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Soil stabilization with Flyash and SoybeanWaste 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 Soybean Waste ash. For this purpose, a soil with high clay content was mixed with fly ash and Soybean Waste ash. Several engineering improvements were reported and discussed as a result of this study.*
The outcome on UCS at 15% flyash and 9% SBWA, for a 28 day curing period, is 590kPa. At 15% flyash and 6 % SBWA, for a 28 day curing period, the UCS is 552kPa. At 15% flyash and 12% SBWA, for a 28 day curing period, the UCS is 631kPa. When the SBWA content was increased from 0 to 12%, CBR improved from 2.4 to 7.0 % for 25% flyash.

KEY WORDS: *Construction Materials, Clays, Soybean Waste Ash, Flyash.*

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I. INTRODUCTION

The success of the design and construction of structures depends to a significant extent on proper accounting of behavior of soils on which they are built. Runways are examples of important structures. Soils with large clay content cause several problems to runways because they have low CBR values and high swell percentages[1,2,,3]. These properties play a significant part of the strength of runways. Fly ash and Soybean Waste ash are good candidates for strengthening the subgrades of runways because they would make the neededmodifications in the engineering characteristics.The objective of this paper is to stabilize soil with the fly ash and Soybean Waste ash.

II. MATERIALS

Soils

As per the USCS classification system, the soil is a CH soil.

Flyash

Table 1 shows the constituents of Class C flyash used in this study.

Soybean Waste Ash

In this investigation, SBWA passing through No. 100 sieve (150 micrometers) was used. The chemical composition of SBWA is listed in Table 2. The SBWA had 17.5% silica content. This amount provides good pozzolanic action.

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 SBWA 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 SBWA 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 282 to 457 kPa at a strain of 6%. When flyash was increased from 0 % to 25 %, the compressive strength increased from 224 to 573 kPa at a strain of 9%.

The influence of SBWA on CBR of clay-flyash mix is shown in Fig. 3. At any flyash content, addition of SBWA up to 12% led to increases in CBR. Further increase in SBWA decreased CBR, indicating that 12% is the optimum value of SBWA. When the SBWA content was increased from 0 to 12%, CBR improved from 1.4 to 5.1 for 0% flyash. When the SBWA content was increased from 0 to 12%, CBR improved from 2.4 to 7.0 % for 25% flyash as shown in Figure 3.Low cohesion makes SBWA a poor cushioning and construction material. However, after stabilizing with flyash and curing for 28 days, SBWA 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% SBWA, for a 28 day curing period, the UCS is 631 kPa 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 SBWA-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 37 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 outcome on UCS at 15% flyash and 9% SBWA, for a 28 day curing period, is 590kPa
2. At 15% flyash and 6 % SBWA, for a 28 day curing period, the UCS is 552kPa
3. At 15% flyash and 12% SBWA, for a 28 day curing period, the UCS is 631kPa
4. When the SBWA content was increased from 0 to 12%, CBR improved from 2.4 to 7.0 % for 25% flyash.

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.

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Table 1 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

Table 2 Chemical Composition of Soybean Waste Ash

Constituent	%
Silica – SiO_2	17.5
Alumina – Al_2O_3	2.5
Calcium Oxide – CaO	45.8
Potassium Oxide - K_2O	22.8
Ferric Oxide – Fe_2O_3	3.1
Phosphorus Oxide – P_2O_5	5.8

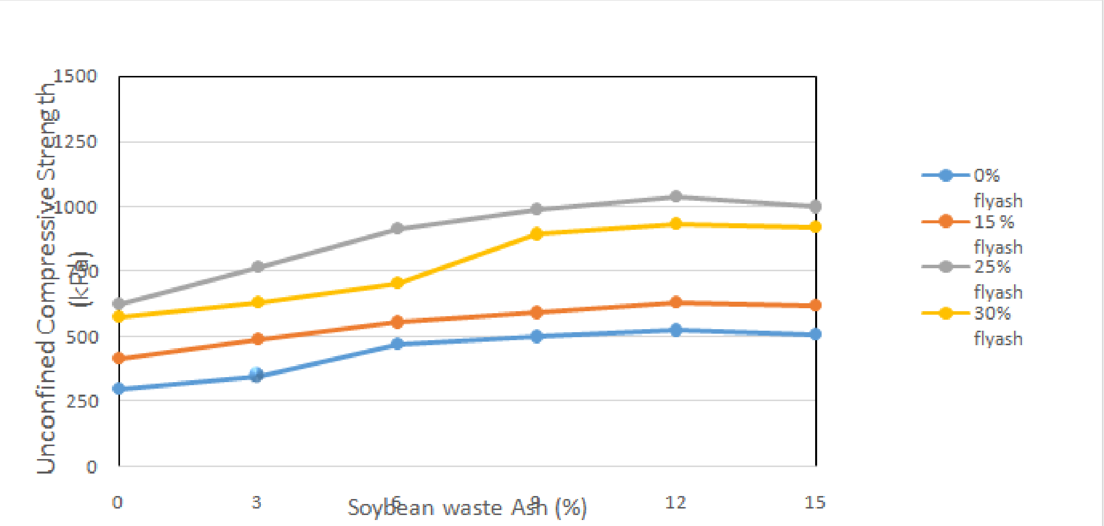

Fig. 1. Influence of Soybean Waste Ash on UCS for clay-flyash mixture.

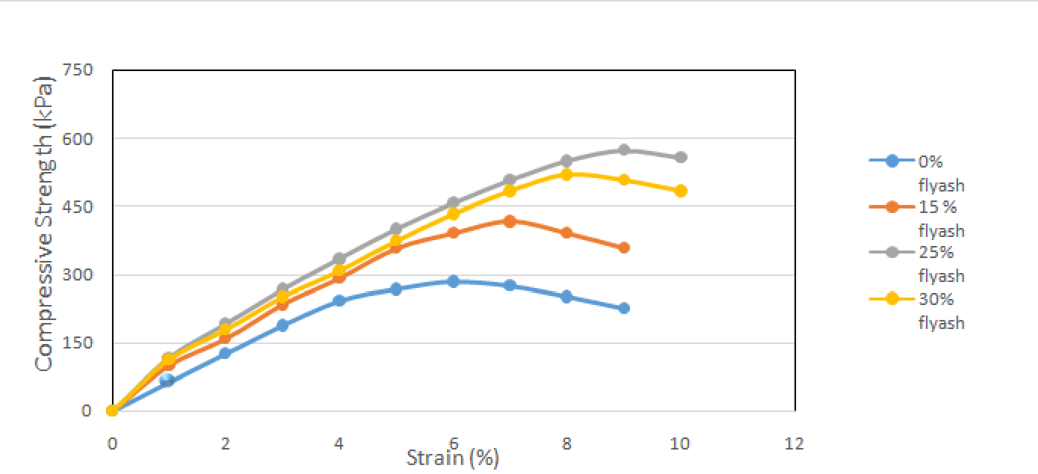

Fig. 2. Influence of flyash on the stress-strain behavior of the soil.

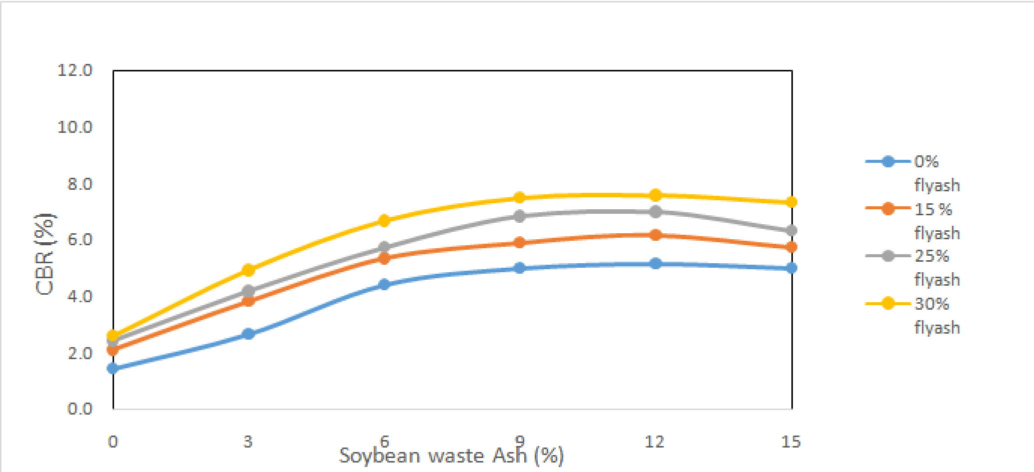

Fig. 3. Influence of Soybean Waste Ash on CBR for clay-flyash mixture.

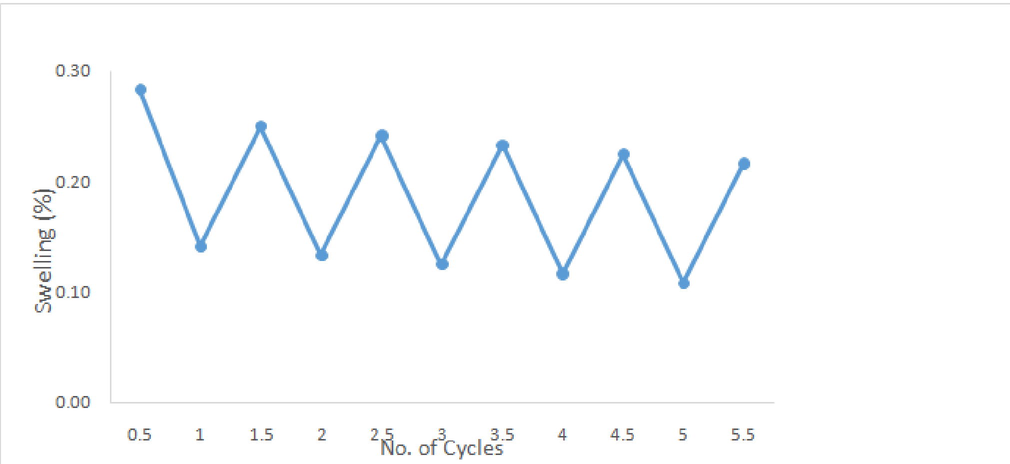

Fig. 4. Influence of number of cycles on swelling of 15% flyash and Soybean WA blend under surcharge of 5kPa.

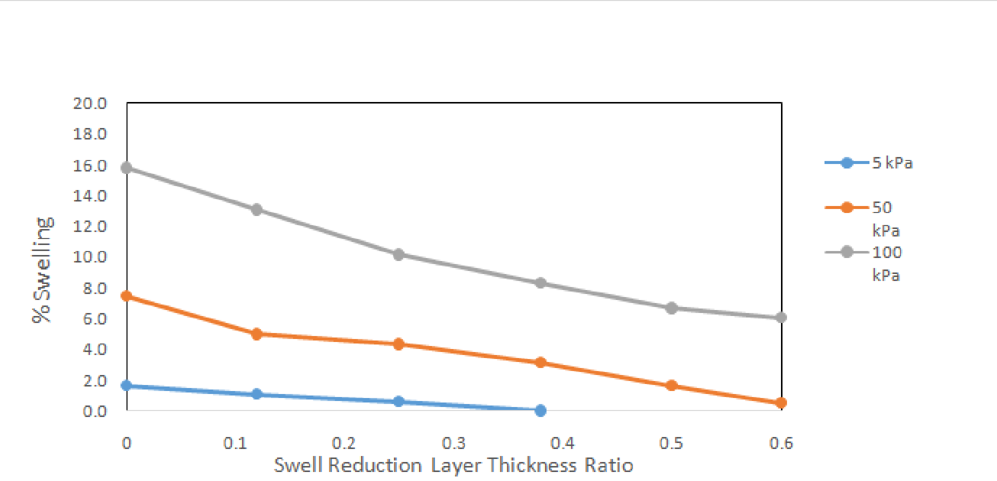

Fig. 5. Influence of Swell reduction layer thickness ratio on swell percentage of soil for various surcharges.

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