ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome XV [2022] | Fascicule 1 [January – March]

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STABILIZATION OF LATERITIC SOIL WITH CEMENT AND TREATED SISAL FIBRE

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Abstract: Lateritic soil collected at Shika Zaria was stabilized with Cement (C) and sisal fibre (SF) to determine its effect on the unconfined compressive strength. The preliminary investigation conducted shows that it falls under A–7–6 (10) classification and CL. The soil was treated with cement–sisal fibre in concentrations of 0%, 2%, 4%, 6%, and 8% and 0%, 0.25%, 0.5%, 0.75% and 1% by dry weight of soil. The Sisal Fibre was treated with Sodium Borohydride ($NaBH4$) (1% wt/vol) for 60 minutes at room temperature to remove the cellulose content present in the Fibre. Compaction was carried out using Standard Proctor energy and the Maximum Dry Density (MDD) decreases from 1.85Mg/m^3 for the natural soil to 1.6Mg/m^3 at 4% cement/0.25% sisal fibre treatment. The Optimum Moisture Content (OMC) increases from 18% to 24.5% at 6% cement of 0.5% sisal fibre content. The Unconfined Compressive Strength (UCS) value increased from 186kN/m^2 for the natural lateritic soil to a peak value of 1942kN/m^2 at 4% cement /0.5% sisal fibre. This peak value is higher than the 1720kN/m^2 criterion for adequate cement stabilization of base courses. Analysis of variance was carried out using Microsoft Excel Analysis Tool Pak Software Package. Mini–tab R15 Software was used for regression analysis. Laboratory results were used to generate reliability indices using a FORTRAN based first order reliability program. The reliability analysis carried out indicates that the reliability indices were more pronounced for MDD and OMC which are also related to the UCS of the soil evaluated. Model 1 produced successful result in coefficient of variation (COV) range 1 – 50 % that can be used to predict field UCS of lateritic soil stabilized with Cement and sisal fibre for base and sub–base materials for pavement structures.

Keywords: Lateritic soil, Cement, Sisal fibre, Unconfined Compressive Strength and Sodium Borohydride ($NaBH4$), Regression analysis and Reliability index

INTRODUCTION

Soil stabilization is the improvement of the original soil properties to meet specific engineering requirements. It is aimed at the enhancement of the engineering properties of deficient soils to enable them perform and sustain their intended engineering use [1]. Its objectives are: improvement of the strength of the soil and bearing capacity, decreasing permeability and water absorption, and to increase the durability under varying moisture content. Stabilization increases the shear strength of a soil or control the shrinkage–swell properties of the given soil thus improving the load bearing capacity of a sub grade to support pavement and foundation [2]. Soil stabilization can be utilized on roadways, parking areas, site development projects, airports and many other situations where subsoil are not suitable for construction.

Laterites, which are formed in tropical and sub–tropical regions of hot and humid climatic condition with heavy rainfall, warm temperature and good drainage according to Townsend [3], are very rich in iron and aluminium and occur mostly as the capping of the hill. They therefore find extensive use in numerous construction activities such as subgrade material for road construction and brick production material [4]. Most tropical laterites predominantly composed of kaolinite, non–swelling, non–expanding 1:1 clay mineral which are engineering materials [5]; some often contain swelling 2:1 clay mineral sand therefore constitute problematic engineering materials for road construction. Stabilization can be used to improve a wide range of sub grade materials varying from expansive clays to granular materials. This process is accomplished using wide variety of additive; including lime, fly ash, and Portland cement other by–products include lime kiln dust and cement kiln dust [2].

Cement stabilized soils generally have high compressive strength but low ductility. Cement stabilization generally increases durability, shrinkage and volume stability for expansive clays but reduces the permeability for most other soils. Additives other than pozzolanas used in soil stabilization include fibres, shredded tyres and polymers and lime. Sisal fibre can also be used in addition with cement stabilize soil for construction purpose as they increase the soil ductility [6]. Also. Tanko [6] indicated that sisal fibre are bio–degradable materials because of the cellulose present in the fibre which when used for reinforcing soil can degrade at long time curing, therefore the sisal fibre used for this research work was treated with Sodium Borohydride ($NaBH4$) (1% wt/Vol) as recommended by [7].

Sisal fibres comes from sisal plant and from Chinese origin, the plant is repeatedly beaten and pulped to form the fibre along with other natural fibres. Sisal fibres have recently become popular in soil reinforcing due to their affordable cost, strength and availability the addition of sisal fibre increases the shear strength of soil as well as cohesion and ductility. They are important agricultural products used in the manufacture of rope. They are also used in reinforcement of polymeric or cement based composite. The production process leads to large amount of residues generation, which currently have low potential for commercial use. The length and percentage of fibre is important because being too long reduces the shear strength and percentage greater than 0.75% also reduces shear strength [6].

Therefore, this research aimed at stabilizing lateritic soil using cement and treated sisal fibre to improve the strength of the lateritic soil. This was achieve through the treatment of the sisal fiber with Sodium Borohydride (NaBH4) (1% wt/Vol) and determination of compaction characteristic, compressive strength of cement – treated sisal fiber stabilized lateritic soil and carrying out statistical analysis together with the reliability analysis of the results obtained.

MATERIALS AND METHODS

— Materials

- **Lateritic soil:** The lateritic soil sample used for this study was collected by method of disturbed sampling from a borrow pit located at Shika in Zaria Local Government Area (Longitude 7^0 36' E Latitude 11^0 4' N). The top soil was removed to a depth of 0.5m before the soil samples were taken, sealed in plastic bags to avoid loss of moisture and placed in sacks before transportation to the laboratory. The soil samples were then air–dried before lumps were broken to obtain particles passing BS No. 4 sieve (4.76 mm aperture).
- **Cement:** Cement used for the study was obtained from Dangote Portland Cement deport in Kaduna State.
- **Treated Sisal Fibre:** Sisal fibre was gotten from Central Market in Kaduna metropolis in Kaduna State. A length of 3.5cm sisal fibre was used.

— Methods

The soil was subjected to tests in accordance with [8], for the natural soil and [9] for the treated soil samples.

- **Index properties:** Index tests were carried out on the natural soil in according to [8] and [9].
- **Oxide composition:** The oxide composition of Cement was determined at defense industry cooperation of Nigeria (DICON), Kaduna, Nigeria, using the method of X–Ray Fluorescence (Nuclear Energy Test). The Properties of sisal fibre and the tensile and elongation test was carried out at Standard Organization of Nigeria (SON) at Kawo New Extension Kaduna. The test was carried out by inserting three strand of the sisal fibre into the test machine and the tensile and elongation value was recorded as recommended by [6]. This ensures that the peak value of strength gain in sisal fibre stabilized soil was obtained at 3.5cm length. The sisal fibre was soaked in a solution of Sodium Borohydride containing 1% wt/Volume and allowed for 24 hours to extract the cellulose contained in the sisal fibre. The treated sisal fibre was allowed to dry at room temperature before been used together with cement to stabilize the soil.
- **Compaction:** Tests involving moisture–density relationships carried out for untreated and cement – treated sisal fibre treated specimen using the Standard Proctor energy level. The Standard Proctor effort consists of the energy derived from a 2.5kg rammer falling through 30cm onto three layers, each receiving 27 blows.
- **Unconfined compressive strength:** Lateritic soil was treated with both cement and treated sisal fibre in stepped concentrations of 0, 2, 4, 6 and 8% as well as 0, 0.25, 0.5, 0.75, and 1.0 %, respectively. Thoroughly mixed air–dried soil – Cement – Treated sisal fibre mixtures were compacted at Optimum Moisture Contents (OMC) and compacted using standard Proctor (SP) energy. The compacted samples were extruded from the standard 1,000 cm^3 mould using a cylindrical steel mould with height of 76mm and internal diameter of 38 mm. The specimens were sealed in polythene bags and kept in the humid room at a constant temperature of 25 ± 2^0C for 7 days curing period so as to compare the result with the standard UCS value of 1720kN/m^2 as recommended by [10]. The specimens were then placed in a load frame driven at a constant strain of 0.10 %/min until failure occurred. Three specimens were used for each test and the average result was taken.
- **Set up of regression and reliability analysis procedures**

Laboratory results measured from all experiments were used for the regression and reliability analysis. Measured soil variables were classified as dependent and independent variables. The UCS was dependent variable while C, SF, MDD and OMC are called the independent variable. A regression model was developed using Minitab R15 to predict the unconfined compressive strength from the measured laboratory results.

Statistical analysis was carried out on the obtained results using analysis of variance with the Microsoft Excel Analysis Tool Pak Software Package. The regression equation developed was used as a limit state function for the reliability analysis. The regression model was incorporated into a FORTRAN based program, FORM 5 to produce the reliability index for each variable, one at a time within a range of coefficient of variation (COV) between 1 and 100% while the original values for other variables were allowed to remain constant. The UCS, MDD and OMC values were assigned lognormal distributions while C and SF values were assigned normal distributions. The various data for the reliability analysis are contained in Table 1.

Table 1: Input data for reliability based design for six independent variable using FORM 5 from laboratory measured strength.

S/no	Variables	Distribution type	Mean e(x)	Standard deviation s(x)	Coefficient Of variation Cov (%)
1	UCS	Lognormal	598.2	330.5	55.25
2	C	Normal	4.0	2.887	72.18
4	SF	Normal	0.5	0.361	72.20
5	MDD	Lognormal	1.674	0.0524	3.13
6	OMC	Lognormal	20.80	2.116	10.17

RESULTS AND DISCUSSION

— Index Properties of the Natural Soil

The index properties of the natural soil used are summarized in Table 2. The oxide composition of the lateritic soil and cement used are shown in Table 3 and Table 4 respectively. The property of the sisal fibre used is shown in Table 5. The soil belongs to the CL group in the Unified Soil Classification System [11] or A–7–6(10) soil group of the AASHTO soil classification system [12].

Table 2: Properties of the Natural Soil

Property	Quantity
Percentage passing BS No 200 sieve, %	57.5
Natural Moisture Content, %	20.76
Liquid Limit, %	48.00
Plastic Limit, %	27.27
Plasticity Index, %	20.73
Linear Shrinkage, %	7.87
Free Swell, %	19.09
Specific Gravity	2.73
AASHTO Classification	A–7–6(10)
USCS	CL
Maximum Dry Density, Mg/m^3	1.85
British Standard Light	
Optimum Moisture Content, %	18.0
British Standard Light	
Unconfined Compressive Strength, kN/m^2	189
British Standard Light	Reddish Brown
Colour	

Table 3: Oxide composition of lateritic soil [13]

Oxide	Concentration %
SiO_2	47.1
Al_2O_3	17.40
K_2O	0.48
CaO	0.17
TiO_2	3.69
V_2O_5	0.070
Cr_2O_3	0.035
Fe_2O_3	19.04
MnO	0.054
CuO	0.065
ZrO	0.966
L.O.I	10.3

Table 5: Properties of the sisal fibre [13]

Property	Quantity
Natural Humidity, %	14.48
Average Diameter, mm	0.13
Water Absorption, %	340
Specific Gravity, g/cm^3	0.22
Tensile Strength, N/mm^2	
One Strand	10.60
Two Strands	24.45
Three Strands	30.60
Elongation at Break, mm	5.58
Colour	Shiny white

Table 4: Oxide composition of cement [13]

Oxide	Concentration %
CaO	73.05
SiO_2	14.42
Al_2O_3	3.48
Fe_2O_3	3.38
MgO	1.30
Mn_2O_3	0.03
Na_2O	0.00
SO_3	2.99
P_2O_5	0.11
Cr_2O_3	0.01
SrO	0.46
ZnO	0.00
Cl	0.15
TiO_2	0.21
L.O.I	–

— Compaction Characteristics

The variations of the Maximum Dry Density (MDD) and Optimum Moisture Content (OMC) of lateritic soil – sisal fibre mixtures with cement are shown in Figure 1 and 2, respectively.

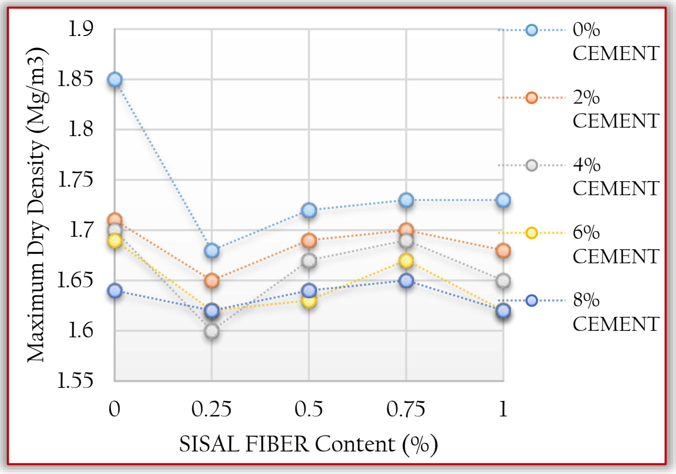

Figure 1: Variation of maximum dry density of lateritic soil – sisal fibre content mixture with cement content

The MDD shows a general trend of decreasing in MDD value from 0% sisal fiber to 0.25% sisal fiber and thereafter increases with increase in sisal fiber content up to 1% sisal fiber for all cement contents considered.

The MDD decreased from 1.85 to 1.6Mg/m^3 at 0.25% sisal fibre/4% cement contents. The reduction may be due to the effect of cement (with high calcium oxide) on the workability of the stabilized soil and also attributed to sisal fibre having low density as compared to the density of the soil. This also reduces the average unit weight of the solids in the mixture and making compaction difficult because the sisal fibre occupy more space thereby creating voids within the mixture.

The trend of decreasing MDD with admixture contents was reported by [14 – 17]. Other probable reasons for the drop in MDD may be due to the flocculated and agglomerated clay particles.

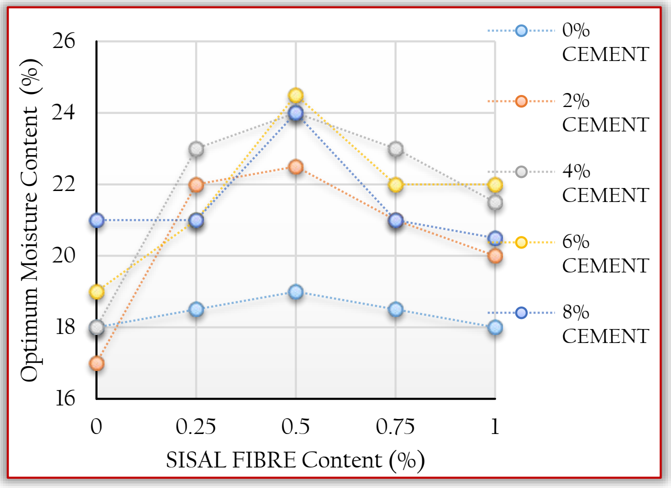

Figure 2: Variation of optimum moisture content of lateritic soil – sisal fibre content mixtures with cement content

The OMC increased generally for all the cement contents with increasing sisal fibre content up to 0.5% sisal fibre content. Thereafter there was a general decrease in OMC as the sisal fibre content increased. The OMC increased from 18% to 24.5 % at 0.5% sisal fibre/6 % cement. Upon further increase in the fibre content, the OMC reduced as the sisal fibre content increased. This means that the fibre, which naturally had a high water absorption rate, caused an initial increase in OMC from the plain state of the soil to 0.5% content of the fibre by dry weight of soil and thereafter reduced the OMC with increasing aspect ratio and percentage content. Similar trends were observed by [14, 15] who used laterite soil and black cotton soils respectively

— Unconfined Compressive Strength

The variation of unconfined compressive strength (UCS) of lateritic soil – sisal fibre mixtures with cement for 7 days curing periods is shown in Figure 3. The UCS value for 0% and 2% cement peaks at 0.75% sisal fibre while at 4%, 6% and 8% cement peaks at 0.5% sisal fibre content which correspond to the maximum dry density values peaked at 0.5% sisal fibre. This can be attributed to the fact that at higher percentage of sisal fibre it absorbed the moisture present in the mix meant for cement hydration reaction, thereby reducing the extent of hydration leading to lower strength value.

The peak 7–day UCS values of 1942, 1757 and 2343kN/m^2 were obtained at 4%, 6% and 8% cement from a natural value of 189kN/m^2. These UCS values met the conventional 1720kN/m^2 for adequate cement stabilization of base courses specified by [10]. Prabakar and Srindhar, [14] obtained the highest deviator stress values at 0.75% and at 3.5cm fibre lengths. Santhi and Sayida [15] obtained their peak at 0.50% fibre inclusion.

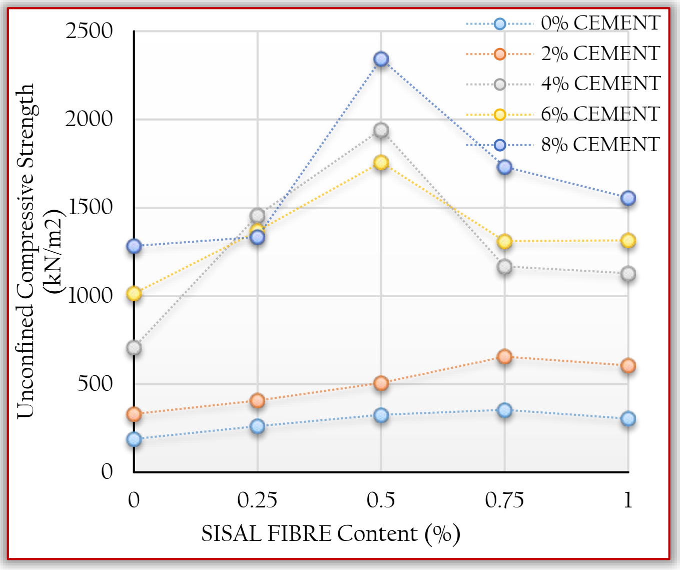

Figure 3: Variation of unconfined compressive strength of lateritic soil –sisal fibre content mixture with cement content

— Regression analysis for unconfined compressive strength

Researchers like [18–19, 13] have successfully used regression models in many geotechnical engineering applications. The regression model (see Eq. (1)) used for this analysis was developed from laboratory results and used for predicting UCS from measured UCS values in the laboratory. Results show that the effect of the several independent variables considered (C, SF, MDD and OMC) on the dependent variable UCS of the treated soil were statistically significant.

The coefficient of determination value (R^2) of 88.9% which was obtained which is equivalent to correlation coefficient (R) value of 94.3% indicates that there is a very strong association between UCS and the independent variables considered.

All the independent variables have positive coefficients in the regression model which indicate that an increase in each of the independent variables will lead to a corresponding increase in the UCS values of the treated soil and vice versa. The possible explanation to this model entails the need to monitor these independent variables for a SF treated lateritic soil with Cement as admixture for use as sub–base/base material or for any geotechnical application.

A plot of predicted UCS values from the model plotted against the measured UCS values measured from the laboratory shows a strong correlation between the UCS values obtained in the laboratory and the predicted values from the regression model using a Third order polynomial relationship with approximate coefficient of determination value (R^2) of 0.889 which was equivalent to correlation coefficient (R) value of 0.943 (see Figure 4).

$$\begin{gathered}\mathrm{UCS} = -3650.09 + 94.18\mathrm{C} + 400.75\mathrm{SF} + \\ 1677.76\mathrm{MDD} + 41.47\mathrm{OMC} \qquad (1) \\ \mathrm{R}^2 = 88.9\% \\ \mathrm{R} = 94.3\%\end{gathered}$$

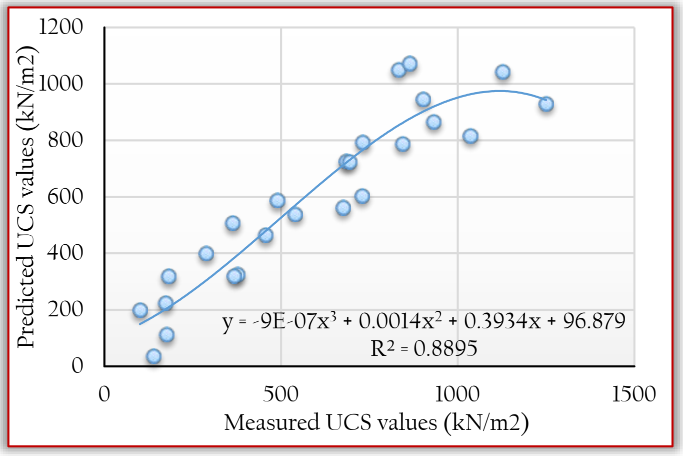

Figure 4: Plot of predicted UCS values against measured UCS values from the regression model

— Reliability assessment on unconfined compressive strength

≡ Influence of unconfined compressive strength on reliability index

The influence of reliability index for UCS of lateritic soil stabilized with cement and treated SF with coefficient of variation in the range of 1–100% is shown in Figure 5–7. Generally, a trend of decrease in the reliability indices was noticed with increase in the coefficient of variation. The reliability index varied linearly with coefficient of variation from 1 to 100%. Reliability index changed significantly which indicate that variation in UCS has major effect on the reliability index for road pavement sub–base materials.

As coefficient of variation changed from 1 to 100%, reliability index for the natural soil computed with 100.57 kN/m^2 changed from −1.48 to −1.54 (see Figure 5) which indicates that all reliability index obtained were negative indicating failure.

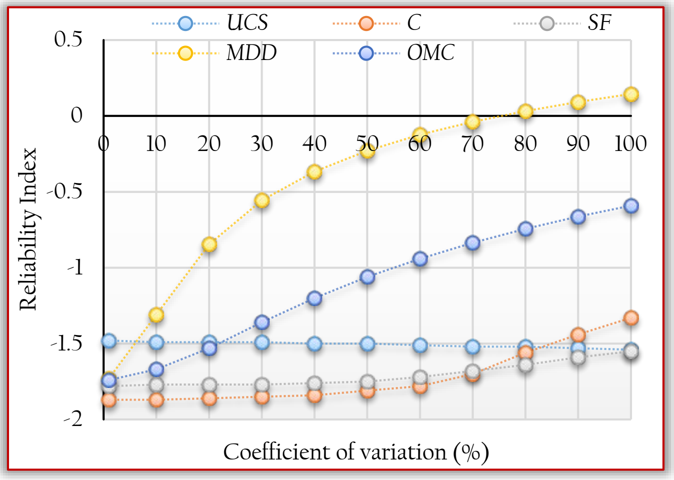

Figure 5: Variation of reliability index with coefficient of variation for unconfined compressive strength for the natural soil

The result was computed using UCS value obtained for the treated but using the standard regulatory minimum requirement of 687–1373 kN/m^2 for sub–base material of UCS as specified by [20].

The reliability index when computed with 687kN/m^2 changed from −0.196 to 0.285 (see Figure 6). The reliability index when computed with 1373kN/m^2 changed from 0.503 to 2.34 (see Figure 7).

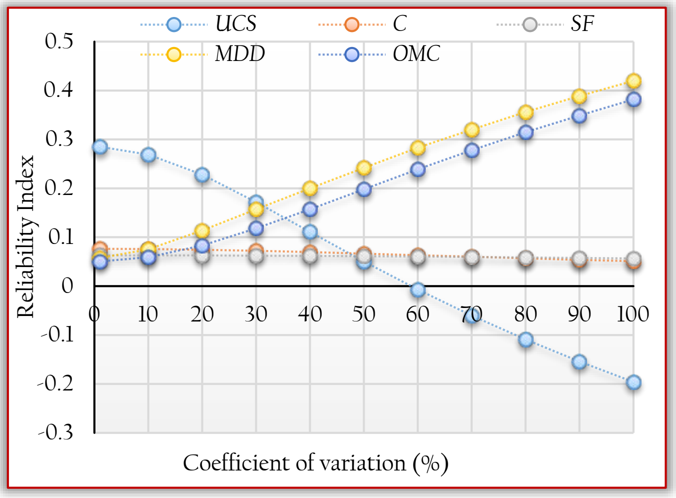

Figure 6: Variation of reliability index with coefficient of variation for unconfined compressive strength of stabilization of lateritic soil with cement and treated sisal fiber computed at 687kN/m^2

The significant changes observe in the reliability index values further shows that addition of cement and treated SF has great effect on the UCS value of the treated lateritic soil. The recorded improvement in strength based on laboratory results can be justified with the significant variations in the reliability indices of the treated soil when compared to the untreated soil [13].

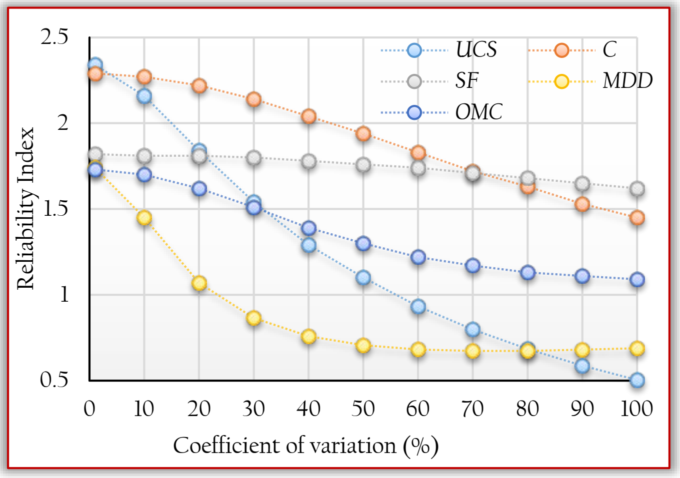

Figure 7: Variation of reliability index with coefficient of variation for unconfined compressive strength of stabilization of lateritic soil with cement and treated sisal fiber computed at 1373kN/m^2

Result shows that Cement and SF can greatly improved the geotechnical properties of lateritic soil as indicated by the changes in their reliability index values obtained, also care should be taken in controlling these parameters during filed operation of any geotechnical application.

≡ Influence of cement content on reliability index of unconfined compressive strength

The effect of cement content on reliability index is shown in Figure 5–7. Cement showed a linear decreasing relationship with changes in the coefficient of variation, while the reliability index varied slightly. This result indicates that change in the content of cement has little influence on the reliability index for road sub–base pavement structures. As coefficient of variation increased from 1 to 100%, reliability index values decreased from −1.33 to −1.87 for natural soil computed with 100.57 kN/m^2 (see Figure 5).

The reliability index when computed with 687kN/m^2 changed from 0.0509 to 0.0763 (see Figure 6). The reliability index when computed with 1373kN/m^2 changed from 1.45 to 2.29 (see Figure 7). Similar trend was reported by [2] when he used cement kiln dust which is an indication that the cement is a factor which must be carefully controlled during field compaction for road pavement or any geotechnical studies when lateritic soil – cement –SF mixtures are be used.

≡ Influence of sisal fibre content on reliability index of unconfined compressive strength

The effect of SF content on reliability index is shown in Figure 5 – 7 (with coefficient of variation in the range of 1 – 100%). SF content showed a decreasing correlation with coefficient of variation in the range 1–100%. A slight variation in the reliability index values was noticed with increase in the coefficient of variation, this is also an indication that variation of SF content has little or no influence on the reliability index. As coefficient of variation increased from 1 to 100%, reliability indices varied between −1.55 to −1.78 for natural soil computed with 100.57 kN/m^2 (see Figure 5).

The reliability index when computed with 687kN/m^2 changed from 0.0565 to 0.063 (see Figure 6). The reliability index when computed with 1373kN/m^2 changed from 1.62 to 1.82 (see Figure 7). Result shows that treated soil produced higher reliability indices than the untreated soil (natural soil) which indicates improvement on the UCS of the soil with Cement and SF content.

≡ Influence of maximum dry density on reliability index of unconfined compressive strength

The influence of MDD shows that for natural soil and for reliability index computed with 687kN/m^2 shows and increase in reliability index with increase in coefficient of variation from 1 to 100% while the reliability index computed with 1373 kN/m^2 shows a decrease in reliability index with increase in coefficient of variation from 1 to 100% (see Figure 5 – 7).

The increase in reliability index for the MDD indicates that a variation in the MDD value has no drastic effect on the strength value of the soil when used for road pavement sub–base materials. For changes in coefficient of variation from 1 to100 %, Reliability indices increased from –1.73 to 0.145 for the natural soil (see Figure 5).

The reliability index when computed with 687kN/m^2 changed from 0.0574 to 0.42 (see Figure 6). The reliability index when computed with 1373kN/m^2 changed from 0.689 to 1.74 (see Figure 7). Treated soil produced higher reliability indices than the natural soil which indicates improvement on the UCS of the soil with Cement and SF content. Similar trend was reported by [2, 21, 19, 13].

≡ Influence of optimum moisture content on reliability index of unconfined compressive strength

The influence of OMC also shows that for natural soil and for reliability index computed with 687kN/m^2 shows and increase in reliability index with increase in coefficient of variation from 1 to 100% while the reliability index computed with 1373 kN/m^2 shows a decrease in reliability index with increase in coefficient of variation from 1 to 100% (see Figure 5 – 7).

The reliability index significantly increased with coefficient of variation. It is evident that changes in the OMC influenced UCS significantly as clearly shown in the changes in reliability index.

Similar trend was reported by [2, 21, 19, 13] which is an indication that the OMC is a factor which must be carefully controlled during field compaction for road pavement or any geotechnical studies when lateritic soil – Cement – SF mixtures are used. As coefficient of variation increased from 1 to 100%, reliability indices varied between –0.591 to –1.74 for natural soil computed with 100.57 kN/m^2 (see Figure 5).

The reliability index when computed with 687kN/m^2 changed from 0.0503 to 0.382 (see Figure 6).

The reliability index when computed with 1373kN/m^2 changed from 1.09 to 1.73 (see Figure 7).

— Comparative sensitivity analysis of the reliability indices of the soil variables

A comparative sensitivity analysis of the reliability indices of the laboratory–based model used was compared with the variation in the independent soil parameters considered (C, SF, MDD and OMC) to determine their effect on UCS. Generally, reliability indices varied for all the variables considered with MDD and OMC having more significant effect on the UCS when compared with C and SF. C and SF content have marginal effect on the UCS of the treated soil. From Figure 6 and 7 it could be observed that the increase in reliability indices was more pronounced for MDD and OMC which are also related to the UCS of the soil evaluated. The result of untreated soil (see Figure 5), low and negative reliability indices were recorded for all the soil variables considered. Higher reliability indices recorded for the treated soil depict improvement in the UCS of the soil.

Similar trend was reported by [13]. Based on this results, good quality control of these variables is vital in the field in order to achieve good road pavement.

— Stochastic model assessment of acceptable safety index for unconfined compressive strength

Results of reliability index obtained for UCS of the soil are shown in Table 6–8 for reliability index computed with 100.57 kN/m^2, 687kN/m^2 and 1373 kN/m^2. NKB Report [22] categorically stated that a minimum safety index value of 1.0 and maximum of 2.5 is recommended for serviceability limit state design of structural components. Table 6 shows that the UCS value did not falls within the acceptable range for serviceability limit state.

Table 7 also shows that for a lower value for UCS for sub–base material recommended by [20] (value of 687kN/m^2) despite having some positive safety index does not attain the minimum safety index of 1.0 for serviceability limit state.

Table 6. Stochastic model assessment of acceptable safety index for natural soil computed with 100.57 kN/m^2

S/N	Variables Factors	Beta Value	Acceptable Range of COV (%)
1	UCS	–1.48 to –1.54	NIL
2	C	–1.33 to –1.87	NIL
3	SF	–1.55 to –1.78	NIL
4	MDD	–1.73 to 0.145	NIL
5	OMC	–0.591 to –1.74	NIL

Table 7. Stochastic model assessment of acceptable safety index for treated soil computed with 687 kN/m^2

S/N	Variables Factors	Beta Value	Acceptable Range of COV (%)
1	UCS	–0.196 to 0.285	NIL
2	C	0.0509 to 0.076	NIL
3	SF	0.057 to 0.063	NIL
4	MDD	0.058 to 0.420	NIL
5	OMC	0.050 to 0.382	NIL

The upper limit of UCS value of 1373 kN/m^2 stipulated by [20] (see Table 8) on the other hand met the requirement of safety index of 1.0 for serviceability limit state but when the coefficient of variation is been varied from 1 to 50 %. This shows that stabilized lateritic soil with Cement and SF can be used to design a geotechnical application when serviceability limit state is been considered.

Table 8. Stochastic model assessment of acceptable safety index for treated soil computed with 1373 kN/m^2

S/N	Variables Factors	Beta Value	Acceptable Range of COV (%)
1	UCS	0.503 to 2.34	1 to 50 %
2	C	1.45 to 2.29	1 to 100 %
3	SF	1.62 to 1.82	1 to 100 %
4	MDD	0.689 to 1.74	1 to 20 %
5	OMC	1.09 to 1.73	1 to 100 %

CONCLUSIONS

The cement stabilization of lateritic soil classified as A–7–6 (10) or CL using treated sisal fibre considered in this study shows that a specimen treated with maximum 0.5% sisal fibre/4% cement content when compacted with the standard Proctor energy yielded 7–day UCS values of 1942kN/m^2. The UCS value met the conventional 1720kN/m^2 criterion for adequate cement stabilization of base courses specified by TRRL [10] for 7 days curing. The regression results shows that there is a strong relationship between the predicted UCS value and the Laboratory UCS value given correlation coefficient (R) value of 0.943.

The reliability analysis carried out indicates that the reliability indices were more pronounced for MDD and OMC which are also related to the UCS of the soil evaluated. Model 1 produced successful result in COV range 1 – 50 % that can be used to predict field UCS of lateritic soil stabilized with Cement and sisal fibre for base and sub–base materials for pavement structures.

Based on the results obtained, the optimum blend of 4% Cement/0.5 % Sisal Fibre treatment on lateritic soil is recommended for used as based material compacted using Standard Proctor energy. Further studies should consider durability analysis and California bearing ratio test on the soil to further assess their strength properties.

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ISSN: 2067–3809
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