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EXTENDED ABSTRACT

Experimental Study of the Horizontal Thin Layer Effect on the Bearing Capacity of Circular Footings Resting on Sand

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1. Introduction

In general, despite their seeming insignificance, there are some details in the ground that have significant effects on soil-foundation system behavior such as slip surfaces, shear bands, and thin layers (Valor et al. 2017). Terzaghi (1929) termed "these features minor geologic details and pointed out their enormous potential effects on the safety of dams". In the literature review very little study has been performed on the effects of a thin layer (Valor et al. 2017, Ziccarelli et al. 2017, Oda and Win, 1990)

In the present paper, the influences of the horizontal thin layer on the ultimate bearing capacity of the circular foundation resting on the sandy bed were studied by implicating a small-scale physical model for the soil-foundation system. The problem of the soil- circular footing system is schematically illustrated in Fig. 1. The problem is investigated under the axisymmetric condition, and the circular foundation is rigid. This foundation rests on the ground surface, on the other hand, the initial depth of embedment is nil. The studies were performed by the material type, thickness, and depth of the thin layer variation. For the bed sand, crushed uniform silica sand (SP) with medium density was used. For the thin layer, materials with different strength properties (strong and weak) in comparison with the sandy bed were used.

For the weak layer, the clay powder with CL classification was used. Clay with a natural moisture content of 5.5% and a very low density of 12.1 kN/m^3 was used consistently in all of the experiments.

For the strong layer, a fine-grained asphalt mixture with an unconfined compressive strength of 1460 kPa and unit weight19.12 kN/m^3 was used.

2. Methodology

2.1. Experimental method

To perform the tests, a small-scale experimental model was designed and built (Fig. 2). At the test beginning, the sand raining screen device was located directly above the test box. Then the following the sand was deposited in the 4 cm thick layers by using the raining method. During sand raining, the sand density was controlled by placing the cans of specified volume in different locations of the box. The weak and strong thin layers were applied using simple templates at the specified depths and thicknesses and the subsequent sand layers were applied to the required level and were followed by placing the foundation model at a specific location on the surface of the sandy bed. Finally, the vertical pressure is transferred to the foundation model by manual hydraulic jack at a constant rate equals to 1mm/min. Then the vertical settlement was measured by dial gauge with a precision of 0.01 mm.

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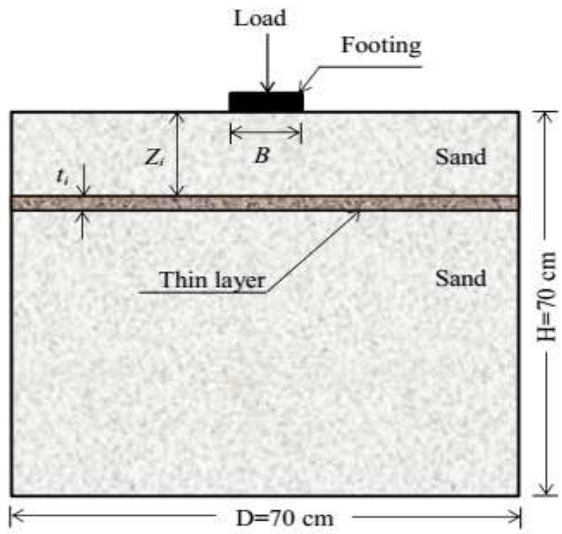

Fig. 1. Scheme of the problem

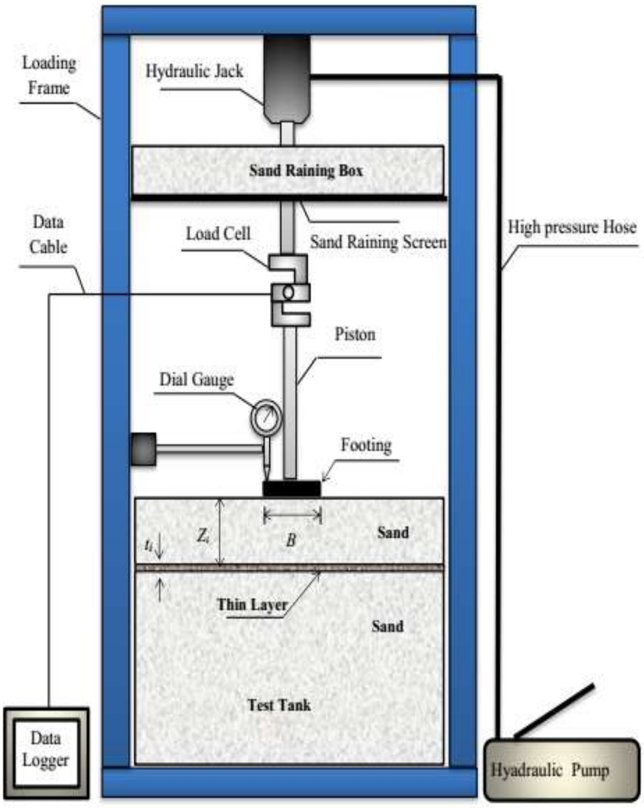

Fig 2. Section view of the physical model

2.2. Experimental parameters and program

The variable parameters used in the experiments (in accordance with the schematic Fig. 1) and their values are shown in Table 1. Three series of tests have been carried out. First, the behavior of the circular footing resting on a uniform sand bed is investigated. Then, in the second and third series, the behavior of the circular foundation resting on the sandy bed with a weak or strong layer at different thicknesses and depths was investigated.

Table 1. Model test program

Type of test	Constant parameters	Variable parameters
Uniform sand	D_r = 41%, D_f/B = 0	---------
Uniform sand with weak layer	D_r = 41%, D_f/B = 0	Z_i/B=0, 0.5, 1, 2 t_i/B=0.1, 0.2
Uniform sand with strong layer	D_r = 41%, D_f/B = 0	Z_i/B=0, 0.5, 1, 2 t_i/B=0.1, 0.2

3. Results and discussion

3.1. Behavior of the circular foundation resting on sandy soil with a weak thin layer

Foundation bearing pressure-settlement curves were obtained from the results of the testing model Results indicate that the weak thin layer decreases both the ultimate bearing capacity and stiffness of the soil-foundation system. The values of the ultimate bearing capacity for different states are compared in Figure 3. Obviously, the effect of a thicker layer is more evident.

3.2. Behavior of the circular foundation resting on sandy soil with a strong thin layer

Bearing pressure-settlement curves of circular foundation resting on the sandy bed with a strong thin layer indicate that the strong thin layer increases both the ultimate bearing capacity and stiffness of the soil-foundation system. The values of the ultimate bearing capacity for different states are compared in Figure 4. Obviously, the effect of a thicker layer is more evident.

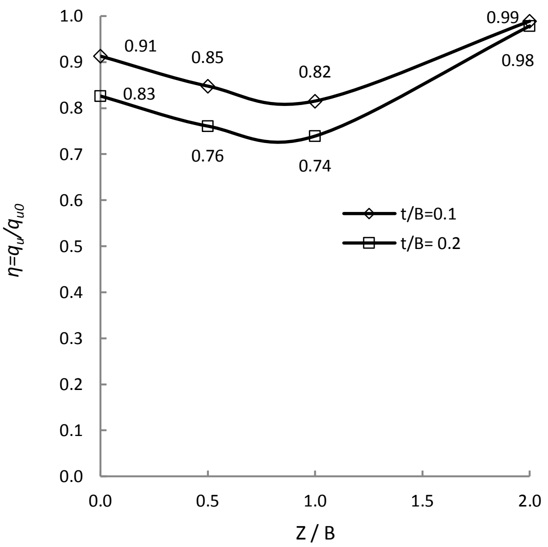

Fig. 3. Comparison of normalized ultimate bearing capacity q_u/q_{u0} against normalized depth of the weak layer Z/B

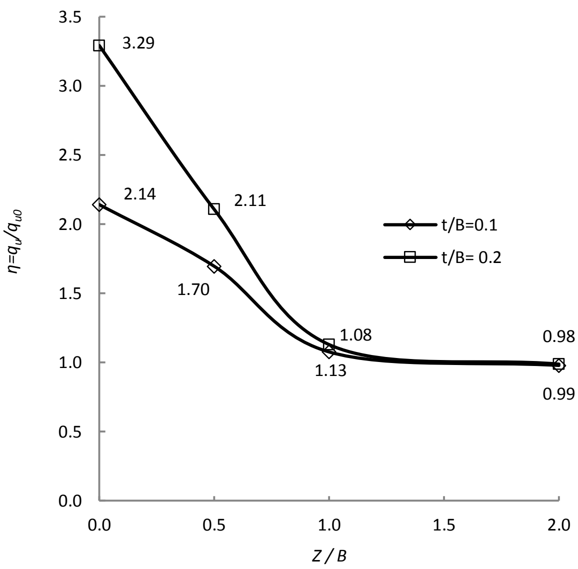

Fig.4. Comparison of normalized ultimate bearing capacity q_u/q_{u0} against normalized depth of the strong layer Z/B

4. Conclusions

Based on the experiment results, the horizontal weak thin layer decreases both the ultimate bearing capacity and stiffness of the soil-foundation system. The extent of this effect depends on the thickness and depth of the weak thin layer. The horizontal strong thin layer increases both the ultimate bearing capacity and stiffness of the soil-foundation system. The extent of this effect depends on the thickness and depth of the strong thin layer. Another result of this study can be expressed so that the geotechnical engineers should never neglect the small geological details such as thin layers during the site investigation.

5. References

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