International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 04 | Apr 2019 www.irjet.net p-ISSN: 2395-0072

SLOPE SUBSIDENCE: EVALUATION OF REASONS AND SUGGESTION FOR RECTIFICATION

ADHIL P[1], ANJANA A[2], DAMIAN J WILSON[3], BINI RAJ B G[4], Dr.BALU E GEORGE[5]

[1,2,3,4]Under Graduate Students, Mar Athanasius College of Engineering, Kothamangalam, Kerala, India
[5]Professor, Dept. of Civil Engineering, Mar Athanasius College of Engineering, Kothamangalam, Kerala, India

---

Abstract - *The month of August 2018 experienced torrential rain, and the associated deluge resulting in a sequential Geotechnical phenomenon including mass subsidence, slope failures, soil avalanche and certain others yet to be identified. Soil subsidence may be triggered by a wide variety of causes ranging from slope instability to piping failure. The scope of the project involves identifying a typical site near Idukki, Kerala, carry out detailed analysis of the geographical and geotechnical characteristics of the site, identify the potential causes of environmental and engineering factors that triggered the failure, propose a remedial measure to avoid further failure and suggest designed steps to ensure the safety of existing mass.*

To identify the failure plane and pattern of crack propagation, the commercially available Plaxis 3D software may be used. Numerical analysis of the slope stability is done by modeling the slope with the data from leveling survey conducted at the site. Various planes are considered and soil parameters, determined by the laboratory tests, are then properly input into the model to determine the factor of safety of each slope. The critical failure plane is thus identified by the analysis and the reasons are also recognized. A proper remedial measure can then be suggested to avoid any instances of failure in the future.

***Key Words*: PLAXIS 3DIMENSION,**

1. INTRODUCTION

The Western Ghats cover the 47% of the land area of Kerala and it has given way to the entire landslides that has occurred in Kerala. The Monsoon brings in heavy rains which lead to these particular geological phenomena and in the year 2018, Kerala has received one of the heaviest downpours in its history. This has disturbed the slopes all over Kerala where total collapse to failure initiation has been recorded. The district of Idukki itself has the most number of landslides and slope failures recorded. The landslides even if not new to the people of Idukki, concern is growing since the entire topography gets affected by the monsoon of 2018 and failure of many slopes new to the list has also occurred. One among them is a slope at Memanam near Kuttikkanam on the road connecting Kuttikkanam and Elappara.

The people living down slope were in fear of a landslide after a major crack had formed on the slope which propagated down and cut through the road and further downwards. This was the after effect of the torrential rain which had been over the area for many days. The crack had left the traffic flow to a halt for over a week and many houses on the path of the crack were on the verge of collapse. If the rain had continued, a debris flow was suspected.This incident has opened an opportunity to conduct a study to find out the probable reasons for the phenomena. The study will help to provide with a suitable remedy measures to save the life of people and guard the infrastructure of the state from a possible landslide.

2. METHODOLOGY

The reason behind the slope subsidence and crack formation at Kuttikanam can be found out by analysing the slope for stability using the software Plaxis 3D.

A visit to the site was done to collect samples and to find out the extent of crack formation. The dumpy level instrument is used. The data was then used to find out the general gradient of the slope.

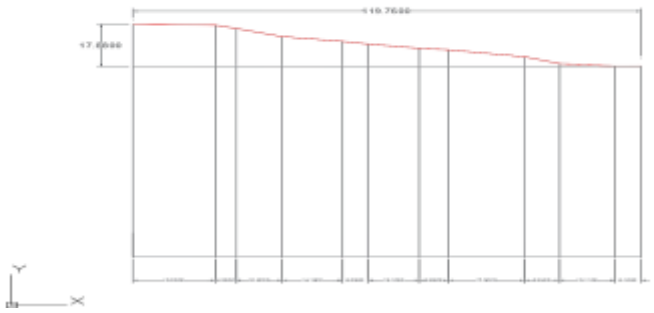

Fig-1: Elevation through the crack line

The gradient of the slope is 1 in 6.77m.

The data from field visits and laboratory test were used to model the slope in Plaxis 3D. To get a more accurate 3 dimensional model the contour of the region including the slope was developed using Google earth and Google sketch up software. Using the contour data, the 3D slope was founded in Plaxis 3D.

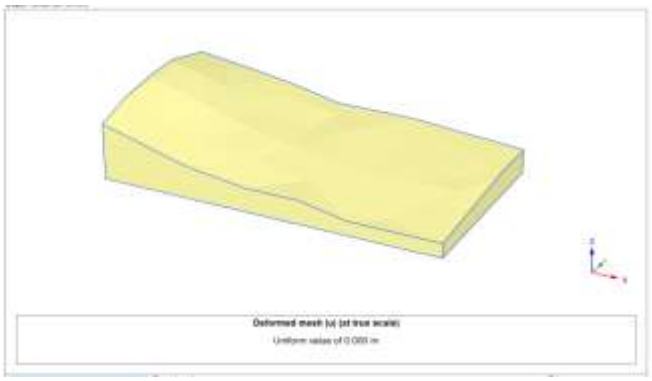

Fig -2: Deformed Mesh

The Mohr-Coloumb of the slope was made and the soil model was given the parameter found out in laboratory. With the aim of simulating the subsidence, a 15 cm clay layer was also included below the region where the subsidence occurred. The precipitation of 0.35m/day as also active while the analysis. The finite element analysis was done for 2 days during which the rainfall was intense and the crack formation has been reported with an intensity of 0.35m/day.

The analysis was done with and without deactivating the clay layer.

Table 1: Input Parameters

Parameters	**Values**
Saturated unit weight, γsat	18.8kN/m³
Unsaturated unit weight, γunsat	21.0kN/m²
Permeability, k	1.93cm/s
Cohesion, C	5.88kPa
Friction angle, Φ	26.565^0

3. RESULT

The analysis of the slope was done by considering the action of precipitation on the slope. The precipitation of 0.35 m/day was input for the analysis. A hypothesis was made on the slope subsidence which states that a clay layer which was present below the slope was washed away by the infiltrated water due to the abnormal rise in pore water pressure caused by the heavy rainfall. To simulate this phenomenon, consolidation analysis was done by deactivating the clay layer beneath the cracked surface.

The total displacements were recorded. The factor of safety was evaluated by doing safety analysis on the model with and without the clay layer.

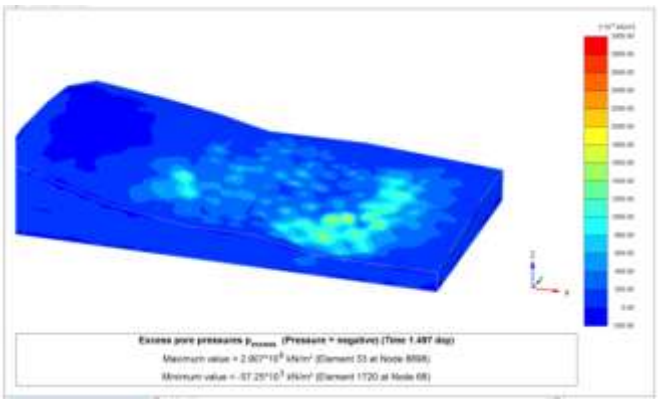

Fig-3: Excess Pore Pressure

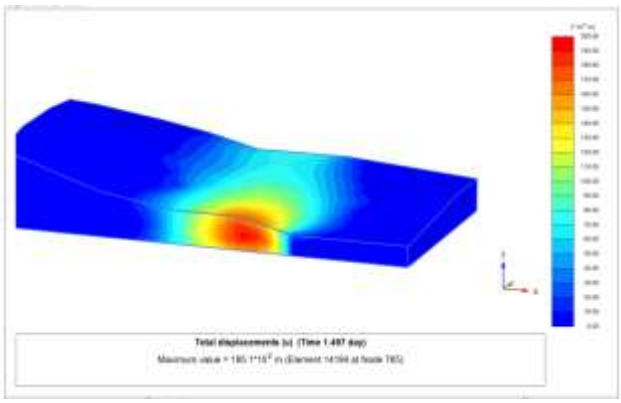

Fig-4: Total Displacement

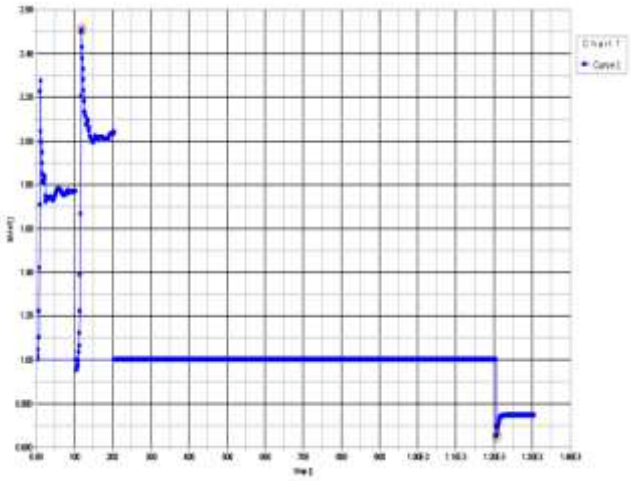

Chart 1 : Factor of Safety

4. CONCLUSIONS

The phenomenon of slope subsidence in Kuttikkanam poses a potential threat to the life of the people and the infrastructure of the state.

Plaxis 2D and 3D provides an efficient method to analyze the slope for its stability. The various site conditions are simulated and analysis has been done. The precipitation of 0.35 m/day was the rainfall that has showered over the area during the subsidence. The case of piping was also considered during the analysis. This was done by adding a small depth of layer and analyzing the slope with and without the layer, indicating the piping action during the heavy rainfall and increased suction and rise in pore water pressure. The analysis of the slope in Plaxis 3D has showed the specific incident that has occurred in

Kuttikkanam. The slope subsided when a certain depth of soil layer beneath the slope was washed away by the rain due to the rise in pore water pressure. This might be reason for the occurrence of vertical subsidence in the area.

The factor of safety for the slope with and without the certain layer of soil layer was 2.28 and 0.77 respectively.

ACKNOWLEDGEMENT

First and foremost, we sincerely thank the 'God Almighty' for his grace for the successful and timely completion of the project.

We express our sincere gratitude and thanks to Dr. Solly George, our Principal and Dr.Binoy Alias M, Head of the Department, Department of Civil Engineering, for providing the facilities and all the encouragement and support.

We express our sincere gratitude from the bottom of our heart to our project guide, Dr. Balu E George, Department of Civil Engineering, for providing us the valuable guidance and encouragement throughout the project work. We are indeed indebted to her toiling hard with us for the successful completion of the project work.

We express our sincere gratitude to Saint Gits College of Engineering, Kottayam for providing facilities, like Plaxis 3D for successful completion of our project work.

We also take this opportunity to thank Dr. Alice Mathai, project coordinator for her guidance.

Finally, we would like to acknowledge the heartfelt efforts, comments, criticisms, cooperation and tremendous support given to us by our dear friends during the preparation of the project and also during the presentation without whose support this work would have been all the more difficult to accomplish.

REFERENCES

[1] Techniques for Slope Stability Analysis: Site Specific Studies from Idukki District, Kerala (S. SREEKUMAR, JOURNAL GEOLOGICAL SOCIETY OF INDIA, Vol.73, June 2009)

[2] Study of a partially failed landslide and delineation of piping phenomena by vertical electrical sounding(VES) in the Wayanad Plateau, Kerala, India(K. S. Sajinkumar , R. Castedo , P. Sundarajan V. R. Rani, 27 July 2014)

[3] Pore Water Pressure As A Trigger Of Shallow Landslides In The Western Ghats Of Kerala, India: Some Preliminary Observations From An Experimental Catchment (Sekhar L. Kuriakose, V. G. Jetten, C. J. van Westen, G. Sankar, L. P. H. van Beek, Physical Geography, 15 May 2013.)

[4] Analysis of physical testing of rainfall-induced soil slope failures. (L. Z. Wu R. Q. Huang , Q. Xu ,L. M. Zhang , H. L. Li, Environ Earth Sci 2014)

[5] Forecasting giant, catastrophic slope collapse: lessons from Vajont, Northern Italy (Christopher R.J. Kilburna, David N. Petleyb, Geomorphology, 2003).

[6] Hossain, S., Khan, S., & Kibria, G. (2017). *Sustainable Slope Stabilisation using Recycled Plastic Pins*. CRC Press.