EXPERIMENTAL ANALYSIS ON STABILITY OF EXPANSIVE SOIL BY PARTIAL REPLACEMENT OF EGGSHELL POWDER AND POWDERED GLASS

L. Ranjith Kumar[1], Agilan M[2], Kaviraj D[3], Livingston Pauldurai J[4], Pragadeshwaran K[5]

[1-5]*Department of Civil Engineering, Panimalar Engineering College, Chennai*

ABSTRACT: Soil is one of the most important materials used in a variety of construction projects including earth canals and earth dams. Nowadays, considerable attention has been paid tothe utilization of alternative materials, which bear higher engineering quality than traditional materials and are financially affordable. In the present study, eggshell powder and glass powder were used as the wastes, to combine with soil so that the properties of clay soil were investigated in different mixture proportions. Then the properties of soils including liquid and plasticity limits as well as plasticity index, dry density, optimum moisture content and unconfined compressive strength, which were already measured, were compared with those of the experimental specimens mixed witheggshell powder and glass powder in different proportions. Since the introduction of egg shell powder and glass powder improves the engineering behaviour of soils, also make theglass powder and egg shell powder a good replacement or admixture during soil improvement and for a more economic approach.

Keywords - Alternative materials, Egg Shell powder, glass powder, Admixture.

INTRODUCTION

Foundations in expansive soils, popularly known as black cotton soils in this country, undergo alternate swelling and shrinkage upon wetting and drying due to seasonal moisture fluctuations Black cotton soils are a worldwide problem that creates challenges for Civil Engineers. They are considered as potential natural hazard, which can cause extensive damage to structures if not adequately treated The disadvantagesof black cotton soil can be overcome by stabilizing with suitable material. In India these soilscover about x 106 Sq. Km. area which is more than one fifth of its surface area and extend over the states of Maharashtra, Gujarat, parts of Uttar Pradesh, Madhya Pradesh, Rajasthan, Andhra Pradesh and Tamil Nadu. In recent years reinforced earth technique has been gaining popularity in the field of geotechnical engineering due to its highly versatile and flexible nature and is being widely used for the construction of retaining walls, embankments, earth dams, foundation beds for heavy structures on soft grounds viaducts and other applications.

SOIL STABILISATION

In situ improvement of soil properties using additivesis commonly referred to as soil stabilization, which isoften used with fine soils. Indeed, soil stabilization is a process whereby natural or synthetic materials are added to soil improving soil properties It is typically used to modify and improve low- quality materials, which brings about changes in soil properties including decreased rate of subsidence, decreased adhesion coefficient in soils with high cohesion, increased adhesion coefficient in soils with low cohesion, reduced percentage of water absorption and prevention of soil expansion, resistance to frost and defrost, improved ductility, reduced rigidity of earth structures.

HIGH SWELLING SOIL

High swelling soils shrink when they lose their moisture but swell when they absorb water. Moisture absorption may occur as a result of raining, leaking pipes of water or sewage, and impeded surface water evaporation due to the built structures adjacent towater reservoirs. Clay soils are highly vulnerable to swelling. One of the most common methods of fine soil improvement is to stabilize it using additives that improve soil properties through physical and chemical changes. In the present study, Egg Shell Powder (ESP) and glass powder (GP) were used to study the effect on the properties of clayey soil

EGG SHELL POWDER

Eggshell powder (ESP) can be a good replacement for industrial lime, since its chemical composition is similar to that of lime. Literature has shown that eggshell powder primarily contains CaO (99.83%) and the remaining consists of Al2O3, SiO2, Cl, Cr2O3, MnO and CuO. When lime is added to expansive clay, complex chemical reactions take place. At the colloidal level, Base Exchange occurs with the strong calcium ions of lime replacing the weaker ions such as sodium on the surface of the clayparticle. Further adsorption of non-exchanged calcium ions also lead to an increase in ion density. This results in a change of soil texture that reduces clay content and increases the percentage of coarse particles. The eggshell waste was washed and dried before grinding. The eggshell powder was sieved using 425µ sieve and the powder passing the sieve was used. This sieve was chosen in order to achieve auniform powdery.

GLASS POWDER

The glass bottles were washed, dried, broken down manually into smaller sizes with the use of hammer and passed through sieve number 400 to produce the glass in powdery form. The chemical composition of the glass material used is as follows; 76% of Si02, 11.50% of Al203, 11.6% of Na20 while other constituents accumulate to 0.9%. In terms of physicalproperties, 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.

RESULTS AND DISCUSSION

Table 1 Grain Size distribution

Particle Size	% Finer
4.75	99.2
2.36	98.86
1.18	95.36
0.6	91.25
0.3	84.04
0.15	80.79
0.075	78.82

SPECIFIC GRAVITY

Specific gravity (G) is defined as the ratio of theweight of the given volume of the soil solids at a given temperature to the weight of an equal volume of distilled water at that temperature, both weights being taken in air. The IS specifies 27°C as the standard temperature for reporting the specific gravity. Specific gravity is determined by the resulting in reduction in plasticity index. The rate of increase in plastic limit is first rapid and then the rate decreases beyond a certain lime content. Increase in the addition of ESP to the soil sample decreases the liquid limit but increases the plastic limit.

Table 3 – Varying Proportions of Egg Shell Powder

% ESP	LL	PL	PI
0	60	31.1	28.8
0.5	59.1	31.5	27.5
1	58.3	32.1	25.8
1.5	56.5	32.7	24
2	55.4	33.2	22.2
2.5	54.8	33.6	21.3
3	54	34.1	20.2
3.5	53.5	34.6	19
4	52.1	35.3	17.2
4.5	50.9	35.8	15.3
5	49.4	36.5	13.1
5.5	48.1	37.1	11.3

XI UNCONFINED COMPRESSION TEST

The unconfined compressive strength of clayey soil isdetermined using controlled strain. From the value of unconfined compressive strength test result, upto 4 Pycnometer addition of eggshell powder to the soil, the UCS value increased and a sudden decrease was observed at 4.5% addition of eggshell powder to the soil.

Table 2 Specific Gravity

Materials	Sp. Gravity
Soil Specimen	2.39
Glass powder	2.65
Egg Shell Powder	2.09

Table 4 – UCS Values

% ESP	UCS x 10^{-3} N/mm^2
0	7.18
0.5	9.02
1	11.24
1.5	13.68
2	15.96
2.5	18.38
3	20.29
3.5	21.87
4	23.77
4.5	20.60
5	18.52
5.5	17.41

VIII FOR VARYING PROPORTIONS OF EGGSHELL POWDER **ATTERBERG LIMITS**

The atterberg limits which are most useful for engineering purposes are liquid limit, plastic limit and shrinkage limit. These limits are expressed as percentage water content

Liquid limit: Liquid limit is defined as the minimum water content at which the soil is still in the liquid state. It is determined using Casagrande type mechanical liquid limit apparatus. Generally an increase in lime content causes a slight change in liquid limit.

Plastic limit: Plastic limit is defined as the minimum water content at which the soil will just begin to crumble when rolled into a thread approximately 3mm in diameter.

Plasticity index: The range of consistency within which a soil exhibits plastic properties is called plastic range and is indicated by plasticity index. It is the numerical difference between the liquid limit and the plastic limit of a soil. An increase in lime content results in considerable increase in plastic limit

INFLUENCE OF ESP ON UCS

From the above results, it is concluded that 4% addition of egg shell powder to that of the soil sample showed best results with the increased OMC, dry density and unconfined compressive strength. Egg shell powder – glass powder stabilization is cheap and is a method with considerable scope for construction of low cost roads

Table 5 – Compaction Test Results

Proportion	OMC %	
	Without ESP	With 4% ESP
100% Soil +0% GP	25	20
95% Soil +5% GP	23	19
90% Soil +10% GP	22	18
85% Soil +15% GP	21	17
80% Soil +20% GP	19	16
75% Soil +25% GP	16	13
70% Soil +30% GP	11	9

SOAKED CALIFORNIA BEARING RATIOTEST

In order to design a pavement, soaked CBR value of the soil subgrade is evaluated. From that, the total thickness of the flexible pavement needed to cover the sub-grade is obtained. The expansion ratio is used to qualitatively identify the potential expansiveness of the soil

Table 6 – SCB Values

Proportion with 4% ESP	CBR Value (%)	Expansion Ratio (%)
100% Soil +0% GP	1.38	6.2
95% Soil +5% GP	2.54	5.3
90% Soil +10% GP	3.92	4.3
85% Soil +15% GP	4.69	2.7
80% Soil +20% GP	7.20	2.2
75% Soil +25% GP	8.53	1.6
70% Soil +30% GP	10.61	1.1

SWELL TEST

The main purpose of swelling pressure test is to determine the intrinsic swelling pressure of the expansive soil tested. The expansive clays increase in their volume when they come in contact with water owing to surface properties of these clay types. Light structures founded on these type of clays experience severe structural damage due to the swelling of the subsoil. Since the intrinsic swelling pressure is to be associated with the design of structures against such damages, measurement of swelling pressure assumes importance

Swell Pressure of soil sample without any additives

= 128 kN/mm^2

Swell Pressure of optimum proportion of sample

= 18.88 kN/mm^2

CONCLUSIONS

The following conclusions can be drawn on the basis of the result obtained and discussion made in this study

1. Increase in the addition of GP decreases the liquid and plastic limits while increase in addition of ESP to the soil sample decreases the liquid limit but increases the plastic limit.
2. OMC decreases and maximum dry densityincreases up to 4% of ESP by weight.
3. From the analysis, it is obtained that 4% of ESP gives considerable improvement in UCS of clay soil. So 4% selected as optimum percentage.
4. OMC decreases and maximum dry densityincreases with increase in GP percentage.
5. Maximum dry density increases and optimum moisture content decreases considerably with addition of optimum percentage of ESP and varying percentage of GP.
6. The optimum mix proportion was found to be 70% soil + 30% Glass powder added with 4% Egg Shell Powder.
7. The swell pressure reduces by almost 85% for the optimum mix proportion
8. The combination of glass powder and egg shell powder is more effective than the addition ofglass powder or egg shell powder alone for the improvement of properties of clay
9. In the light of above observation we come to a conclusion that ESP along with GP used in combination with clay possessed certain properties which enables it to be used economically for improvement of high swelling soil. By using the eggshell powder as a soil stabilizer, we can minimize the waste disposal problem of eggshell. Since glass powder is also awaste product, usage of same also reduces the environmental problems.

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