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An Experimental Investigation of Expansive Soil Treated with Glass powder and Granite Dust

Mayank Soni[1], Prof. S. S. Parte[2]
[1]*M E Scholar, Department of Civil Engineering, JEC, Jabalpur*
[2]*Assistant Prof, Department of Civil Engineering, JEC, Jabalpur*

Abstract: ***In urban areas, borrow earth is not easily available which has to be hauled from a long distance. Quite often, large areas are covered with highly plastic and expansive soil, which is not suitable for such purpose. This study involves the collection of clay sample and evaluation of its properties in natural state and after stabilization with Granite dust and Glass powder. In the first set of experimental work the BC soil is mixed with Glass powder in different proportion i.e. 2%,4%,6%,8% and 10% and the optimum quantity of Glass powder is determined. The optimum quantity of Glass powder is found as 8% of the dry weight of clay. In the second set of experimental work the BC soil is stabilized by Glass powder and Granite dust in combination. Granite dust used 10-20 % of the dry weight of clay with Glass powder additives. From the experimental study it can be concluded that the stabilization of BC soil with Granite dust and Glass powder is more effective as compared to the stabilization with Glass powder only.***

Keywords: Granite dust, stabilization , Glass powder , BC soil, expansivesoil, plastic behavior.

I. INTRODUCTION

Expansive soils, well-known as Black Cotton Soils in India. A Large part of central India and a portion of South India are covered with Black cotton soils. Black Cotton Soils are residual deposits formed from basalt rocks. They contain significant amount of montmorillonite mineral. Black cotton soils are known for their potential volume changes in the presence of water. Most of the problems with structure constructed on expansive soils are associated with the alternate swelling and shrinkage. It swells and shrinks excessively with change of water content. The Shearing strength of the soils is extremely low. The Black cotton soils are highly compressible and have very low bearing capacity. The Such tendency of soil is due to the presence of fine clay particles which swell, when they come in contact with water, resulting in alternate swelling and shrinking of soil due to which differential settlement of structure takes place. The problems associated with expansive soils include heaving and cracking of structures such as foundation, retaining walls, pavements, canal beds and linings. The properties of black cotton soil can be modified by stabilizing the soil with the use of additives or by mechanical means. There are several materials such as cement lime and also some industrial waste products like fly ash which may be used as an additive for improving the properties of Black cotton soil. In this study stabilization of black cotton soil has been done by using Granite dust and Glass powderas an admixture.

II. OBJECTIVE OF THE STUDY

The main objective of the study is to investigate the change in Engineering and Index properties of Black cotton soil mixed with different percentage of Granite dust and Glass powder. Following are objective of the Study

A. To find out the effect of Granite dust and Glass powder on aAtterberg's limit when mixed with soil sample.
B. To determine the optimum quantity of Granite dust and Glass powder.

III. MATERIALS AND METHODOLOGY

A. General

In this chapter, details of materials like BC soil, Granite dust and Glass powder used in this study is represented and the various tests performed and their brief procedure is outlined in this chapter.

B. Black Cotton Soil

Black cotton soil sample used in this project was collected from the near Adhartal area, Jabalpur (MP). Latitude and Longitude of location are 23°09′37.5"N and 79°52′13.7"E respectively.

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C. Laboratory Tests

A series of laboratory test were conducted on Black cotton soil mixed with different proportion of Granite dust and Glass powder. Glass powder is added in 2%, 4%, 6%, 8% and 10% by weight of dry of soil and Granite dust is added in 10% and 20% by weight of dry soil. Various soil samples mixed with different percentage of Granite dust and Glass powder was prepared. Following test were conducted on prepared samples as per relevant IS code of Practice:

1) Specific Gravity Test
2) Wet sieve analysis
3) Liquid limit
4) Plastic Limit

D. Observation And Calculation

The experiment work has been carried out to analyze the improvement in geotechnical properties of expansive soil mixed with Granite dust and Glass powder at different proportion. Glass powder is added in 2%, 4%, 6%, 8% and 10% by weight of dry of soil and Granite dust is added in 10% and 20% by weight of dry soil. Various soil sample mixed with different percentage of Granite dust and Glass powder at was prepared. Geotechnical properties of Black cotton soil used are given in TABLE 4.1 and following test were conducted on prepared samples as per relevant IS code of Practice:

E. Mix Proportion

Following mix has been prepared with different percentage of Granite dust and Glass Powder.

1. Soil Sample + 0% Glass powder+ 10% Granite dust
2. Soil Sample + 2% Glass powder+ 10% Granite dust
3. Soil Sample + 4% Glass powder+ 10% Granite dust
4. Soil Sample + 6% Glass powder+ 10% Granite dust
5. Soil Sample + 8% Glass powder+ 10% Granite dust
6. Soil Sample + 10% Glass powder+ 10% Granite dust
7. Soil Sample + 0% Glass powder+ 20 % Granite dust
8. Soil Sample + 2% Glass powder+ 20 % Granite dust
9. Soil Sample + 4% Glass powder+ 20 % Granite dust
10. Soil Sample + 6% Glass powder+ 20 % Granite dust
11. Soil Sample + 8% Glass powder+ 20 % Granite dust
12. Soil Sample + 10 % Glass powder+ 20 % Granite dust

F. Specific Gravity Test

Test results are presented in TABLE 4.1.

TABLE 4.1 Specific Gravity of Virgin Black Cotton soil

Particular	I	II	III
Mass of empty pycnometer (gm)	654.45	654.45	654.45
Mass of pycnometer + soil (gm)	1054.45	1004.45	954.45
Mass of pycnometer + soil + water (gm)	1760.19	1731.53	1702.43
Mass of pycnometer + water (gm)	1527.02	1527.02	1527.02
Specific Gravity (G)	2.39	2.405	2.41
Average Specific Gravity (G)	2.4		

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G. Wet Sieve Analysis Of Normal Black Cotton Soil

Test results are shown in TABLE 4.2

Total weight of soil sample = 1000gm.

TABLE 4.2 Wet Sieve Analysis of Normal Black Cotton soil

Sieve Size	Particle Size	Mass retained on sieve	% Mass retained	Cumulative Mass retained %	% passing
(mm)	(mm)	(gm)	-	-	(100 - cumulative)
4.75	4.75	44	4.4	4.4	95.6
2	2	16	1.6	6	94
1	1	52	5.2	11.2	88.8
0.600	0.6	75	7.5	18.7	81.3
0.425	0.425	72	7.2	25.9	74.1
0.300	0.3	78	7.8	33.7	66.3
0.212	0.212	60	6.0	39.7	60.3
0.150	0.15	50	5	44.7	55.3
0.75	0.075	33	3.3	48	52

H. Plasticity Index

Test results of plasticity index for different types of soil sample are presented in TABLE 4.3 and 4.4.

TABLE 4.3Plasticity Index of Black Cotton Soil+ Various % of Glass Powder+ 10% Granite Dust

SAMPLE	Liquid Limit (%) (LL)	Plastic Limit (%) (PL)	Plasticity Index (%) PI = LL-PL
BCS + 0%	67.49	30.33	37.16
BCS + 2%	62.73	41.27	21.46
BCS + 4%	56.85	40.25	16.6
BCS + 6%	55.65	39.68	15.97
BCS + 8%	52.01	41.58	10.43
BCS + 10%	52.78	41.69	11.09

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TABLE 4.4Plasticity Index of Black Cotton Soil + Various % of Glass Powder+ 20 % Granite Dust

SAMPLE	Liquid Limit (%) (LL)	Plastic Limit (%) (PL)	Plasticity index (%) (PI)
BCS + 0%	67.49	30.33	37.16
BCS + 2%	59.09	39.19	19.9
BCS + 4%	56.25	40.22	16.17
BCS + 6%	54.93	37.18	17.75
BCS + 8%	52.95	38.41	14.54
BCS + 10%	51.84	37.94	13.73

IV. RESULTS AND DISCUSSION

A series of laboratory tests were conducted on black cotton soil mixed with different proportion of Glass Powder i.e.0%, 2%, 4%, 6% 8% and 10% and Granite Dust i.e.10% and 20% by dry weight of soil.

A. Liquid Limit

Figure 5.1and 5.2 shows the variation of liquid limit for different proportion of Glass Powder and Granite Dust.

1) Figure 5.1shows thatliquid limit of Black cotton soil decreases from 67.49% to 52.01% with increase in Glass Powder content up to 8% after that there is further increase in Glass Powder content there is no significant change in liquid limit.

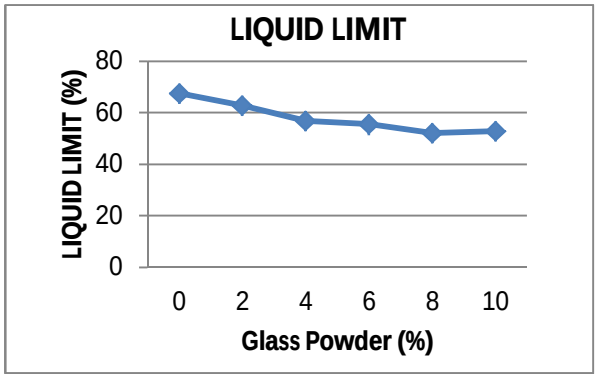


Figure 5.1 Variation of Liquid Limit with increasing % of Glass Powder

2) The variation of liquid limit of Glass Powder stabilized BC soil with % Granite Dust is shown in figure 5.2.The LL of Glass Powder stabilized soil decreases with the increase in Granite Dust content. For BC soil containing 2% Glass Powder the LL decreases from 67.49% to 56.25% with the addition of 20% Granite Dust in to it. For BC soil containing 4% Glass Powder the LL decreases from 67.49% to 52.95% with the addition of 20% Granite Dust in to it.

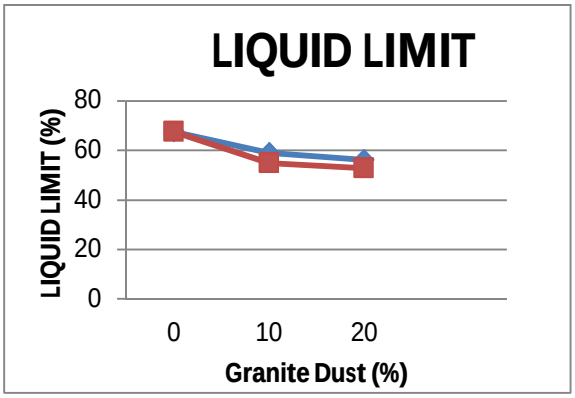


Figure 5.2 Variation of Liquid Limit with BCS-Glass Powder - Granite Dust mix

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B. Plasticity Index

1) Figure 5.3shows that plasticity index of Black cotton soil decreases from 37.16% to 10.43% with increase in Glass Powder content up to 8% after that slight change observed with increase in Glass Powder content.

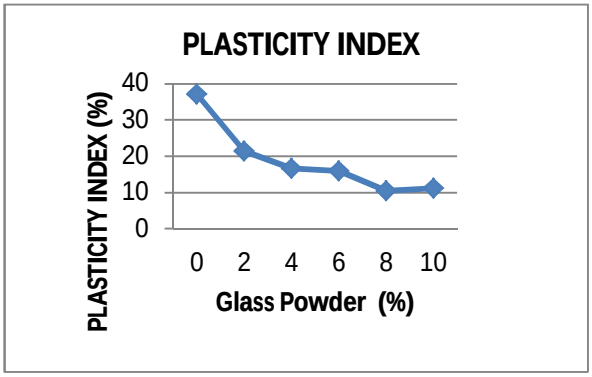


Figure 5.3 Variation of Liquid Limit with increasing % of Glass Powder

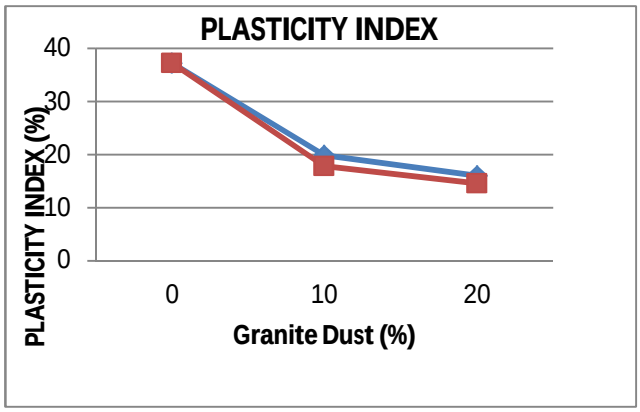


Figure 5.4 Variation of PI with BCS-Glass Powder - Granite Dust mix

2) Figure 5.4 shows that the variation of plasticity index of Glass Powder stabilized BC soil with % Granite Dust.The PI of Glass Powder stabilized soil decreases with the increase in Granite Dust content. For BC soil containing 2% Glass Powder the PI decreases from 37.16% to 16.03% with the addition of 20% Granite Dust in to it. For BC soil containing 4% Glass Powder the PI decreases from 37.16% to 14.54% with the addition of 20% Granite Dust in to it.

V. CONCLUSION

From the test results obtained from series of experiments conducted on BC soil mixed with different proportion of Glass Powder (2%, 4%, 6%, 8% and 10%) and different proportion of Glass Powder and Granite Dust in combination the following conclusion can be drawn.

A. BC soil mixed with Glass Powder only

1) Liquid limit of soil decreases from 67.49% to 52.53% with increase in Glass Powder content up to 8% after that there is no significant change with increase in Glass Powder content.
2) Plasticity index soil decreases from 37.16% to 10.43% with increase in Glass Powder content up to 8% after that slight change is observed with increase in Glass Powder content.

Therefore it can be concluded that the optimum quantity of Glass Powder found as 8% if the soil is stabilized with Glass Powder only.

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B. BC soil mixed with Glass Powder and Granite Dust

1) Liquid limit of soil decreases from 67.49% to 52.95% when 4% Glass Powder and 20% Granite Dust is mixed in to the soil sample.

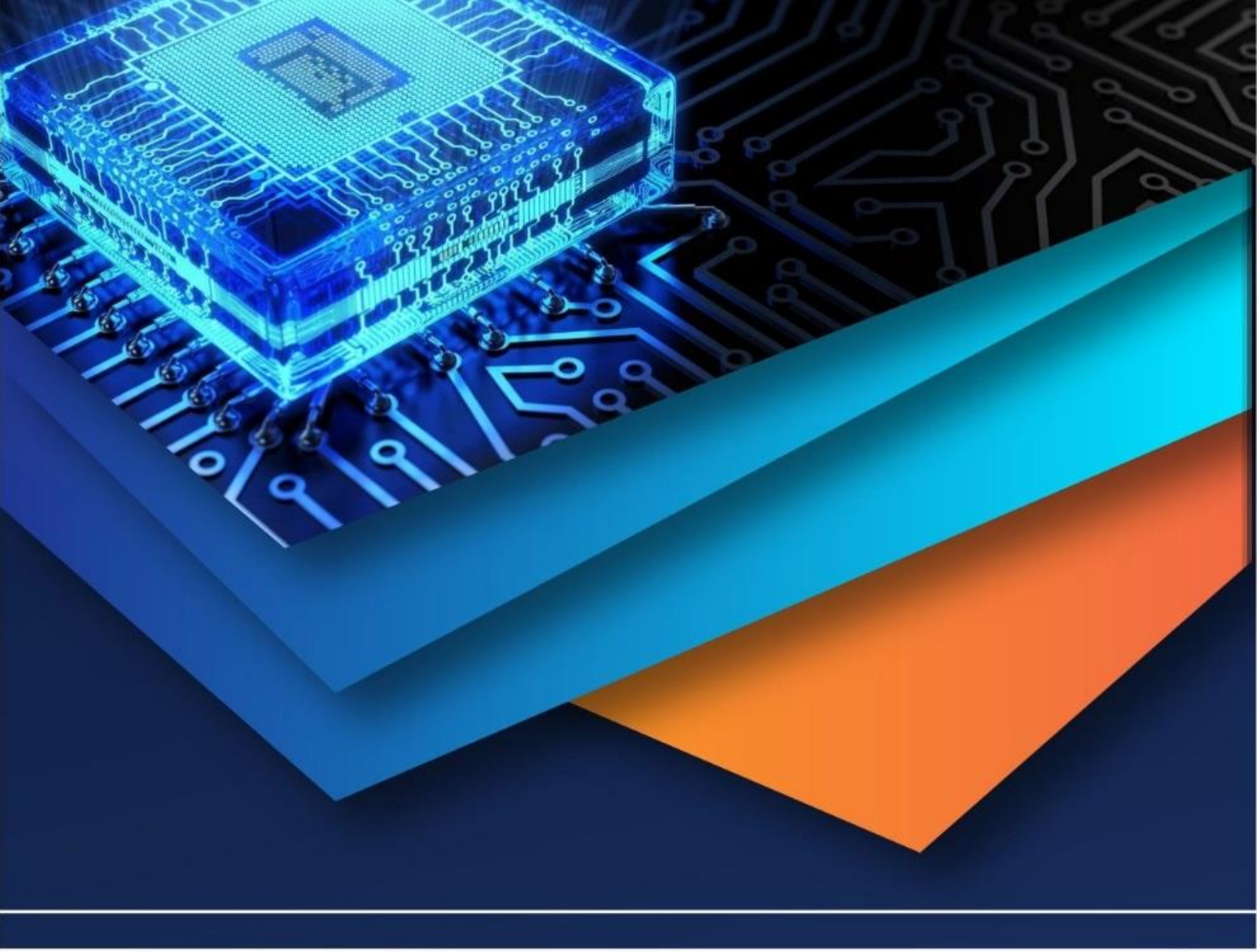
2) Plasticity index of soil decreases from 37.16% to 14.54% when 4% Glass Powder and 20% Granite Dust is mixed in to the soil sample.

Therefore it can be concluded that for the stabilization of BC soil the optimum quantity of Glass Powder and Granite Dust mixed soil sample was found as 4% and 10% respectively, by weight of dry soil. From the above test results it can be concluded that the stabilization of BC soil with Glass Powder and Granite Dustis more effective as compared to the stabilization with Glass Powder only. The quantity of Glass Powder consumed is approximately half in Glass Powder and Granite Dustcase as compared to that consumed in stabilization with Glass Powder only. Further the large quantity of Granite Dust causing disposal problem will also be utilized therefore this will be cost effective also.

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