AN EXPERIMENTAL STUDY OF FLYASH COLUMNED BED IN EXPANSIVE SOIL

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ABSTRACT: In this paper an experimental study is carried to estimate effect of vertical flyash columns in the expansive clay bed on controlling the heave of the expansive soil bed. It is observed that the heave is considerably reduced with the vertical flyash columns in the expansive soil bed. Puzzolanic activity of the flyash is studied by replacing the flyash by sand in the vertical columns in the expansive clay bed. It is observed that the heave of the expansive clay bed increasing with the increasing sand content in the vertical flyash columns, since the flyash content decreases results in reduction in puzzolanic activity.

1. INTRODUCTION
Expansive soils are highly problematic, as they swell on imbibition of water and shrink on evaporation thereof. Because of this alternative swell and shrink behaviour cause volume change, result in distress of the structures founded in such soils. Extensive research has been carried out to suggest techniques to reduce the swell of expansive clays.

Heave of the expansive clay bed is reduced by providing the horizontal stabilized flyash cushions (Sreeramarao et al. 2005) on the top of the expansive clay bed. The heave of the expansive clay bed further reduced by providing vertical flyash piles in the expansive soil bed (Ramu & Kishore 2007).

Granular Pile-Anchor (GPA) foundation is found to be quite effective in reducing heave and improving the engineering behaviour of expansive clay beds (Phani Kumar et al. 2004), since the tensile uplift force caused on the foundation by the swelling soils absorbed by the granular pile anchor.

The behavior of foundation anchored to granular pile depends on the uplift capacity of the granular pile-anchor. Pullout capacity increased with the increasing length and diameter of the granular pile. Based on this concept, an experimental investigations are carried out in this study, with vertical flyash piles in the expansive clay bed, to study the heave of the expansive soil bed. Puzzolanic activity of the flyash also studied by replacing the part of flyash used in the vertical columns by sand.

2. EXPERIMENTAL STUDY

2.1 Materials Used
The following materials are used in the experimental study.

2.1.1 Soil
The soil used in the experimental study is collected from 1.2 m below the ground level from a site Godilanka near Amalapuram in E.G. District in Andhra Pradesh. The soil has liquid limit = 75%, plastic limit = 25% and clay content 62.2%. Differential free swell 130% and swell pressure = 223 kPa.

2.1.2 Flyash
The fly ash has been collected from Vijayawada Thermal Power Plant, Vijayawada at slightly moist state. The flyash has fine sand size 86.4% and silt & clay size 13.6%.

3. EXPERIMENTAL INVESTIGATION

3.1 Preparation of Compacted Expansive Soil Bed
Computed quantity of air-dried and pulverized soil, passing through 4.75 mm sieve, is mixed thoroughly. Based on the natural water content in the soil, computed quantity of water is added to reach 15% moisture content. The mixture is covered with wet cloth, and left for a maturing time about 2 hours to permit proper absorption of water.

A test tank of 400 mm diameter and 400 mm height is taken. Sand layer of 10 mm thick has been laid at the bottom of the test tank. An iron casing of size of 300 mm diameter and 450 mm height is coated with oil on both sides and pushed in to the test tank as shown in Figure 1. The gap between tank and casing is filled with sand.

The mixed and matured expansive soil is divided into three nearly equal amounts. Each part of the expansive soil is compacted in the space inside of the casing and is compacted to approximately 50 mm thick. The top of the compacted surface is scratched to develop bond between the layers and the total thickness of three layers would be 150 mm to maintain the dry density of the expansive soil bed at 13.6 kN/m$^3$. After the soil has been compacted the casing is filled with sand.

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3.2 Preparation of Vertical Columns in the Expansive Soil Bed
An open mild steel tube of 38 mm diameter and 300 mm height are pushed into the clay bed. The tube is turned for
two revolutions to shear the sample off at the bottom. Then the tube is removed from the clay bed. The void created by the mild steel tube is filled with the flyash in 3 layers. Each layer compacted with tamping rod, to get the required density. Similarly total five flyash vertical columns are prepared, one at the center and the remaining four are radially at a distance of 110 mm from the center of the clay bed.

4. TESTING PROGRAM

A mild steel plate of 30 mm diameter is placed on the top of the clay bed. A dial gauge is placed on the top of the steel plate to measure the vertical displacement of the bed. Set dial gauge reading to zero or note the initial reading. Now water is added through the sand drain around the clay bed. When the water is available to the expansive clay bed, it starts absorbing the water results in increase in volume. Since the sides and bottom of the clay bed are fixed boundaries the increase in volume results in increase in height of the clay bed which can be measured in the dial gauge. Since the process of absorbing water by the expansive soil bed is a time consuming, hence the dial gauge reading are to be recorded with respect to time till the complete swelling. A graph is plotted between the time as abscissas and corresponding heave as ordinates. When the equilibrium condition arrives, there is no further increase in height of the clay bed, where the dial readings are constant and curve becomes asymptotic. The maximum heave is recorded at this condition.

5. RESULTS AND DISCUSSION

Expansive soil bed is prepared in the model test tanks with dry density of 13.6 kN/m³ and moisture content of 15%. Dial gauge is arranged on the top of the expansive clay bed to measure the heave. Then water is added to the expansive clay bed and the dial gauge readings are recorded with respective time and presented in Figure 2. The dial gauge readings are recorded with time till the curve (Fig. 2) became asymptote indicating that there is no further increase in dial gauge readings with time. The maximum heave recorded for expansive clay bed of thickness 150 mm is 49.16 mm.

Flyash columned expansive clay bed is prepared as explained above. On top of bed heave is recorded and its variation with time is presented in the Figure 2. The maximum heave of the expansive clay bed with flyash columns is recorded as 27.27 mm. With the vertical flyash columns in it, the heave of the expansive clay bed is reduced from 49.16 mm to 27.27 mm, a reduction of 44.53%. The reduction of heave may be due to the frictional resistance developed along the vertical surface of the flyash columns and the pozzolanic action between the flyash and expansive clay.

Sand and flyash mix is prepared with different proportions and is used in the vertical columns instead of flyash alone. The measured heaves on the top of the expansive clay bed, with these vertical columns are 29.29, 31.31, 31.7, 32.31 and 33.35 mm respectively for 10%, 20%, 30%, 40% and 50% of sand replaces the flyash used in the construction of vertical columns in the expansive clay bed (Fig. 2). It is observed that, with increasing the sand content in the flyash-sand mix the heave is increasing. This phenomena is observed may be due to decree-as the puzzolanic action of flyash, with the increasing sand content (i.e. decreasing flyash content) in the vertical columns.

6. CONCLUSIONS

From the laboratory study the following conclusions can be drawn

- With the vertical flyash columns inserted into the expansive clay bed, the measured heave is observed to be reduced from 49.19 to 27.27 mm.
• With increasing the percentage of sand and decreasing the percentage of flyash in the vertical columns inserted into the expansive clay bed, the measured heave increases, may be due to the reduction in puzzolanic action.

REFERENCES

