

Bearing Capacity of Strip Footings in various Locations with Respect to Sloped Ground

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1-Introduction

Structures are mostly built near a slope due to the limited area of land or architectural purposes. In this case, the slope impact on final loading capacity of the footing is taken into consideration and the foundation is so designed that the structure load is transferred to the soil beneath the footing without causing any instability in the slope. To make sure of the structure's safety, engineers should determine the situation and the depth of the built footing near the slopes. Therefore, the ground footing is designed in a more complicated manner by digital methods in order to ensure safety and economy. On the other hand, a few studies have been done regarding analytical formulations to determine the footing bearing capacity in various conditions of sloped land. Generally, the analytical formulations presented by Meyerhof, Hansen, Vesic and Saran are applied to determine the footing bearing capacity in various conditions of sloped land. Since these equations are experimental, the coefficients are highly approximate and the project's economy is affected. Even there is no margin supplied for the design. Therefore, an analytical equation is required that presents the impact of slope, the footing's various conditions versus the slope and reinforcement in a variety of soil without applying experimental coefficients. A simple analytical method is applied in the present research study in order to determine the footing bearing capacity around disarmed soil in various conditions versus sloped land. In addition, the impact of footing's various conditions versus ground slope, the distance of footing versus sloped land and the footing's depth and width versus its bearing capacity are studied.

2- Research Method

Here, the analytical method is presented to determine the footing's bearing capacity in various conditions versus sloped land. The presented equations are based on stability of the soil beneath the footing, i.e. the slope is assumed to be stable and no trembling exists. The applied analytical method is the figure retaining wall. As shown in Figure 1, a given retaining wall is assumed on the edge of the footing and near the slope's crown. The wall tolerates the active pressure P_a from the footing load and the soil

beneath the footing. The peripheral soil on the left of the wall (i.e. the sloped ground) is passive and imposes the resultant load P_p on the wall. The active and passive loads on the figure wall are calculated through Coloumb's method. Finally, the footing bearing capacity in various conditions versus sloped ground is determined by making the active and passive loads on the wall equal. In the present research study, the MATLAB software is used to analyze the various conditions of the footing bearing capacity versus sloped ground and to study the effect of various parameters on the bearing capacity (equation 1).

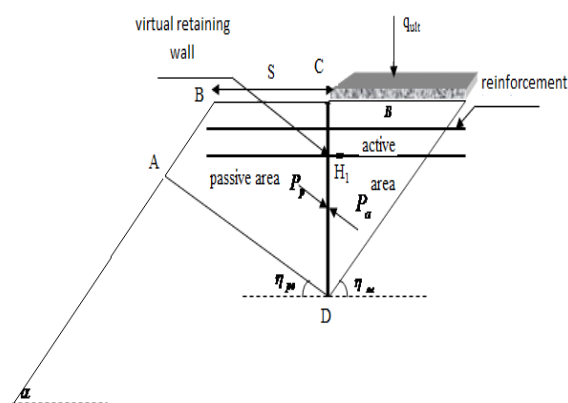


Fig. 1. Soil failure mechanism beneath the footing on sloped ground with virtual retaining wall method

$$q_{ult} = (P_{pweight} + c(K_{pc}H_1 + K_{ac}H_1) + \gamma(1-k)(K_p D \frac{S}{l} H_1 - \frac{1}{2} K_a H_1^2) + (c + \gamma(1-k)H_1 \tan(\frac{2}{3}\phi))(l_{activerem} + l_{passiverem}))(\frac{1}{K_a H_1}) \quad (1)$$

In fact, one of the innovations in this research study is presentation of a general equation to determine the bearing capacity by which the effect of footing distance from the slope's crown, the footing situation versus the slope, the slope angle, existence of reinforcement in the slope and beneath the footing, and seismic coefficients are studied. The said equation is also acceptable for both cohesive and cohesion less types of soil. In this part, the footing bearing capacity found by previously presented methods is compared with the one found by the present method in cohesion less soil (Fig. 2). It is assumed that soil friction angle equals 35°. Based on the results, when the footing is located above the slope, the footing bearing exceeds the situations in this method when the footing is above and beneath the slope. This is due to the fact that when the footing is above the slope, the active force on the virtual wall

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is less than other situations (due to soil weight drop in active area) and it causes more footing bearing capacity when it is above the slope. In addition, the footing's bearing capacity on the slope is less than that in the other situations versus sloped ground.

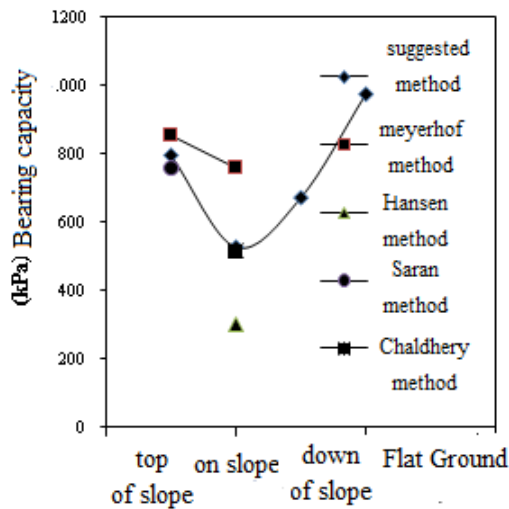


Fig. 2. Comparing of the presented method with the results of other methods in various positions of footing with respect to sloped ground

Fig. 3 shows the effect of footing's width and depth on the footing's bearing capacity in various situations regarding steep ground. The value of q/q_{wos} reveals the ratio of footing bearing capacity in various situations for steep ground to footing bearing capacity on flat ground.

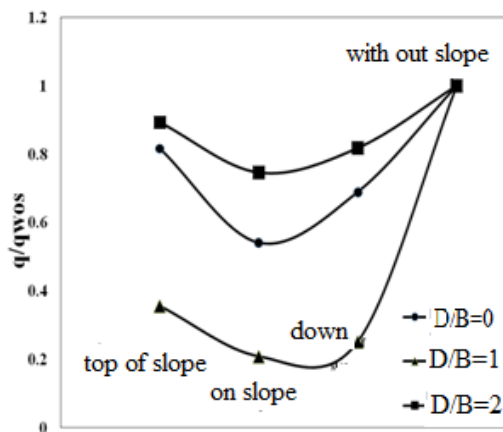


Fig. 3. The effect of depth and width of footing on bearing capacity in various positions with respect to slope

3- Conclusion

The figure retaining wall analytical method is used to determine footing bearing capacity in various situations for sloped ground, and the effect of footing features (width and depth) as well as the distance of the footing from slope crown on footing bearing capacity is studied in the present study. Finally, the results from this method were compared with those obtained from previous methods which led to acceptable results. The following results were obtained from the present research study:

- 1- The effective distance of the slope crown is about 4.5 times as much as footing width. The more the distance is the less the effect of the slope on footing bearing capacity becomes. By increasing the ratio of the footing distance from the slope's crown to the footing width up to 2, footing, the bearing capacity from the suggested method becomes almost 2 times more.
- 2- In different situations of the footing's width and depth, the footing's bearing capacity on flat ground, above the slope, beneath the slope, and on the slope gets higher respectively. According to the present method, the footing situation versus sloped ground affects the active passive force on the virtual retaining wall and then the footing bearing capacity.
- 3- Any increase of the footing's depth versus its width causes footing bearing capacity in various situations of sloped ground to become close to the footing's bearing capacity on flat ground. This effect is highlighted particularly when the footing is on the top and down of the slope.