Soil stabilization with Flyash and Corn Waste 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 Corn Waste ash. For this purpose, a soil with high clay content was mixed with fly ash and Corn Waste ash. Several engineering improvements were reported and discussed as a result of this study.

The impact on UCS at 15% flyash and 6% CWA, for a 28 day curing period, is 840 kPa. At 15% flyash and 12% CWA, for a 28 day curing period, the UCS is 959 kPa. When the CWA content was increased from 0 to 12%, CBR improved from 3.7 to 10.6% for 25% flyash.

Keywords: Construction Materials, Clays, Corn Waste Ash, Flyash.

INTRODUCTION
Infrastructure plays an important role in a nation’s development. An example of infrastructure is highways. Clays cause uneven settlements of highways. Clays have low resistance to permanent deformation. This property plays a significant part of the strength of any pavement built over clay soil. Pavement structures are designed to serve their design life. However, several factors affect their serviceability and cause premature failures. The subgrade factors include high clay content, poor compaction, and insufficient drainage.

Adding admixtures to such type of subgrade using fly ash and Corn Waste ash is a doable method. This would make the needed modifications in the engineering characteristics. The objective of this paper is to stabilize soil with the fly ash and Corn Waste ash.

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.

<table>
<thead>
<tr>
<th>Constituents</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>56.0</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>21.0</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>6.5</td>
</tr>
<tr>
<td>CaO</td>
<td>12.2</td>
</tr>
<tr>
<td>MgO</td>
<td>3.6</td>
</tr>
<tr>
<td>Alkali</td>
<td>1.1</td>
</tr>
<tr>
<td>SO₃</td>
<td>1.6</td>
</tr>
<tr>
<td>Heavy Metals</td>
<td>trace</td>
</tr>
</tbody>
</table>

Corn Waste Ash
In this investigation, CWA passing through No. 100 sieve (150 micrometers) was used. The chemical composition of CWA is listed in Table 2. The CWA had 60% silica content. This amount provides good pozzolanic action.

<table>
<thead>
<tr>
<th>Constituent</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silica – SiO₂</td>
<td>60</td>
</tr>
<tr>
<td>Alumina – Al₂O₃</td>
<td>1.1</td>
</tr>
<tr>
<td>Calcium Oxide – CaO</td>
<td>5.0</td>
</tr>
<tr>
<td>Potassium Oxide - K₂O</td>
<td>15</td>
</tr>
<tr>
<td>Sulfur Trioxide - SO₃</td>
<td>1.2</td>
</tr>
<tr>
<td>Magnesium oxide - MgO</td>
<td>3.0</td>
</tr>
<tr>
<td>Phosphorus Oxide – P₂O₅</td>
<td>7.1</td>
</tr>
</tbody>
</table>
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 subgrade 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 CWA as a cushioning layer between the foundation and subgrade was also tested using the consolidation test.

TEST RESULTS AND DISCUSSION
The effect of flyash content on the UCS of CWA is presented in Figure 1. The effect 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 improved from 429 to 694 kPa at a strain of 6%. When flyash was increased from 0 % to 25 %, the compressive strength improved from 341 to 871 kPa at a strain of 9%.

The effect of CWA on CBR of clay-flyash mix is shown in Fig. 3. At any flyash content, addition of CWA up to 12% led to increases in CBR. Further increase in CWA decreased CBR, indicating that 12% is the optimum value of CWA. When the CWA content was increased from 0 to 12%, CBR improved from 2.1 to 7.8 for 0% flyash. When the CWA content was increased from 0 to 12%, CBR improved from 3.7 to 10.6% for 25% flyash as shown in Figure 3.

Low cohesion makes CWA a poor cushioning and construction material. However, after stabilizing with flyash and curing for 28 days, CWA 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% CWA, for a 28 day curing period, the UCS is 959 kPa as shown in Figure 1. As per Kate and Katti, this qualifies as a cushioning material at 15% flyash. Similar results were found by Sivapulliah et al. for an CWA-lime mixture.

Fig. 1. Influence of Corn 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 Corn Waste Ash on CBR for clay-flyash mixture.

Fig. 4. Influence of number of cycles on swelling of 15% flyash and Corn WA blend under surcharge of 5kPa.
CONCLUSIONS
The following are the conclusions.

1. The impact on UCS at 15% flyash and 6% CWA, for a 28 day curing period, is 840 kPa
2. At 15% flyash and 12% CWA, for a 28 day curing period, the UCS is 959 kPa
3. When the CWA content was increased from 0 to 12%, CBR improved from 3.7 to 10.6% 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.

ACKNOWLEDGEMENT
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REFERENCES


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