

A Comparative Study on the Effect of Glass Powder and Groundnut Shell Ash on Clayey Soil

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Abstract—Soil stabilization is done in order to enhance the engineering properties of the soil. The clay soil exhibits generally undesirable engineering property, such as low shear strength, plastic and compressible, expand when wetted and shrink when dried. Its properties can be improved using suitable stabilization techniques. The strength characteristics of the soil can be improved by different additives. The additives added should be environmental friendly, cheap and effective. The additives used in this study are waste products such as, municipal solid waste glass in powdered form and organic waste groundnut shell ash. This paper compares the property of soil stabilized using glass powder and groundnut shell ash. Various tests such as specific gravity, atterberg limit, particle size distribution were conducted to find the properties of the soil sample. Thereafter, compaction, unconfined compressive strength (UCC), California bearing ratio (CBR) tests was carried out on the soil with various percentages of additives.

Keywords— Soil stabilization; Glass powder; Groundnut shell ash; UCC; MDD; CBR;

I. INTRODUCTION

For construction of any structure the foundation soil plays an important role. There are different methods used to improve the bearing capacity and reduce the settlement of soils which are not suitable for construction purpose. Soil stabilization helps to improve the soil characteristics and economy of construction on it. Now a days the cost of waste disposal and cost of soil stabilizers are very high, based on this many researches are going on for the utilization of waste products for soil stabilization purpose. In this paper we use municipal solid waste glass in powdered form and organic waste groundnut shell ash as additives along with clay soil. Various laboratory tests were conducted on the soil sample with varying percentages of additives. Thus, this study is aimed at evaluating the possibility of utilizing groundnut shell ash and powdered glass in the stabilization of clay soil.

A. Objective of the study

- To use municipal solid waste glass and agricultural waste groundnut shell ash as a stabilizing material and to solve the problem of waste disposal.
- To study the properties of cohesive soil by conducting test like Proctor Compaction test, Atterberg Limits, UCS, CBR.
- To investigate the effect of glass powder and groundnut shell ash inclusion on properties of clayey soil.

- To determine optimum amount of the glass powder and groundnut shell ash required for adequate stabilization of the clayey soil.

II. MATERIALS AND METHODS

A. Materials

1) Soil:

The soil was collected from kuttanadu in Alapuzha district, Kerala. The geotechnical properties of soil such as specific gravity, soil classification, atterberg limits, compaction characteristics etc were tested as per Indian Standard Specification "Table. 1," shows the properties of soil.

Table.1: Properties of Soil

Properties	Soil
Specific Gravity	2.12
Liquid limit, W_L	75%
Plastic limit, W_P	36%
Plasticity index, I_P	39%
Percentage of clay	52%
Percentage of silt	48%
Maximum dry density	1.37 gm/cc
Optimum moisture content	25%
Unconfined compressive strength, q_u	0.29 kg/cm ²
California bearing ratio	2.77%

2) Glass powder:

Glass is an inert amorphous non crystalline material which is typically brittle and optically transparent. Locally available waste glass has been collected and it is made into powdered form. Before adding the glass powder in the soil it has to be powdered to required size. In this study glass powder of particle size less than 90 micron was used. This material contains silica which is indication of cementing properties, which can develop good bonding between soil grains in case of weak soil. "Table.2," shows the physical properties of glass powder. "Table.3," shows the chemical composition of glass powder. "Fig. 1," shows the sample of glass powder.

Table.2: physical properties of glass powder

Physical property	
Specific gravity	2.6
Colour	White
Particle size	< 90µ



Fig.1: Glass powder

Table.3: Chemical Composition of glass powder

Chemical Composition	% by Weight
SiO ₂	67.33
Al ₂ O ₃	2.61
Fe ₂ O ₃	1.43
TiO ₂	0.16
CaO	12.45
MgO	2.74
Na ₂ O	12.06
K ₂ O	0.64

3) *Groundnut shell ash:*

Groundnut shell ash is produced by burning groundnut shell to ash; and groundnut shell is produced by milling of groundnut. Groundnut, or peanut, is commonly called the poor man's nut. Today it is an important oil seed and food crop. This plant is native to South America and has never been found uncultivated. It is generally distributed in the tropical, sub-tropical and warm temperate zones. Groundnut shell is an agricultural waste obtained from milling of groundnut. Meanwhile, the ash from groundnut shell has been categorized under pozzolana, the utilization of this pozzolana as replacement for traditional stabilizers will go a long way in actualizing the dreams of most developing countries of utilization for cheap and readily available construction materials. Groundnut shell ash has been used in concrete as a partial replacement material for cement with a measure of success achieved. Groundnut shell was collected from Thirunelveli district, Tamilnadu. "Table.4," shows the chemical composition of groundnut shell ash. "Fig.2," shows the sample of groundnut shell ash.

Table.4: Chemical Composition of groundnut shell ash

Chemical Composition	% by Weight
SiO ₂	27.01
Al ₂ O ₃	6.58
Fe ₂ O ₃	0.53
CaO	9.43
MgO	5.57
SO ₃	1.79
K ₂ O	20.13
P ₂ O ₅	1.95
MnO ₂	0.34
TiO ₂	0.68
LOI	23



Fig.2: Groundnut shell ash

B. Methodology

The properties of natural soil, compaction and strength properties of blended mixes (glass powder alone and groundnut shell ash alone) were tested in the laboratory. The results obtained were compared. The following laboratory tests were carried out for soil sample and stabilized soil using glass powder and groundnut shell ash with various percentages (2%, 4%, 6%, 8%, and 10%).

- Proctor compaction test
- Unconfined compressive strength test
- California bearing ratio test

III. RESULTS AND DISCUSSIONS

On the basis of different tests conducted a comparative study on glass powder and groundnut shell ash inclusion in clay soil and a detailed discussion have been made. The effect of glass powder and groundnut shell ash on maximum dry density, UCC, CBR values of soil-glass powder and soil- groundnut shell ash mixed samples are discussed here.

A. Results of MDD for clayey soil stabilized with glass powder

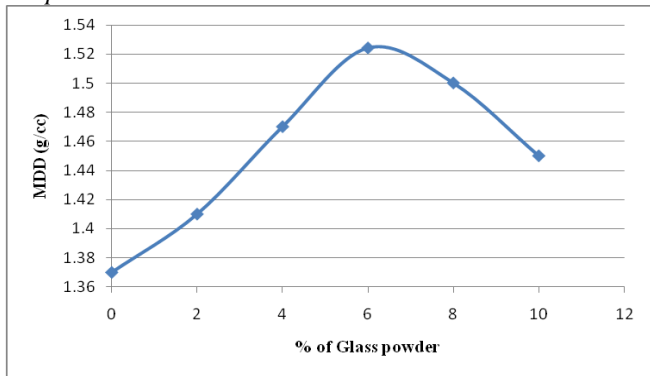


Fig: 3 Graph of MDD v/s % of Glass powder

From Fig.3 the maximum dry density of clayey soil stabilized with glass powder is obtained as 6%. The dry density of the soil increases gradually till 6% addition of glass powder then it starts to reduce. The MDD obtained at 6% glass powder addition is 1.524 g/cc.

B. Results of UCC for clayey soil stabilized with glass powder

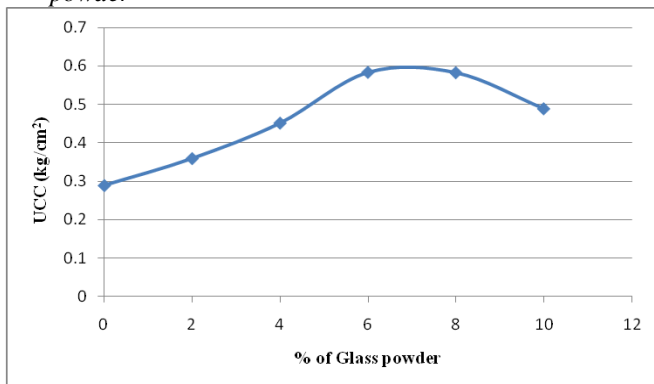


Fig: 4 Graph of UCC v/s % of Glass powder

From Fig.4 the maximum UCC value of 0.583 kg/cm² is obtained at 6% glass powder addition. The UCC value of the soil increases gradually until 6% addition of glass powder then it starts to reduce.

C. Results of CBR value for clayey soil stabilized with glass powder

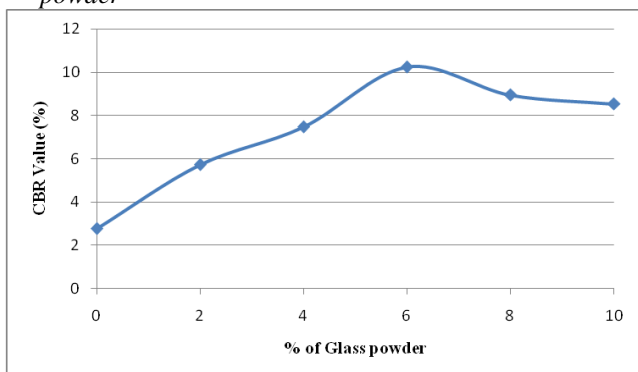


Fig: 5 Graph of CBR Value v/s % of Glass powder

From Fig.5 the UCC value of clayey soil stabilized with glass powder is obtained as 6%. The maximum CBR value obtained at 6% glass powder addition is 10.23%.

D. Results of MDD for clayey soil stabilized with groundnut shell ash

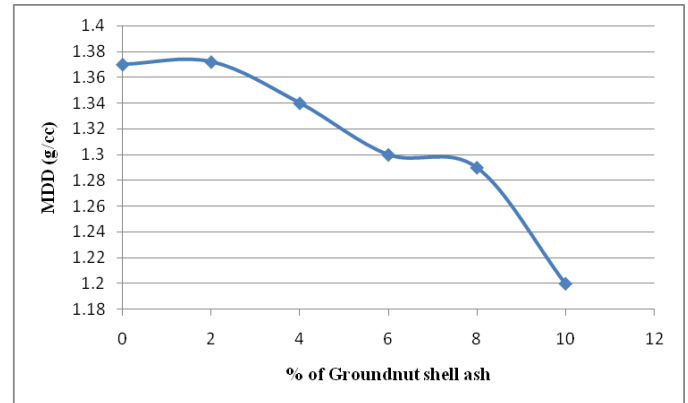


Fig: 6 Graph of MDD v/s % of Groundnut shell ash

From Fig.6 the maximum dry density of clayey soil stabilized with glass powder is obtained as 2%. The dry density of the soil increases up to 2% addition of groundnut shell ash then it starts to reduce. The MDD obtained at 2% groundnut shell ash addition is 1.372 g/cc.

E. Results of UCC for clayey soil stabilized with groundnut shell ash

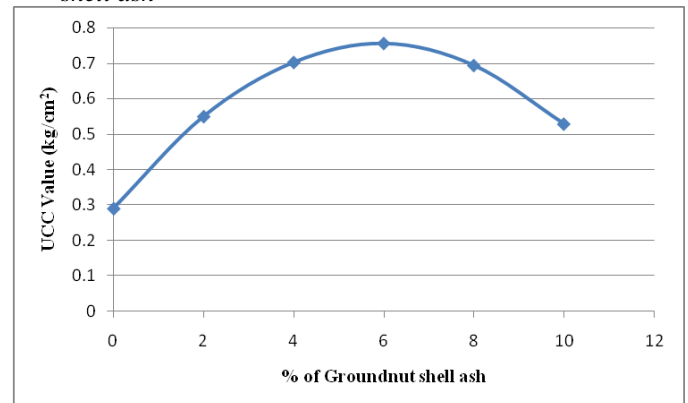


Fig: 7 Graph of UCC v/s % of Groundnut shell ash

From Fig.7 the maximum UCC value of 0.756 kg/cm² is obtained at 6% groundnut shell ash addition. The UCC value of the soil increases gradually until 6% addition of groundnut shell ash then it starts to reduce.

F. Results of CBR value for clayey soil stabilized with groundnut shell ash

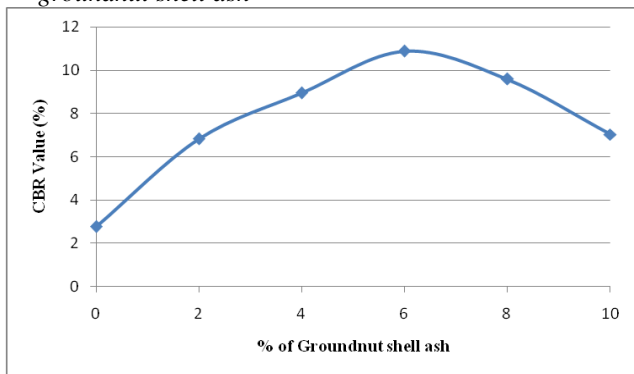


Fig: 8 Graph of CBR Value v/s % of Groundnut shell ash

From Fig.8 the CBR value of clayey soil stabilized with groundnut shell ash is obtained as 6%. The maximum CBR value obtained at 6% groundnut shell ash addition is 10.87%.

G. Comparison on varying percentage of glass powder and groundnut shell ash on clayey soil

1. Results of MDD

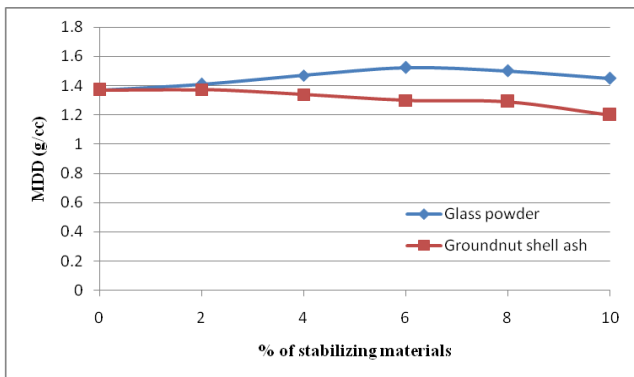


Fig: 9 Comparison graph of MDD Value v/s % of stabilizing materials

From Fig.9 shows the comparison of maximum dry density of the clayey soil stabilized with glass powder and groundnut shell. The MDD is obtained as 1.524 g/cc at 6% glass powder addition.

2. Results of UCC test

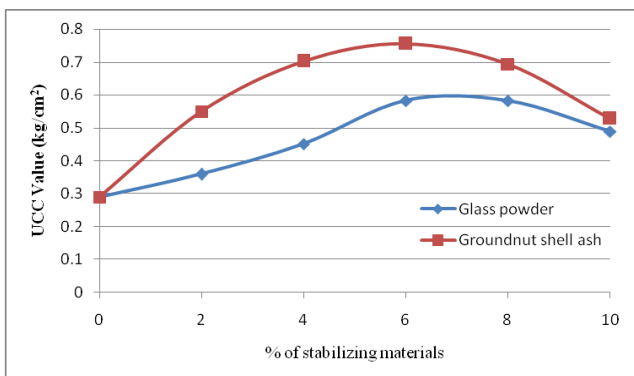


Fig: 10 Comparison graph of UCC Value v/s % of stabilizing materials

From Fig.10 shows that the maximum UCC value of 0.756 kg/cm² is obtained at 6% groundnut shell ash as additive.

3. Results of CBR test

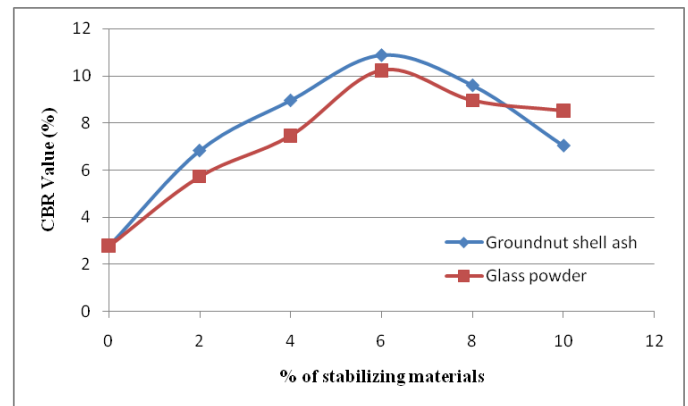


Fig: 11 Comparison graph of CBR Value v/s % of stabilizing materials

From Fig.11 shows the comparative graph of CBR test conducted on clayey soil with glass powder and groundnut shell ash. The maximum CBR value obtained at 6% for both the additives. The maximum CBR value is obtained as 10.87%.

IV. CONCLUSION

The following conclusion can be made from the above results obtained from the laboratory tests.

- The property of clayey soil is improved by the addition of glass powder and groundnut shell ash.
- The MDD of soil compacted with groundnut shell ash increases slightly at 2% and it decline gradually.
- The MDD of soil- glass powder mix improved with the addition of glass powder up to 6% thereafter it decreased.
- The maximum UCC value of 0.756 kg/cm² is obtained at 6% groundnut shell ash as additive.
- The maximum UCC values for both glass powder and groundnut shell ash were obtained at 6%.
- The maximum CBR value is obtained as 10.87% for 6% groundnut shell ash.

From the test results the optimum value for both glass powder and groundnut shell ash is obtained as 6%. From this comparative study it is observed that groundnut shell ash is better than glass powder.

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