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Experimental Investigation of Bearing Capacity of Strip Footing Rest on Layered Soils Next to the Geogird Reinforced Retaining Walls

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ABSTRACT: In general, stable vertical or near-vertical soil embankments, natural and unnatural slopes near the roads can resist existing forces and when the stip loading act on near them, those can be unstable because of tension problem of soils, so increasing of tension resistance of soil is a very important problem in geotechniacal engineering. The use of reinforced soil to design of foundations and soil structures such as retaining walls is an innovation that is considered as the most versatile and most economical problems for soil improvement. Despite numerous studies about the techniques of reinforced soil on lateral displacement of the retaining wall and bearing capacity of strip foundation located on the retaining wall under the soil homogeneity conditions, few studies have been carried out on these walls in the layered soil conditions. In this study small scale laboratory tests conducted to investigate the bearing capacity of strip footing rest on layered soil next to geogrid reinforced retaining walls. The results showed that increasing the number of reinforcement layers ,at appropriate intervals on the multi-layer embankment, decreases the lateral displacement of the wall and increases the bearing capacity of strip foundation and maximum amount of bearing capacity of footing can be achieved at u/B=0.25. Also the results showed that increasing the length of geogrid layer increases the bearing capacity of footing and the optimum length ratio is equal to 4 (L/B=4). Also when the first layer thickness of soil is greater than footing width the bearing capacity of footing depends on only first layer properties.

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1- Introduction

According to increasing trend of urban areas and limitations of using planar lands, many constructions are built along the slopes and walls that cause an overload on the embankment behind the wall. The horizontal displacement of the retaining wall and its instability under this overload due to weakness of soil against tensile stresses is considered as one of the important issues of reinforced soil-wall interaction mechanism under the strip loads. Soil reinforcing plays an important role in reducing the pressure on the walls and increasing the bearing capacity of the soil under the foundation. Physical model experiments of walls and reinforced soil slopes are often conservatively have been studied as static and pseudo-static cases. Henri Vidal (1969), performed physical model tests on the reinforced walls for the first time [2]. Subsequently, numerous studies conducted by other researchers that led to identification of new techniques in reinforcement subject. Paulsen (2002), Sitar and Roessing (1999) found that deformation of reinforced soil walls depends on different variables such as soil density, length and distance of reinforcements, type of shields, tensile strength and friction between reinforcements [3, 4].

Despite the researches done to study the bearing capacity of strip foundation and stability of the geogrid reinforced retaining wall, so far no considerable research has been done to study the multi-layer embankment to determine the performance of wall and strip foundation. Therefore, considering the location of the overload on the retaining walls in regions containing heterogeneous soil profile, the results of the present study have significant effect on determining the bearing capacity of strip foundation and stability of the retaining wall.

2- The program tests

In order to investigate the factors influencing the bearing capacity of strip foundation and stability of the retaining wall, 225 experiments were designed and performed. The test programs are summarized in Table 1.

3- Experimental model characteristic

The small-scale loading device was used to do experiments. The main parts of this device are shown in Figure 1.

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Figure 1. Characteristics of loading mechanism

4- Materials used in tests

Two soil types of fine-grained siliceous sand and coarse-grained crushed sand (SP) and sided woven geogrid (GP 20/20) are used in the tests.

5- Test parameters

As shown in Figure 2, “b” denotes the distance of the foundation corner from retaining wall, “U” indicates the depth distance of the first layer and other layers of geogrid from each other, “L” is the length of geogrid, “N” is the number of geogrid layers, and “H” is the thickness of soil layers.

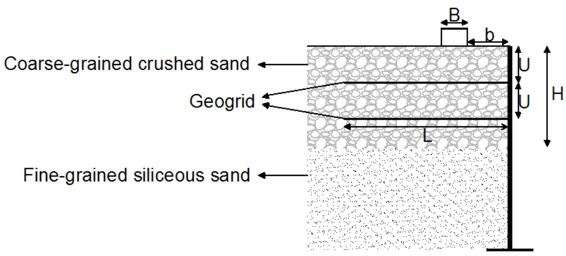

Figure 2. Schematic image of experimental model and related parameters

6- Production of prototypes and testing

In this study, in order to evaluate and compare the effect of parameters, all tests have been carried out in dry conditions. Fine-grain soil was used at lower part and coarse-grain soil at the top with intended thicknesses up to a height of 40 cm. To create a uniform embankment, precipitation method was used for pouring the sand into the tank. At each step, first the fine-grain soil with intended thickness was poured up to the level of the reinforcement and in addition to smoothing the soil surface, the reinforcements were applied at the intended level. The same steps were exactly repeated for coarse-grain soil over the fine-grain soil up to the finished height of the wall (40 cm). Then, the metal strip foundation on which a screw was embedded (in the center of the strip foundation) is slowly and without messing up the smooth surface of the soil fasten to Jack leverage and the system was prepared for loading.

7- Sensitivity analysis

In all experiments that their implementation steps have been mentioned; in order to study and compare the results and make a conclusion about the effect of parameters on the bearing capacity of strip foundation and lateral displacement of the wall, some changes have purposefully been done in these parameters. All parameters have been applied to the width of the foundation, B, as dimensionless and normalized ones such as b/B, U/B, L/B, and H/B.

8- Presentation of results and interpretation of data

Increasing in bearing capacity is stated as dimensionless parameter of BCR (bearing capacity ratio) due to smoothing of the soil, which has been used to compare bearing capacity in reinforced and non-reinforced states and is defined as following:

$$BCR = \frac{q_r}{q_{un}} \tag{1}$$

In order to compare lateral displacements of the retaining wall, the dimensionless parameter of WDR was used as follows:

$$WDR = \frac{\Delta_r}{\Delta_{un}} \tag{2}$$

9- Results and Discussion

In terms of the effect of the dimensions and parameters related to the constructed laboratory model including the length of the geogrid, depth of location, and the number of geogrid layers, the distance of strip foundation from the wall and the layering depth of embankment on the obtained results, in terms of quality and behavior the following results can be stated for using reinforcements behind the flexible retaining wall at the mentioned conditions by applying multi-layer embankment.

1. By placing geogrid inside the embankment, the bearing capacity of strip foundation significantly increases.
2. By placing geogrid inside the embankment, retaining wall displacement decreases.
3. The most benefits resulted from placing geogrids inside the embankment are obtained at depth ratio of 0.25 (U/B=0.25). With increasing the depth more, the total capacity of geogrid does not used and the bearing capacity of strip foundation decreases and wall displacement increases.
4. By increasing the length of geogrid plates, the bearing capacity increases and wall displacement decreases, which is the result of preventing diffusion level development. In the present research the ratio of geogrid length equal to 4 (L/B=4) was chosen as the optimal value, because by increasing the length more a considerable change has resulted in the bearing capacity of the strip foundation and wall displacement no longer.
5. With increasing the number of geogrids from 1 to 2, the bearing capacity increased significantly and wall

displacement reduced. However, achieving to an optimal value in this field requires more experiments with various numbers of reinforcements.

6. In terms of the distance of the strip foundation from the wall edge, the distance ratio of b/B=1 was considered as the optimal value. By increasing the distance of strip foundation from the wall, bearing capacity decreases and wall displacement increases. One of the reasons for this phenomenon is the solidity resulted from applying the brace used in the wall.
7. In terms of embankment layering depth, the depth ratio of H/B=1 was considered as the optimal value. By increasing the depth of layering, bearing capacity decreases and wall displacement increases

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