

IMPROVEMENT OF SUB GRADE PROPERTIES BY USING EGGSHELL POWDER

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Abstract— The overall strength and performance of a pavement is dependent not only upon its design but also on the load-bearing capacity of the subgrade soil. The quality of a flexible pavement depends on the strength of its sub-grade soil. The main function of the sub grade is to give adequate support to the pavement and for this the sub grade should possess sufficient stability under adverse climatic and loading conditions. The strength of sub-grade is the major parameters for determining the thickness of pavement. Material selected for use in construction of subgrade must have to be of adequate strength and at the same time it must be economical for use. In view of the present investigation has been carried out with easily available material like eggshell powder in combination with locally available red soil. Index properties of soil are observed to classify the soil. Since CBR is an important criterion in flexible pavement design, the strength improvement has been found in terms of CBR in the present study. The laboratory test results shows marked improvement of strength of soil with the addition of eggshell in respect of California Bearing Ratio (CBR) in unsoaked conditions

Keywords— Eggshell powder, CBR, Plastic limit, Liquid limit, Soil sample

I. Introduction

Soil is an accumulation or deposit of earth material, derived naturally from the disintegration of rocks or decay of vegetation that can be excavated readily with power equipment in the field or disintegrated by gentle mechanical means in the laboratory. Soil is a broad term used in engineering applications which includes all deposits of loose material on the earth's crust that are created by weathering and erosion of underlying rocks.

The supporting soil beneath pavement and its special under courses is called sub grade. Undisturbed soil beneath the pavement is called natural sub grade. Compacted sub grade is the soil compacted by controlled movement of heavy compactors.

A. Eggshell

Eggshell is a unique, cost-effective, environment friendly technological breakthrough in soil stabilization, waste binding and pavement layer design for the road and highway building world. Eggshell powder is a unique and highly effective natural inorganic soil stabilizer for infrastructure development and repair.

Meets the requirement for a well-proven, reliable and very cost-effective method by creating a strong and irreversible impermeable layer resistant to adverse climatic conditions, from very high temperatures to permafrost conditions, and accommodating all types of roads and load requirements.

It is environment friendly and emphasizes the use of recycled material, recognizing the lack of readily available

resources. It reduces the Carbon Footprint of any project by reducing transportation requirements and carbon emissions. This makes it eligible for Carbon Credits in the environment friendly sensitive global marketplace.

An eggshell is the outer covering of a hard-shelled egg and of some forms of eggs with soft outer coats. Bird eggshells contain calcium carbonate and dissolve in various acids, including the vinegar used in cooking. While dissolving, the calcium carbonate in an eggshell reacts with the acid to form carbon dioxide.

Eggshell is made almost entirely of calcium carbonate (CaCO₃) crystals. It is a semipermeable membrane, which means that air and moisture can pass through its pores. The shell also has a thin outermost coating called the bloom or cuticle that helps keep out bacteria and dust.

The chicken eggshell comprises calcified shell and shell membranes including inner and outer membranes. These membranes retain albumen and prevent penetration of bacteria. Shell membranes are also essential for the formation of eggshell. The organic matter of eggshell and shell membranes contain proteins as major constituents with small amounts of carbohydrates and lipids.

Bronsch and Diamantstein (1965) analyzed uronic acid in eggshells and reported a significant correlation between the uronic acid content and the breaking strength of the shell. Uronic acid is a constituent sugar of glycosaminoglycan. We have shown that the organic matter of eggshell contains two glycosaminoglycans including hyaluronic acid and chondroitin sulfate dermatan sulfate copolymer. Silica acid is another carbohydrate found in

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eggshell membranes. However, little is known about the difference in concentrations of silica acid between the inner and outer eggshell membranes.

There is also limited information available concerning variations in nitrogen concentrations and amino acid composition among the organic matter of eggshell and shell membranes. Eggshell and shell membranes are non-edible by-products with little saleable value. However, they may contain biologically active compounds. Better understanding of chemical composition of these by-products is of basic importance.

Such knowledge may also be important for investigating the biological role of eggshell and shell membranes. This study was undertaken to analyze uronic acid, silica acid, nitrogen, and amino acids in the organic matter of eggshell and the inner and outer shell membranes and to compare analytical data among these samples.

TABLE 1 :The Physical Properties Of eggshell powder

physical properties	Eggshell powder
Odour	Odourless
pH	8.3
Freezing point	None
Flammability	Non-flammable
Shelf life	12 months
Storage	Dry storage
Specific Gravity	0.85g/cm ³
Moisture content	1.18
Bulk Density	0.8(g/m ³)
Particle Density	1.012(g/m ³)
Porosity%	22.4 BET

TABLE 2 : The Chemical Properties Of Eggshell powder

ELEMENTS	% BY MASS
CaO	50.7
SiO ₂	0.09
Al ₂ O ₃	0.03
MgO	0.01
Fe ₂ O ₃	0.02
Na ₂ O	0.19
P ₂ O ₅	0.24
SrO	0.13
NiO	0.001
SO ₃	0.57
Cl	0.08



Fig 1 :Eggshell powder sample

II. Objectives

- 1) To determine the selected red soil characteristics by conducting laboratory tests such as LL, PL and CBR.
- 2) To determine the above properties of the soil admixed with Eggshell by varying proportions.
- 3) To determine optimum quantities of the Eggshell which are admixed with the soil .
- 4) To compare the various changes occurred in the soil with the stabilizers i.e.Eggshell

III. Literature Review

Eggshell known as a smooth surface that is desirable compared rough eggshells fracture more easily. 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% of magnesium, phosphorous, and traces of sodium, zinc,, potassium, iron, copper and manganese. There are many factor influences in quality of eggshell which is nutrient adequacy, flock health problem, environmental condition and breeding. Apart from that, the controlling rate of egg weight also contributes to a good quality of eggshell and it is not depends on the thick eggshell mean strong. Sometimes, thinner eggshell is stronger than thicker eggshell. This fact is due to shape and organization of organic and inorganic component of the shell. (Gary et al. 2004).

Eggshell is a rich source of lime, calcium and protein so that it may be used as an alternative to such soil stabilizers as lime because it contains lime-like ingredients. Used as source of lime in agriculture, eggshell proved to contain a Considerable amount of lime. In the present study, eggshell powder was used as an alternative to stabilize expansive soils. To this end, various laboratory experiments were carried out on soil specimens mixed with different percentages of additives. Application of eggshell powder was carried out by researchers in the past and

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observations of investigation program are summarized below.

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The quality of lime in eggshell waste is influenced greatly by the extent of exposure to sunlight, raw water and harsh weather conditions. It is the fine grained powder with suitable proportion which is sieved to the required size before use with soil. F.Z. Aissiou¹, A. Nechnech¹, and H. Aissiou, had a work which consists of the presentation of the results of a laboratory study on the treatment of a clay soil in the area of the Inhabitant of Algiers by incorporation of various contents of extinct lime. For that, physical and mechanical tests such as (unconfined compression test, classification tests of the grounds in 1st place and shear test) were carried out and the results obtained highlight an unquestionable and definitely better improvement of the characteristics of geotechniques such as the resistance of compression, resistance of shearing (angle of friction and cohesion) etc. eggshell powder was examined on Atterberg properties of the specimens.

A. J. Olarewaju (et al, 2011) studied suitability of eggshell stabilized soil as subgrade material for road construction. Amu (et al., 2005) studied eggshell powder as a stabilizing material for improving soil properties. Eggshell waste generation in India, the United States and the United Kingdom is 190000, 150000 and 110000 tones per annum respectively. Eggshell waste can be used as fertilizer, animal feed ingredients and other such uses. However, majority of the eggshell waste is deposited as landfills. Eggshell waste in landfills attracts vermin due to attached membrane and causes problems associated with human health and environment. Few investigations were conducted to use eggshell waste in civil engineering applications.

A study of the influence of compactive effort on the properties (i.e., OMC, CBR, Ps) of eggshell powder-red soil mixtures has been conducted by Charles M. O. Nwaiwu,¹ Samson H Mshelia,² and Joshua K. Durkwa. Maximum dry unit weight as well as CBR increased with eggshell powder content while OMC decreased at higher eggshell powder content. These effects were more pronounced at the heavy compaction which yielded the highest compactive effort.

IV. Materials Used

The materials used in the present investigation were

1. Red soil
2. Eggshell

V. Test to be Conducted

1. Liquid limit
2. Plastic limit
3. Plasticity index
4. California bearing ratio (CBR) test

VI. Results & Discussions

TABLE 3: Test results of virgin soil

Soil sample	Liquid limit	Plastic limit	Plastic index	CBR
Virgin soil	26.2	7.43	11.1	1.54

TABLE 4: soil + eggshell powder

Particulars	Soil+2%ESP	Soil+4%ESP	Soil+6%E SP
Liquid limit	26	24.2	17.5
Plastic limit	8.54	11.78	12.12
Plasticity index	17.46	12.42	5.38
CBR	1.605	1.897	2.043

Fig 2: plastic characteristic of untreated and treated soil with Eggshell powder

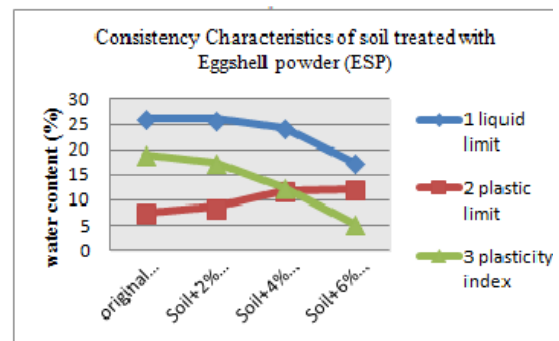


Fig 3. CBR load- penetration curve of untreated soil

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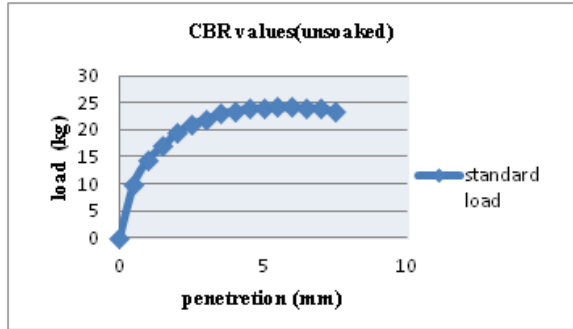


Fig 4. Soil+2% Eggshell powder

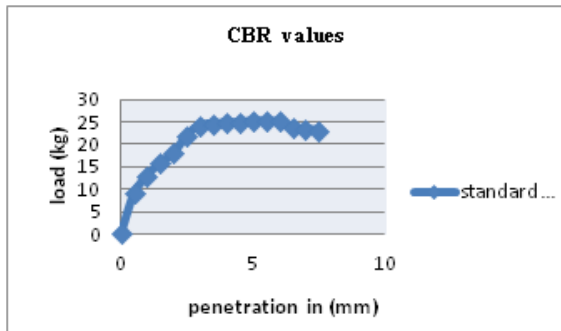


Fig 5. Soil+4% Eggshell powder

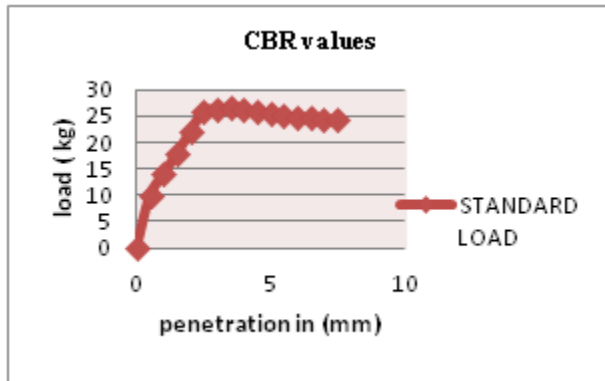


Fig 6. Soil+6% Eggshell powder

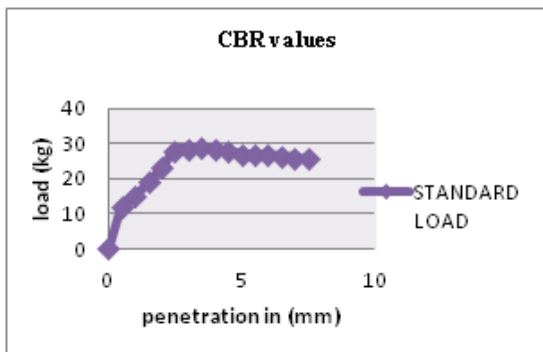


Fig.7 Liquid Limit of Soil with Varying % of Eggshell powder(ESP)

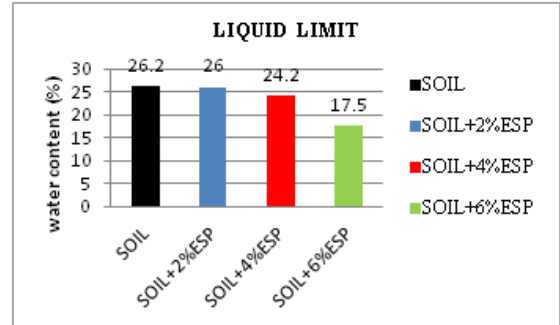


Fig.8 Plastic Limit of Soil with Varying % of Eggshell powder (ESP)

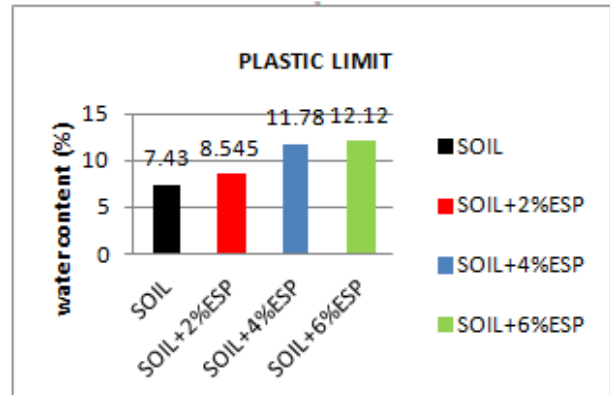
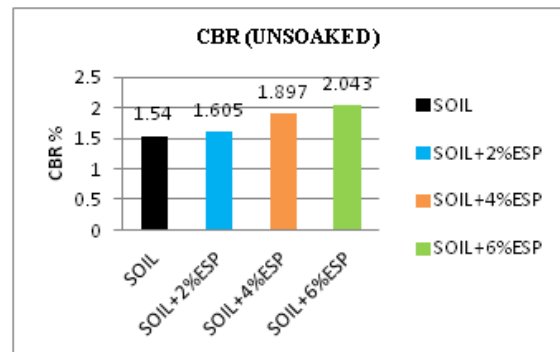


Fig.9 CBR % of Soil with Varying % of Eggshell powder(ESP)



VII. Conclusion

Based on the findings of the present investigations, the following conclusion can be drawn.

- Treatment of soil with admixture like Eggshell powder has resulted in change in atterberg's limit. Liquid Eggshell powder mixed Soil decreases with the increasing proportions of the admixture.
- It is observed that plastic limit of Eggshell powder mixed soil increases with increasing proportions of admixture.
- Addition of Eggshell powder with soil increases both CBR value substantially.

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- But addition of Eggshell powder improves CBR value.
- Eggshell powder has high potential to improve the engineering properties of soil of red soil and marked more influence on strength characteristics of soil.
- Soil improvement has being in the qualitative sense only, but more recently, it has also become associated with quantitative values of strength and durability, which are related to performance.

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