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Soil Stabilization with Flyash and PotatoWaste Ash – Optimization

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ABSTRACT:*An important indicator of successful soil stabilization process is the improvement in its shear strength. All structures requires stable soils for safety and durability. Soils with high clay content cause shear failure. One of the challenges for the design of dams is ensuring adequate shear strength for the soils underneath them. The objective of this paper is to stabilize soil with the optimum Potato Waste ash along with fly ash. The conclusion includes the following: At 0 % flyash, 6% strain the optimum compressive strength is 194 kPa***.** *At 30 % flyash and optimum PWA of 12%, the optimum CBR is 5.2 %. At 15 % flyash and optimum PWA of 12%, the optimum CBR is 4.2 %. A At 25 % flyash and optimum PWA of 12%, for a 28 day curing period, the optimum UCS is 713 kPa. At 0 % flyash and optimum PWA of 12%, the optimum CBR is 3.5 %. At 30 % flyash and optimum PWA of 12%, for a 28 day curing period, the optimum UCS is 641 kPa. At 25 % flyash and optimum PWA of 12%, the optimum CBR is 4.8 %. At 0 % flyash and optimum PWA of 12%, for a 28 day curing period, the optimum UCS is 359 kPa. At 15 % flyash and optimum PWA of 12%, for a 28 day curing period, the optimum UCS is 443 kPa.*

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

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I. INTRODUCTION

Shear strength plays an important role in soil stabilization. Dams are examples of structures that need stable soils for safety and durability. Soils with high clay content cause shear failure[1,2,3]. One of the challenges for the design of dams is ensuring adequate shear strength for the soils underneath them. The objective of this paper is to stabilize soil with the optimum Potato Waste ash along with fly ash.

Materials

Flyash, Potato 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, Potato Waste Ash passing through No. 100 sieve (150 micrometers) was used. The chemical composition of Potato Waste Ash is shown in Table 2.

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 Potato 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 on the stress strain behavior of the clay specimens in compressive strength test is shown in Fig. 1. The flyash content varied from 0 to 30%. When flyash was increased from 0 % to 25 %, the compressive strength increased from 194 to 314 kPa at a strain of 6%. When flyash was increased from 0 % to 25 %, the compressive strength increased from 154 to 393 kPa at a strain of 9%.The Influence of flyash content on the UCS of Potato Waste Ash is presented in Figure 2.

The influence of Potato Waste Ash on CBR of clay-flyash mix is shown in Fig. 3. At any flyash content, addition of Potato Waste Ash up to 12% led to increases in CBR. Further increase in Potato Waste Ash decreased CBR, indicating that 12% is the optimum value of Potato Waste Ash. When the Potato Waste Ash content was increased from 0 to 12%, CBR improved from 1.0 to 3.5 for 0% flyash. When the Potato Waste Ash content was increased from 0 to 12%, CBR improved from 1.7 to 4.8 % for 25% flyash as shown in Figure 3.Low cohesion makes Potato Waste Ash a poor cushioning and construction material. However, after stabilizing with flyash and curing for 28 days, Potato Waste Ash 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% Potato Waste Ash, for a 28 day curing period, the UCS is 433 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 Sivapulliah et al.[5] for aPotato 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 0 % flyash, 6% strain the optimum compressive strength is 194 kPa
2. At 30 % flyash and optimum PWA of 12%, the optimum CBR is 5.2 %.
3. At 15 % flyash and optimum PWA of 12%, the optimum CBR is 4.2 %
4. A At 25 % flyash and optimum PWA of 12%, for a 28 day curing period, the optimum UCS is 713 kPa
5. t 0 % flyash and optimum PWA of 12%, the optimum CBR is 3.5 %
6. At 30 % flyash and optimum PWA of 12%, for a 28 day curing period, the optimum UCS is 641 kPa
7. At 25 % flyash and optimum PWA of 12%, the optimum CBR is 4.8 %
8. At 0 % flyash and optimum PWA of 12%, for a 28 day curing period, the optimum UCS is 359 kPa
9. At 15 % flyash and optimum PWA of 12%, for a 28 day curing period, the optimum UCS is 443 kPa

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 Potato Waste Ash

Constituent	%
Silica – SiO_2	0
Calcium Oxide – CaO	1.0
Potassium Oxide - K_2O	59
Sodium oxide - NaO	4.2
Sulfur Trioxide - SO_3	7.1
Magnesium oxide - MgO	5.3
Phosphorus Oxide – P_2O_5	14

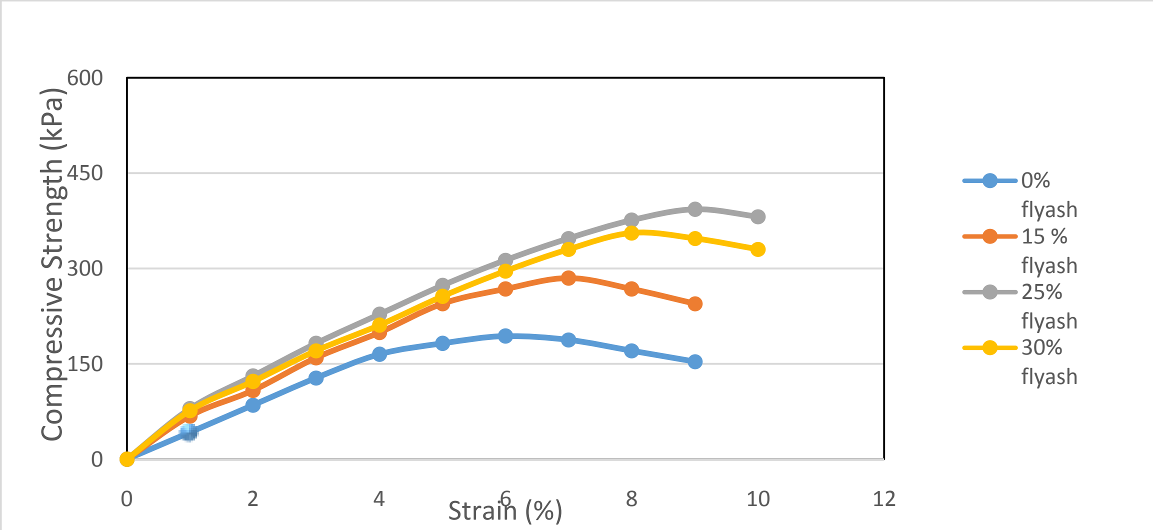

Fig. 1. Influence of flyash on the stress-strain behavior of the soil.

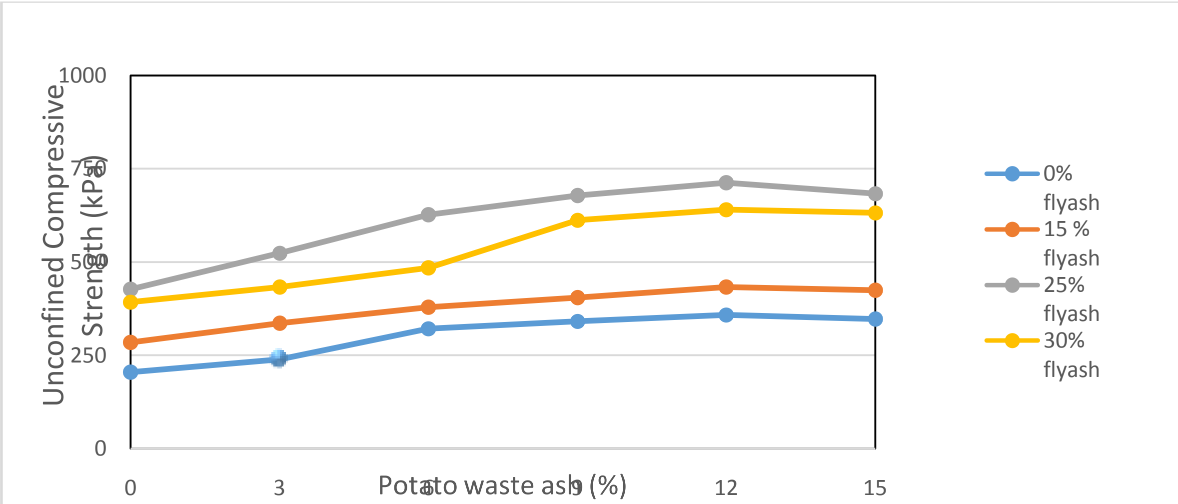

Fig. 2. Influence of Potato Waste Ash on UCS for clay-flyash mixture.

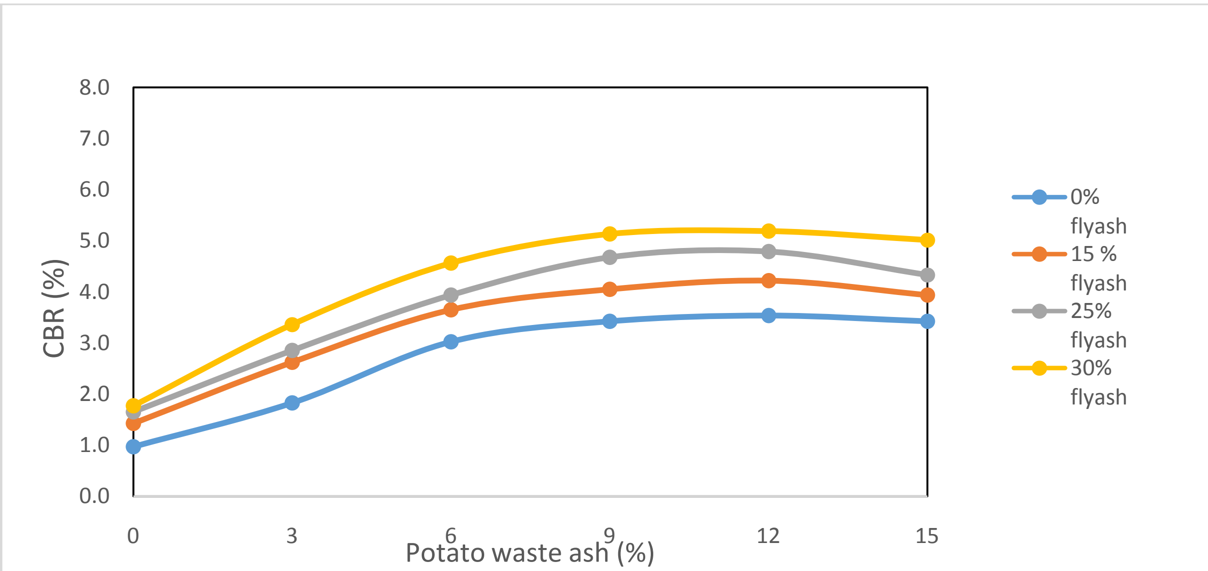

Fig. 3. Influence of Potato Waste Ash on CBR for clay-flyash mixture.

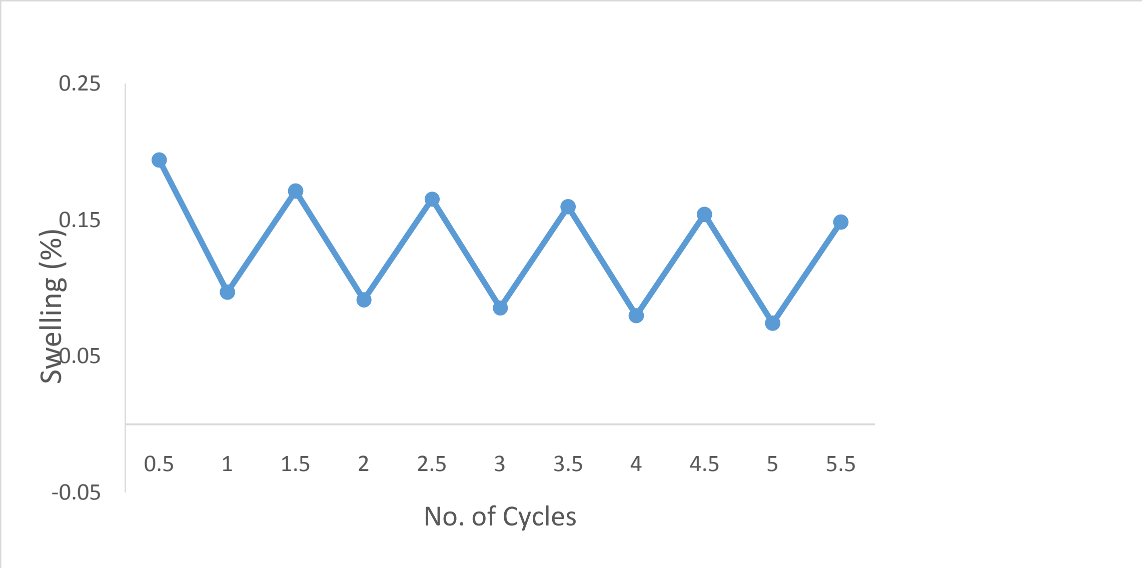

Fig. 4. Influence of number of cycles on swelling of 15% flyash and Potato WA blend under surcharge of 5kPa.

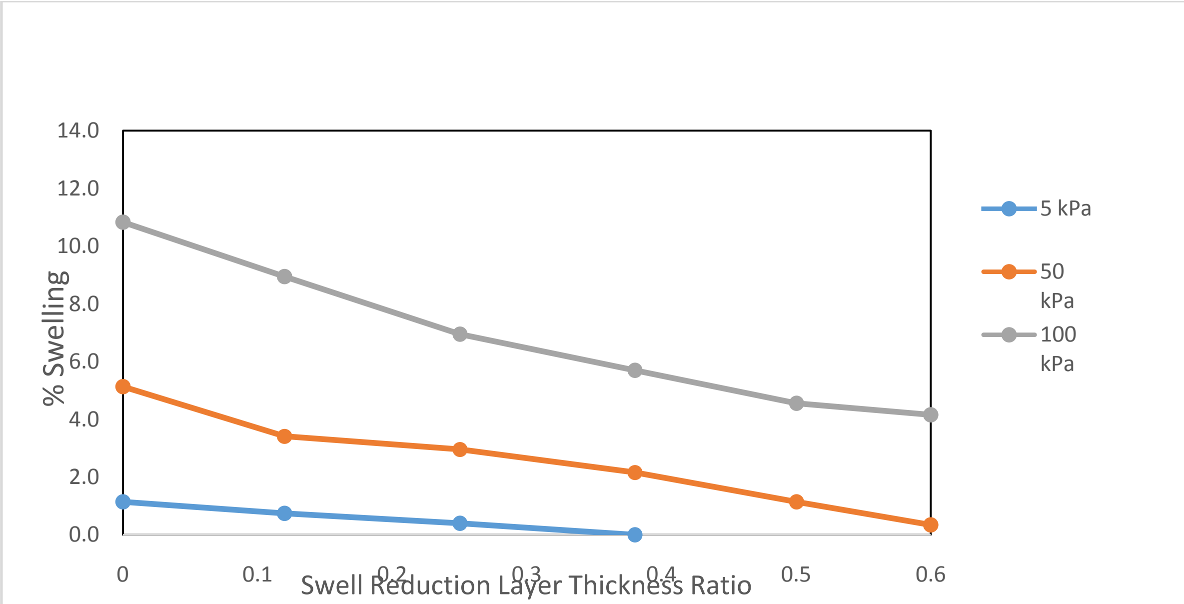

Fig**. 5.** Influence of Swell reduction layer thickness ratio on swell percentage of soil for various surcharges.

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