LANDSLIDE RISK ASSESSMENT ANALYSIS USING MONTE CARLO SIMULATION

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Dedicated to

my beloved family, friends, and lectures

for your

Love…

Patience…

Encouragement . . .

and Help . . .

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ABSTRAK

Kebanyakkan analisis kecerunan menggunakan pendekatan metod tradisional iaitu menggunakan reka bentuk nilai purata parameter. Oleh itu, kaedah ini menghasilkan anggaran nilai tunggal untuk menganggarkan kestabilan cerun. Pendekatan faktor keselamatan tidak boleh digunakan untuk mengira kebarangkalian kegagalan atau tahap risiko yang berkaitan dengan situasi reka bentuk disebabkan keadaan tanah yang tidak pasti. Ketepatan analisis kestabilan tahap kecerunan boleh dikira menggunakan Analisis Kebarangkalian. Metod analitikal menggunakan maklumat tentang taburan kebarangkalian ciri-ciri kecerunan untuk menentukan analisis output taburan kebarangkalian. Objektif kajian ini adalah untuk menentukan kebarangkalian kegagalan kecerunan berdasarkan bidang dan kesan kajian parameter statik dalam kegagalan hasil pengiraan. Simulasi Monte Carlo adalah berguna untuk memodelkan satu sifat yang tidak boleh disampel atau diukur secara langsung, tetapi boleh diungkapkan sebagai fungsi matematik yang boleh dijadikan contoh. Faktor keselamatan juga sesuai dengan keadaan ini. Oleh yang demikian, metodologi kajian ini telah dipilih berdasarkan jurnal dan kertas kerja yang lepas. Data diperoleh daripada kes kajian kecerunan di Majlis Peperiksaan Malaysia, Selayang, Selangor, berdasarkan laporan makmal dan disimulasikan menggunakan perisian SLOPE/W. Hasil keputusan metod penentuan ialah 1.184, manakala anggaran kegagalan cerun ialah 9.49%. Ini adalah disebabkan ketidakpastian bahan yang terkandung dalam tanah. Kajian ini juga mendapati bahawa, lebih tinggi ketidakpastian sifat tanah, peluang yang lebih tinggi untuk cerun akan gagal.

ABSTRACT

Most slope analyse are based on traditional method approach which adopts average valued design parameter are adopted. Consequently, the method yields the single valued estimate of slope stability. The factor of safety approach cannot quantify the probabilities of the failure or level risk associated with a particular design situation because due to the uncertainty exist in the soil. The analysis of the slope stability can be more accurately evaluated through the use of the probabilistic analysis. The analytical method uses the information about the probability distribution of the slope characteristic to determine the probability distribution of the output of the analysis. The objective of the research is to determine the probabilities of slope failure based on a given field study and study effect of statistical parameters in result calculation of failure. Monte Carlo simulation is useful for modelling an attribute that cannot be sampled or measured directly, but can be expressed as a mathematical function of properties that can be sampled. Factor of safety also fits this situation. The methodology of this research is based on the previous relevant papers and journals. The data is collected from the case study of the slope at Majlis Peperiksaan Malaysia, Selayang, Selangor based on the lab report and simulated with SLOPE/W software program. The result deterministic method is 1.184, while for the probability of the slope failure is equal to 9.49%. This is due to low uncertainty in the soil properties. The study also found that the higher the uncertainty of the soil properties of the soil, the higher chance the slope to fail.

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INTRODUCTION

1.1 Background of the Study

The tragic events of Bukit Antarabangsa in 2008 are one of landslide disaster that happened in Malaysia four years ago. Unfortunately, there was another tragic incident that happened last year at Hidayah Madrasah Al-Taqwa in FELCRA Semungkis. On 21st May 2011, the landslide disaster happened near the Madrasah that killed 16 people, where 15 of the victims are children. The tragic incident had prompted the government and public awareness about the importance of the stability of slope design in reducing the risk of failure of which result landslide event. Hence, it is importance that the current practices of slope stability need to be updated and revised to reduce the occurrence of the tragedy.

Nowadays, most of the slope stability designed based on the traditional slope stability method. For this traditional slope stability method, it still used single values estimate for each variables in the slope stability analysis. The shear strength, slope geometry, external load and pore water pressure are assigned as the parameter in the design. The result of the analysis would be the slope stand still or collapse, which is the factor of safety.

Figure 1.1: Landslide Event at Bukit Antarabangsa Area

Figure 1.2: Landslide Event at Hidayah Madrasah Al-Taqwa in FELCRA Semungkis

The ability of geotechnical engineer to accurate model slope performance is compromised by a variety factor. These may be broadly classified as theoretical and practical consideration. The net result of this consideration is the exact behavior of slope cannot be accurately predicted. Hence, the engineer resorts the factor of safety to reduce a risk of landslide. However, the factor of safety cannot quantify the probabilities of failure, level of risk and must be associated with particular design situation.

1.2 Problems of statement

Most of the slope stabilization is based on conventional or deterministic approach when the set of single value design are adopted and set of single value of factor of safety is obtained. However, the inherent variability of the characteristic that affected slope stability is a probabilistic rather than a deterministic situation. Due to the presence of uncertainty that not included in the normal factor of safety calculation, the factor of safety could not quantify the probability of failure or level of risk that associated with particular design situation.

The analysis of the slope stability can be evaluated accurately through the use of the probabilistic analysis. In addition, the analytical methods use the information about the probability distribution of the slope characteristic to determine the probability distribution of the output of the analysis. Knowledge of the probability distribution results allowed the engineer to assess the probability of failure slope stability. Due to that, it is needed to facilitate the adoption of probability analysis in slope design practice among the engineers.

1.3 Objectives of the study

The objectives of the study are:-

- To determine the probabilities of slope failure based on a field study given
- To study the effect of statistical parameters from the failure calculation

1.4 Scope of the study

This research is focuses on:-

- The SLOPE/W that will use as simulation program.
- The Majlis Peperiksaan Malaysia (MPM) that will be used for the field study.
- The analysis will focus on the slope cut.
- The MSE wall and the presence of the boulder excluded from analysis.
- The uncertainty that included in the shear strength of the soil which are Cohesion, angle of friction and unit weight of the soil.
- The deterministic method that will focus only on Morgenstern-Price method.

1.5 Significance of the study

The limitation of this research are the excluding presence of MSE wall and boulder. Besides that, the deterministic method only focus on Morgenstern-Price method. MSE wall and boulder exclude from the analysis due to lack of skill and knowledge in inserting the presence MSE wall and boulder on the SLOPE/W program and also because of the short duration period of research to learn it.

The deterministic method only focuses on Morgenstern-Price method because the method only suited to both circular and non-circular problems. Besides that, it is theoretical and more accurate than Bishop's method. The method is similar to Spencer's method except it allows for a variable interslice force angle on every slice and instead of theoretically, but more mathematically correct.

From the research, we are able to understand on how risk assessment on probabilistic approach through Monte Carlo has done. The probability of failure will help the engineer to design accurately the stability of the slope. With the change of the statistical parameter of the soil, the uncertainty effect can be identified on the stabilization of the slope thus can help the engineer to select the best method in stabilizing the slope.

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