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EFFECT OF COMMON SALT ON SOME ENGINEERING PROPERTIES OF EGGSHELL STABILIZED LATERITIC SOIL

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ABSTRACT

This paper studied the effect of common salt on the compaction and California Bearing Ratio (CBR) properties of eggshell stabilized lateritic soils with a view of obtaining a good compliment for eggshell as a useful stabilizer for road works. Classification and consistency tests were performed on the soil samples which were also subjected to compaction and CBR tests. 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. Maximum Dry Density (MDD) increased from 1995 to 2140 kg/m^3 and 2000 to 2110 kg/m^3 in samples B and C respectively. The unsoaked CBR values also increased from 34.78 to 50.99 kN/m^2, 15.64 to 28.89 kN/m^2 and 27.31 to 34.20 kN/m^2 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.

Keywords: common salt, eggshell stabilization, lateritic soils.

1. INTRODUCTION

The pursuit for improved soil structure, its cost-effectiveness in road and other construction work and the effect of common salt on it form the basis for this research. As the conventional road construction materials become scarce or more expensive, there is the need to turn to alternatives. Nearly all industrial activities lead to depletion of natural resources, and in the process may result in accumulation of by-product and /or waste materials. On most occasions there are problems about the disposal of these waste heaps. In recent years there has been an intensified research towards the use of these by-products and waste materials in road construction. The use of these materials as alternatives results in two-fold advantages - conservation of natural resources and disposal or reduction in size of waste heaps. Some of the principal wastes and by-products with road-making potentials include colliery shale, pulverized fuel ash, furnace clinker, pulverized egg shell, blast furnace and steel slug, incinerator waste, agricultural waste among other wastes. Most of the above wastes have been used in many countries of the world, a good example is Japan. In Nigeria, these dignified wastes and by-products have not been known to have much economic use. This study is therefore to find use for common salt as a compliment for eggshell in lateritic soil stabilization.

1.1 Lateritic soil

Lateritic soils refer to materials with lower concentrations of oxides which behave more like fine-grained sands, gravels, and soft rocks. Laterite typically has a porous or vesicular appearance. Some particles of laterite tend to crush easily under impact, disintegrating into a soil material that may be plastic. Lateritic soils may be self-hardening when exposed to drying; or if they are not self-hardening, they may contain appreciable amounts of hardened laterite rock or laterite gravel. For engineering purpose, laterites and lateritic soils form a group comprising a wide variety of red, brown, and yellow, fine-grained residual soils of light texture as well as nodular gravels and cemented soils. They may vary from a loose material to a massive rock. They are characterized by the presence of iron and aluminium oxides or hydroxides, particularly those of iron, which give the colours to the soils. For engineering purposes, the term 'laterite' is confined to the coarse-grained vermicular concrete material, including massive laterite. Makasa (2004) stated that the degree of laterization is estimated by the silica sesquioxide ratio (SiO_2/Fe_2O_3 + N_2O_3). Laterites and lateritic materials occur frequently throughout the tropics and subtropics. Lateritic soil is formed in hot, wet tropical regions with an annual rainfall between 150mm to 300mm. it is formed under conditions that lead to the removal of silica (laterization), alkali and alkaline earths. This resulting concentration of iron and aluminium oxides sharply differentiates laterization from temperate climatic weathering in which the end product is largely clay materials (hydrous aluminium silicate) (Goldich, 1987).

1.2 Compaction characteristics of laterite

The compaction characteristics of laterite are determined by their grading characteristics and plasticity of fines (Makasa, 2004). These in turn can be traced to genetic and pedological factors. Placement variables (moisture content, amount of compaction and type of compaction effort) also influence the compaction characteristics. Varying each of these placement variables has an effect on permeability, compressibility, strength and stress-strain characteristics (Lambe, 1984). The significant characteristics of lateritic soil are the influence of the strength of the concretionary coarse particles on compaction. Most laterite soils contain a mixture of quartz and concretionary coarse particles, which may vary from hard to very soft. The strength of these particles has major implications in terms of field and laboratory compaction results and their subsequent performance in road pavements. Weak coarse fractions break down under rolling and traffic loading with a resulting increase in fines of the soil. The degree to which the materials break down is related to the content of iron oxide and the degree of dehydration. For example, soils compacted on the dry side of the optimum moisture content swell more that soils compacted on the wet side because the soil compacted on the dry side has greater moisture deficiency and a lower degree of saturation. On the other hand soil compacted on the wet side of the optimum moisture content will shrink more on drying than a soil compacted on the dry side (Lambe, 1984).

1.3 California bearing ratio (CBR) of soil

The CBR is a strength-based method of pavement design which uses the load-deformation characteristics of the roadbed soils, aggregate subbase, and base materials, and an empirical design chart to determine the thicknesses of the pavement, base, and other layers. The test originated with the California Division of Highways, although this agency now uses the Hveem stabilometer method. The CBR value is an estimate of the quality of the material as compared to that of an excellent base material, for which the CBR is assumed to equal 100 percent. Thus, CBR states the quality of the material in terms of that of an excellent base course, which has a CBR of 100. As examples, the disintegrated granite subbase has a CBR of 70, whereas Clay loam is only about 10. Once the CBR for the basement soil and that in other layers is known, the thickness of overlying material to provide a satisfactory pavement can be determined.

1.4 Soil stabilization

Thagesen (1989) defined stabilization as any process by which a soil material is improved and made more stable. Garber and Hoel (1998) described soil stabilization as the treatment of natural soil to improve its engineering properties. In general, soil stabilization is the process of creating or improving certain desired properties in a soil material so as to make it useful for a specific purpose. Soil stabilization may be broadly defined as the alteration or preservation of one or more soil properties to improve the engineering characteristics and performance of the soil. When the mechanical stability of a soil cannot be obtained by combining materials, it may be advisable to stabilize the soil by adding lime, cement, bituminous materials or special additives. Cement stabilization is mostly applied in road works, especially when the moisture content of the sub grade is high. Calcium hydroxide (slaked lime) is the most widely used for stabilization. Calcium oxide (quick lime) may be more effective in some cases; however, quick lime will corrosively attack equipment which may cause severe skin damage or burns to personnel. Ingles and Metcalf (1992) recommended the criteria of lime mixture. The effectiveness of stabilization depends on the ability to obtain uniformity in blending the various materials. The method of soil stabilization is determined by the amount of stabilization required and the conditions encountered on the project. An accurate soil description and classification is essential for the selecting the correct materials and procedures.

1.5 Properties of salts

Salts are usually solid crystals with a relatively high melting point. However, some salts are liquid at room temperature, and are the so-called ionic liquids. Inorganic salts usually have a low hardness and a low compressibility similar to edible salt. They can be clear and transparent (sodium chloride), opaque (titanium dioxide), and even metallic and lustrous (iron disulfide). They exist in all different colors, e.g. yellow (sodium chromate), orange (potassium dichromate), red (mercury sulfide), mauve (cobalt chloride hexahydrate), blue (copper sulfate pentahydrate, ferric hexacyanoferrate), green (nickel oxide), colorless (magnesium sulfate), white (titanium dioxide), and black (manganese dioxide). Most minerals and inorganic pigments as well as many synthetic organic dyes are salts. Different salts can elicit all five basic tastes, e.g. salty (sodium chloride), sweet (lead diacetate), sour (potassium bitartrate), bitter (magnesium sulfate), and savory (monosodium glutamate). 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%. It also reduces changes in moisture content by forming barrier to the movement of water in the liquid phase. Table-1 shows the compounds of common salt. In addition, sodium chloride has a very stable configuration due to the electrovalent or ionic type of bond it possesses (Kaufman, 1971).

Common salt falls under water-retaining agents used in soil stabilization to improve soil strength, bearing capacity and durability under adverse moisture and stress conditions. Kaufman (1971) gave the following interrelated effects of the stabilizing effect of sodium chloride on clay - sand gravel aggregates; coagulation of clay particles, reduction in tendency of clay to expand when wet, reduction in volume shrinkage in clay, retardation of permeability of soil water, lowering of moisture film thickness in soil, thus retarding out.

Table-1. Common salt compounds. (Source: Cardon *et al* (2006); Colorado State University cooperative extension fact sheet).

Salt compound	**Cation** (+)	**Anion** (-)	**Common name**
NaCl	sodium	chloride	halite (table salt)
Na_2SO_4	sodium	Sulfate	Glauber's salt
$MgSO_4$	magnesium	Sulfate	epsom salts
$NaHCO_3$	sodium	bicarbonate	baking soda
Na_2CO_3	sodium	carbonate	sal soda
$CaSO_4$	calcium	Sulfate	gypsum
$CaCO_3$	calcium	carbonate	calcite (lime)

1.6 Salt and soil stabilization

Salt has been used for some sixty years as a dust palliative. In recent years, it has been used as an additive in the construction of granular stabilized road wearing and base courses. Studies have shown the improvements in quality and reductions in maintenance cost resulting from use of salt in both unsurfaced and surfaced roads. While the benefits from salt treatment are recognized, complete comparative technical data between treated and untreated roads are not available; moreover, scientific explanations for the benefits of salt have proved to be elusive. According to Samuel (1992) salt is used for countless other purposes, such as removing snow and ice from roads, softening water, preserving food, and stabilizing soils for construction. 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 and lower the vapour pressure of water. Salt also reduces or prevent frost heave in soil by lowering the freezing point of water. Since most of the benefit of salt require the presence of salt in the pore fluid, they are lost if the salt is leached out. The performance of soil treatment depends therefore on the amount of groundwater movement.

1.7 Eggshell

The term *eggshell* is a term for the outer covering of a hard-shelled egg, and some forms of eggs with soft outer coats. 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 distribution of calcite crystals is not homogeneous throughout the shell. The shell is porous, permitting respiratory gases to pass through it. The morphology of the shell materials is highly complex and mechanically enigmatic (Vincent, 1990). The shell is arranged in layers starting externally with a cuticle, crystal layer, palisade layer, cone layer, outer membrane, and inner membrane. As a result, the physical properties of the shell vary through its thickness. Hardness is lower in the centre of the shell compared to the inside and outside of a domestic hen's egg (Tung *et al*., 1968). However, the particular geometry of the eggshell makes it remarkably resistive to external loading.

Most good quality eggshells from commercial layers contain approximately 2.2 grams of calcium in the form of calcium carbonate. About 95% of the dry eggshell is calcium carbonate weighing 5.5 grams. The average eggshell contains about 0.3% phosphorous, 0.3% magnesium, and traces of sodium, potassium, zinc, manganese, iron and copper. 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. The organic material must be deposited so that the size and organization of the crystalline components (mostly calcium carbonate) are ideal, thus leading to a strong shell. The majority of the true shell is composed of long columns of calcium carbonate. There are other zones that are involved in the self-organization giving the eggshell its strength properties. Thus, shell thickness is the main factor, but not the only factor that determines strength. At present, dietary manipulation is the primary means of trying to correct eggshell quality problems. However, the shell to organic membrane relationship is also critical to good shell quality and must be considered.

An eggshell that is smooth is desirable, as rough-shelled eggs fracture more easily. Large eggs will usually break more easily than small ones. The main reason for this is that the hen is genetically capable of placing only a finite amount of calcium in the shell. As the hen ages and the eggs get bigger, a similar amount of calcium has to be spread over a larger surface. The specific gravity of the egg is positively correlated with shell weight per unit area and hence is related to shell thickness. The relationship is shown in Table-2.

Table-2. Relationship between specific gravity of egg and the shell thickness (Source: Poultry production in warm climate, page 190).

Average specific gravity	**Range in shell thickness** (mm)
1.07	0.28 - 0.30
1.08	0.33 - 0.36
1.09	0.38 - 0.41

Eggshell, preferably the chicken eggshell perceived a waste material could be annexed for use as a replacement for soil stabilizer like lime since they share the same chemical composition (Amu, 2005). Eggshell waste falls within the category of waste food; they are materials from the preparation of foods and drinks, if subjected to adequate scrutiny could be suitable for soil stabilization (Croft *et al*, 1999). The use of stabilization agents like lime and bitumen proves expensive and requires an economic replacement. Literature has shown that eggshell primarily contains lime, calcium and protein. It has being in use as a source of lime in agriculture, which confirms that lime is present in considerable amount in eggshell. Subsequent finding revealed that eggshell powder was used for the stabilization of a cohesionless soil in Japan (Croft 1999). Ground eggshells are effective liming source (John and Paul, 2006).

2. MATERIALS AND METHODS

Materials

The materials used for this study are; lateritic soil, eggshell, common salt (NaCL) and potable water. The soil samples were obtained from three different locations and at predefined depths in Obafemi Awolowo University Ile-Ife, Nigeria. They were kept safe and dry in jute bags in the Geotechnics Laboratory of Civil Engineering Department of the University. They were kept in a clean plastic bag and properly sealed with adhesive tape. Sample numbers with soil descriptions, sampling depths and dates of sampling were marked clearly on papers and stapled to the plastic bags. The samples were later taken out of the bags and were spread out on jute bags at the laboratory to facilitate quick air drying before tests were run on them. Eggshells were obtained from two agricultural farms at Ibadan, Nigeria. They were spread on the ground and air dried to facilitate easy milling. After air drying, the eggshells were manually broken and milled into powdery forms which were collected in polythene bags and stored under room temperature until they were used. The eggshell powder was finally sieved through BS sieve 75µm to get a very fine eggshell. Throughout this study, the eggshell powder was covered before and after use to avoid contamination with other materials and also prevented against moisture from the ground which could cause hardening and loss of some of its properties. Common salt was obtained from a market. It remained covered before and after use to avoid absorption of atmospheric moisture and was kept safe at the laboratory. The water was pipe borne water from Opa waterworks of the University.

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. Thereafter, the optimum requirement of eggshell on each of the three samples were determined and recorded. 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.

3. RESULTS 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 summary of the preliminary analysis of the soil samples are shown in Table-3. The natural moisture content of samples A, B and C are 11.72, 10.71 and 9.09% respectively. Sample A has the highest natural moisture content and sample C the lowest. This could be associated with the void ratio and specific gravity of Sample A. Moisture content depends largely on the void ratio. The specific gravity of samples A, B and C are 2.75, 2.62 and 2.57 respectively. Most clay minerals have specific gravities that fall within a general range of 2.6 - 2.9 (Das, 2000). The specific gravity of eggshell was found to be 2.05. In the grain size analysis, less than 35% of the three samples passed the 200µm sieve. This showed that they all belong to the granular family; hence hydrometer analysis was conducted using the oven-dried particle passing 75µm sieve.

The soil samples were classified using the AASHTO soil classification system. All the samples fell within the SILTY OR CLAYEY GRAVEL AND SAND mineral under the general classification. Their percentage passing 75µm sieve were 4.80, 5.20 and 8.40% for sample A, B and C respectively which were all less than 35%. They all therefore belong to A-2-4, A-2-5, A-2-6 and A-2-7 groups. Based on their LL and PI, samples A, B and C were further classified as A-2-6(2), A-2-5(2) and A-2-4(3), respectively.

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

Sample	Natural moisture content (%)	Specific gravity	Liquid limit (%)	Plastic limit (%)	Plastic index (%)	AASTHO classification
A	11.72	2.75	29.30	14.48	14.82	A-2-6(2)
B	10.71	2.62	24.51	13.40	11.11	A-2-6(2)
C	9.09	2.57	19.20	11.21	7.99	A-2-4(3)

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. According to Whitlow (1995), liquid limit less than 35% indicates low plasticity, between 35% and 50% indicates intermediate plasticity, between 50% and 70% high plasticity and between 70% and 90% very high plasticity. The addition of eggshell powder in 2, 4, 6, 8 and 10% to the soil samples caused a change in the liquid and plastic limits of all the soil samples as shown in Figures 1 to 3. 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.

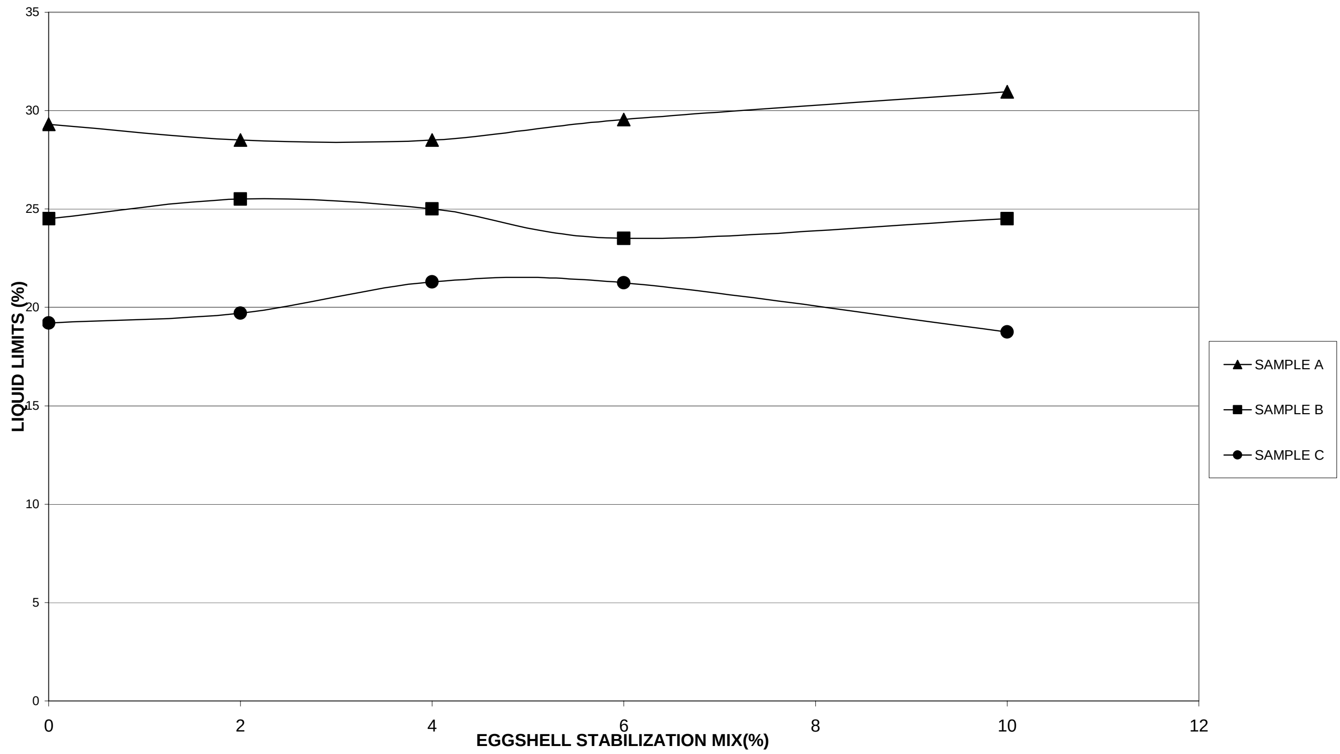

Figure 1: Variation of liquid limits of soil samples A, B and C with eggshell stabilization.

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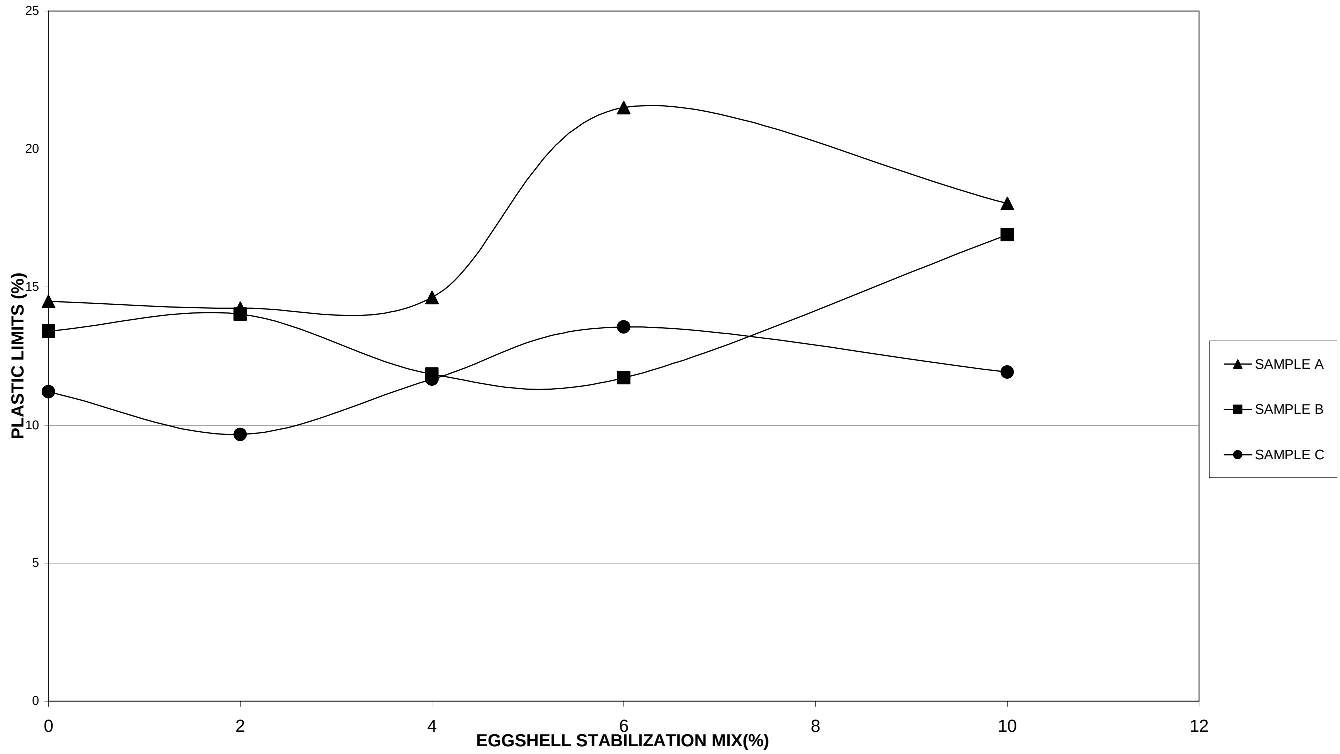

Figure 2: Variation of plastic limits of soil samples A, B and C with eggshell stabilization.

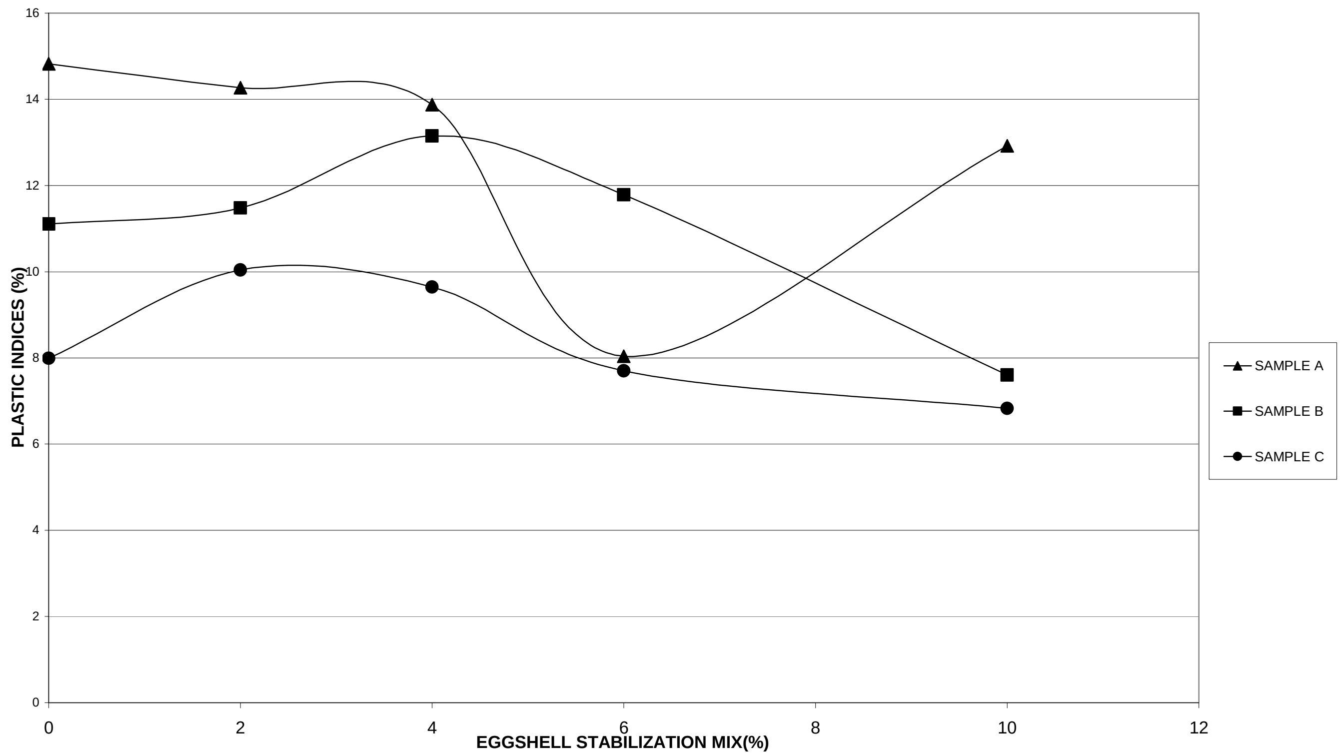

Figure 3: Variation of plastic indices of soil samples A, B and C with eggshell stabilization.

Table-4. Summary of Atterberg's limits test on common salt + optimum eggshell stabilization.

Sample	**Percentage stabilization + common salt**	**Liquid limit** (LL) %	**Plastic limit** (PL) %	**Plastic index** (PI) %
A	6% eggshell + 2% common salt	27.50	12.70	14.80
	6% eggshell + 4% common salt	29.35	9.97	19.38
	6% eggshell + 6% common salt	28.50	20.47	8.03
	6% eggshell + 8% common salt	27.30	17.17	10.13
	6% eggshell + 10% common salt	28.10	16.53	11.57
B	10% eggshell + 2% common salt	18.35	18.96	-0.61
	10% eggshell + 4% common salt	17.55	17.66	-0.11
	10% eggshell + 6% common salt	17.55	13.58	3.97
	10% eggshell + 8% common salt	16.75	15.50	1.25
	10% eggshell + 10% common salt	17.35	15.32	2.03
C	10% eggshell + 2% common salt	19.55	15.87	3.68
	10% eggshell + 4% common salt	19.20	17.97	1.23
	10% eggshell + 6% common salt	17.75	14.37	3.38
	10% eggshell + 8% common salt	19.45	15.44	4.01
	10% eggshell + 10% common salt	17.75	14.96	2.79

3.2 Compaction test

Table-5 shows the summary of the compaction test results. The natural OMC of samples A, B and C are 13.20, 10.80 and 10.40% and MDD of 2155, 1955 and 2000kg/m^3 respectively. The addition of eggshell at optimum level caused a reduction in the OMC to 10.20, 6.60 and 6.40% and corresponding changes in the MDD respectively. For samples A and C, MDD decreased but increased in sample B. In contrast with eggshell-common salt stabilized soil, the OMC decreased and the MDD increased consistently in samples A, B and C. The decrease in optimum moisture content is probably a consequence of the absorption capacity of the eggshell as a result of its porous properties. Lambe and Whiteman (1979) state that 'for good soil, the lower the OMC, the better its workability'. Principally, increase in dry density is an indicator of improvement.

Table-5. Summary of compaction test results.

Sample	Percentage stabilization	**Optimum moisture content** (OMC) (%)	**Maximum dry density** (kg/m^3)
A	0% eggshell	13.20	2155
	6% eggshell only	10.20	2137
	6% eggshell+ 2% common salt	7.88	2100
	6% eggshell + 4% common salt	7.60	2100
	6% eggshell + 6% common salt	8.80	2105
	6% eggshell + 8% common salt	8.30	2080
	6% eggshell + 10% common salt	7.60	2080
B	0% eggshell	10.80	1995
	10% eggshell only	6.60	2065
	10% eggshell + 2% common salt	8.00	2030
	10% eggshell + 4% common salt	6.40	2135
	10% eggshell + 6% common salt	5.80	2140
	10% eggshell + 8% common salt	7.50	2055
	10% eggshell + 10% common salt	8.20	1945
C	0% eggshell	10.40	2000
	10% eggshell only	6.40	1977
	10% eggshell + 2% common salt	7.60	2090
	10% eggshell + 4% common salt	8.80	2065
	10% eggshell + 6% common salt	8.55	2100
	10% eggshell + 8% common salt	8.00	2110
	10% eggshell + 10% common salt	8.20	2070

3.3 California bearing ratio test

The summary of the soaked and the unsoaked CBR tests are shown in Table-6. The CBR values for the 72hours soaked samples were lower compared to the unsoaked samples. The CBR values of all samples increased considerably on stabilization with the eggshell powder. 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 unsoked and the soaked CBR further. This increment shows that the soil samples were effectively stabilized, which in turn improved the engineering properties of the soil by making them a good non-plastic subbase material. This will considerably reduce the subbase and surfacing materials required for road construction works. Optimum values were used in the test because it is believed that the same increase in strength as experienced in the compaction would be experienced in the CBR values which were proved right. This shows that the load bearing capacity of the soil increased with the stabilization mix. The increment in the CBR values for the three soil samples satisfied the minimum requirement that qualify them for road construction works. According to Whitlow (1995) the minimum requirements for CBR subgrade, sub base and base courses are 10% CBR (soaked), 30% CBR (soaked) and 80% CBR (unsoaked).

Table-6. Summary of CBR test.

Type and % of additives	**Penetration** (mm)	**Average unsoaked CBR** (%)	**Average soaked** (%)	**Actual CBR unsoaked** (%)	**Actual CBR soaked** (%)
0% Eggshell + sample A	2.5	9.29	3.75	10.57	4.24
	5.0	10.57	4.24		
6% Eggshell + sample A	2.5	34.78	8.69	34.78	8.69
	5.0	29.31	7.31		
0% Eggshell + sample B	2.5	11.10	3.89	12.25	4.26
	5.0	12.25	4.26		
10% Eggshell + Sample B	2.5	15.64	5.85	15.64	5.85
	5.0	14.96	5.66		
0% Eggshell + sample C	2.5	2.49	0.95	2.49	0.95
	5.0	1.96	0.73		
10% Eggshell + sample C	2.5	27.31	8.38	27.31	8.38
	5.0	21.50	6.61		
6% Eggshell+6% common Salt + sample A	2.5	50.99	13.79	50.99	14.18
	5.0	48.70	14.18		
10% Eggshell+6% common Salt + sample B	2.5	28.89	8.31	28.89	8.31
	5.0	24.43	7.09		
10% Eggshell+8% common Salt + sample C	2.5	34.02	16.61	34.20	16.72
	5.0	24.20	16.72		

4. CONCLUSIONS

Eggshell improved the quality of the soil samples by significantly reducing their plastic indices. The unsoaked and soaked CBR values of all soil samples increased considerably with the addition of eggshell powder. Adding common salt to the eggshell-stabilized soil samples further increased the engineering qualities of the samples. Common salt is therefore effective in improving the compaction and CBR characteristics of eggshell stabilized lateritic soil and can be used to significantly improve the strength of lateritic soils to be used as subgrade materials in road construction works.

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