Study on Strength Behaviour of Granular Pile on Clayey Soil with Different Materials

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Abstract— Due to the lack of availability of land, people are now forced to construct buildings on soft soils. But these soft soils are usually associated many substantial difficulties. The present investigation was under taken to study the behavior of granular piles in improving load carrying capacity and settlement resistance in weak soils using different materials. In this study, materials used for the formation of granular pile were aggregates and demolished materials like concrete waste, brick waste and tile waste. From the study it is clear that aggregates are effective in reducing settlement. Demolished materials like concrete waste and tile waste can also be used as effective materials in formation of granular piles.

Keywords: Clayey Soil, Aggregates, Tile Waste, Granular Pile

I. INTRODUCTION

Construction on soft ground area is a huge challenge in the field of geotechnical engineering. Soft soils are characterized by low shear strength, high compressibility and low bearing capacity. Construction in these soils may lead to structural damages during the execution as well as throughout the life of the projects, especially in urban areas. Stone columns, also known as granular piles are popular as a technique of ground improvement not only in cohesive soils but also in cohesion less soil deposits. In this investigation, an attempt is made to examine the load settlement characteristics of granular pile using different materials. In order to study the load settlement behavior plate load test was conducted on granular pile using different materials. In this study, aggregates, concrete waste, tile waste, brick waste were used for the construction of granular pile. Also studied the effect of L/D ratio in load carrying capacity of soil. Simultaneously, due to a high increase in a volume of demolished materials which are formed during the demolition of old buildings, concrete pavements, bridge structures etc. are causing dumping problem and pollution. Utilization of these materials in construction of stone columns not only helps to preserve natural materials but also helps to avoid the dumping problems of these demolished materials. Mohd Furkhan, M. Kameswara Rao (2017) conducted studies on load carrying capacity of soft clays provided with granular pile of different materials. Laboratory tests were conducted on granular piles installed in soft soils by using aggregates, sand, marble dust etc. T. G Shilpa, Santhosh kumar (2016) carried out studies on the topic "Load settlement behavior of granular pile on cochin marine clay using recycled aggregates". In this study, they conducted load tests on granular piles formed using recycled aggregates on cochin marine clay.

II. MATERIALS USED

The clayey soil is collected from English Indian Clay Factory, Veli, Thiruvananthapuram district of Kerala. The index properties of the soil is determined as per IS specifications.

Properties	Values
Specific gravity	2.68
Liquid Limit	68%
Plastic Limit	40%
Optimum moisture content (OMC)	23%
% of clay	66%
% of silt	24%

Table 1: Properties of clay

In this study granular pile is formed using aggregates, concrete waste, brick waste, and tile waste.

Properties	Value
Bulk density (KN/m^3)	1.69
Specific gravity	2.59

Table 2: Properties of aggregates

Properties	Value
Bulk density (KN/m^3)	1.52
Specific gravity	2.51

Table 3: Properties of brick waste

Properties	Value
Bulk density (KN/m^3)	1.65
Specific gravity	2.53

Table 4: Properties of concrete waste

Properties	Value
Bulk density (KN/m^3)	1.63
Specific gravity	2.43

Table 5: Properties of tile waste

III. METHODOLOGY

Granular piles are constructed using different materials in the selected soil sample and Plate load test was carried out to determine the strength behaviour of granular pile. The test was conducted using different materials. In the first stage tests are carried out on normal clay without granular pile. In the next stages testing was conducted on granular pile formed using different materials. The tests were conducted on individual pile as well as group pile. The tests were also conducted by varying length of granular pile. From the obtained results, load-settlement graph was plotted and compared strength behaviour of pile on various materials. The measured quantity of soil is mixed with water to achieve required consistency. Usually soil is mixed with optimum moisture content. The mould was a metallic cylinder with inside diameter 25cm and height 30cm.

The mould was placed at a levelled surface. The mould was cleaned and filled with soil at required height. The soil was filled in layers so that each layer can be provided

with enough compaction. The granular piles with different pile materials were installed by a displacement method. An open PVC pipe of 5cm diameter, smeared with petroleum jelly (to reduce friction) was inserted into the soft clay up to a depth equal to a length of the granular pile. Stones aggregates were charged in and compacted with a rod to obtain uniform diameter of a granular pile. Now the pipe was slowly raised, simultaneously aggregate was charged ensuring outside clay not intruding in. This was continued till granular pile is formed. Similarly the procedure was repeated with concrete waste, tile waste and brick waste as single pile and group pile. The load settlement characteristics of single pile and group pile were studied separately. Tests were conducted on granular piles with length equal to that of the height of the soil filled and also length half to the height of soil filled. Load is applied using a hand operated hydraulic jack. A calibrated proving ring is attached to the shaft which gives load. Vertical settlement is measured using dial gauges of least count 0.01mm. This procedure was repeated in all cases. In every test set up load and corresponding settlement was noted.

Fig. 1: Test setup for vertical loading

IV. RESULTS AND DISCUSSIONS

Load test were conducted on samples to determine the load-settlement characteristics of soils. The load-settlement curves obtained from experimental data have been plotted. Test series wise results and interpretation is as follows.

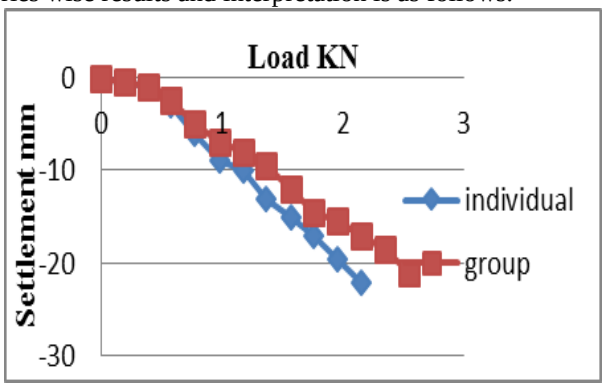

Fig. 2: comparison of load settlement behavior of granular pile using aggregates

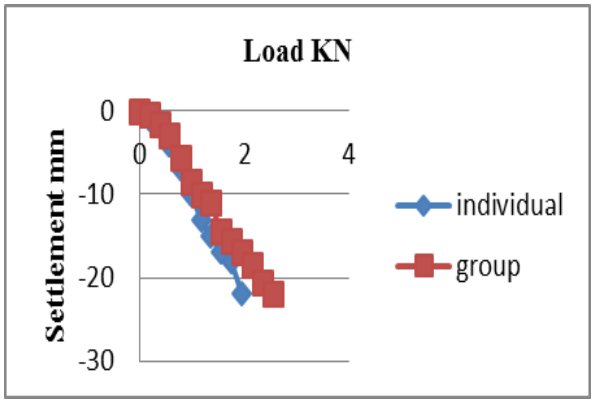

Fig. 3: comparison of load settlement behavior of granular pile using concrete waste

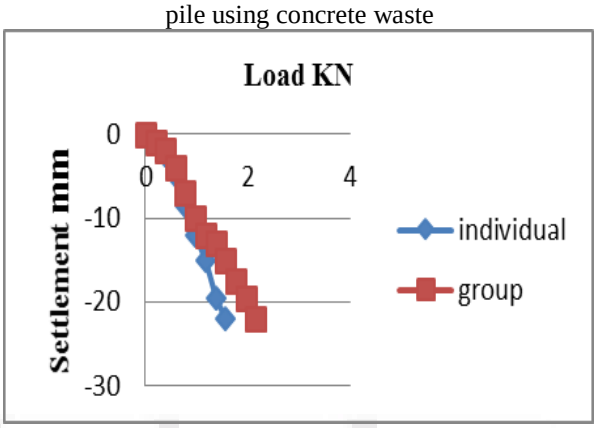

Fig. 4: comparison of load settlement behavior of granular pile using tile waste

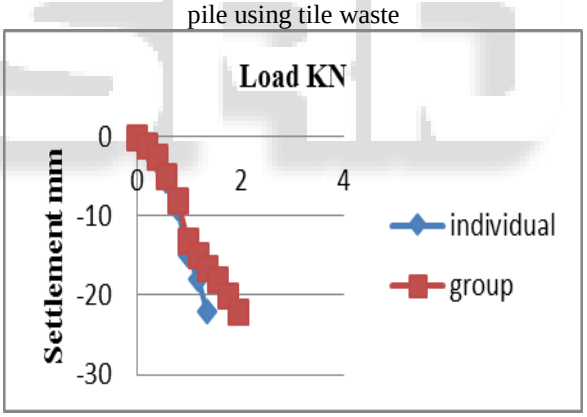

Fig. 5: comparison of load settlement behavior of granular pile using tile waste

It can be seen from the figure that the load carrying capacity increases by the installation of granular pile in the clayey soil. Also it is seen that the load carrying capacity increases with the installation of group pile. Use of aggregates and concrete waste shows better results than other materials. The load carrying capacity of pile using brick waste is quite low comparing to other materials. The value of settlement also decreases with installation of group pile. This is because in the case of group pile there is a combined effect of three granular pile which is greater than individual pile.

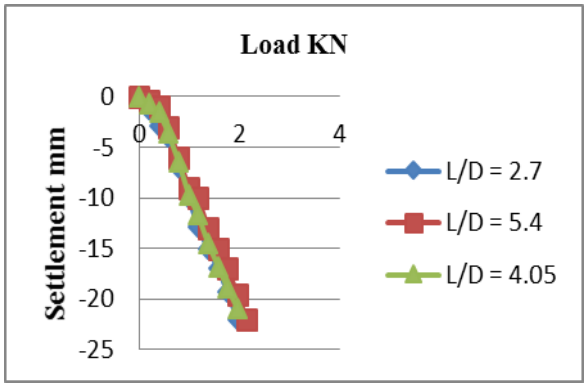

Fig. 6: comparison of granular pile formed using aggregates with varied L/D ratio

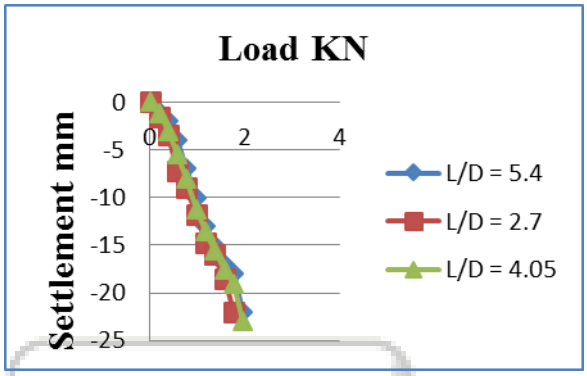

Fig. 7: comparison of granular pile formed using Concrete waste with varied L/D ratio

In this test series, analysis is done by changing the L/D ratio of the pile. Here diameter of the pile is kept same and length of the pile is varied. In this study, test was conducted in different L/D ratios like 5.4, 2.7, 4.05.

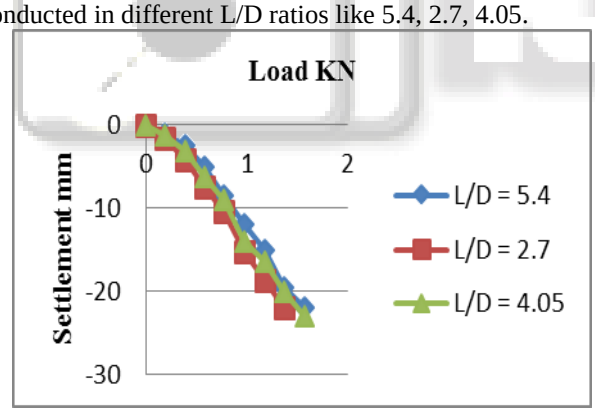

Fig. 8: comparison of granular pile formed using tile waste with varied L/D ratio

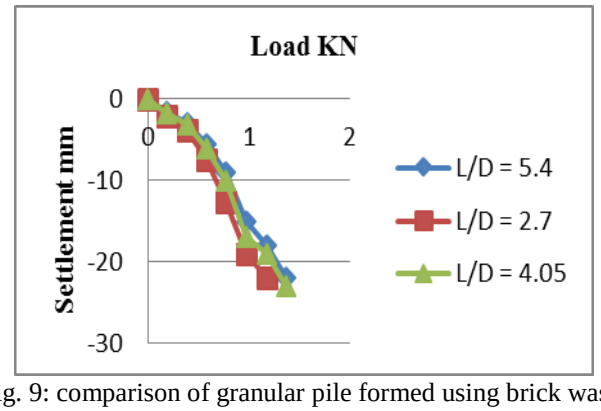

Fig. 9: comparison of granular pile formed using brick waste with varied L/D ratio

From the above figures, load settlement characteristics of the granular pile increases with increase in L/D ratio. When the L/D = 5.4 provides better results than when the L/D = 2.7 and L/D = 4.05. Here diameter of the pile is kept constant. As the length of the pile is reduced load settlement characteristics increased.

V. Conclusions

Series of laboratory tests were conducted to determine the load-settlement characteristics of granular pile using different materials and at different length on the soft soil. The soil shows increase in load carrying capacity and reduction in settlement due to insertion of granular piles the use of aggregates provides greater load carrying capacity than other materials. In the case of demolished materials, granular pile formed using concrete waste provides 90% increase with aggregates. Therefore, concrete can used in formation of granular pile. The use of tile waste also provides significant increase in load carrying capacity. The brick waste also increases load carrying capacity compare to normal soil. Length of the granular pile has also impact on the settlement. Granular piles with greater length provide better results.

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