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EFFECT ON COMPACTION AND CBR CHARACTERISTICS OF CLAYEY SOILS USING GLASS POWDER AS STABILIZING AGENT

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Abstract
In the present experimental investigation glass powder is used as a soil stabilizer in clayey soils. The different percentage of glass powder are added to the soil and the parameters like dry density, liquid limit, plastic limit, CBR are determined and compared with non-stabilized clay soil. The glass powder was used in varying percentages from 0-6%. On varying the percentages of glass powder by weight of soil the value of liquid limit and plastic limit increased from 21.54% to 22 % and from 7.1% to 15% respectively up to 5% glass powder and there after it started decreasing on further addition of glass powder. The values of maximum dry density where obtained as 1.82 g/cm^3, 1.84 g/cm^3 and 1.83 g/cm^3 at 4%, 5% and 6% glass powder by weight of soil respectively, hence maximum value of dry density was observed at 5% glass powder. The maximum value of Optimum moisture content (equal to14.83%) was observed at 6% glass powder and after upon further addition of glass powder, it decreased continuously. The California Bearing Ratio values were observed as 0.4149 and 0.309 at 4% and 6% glass powder by weight of soil respectively, the maximum value of California Bearing Ratio i.e. 0.575 was observed at 5% glass powder by weight of soil. Hence from the above experimental observations it can be predicted that soil stabilization occurs maximum at 5% glass powder, so 5% glass powder can be taken as optimum value.

Key Words: Soil Stabilization, Glass Powder, OMC, MDD, CBR.

I. INTRODUCTION

Soil stabilization is the process which involves enhancing the physical properties of the soil in order to improve its strength, durability etc. by blending or mixing with additives. The various methods of Soil Stabilization can be used to improve the ground conditions. The range of properties obtained by adding recycled glass powder offers a versatility to improve the marginal high plasticity materials for the design of fills properties that can optimize on multiple design parameters such as maximum strength, maximum density, and compressibility [1]. The percentage quantity of the powdered glass required achieving the best results in terms of the clay soil properties lies between 5% and 10% by mass of the soil. This is because the corresponding maximum values from both the compaction and CBR tests were obtained at 5% glass powder content while the maximum values from the shear strength test were obtained at 10% glass powder content [2]. The addition of waste glass resulted in the reduction of plasticity index, Optimum Moisture Content and increase in the Dry Density and CBR values [3]. Stabilization of soil using glass powder is a good and economical ground improvement technique especially in engineering projects on weak soil [4]. In the present experimental investigation the different percentage of glass powder is added and the parameters like dry density, liquid limit, plastic limit, CBR are determined and compared with non-stabilized clay soil as per IS specifications [5-12] . The optimum glass content needed to get maximum value of Liquid Limit, Plastic Limit, Maximum Dry Density, Optimum Moisture Content and California Bearing Ratio is determined. The test results revealed that the parameters like liquid limit, plastic limit, CBR increased while the optimum moisture content decreases and dry density increases up to the addition of 5% glass powder and there after decreases.

II. MATERIALS AND METHODOLOGY

The glass used for this study was obtained from the general glass panes used in windows. They were washed, dried and then broken down into powdered form and passed through sieve number 400 to produce the glass in minutest powdery form possible. The chemical composition of the glass material used is as follows: 76% of $Si0_2$, 11.50% of Al_20_3, 11.6% of Na_20 while other constituents accumulate to 0.9%. In terms of physical properties, it has a specific gravity of 2.5-2.9, tensile strength of 27- 62 MPa, softening point of 1500- 1750°C and hardness of 5 to7 [4]. the soil was collected from the outskirts of the University Campus, after removing the top soil and excavating to a depth of about 1 m, for both disturbed and undisturbed samples. Prototypes for soils were created in Geotechnical Engineering lab at college of Engineering and Technology BGSBU Rajouri J&K. The various preliminary tests for the index properties, Compaction characteristics, CBR characteristics were carried out as per IS: 2720 (1985) reaffirmed in 2006. The various properties of the soil are summarized in Table 1.

Table 1: Summary of various properties of soil.

Property	Soil (with 0% Glass Powder)
Site from where soil is taken	On outskirts of BGSB University Rajouri (33.397575, 74.346447)
Color of soil	Light brown
Depth at which sample was taken (in m)	1 to 1.5 m
Natural moisture content (w) in percentage	11
Specific gravity at room temperature	2.48
Uniformity Coefficient (C_u)	17.5
Co-efficient of curvature	3.21
Liquid limit in percentage	21.54
Plastic limit in percentage	7.1
Plasticity index	14.44
PIA = 0.73 (Liquid Limit – 20) in percentage	1.12
Soil type based on Plastic limit and PIA	Fine grained inorganic clay
Compression index	0.08
Liquidity index	0.720
Relative consistency	1.47
Maximum dry density (gm/cc)	1.93
Optimum moisture content in percentage	11
CBR Value at optimum moisture content (in %)	0.1549

II. RESULTS AND DISCUSSIONS

From the experimental investigation it was observed that the liquid limit increased from 21.54% to 22% and plastic limit increased from 7.1% to 15% on addition on addition of 5% glass powder by weight of soil which may be due to the fact that glass powder has higher water adsorption affinity. The value of maximum dry density decreased on the addition of glass powder as shown in figure 1. Similarly the value of optimum moisture content increased on the addition of glass powder (up to 4% glass powder) and there after it decreased on further addition of glass powder as shown in figure 2. This decrease in dry density and optimum moisture content on further addition of glass may be due to the low specific gravity of glass. The variation in California Bearing Ratio with percentage in glass is shown in figure 3. From the figure it is clear that the maximum value of California Bearing Ratio value increased continuously up to 5% glass powder by weight of soil and there after it started decreasing on further addition of glass powder. This may be attributed to the increase in the contact area and adhesion between soils by glass powder which will create a dense network of interconnected particles. Hence from the above results it can be predicted that soil stabilization occurs maximum at 5% glass powder. The Summary of comparative properties of only soil (with 0% Glass Powder) and Soil (with 5% Glass Powder) as observed during the experimental investigation is shown in table 2.

Table 2. Comparative properties of pure soil and Soil (with 5% Glass Powder)

Property	Only Soil	Soil (with 5% Glass Powder)
Plastic Limit	7.1%	15%
Liquid Limit	21.54%	22%
Maximum Dry Density	1.93 g/cc	1.84 g/cc
Optimum Moisture Content	11%	13.70%
California Bearing Ratio Test	0.1549%	0.575%

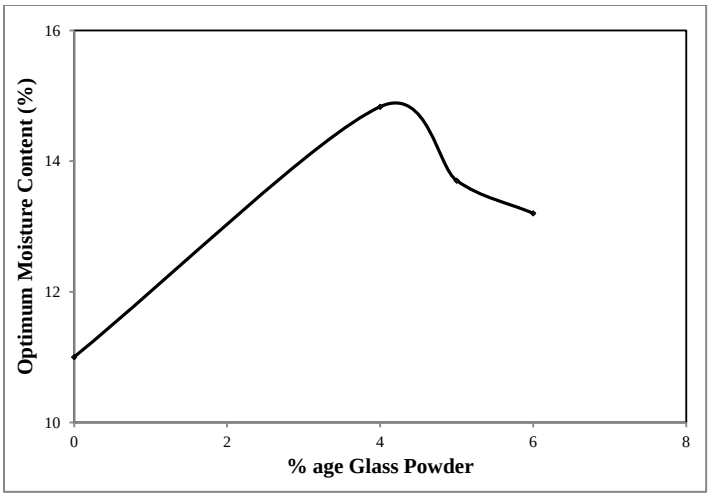


Fig. 1. Variation of optimum moisture content with glass powder

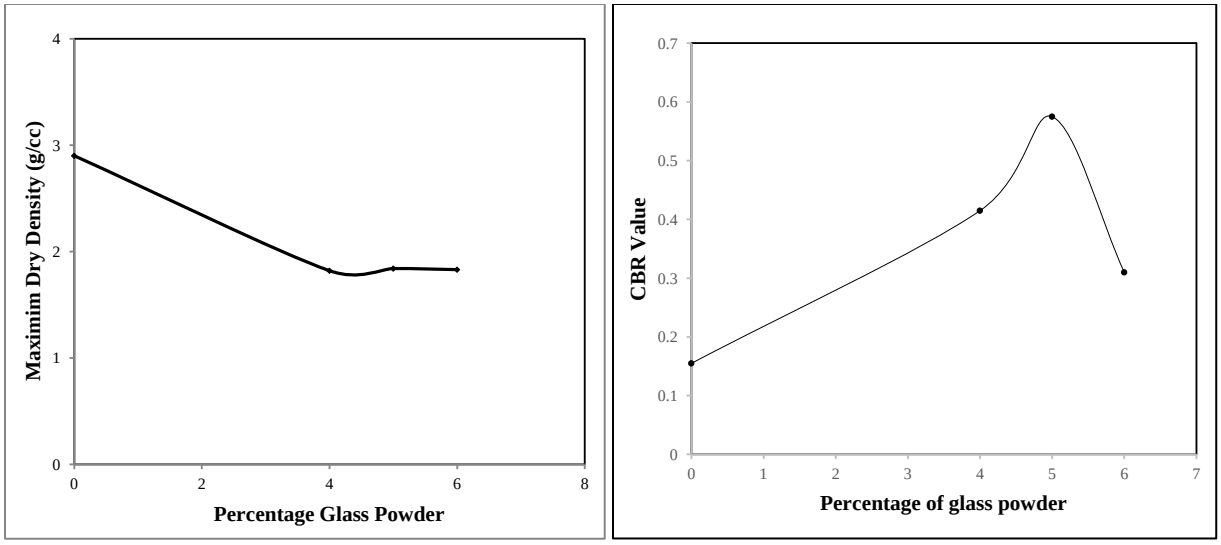


Figure 2. Variation of maximum dry density with glass powder. Figure 2. Variation of CBR Value with glass powder

IV. CONCLUSION

From the experimental investigations it was observed that the addition of Powdered Glass improved the properties of the soil. From the experimental observations it can be concluded that:

1. The liquid limit of the clayey soil has been increased from 21.54% to 22% on the addition of 5% powdered glass content.
2. The plastic limit of the clayey soil has been increased from 7.1% to 15% on addition of 5% powdered glass content.
3. From the plasticity chart, it is found that soil has been classified as fine grained clay lies above A-line.
4. It is observed that the maximum dry density decreased from 1.93g/cc to 1.82g/cc, 1.84g/cc and 1.83g/cc on addition of 4%, 5% and 6% powdered glass content respectively.
5. It is observed that the CBR value increased from 0.1549% to 0.4149%, 0.575% and 0.3098% on addition of 4%, 5% and 6% powdered glass content.

Thus in short it can be concluded that powdered glass is a satisfactory stabilizing agent for clay soils. The present work can be extended considering various proportions of powdered glass and other admixtures. Field tests can be carried out to get more practical results. The effect of the powdered glass on other kinds of soils should also be investigated to determine whether similar results will be obtained which will help to establish it as an all-round or general soil stabilizer.

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