Soil mapping of slope failure due to rainfall at USM Hostels Penang

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ABSTRACT

Hill slope landslide and erosion were happening at the USM hostel due to heavy rainfall and stormy weather during the month of November till December 2017. This was a monsoon season, however this occurrences was not normal and in Penang alone there were so many slope failure and flash floods. A remedial work was carry out to correct the slope failure on site, where during the seasonal rainfalls the slope was heavily eroded and all the trees and grouted slope which was in placed before failed to sustained from the water movement. The site was then explored to foresee the major problems and to counter the stability by carrying out 2D Soil Resistivity and site investigation to understand, analyze and rectify the problem. From this study, we have conducted the soil mapping of the ground to further understand the soil condition so that all the correct measures can be done effectively. Since, this needs to be rectified immediately; therefore soil nailing and grouting method were proposed along with different counter measure to stabilize the slope. This was done under three weeks and monitoring systems was included to measure ground water level and inclination of ground movement. From the study it shows that after rectification and placing the right infrastructure to the slope, the system in place are now stabilized and able to cater heavy downpour after completion.

Keywords: Soil Mapping, 2D Resistivity, Landslide, Erosion, Soil Nailing

1 INTRODUCTION

In Malaysia, hilly area in Penang Island can be considered as a potential for development because of the attractive setting they provide. However, hill area development is often open to risks in constructions, people and environment. Examples of environmental risk at hill areas are erosion, sliding and fall of slope which creates many issues and problems. Slope failure is one of the common natural disasters that have been occurred after event of rainfall and stormy weather. From the experience, slope failure, landslide, flooding and soil erosion has been an example which can cause injury to person, danger to life, environment and economy (Ahmad et al, 2013, Ali et al, 2011 and Yahaya et al., 2013), especially in Penang area. Hilly area experience incidence result of landslide threat caused by slope instability, especially the intensity of rainfall in Malaysia is very high and hence, the slope is easily exposed to erosion and landslide. Due to climatic change and heavy rainfall over the past years that has cause the problem in Penang. The incident site effects of Typhoon Damrey between 1st to 4th November 2017 has caused quite a number of slope failures in Penang and a few of the incidences is at Universiti Sains Malaysia (USM) slope near the hostels that accommodate the university students.

2 BACKGROUND

The locations of the site is shown in Fig 1, where the ease of failure has started in earlier years, however it was spread to the new places depending on the influences caused the slope erosion triggered by rainfall. The rainfall recorded over a 24-hour period from from 1 st till 4 th Nov 2017 was 315mm, which was 40mm more than on Sept 2015.

Fig 2 show the failure that has occurred just after the stormy weather in November 2017. The picture show the severity of the area which create streams of water flowing from the hill top and caused failure within the ground of USM. The overflow of water have created tress falling, transporting soil, debris and blocking sump drain at the top and bottom of the hill.

Due to the failures, further investigation and assessment was done to consider the best solution for corrective measure which required fast action for effective and safe for the community of USM hostel and public that use the amenities. This study was done under the USM healthy campus program for the sustainability for tomorrow since 2003 (Ahmad et al, 2013).
3. GROUND INVESTIGATION

A 2D resistivity tests were carried out to further investigate the ground conditions of the area to support in designing for ground stabilization. The survey was carried out with 2.5 m minimum electrode spacing using Wenner Schlumberger. The data collected were processed using RES2DINV software. The 2D were mapped as shown (L1) and Pole dipole array (L2-L5) as shown in Fig 3, the location of each line.

4 ANALYSIS

In Fig 4. The profiles (L1-L5) trends S -N direction to a length of 100 m (Fig 3). The inversion displays the ranges by resistivity values from 5 Ohm.m to 1000Ohm.m indicating the overburden material which consist of saturated zone (1-100 Ohm.m) and alluvium (silt, clay and sand) with resistivity values of 100-800 Ohm.m up to a depth of 15 m. The intermediate second layer exhibits resistivity values that ranges...
from 1000-2000 Ohm.m represents the weathered granitic rock. The high resistivity zone with range of > 5000 Ohm.m at depth of > 15 m indicates granitic rock. From the result obtained, the weak zone is relatively thick with an estimated thickness of 15 m with low resistivity value (1-100 Ohm.m) and alluvium (100-800 Ohm.m).

The shallow fractured/weathered granite with resistivity values of 1000-2000 Ohm.m therefore is considered unstable. There were boulders located at a distance of 75 m of L1, 25 m of L2, 85 m of L3 and 60 m of L5 covered by top soil. Therefore it shows that how the ground can be vulnerable if the water seeps through the soil and weathered rock.

5. CONCLUSION

After all the observations and study the conditions of the site, a necessary steps was considered, which is to rectify the slope failure as indicated in Figure 1. The steps taken were:

i. All exposed slope failures were covered with plastic sheets to make sure no direct water from the rainfall shall further erode the slope,
ii. All trees on the slope were cut off.
iii. Clearing all large and loose debris on the slope to avoid further rolled over the slope.
iv. All drains was and sump were cleared from blockages to avoid self-creating streams and transporting loose and weathered material to other locations.

Fig. 4. 2D resistivity survey mapping

Fig 5 Plan of Slope Stabilization for as Built Plan
Then rectifications of the slope were stabilized by using soil nailing and grouting to the slope with proper construction in accordance to specifications as shown in Fig.5. The monitoring using inclinometer and piezometers installed shows that the slope are in stable state after completion for more than 6months.

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REFERENCES


