

EFFECT OF COMMON SALT AND EGG SHELL POWDER ON GROUND IMPROVEMENT TECHNIC OF CLAYLY SOIL

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Abstract: *Using of chemical admixtures like lime, cement, bitumen in soil stabilization are highly expensive in now a days. However, egg shell powder and common salt are could be preferable replacement in case of these manufactured materials as they are cost reducing. This research investigates an experimental study for stabilizing a clayly soil with eggshell powder as a replacement of industrial lime as well as the engineering properties of soil. Stabilization was performed at optimum eggshell and with 2, 4, 6, 8, and 10% of common salt. The addition of common salt reduced the Plastic Indices (PI) of the samples. The values reduced from 14.82, 11.11 and 7.99% to 8.03, 1.25 and 1.23% in samples A, B and C respectively. The unsoaked CBR values also increased from 34.78 to 50.99 kN/m², 15.64 to 28.89 kN/m² and 27.31 to 34.20 kN/m² at optimum stabilization in samples A, B and C respectively. The result showed that the addition of common salt improved the compaction and CBR characteristics of eggshell stabilized soils. Moreover, it is observed that curing duration had significantly improved the strength properties mentioned of the stabilized soil samples.*

Key words: *Common salt, Clayly soil, Eggshell powder, soil stabilization*

1. INTRODUCTION

The pursuit for ground improvement Technique by soil stabilization its cost effectiveness by constructing buildings, bridges, roads and other civil engineering structures the effect of common salt on it form the basis for this research. As the common construction materials are quite expensive so it is the time to replace the conventional materials with alternatives. On most occasions there are problems about the disposal of these waste heaps. In recent years there has been intensified research towards the use of these byproducts and waste materials in road construction. Construction in clayey soil is considered to be very risky as clayey soil has poor engineering properties as well as settlement, volume change in compressibility or swelling. Expansive soils like clay often need stabilization. Stabilization aimed the improving of different engineering properties. Chicken egg shale is a domestic waste material from kitchen, poultries, hatcheries and fast food joints. Eggshell waste falls within the category of waste food, they are materials from the preparation of foods and drinks, if subjected to adequate scrutiny, and they could be suitable for soil stabilization. One such agro-waste is eggshells, which is the hard outer layer. This study is thus directed towards identifying eggshell powder as an effective stabilizing agent by replacing a certain, percentage of the lime in the stabilized soil with ESP. ESP is precursor in an alkali-activated binder. Disposal of waste poses is a great problem in now a day, as regards where and how to effectively dispose the waste product without any adverse effect on the society. The utilization of eggshell for soil improvement, either for agriculture or engineering purposes will be a welcome development.

Fig. 1 summarizes the worldwide egg production in the years between 2000 and 2018 and the country-wise egg production in 2018. There is a gradual increasing trend in egg production worldwide. Specifically, the disposal of eggshell and hatchery waste is reported to be a great difficulty in the United Kingdom, the estimated quantity of eggshell waste to be disposed each year is between 10,000-11,000 Tonnes in UK[4]. Thus, an estimate of about 5,000-6,000 Tonnes could also be expected in Nigeria annually.



Figure 1 Worldwide egg production (2000-2018)

1.1. Clay: It is the fine particles of soil dia. less than 0.002 mm. They usually have very large surface area. Clay is cohesive type soil with high plasticity. The analysis of clay minerals is for the study of the shrinkage and swelling behaviour otherwise known as ‘activity’ as clay finds its applications surprisingly in the manufacture of edible materials. Montmorillonite is one of the most interesting clay minerals; it is better known as expansive clay or swelling clay. Water can be added to Montmorillonite water molecules get absorbed between the spaces of silicate layer. Adsorption results in large increase in volume, sometimes up to several hundred percent. The pressure generated can be up to 50,000 kgm⁻². This is sufficient to lift a good-sized building [3]. If a building is constructed on clayey soil and continuously gets wet then the building get shoved upward. In one word building will break. It is noticed that expansive clay more damages than earthquakes and landslides combined together.

1.2. Eggshell powder: The generalized eggshell structure, which varies widely among species, is a protein matrix lined with mineral crystals, usually of a calcium compound such as calcium carbonate, along with sometimes lethal doses of arsenic. Harder eggs are more mineralized than softer eggs. Birds are known for their hard-shelled eggs. The shell is a composite of a biological ceramic, calcite, and 2-4% of organic fibres (Vincent, 1990). The calcite component in the shell has greater strength and stiffness compared to structural proteins and insect chitin, but calcite is more brittle. The shell is arranged in layers starting externally with a cuticle, crystal layer, palisade layer, cone layer, outer membrane, and inner membrane. Eggshell consists of several mutually growing layers of CaCO₃, the innermost layer-maxillary layer (=100 μm) grows on the outermost egg membrane and creates the base on which palisade layer constitutes the thickest part (=200 μ) of the eggshell. The top layer is a vertical layer (=5.8 μ) covered by the organic cuticle. Table 1 shows the mineral composition of eggshell. If the calcium from the shell is removed, the organic matrix material is left behind. This organic material has calcium binding properties, and its organization during shell formation influences the strength of the shell.

Tocan stated that primary ingredients of eggshell are Calcium, Magnesium carbonate and protein. Eggshell waste either can be used as animal feed, fertilizer or as replacement of lime stabilization. The quality of lime in eggshell waste is influenced greatly by the extent of exposure to sunlight, raw water and adverse weather conditions. Accordingly, Froning and Bergquist eggshell waste should be ground not more than 2 days after recovery from source to prevent depletion of lime content. Accordingly, Tacon the physical nature of the shell waste and the foul rotten egg odours produced when the material degrades, reduce the lime value and renders the waste difficult to recycle to land. Ideally, the waste should be dried at source, transported to a site where it would be finely ground immediately and used as source of lime to agriculture and for other applications.

Table 1: Mineral composition of eggshell

Mineral composition	Percentage(%)
Calcium Carbonate	95%
Phosphorous	0.3%
Magnesium	0.3%
sodium, potassium, zinc, manganese, iron and copper	Rest

1.3. Common Salt: Salts are generally solid crystals and have very high melting point., but some salts are liquid in room temperature and they are known as ionic liquids. Inorganic salts are very low compressibility like edible soil. They are clear and transparent e.g. Sodium Chloride, opaque (Titanium Dioxide), colourless ((magnesium sulphate), Most minerals and inorganic pigments as well as many synthetic organic dyes are salts. Common salt is hygroscopic; it absorbs and retains moisture It has electrolytic and crystal forming properties but is not strongly deliquescent; it absorbs moisture only when the relative humidity is above 75%. Table-1 shows When you have lots of employees and managers but no leaders – that’s a soft skills gap. The compounds of common salt. In addition, sodium chloride has a very stable configuration due to the electrovalent or ionic type.

Table 2: Ions of Salt

Salt compound	Cation (+)	Anion (-)	Common name
NaCl	sodium	chloride	halite (table salt)
Na ₂ SO ₄	sodium	Sulphate	Glauber’s salt
MgSO ₄	magnesium	Sulphate	epsom salts
NaHCO ₃	sodium	bicarbonate	baking soda
Na ₂ CO ₃	sodium	carbonate	salt soda
CaSO ₄	calcium	Sulphate	gypsum
CaCO ₃	calcium	carbonate	calcite (lime)

Continuous studies and researches shown that improvement of quality and reduction of cost by using common salt as a stabilizing agent both in unsurfaced and surfaced roads. n. According to O' Flaherty (2002) the effect of salt on soil arises from; causing colloidal reactions and altering the characteristics of soil water. Calcium and sodium chlorides usually act as soil flocculants; they are not as potent as other chemicals such as ferric chlorides Most of the beneficial actions of salts in soil are usually attributed to the changes salt makes in the characteristics of the water in the soil pores. These changes reduce the loss of moisture from the soil and are explained by the fact that salts (especially calcium chloride) are deliquescent and hygroscopic in nature. Salt also reduces or prevent frost heave in soil by lowering the freezing point of water. The performance of soil treatment depends therefore on the amount of groundwater movement.

2. METHODS

Classification tests (natural moisture content, specific gravity, particle size analysis and Atterberg's limits test) and engineering property tests (compaction and CBR) were performed on samples A, B, and C at their unstabilized states. Eggshell powder was then added to the soil samples in 2, 4, 6, 8 and 10% by weight of samples. Atterberg's limit, compaction and CBR tests were performed on each of the stabilized samples. Common salt was added in 2, 4, 6, 8 and 10% by weight of samples to the eggshell stabilized samples at their optimum percentages. Atterberg's limit, compaction and CBR tests were repeated on each of the salt-eggshell stabilized samples to determine the effect of the common salt on the mixture.

professional sphere, directly affects performance and productivity, and in turn, impacts in promotion and career enhancement.

3. RESULT AND DISCUSSIONS

The results of the classification tests (natural moisture content, specific gravity, particle size analysis and Atterberg's limits test) and engineering property tests (compaction and CBR) are presented and discussed below.

3.1. Classification test: The observation data are shown in the Table 3. The natural moisture content of samples A, B and C are 11.72, 10.71 and 9.09% respectively. Sample A has highest moisture content and sample c has lowest moisture content. Moisture content depends on void ratio and specific gravity. The specific gravity of samples A, B and C are 2.75, 2.62 and 2.57 respectively. The specific gravity of eggshell was found to be 2.05.

Table 3: Summary of the preliminary analysis of soil samples.

Sample	moisture content (%)	Specific gravity	Liquid limit (%)	Plastic limit (%)	Plastic index (%)
A	11.72	2.75	29.30	14.48	14.82
B	10.71	2.62	24.51	13.40	11.1
C	9.09	2.68	19.20	11.21	8.9

The results of eggshell stabilization on the Atterberg's limits test (liquid limits and plastic limits) of the three soil samples are shown in Figures 1 to 3. In sample A, the liquid limits (LL), plastic limits (PL) and the plastic index (PI) of the natural soil samples are 29.30, 14.48 and 14.82% respectively, sample B are 24.51, 13.40 and 11.11% respectively and 19.20, 11.21 and 7.99%, respectively for sample C. This shows that samples A, B, C have low plasticity.

The addition of eggshell powder in 2, 4, 6, and 8% to the soil samples caused a change in the liquid and plastic limits of all the soil sample. The results of eggshell + common salt stabilization on the soil samples are shown in Table-4. The addition of the common salt to the optimum eggshell stabilization of the soil samples caused a decrease in the liquid limits of all the soil samples.

Table 4: Atterberg Limit

Sample	(Egg shale powder+ common salt)%	Liquid limit (LL)%	Plastic limit (PL)%	Plasticity index (PI)
A	6% egg shale powder+ 2% common salt	26.99	12.00	14.80
	6% egg shale powder+ 4% common salt	28.99	10	19.00
	6% egg shale powder+ 6% common salt	27.90	20.21	8.02
	6% egg shale powder+ 8% common salt	27.70	17.70	9.97
B	10% eggshell powder + 2% common salt	18.35	18.9	-0.59
	10% eggshell powder + 4% common salt	17.35	17.54	-0.11
	10% eggshell powder + 6% common salt	17.20	13.33	3.38
	10% eggshell powder + 8% common salt	15.95	15.80	1.29
C	10% eggshell powder + 2% common salt	18.95	16.09	4.00
	10% eggshell powder + 4% common salt	19.00	18.12	1.13
	10% eggshell powder + 6% common salt	17.75	14.12	3.28
	10% eggshell powder + 8% common salt	19.45	15.13	3.99

3.2. California Bearing Ratio Test: The CBR of a soil is an indefinable index of its strength and it is dependent upon the condition of the materials at the time of testing.. At any given moisture condition the CBR value will increase if the Maximum dry density also increased. The unsoaked CBR values increased from 10.57 to 34.78%, from 12.25 to 15.64% and from 2.49 to 27.31% in samples A, B and C respectively at optimum stabilizations of eggshell. The introduction of common salt also increased the unsoaked and the soaked CBR further.

Table 5: CBR value

Sample + % of Eggshell	Average Unsoaked CBR%	Actual Unsoaked CBR%
0% Eggshell + Sample A	9.29	10.57
6% Eggshell + Sample A	34.78	34.78
0% Eggshell + Sample B	11.10	12.25
10% Eggshell + Sample B	15.64	15.64

5. CONCLUSION

Eggshell powder improved the quality of soil sample by significantly reducing their plastic property. Addition of common salt with eggshell powder further increased the engineering properties of soil. Common salt is therefore effective in improving the compaction and CBR characteristics of eggshell stabilized soil.

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