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Analysis of Bulging Behaviour of Granular Pile

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Abstract— In order to improve the soft clay bed, providing granular pile is an absolute solution to restrict the settlement and provide strength to the soft clay bed. Ordinary granular pile (OGP) transfers the load acting on the soft soil to the larger depth. The load concentration at the top of the pile is very high and this stress concentration is responsible for one of the pile deformations, called bulging. Due to applied load, a type of irregularity in the shape of a pile known as bulging, enlarges the cross section of the pile in particular places along its length. Bulging analysis is done with the help of PLAXIS 2D software.

Index Terms—Bulging, Granular Pile, Plaxis2D, Soil Improvement.

I. INTRODUCTION

Possibly the most unique feature of soft soil deposits challenging soil to work with from a geotechnical perspective engineering. Excessive settlement and low shear strength are the two main issues that arise while constructing civil projects in soft soil deposits. Due to these clays' high void ratio and natural compressibility, consolidation and displacements can be seen during construction and last for a very long time after implementation of the building. Thus, it is necessary to adopt the scheme of ground improvement.

Granular piles are more rigid and have better drainage than the soft soil around them. Therefore, ground reinforcement with granular piles has the benefit of lower settling and accelerates the consolidation process, solving the difficulties of the soft soil. The ease of construction of this technology is another benefit.

The granular pile's carrying capacity depends on mostly on the side support. The lateral assistance offered based on the shear strength of the local soil. When soft ground is reinforced by granular piles, stress concentration develops in the pile accompanied by a reduction of the stress of the surrounding clay ground [1-6]. Stress concentration in granular piles depends mainly on the pile/soil stiffness, load level and pile depth [7- 9]. Granular pile installation in soft soil has been found to boost the foundation's bearing capacity and speed up consolidation, according to field observations and numerical analyses [10-11].

II. PARAMETRIC TESTING PROGRAM

In the present study, the prescribed settlement is taken 50 mm, and the L/D ratio of pile is kept 4,5and 6. The diameter of the OGP is taken 80mm,100mm, and 120mm. The loading plate is provided at the top of the OGP of 2 times of the diameter of the OGP. The improvement in strength of the soft soil is analysed after providing the OGP. After providing the OGP there is significant improvement in the strength of the soft soil bed.

III. RESULTS AND DISCUSSION

A. For 80mm 160mm plate

The diameter of the OGP is kept 80mm and the length of the OGP for the same diameter and L/D 4,5,6 will be 320mm, 400mm, 480mm.The loading plate is also provided of 2 times the diameter of the OGP i.e., 160mm. Due to applied load, the top portion of the OGP is under the high concentration of stresses and the irregularity in the shape of the pile generates in the top portion of the OGP that is called bulging of the OGP. The bulging of the OGP for 80mm diameter and L/D = 4,5 and 6 is shown in fig.1 below. After applying the load, the bulging in the top portion of the OGP for L/D =4,5 and 6 is shown in the fig.1. The bulging effect varies with the depth as the stress concentration varies with the depth of the OGP. As the depth increases the stress concentration decreases hence the bulging effect also decreases at the lower portion of the OGP at larger depth. The size of OGP like length and diameter of the OGP affects the bulging.

In fig.2, the variation of bulging with depth is depicted. The bulging effect is seen in the top portion of the OGP due to high concentration of the stresses. The variation of bulging with depth for L/D=4,5 and 6 is shown in fig.2. The maximum bulging effect is in the OGP of L/D=6, and minimum bulging in the OGP of L/D=4. The OGP having L/D=6 can carry more load in comparison of OGP having L/D=4 &5, hence the bulging in the OGP of L/D=6 is more.

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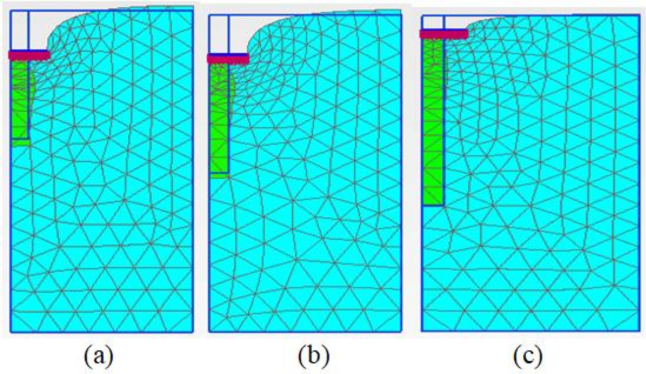

Fig. 1 (a, b, c) Represents Bulging of OGP of 80mm diameter, for L/D 4,5, and 6 respectively

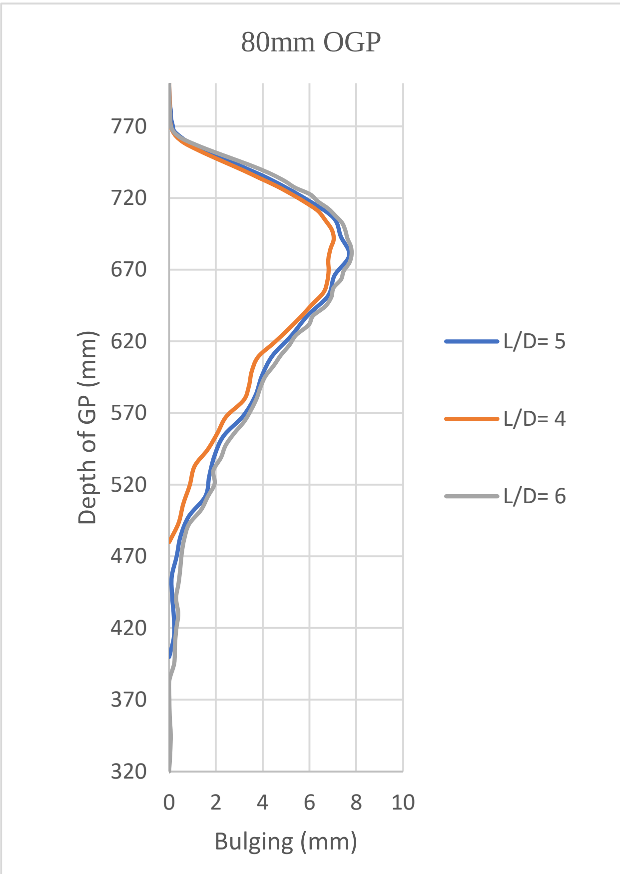

Fig.2 Variation of Bulging with Depth of the OGP for 80mm diameter OGP

B. For 100mm 200mm plate

The diameter of the OGP is increased from 80 mm to 100 mm. As the Loading plate of size 2 times the diameter of the OGP is provided in this research, the loading plate of 200mm diameter is provided in this case. By keeping diameter 100 mm, in order to have L/D =4,5 and 6, the length of the OGP is kept 400,500, and 600 respectively.

The loading is applied at the top of the OGP of 100 mm diameter through loading plate and the bulging effect is seen. The bulging for OGP of L/D =4,5 and 6 is shown on the fig.3.

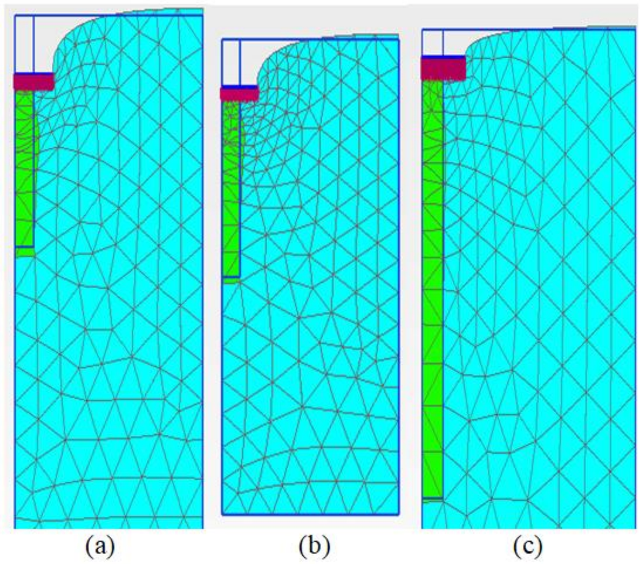

Fig.3 (a, b, c) represents Bulging of OGP of 100mm diameter for L/D 4,5 and 6

In fig.4, the variation of bulging with depth is presented. The bulging effect is seen in the top portion of the OGP due to high concentration of the stresses. The variation of bulging with depth for L/D=4,5 and 6 is shown in fig.4. The maximum bulging effect is in the OGP of L/D=6, and minimum bulging in the OGP of L/D=4. The OGP having L/D=6 can carry more load in comparison of OGP having L/D=4 &5, hence the bulging in the OGP of L/D=6 is more.

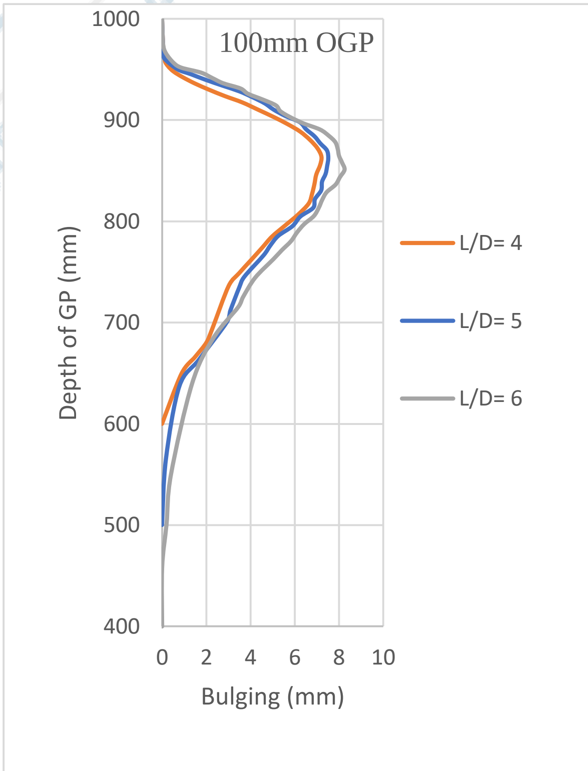

Fig.4 Variation of the bulging with depth for OGP of 100mm diameter

C. For 120 mm 240mm plate

The diameter of the OGP is increased from 100 mm to 120 mm. As the Loading plate of size 2 times the diameter of the OGP is provided in this research, the loading plate of 240mm diameter is provided in this case. By keeping diameter 100 mm, in order to have L/D =4,5 and 6, the length of the OGP is kept 480,600, and 720 respectively.

The loading is applied at the top of the OGP of 120 mm diameter through loading plate and the bulging effect is seen. The bulging for OGP of L/D =4,5 and 6 is shown on the fig.5.

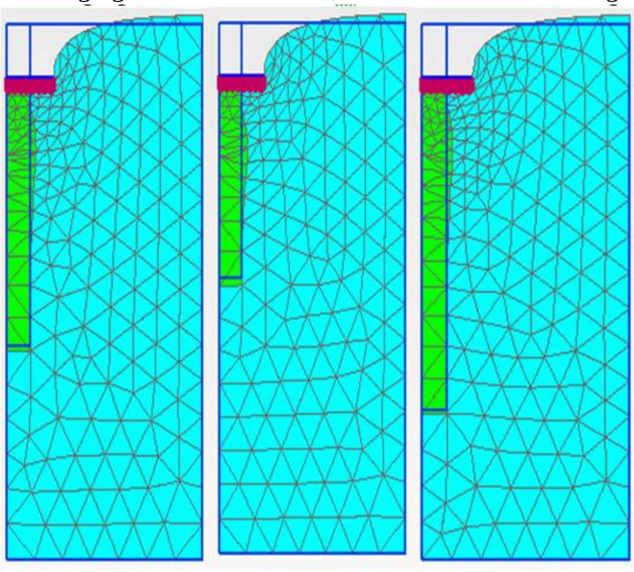

Fig.5 (a,b,c) Represents Bulging in OGP of 120 mm diameter, of L/D 4,5 and 6

In fig.6, the variation of bulging with depth is presented. The bulging effect is seen in the top portion of the OGP due to high concentration of the stresses. The variation of bulging with depth for L/D=4,5 and 6 is shown in fig.6. The maximum bulging effect is in the OGP of L/D=6, and minimum bulging in the OGP of L/D=4. The OGP having L/D=6 can carry more load in comparison of OGP having L/D=4 &5, hence the bulging in the OGP of L/D=6 is more.

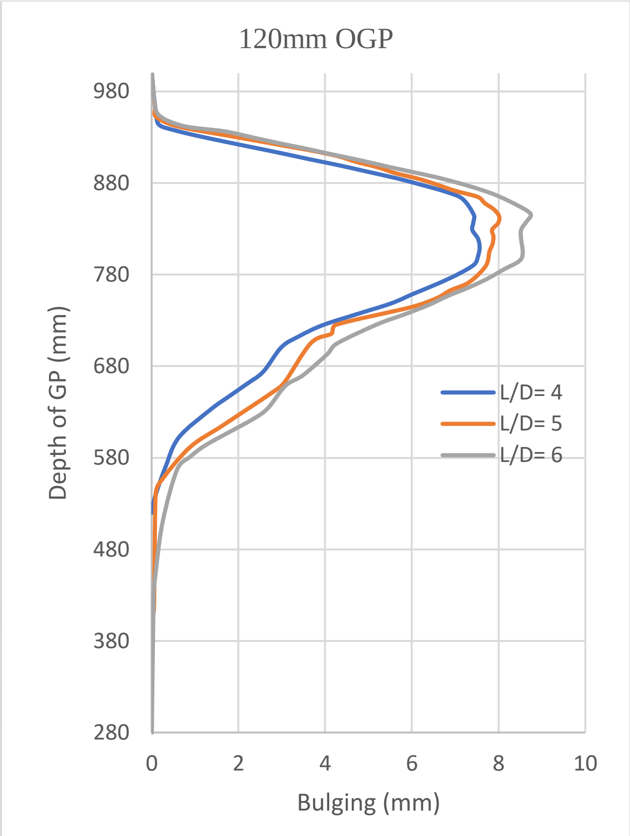

Fig.6 Variation of the bulging with depth for OGP of 100mm diameter

Maximum bulging is seen in the case of OGP of diameter 120mm and L/D=6 because the load carrying capacity of the OGP will be maximum in the following cases. Due to more load carrying capacity, the value of stresses will be maximum in the case of OGP of 120mm diameter having L/D=6, and the bulging obtained in this OGP is maximum in the all cases of this study.

IV. CONCLUSION

The following conclusions are made based on the present study

1. It can be concluded from the results that the bulging effect in the OGP occurs in top region of all OGP due to high concentration of stresses is located at the top portion of the OGP.
2. The Maximum Bulging is seen in the OGP of 120mm diameter having L/D=6 in comparison to other OGPs. Hence It can be concluded that the bulging depends on the size of the pile.

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