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A PATH FOR HORIZING YOUR INNOVATIVE WORK

EFFECT OF CREST FOOTING ON PERFORMANCE OF SLOPE

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Abstract: Nowadays, there are many situations that foundations are built near the slopes. To design such foundations large settlement towards the slope are expected. Performance of the Structure on slope or near the edge of the slope depends on the bearing capacity of soil and stability. When the foundation is constructed on the slope the bearing capacity is found to be much lesser than that of bearing capacity on plain ground. And therefore the stability of the foundation on slope is one of the major problems in the field of geotechnical engineering. In this paper focus is made on studying the performance of footing resting on crest of slope for different loading condition using PLAXIS2D. It is observed that the factor of safety of slope goes on reducing as load on footing increases for all slopes studied. This indicate that any stable slope may become unstable if a new construction activity is carried out near slope. To overcome this difficulty, proper study on slope stability with present load shall be carried out..

Keywords: Foundation on Slope, Plaxis 2D, Bearing Capacity, Slope Stability

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INTRODUCTION

When a shallow foundation is placed on slope surface, its performance will depend on location of footing and slope inclination. These cases aries due to the limitation of available land for construction or due to architectural provision. In such situation it is convenient to locate the footing near crest of the slope. The many buildings or roads are constructed in hilly region and foundation for bridge abutments resting closed to slope. This may lead to failure of slope along with the structure built on it. The present natural disaster on the bank of Ganga river in Uttarkhand make it necessarly to think twice before constructing anything on the slope. This disaster prompted us to take this work presently for man made slopes.

The stability of the foundation located on the top of slope is further affected by the edge distance and the slope angle. Design of such structures, as they are more liable to failure than other types of structures is of great concern.

This research of provision foundation on slope will enhanced the knowledge regarding the slope performance. In order to give an optimum solution for foundation on slope and achieved economy in construction, there is need to study foundation on slope with different parametrical aspect.

Literature Review

Meyerhof (1957) had studied the problem of the ultimate bearing capacity of foundation on slopes. He extended his classical theory of bearing capacity of foundation on level ground and combined with theory of the stability of slopes to cover the stability of foundations on slopes. The slip lines were constituted by taking into account the slope angle, the distance from the edge of the slope and the angle of shearing resistance.

Jao *et al.* (2008) studied stability of eccentrically loaded footings on slopes to analyze the stability of eccentrically loaded strip footings on top of slopes for different loadings as well as different geometric and soil conditions and they made the statement that the bearing capacity for eccentric loading is smaller than that of central loading.

Georgiadis (2010) studied the untrained bearing capacity of strip footings on slopes to take into account the factor that affects the bearing capacity like distance of footing from slope, slope height and soil Properties. Results of the analyses were compared to available methods based on the finite element results, design charts, equations, and a design procedure were proposed for the calculation of the undrained bearing capacity factor N_c as a function of the undrained shear strength and the bulk unit weight of the soil. Fig. 1 shows variation of N_c with slope angle given by various author and with normalized sloped height.

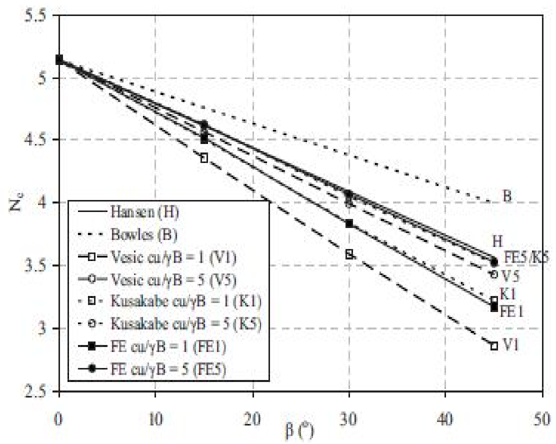

Figure 1: N_c with slope angle and normalized sloped height.

Keskin and Laman (2013) studied the bearing Capacity of strip footing on sand slope. He observed that the ultimate bearing capacity increases with increase in setback distance, relative density of sand, footing width and decrease in slope angle and when the footing is moved away from the slope crest (b/B=0) to the setback distance of b/B=1.0, there is a serious increase in bearing capacity (an average value of 70%.) as shown in Fig. 2.

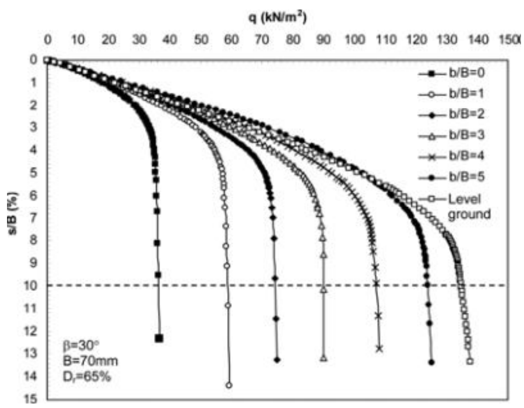

Figure 2: Variations of *q* with s/B

From the literature review it was observed that much study has been carried out on bearing capacity of footing resting near to slope on unreinforced soil. However, the study on performance of slope with respect to footing resting on crest is not observed. The other parameter factor which may be influencing the performance may includes depth of footing, shape of footing, distance from crest, slope with and without berms. The present paper will illustrates only the behavior of slope when footing is palced on crest of different slopes. The influence of other parameters is part of further studies.

Mode of Study

The slopes with different inclination are considered for the study. The footing is placed on crest of each slope. The load applied on the footing is varied and the factor of safety of the slopes in each case is obtained using a Finite Element Simulation software PLAXIS 2D foundation. The study majorly focus on stability of slope with respect to increase in load. The slopes studied were 1:1.5 to 1: 3.0 and the footing load varies from 0 kN/m^2 to 700 kN/m^2. The height of slope studied was 20m for all cases.

Numerical Modeling

The geometry of the slope was modeled to scale in PLAXIS2D foundation. The soil propetiese were assigned to the model as given below. The slope was analysed first without any footing. Fig. 3 shows the slope model along with mesh formed during the analysis. The slope was analysed to determine the factor of safety. Then a footing was placed on crest which was subjected to load intensity of 100 kN/m^2 and factor of safety was determined. The deformed shape of slope obtained during analysis is shown in Fig.4. The process was repeated for all the slopes and loads.

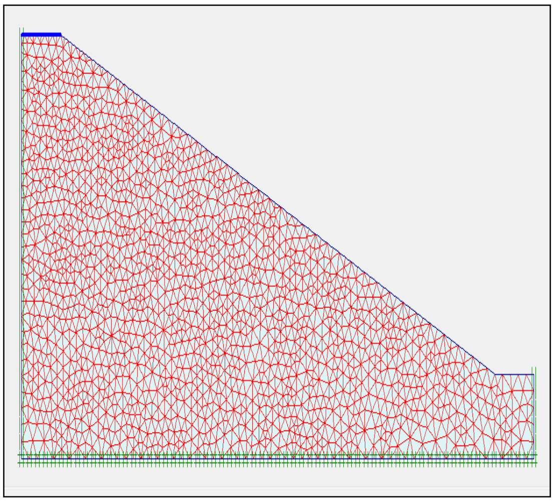

Figure 3: Formation of mesh in Plaxis 2D software

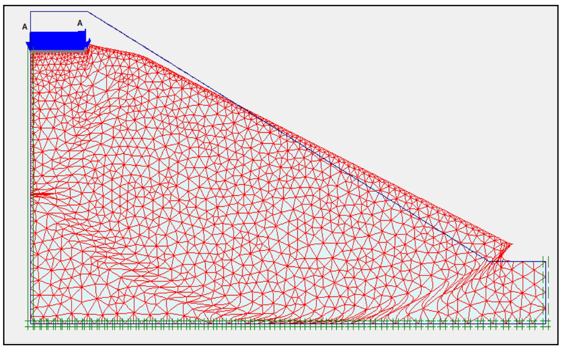

Figure 4: Deformed shape in Plaxis 2D software

Material Properties

The soil used for study is claye soil. The properties of soil used in the analysis are shown in Table 1.

Table 1: Soil Properties Used for Study

Parameter	Value
Type of Soil	Clay
Youngs Modulus (kN/m^2)	1000
Cohesion, (kN/m^2)	200
Frictional Angle, °	0
Unit Weight (kN/m^3)	20

RESULT AND DISCUSSION

The slopes studied varies from 1: 1.5 to 1: 3 and load from 0 kN/m^2 to 700 kN/m^2. They were analysed using Plaxis 2D. The factors of safety were calculated for each slope for different loading. The results obtained are tabulated in Table 2.

Table 2: Factor of Safety for Slopes

LOAD kN/m^2	SLOPES						
	1 : 1.5	1 : 1.75	1 : 2.0	1 : 2.25	1 : 2.5	1 : 2.75	1 : 3.0
0	3.00	3.13	3.35	3.38	3.64	3.82	4.00
100	2.55	2.71	2.82	2.89	3.05	3.23	3.38
200	2.16	2.31	2.40	2.45	2.58	2.70	2.81
300	1.84	1.97	2.05	2.09	2.20	2.29	2.37
400	1.59	1.71	1.78	1.83	1.90	1.97	2.00
500	1.39	1.49	1.55	1.58	1.62	1.66	1.70

600	1.19	1.28	1.32	1.34	1.38	1.40	1.43
700	1.04	1.12	1.15	1.17	1.19	1.22	1.24

For slope of 1:1.5, the factor of safety reduces from 3 to 1, when load is increased from 0 to 700 kN/m^2. This shows that a slope design without any surcharge if subjected to any load during its lifetime may lead to failure. It is also observed that factor of safety of slope reduces with increase in footing load at crest of slope for all slopes.

Fig. 5 shows the % reduction of factor of safety with increase in load for all slopes. This indicates that for all slopes % reduction varies from 15% to 65%. For any slope, reduction in factor of safety is approximately same for the given load.

It can be seen from Table 2 that if due to footing load a slope fails, it can be made safe by redesigning a slope, e.g. 1:1.5 slope fails when load exceeds 400 kN/m^2, a safe slope of 1:2 can be redesign.

CONCLUSIONS

The present analysis shows that placement of footing load have greater effect on factor of safety of the present slope. The slope needs to be redesign if it subjected to additional load.

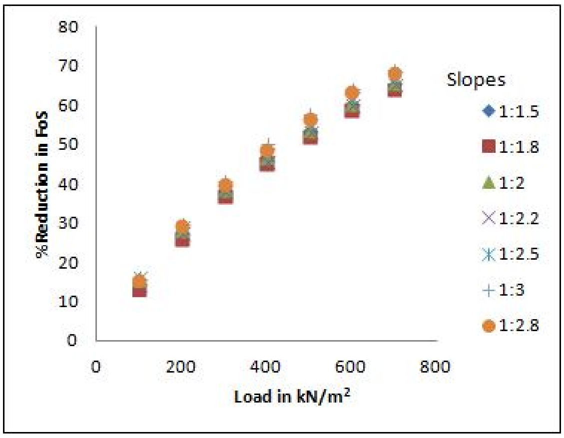

Figure 5: % Reduction in Factor of Safety

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