



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Special Issue 3, May 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

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Stability Improvement of Black Cotton Soil Incorporating using Waste Glass Powder

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ABSTRACT: Stabilization is a process which helps to increase the strength of the soil. Not all soils require to be stabilized unless if any properties of soil make it unfit for use. Black cotton soil tends to have a poor engineering property. this is the reason why black cotton soils are not recommended for construction purposes. Various materials are available for stabilization. Amongst all of them in this paper 'recycled glass powder' is used for stabilization. So the effective percentage of addition glass of powder should be known and its reaction with the soil.

KEYWORDS: Stabilization, black cotton soil, glass powder, properties .

I.INTRODUCTION

One of the primary objectives of stabilization is to provide strength to the soil making fit for construction. Black cotton soil has properties that are unfit for construction and have high swelling and shrinkage. And BCS easily gets affected by the water table rise and fall. And the footprint of glass bottles is also very high as they do not get disintegrated into soil and also recycling of all the bottles are not possible. Soil stability refers to increasing the properties of the soil like the load bearing capacity, stability. Different types of stabilization are categorised into two, namely mechanical and chemical stabilization. In mechanical stabilization, the grading of a soil is changed by mixing it with other types of soils of different grades. By doing so, a compacted soil mass can be achieved. On the other hand, chemical stabilization is associated with the modification of soil properties by the addition of chemically active materials. In soil stabilization, it is very important to understand the material properties involved in the mixture and the outcome after mixing. Moreover, it is important to find out how the material is going to perform after stabilization.

At the same time the effects of the process on the nearby structures and surrounding conditions need to be evaluated. Accordingly, decisions can be taken on the selection of materials and the corresponding doses. In addition to the selection of materials and the doses there are many other factors governing the effectiveness of this method, e.g. mixing and spreading, selection of roller, compaction layer thickness, compaction effort, sequence of operation, curing, environmental and climatic conditions, etc. In this paper, it proposes efficient use of glass powder for stabilization and help the soil in increasing its physical properties. Glass powder provides pozzolanic action and also provides as a filler material. It fills the pores also helping soil to improve its water retention capacity.

II. MATERIAL

Black cotton soil -: soil sample used in this study was black cotton soil which was obtained from field of Nazare K.P in Jejuri, Maharashtra

Glass powder -: glass powder material used in this study was obtained from Rhythm media solutions located in Nallasopara, Mumbai. The size of the glass powder was of 0.8- 1.0 mm. The properties of glass powder were as follows- specific gravity of 2.5- 2.6.

Methodology -: the BCS used in testing was obtained from the fields of Nazare. Top surface of the soil was removed and the soil was excavated from a pit of size 1mX1m. the soil was obtained and tests were conducted on the soil to determine their properties. tests conducted were plastic limit, liquid limit, standard proctor test and unconfined compression test. After that test were conducted on BCS and WGP (waste glass powder). WGP was used in the soil by replacing of 6%, 8%, 10% and 12% by its weight.



Fig 2.1 Glass powder

III. METHODOLOGY

various tests were carried in this study which helped to determine the effect of glass powder on black cotton soil. The test which was carried out are, specific gravity test, Atterberg limits, standard proctor test and unconfined compression test. Based on this the maximum amount of soil and glass powder combination was determined which gave the highest percentage of increase in values.

3.1 Specific gravity

Specific gravity is a measure to describe the ratio of unit weight of material to the unit weight of the soil. First step in the test is to measure the empty weight of the pycnometer bottle with lid as W1. Then about 200 gm of soil is added to the bottle and weighed as W2. Then pycnometer bottle is filled up to its lid and weighed as W3. Then the pycnometer bottle is emptied and weighed as W4. Specific gravity is calculated as

$$\frac{W2-W1}{(W4-W1)-(W3-W2)}$$

Trail no.	1	2	3
Empty weight of the pycnometer bottle	638	490	492
weight of the pycnometer + soil sample	838	692	640
weight of the pycnometer + soil +water	1580	1144	1164
weight of the pycnometer bottle + water filled	1438	1036	1046
Average	2.70		

Table. Specific gravity of black cotton soil.

3.2 Plastic limit

This test is used to determine the plastic limit and plasticity index of soil. First step of the procedure is to weight 20 gm of soil. Soil is taken into the crucible and then water is added to it. Then soil should be mixed properly so the water and soil get mixed evenly. Then about 8 gm of soil is taken and is been kneed into thread. This is done by rolling the soil into thread and should break with a dia of 3mm. then the water content of the soil is calculated by keeping some soil into oven and take its dry weight. This procedure gives the plastic limit.

3.3 Liquid limit

In this test soil sample of 200 gm passing through 425 micron is taken and then water was added at varying percentages. Casagrande apparatus was used in this test. Soil was mixed properly to get an paste of soil. Then this soil was placed onto the apparatus and a grooving tool was used to make a deep cut. Then blows were given to the soil and the number of blows on which soil separated edges of the soil meets each other is noted. Some soil is placed in the oven to determine the moisture content of the soil. After that a graph is plotted of the number of blows to the water content and then water content is obtained for 25 number of blows. This water content achieved is called as the liquid limit of the soil.

3.4 Standard proctor test

This determines the maximum dry density and optimum moisture content for the soil sample with and without the stabilizing material. This test can be carried by two methods either standard proctor or modified proctor test. This test is very important as the next test the unconfined compression test depends upon this test. For this test sample of 2.5 kg is taken, this sample should not have any lumps. Then water is added to the sample in percentage of its weight. Unlike other test this test is carried until maximum dry density and optimum water content is not found. In this study water was added in percentages of 12, 16, 20, 24 in increments of 4%. Water and soil are mixed thoroughly. Weight of the empty mould is taken along with the base plate W1. Then a standard proctor mould is used in which soil is placed by compacting it in 3 layers. Then the weight of the mould and soil sample taken as W2. Then the soil sample is extracted and some sample is placed in oven for degerming the moisture content.

3.5 Unconfined compression test

This test can be conducted by two methods for undisturbed soil sample and disturbed soil sample. In this study undisturbed soil sample was used so undisturbed soil sample method was used. In this test the results of standard proctor test were used. Results used were the maximum dry density and optimum moisture content of the soil for best values of standard proctor test. By using optimum moisture content soil was mixed with properly. Then a mould of size 3.8 cm and length of 7.6 cm was prepared. Then sample was placed under the device and load is applied until the soil sample fails and the proving rings move in the opposite direction. From this test the axial compression on the sample can be tested.

IV. RESULTS

4.1 Plastic limit

plastic limit of the BCS was 39.83 % which reduced with the increasing percentages of glass powder. The lowest plastic limit was 24.95 for 12 % of glass powder.

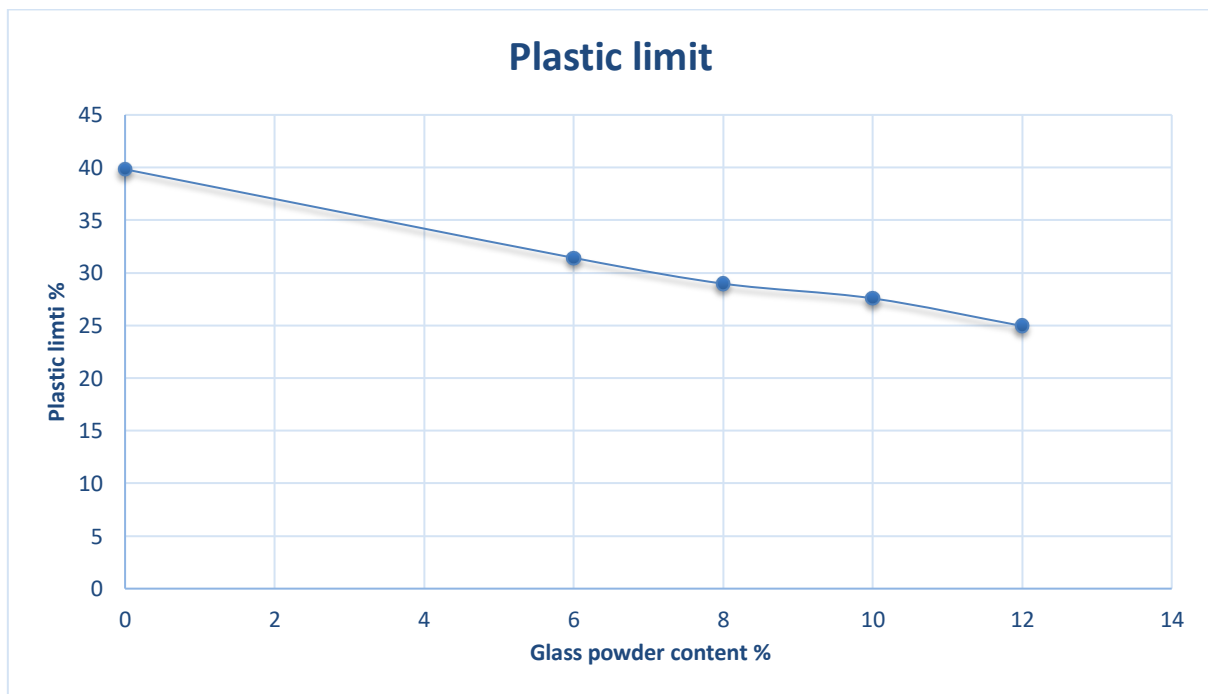


Fig no. 1 plastic limit

4.2 liquid limit

Liquid limit for the soil sample with 0% of glass powder was 57.04, and the least value was 55.035. but like plastic limit values did not reduce with increasing percentages of glass powder, 8% usage of glass powder showed least value where as by using 10 % of glass powder the value of liquid limit increased to 56.396 from 55.035.

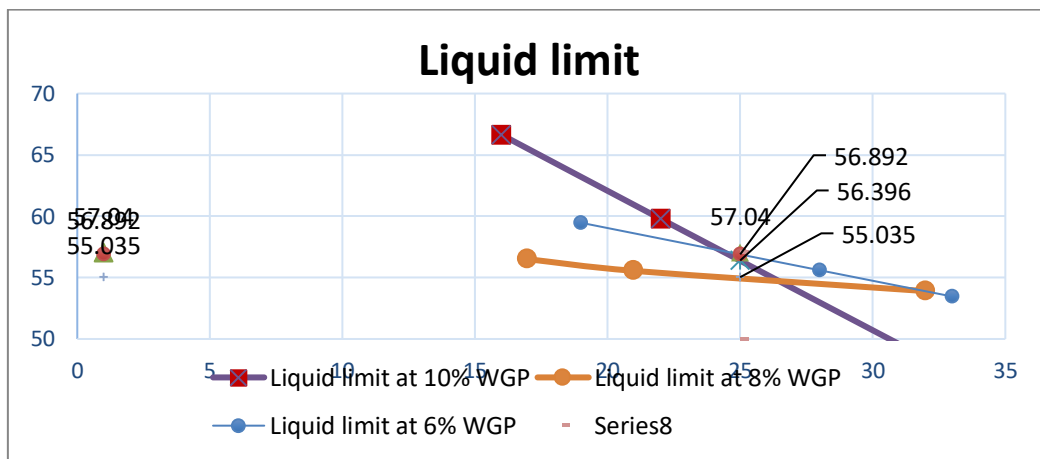


Fig no. 2. Liquid limit for BCS (57.04) and with WGP.

4.3 Standard proctor test

in this test the maximum dry density and optimum moisture content is been obtained. In this test the value of maximum dry density should increase while the optimum moisture content should decrease. But after a certain percentage of adding the stabilizer the value of maximum dry density and optimum moisture content should not increase, it may decrease or remain constant after a time. In this study WGP of 6, 8, 10, 12 % were used and didn't show the above-mentioned trend. So, there might be a chance that if WGP added above 12% might show a decrease in the values or it may also state that after 12% any further increase of WGP in the soil may not show any effect.

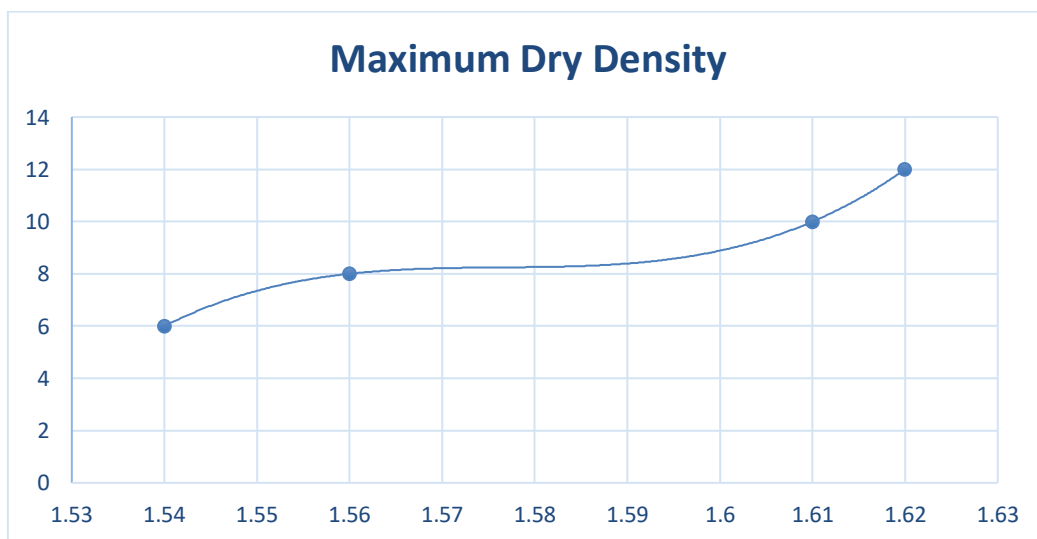


Fig no.3. maximum dry density for BCS and WGP

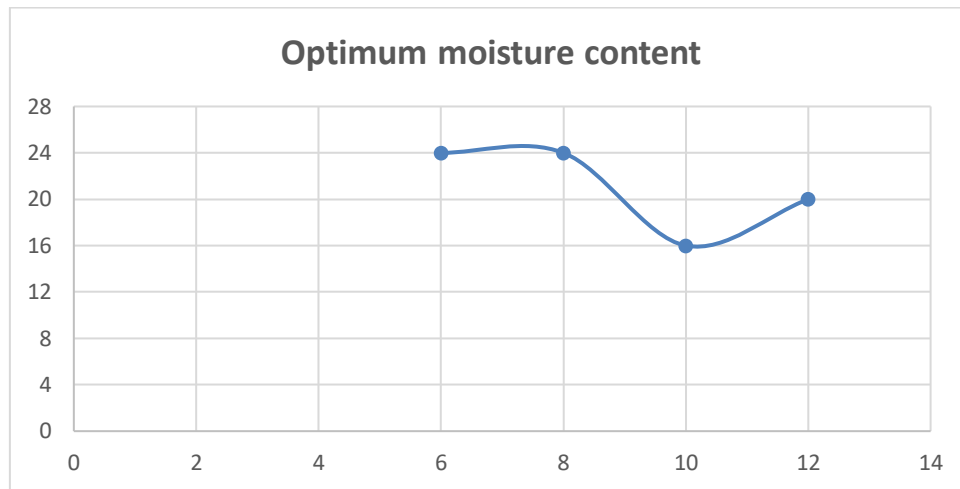


Fig no.4. Optimum moisture content for BCS and WGP

4. Unconfined compression test

this test is used to check the improvement in soil because of the increased resistance against the compression stresses. In this test WGP was added to the soil by 12% of its weight.

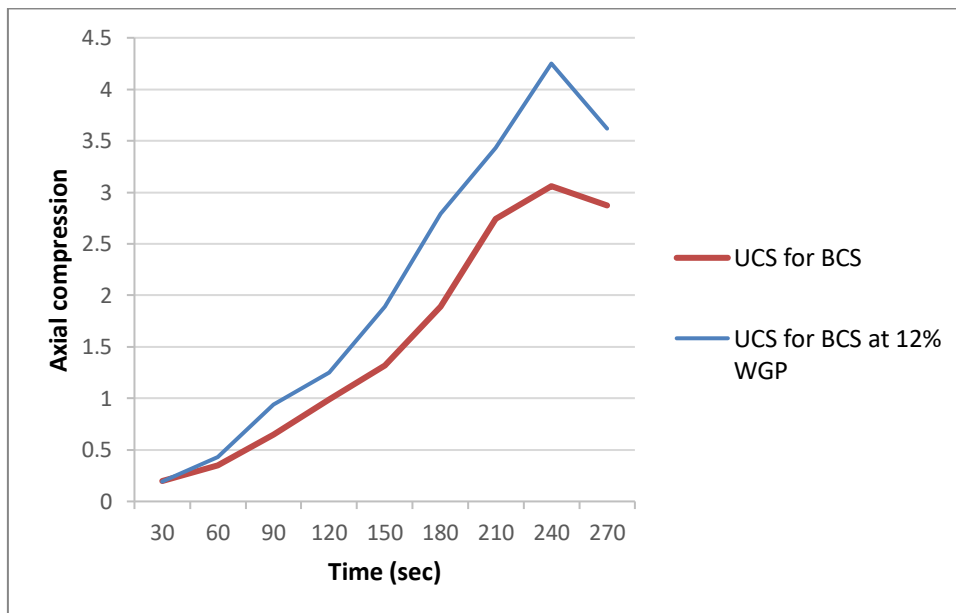


Fig no. 5. Unconfined compression test

V.CONCLUSION

From the study following conclusions made as follows- :

1. The plastic limit and the liquid limit for soil having 0% WGP were 39.83 and 57.12 respectively.
2. For plastic limit with the increase in the percentage of glass powder the plastic limit also reduced along with it.
3. But in case of liquid limit least value was observed at 8 % of glass powder which was 55.035.
4. In standard proctor test the value of maximum dry density should increase while the optimum moisture content should decrease. But after a certain percentage of adding the stabilizer the value of maximum dry density and optimum moisture content should not increase, it may decrease or remain constant after a time.
5. For UCS test soil with WGP of 12 % of its weight was taken. Initially the value of UCS was 3.06 N/mm² which changed to 4.25 N/mm², which is about 72 % increase in the axial compression strength of the soil.

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