ACOREANA || Volume 19, Issue 1, 2018 || DOI : 16.10089/ACO191-10 || ISSN : 0874 - 0380

EVALUATING THE PERFORMANCE OF SKIRTED FOUNDATIONS NEAR SAND SLOPES WITH FINITE ELEMENT ANALYSIS

Joshua Walker[1], Chloe Hill[1], Jack Robinson[2], Ryan Harris[3], and Grace Jenkins*[3]

[1] Department of Biological Sciences, University of Tokyo, Japan
[2] Department of Geophysics, University of Edinburgh, UK
[3] School of Chemical Engineering, University of Melbourne, Australia

ABSTRACT

Skirt foundations are generally used to improve the bearing capacity of the shallow footing on sandy soil. These are also considered as an alternative to the deep foundations in low strength soil. Slope stability is the resistance of inclined surface to failure either by sliding or collapsing. This paper reports the application of using a skirted foundation system to study the behavior of foundations with structural skirts adjacent to a sand slope. The skirts effect on controlling horizontal soil movement and decreasing pore water pressure beneath foundations and beside the slopes. This thesis paper is investigated numerically using MIDAS . A series of models for the problem under investigation were run under different skirt depths and lactation from the slope crest. Nodal displacement and element strains were analyzed for the foundation with and without skirts and at different parameters.

KEYWORDS: Slope Stability, Skirt Foundation, MIDAS, Finite Element Modelling.

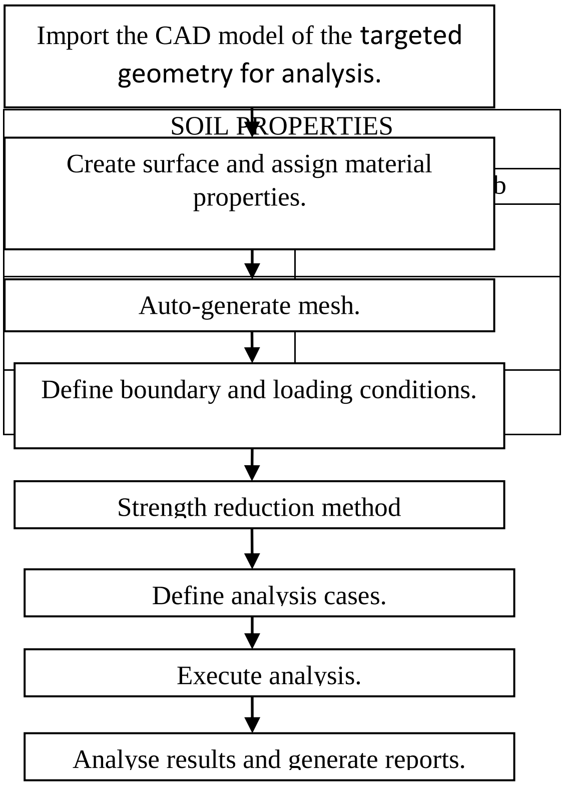
1. INTRODUCTION

There are many situations where footings are constructed on sloping surfaces or adjacent to a slope crest such as footings for bridge abutments on sloping embankments. When a footing is located on a sloping ground, the bearing capacity of the footing may be significantly reduced, depending on the location of the footing with respect to the slope. Therefore it may not be possible to use a shallow foundation and the use of uneconomic foundation types (piles or caissons) becomes the only appropriate solution of the problem. Over years, the subject of stabilizing earth slope has become one of the most interesting areas for scientific research and attracted a great deal of attention. Slope stability can be increased in different ways such as: modifying the slope surface geometry, using soil reinforcement, or installing continuous or discrete retaining structures such as walls, nailed elements or piles. There have been several studies on the use of slope reinforcement to improve the load bearing capacity of a footing on a slope These investigations have confirmed that not only that the slope stability can be increased but also both the ultimate bearing capacity and the settlement characteristics of the foundation can be significantly improved by the inclusion of reinforcements in either horizontal or vertical form (layers of geogrid, strips or geotextile) in the earth slope. The problem of loaded slope with foundation was extensively investigated at a normal loading condition, static loading as presented in the above researches. However, a dynamic analysis of a loaded slope that is subjected to an earthquake loading cannot be thoroughly investigated, apart from a variety of researchers who studied only the behavior of slope under dynamic loading without considering existing structures adjacent to such slopes. The stability of seismically loaded slopes using limit analysis was studied. A conventional pseudo-static approach is still widely used in engineering designs of slope stability subjected to seismic loads. But this approach is generally not applicable to saturated soils with a high liquefaction potential, or to soils that will soften considerably when cycled. Accurate analysis of problems involving these soils requires elaborate dynamic finite element modeling with advanced constitutive relations capable of simulating the pore pressure generation during an earthquake, as well, to avoid the scale effect and the problem of shaking table. In the current research, full scale tests were used to simulate the actual skirted foundation and building behavior adjacent to a sand slope subjected to an earthquake using a finite element method by the commercial dynamic program MIDAS version. This theoretical analysis helped in better understanding of the failure pattern and in discovering the results that cannot be measured in the laboratory for the adopted system.

1.2 OBJECTIVES OF THE PROPOSED WORK : Shallow foundations are now available foundation for both offshore and surface areas. Skirted foundations are a type of shallow foundations which satisfy bearing capacity requirement and it also minimise the embedment depth and dimensions of the foundation. The main objectives of the study is to develop an understanding of performance and behaviour of skirted foundation , that objectives includes the study of stability analysis of skirted foundation and effect of adopted skirts to safeguard the foundation and slope from collapse.

2. METHODOLOGY

Work flow of skirted foundation are:



2.1.MIDAS/GTS software:Midas/ GTS NX is a comprehensive geotechnical finite element software package that is well equipped to handle the wide range of 2-Dimensional and 3-Dimensional analysis of deformations and stability of most of soil structures in various geotechnical applications including : Deep Foundations, Complex Tunnel systems, Seepage Analysis, Consolidation Analysis, Embankment Design, Dynamic and slope stability analysis.Types of soil models available in the MIDAS software are: Linear Elastic, Tresca, Von Mises, Mohr-coulomb, Drucker-prager, Strain softening, Soft soil creep etc.GTS NX also offers an advanced user friendly modelling platform that enables different levels of precision and efficiency.

2.2 Geometry and Data for the model :(Figure 1) represents the geometry of the model studied and its required parameters. The subsoil consisting of deposit of a sandy layer of 20m thickness and slope height H, is constant and equal to 8m. The slope angle is taken as 40. The model is considered as Mohr-coulomb model and the model behaviour is chosen as undrained behaviour. The material properties of the soil required for this study is shown in Table 1 and they are derived from previous literature (ref. Journal).The water table is located at a depth of 1m from the surface. When we consider the skirt, its composed of a steel with its mechanical properties shown in Table 2.

Table.1.Characteristics of soil

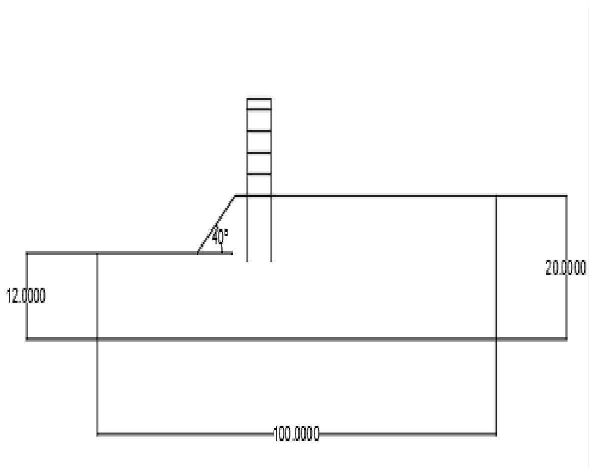


Fig.1.geometry of the finite element model and studied parameter

Table.2.skirt propertieS

Table.2.skirt properties Youngs modulus	2x10[8] (kN/m[2])
Unit weight(kN/m[3]	39

2.3.2D finite element mesh : model used for the study consists of 7633 nodes.2D finite element mesh is shown below.

Step1: Analysis case setting

Step2:DefineGround and Structural Materials

Step3:Define Properties

Step4:Modelling

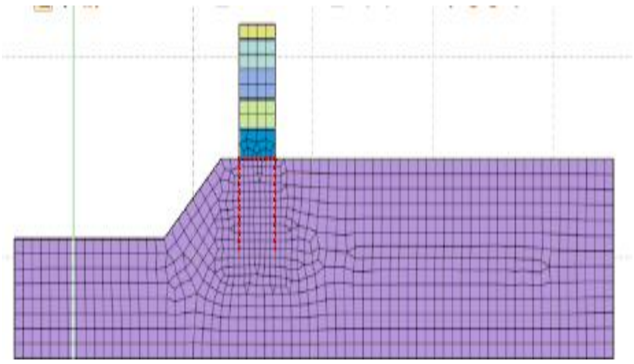


Fig.2.2D finite element mes

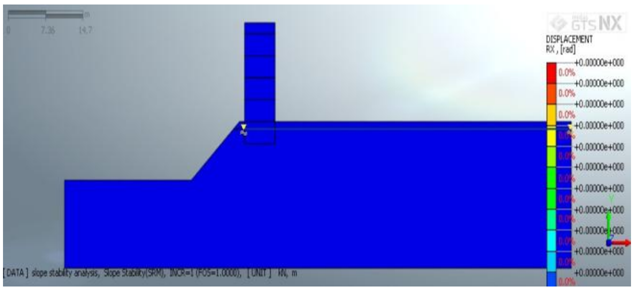


Fig.3.Displacement

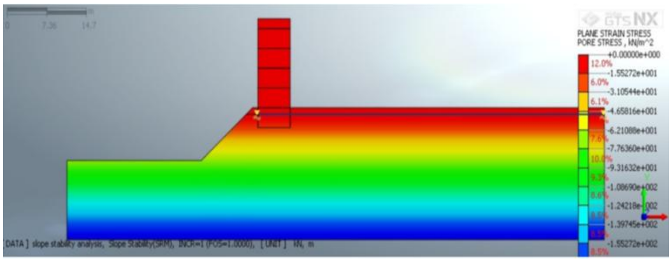


Fig.4.Plane strain stress

3. RESULTS AND DISCUSSION

Table.3. shows the variation of displacement with depth

Depth(m)	Displacement(m)0.5B depth			
	1m crest	1.5m crest	2m crest	2.5m crest
0.007813	0.000743	0.000744	0.000745	0.000746
0.015625	0.001498	0.0015	0.001502	0.001503
0.023438	0.002263	0.002266	0.002268	0.00227
0.03125	0.003038	0.003042	0.003045	0.003049
0.039063	0.003824	0.00383	0.003835	0.00384
0.046875	0.004623	0.00463	0.004637	0.004643
0.048828	0.004882	0.00489	0.004898	0.004905
0.049805	0.005055	0.005063	0.005071	0.005169

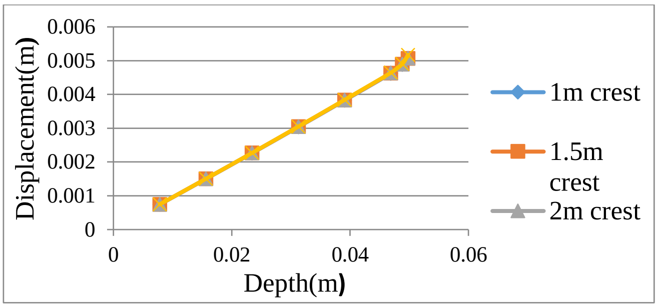


Fig.6.Displacement vs depth

Table.4.shows variation of stress vs depth

Depth(m)	Stress(kN/m ^{2}) 0.5B depth			
	1m crest	1.5m crest	2m crest	2.5m crest
0.007813	0.004509	0.004363	0.004536	0.004837
0.015625	0.020408	0.020737	0.020843	0.020756
0.023438	0.050309	0.050133	0.050535	0.051288
0.03125	0.080622	0.075639	0.074454	0.075553
0.039063	0.199437	0.197742	0.196902	0.196731
0.046875	0.251458	0.256591	0.259721	0.261799
0.048828	0.279233	0.280893	0.28191	0.282579
0.049805	0.24625	0.256692	0.265726	0.28697

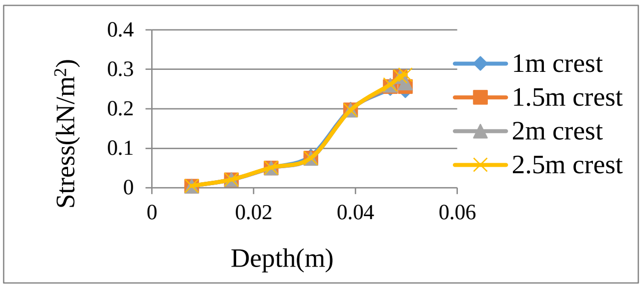


Fig.7.Stress vs Depth

Table.5.shows variation of strain vs depth

Depth(m)	Strain 0.5B depth			
	1m crest	1.5m crest	2m crest	2.5m crest
0.007813	2.81E-05	2.82E-05	2.82E-05	2.82E-05
0.015625	6.65E-05	6.67E-05	6.67E-05	6.66E-05
0.023438	0.000114	0.000115	0.000115	0.000114
0.03125	0.000171	0.000171	0.000171	0.000171
0.039063	0.000236	0.000236	0.000236	0.000235
0.046875	0.00031	0.000309	0.000309	0.000308
0.048828	0.00037	0.000369	0.000368	0.000367
0.049805	0.000429	0.000427	0.000425	0.000428

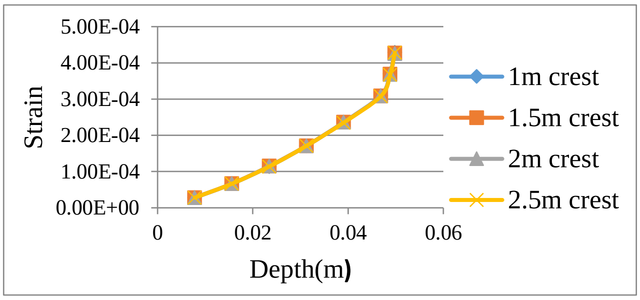


Fig.11.Strain vs Depth

Table.9. shows the Displacement vs Depth

Depth(m)	Displacement(m)1.5B depth			
	1m crest	1.5m crest	2m crest	2.5m crest
0.007813	0.000743	0.000744	0.000745	0.000746
0.015625	0.001498	0.0015	0.001502	0.001503
0.023438	0.002264	0.002266	0.002268	0.00227
0.03125	0.003038	0.003042	0.003045	0.003049
0.039063	0.003824	0.00383	0.003835	0.00384
0.046875	0.004623	0.00463	0.004637	0.004643
0.048828	0.004882	0.004891	0.004898	0.004905
0.049805	0.005055	0.005063	0.005071	0.005169

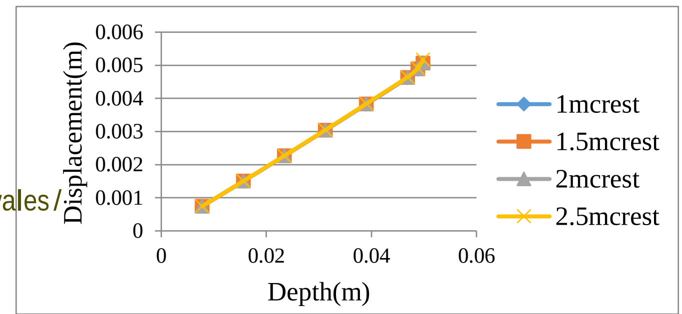


Fig.12.Displacement vs Depth

Table.10.Shows the stress vs depth

Depth(m)	Stress1.5B depth			
	1m crest	1.5m crest	2m crest	2.5m crest
0.007813	0.00451	0.004365	0.004538	0.004839
0.015625	0.020409	0.020736	0.020843	0.020754
0.023438	0.050316	0.050142	0.050543	0.051298
0.03125	0.080651	0.075688	0.074489	0.075615
0.039063	0.199456	0.197767	0.196919	0.196761
0.046875	0.251461	0.256576	0.259718	0.261781
0.048828	0.279254	0.280906	0.281932	0.282595
0.049805	0.246249	0.256664	0.265728	0.286945

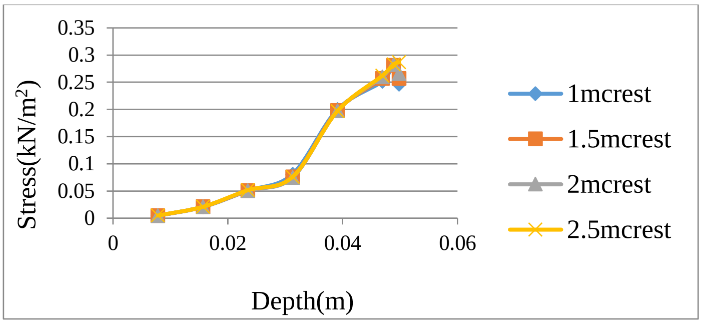


Fig.13.Sress vs Depth

Table.11. shows Strain vs Depth

Depth(m)	Stress1.5B depth			
	1m crest	1.5m crest	2m crest	2.5m crest
0.007813	2.81E-05	2.82E-05	2.82E-05	2.82E-05
0.015625	6.65E-05	6.67E-05	6.67E-05	6.66E-05
0.023438	0.000114	0.000115	0.000115	0.000114
0.03125	0.000171	0.000171	0.000171	0.000171
0.039063	0.000236	0.000236	0.000236	0.000235
0.046875	0.00031	0.000309	0.000309	0.000308
0.048828	0.00037	0.000369	0.000368	0.000367
0.049805	0.000429	0.000427	0.000425	0.000428

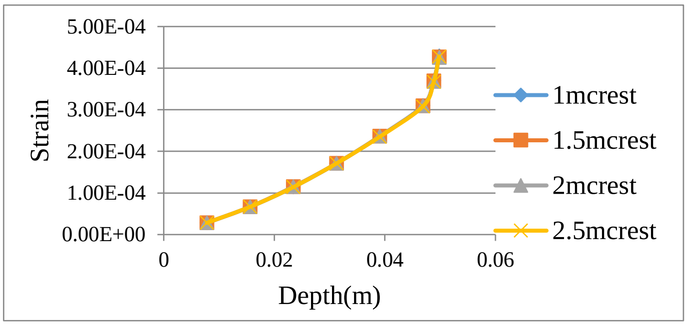


Fig.17.Strain vs Depth

4. CONCLUSION

- Using structural skirts in conjunction with foundation is a good method to safeguard slope from collapsing and to control the lateral deformation of a slope.
- The deformation behaviour of a slope stabilised by skirts is obviously different from case of foundations without skirts.
- Skirts effectively increase the inertial stability of a slope by decreasing the slope deformation.
- Increasing the distance from crest and depth of skirt , also increases the slope stability.
- The lowest displacement is obtained for 1.5m crest and 1.5B depth.

5. ACKNOWLEDGEMENTS

First of all I would like to thank almighty for his grace and blessings on me.It is my pleasure to place on report my deep sense of gratitude to my guide Mrs.Veena Vijayan L ,Assistant professor civil engineering department St.Thomas Institute for science and technology Trivandrum Kerala.It was her deep interest and guidance through out the course of study that maid this work possible. I gratefully acknowledge her constant encouragement and valuable suggestion which have given me the confidence to pursue the study.I extent my sincere gratitude to all my friends who have constantly encourage and supported me in my project work.

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