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Analysis the level of landslide using the ROM scale: a study at the sultan haji ahmad shah polytechnic campus

Nur Bazilah binti Ishak*), Suhaimi bin Yajid, Rozalina binti Ab Rashid
Civil Engineering Department, Polytechnic Sultan Haji Ahmad Shah, Kuantan, Pahang, Malaysia

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ABSTRACT

Landslides are a geomorphological process that commonly occurs in tropical climates. Accordingly, a study has been conducted to determine the level of soil collapsibility in problematic slopes around the Sultan Haji Ahmad Shah Polytechnic campus (POLISAS), Kuantan. A total of 3 problematic slope locations were involved in this study. The ROM scale is used as a basis in determining the level of collapsibility of problematic slopes around the POLISAS campus, Kuantan. The results of the study show that Location 1 has a moderate level of collapsibility and is categorized as sandy silt soil with high plasticity. While the other two slope locations, namely Locations 2 and 3, are categorized as high level of collapsibility and categorized as sandy silt with intermediate plasticity. The texture composition of the soil dominated by sand and silt was found to greatly influence the level of soil collapsibility at each sampling location. Accordingly, several problematic slopes around the campus area that have not been maintained need to be restored immediately to avoid the possibility of large- scale landslides occurring in the future.

Corresponding Author:

Nur Bazilah binti Ishak,
Polytechnic Sultan Haji Ahmad Shah
Email: nurbazilah@polisas.edu.my

Introduction

Natural phenomena such as landslides often put the well-being of human life, property, and activities in danger. Landslides are also a common phenomenon in any tropical country, and Malaysia is no exception. Malaysia's Equatorial climate contributes to high annual rainfall with an average of 2,400 mm per year. A large amount of rain accompanied by a high intensity of rain is the main driving agent in making landslides possible. In general, landslides are associated with the movement of rocks, debris, and soil groups down a slope by Cruden, (1991). Landslides easily occur on steep slopes and slope materials that have weak particle bonds.

However, the presence of rain at a high magnitude can be a very significant driving factor that makes large-scale landslides possible. According to Bujang et al. (2008), the amount of rainfall and high annual temperature will encourage the weathering process to be able to penetrate 100m into the ground, and subsequently be able to produce large-scale landslides. Because of this, high rainfall can cause landslides that often occur in the country, especially during the monsoon season. High temperature and humidity, a chemical weathering process occurs which moistens the rock material and produces a very thick residual soil. Landslides usually occur in Malaysia due to man-made slopes, especially cut slopes and embankment slopes along highways, residential areas, and cities.

This research study was carried out to study soil collapsibility using a scale known as the ROM Scale. The ROM scale was created by Prof. Associate Dr. Roslan Zainal Abidin and Mazidah Mukridi from the Faculty of Civil Engineering, University of Technology Mara (UiTM), Shah Alam. The method used today,which is the Bouyancos Equation, can only determine the soil erosion index and find out whether an event in an area is of low or high risk. According to Dr. Roslan, the measurements obtained through the ROM scale will not only show the level of soil collapsibility in the area involved but it also shows the safety levels of the area. Next, the results of this research will be compared with data obtained from the Public Works Department also known as Jabatan Kerja Raya (JKR).

There have been several small-scale landslides on the slopes around the campus and near student residences in POLISAS. Because of this, initiatives need to be taken to study the potential for soil erosion that may occur in the future. Some of the slopes that suffered from small-scale landslides have been repaired with an approach that suits the topographical conditions of the slopes, while the other part is still abandoned without any action.

Soil erosion can occur due to various factors, including man-made and natural factors. The first factor, very high rainfall can affect the structure of the soil, causing friction between the soil to decrease and subsequently can cause landslides. Second, human activities such as deforestation can increase soil erosion and remove natural soil buffers and increase the risk of landslides. Third, soil changes caused by infrastructure development, changes in land use or soil excavation can affect soil stability and cause landslides. Slope failure is an important issue that can cause damage to the environment and property, and it can also cause loss of life. Therefore, the objective of this research study is to study the soil characteristics as well as classify the types of landslides around POLISAS and determine the level of soil collapsibility by using the ROM Scale.

The results obtained from the research conducted can identify the types of soil in the study area. Slope repair work is also easier, especially in determining the type of soil that is suitable to be used as an embankment if necessary, and in planning the design of a retaining wall that is suitable to be built in the study area. Slope construction is very important in project construction to distinguish between land that has a difference in height. However, effective stabilization measures need to be done to stabilize the slope.

Method

The research methodology consists of 4 levels. The first stage is to conduct a field study which is the selection of a location for soil sampling. The second stage is the process of taking soil samples, then the third stage is conducting experiments in the Laboratory. At the last stage is to determine the level of soil collapsible by using the ROM Scale.

Results and Discussions

Field Study

The study areas that have been selected based on preliminary observations and reports from the Public Works Department (JKR) are two locations in Al-Biruni Block (male dormitory building) and one location on the entrance route near the Sultan Haji Ahmad Shah Polytechnic field. This observation aims to identify the location of slopes that have collapsed or are experiencing landslides. Figure 1 to 3 shows the locations that have been selected for sampling.

Figure 1 <Location 1 the Entrance Path Near the Politeknik Sultan Haji Ahmad Shah Field>

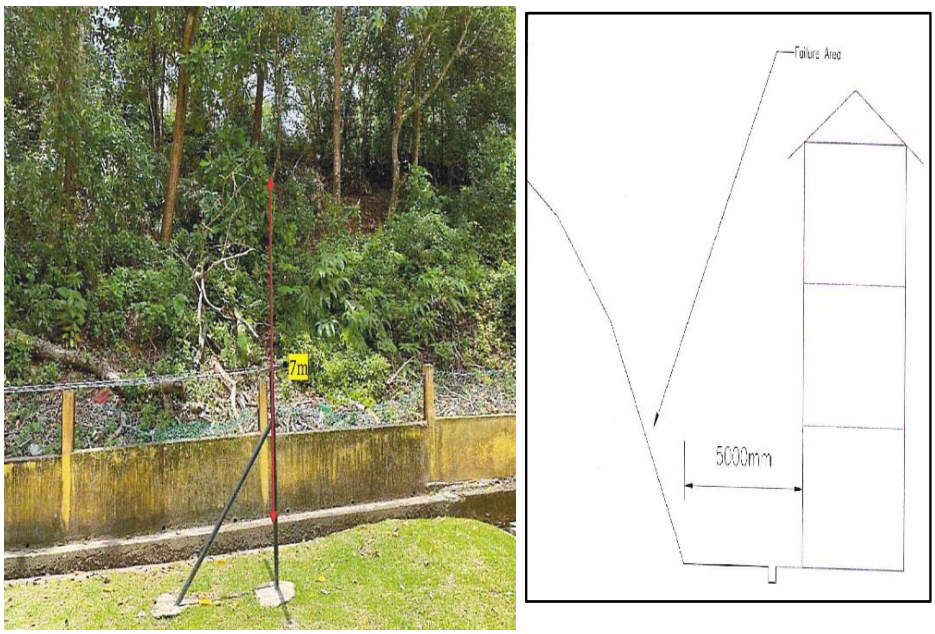

Figure 2 <Location 2 Slope At Al-Biruni Dormitory College Near to Gabion Wall>

Figure 3 <Location 3 Slope Near Al-Biruni Dormitory College Near to Kayak Storage>

Soil Sampling

The second stage of the study is sampling at 3 slope locations that have been set in the first stage. Sampling was taken when the weather was normal, ie no rain. Soil samples were taken at the top of the rubble to represent the area of the rubble cluster and the surrounding area (Mokhtar Jaafar, 2011). A total of 3 soil samples for each location were taken at a depth of 1 meter using the Hand Auger method. Each soil sample taken will be placed separately in a tray placed in the laboratory before the test is carried out.

Laboratory Experiments

The third stage is conducting laboratory experiments. The tests conducted are the Sieve Test, the Atterberg Limit Test and the Hydrometer Test. The test was conducted at the Geotechnical Laboratory of the Civil Engineering Department, POLISAS and at the Soil Mechanics and Geotechnical Laboratory of Universiti Malaysia Pahang (UMPSA) in accordance with the prescribed procedures.

ROM Scale Determination

The last stage, which is the fourth stage, the findings from the test data will be used to determine the level of soil collapsibility using a scale known as the ROM Scale. According to Dr. Roslan (2011), the measurements obtained through the ROM scale will not only show the level of soil collapsibility in the area involved but it also

shows the safety levels of the area. The ROM scale places more emphasis on the function of the clay content in the soil where this content is able to hold more water content. Clay soil is able to bind soil particles strongly making it more stable than sand and silt soil. Not only that, the method used in calculating the value of soil collapsibility based on the composition of sand-silt-clay according to the ROM Scale is done according to the following formula.

$$EI_{ROM} = \frac{\% \text{ Sand} + \% \text{ Silt}}{2\ (\% \text{ Clay})}$$

Based on the calculated value obtained from the formula, the level of soil collapsibility is categorized into four as shown in Table 1. This formula gives greater emphasis to the function of clay as a product of 2. As explained in the paragraph above, the clay content that high in the soil is able to strengthen the bonds of soil particles and indirectly lowers the potential of the soil from being eroded or experiencing soil collapse.

Table 1 <ROM Scale Table>

ROM Scale	Soil Collapsibility
< 1.5	Low
1.5 – 4.0	Moderate
4.0 – 8.0	High
>8.0	Critical

Source: Roslan et al (2007)

Sieve Test Analysis

Table 2 <Sieve Test Result

Types of Soil	Location 1	Location 2	Location 3
Gravel, %	11	5	7
Sand, %	77	81	80
Clayt, %	10	6	6
Slit, % (Hydrometer Test)	2	8	7
Coefficient of Curvature,CC	1.60	1.08	1.46
Coefficient of Uniformity,CU	7.38	6.56	8.18
Grade of Soil	Well graded Sand	Well graded Sand	Well graded Sand

Atterberg Limit Test

Table 3 below shows the results from the Atterberg Limit Test for the three locations. Based on the value of the plasticity limit, liquid limit and plasticity index obtained, then compared with the Table of theAssociated Soil Classification System, the characteristics of the soil obtained are type MH, silty soil with high plasticity for location 1. While at location 2 and 3 are types MI, silty soil with Intermediate plasticity.

Table 3 <Classifying Soil Plasticity>

Soil Types	Location 1	Location 2	Location 3
Platic Limit (%)	38.3	23.07	19.42
Liquid Limit (%)	67.1	43.35	43.2
Plasticity Index (%)	28.8	20.28	23.78
Soil Plasticity Classification	MH, Silt with High Plasticity	MI, Silt with Intermediate Plasticity	MI, Silt with Intermediate Plasticity

Hydrometer Test

The silt percentage value obtained from the Hydrometer Test was then entered into the ROM Scale formula to determine the level of soil collapsibility at each sampling location and the results are shown in Table 4. Two sampling locations, namely Locations B and C, recorded the level of collapsibility in the highcategory which this slope respectively each close to Al-Biruni Dormitory College. While Location 1 which is on the entrance path near the POLISAS field recorded a moderate level of collapse.

Table 4: <Level of Collapse from the ROM Scale Formula>

Location	Soil Collapsibility
Location 1 (the entrance path near the POLISAS field)	$EI_{ROM} = \frac{77\% + 2\%}{2\ (10)} = 3.95$ (Moderate)
Location 2 (Al-Biruni Dormitory College near to gabion wall)	$EI_{ROM} = \frac{81\% + 8\%}{2\ (6\%)} = 7.42$ (High)
Location 3 (Al-Biruni Dormitory College near kayak storage)	$EI_{ROM} = \frac{80\% + 7\%}{2\ (6\%)} = 7.25$ (High)

Conclusion

The conclusion from this soil research study is that the collapsed slope in Location 1 is a type of silty sandy soil with high plasticity, while locations 2 and 3 are sandy silty soil with intermediate plasticity. The collapsibility rate obtained from the ROM Scale shows that the level of collapsibility of the slope in location 1 is moderate while for locations 2 and 3 it is high which can potentially cause mass movement and subsequently be able to create large-scale landslides in the existing area. This data was then comparedwith the report issued by the Public Works Department (Jabatan Kerja Raya, JKR) as shown in table 6. Although this study only focused on problematic slopes, when field observations were made, there were several small-scale landslides on other slopes around the campus. Currently, there have not been any landslides on campus involving injuries or loss of life, but monitoring measures on problematic andpotential slopes should be done periodically, especially for slopes near student residential areas.

Table 6 <Comparison of soil collapsibility level ROM Scale and JKR Data>

Location	Level of Collapse from the ROM Scale Formula	ROM Scale collapsibility Level	Data from JKR
1	3.95	Moderate	Moderate
2	7.42	High	High
3	7.25	High	High

Since this study only focuses on the physical characteristics of the soil, a detailed study needs to be done in the future that involves the aspect of porosity, seepage rate and soil structure where those characteristics are able to influence the stability of the slope and the weakness or lack of one of them may have potential causing landslides

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