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Soil Stabilization with Flyash and SoybeanWaste Ash – Optimization

Robert M. Brooks, Ph.D., PE, F.ASCE
Associate Professor, Department of Civil and Environmental Engineering Temple University, Philadelphia 19122
Hamza Al-Ayaydah, Ph.D. Scholar, M. ASCE

ABSTRACT: *Clay content has an adverse influence on the permanent deformation of soils. The objective of this paper is to stabilize weak soils with the fly ash and optimized Soybean Waste ash. The results are listed here: At 30 % flyash, 8% strain the optimum compressive strength is 384 kPa. At 25 % flyash and optimum SBWA of 12%, for a 28 day curing period, the optimum UCS is 769 kPa. At 15 % flyash and optimum SBWA of 12%, the optimum CBR is 4.6 %. At 25 % flyash and optimum SBWA of 12%, the optimum CBR is 5.2 %. At 25 % flyash, 9% strain the optimum compressive strength is 424 kPa.*
***KEY WORDS**: Construction Materials, Clays, Soybean Waste Ash, Flyash.*

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I. INTRODUCTION

There are many superstructures that are needed for the thriving of civilization. Runways are some of them. Subgrades effect the performance of runways by accumulating permanent deformation. Clay content has an adverse influence on the permanent deformation of soils [1,2,3]. The objective of this paper is to stabilize soil with the fly ash and optimized Soybean Waste ash.

Materials

Flyash, Soybean Waste Ash, and soil were used in this study. A CH soil of the USCS classification was utilized for the research. Class C flyash constituents are given in Table 1. In this investigation, Soybean Waste Ash passing through No. 100 sieve (150 micrometers) was used. The chemical composition of Soybean Waste Ash is shown in Table 2. The Soybean WA 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 Soybean Waste Ash as a cushioning layer between the foundation and subgrade was also tested using the consolidation test.

II. TEST RESULTS AND DISCUSSION

The Influence of flyash content on the UCS of Soybean Waste Ash is presented in Figure 1.

The influence of Soybean Waste Ash on CBR of clay-flyash mix is shown in Fig. 2. At any flyash content, addition of Soybean Waste Ash up to 12% led to increases in CBR. Further increase in Soybean Waste Ash decreased CBR, indicating that 12% is the optimum value of Soybean Waste Ash. When the Soybean Waste Ash content was increased from 0 to 12%, CBR improved from 1.0 to 3.8 for 0% flyash. When the Soybean Waste Ash content was increased from 0 to 12%, CBR improved from 1.8 to 5.2 % for 25% flyash as shown in Figure 2.Low cohesion makes Soybean Waste Ash a poor cushioning and construction material. However, after stabilizing with flyash and curing for 28 days, Soybean Waste Ash acquires better cushioning properties and hence it can be used as a construction material between the subgrade and foundations.The influence of flyash on the stress strain behavior of the clay specimens in UCS test is shown in Fig. 3. The flyash content varied from 0 to 30%. When flyash was increased from 0 % to 25 %, the compressive strength increased from 209 to 338kPa at a strain of 6%. When flyash was increased from 0 % to 25 %, the compressive strength increased from 166 to 424kPa at a strain of 9%.

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% Soybean Waste Ash, for a 28 day curing period, the UCS is 467kPa 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 Soybean Waste Ash-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.

III. CONCLUSIONS

The following are the conclusions.

1. At 30 % flyash, 8% strain the optimum compressive strength is 384 kPa.
2. At 25 % flyash and optimum SBWA of 12%, for a 28 day curing period, the optimum UCS is 769kPa.
3. At 15 % flyash and optimum SBWA of 12%, the optimum CBR is 4.6 %.
4. At 25 % flyash and optimum SBWA of 12%, the optimum CBR is 5.2 %.
5. At 25 % flyash, 9% strain the optimum compressive strength is 424kPa.

IV. LIMITATIONS OF THIS STUDY

The results of this paper are limited to the materials tested in this study. Therefore, the results of the study must not be used for any design or construction. 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

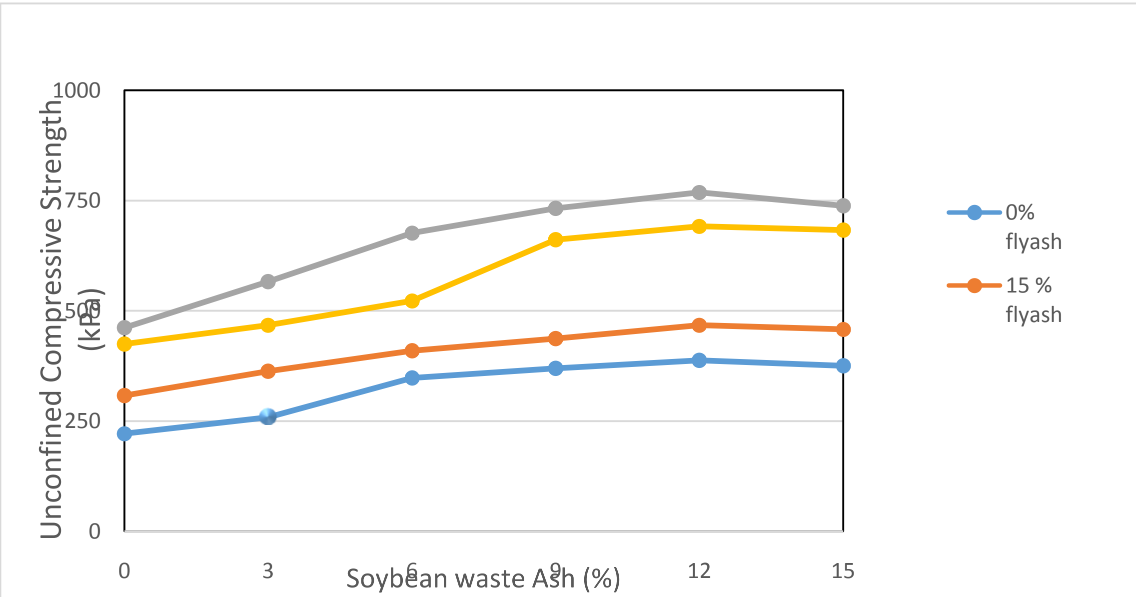

Fig. 1. Influence of Soybean Waste Ash on UCS for clay-flyash mixture.

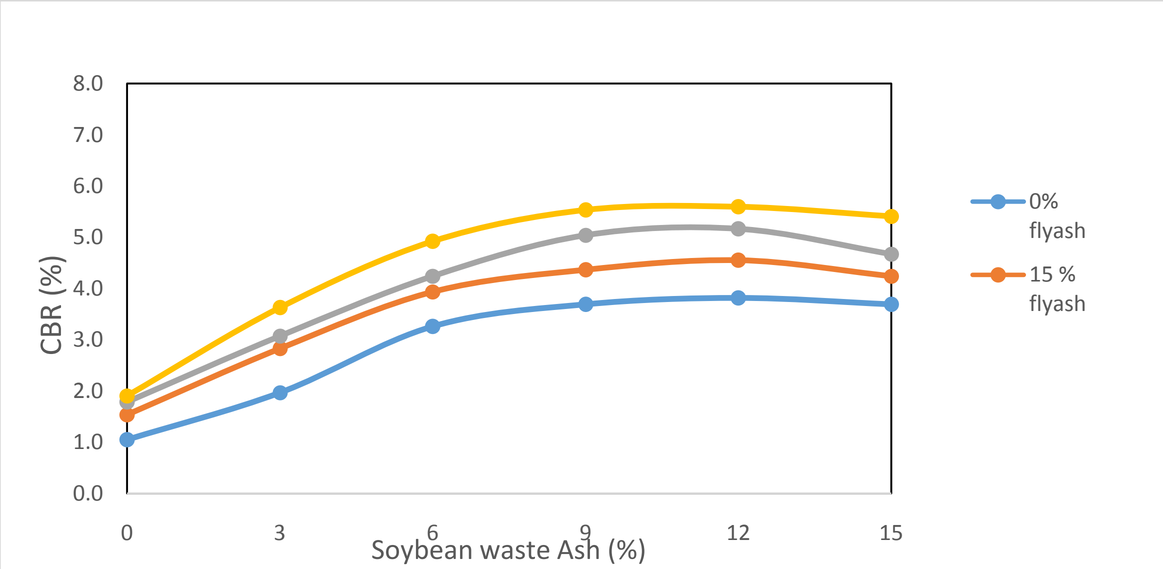

Fig. 2. Influence of Soybean Waste Ash on CBR for clay-flyash mixture.

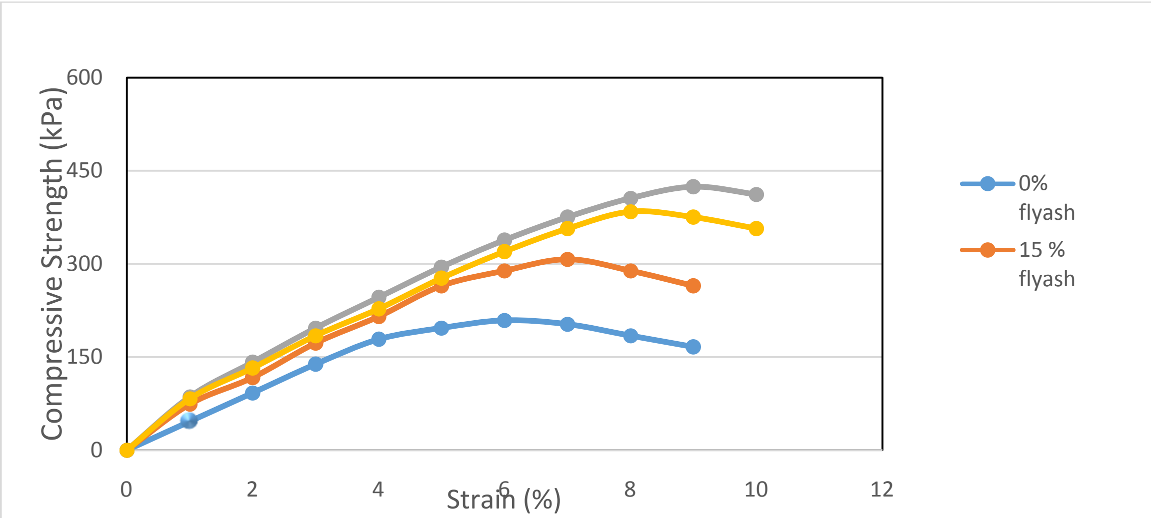

Fig. 3. Influence of flyash on the stress-strain behavior of the soil.

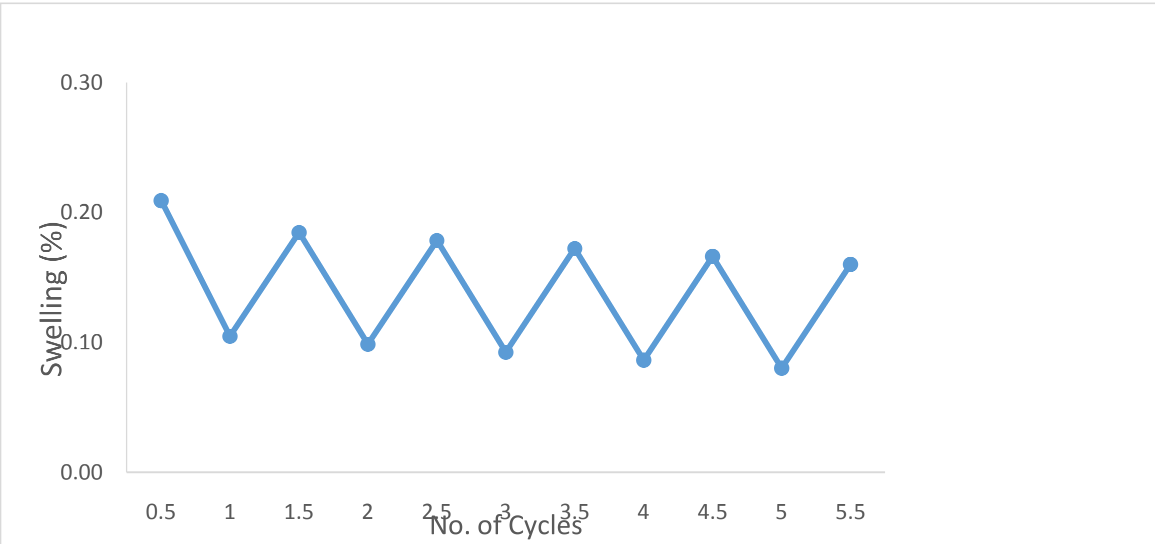

Fig**. 4.** Influence of number of cycles on swelling of 15% flyash and Soybean WA blend under surcharge of 5kPa.

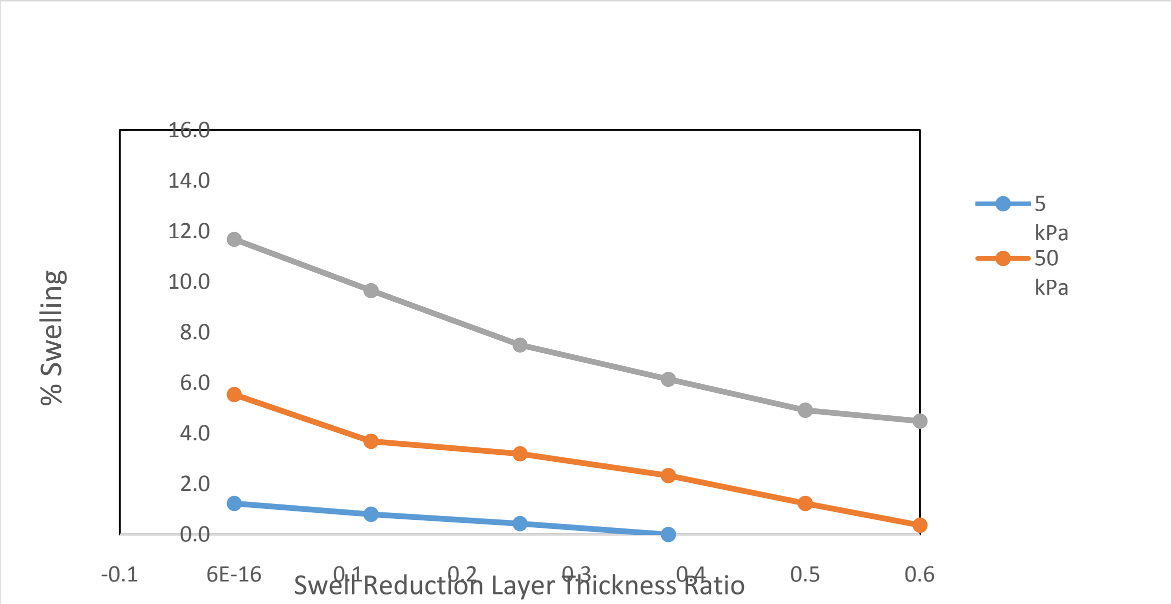

Fig. **5.** Influence of Swell reduction layer thickness ratio on swell percentage of soil for various surcharges.

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