A REVIEW OF LITERATURE ON EFFECT OF AGRICULTURAL SOLID WASTES ON STABILIZATION OF EXPANSIVE SOIL

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Abstract: Change in moisture content of black cotton soil also known as expansive soils leads to high shrinking and swelling which if not appropriately treated may lead to the reduction of design life of civil engineering structures such as highways, railways etc. Because this soil tends to put a challenging task to civil engineers, attempts have been made by so many researchers in trying to proffer solutions to this defect by experimenting in innovative ways with different materials that could possibly improve the soil engineering properties, reduce environmental hazards and as well be very cost effective. Wastes from different industries have been used for this purpose, however, the aim of this paper is to explore the agricultural solid waste materials already used for stabilization and as well develop the gaps that are found in other agricultural solid wastes.

Key Words: Agricultural Solid wastes, Rice Husk ash (RHA), Bagasse Ash, Groundnut Shell Ash, Olive Cake Residue, Coconut Husk Ash.

INTRODUCTION:

Construction is a very vital stage in execution of civil engineering structures of any type, as much important as it is, it must not be trivialised as wrong construction of well-designed civil works may lead to poor safety and as well increase the cost of a specified project. Construction of standard quality roads require a lot of commitment, labour, good planning with good engineering and construction practices. Modern roads are engineered systems designed to spread or carry wheel loads on surface layer systems which are stiff down to the less stiff layers called the sub grade. The subgrade which is an important part of the road structure usually is considered to be a weak layer, since road construction is executed on the soil, different types of soils are met along the stretch of a proposed alignment, however, black cotton soil also known as expansive soils seem to be the most challenging type of soil encountered by engineers due to the presence of montmorrillonite which is a mineral that is highly unstable thus leading to shrinking and swelling of this type of soil on slight change in moisture content of back cotton soil. Since it is not only uneconomical to excavate soils with poor engineering characteristics and replace from borrow sites with soil having better engineering properties but as well constitute environmental hazards, the use of material wastes that would have constituted such environmental hazards to the society through indiscriminate disposal or wrong methods of incineration are put back into the soil to improve the engineering properties such as California Bearing ratio(CBR), Unconfined Compressive strength(UCS), plasticity, liquid limit, maximum dry density (MDD), optimum moisture content(OMC) etc. The improvement of unstable soil is thus called soil stabilization.

AIM:

This research work is geared towards presenting a literature review on effect of agricultural solid wastes (ASW) on stabilization of expansive soil, putting in place the gap that needs to be bridged with more research on more (ASW).

LITERATURE REVIEW ON SOIL STABILIZATION:

Rice Husk Ash (RHA)

Brook (2009) conducted a study on soil stabilization with fly ash and Rice Husk Ash, it was shown that the stress –strain behaviour of UCS showed that failure stress and strains increased by 106% and 50% respectively when fly ash content was increased from 0 to 25%. When the RHA content was increased from 0 to 12 %, UCS increased by 97% while CBR improved by 47%. It was therefore concluded that RHA content of 12% and fly ash content of 25% are recommended for blending into RHA for forming a swell reduction layer because of its satisfactory performance in Laboratory tests.

Anil and Sudhanshu (2014) performed a study on laboratory study on soil stabilization using fly ash and rice husk ash ,they treated black cotton soil with fly ash at (5%, 10%, 15%, 20% and 25%) while Rice husk ash was treated with (10%, 15%, 20%,25% and 30%) and examined after 28 days of curing. It was observed that Liquid limit was reduced to 55% for (20% fly ash and 25% RHA mixed with soil sample. Plasticity index was reduced to86% for 20% Fly ash and 25% RHA mixed with soil, differential free swell reduced to 75% for 15% fly ash and 20% RHA mixed with soil, specific gravity reduced significantly as well

Agbede et al (2016) did a study on production of concrete roofing tiles using rice husk ash (RHA) in partial replacement of cement, The work was based on an experimental study of roof tiles produced with ordinary Portland cement (OPC) and 5 %,10 %, 15 % , 20 % and 25 % (OPC) replaced by RHA. The result showed that addition of RHA show better results at 10 % replacement level than OPC at 28 days.

Sudipta and Koyel (2016) made a study on potentials of Rice –Husk Ash as a soil stabilizer with virgin soil. RHA was added in 5%, 10%, 15% and 20% by weight of dry virgin soil. They conducted UCS, CBR, Atterberg's Limit, and Standard Proctor tests, maximum dry density (MDD), optimum Moisture content (OMC) .It thus concluded that RHA is good material to be used in soil stabilization for special fine grained soil. Considering the fact that it is very cheap in terms of its availability and financial aspects as well.

Akshaya et al. (2012) made a study on effect of Polypropylene fibre on engineering characteristics of RHA-Lime stabilized expansive soil.0.5 -2% of polypropylene fibre was added at an increment of 0.5 %. The optimum proportion of soil: RHA: Lime fibre was found to be 84.5: 10: 4:1.5.

Muntohar and Hantoro (2000) made a laboratory study on effects of Rice Husk and Lime on engineering characteristics of black cotton soil also known as expansive soil and noticed a significant improvement in engineering properties such as CBR , plasticity Index, Shear strength parameters etc.

Rao et al (2011) studied effect of Rice Husk Ash, Lime and gypsum on engineering properties of expansive soil and found an increase in Unconfined compression strength by 548% at 28 days of curing and CBR increased by 1350 %at 14 days curing at RHA- 20%, Lime -5% and gypsum -3%.

Basha et al (2003) made a study on effects of RHA and cement on plasticity and compaction properties of expansive soil (bentonite) and had recommended 10-15% of RHA and 6-8% of cement as optimum percentages for expansive soil stabilization.

Sabat (2013) on effect of Lime sludge on compaction, CBR, shear strength, Compressive Coefficient and durability of an expansive soil stabilized with optimum Percentages of RHA after 7days of curing. The optimum proportion soil: RHA: Lime sludge was found to be 75:10:15.

Ashango and Patra (2014) made a study on both static and cyclic properties of RHA and Portland slag cement stabilized clay subgrade. They obtained optimum percentage of RHA to be 10% while Portland slag cement as 7.5% for expansive soil stabilization.

Sharma et al. (2008) in their study on the characteristics of expansive clay stabilized using lime, Rice husk Ash and calcium chloride. The optimum percentage for calcium chloride and was obtained to be 1% and 4% respectively in stabilization of expansive soil without addition of RHA. From UCS and CBR point of view when the soil was mixed with lime or calcium chloride, RHA content of 12% was found to be the optimum. In expansive soil – RHA mixes, 4% lime and 1% calcium chloride were also found to be optimum.

Bagasse Ash:

Bagasse is the solid remnant from sugar cane after juice is extracted from it. Bagasse Ash is obtained after the Bagasse is burnt. Several researchers have attempted to study this material in relation to its effect on expansive soils and or black cotton soil. A few of such are as mentioned below.

Manikandam and Moganraj (2014) made an elaborate study on bagasse ash and found that the combined effect of bagasse and Lime had more efficacy than just bagasse only in terms of consolidation of properties of expansive soil along with improvement in other characteristics.

Eberemu et al (2012) did a study on diffusion of municipal waste contaminants in compacted lateritic soil treated with bagasse ash. They experimented with 0%, 4%, 8% and 12% bagasse ash. It was shown that compacted soil bagasse ash mix has the capacity to attenuate Ca2+, Pb2+ and Cr3+ Ions.

Arunav et al (2016) studied Stabilization of Expansive Soil using Sugarcane Straw Ash (SCSA). Experiments were carried by varying the percentages of sugarcane straw ash (5%, 10% and 15%) at varying curing periods (3, 5 and 7 days). It was found that 10 % increase in the percentage of sugarcane straw ash increases the UCS and CBR value with increasing curing periods.

Sabat (2012) had studied the effect of bagasse ash and Lime sludge on OMC, MDD, UCS, soaked CBR and PS of an expansive soil in order to determine its cost effectiveness in strengthening the subgrade of a flexible pavement in expansive areas. The best stabilization effect were obtained when optimum percentage of bagasse ash was 8% and lime sludge was 16%.

Sadeen et al (2015) studied assessment of Bagasse Ash Effect on the California Bearing Ratio of Used Oil Contaminated Lateritic Soils in Nigeria. Laboratory tests were conducted mixing the soil with bagasse ash in steps of 0, 2, 4, 6 and 8 % by weight of dry soil steps of 0, 2, 4, 6 and 8 % by weight of dry soil and contaminating it with used oil in steps of 0, 2, 4, and 6 % by, 4, and 6 % by weight of dry soil. It was thus recommended that Oil contamination resulted in reduced strength in lateritic soils and therefore, contaminated soils should be avoided in use as construction materials.

Osinubi (2009) made a study of effect of bagasse ash on compaction and strength characteristics of Lime stabilized black cotton soil. At 8% lime and 4% bagasse ash combination the highest CBR value was obtained.

Groundnut Shell Ash:

Iorver et al (2016) studied stabilization of makurdi shale using lime-groundnut shell ash. The research was carried out in other to investigate the effect of Lime (L) and Groundnut shell ash (GSA) on some geotechnical properties of Makurdi shale. In this research work, soil classification tests, (CBR), (UCS) and durability test were carried out on the natural shale as well as shale treated with combined range of 2 – 10 % lime and 4 – 20 % groundnut shell ash. Strength improvement was observed with the use of lime – groundnut shell ash combination more than when they were applied in single as the CBR value increase from 8 % to a maximum value of 67 % for the natural shale and shale treated with 10 % L, 20 % GSA respectively. 7 – day, 14 – day and 28 – day UCS increase from 286.42 kN/m2, 463.25 kN/m2 and 340.16 kN/m2 respectively for the natural shale to a maximum value of 933.73 kN/m2, 1018.62 kN/m2, 1030.74 kN/m2 at the respective day for the shale treated with 10 % L, 4 % GSA respectively and the durability value increase from 8.0 % to 43.4 % for the natural shale and shale treated with 4 % L, 16 % GSA respectively. Response of Makurdi shale to treatment clearly shows that, shale can be stabilized with lime + Groundnut shale ash for Civil engineering work.

Adetoro and Dada (2015) studied Potentials of Groundnut Shell Ash for Stabilization of Ekiti State Soil, Nigeria. Some laboratory tests (i.e. Particle Size Analysis, Atterberg limits, Compaction and California Bearing Ratio (CBR) tests) were conducted on Soil sample collected from Ido – Ekiti, South-western part of Nigeria stabilized with 2% to 10% (by proportion of soil) Groundnut Shell Ash (GSA) content. It was recommended that it should be employed with other additive like cement for the formation of secondary cementitious compounds which will be produced from the cement hydration.

Oriola and Moses (2010) studied Groundnut Shell Ash Stabilization of Black Cotton Soil. The stabilization of black cotton soil with groundnut shell ash is not attainable. However, it was found that groundnut shell ash shows progressive strength development with longer curing periods from the observations of the 7, 14 and 28 days cured unconfined compressive strength of specimens.

Gajera and Thanki (2015) studied Stabilization Analysis of Black Cotton Soil by using Groundnut Shell Ash. The Liquid limit and Plasticity index values of 83.36 % and 89.32 % respectively for the natural soil suggested that the soil had high plasticity. There was gradual decrease in the free swell to a minimum value of 2.91% at 10% GSA (Groundnut Shell Ash) as compared to the natural value of 15.25%. The soaked CBR for the natural soil is 1.67% which increased to 2.17% at 10% GSA. This value fell short of specification requirement of the CBR value to be used as sub-base or base material. However, there was increase in strength for UCS of 21 days curing period from a value of 134kN/m2 as compared to 313kN/m2 for the unstabilized soil.

Krisha and Shekun (2015) studied Soil Stabilization by Groundnut Shell Ash and Waste Fibber Material. Based on direct shear test on soil sample, with groundnut shell ash percentages of 3%, 6% and 9%, the increase in cohesion was found to be 7.11%, 14.22% and 20.89% respectively. The increase in the internal angle of friction was found to be 7.69%, 14.48% and 23.98% respectively. Based on unconfined compressive strength test on soil sample with groundnut shell ash of 3%, 6% and 9%, the increase in unconfined compression strength was found to be 24.60%, 44.26% and 59.01% respectively. This increment was substantial and applying it for soils similar to the soil sample is effective. Based on unconfined compressive strength test on soil sample with polypropylene fibre of 0.05%, 0.1% and 0.15%, the increase in unconfined compression strength was found to be 19.67%, 47.54% and 65.57% respectively. Overall it can be concluded that the groundnut shell ash and polypropylene fibre reinforced soil can be considered to be good ground improvement technique especially in engineering projects on weak soils where it can act as a substitute to deep/raft foundations, reducing the cost as well as energy.

George and Karibo (2014) studied stabilization of Nigerian deltaic clay (chikoko) with groundnut shell ash. It is concluded that the marine clays are characterized by low undrained shear strength, high Atterberg limits and natural water contents. On stabilizing the soil with groundnut shell ash (GSA), the unconfined compressive strength (UCS) improved from 315kN/m2 to 450kN/m2 (for standard Proctor compaction) and from 430kN/m2 to 525kN/m2 (for West Africa standard compaction) at 3% and 5% groundnut shell ash content respectively, which represents peak values of UCS. However, these improvements were not satisfactory as they were not up to the 1710kN/m2 UCS value for 7days cured specimens recommended by road note 31 for base material. Similar trend was observed for the California bearing Ratio (CBR); although GSA shows progressive strength development with longer curing periods.

Rashmi et al (2016) studied laboratory investigation of expansive soil stabilized with groundnut shell ash. It can be concluded that the by the decrease in plasticity index and increase in dry density improves the bearing capacity of clayey soil. The improved PI value is due to addition of groundnut shell ash as admixtures to the BC soil. It also reduces the hydraulic conductivity of BC soil. There will be no need of drainage layer after treatment of BC soil. In combination, the admixtures are beneficial for lower plasticity and higher silt content soils.

Olive Cake Residue:

Zahile and Salma (2006) studied Evaluation of the effectiveness of olive cake residue as an expansive soil stabilizer. Test results indicated that addition of only 3% burned olive waste into the soil caused a reduction in plasticity, volume change and an increase in the unconfined compressive strength. However, it was observed that the presence of burned olive waste in the soil greater than 3% caused an increase in the compressibility and a decrease in the unconfined compressive strength. Test results indicate that the use of olive waste in soil stabilization gives greater benefits to the environment than simply disposing off the by-product, olive cake residue. Thus was recommended for use.

Mutman (2013) studied Clay Improvement with Burned Olive Waste Ash. Burned olive waste ash was evaluated for use as clay stabilizer. Before the laboratory, the olive waste is burned at 550°C in the high temperature oven. The burned olive waste ash was added to bentonite clay with increasing 1% by weight from 1% to 10%. The study consisted of the following tests on samples treated with burned olive waste ash: Atterberg Limits, Standard Proctor Density, and Unconfined Compressive Strength Tests. The test results showed promise for this material to be used as stabilizer and to solve many of the problems associated with its accumulation.

Nalbantoglu and Towfiq (2006) made a study on stabilized expansive soil using olive cake residue ash. The production of ash was effected by heating the olive cake residue up to 5500C for a period of one hour. The study authenticated 3% olive cake residue ash as optimum in soil stabilization.

Ureña et al (2013) did a study on Magnesium hydroxide, seawater and olive mill wastewater to reduce swelling potential and plasticity of bentonite soil. To evaluate the effects of the additives, the physical properties of the soil such as compaction, consistency, bearing capacity and swelling pressure were studied. The mineral compositions of the treated soils were evaluated by XRD tests. Test results showed that the non-conventional additives tested reduced the plasticity and the swelling potential of the soil. Indeed the tested agents proved to be very effective to produce reductions in the swelling pressure of 60–87% in comparison with the original swelling pressure of the untreated bentonite. X-ray diffraction tests proved that magnesium hydroxide, seawater and olive mill wastewater promoted mineral changes within bentonite, especially smectite to illite conversion. This conversion is due to the alterations promoted by the additives on conditions such as pH and concentration of different cations (magnesium, calcium, potassium, etc.) The mineral modifications occurred are behind the sharp reductions in swelling pressure and plasticity of bentonite.

Wheat Husk Ash:

Santosh and Vishwanath (2015) conducted a study on stabilization of expansive soil by using wheat husk ash and granulated blast furnace slag and the results showed that both wheat husk Ash and granulated blast slag were optimum at (9%).

Attom and Shatnawi (2005) studied effects of wheat husk on expansive soil. The result showed that there was an increment in shear strength of the soil and a decrease in Plasticity in the expansive soil used.

Cassava Peels Ash:

Afeez, Ige and Ayodele (2015) conducted an investigation on Stabilization of Lateritic Soil with Cassava Peels Ash. The work was carried out to study the characteristics of Cassava Peels Ash (CPA) stabilization on lateritic soil. It was therefore concluded that Cassava Peels Ash has a good potential for stabilizing lateritic soil.

Bello et al (2015) investigated Stabilization of Soil with Cassava Peel Ash – Lime Admixture. Engineering property tests (compaction, California bearing ratio (CBR) and Unconfined Compressive Strength) were performed on both the stabilized and unstabilized soils with the addition of 2, 4, 6 and 8% Cassava Peel ash and 1%, 2% and 3% lime contents. There was reductions in the PI of samples 1 from 9% to 1% and 6%. Optimum values of maximum dry densities (MDD) and shear strengths were obtained at 4% for sample 1 and 3, 6% at sample 2 CPA+Lime stabilization. MDD increased to 1.680, 1.680 and 1.920 Mg/m3 respectively in samples A, B and C. It was therefore concluded that Cassava Peel Ash-Lime Admixture has a good potential for improving the geotechnical properties of lateritic soils.

Edeh et al (2014) made a study on Cassava peel ash stabilized lateritic soil as highway pavement material. Test results showed that properties of lateritic soil made a significant improvement when treated with Cassava peel ash. It was recommended that cassava peel ash could be used in both subgrade and sub-base in construction of roads.

Olutaiwo and Adinikin (2016) conducted a research on Evaluation of the Structural Performance of Lateritic Soil Stabilized with Cassava Peel Ash (CPA) and Cement. The result of experimental investigation on the evaluation of the effects of Cassava Peel Ash (CPA) on the index and structural properties of lateritic soil of A-7-5 (AASHTO Classification) and SP soil (USCS classification) respectively. The CPA additions were performed using 0, 2, 4, 6, 8 and 10% increment by weight of dry soil thoroughly mixed. The results of the treated soil showed that the index properties: plastic limit and the maximum dry density (MDD) decreased as the CPA addition increased whereas the liquid limit, plasticity index, Optimum Moisture Content (OMC) and California Bearing Ratio (CBR) increased as the CPA content increased. It was also discovered that the Unconfined Compressive Strength (UCS) increased up to 4% of CPA addition after which was a reduction. This implies that CPA possesses the potential for use in the modification/ stabilization of lateritic soils. Thus the use of CPA in road construction works can be said to have two major advantages – as an effective agricultural waste management and the improvement of road construction soils for better road performance.

Egg Shell:

Kumar and Tamilarasan (2014) investigated Effect of Eggshell Powder in the Index and Engineering Properties of Soil. Soil samples were collected and stabilized with eggshell powder in proportions of 0.5% to 5.5% at 0.5% interval by dry weight. The index and engineering properties were carried out to access the behaviour of soil with the addition of eggshell powder. The unconfined compressive strength test was carried out with and without delay in compaction. Addition of eggshell powder to soil sample lead to increase in unconfined compressive strength. The study found that the optimum percent of Egg shell is 3%, increase beyond 3% makes it undesirable.

Paul et al (2014) made an investigation on Improvement of Clayey Soil Using Egg Shell Powder and Quarry Dust. With addition of ESP, there was a considerable decrease in Atterberg's Limits, and after 20% the value was constant. The OMC increased and maximum dry density decreases with increase in percentage of ESP. With addition of varying percentages of ESP cohesion decreased and angle of internal friction increased. Shear strength increased with increase in percentage of ESP and after 20% strength was constant. Permeability increases with increase in ESP. Coefficient of consolidation increased and compression index decreased with increase in percentage of ESP. From the analysis it was found that 20% of ESP gave considerable improvement in properties of clay soil. So 20% selected as optimum percentage. Maximum dry density increased and optimum moisture content decreased considerably with addition of optimum percentage of ESP and varying percentage of QD.The Shear strength and angle of internal friction increased and cohesion decreased with addition of optimum percentage ESP and increase in percentage of QD. Atterberg's limits decreased considerably with addition of optimum percentage of ESP and QD. PI is almost constant for 20% and 30% QD with optimum percentage of egg shell. Hence 20% ESP & 30% QD is selected as optimum percentage. It was thus concluded that egg shell and quarry dust are recommended for soil stabilization of clayey soils.

Okonkwo et al (2012) studied The Effects of Eggshell Ash on Strength Properties of Cement-Stabilized Lateritic. The study aimed at determining the effect of eggshell ash on the strength properties of cement-stabilized lateritic soil. The lateritic soil was classified to be A-6(2) in AASHTO rating system and reddish-brown clayey sand (SC) in the Unified Classification System. Constant cement contents of 6% and 8% were added to the lateritic soil with variations in eggshell ash content of 0% to 10% at 2% intervals. All proportions of cement and eggshell ash contents were measured in percentages by weight of the dry soil. The Compaction test, California Bearing Ratio test, Unconfined Compressive Strength test and Durability test were carried out on the soil-cement eggshell ash mixtures. The increase in eggshell ash content increased the Optimum Moisture Content but reduced the Maximum Dry Density of the soil-cement eggshell ash mixtures. Also the increase in eggshell ash content considerably increased the strength properties of the soil-cement eggshell ash mixtures up to 35% in the average but fell short of the strength requirements except the durability requirement was satisfied.

Amu et al (2005) studied Effect of Eggshell Powder on the Stabilizing Potential of Lime on an Expansive Clay Soil. Tests were carried out to determine the optimal quantity of lime and optimum percentage of lime –ESP combination, the optimal quantity of lime was gradually replaced with suitable amount of eggshell powder. The lime stabilized and lime ESP stabilized mixtures were subjected to engineering tests. The optimal percentage of Lime-ESP combination was attained at 4% ESP +3% lime. Which served as control. Results of maximum Dry Density ,CBR,UCS test and undrained triaxial shear strength test all indicated that lime stabilization at 7% is better than combination of 4% ESP + 3% Lime.

Corn Cob:

Akinwumi and Aidomojie (2015) Studied Effect of Corncob ash on the geotechnical properties of Lateritic soil stabilized with Portland cement. The article aimed at providing experimental insights on the engineering properties of lateritic soil stabilized with cement-corncob ash (CCA) to ascertain its suitability for use as a pavement layer material. Series of specific gravity, consistency limits, compaction, California bearing ratio (CBR) and permeability tests, considering three CCA blends and four CCA contents, varying from 0 to 12%, were carried out. The results showed that the addition of CCA to the soil generally reduced its plasticity, swell potential and permeability; and increased its strength. CCA-stabilization, aside being more economical and environment-friendly than cement-stabilization, improved the geotechnical properties of the soil for pavement layer material application. Thus was recommended for use in pavement layers.

Yinusa and Apampa (2014) Did an Evaluation of the Influence of Corn Cob Ash on the Strength Parameters of Lateritic Soils. The soil was mixed with CCA in varying percentages of 0%, 1.5%, 3%, 4.5%, 6% and 7.5% and the influence of CCA on the soil was determined for Liquid Limit, Plastic Limit, Compaction Characteristics, CBR and the Unconfined Compression Test. These tests were repeated on laterite CCA-cement mix and laterite-cement mix respectively in order to detect any pozzolanicity in CCA when it combines with Portland cement and to compare results with a known soil stabilizing agent. The result showed a similarity in the compaction characteristics of soil-cement, soil-CCA and soil-CCA-cement, in that with increasing addition of binder from 1.5% to 7.5%, Maximum Dry Density progressively declined while the OMC steadily increased. In terms of the strength parameters, the maximum positive impact was observed at 1.5% CCA addition for soil-CCA with a CBR value of 84% and a UCS value of 1.0MN/m2, compared with the control values of 65% and 0.4MN/m2 respectively. For the soil-CCA-cement mix, the strength parameters CBR and UCS continued to increase with increasing binder addition within the tested range for the ratios 1:2 and 1:1 and 2:1 CCA: cement. Significantly, the results from the soil-CCA-cement mix, indicated the pozzolanicity of CCA in that UCS values were higher by at least 14% for the 1:1 ratio, than was attained with the addition of only the corresponding quantity of cement. In the light of the above, it was recommended that CCA can be made commercially available in its pure form or as CCA-cement blends and promoted as a stabilizing agent for soils in pavement construction.

Apampa et al (2015) studied Modelling of Compaction Curves for Corn Cob Ash-Cement Stabilized Lateritic Soils. The study proposed a model for predicting the dry density of lateritic soils stabilized with corn cob ash (CCA) and blended cement - CCA. Lateritic soil was first stabilized with CCA at 1.5, 3.0, 4.5 and 6% of the weight of soil and then stabilized with the same proportions as replacement for cement. Dry density, specific gravity, maximum degree of saturation and moisture content were determined for each stabilized soil specimen, following standard procedure. Polynomial equations containing alpha and beta parameters for CCA and blended CCA-cement were developed. Experimental values were correlated with the values predicted from the Mat lab curve fitting tool, and the Solver function of Microsoft Excel 2010. The correlation coefficient (R2) of 0.86 was obtained indicating that the model could be accepted in predicting the maximum dry density of CCA stabilized soils to facilitate quick decision making in road works.

Areca Nut Husk Ash:

Neelu and Singh (2016) made an investigation on effect of Areca nut Husk Ash and Water Hyacinth Stem Ash on Plasticity Behaviour of Lateritic Soil. The paper presented investigations on the influence of areca nut husk ash and water hyacinth stem ash as an additive on the plasticity behaviour of soil. Ashes were mixed with the soil at 5, 10, 15 and 20 wt. %. It was observed that the areca nut husk ash decreased the plasticity index, whereas water hyacinth stem ash increased the plasticity index with the increase in ash content. Thus optimum 15% addition of ANA was recommended from the study.

Lekha et al (2014) made a study on Evaluation of lateritic soil stabilized with Areca nut coir for low volume pavements. The study mainly focused on the durability test and physical evaluation of soil cement mixtures reinforced with Areca nut coir. Coir content was varied from 0.2% to 1% with an increment of 0.2%. For further improvement, a uniform dosage of 3% cement was added to soil. Laboratory tests including the Unconfined Compressive Strength (UCS), California Bearing Ratio (CBR), durability and fatigue behaviour, were conducted as per standards. The test results indicated that the improvement in characteristics of the soil cement coir mixtures were functions of coir dosage, soil type and curing days. Durability test satisfied at 1% Areca nut coir with 3% cement. The stress–strain values were determined and damage analysis was conducted for the higher dosage of Areca nut coir using KENPAVE software. From the results it was observed that, the Areca nut coir reinforced cement soil mix can be used for low volume roads (traffic $\leqslant$1 million standard axles).

Muni, et al (2014) investigated strength and stiffness response of Itanagar Soil Reinforced with Areca nut Fibre. In the study a series of triaxial compression tests under different confining pressures were conducted on locally available (Itanagar, Arunachal Pradesh, India) soil without and with Areca nut Fibre. The percentage of Areca nut fibre by dry weight of soil was taken as 0.25 %, 0.5 %, 0.75 and 1 % and they were randomly mixed with the soil. The soil samples of unreinforced and reinforced soil for triaxial tests were prepared at maximum dry density corresponding to optimum water content The shear strength parameters (c and Ʋ) and stiffness modulus (σd /□ i.e. ratio of deviator stress to corresponding strain) of soil corresponding to each fibre content was determined. The effect of change in length of fibre was also investigated. Tests results indicate that on inclusion of Areca nut fibre, the shear strength parameters (c and Ʋ) and stiffness modulus (σd /□) of soil increased. It was also observed that on increasing the percentage of Areca nut fibre, these parameters further increased and this increase was substantial at fibre contents of 1 %. Thus there was a significant increase in shear strength parameters and stiffness modulus of soil due to addition of Areca nut fibre and was recommended as it was found to considerably increase the load carrying capacity and reduce the value of immediate settlement of soil significantly.

Millet Husk Ash:

Uche and Ahmed (2013) investigated effect of millet husk ash on index properties of marginal lateritic soil. Experimental investigation classified the untreated soil as A-7-6 and CL soil according to AASHTO and USCS classification respectively. The MHA additions were performed using 0, 2, 4, 6, 8 and 10% of MHA by weight of dry soil thoroughly mixed. The results of the treated soil showed that the index properties: liquid limit, plastic limit and the maximum dry density (MDD) decreased as the MHA addition increased whereas the plastic index and Californian bearing ratio (CBR) increased as the MHA content increases. This implied that the Millet husk ash (MHA) possesses the potential for use in the modification/ stabilization of marginal lateritic soils and hence recommended for use. It was found that MHA can added to soil at above 10% can be used for soil stabilization.

Coconut Husk Ash:

Oluremi et al (2012) studied stabilization of poor lateritic Soils with Coconut Husk Ash (CHA). The soil used for experiments was air dried and divided into six samples and each sample was stabilized using 0, 2, 4, 6, 8 and 10% of coconut ash by mass of soil sample. The result indicated that coconut husk ash is suitable for improving the California bearing ratio because this parameter increases with addition of coconut husk ash. Addition of coconut husk ash also increased the plastic limit but reduced the plasticity index. Therefore, this study shows that coconut husk ash can be effectively used to improve lateritic soils with low CBR values but not suitable for improving soils with high liquid limit.

Shabana et al (2014) studied on CBR values of soil with crushed coconut shells. The study focused on investigating the improvement of the soil strength by the inclusion of coconut shell pieces of different concentration, of varying sizes at different depths. The results of the study clearly indicated that the inclusion of Crushed Coconut Shells had noticeable influence on CBR value of soils. Location of Crushed Coconut Shell layer across the depth of the specimen shows significant variation in CBR value. It was observed that beyond 0.2H depth, effects of Crushed Coconut Shell were nominal. Effects of multiple layers and size of particles of Crushed Coconut Shell were also examined and found that with additional layers, the percentage increase in CBR were high, except in case of four layer inclusion. But when percentage improvement was normalized with unit material consumption, the most effective and economical results were obtained for single layer inclusion of Crushed Coconut Shell of 1cm size, 25gm at a depth of 0.2H.

Vysak and Bindu (2012) investigated Stabilisation of lateritic soil using coconut shell, leaf and husk ash. The study analysed the suitability of coconut shell, husk and leaf ash to stabilize the lateritic soil. The results showed the addition of CSLHA improves the strength properties of soil. The optimum amount of CSLHA to be added for pavement construction is found to be 7%.

Ibrahim and Oluwafemi (2015) Investigated strength characteristics of genetically different rice and coconut husk ash compacted shales, 2 to 20 % by weight of both RHA and CHA. It was concluded that, addition of 10 % RHA and 6–10 % CHA brought about optimal effect on the geotechnical properties of shales and as such can be regarded as the optimum content. It was concluded that these materials could thus serve as suitable alternatives to modify and stabilize problematic shale and hence help reduce construction costs, environmental hazards and ultimately bring about shales with improved geotechnical properties.

Need for study:

From the literature review studied carefully on expansive soil stabilization using Agricultural solid wastes, the following gaps needs to be bridged.

It is observed that most researchers study the effect of soil stabilization on CBR, UCS atterberg's limits, however tests determining resilient modulus of materials, coefficient of consolidation, permeability, cohesion and angle of internal friction have not been studied by most researchers.

There is few discussion of results based on field experience of use of any of the materials widely experimented for use in expansive soil stabilization.

There is minimal research is done on damage analysis.

Very minimal research is done on stress – strain relationship of soils.

Very minimal or no research has been conducted on other agricultural solid wastes emanating from Potato, yams, orange, Banana, soya beans, Forest leaves, coco yam, cocoa, Eggs, Tobacco, cotton, Millet, Sorghum, Rye, etc. despite the fact that they constitute environmental hazards and could have their usefulness in soil stabilization.

CONCLUSION:

It is concluded from the above discussion that there is need to incorporate the above mentioned without limitations to specific soil tests but exploring more soil tests in determining effect of agricultural solid wastes.

It should also be noted that while some agricultural solid wastes are very effective at certain optimum percent in soil stabilization of expansive soils some have been found inefficient but still useful when added with other materials.

The scope of use of Agricultural solid wastes in soil stabilization should be extended to wastes as mentioned above and many more.

Use of agricultural solid wasted in soil stabilization have in many perspectives proven to be effective as they improve engineering characteristics of soil, reduce immensely environmental pollution , increases the span of life of structures constructed on stabilized soil and as well are considered to be very cost effective.

ACKNOWLEDGMENT:

The authors would like to thank God almighty the creator of heaven and earth, their Parent, Mr. & Mrs. Tiza, Late Mr. & Mrs. Iorver and much thanks to S.T. Hon (SAN) and Mummy Hon Felicia for all their love and support through the years.

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