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Soil Stabilization with Flyash and Wheat Husk Ash – Optimization

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Abstract

The end uses of optimization involves many purposes. This includes saving of materials. This paper focuses on the stabilization of soil with the fly ash and optimum amount of Wheat Husk ash. The optimized results are given below: At 25 % flyash and optimum WHA of 12%, the optimum CBR is 7.1 %. At 15 % flyash, 7% strain the optimum compressive strength is 420 kPa. At 25 % flyash, 9% strain the optimum compressive strength is 580 kPa. At 25 % flyash and optimum WHA of 12%, for a 28 day curing period, the optimum UCS is 1050 kPa.

Keywords: Construction Materials, Clays, Wheat Husk Ash, Flyash.

INTRODUCTION

Optimum values are useful in obtaining among other things, savings of the materials. The characteristics targeting the optimum values investigated in this study include unconfined compressive strength, CBR, and swell percentage. Many additives are available to improve these characteristics[1,2,3]. However, fly ash and Wheat Husk ash are selected as additives in this study. The objective of this paper is to stabilize soil with the fly ash and optimized percentage of Wheat Husk ash.

MATERIALS

Flyash, Wheat Husk 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.

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

In this investigation, Wheat Husk Ash passing through No. 100 sieve (150 micrometers) was used. The chemical composition of Wheat Husk Ash is shown in Table 2. The Wheat Husk Ash had 56% silica content.

Table 2: Chemical Composition of Wheat Husk Ash

Constituent	%
Silica – SiO_2	56
Alumina – Al_2O_3	21
Calcium Oxide – CaO	12.2
Magnesium Oxide – MgO	0.5
Ferric Oxide – Fe_2O_3	6.5

EXPERIMENTS

Several simple but valuable tests were conducted to support the efficacy of the 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 bearing capacity test is a thorough test that simulates more closely the realistic field conditions of the soil. It may not be practical to conduct the full scale bearing capacity test because it is time consuming and costly. However, the unconfined compression test is a low cost test since it makes use of the undisturbed soil. It quantifies the undrained and unconsolidated strength of a cohesive soil in the laboratory.

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

CBR

The CBR tests were conducted in accordance with ASTM D 1883. The sample sizes were of 152mm diameter and 126mm length.

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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 Wheat Husk Ash as a cushioning layer between the foundation and subgrade was also tested using the consolidation test.

TEST RESULTS AND DISCUSSION

The following mechanism explains the obtained improvements. The chemical reactions that occur when flyash is mixed with clay include pozzolanic reactions, cation exchange[4], carbonation and cementation. These result in agglomeration in large size particles. This causes the increase in compressive strength[5]. Influence of flyash content on the UCS of Wheat Husk Ash 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 286 to 462 kPa at a strain of 6%. When flyash was increased from 0 % to 25 %, the compressive strength increased from 227 to 580 kPa at a strain of 9% as shown in Fig. 2.

The influence of Wheat Husk Ash on CBR of clay-flyash mix is shown in Fig. 3. At any flyash content, addition of Wheat Husk Ash up to 12% led to increases in CBR. Further increase in Wheat Husk Ash decreased CBR, indicating that 12% is the optimum value of Wheat Husk Ash. When the Wheat Husk Ash content was increased from 0 to 12%, CBR improved from 1.4 to 5.2 for 0% flyash. When the Wheat Husk Ash content was increased from 0 to 12%, CBR improved from 2.4 to 7.1 % for 25% flyash as shown in Figure 3.

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% Wheat Husk Ash, for a 28 day curing period, the UCS is 638 kPa as shown in Figure 1. As per Kate and Katti[6], this qualifies as a cushioning material at 15% flyash. Similar results were found by Sivapulliah et al.[7] for an Wheat Husk Ash-lime mixture.

References 8 through 19 deal with more research studies on the behavior of clays and admixtures of other husk materials. References 20 through 41 indicate the importance of this research study which is applied in class room teachings for the benefit of engineering students.

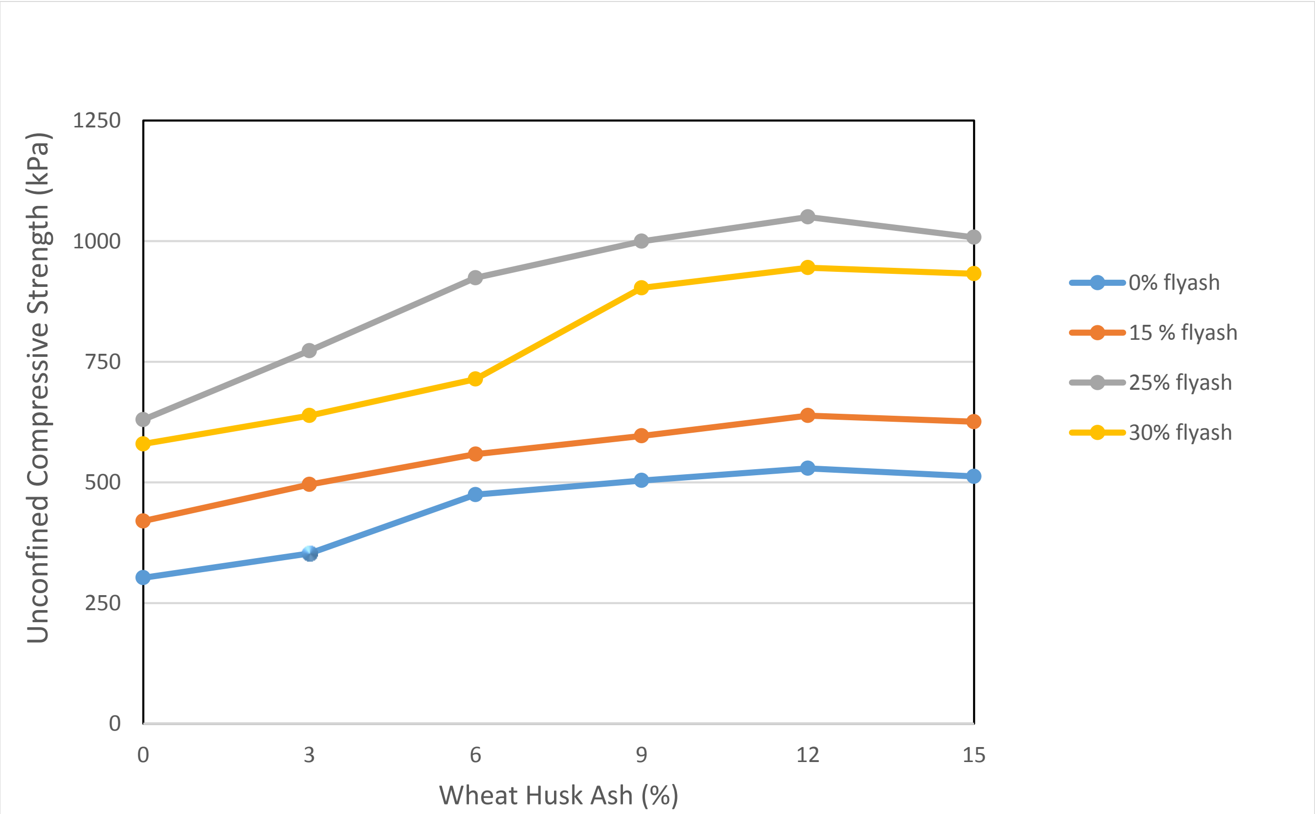

Fig. 1. Influence of Wheat Husk Ash on UCS for clay-flyash mixture.

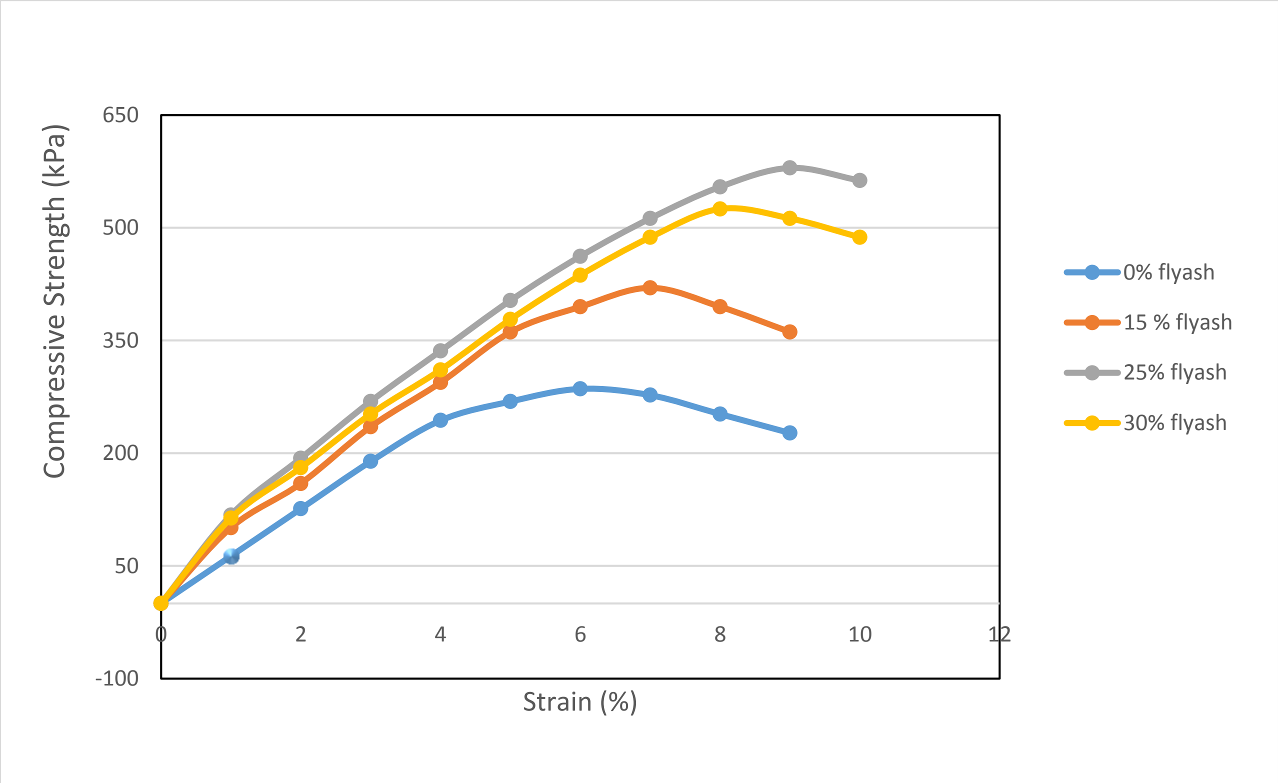

Fig. 2. Influence of flyash on the stress-strain behavior of the soil.

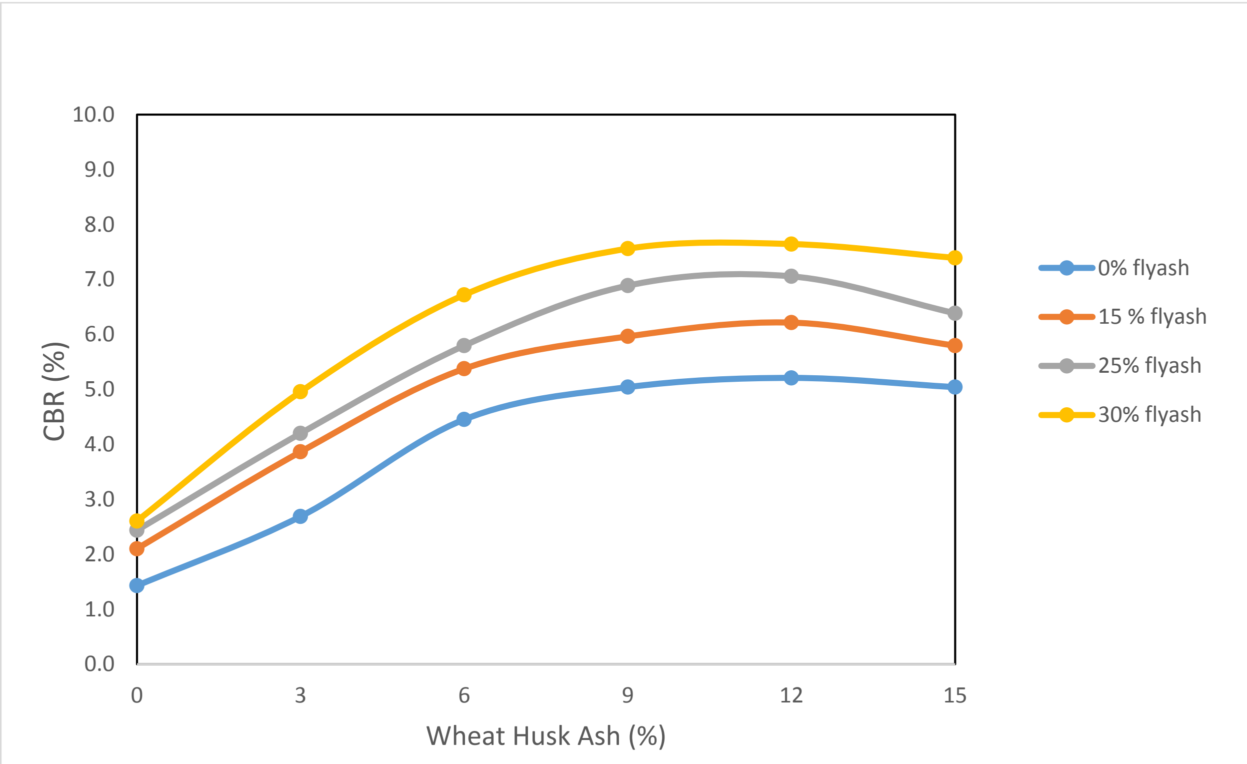

Fig. 3. Influence of Wheat Husk Ash on CBR for clay-flyash mixture.

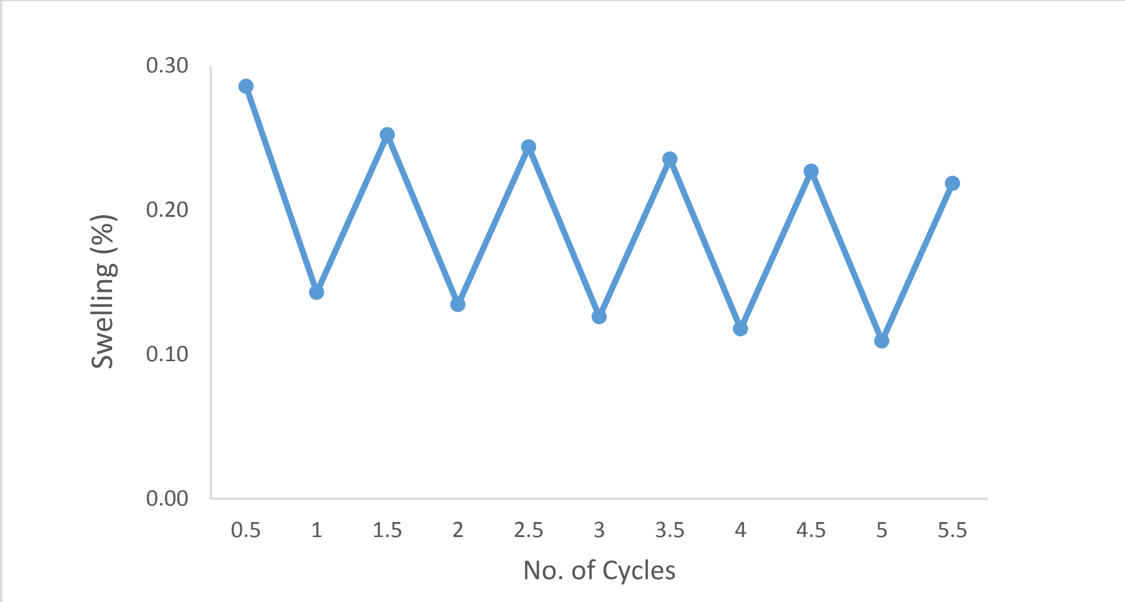

Fig. 4. Influence of number of cycles on swelling of 15% flyash and Wheat Husk Ash blend under surcharge of 5kPa.

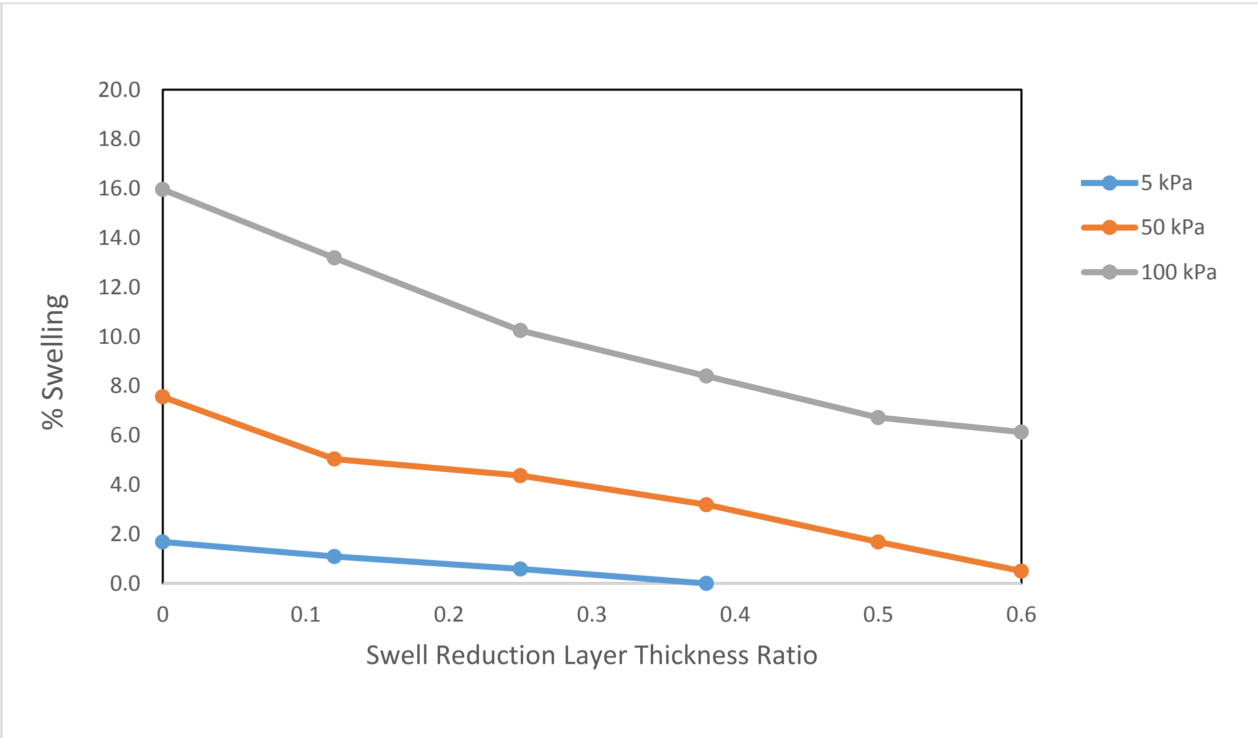

Fig. 5. Influence of Swell reduction layer thickness ratio on swell percentage of soil for various surcharges.

CONCLUSIONS

The following are the conclusions.

1. At 0 % flyash and optimum WHA of 12%, for a 28 day curing period, the optimum UCS is 529 kPa
2. At 15 % flyash and optimum WHA of 12%, for a 28 day curing period, the optimum UCS is 638 kPa
3. At 25 % flyash and optimum WHA of 12%, for a 28 day curing period, the optimum UCS is 1050 kPa
4. At 30 % flyash and optimum WHA of 12%, for a 28 day curing period, the optimum UCS is 945 kPa
5. At 0 % flyash and optimum WHA of 12%, the optimum CBR is 5.2 %

6. At 15 % flyash and optimum WHA of 12%, the optimum CBR is 6.2 %
7. At 25 % flyash and optimum WHA of 12%, the optimum CBR is 7.1 %
8. At 30 % flyash and optimum WHA of 12%, the optimum CBR is 7.6 %.
9. At 0 % flyash, 6% strain the optimum compressive strength is 286 kPa
10. At 15 % flyash, 7% strain the optimum compressive strength is 420 kPa
11. At 30 % flyash, 8% strain the optimum compressive strength is 525 kPa
12. At 25 % flyash, 9% strain the optimum compressive strength is 580 kPa

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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