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Soil Mass Movement with Recent Deluge in Kerala as Backdrop

Ajay Shibu Parackal[1], Pooja Nair[2], Sandhra Benny[3], Shaheer M.R.[4], Dr. Balu E George[5]

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

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Abstract - *In the beginning of July 2018, severe floods affected the south Indian state of Kerala due to unusually high rainfall in the monsoon season. The rain subsequently resulted in devastating effects on land and on properties including major cracks and soil mass movement. The project was dealt in the geotechnical engineering point of view as this scenario pose very dangerous threats to the systems that existed within. The aim of the project is to plot the failure pattern of a site. The work also included determining the basic soil properties such as optimum moisture content, maximum dry density, sieve analysis and direct shear test. The stresses are calculated based on a linear-elastic behaviour using a Young's modulus and Poisson's ratio.*

Key Words: Deluge, Slopes, Failure slip circle, Factor of safety, Plaxis

1. INTRODUCTION

Slope stability problems have been faced throughout history whenever the delicate balance of nature has been disturbed by any kind of internal or external forces. In the beginning of July 2018, severe floods affected the south Indian state of Kerala due to unusually high rainfall in the monsoon season, during which the "pressure gradient"–which determines pressure changes and, in turn, rainfall–between land and the Arabian sea was significantly strong, resulting in heavy rain. The rain subsequently resulted in devastating effects on land and on properties including major cracks and soil mass movement. This scenario pose very dangerous threats and thus is very significant from the geotechnical engineering point of view.

2. LITERATURE REVIEW

Mass movement is the process by which soil, sand, rock move downslope as a solid mass under the force of gravity. Falls have a mass of any size detached from a steep slope or cliff along a surface on which little or no shear displacement take place while in topples consist of a forward rotation of a unit about some pivot point under gravity or by fluids in the cracks. In slides the movement consists of sear strain and displacement along one or several surfaces. The Swedish circle method assumes the surface of sliding as an arc of the circle. A series of slip circles are checked and the lowest factor of safety is the likely failure plane. PLAXIS is a finite element program for geotechnical applications in which soil models are used to simulate the soil behaviour. PLAXIS can be used for Geotechnical applications that require advanced constitutive models for the simulation of the non-linear, time-dependent and anisotropic behaviour of soils and/or rock.

3. METHODOLOGY

The project was initiated by visiting a site which was highly affected but accessible to carry out the reconnaissance survey. After analyzing the crack pattern in the area using auto level, the profile of the crack was plotted. An undisturbed sample by core cutter and a sample of soil from the area was collected to carry out the basic tests. The slip circles of different radii were analyzed and the failure plane was determined by Swedish circle method and PLAXIS2D. The possible reasons for the failure at the site was predicted and different methodologies were suggested to make sure that the area remains safe at least in the recent future.

4. LAB TESTS

- **Sieve Analysis**

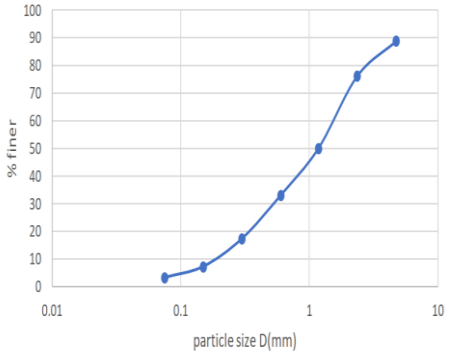

Chart 1: Sieve Analysis

- **Direct shear test**

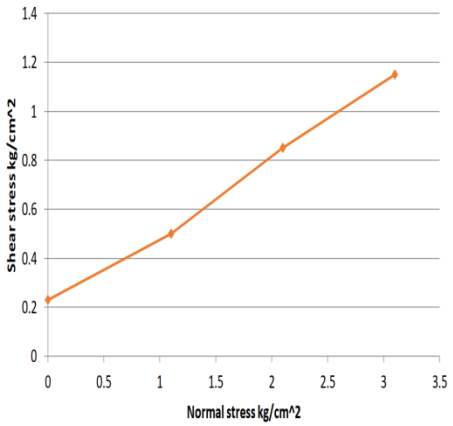

Chart 2: Direct shear test

From the graph,

$C=22.563\ kN/m^2$

$\Phi=21^0$

- **Specific Gravity using Pycnometer,**

G=2.36

- **Bulk Density using Core cutter,**

$\gamma=15.484\ kN/m^3$

5. SLOPE STABILITY ANALYSIS

Stability analysis of slopes was done by Swedish circle method and PLAXIS2D

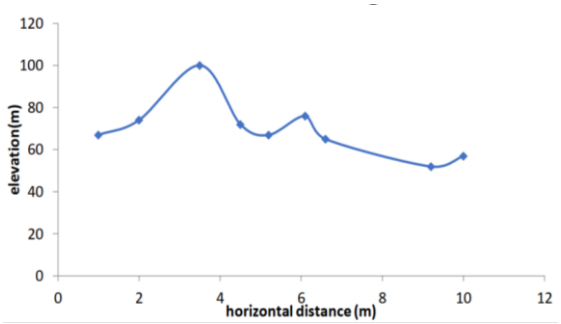

Chart 3: Plot of crack

- **Swedish circle method**

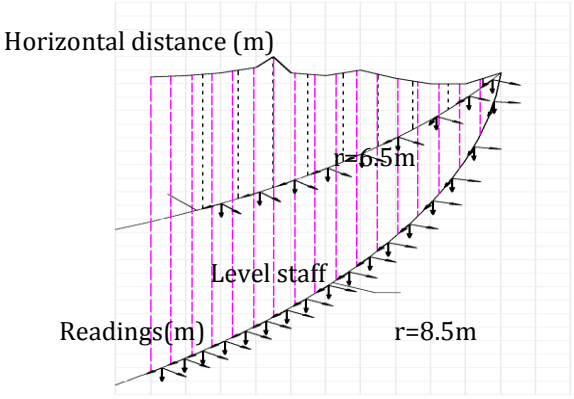

Chart 4: Swedish circle method

- **PLAXIS 3D**

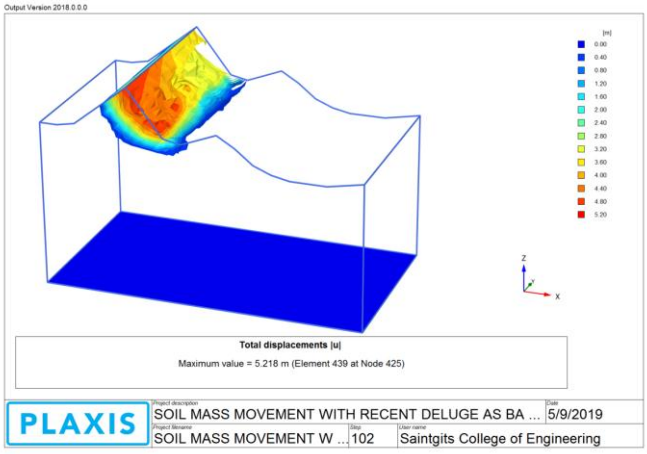

Chart 5: Isosurface for total displacement without anchors

Factor of safety obtained without anchors =8.163

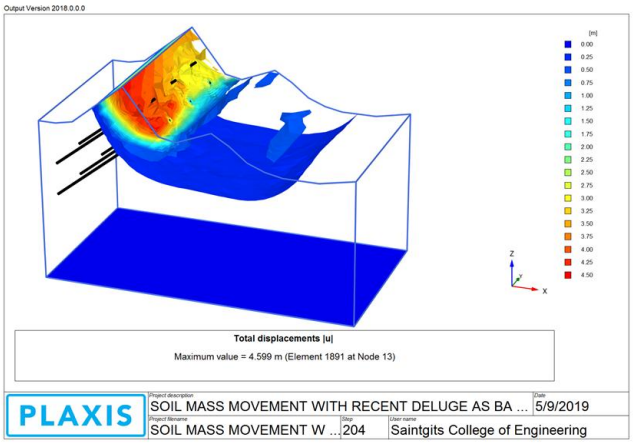

Chart 6: Isosurface for total displacement witn anchors

Factor of safety obtained with anchors=8.445

6. CONCLUSIONS AND DISCUSSIONS

The severe damage of the buildings in the vicinity of the area can be explained through an unplanned and poor construction techniques adopted in an area characterized by high level of soil instability. Also, continuous stagnation of water during the deluge has substantially deteriorated the soil quality. The site that has undergone failure due to the flooding cannot be used for construction of any kind of high rise buildings for commercial purposes nor any residential buildings without any kind of strengthening methods to stabilize the slopes.

Anchors are tension resisting elements prevent excessive erosion and any further landslides in areas severely affected by heavy rainfall and stagnant flooding. In PLAXIS 3D, analysis is done for total displacements before and after providing anchors in the slopes. The results thereby obtained shows that the total displacement in the slope has reduced with installation of anchors. Ground anchors prove to be an efficient solution for maintaining slope stability without considering the complexities and considering as a homogenous linearly elastic mass.

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