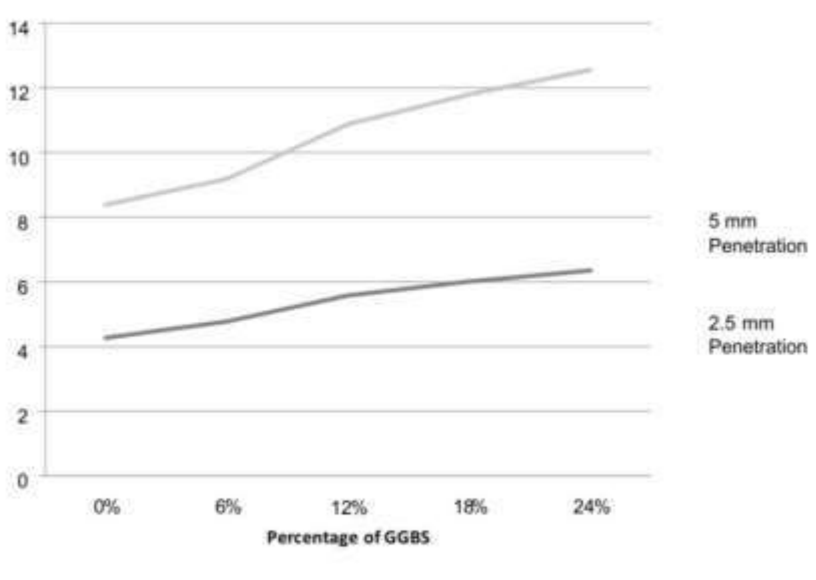

Fig 4:EFFECT OF GGBS ON C B R VALUE FOR UNSOAKED SOIL

Table 11: EFFECT OF GGBS ON C B R VALUE FOR SOAKED SOIL

GGBS	CBR in %at2. 5mm penetration	CBR in%at 5mm penetration
0	2.94	2.72
6	3.23	2.99
12	3.54	3.26
18	3.87	3.53
24	4.49	4.33

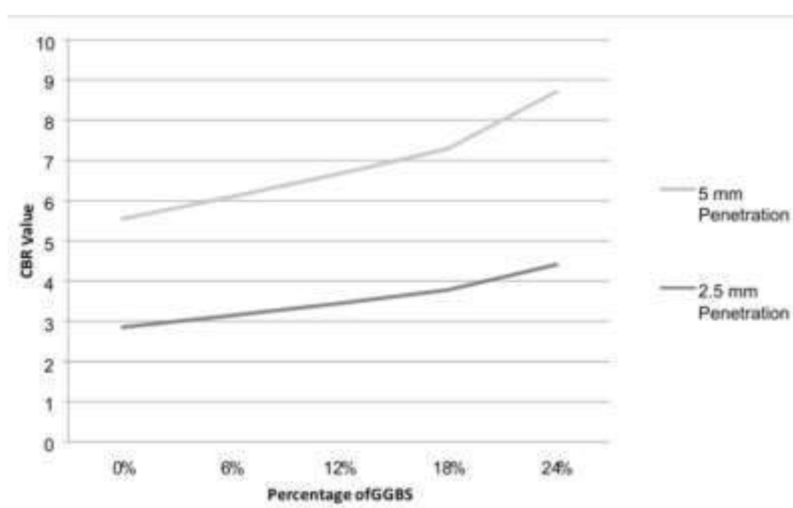

Fig 5: EFFECT OF GGBS ON CBR VALUE FOR SOAKED SOIL.

III. CONCLUSION

The study has been showed to assess the possible of GGBS for stabilization of the same nature of soil and exhaustive comparison has been presented based on various properties of soil. By analysis of outcome the following conclusions may be drawn:

1. The primary benefits of using these seasonings for soil stabilization are
    a. Cost Savings: because slag is classically cheaper than cement and lime; and
    b. Availability: because slag sources are easily available across the country from close steel plants.
2. Waste management one of the industrial wastes can be done economically.
3. Use of slag as an admixture for improving engineering properties of the soils is an economical solution to use the locally available poor soil.
4. It is observed that with increase of slag, more stability of soil is achieved as compared to using lime alone.
5. With the increases of GGBS percentage optimum moisture content goes on decreasing while maximum dry density goes on increasing, hence compatibility of soil increases and making the soil more dense and hard.
6. With percentage increases of GGBS specific gravity goes on increasing, thus making the soil denser.
7. With the increases of GGBS percentage, percentage finer goes on decreases, which strengthens the soil.
8. With the increases of GGBS proportion liquid limit, plastic limit and plasticity index decreases, which makes the soil less plastic and hence plasticity index reduces.
9. With the increases of GGBS percentage compressive strength increases that means arrangement of soil particles are very closely, which reduces the voids.
10. C B R value for sodden and unsoaked increases with increases in percentage of GGBS that show the densification of soil takes place and more suitable for pavement thickness.
11. Triaxial test result designates that with the increases of GGBS percentage cohesion (C) decreases while angle of internal friction (Ø)upsurges considerably, thus making the soil less cohesive and more resistant.
12. The unit weights of a particle of the stabilized clayey soils increase with increasing GGBFS in the clays of low and high plasticity.
13. With percentage increases of GGBS specific gravity goes on increasing, thus making the soil denser.
14. The GGBFS changes the compaction parameters. The addition of GGBS increases both the optimum water content and maximum dry unit weight.
15. The unsoaked and soaked CBR of GGBS mix is obtained 6.21 % and 4.28 % respectively.

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