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# APPLICABILITY OF GEOTEXTILE ENCASED SAND PILES ON EMBANKMENT

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**ABSTRACT:** The ground improvement has been one of the major issues in the geotechnical engineering especially in the design of embankments in soft soil. Currently Sand Compaction Pile, Gravel Compaction Pile and Deep Cement Mixing are widely used for ground improvement. The foundation of traffic road embankments is normally treated by exchanging soft soil or by improving soil with sand piles. But sand piles in some cases are insufficient. It is difficult to install sand piles in soft soil due to bulging of sand piles after loading. In this project a new stabilization method is used in which sand piles are inserted into bearing layers and radial supporting of piles is strengthened by using geotextile coating combined with surrounding soft soil. The objective of this project is to test and compare the load carrying capacity of sand piles on embankments with and without geotextile. Various tests are conducted by varying pattern of sand pile and type of geotextile. The strength of piles can be determined by using any appropriate test which gives load carrying capacity of pile. The results are tabulated and it shows increase in load carrying capacity of pile with the use of geotextile casing.
***Keywords:*** *ground improvement techniques, ordinary sand piles, geotextiles, geotextile reinforced sand piles, individual action of sand piles, group action of sand piles, load carrying capacity, settlement.*

## INTRODUCTION

Embankment stabilization is the process of establishing and implementing resistive measures against erosion and failure of roadway cut slopes or fill embankments. Stabilization may be achieved by either mechanical (structural) means, vegetative or both.

Sand compaction pile method consists of driving a hollow steel pipe with a detachable bottom plate down to desired depth. The driving can be done by using an impact hammer or a vibratory driver. Geo textiles are permeable or porous fabrics, made from synthetic material that are applied with soil, rock or any other geotechnical engineering related material. The geotextile is wrapped (coated) around the sand piles so that load carrying capacity can be increased.

## MATERIALS

### Soil

The soil was collected from Puzhakkal, Thrissur (Kerala). The soil was initially air dried in open atmosphere prior to the testing. The soil was sieved through 4.75mm IS sieve to remove the coarser fraction.

Various tests were conducted on the soil for knowing index as well as engineering properties. The liquid limit was found by Casagrandes apparatus. Plastic limit was found by thread test. The specific gravity was found by density bottle method. The results obtained are tabulated in Table 1.

### Sand

The sand aggregates of size less than 4.75mm was taken to form the sand piles. The bulk density and specific gravity were found. Sieve analysis was conducted to know the particle size distribution of sand.

### Geotextiles

Both natural and artificial geotextiles were used for the study. Coir was used as natural and polyster was used as artificial one.

**Table 1** Properties of soil

| Properties | Values |
|---|---|
| Liquid limit | 47% |
| Plastic limit | 28.906% |
| Plasticity index | 18.09% |
| Unconfined compressive strength | 9.0kN/m² |
| Classification as per plasticity chart | MI |
| Water content | 20% |
| Field density | 1.784 g/cc |
| Specific gravity | 2.77 |
| Max dry density and OMC | 2.22g/cc&16% |

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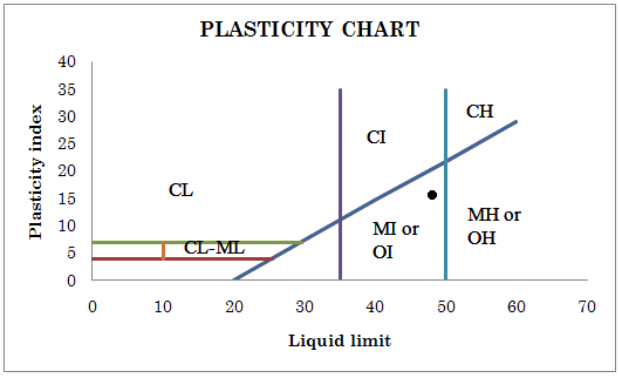


**Figure 1:** Plasticity Chart

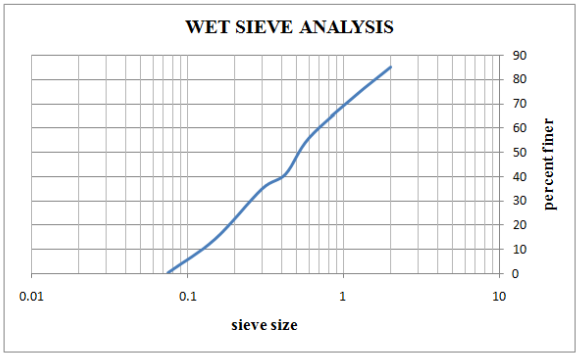


**Figure 2:** Wet Sieve Analysis of Soil

**Table 2** Properties of sand

| Properties | Value |
|---|---|
| Uniformity coefficient, coefficient of curvature | 3.44, 2.615, 0.860 |
| Bulk density(loose/compacted) | 1.575/1.684 |
| Specific gravity(loose/compacted) | 2.527/2.673 |
| Angle of internal friction | 43° |

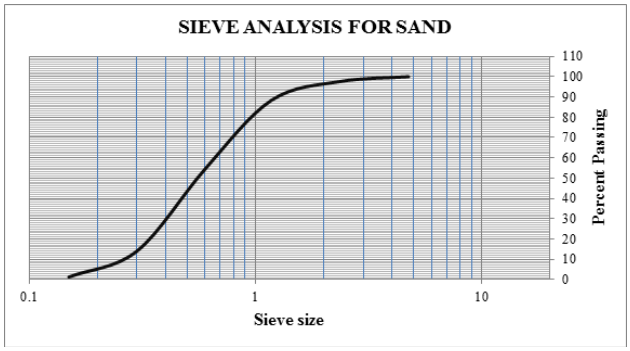


**Figure 3:** Sieve Analysis of Sand

**Table 3** Property of geotextile

| Type of geotextile | Tensile modulus |
|---|---|
| Natural coir geotextile | 15kN/m |
| Polyester geotextile | 200kN/m |

## PROCEDURE

A mould of size 50cm x 50cm x 45cm was prepared. The soil bed with uniform compaction up to a height of 40cm was prepared. A casing pipe having outer diameter equal to the diameter of the sand pile was erected into the soil mass by vibro-displacement process. Entire tank setup is placed on the loading frame & a uniform load is applied to determine the strength of sand piles. The sand columns are placed in a square pattern and triangular pattern. 50mm sand pile is used for the tests. The results were recorded. The same procedure is repeated by varying pattern of sand pile and type of geotextile (coir & polyester).

### Preparation of Soil Bed

The soil bed up to 40 cm depth was prepared in the mould using soil which passes through 4.75mm IS Sieve. The proper mixed soil mass with corresponding field water content was filled in each 10 cm up to the height of 40 cm in the mould. The density of each layer was checked during filling.

### Installation of Sand Piles

For the testing of sand piles the casing of sand pile was first erected to the prepared soil bed. The casing pipe was having diameter equal to diameter of sand pile to be tested. The sand pile was pushed up to full depth of soil layer at center of the loading plate for testing individual effect of piles. For testing the group effect of piles, the square pattern and triangular pattern were made on the soil bed. For square pattern four sand piles of equal diameter were installed. For triangular pattern three sand piles of equal diameter were made. The sand piles were installed so that the spacing between each sand piles was same.

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**Applying Load**

The laboratory test was conducted on Universal Testing Machine. The entire tank set up was placed on the loading frame. The loading pad was placed on top of the soil. Proper centering was done before conducting the test. A proving ring and a dial gauge with magnetic base were attached to the UTM. An initial seating load of loading pad, 8.42 kg was applied first. The load was applied through strain controlled displacement of loading plate at a constant a strain rate of 1.2 mm/min. The readings were noted. The final settlement and load were calculated. Graphs were drawn to show the relationship between load and settlement.

**Figure 4:** Load Setup and Apparatus

**RESULTS & DISCUSSIONS**

**Results without Use of Geotextile**

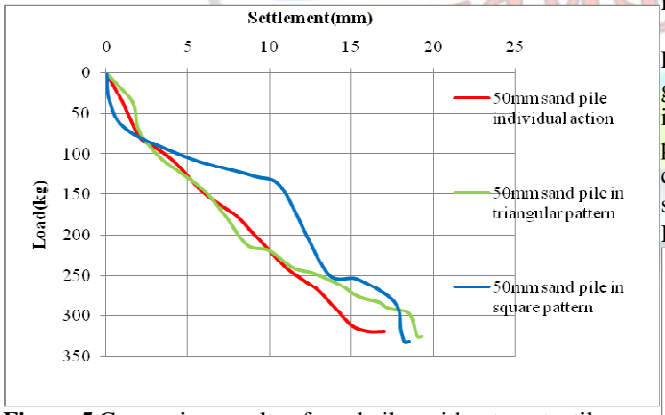


**Figure 5** Comparing results of sand piles without geotextile

The load carrying capacity of individual sand pile was 318.105 Kg at settlement of 16mm. For the triangular pattern it was 325.2Kg at settlement of 19mm and for square pattern it was 332.243Kg at 18.2mm settlement.

From the results of the tests on sand pile without geotextile it can be concluded that soil alone had a low load carrying capacity with higher settlement. The introduction of sand piles improved the load carrying capacity and reduced settlement. The performance of sand piles in square pattern was more superior to the others.

**Results with Use of Coir Geotextile**

The load carrying capacity of individual sand pile coated with coir geotextile was 332.243 Kg at settlement of 16mm. For the triangular pattern it was 353.45Kg at settlement of 18mm and for square pattern it was 367.588Kg at 15.9mm settlement.

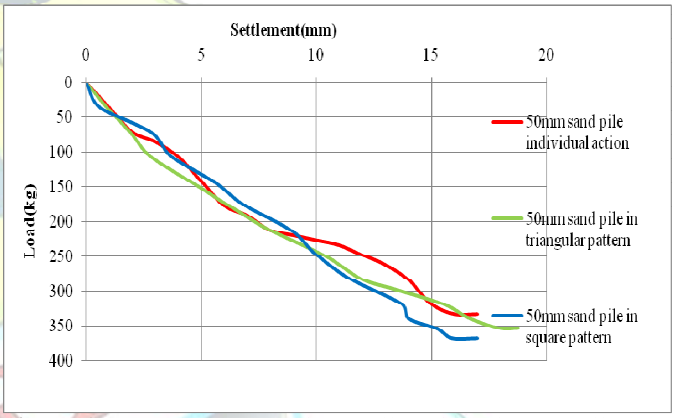


**Figure 6** Comparing results of sand piles with coir geotextile

From the results of the tests on sand pile coated with geotextile it can be concluded that there is significant increment in load carrying capacity of soil compared to sand piles without geotextile. The performance of sand piles coated with coir geotextile in square pattern was more superior to the others.

**Results with Use of Polyester Geotextile**

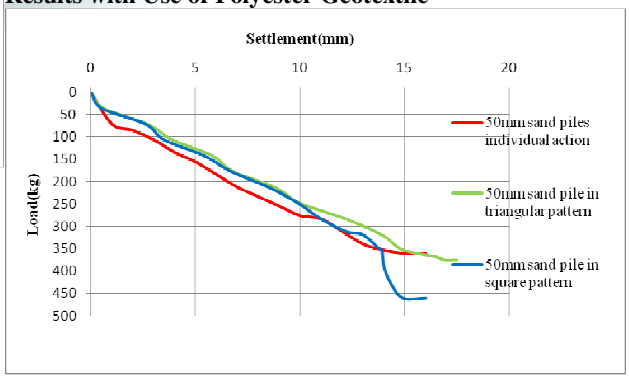


**Figure 7** Comparing results of sand piles with polyester geotextile

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The load carrying capacity of individual sand pile coated with polyester geotextile was 360.519 Kg at settlement of 15mm. For the triangular pattern it was 374.657Kg at settlement of 16.9mm and for square pattern it was 459.485Kg at 14.9mm settlement.

The performance of sand piles coated with polyester geotextile was more superior to those with coir geotextile. Sand piles in square pattern were more superior to the others. 50mm sand piles with polyester geotextile coating in square pattern had higher load carrying capacity with much reduced settlement. The performance of sand piles with polyester geotextile was more superior to that of coir since the tensile modulus of polyester is higher than that of coir.

## CONCLUSIONS

The loading capacity of the sand piles can be increased by coating with geotextile. There is significant reduction in settlement with geotextile encasement of sand piles in soft soil. Sand pile coated with polyester geotextile in square pattern is more superior. The tensile modulus of the geotextile reinforcement plays an important role in enhancing the load carrying capacity of the reinforced piles. The confining pressures generated in the sand piles are higher for stiffer reinforcements.

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