International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 8, Issue 1 [January 2019] PP: 15-20

Soil stabilization with Flyash and YamWaste Ash – Improvements in Engineering Characteristics

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ABSTRACT: *Infrastructure plays an important role in a nation's development. Clay soils play significant part of the strength of any infrastructure built over them. The objective of this paper is to stabilize soil with the fly ash and Yam Waste ash. For this purpose, a soil with high clay content was mixed with fly ash and Yam Waste ash. Several engineering improvements were reported and discussed as a result of this study.*
The result on UCS at 30 % flyash and 6 % YWA, for a 28 day curing period, is 680 kPa. When the YWA content was increased from 0 to 12%, CBR improved from 1.5 to 5.5 % for 0% flyash. When the YWA content was increased from 0 to 12%, CBR improved from 2.6 to 7.4 % for 25% flyash.At 15% flyash and 3 % YWA, for a 28 day curing period, the UCS is 521 kPa. At 15% flyash and 9 % YWA, for a 28 day curing period, the UCS is 627 kPa.
The impact on UCS at 15% flyash and 6 % YWA, for a 28 day curing period, is 588 kPa. At 15% flyash and 12% YWA, for a 28 day curing period, the UCS is 672 kPa. The influence on UCS at 15% flyash and 15% YWA, for a 28 day curing period, is 658 kPa.
KEY WORDS*: Construction Materials, Clays, Yam Waste Ash, Flyash*

Date of Submission: 21-02-2019 Date of acceptance:10-03-2019

I. INTRODUCTION

There are many engineering parameters that characterize the performance of soils. Shear failure is one of them. There are many superstructures that serve the humanity. Dams are some of them. Subgrades provide support for dams. Subgrades effect the performance of dams in many ways. An example of this effect is shear failure. Clay content has direct negative effect on the shear failure characteristics ofsoils [1,2,3]. The objective of this paper is to stabilize soil with the fly ash and Yam Waste ash.

II. MATERIALS

Soils

Table 1 shows the properties of the expansive clay used in this investigation. As per the USCS classification system, the soil is a CH soil.

Flyash

Table 2 shows the constituents of Class C flyash used in this study.

Experiments

Several simple but valuable tests were conducted to support the importance of this paper. These include the following tests: UCS, CBR, compaction and swell-shrinkage tests.

Compaction

The tests were performed in accordance with ASTM D 1557. The specimens were of 102mm diameter and 116mm height.

UCS

The UCS tests were performed in accordance with ASTM D 2166. The sample sizes were of 40mm diameter and 80mm length.

CBR

The CBR test is an important one used for determining the strength of various layers of pavements. The layers include sub grade soil, sub base, and base course material. The CBR test results can play an instrumental role for the comparison of designed thickness for highways and airfield pavements. The CBR tests were conducted in accordance with ASTM D 1883. The sample sizes were of 152mm diameter and 126mm length.

Swelling

Consolidation test (ASTM D 2435) setup was used for determining the cyclic swell-shrink behavior of the soil. The sample sizes were 76mm and 50mm in diameter and height respectively. The samples were prepared at Proctor's dry densities. The compacted admixture was cured for 14 days and placed over the expansive soil. The efficacy of YWA as a cushioning layer between the foundation and subgrade was also tested using the consolidation test.

III. TEST RESULTS AND DISCUSSION

The Influence of flyash content on the UCS of YWA is presented in Figure 1. The influence of flyash on the stress strain behavior of the clay specimens in UCS test is shown in Fig. 2. The flyash content varied from 0 to 30%. When flyash was increased from 0 % to 25 %, the compressive strength increased from 300 to 486kPa at a strain of 6%. When flyash was increased from 0 % to 25 %, the compressive strength increased from 239 to 610kPa at a strain of 9%.

The influence of YWA on CBR of clay-flyash mix is shown in Fig. 3. At any flyash content, addition of YWA up to 12% led to increases in CBR. Further increase in YWA decreased CBR, indicating that 12% is the optimum value of YWA. When the YWA content was increased from 0 to 12%, CBR improved from 1.5 to 5.5 for 0% flyash. When the YWA content was increased from 0 to 12%, CBR improved from 2.6 to 7.4 % for 25% flyash as shown in Figure 3.Low cohesion makes YWA a poor cushioning and construction material. However, after stabilizing with flyash and curing for 28 days, YWA acquires better cushioning properties and hence it can be used as a construction material between the subgrade and foundations.

Fig. 4 shows the influence of number of cycles on swell percent. Fig. 5 shows the influence of swell reduction layer thickness ratio on percent swell for various surcharges.

At 15% flyash and 12% YWA, for a 28 day curing period, the UCS is 672kPa as shown in Figure 1. As per Kate and Katti[4], this qualifies as a cushioning material at 15% flyash. Similar results were found by Sivapulliahet al.[5] for an YWA-lime mixture.

References 6 through 17 deal with more research studies on the behavior of clays and admixtures of other waste materials. References 18 through 39 indicate the importance of this research study which is applied in class room teachings for the benefit of engineering students.

IV. CONCLUSIONS

The following are the conclusions.

1. The result on UCS at 30 % flyash and 6 % YWA, for a 28 day curing period, is 680kPa
2. When the YWA content was increased from 0 to 12%, CBR improved from 1.5 to 5.5% for 0% flyash.When the YWA content was increased from 0 to 12%, CBR improved from 2.6 to 7.4 % for 25% flyash.
3. At 15% flyash and 3 % YWA, for a 28 day curing period, the UCS is 521kPa
4. At 15% flyash and 9 % YWA, for a 28 day curing period, the UCS is 627kPa
5. The impact on UCS at 15% flyash and 6 % YWA, for a 28 day curing period, is 588kPa
6. At 15% flyash and 12% YWA, for a 28 day curing period, the UCS is 672kPa
7. The influence on UCS at 15% flyash and 15% YWA, for a 28 day curing period, is 658kPa

Limitations of This Study

The results of this paper are limited to the materials tested in this study. More materials need to be tested to increase the scope of this study.

ACKNOWLEDGEMENT

KeerthiTakkalapelli, a graduate student of the author conducted the experiments. His work is duly acknowledged.

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Table 1 Soil Properties

Properties	Soil
Specific Gravity	2.63
% Passing #200 sieve	42%
Liquid Limit	46
Plastic Limit	25
Plasticity Index	21
Free Swell Index	18%
USCS Classification	CH

Table 2 Constituents of Fly Ash.

Constituents	%
SiO_2	56.0
Al_2O_3	21.0
Fe_2O_3	6.5
CaO	12.2
MgO	3.6
Alkali	1.1
SO_3	1.6
Heavy Metals	trace

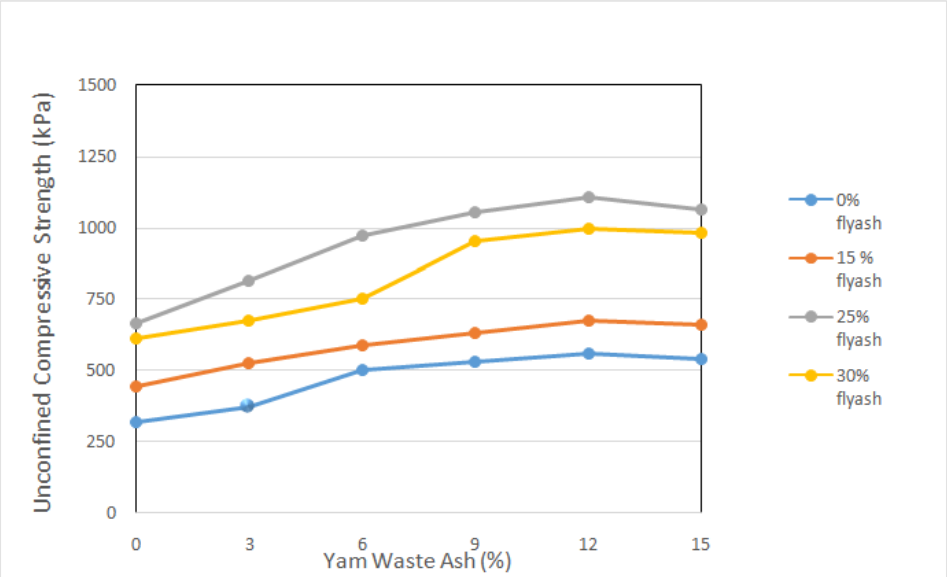

Fig. 1. Influence of Yam Waste Ash on UCS for clay-flyash mixture.

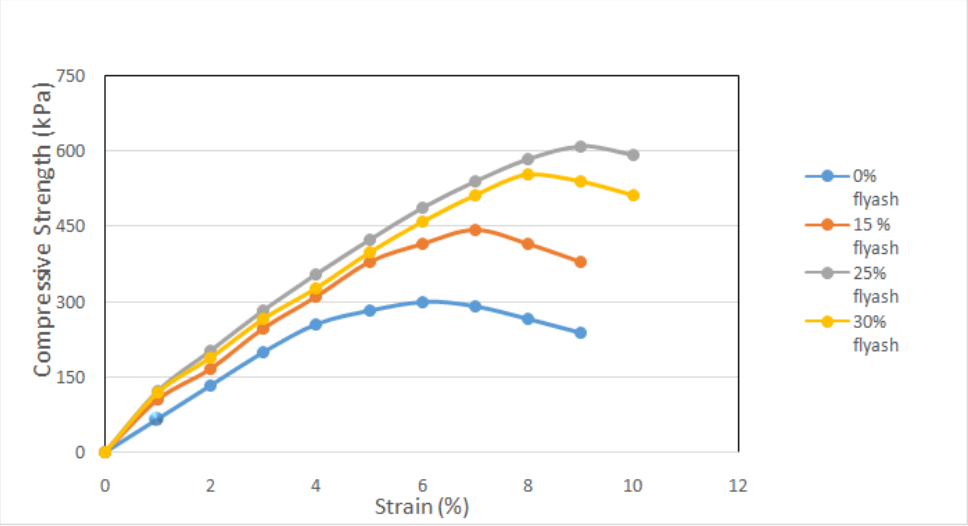

Fig. 2. Influence of flyash on the stress-strain behavior of the soil.

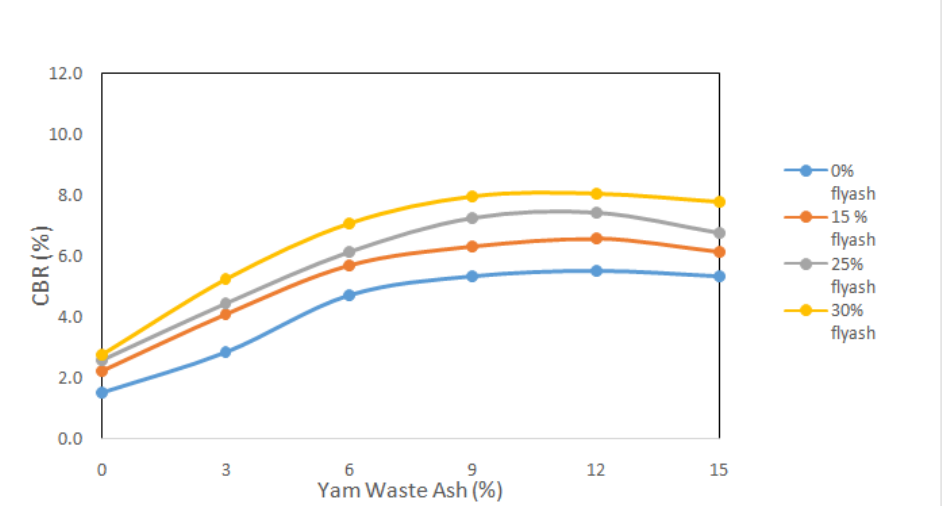

Fig. 3. Influence of Yam Waste Ash on CBR for clay-flyash mixture.

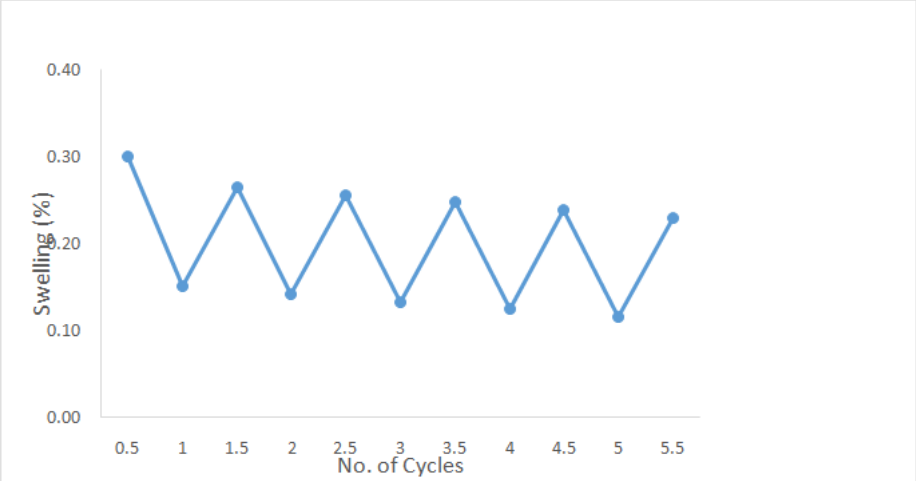

Fig. 4. Influence of number of cycles on swelling of 15% flyash and Yam WA blend under surcharge of 5kPa.

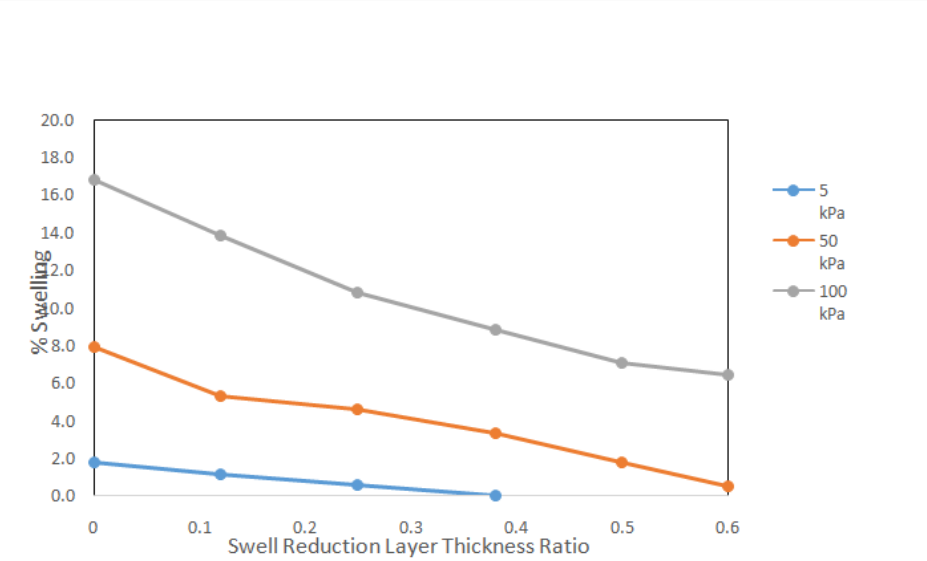

Fig. 5. Influence of Swell reduction layer thickness ratio on swell percentage of soil for various surcharges.

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