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EFFECT OF LOCAL ADMIXTURE *IPOMOEA ASARIFOLIA* ("AJARA") ON THE STRENGTH CHARACTERISTICS OF STABILIZED AND UNSTABILIZED LATERITIC BLOCKS

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ABSTRACT

This paper presents a summary of the results of a study on the use of a local admixture *Ipomoea asarifolia* ('Ajara') on the compressive strength and weight of specimens made from both cement stabilized and unstabilized lateritic soils. The effect of *Ipomoea asarifolia* extractions on the strength characteristic of lateritic blocks was investigated. Three mix proportions of cement: laterite of 0:1, 1:2 and 1:4 using lateritic soils from four different locations from around Ife while using six concentration levels of extracted liquid of *Ipomoea asarifolia* (0; 20; 40; 60; 80 and 100%) in fresh water as the mixing "water" (fluid). *Ipomoea asarifolia* specimen was analyzed to determine constituent chemical composition and their effect in reaction with other materials. Sieve analysis of the lateritic of the lateritic soil mix was carried out while a total of 132 – 100 mm cubes size were tested using a 1570 kN Avery-Denison Compression Testing Machine.

1. INTRODUCTION

In the building industry, over the years, the cost of construction materials has been on the increase resulting in the high cost of housing. To meet the needs of the larger populace, there have been concerned efforts by various researchers to find alternative building materials that are locally available and cheap, particularly the use of lateritic soils. Lateritic soils are readily available in the tropics and can be obtained within the area of construction. Much work has been done on both laterized (cement stabilized) and unstabilized blocks for building. Among works on the improvement of indigenous technology by replacing the fine grain aggregate content of normal concrete is the pioneering work of Adepegba [1]. In this work, the strength of normal concrete was compared with those of concrete in which lateritic fines were used instead of sand, it was concluded that the laterized concrete could be used as a structural material in place of normal concrete. Other researchers have gone further in studying the various factors that affect this material for use as a structural member. On the other hand, it has been shown that the finer the grain size of lateritic soils, the higher the compressive strength of the unstabilized cubes made from such soils [2]. Further works reported that the compressive strength of stabilized landcrete cubes was a function of both the source of laterite and mix proportions [3, 4] while Osunade, et al. [5] did observed that the addition of some fibers to laterized masonry blocks increased the strength appreciably when subjected to weathering. Lasis [3] reported that 10% cement by weight is needed to stabilize lateritic soils to produce blocks of the same order of compressive strength as Sandcrete. Adepegba, et al. [6] found out that for any given lateritic cement mix, there exists an optimum water/cement ratio for maximum strength which increased linearly with increasing cement mix proportions.

Admixtures are used in concrete making to alter a specific property of the mixture either in the fresh or hardened stage in order to achieve a particular strength characteristic. Rahman [7] indicated that the unconfined compressive strength of lateritic soils for sub-base materials in highway construction is higher when stabilized with about 17% rice husk ash content. Falade [8] showed that the addition of saw dust ash in the production of laterized concrete decreased the compressive strength, particularly for those with high aggregate/cement ratio laterized concrete. Osunade [9] working on the use of chemical admixtures, concluded that the compressive strength of stabilized specimens containing either calcium chloride or sugar admixtures increased with the time of curing and that the strength also increased with increasing levels of admixtures. The influence of metakaolin (MK) on the microstructure and diffusion properties of mortar has been studied by Kostuch, et al. [10] from which it was observed that the average pore size significantly reduced when the cement was replaced with 20% MK. Güneyisi, et al. [11] reported that mineral admixtures reduce the permeability of concrete to chloride ion; and that replacing the Portland cement (PC) with mineral admixtures significantly lessened the water permeability of the concretes, depending on the type of mineral admixture used and the replacement level. Udoeyo, et al. [12] worked on the absorption of heavy metals by lateritic soil reported an increase in sorption of heavy metals as concentration of substrate increased.

Ipomoea asarifolia ("Ajara") is an herbaceous plant found largely in South Eastern and South Western Nigeria having climber stems; and according to Ekenyem [13] they have purple flowers which develop three seeds for sexual propagation although asexual propagation can also be achieved by stem cutting. *Ipomoea asarifolia* ('Ajara') from local information in the Oke-Ogun area of Oyo State, a savannah region of Nigeria where the plant grows in the wild, was found to be a good anti-termite material when the extract is used in the mixing of the mud for the construction of buildings. *Ipomoea asarifolia* contains *alkaloids*, *flavonoids*, *saponin* and *steroid* compounds [14] and other researchers [15-22] concluded that the presence of these compounds in concrete and masonry materials result in decrease in water absorption and porosity; increase in compressive and flexural strength. This study ahead of a scientific investigation into the anti-termite property of *Ipomoea asarifolia* is to determine the effect of this material on the characteristic strength of stabilized and unstabilized lateritic blocks; it will also characterize the chemical composition of the material.

2. EXPERIMENTAL PROGRAMME

2.1. Materials

Lateritic soils used for the investigation were collected from four different borrow pit locations around Ile-Ife; sieve analysis of the soils was carried out; the results shown in Figure 1. The cement used was ordinary Portland Cement that conforms to BS 12. The local admixture used was *Ipomoea asarifolia* ('Ajara') obtained from Saki in Oke-Ogun area of Oyo State. It is a climber readily available in the region, broad leafed with the stem acting as storage for fluid and was analyzed in the Department of Biochemistry, Obafemi Awolowo University, Ile-Ife to determine the chemical composition; the result is a in Table 1.

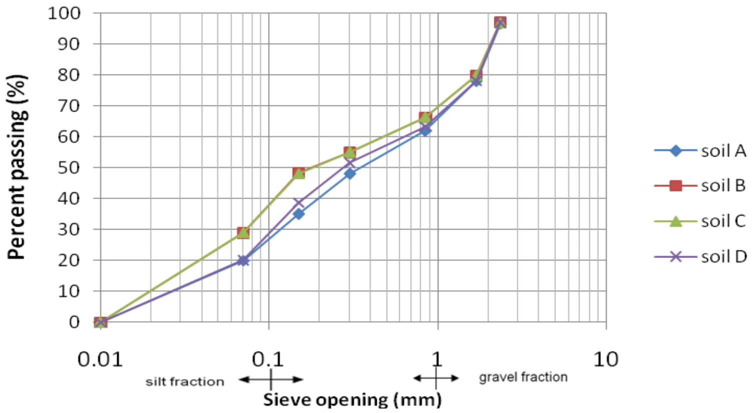


Figure-1. Sieve analysis of the fine aggrgate used.

Table-1. Chemical composition of *Ipomoea asarifolia* ('Ajara')*

Chemical present	Characteristic Effects
Alkaloid	When in optimum proportion it increases sorptivity and strength properties of concrete materials [14-17].
Flavonoids	It decreases water absorption and porosity of mortars; increases both compressive and flexural strength of concrete [14, 17].
Frothing (Saponin)	It increases the amount of air entrained in concrete mix, reduction in water rate, and increase in compressive strength [14, 18, 19]
Steroids	It has a significant reduction in water permeability and ensures better water penetration without altering the physical and performance properties of the concrete, [14, 19-22]
Tannis	Medicinal use.

*Laboratory result from Biochemistry Deparment, Obafemi Awolowo University, Ile-Ife, Nigeria;

2.2. Experimental Programme

2.2.1. Specimen Preparation

The stem of the '*ajara*' (the admixture material) was cut into pieces of about 5 cm lengths, crushed to expose more surface area and then soaked in potable water for 24 hours to obtain an extract that was used as part or whole fluid for the mixing of the laterized masonry material for the test cubes. After the removal of the crushed stems, the resulting fluid was screened out to remove all sediments and then used to prepare the required fluid proportion(s) for mixing the lateritic cubes; six admixture concentrations of 0; 20; 40; 60; 80 and 100% (admixture in potable water) by volume. Three mix proportions of 0:1; 1:2 and 1:4 cement/lateritic soil were used for the experiment while the mould was for a 100 mm × 100 mm × 100 mm were cast.

The working process involved initial dry mixing of cement and lateritic soil and gradual addition of water (the admixture) to the mixture; and continuous stirring with a shovel until uniform mix was obtain. The mould was filled with the mix in three equal layers; while the layers were compacted with stamping rod at the rate of twenty five blows. This was done for each mix proportion; soil source and admixture concentration specimen; care was taken to ensure adequate and uniform compaction over the surface of each layer. The specimens were taken out of the mould after 24 hours and then moist cured by covering with jute bags that are lightly wetted every other day until the 28th day [15] three specimens were made for each test.

2.2.2. Specimen Testing

Tests were carried out on each cube samples to determine both the weight and compressive strength of the specimens. Weights were taken using Mettler Toledo Electronic scale of ± 0.001 g reliability level for each specimen before being subjected to compressive test. The compressive strength characteristic of each test cube was determined using a 1570 kN Avery-Denison Compression Testing Machine to obtain the crushing load then dividing by the loading area of the cube. The compressive strength was determined from the crushing load and the effective area of point of application of the load on the cube. Data collected for each test; weight and strength; were subjected to statistical analysis with results presented as tables and figures.

3. RESULTS AND DISCUSSION

3.1. Effect of Admixture; Soil Source and Mix Proportion on Weight of Specimen

Tables 2 and 3 show the ANOVA and Duncan Multiple Range test tables for weight of specimen as affected by admixture, *Ipomoea asarifolia*, and source of lateritic soil. From Table 2, it was observed that the source of lateritic soil; mix proportion and the admixture concentration all have significant effects on the weight of the specimens and so also are the interactions of the soil source/mix proportion as well as that mix proportion/admixture. From Table 3, the separation of means using Duncan's multiple range test, while considering the soil source, the admixture had such different effects of 0.8292 g; 0.1315 g; 0.0848 g; 0.0486 g; and 0.04667 g between soils A – B; C – D; A – D; B – C; and A – C, respectively, while there is no significant difference between soils A – B (0.0019 g). Figures 2a, b, c show the weight reduction pattern of the specimens; from these it was observed that the weight of cubes under all mix proportions did decrease with increase in the concentration level of the admixture. This result conforms to the result of the chemical analysis of the *Ipomoea asarifolia* from which there is the presence of *Flavonoids* [16] and *Steroid* [19] are said to have weight reduction abilities on concrete and masonry materials with increase in concentration level. This characteristic may also be due to the air entrainment ability of the admixture as it contains *Frothing* (*Saponin*) [17, 18] which is a weight reducing agent present in the admixture.

Table-1. Analysis of variance (ANOVA) for weight of stabilized and unstabilized laterized cubes as affected by admixture (*Ipomoea asarifolia*) and soil source.

Source	Df	Sum of Square	Mean Square	F- Value	Pr > F
Soil source	3	1. 9397	0.6466	23.26	<0.0001
Mix Porportion	2	3.9710	1.9855	71.42	<0.0001
Admixture	5	5.2662	1.0532	37.89	<0.0001
Soil Sc, *Adm	6	2.0965	0.3494	12.57	<0.0001
Soil Sc*Adm	15	0.2125	0.0142	0.51	0.9363
Soil Sc*MP*Adm	30	0.5299	0.0177	0.64	0.9365
MP*Adm	10	0.9859	0.0986	3.55	<0.0001
Error	792	022.0178	0.0278		
Corrected Total	863	37.0196			

Table-2. Mean values weight of stabilized and unstabilized laterized cubes as affected by admixture (*Ipomoea asarifolia*) and soil source

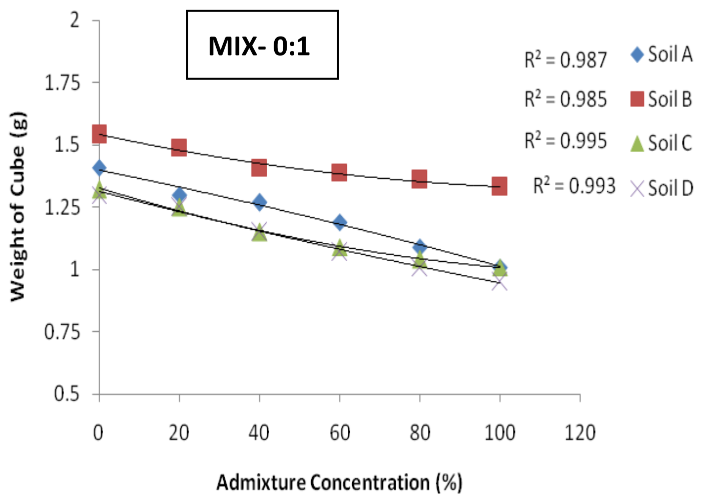
DUNCAN Grouping	Mean	N	Soil Source
A	1.5696	216	D
B	1.4867	216	B
B	1.4848	216	A
C	1.4381	216	C
DUNCAN Grouping	Mean	N	Mix Proportion
A	1.5564	288	1 : 2
B	1.5276	288	1 : 4
C	1.4004	288	0 ; 1
DUNCAN Grouping	Mean	N	Admixture
A	1.6162	144	0
B	1.5607	144	20
C	1.5044	144	40
C	1.4764	144	60
D	1.4294	144	80
E	1.3874	144	100

On the other hand, from Table 2 it was observed that mix proportion of landcrete materials has significant effects on the weight of the specimens, ($p < 0.01$); while considering the Duncan's multiple range tests, Table 3 it was obvious that the mean difference between 0:1 and 1:2; 0:1 and 1:4; and 1:2 and 1:4 are 0.1560 g; 0.1272 g, and 0.0288 g, respectively. Figure 3a, b and c show the pattern of weight variation in the test specimens as affected by mix proportion.

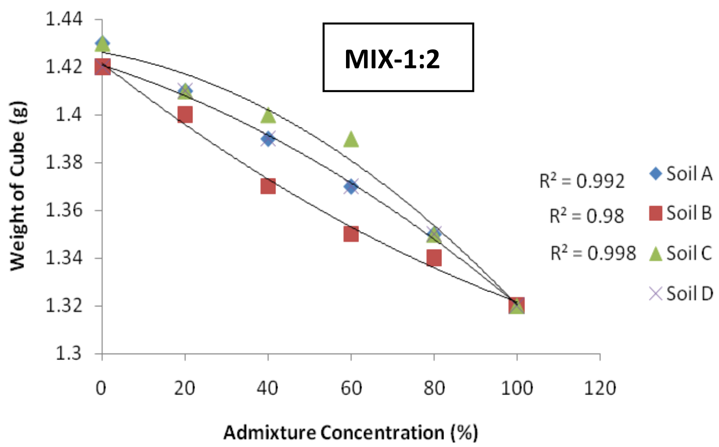
3.2. Effect of Admixture; Soil Source and Mix Proportion on Compressive Strength of Specimen

Tables 3 and 4 show the ANOVA and Duncan's Multiple Range tests for effect of admixture, soil source and mix proportion on the compressive strength of specimen cubes. From Table 3 it was observed that all factors considered have significant effects ($p<0.01$) on the compressive strength of both stabilized and unstabilized cubes tested. Using the Duncan's multiple range tests, Table 4, when considering the soil source there such significant differences of 1.0835; 1.0127; 0.6891; 0.3944; 0.3236 N/mm² between A – C; C – D; B – C; A – B, and B–D, respectively, while the difference of 0.0708 N/mm² for A – D was found to be minute on the compressive strength of both the stabilized and unstabilized cubes, Figures 3a, b and c.

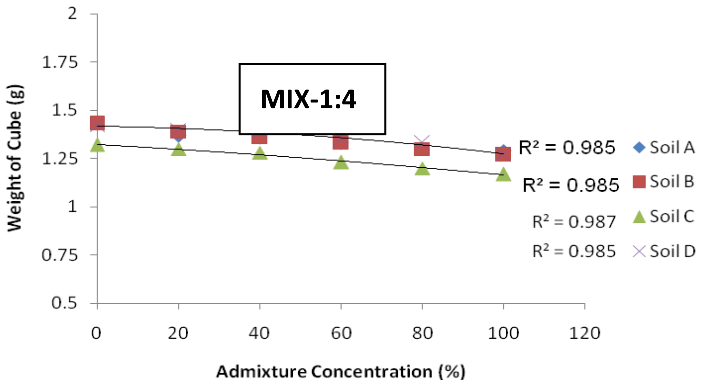
Figure 3c for the unstabilized cube clearly showed that as the admixture concentration



(a)



(b)



(c)

Figure-2. Weight of block as affected by admixture concentration, soil source and mix proportion of mortar material

Table-3. Analysis of variance (ANOVA) compressive strength of stabilized and unstabilized laterized cubes as affected by admixture (*Ipomoea asarifolia*) and soil source.

Source	Df	Sum of Square	Mean Square	F- Value	Pr > F
Soil source	3	158.7435	52.9145	21.67	<0.0001
Mix Porportion	2	13005.5044	6502.7522	2663.31	<0.0001
Admixture	5	10335.3753	2067.0751	846.61	<0.0001
Soil Sc, *Adm	6	300.2919	50.0486	20.50	<0.0001
Soil Sc*Adm	15	144.6631	9.6442	3.95	<0.0001
Soil Sc*MP*Adm	30	7021.6502	702.1650	287.58	<0.0001
MP*Adm	10	277.8579	9.2619	3.79	<0.0001
Error	792	1933.7490	2.4416		
Corrected Total	863	33177.8353			

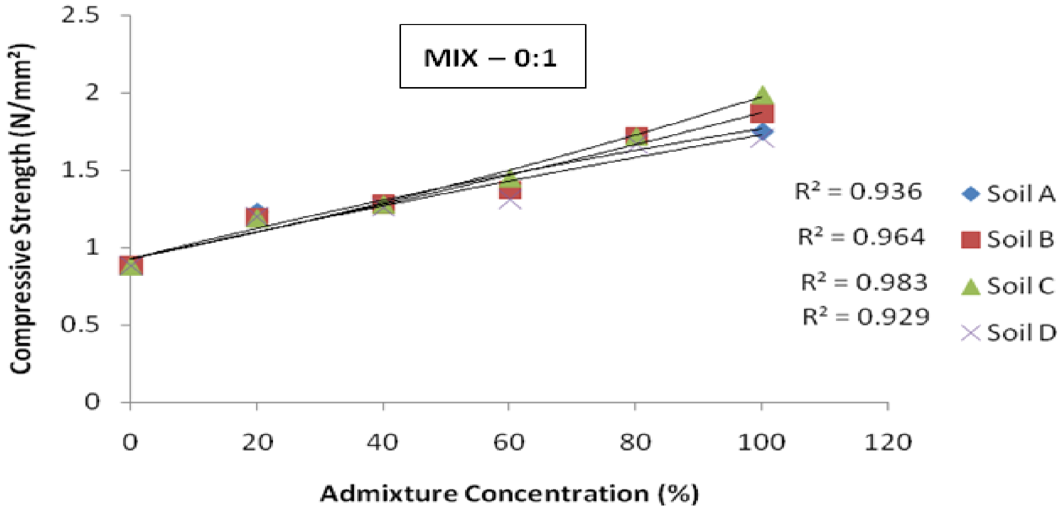
Table-4. Mean values compressive strength of stabilized and unstabilized laterized cubes as affected by admixture (*Ipomoea asarifolia*) and soil source.

DUNCAN Grouping	Mean	N	Soil Source
A	15.2300	216	C
B	14.5412	216	B
C	14.2176	216	D
C	14.1468	216	A
DUNCAN Grouping	Mean	N	Mix Proportion
A	19.9227	288	1 : 2
B	12.7340	288	1 : 4
C	10.9451	288	0 ; 1
DUNCAN Grouping	Mean	N	Admixture
A	20.7264	144	100
B	17.1794	144	80
C	14.2035	144	60
D	12.6917	144	40
E	11.7986	144	20
F	10.6042	144	0

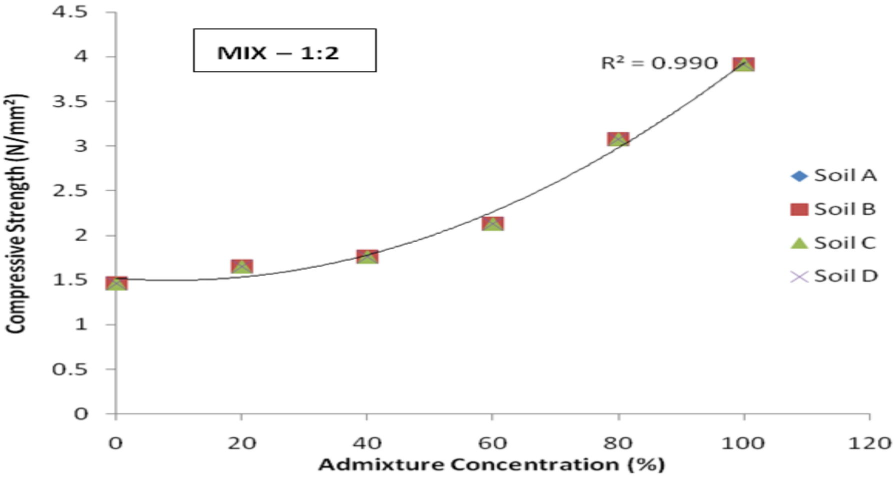
increases, the strength of the cubes increased but with that for Soil C to be highest, followed by those of Soils B, A and D respectively; this pattern was not observed on the stabilized cubes as all soils took same pattern although the strengths increased with increase admixture concentration.

On the other hand, when considering the mix proportion as it affects the strength, Tables 3 and 4, ANOVA and Duncan's multiple range test showed that mix proportion is significant on the compressive strength of both stabilized and unstabilized laterized cubes with such differences are of 8.9776; 7.1887; and 1.7889 N/mm² for 1:2 –

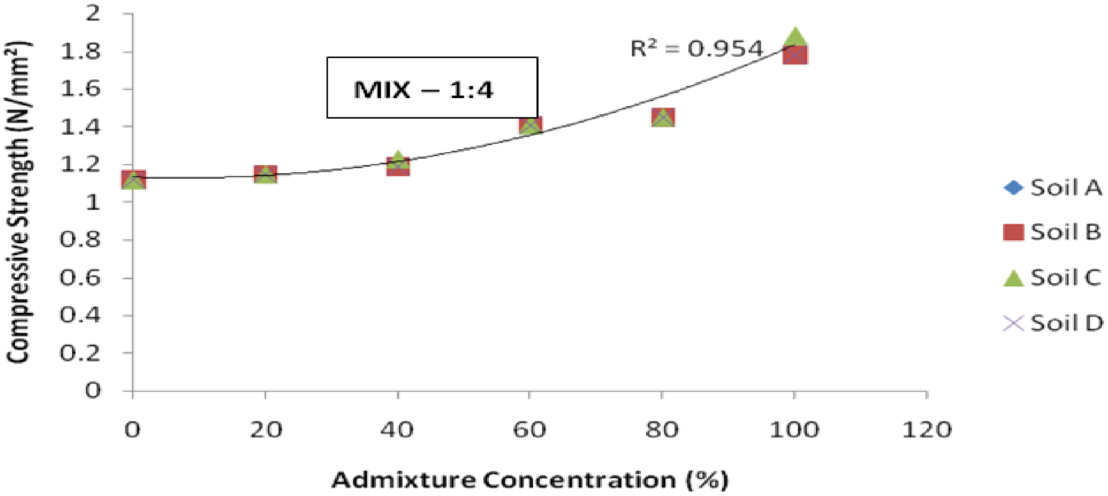
0:1; 1:2 – 1:4 and 1:4 – 0:1 proportions respectively. These effects are clearly observed in Figures 4 a, b, and c, respectively, which are in accordance with the findings of other researchers [4, 5].



(a)



(b)



(c)

Figure-3. Compressive strength of block as affected by admixture concentration, soil source and mix proportion of block material

4. CONCLUSION

From the chemical analysis of *Ipomoea asarifolia* (the local admixture) it was observed that it contains such chemicals as *Alkaloid*; *Flavonoids*; *Saponin* and *Steroids* all of which are found to have increasing effects on the strength of concrete materials. There was observed that the admixture has significant effects (p<0.01) on the strength and weight of both the stabilized and unstabilized laterized blocks. As the admixture concentration increased, the strength of the blocks increased while on the other hand, the weight of the block decreased due to the effect of *Flavonoid*, *Steroids* and the air entrainment ability of *Saponin*. Source of laterite and mix proportion of the mortar materials also have significant effects on both weight and strength of block as in the case of other earlier researchers' results. Further work will need to be carried out to investigate the local believe of the admixture as a termite attack resisting agent.

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