SOIL STABILIZATION WITH FLYASH AND WHEAT HUSK ASH – IMPROVEMENTS IN ENGINEERING CHARACTERISTICS

Robert M. Brooks* and Hamza Al-Ayaydah
Department of Civil and Environmental Engineering
Temple University, Philadelphia 19122
*Email: rmbrooks@temple.edu; Tel: (215) 204-6348; Fax: (215) 204-4696

ABSTRACT

Clays are weak and highly compressible by nature. These characteristics play a major role in the stability of any structure constructed over clay soil. The objective of this paper is to stabilize soil with the fly ash and wheat husk ash. For this purpose an expansive clay was mixed with fly ash and wheat husk ash. Several engineering improvements have been tested and discussed as a result of this study. The conclusion includes the following: when the WHA content was increased from 0 to 12%, CBR improved from 1.9 to 7.0 % for 0% flyash. The swelling potential of expansive soil decreases with increasing swell reduction layer thickness ratio.

***Key words**: Construction Materials, Clays, Wheat Husk Ash, Flyash.*

1. INTRODUCTION

Clay soils cause several problems under various structures. For example, clays cause uneven settlements of walls in houses[1]. Clays have low resilient modulus value and hence are weak and highly compressible by nature[2,3]. These characteristics play a major role in the stability of any structure constructed over clay soil. Many reasons contribute to this uneven settlement. These include but not limited to poorly compacted soil, soils with weak bearing capacity, changes in soil moisture due to natural or artificial conditions, trees and vegetation, and though last but not the least vibrations around the building.

Negligible natural settlement over a long period of time causing uniform deformation is not a serious problem to the super structure. However, a differential settlement results in structural damage to the buildings. Examples of such structural damage include cracks in the walls and slabs. This causes serious devaluation of the real-estate value of the building. Among other problems, the uneven permanent deformations in the walls lead to lopsided alignment of doors and windows. This slanted framework of doors and windows cause them poorly operable. A text book example of uneven settlement is the leaning tower of Pisa. Adding admixtures to such type of soil using fly ash and wheat husk ash would make the necessary improvements in the engineering characteristics indicated by the results in this study.

2. MATERIALS

2.1. SOILS

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

2.2. FLYASH

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

2.3. WHEAT HUSK ASH

In this investigation, WHA passing through No. 100 sieve (150 micrometers) was used. The chemical composition of WHA is listed in Table 2. The WHA had 56% silica content. This amount provides good pozzolanic action.

2.4. 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.

2.5. Compaction

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

2.6. 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.

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

2.8. 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 WHA as a cushioning layer between the foundation and subgrade was also tested using the consolidation test.

3. 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 WHA 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 382 to 618 kPa at a strain of 6%. When flyash was increased from 0 % to 25 %, the compressive strength increased from 303 to 775 kPa at a strain of 9% as shown in Fig. 2.

The influence of WHA on CBR of clay-flyash mix is shown in Fig. 3. At any flyash content, addition of WHA up to 12% led to increases in CBR. Further increase in WHA decreased CBR, indicating that 12% is the optimum value of WHA. When the WHA content was increased from 0 to 12%, CBR improved from 1.9 to 7.0 for 0% flyash. When the WHA content was increased from 0 to 12%, CBR improved from 3.3 to 9.4 % 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% WHA, for a 28 day curing period, the UCS is 854 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 WHA-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 39 indicate the importance of this research study which is applied in class room teachings for the benefit of engineering students.

4. CONCLUSIONS
The following are the conclusions.

1. The swelling potential of expansive soil decreases with increasing swell reduction layer thickness ratio.
2. When the WHA content was increased from 0 to 12%, CBR improved from 1.9 to 7.0 % for 0% flyash.

5. 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 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

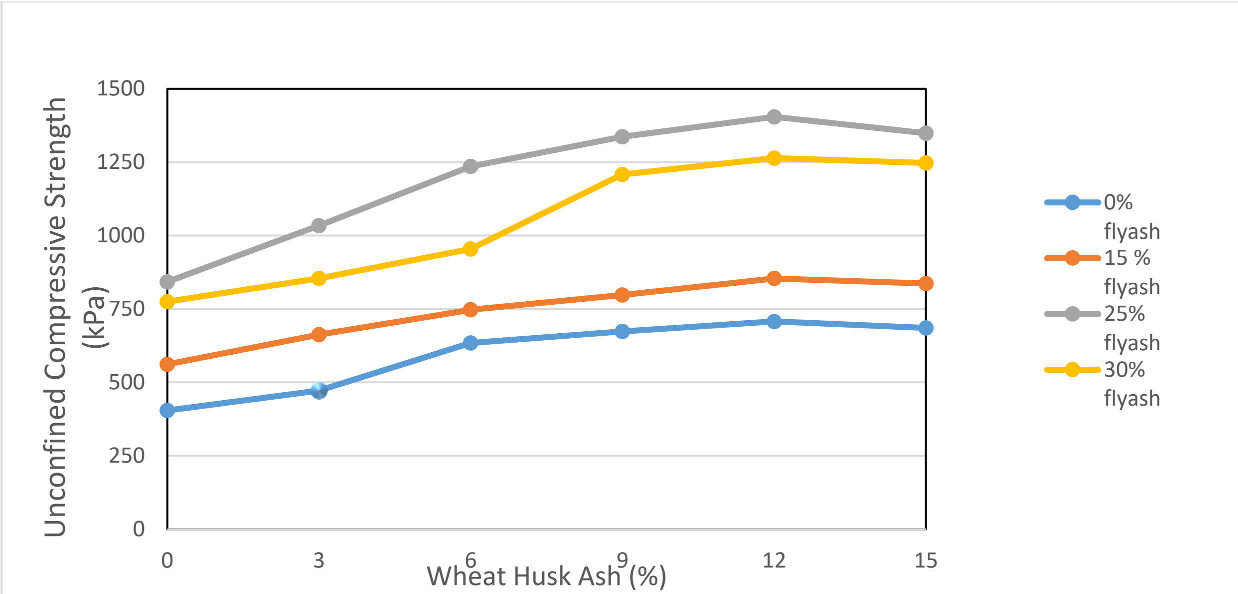

Fig. 1. Influence of WHA on UCS for clay-flyash mixture.

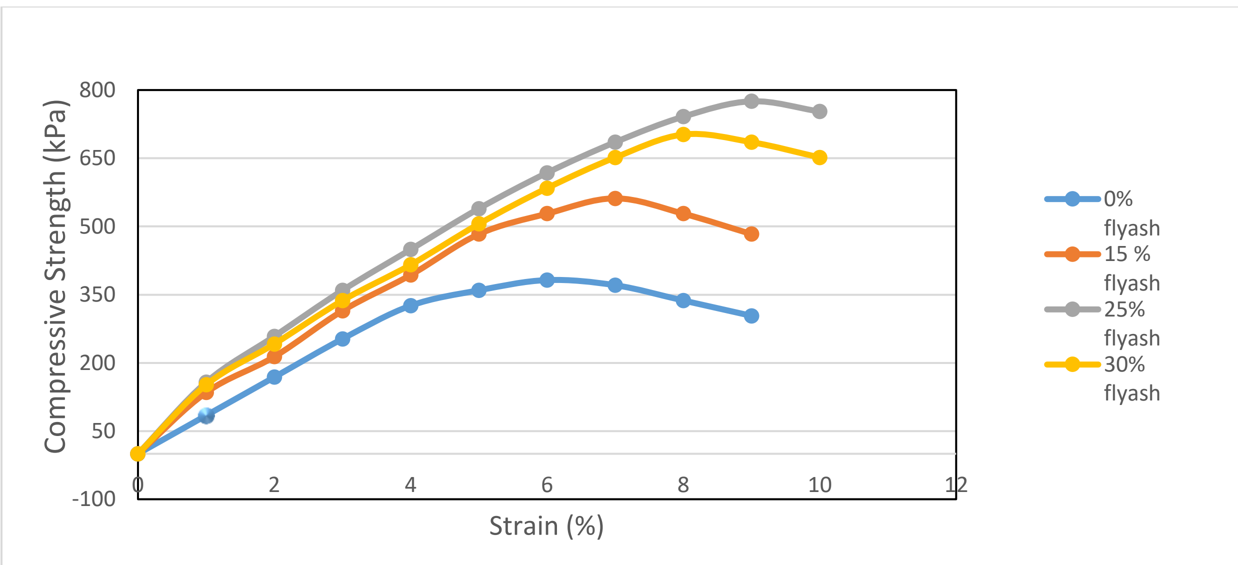

Fig. 2. Influence of flyash on the stress-strain behavior of the soil.

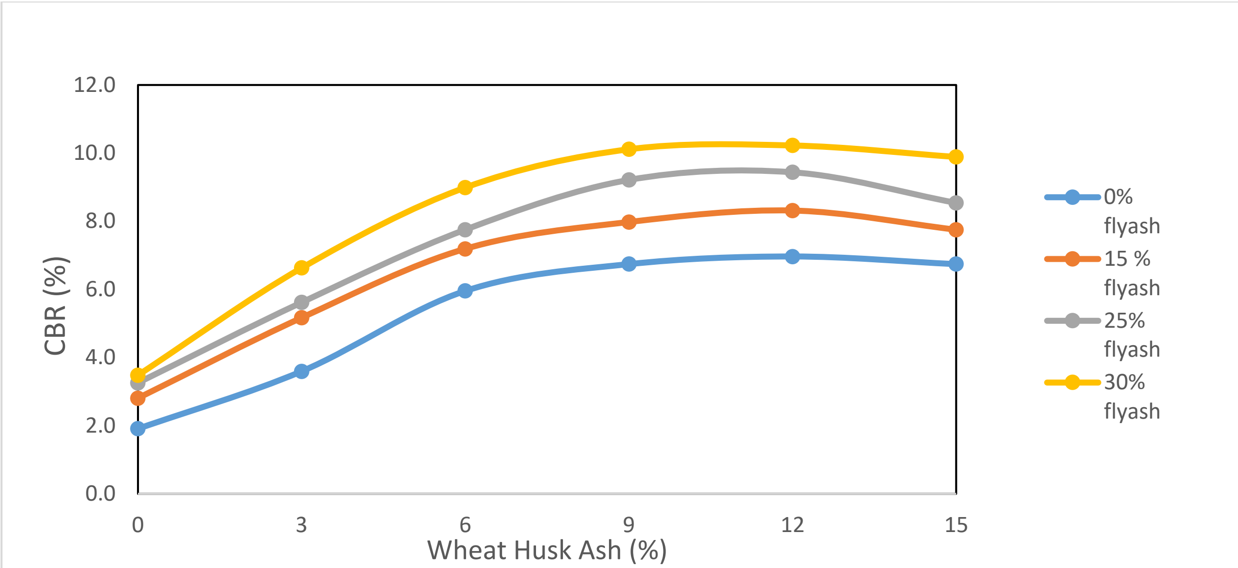

Fig. 3. Influence of WHA on CBR for clay-flyash mixture.

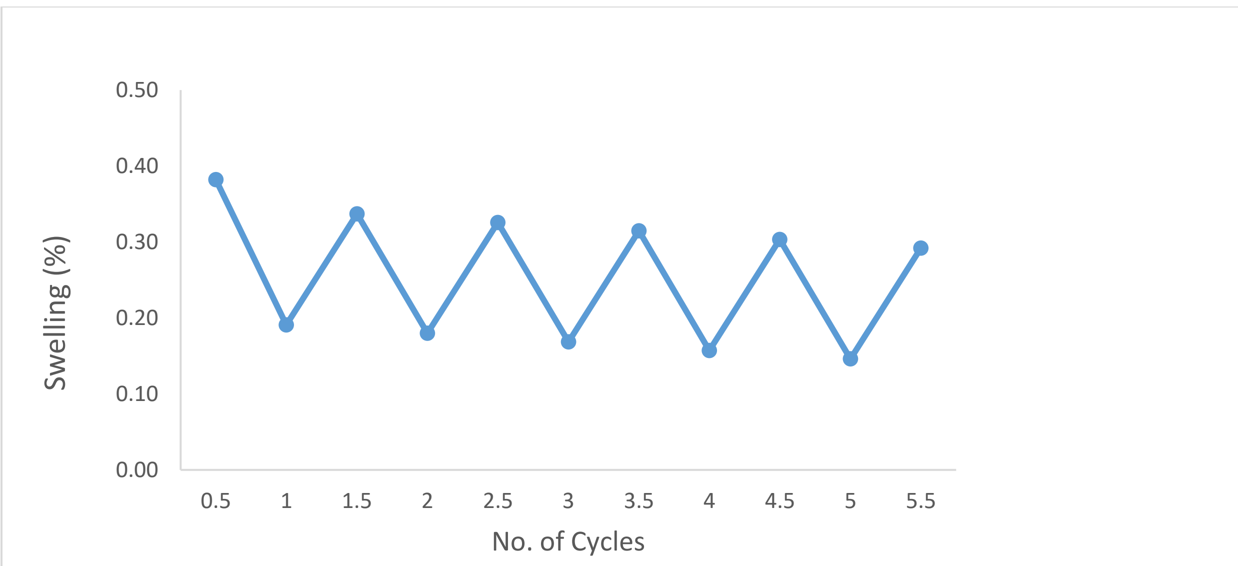

Fig. 4. Influence of number of cycles on swelling of 15% flyash and WHA blend under surcharge of 5kPa.

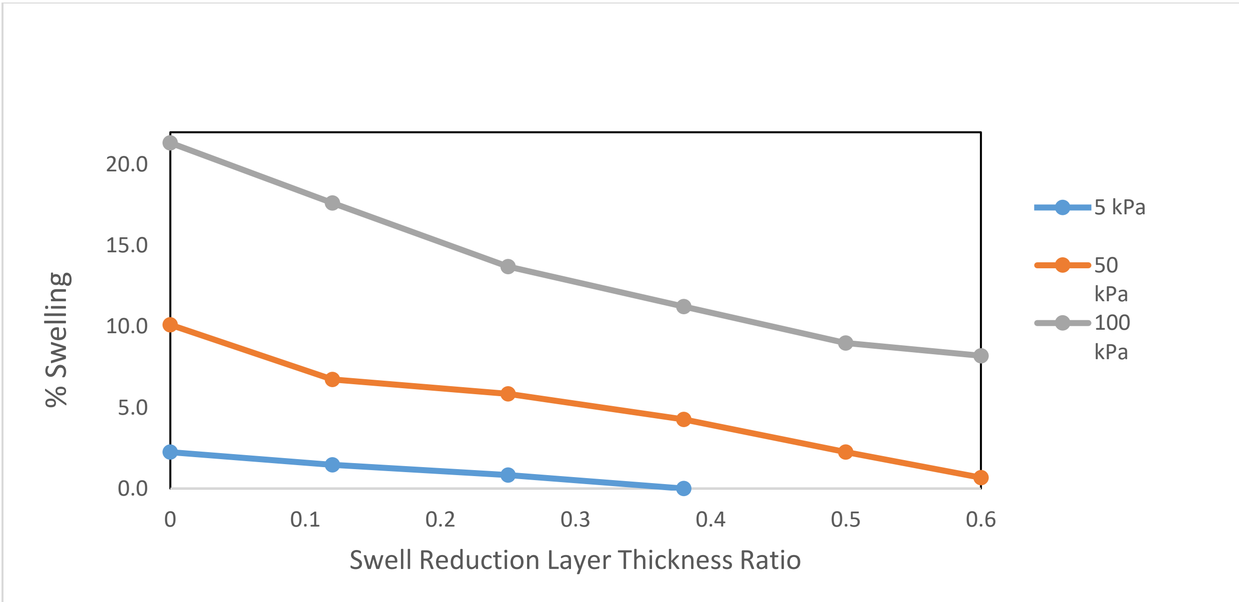

Fig. 5. Influence of Swell reduction layer thickness ratio on swell percentage of soil for various surcharges.