PRELIMINARY SLOPE STABILITY STUDY AT NUCLEAR MALAYSIA USING SLOPE/W

MALAYSIAN NUCLEAR AGENCY R&D SEMINAR 2014

Nazran Harun, Mohd Muzamil Mohd Hashim, Kamarudin Samuding,
Mohd Abd Wahab Yusof, Nurul Fairuz Diyana Bahrudin
Waste and Environmental Technology Division
Malaysian Nuclear Agency
Bangi, 43000 KAJANG, MALAYSIA

Abstract

Analyzing the stability of earth structures is the oldest type of numerical analysis in geotechnical engineering. Limit equilibrium types of analyses for assessing the stability of earth slopes have been in use in geotechnical engineering for many decades. Modern limit equilibrium software is making it possible to handle ever-increasing complexity within an analysis. It is being considered as the potential method in dealing with complex stratigraphy, highly irregular pore-water pressure conditions, various linear and nonlinear shear strength models and almost any kind of slip surface shape.It allows rapid decision making by providing an early indication of the potential suitability of sites based on slope stability analysis. Hence, a preliminary slope stability study has been developed to improve the capacity of Malaysian Nuclear Agency (Nuclear Malaysia) in assessing potential sites for Borehole Disposal for Disused Sealed Radioactive Sources. The results showed that geometry of cross section A-A', B-B', C-C' and D-D' achieved the factor of safety not less than 1.4 and these are deemed acceptable.

Abstrak

Menganalisis kestabilan struktur bumi merupakan analisis berangka paling lama di dalam kejuruteraan geoteknikal. Had keseimbangan analisis untuk menilai kestabilan cerun bumi telah digunakan dalam bidang kejuruteraan geoteknikal untuk beberapa dekad. Perisian had keseimbangan moden memudahkan peningkatan kerumitan di dalam analisis. Ia dianggap sebagai kaedah yang berpotensi di dalam menangani stratigrafi kompleks, keadaan tekanan liang air yang tidak teratur, pelbagai model kekuatan ricih linear dan tak linear dan hampir semua jenis bentuk gelinciran permukaan. Ia membolehkan keputusan cepat dapat dicapai dengan menyediakan petunjuk awal potensi kesesuaian tapak berdasarkan analisis kestabilan cerun. Oleh itu, satu kajian kestabilan cerun awal telah dibangunkan untuk meningkatkan keupayaan Agensi Nuklear Malaysia (Nuklear Malaysia) dalam menilai tapak yang berpotensi untuk Pelupusan Lubang Gerek untuk Sumber Radioaktif Terkedap yang tidak digunakan. Hasil kajian menunjukkan bahawa geometri keratan rentas A-A ', B-B', C-C' dan D-D' mencapai faktor keselamatan tidak kurang daripada 1.4 dan ini boleh diterima.

Keywords/Kata kunci: slope stability, slope/w.

INTRODUCTION

The use of radioactive materials in research, industrial and medicals has generated a volume of radioactive waste. The various type of radioactive waste must to be managed and disposed safely. Waste Management Centre of Malaysian Nuclear Agency led an initiative to plan to construct a Borehole Disposal for Disused Sealed Radioactive Sources (BOSS) to dispose disused sealed radioactive sources (DSRS). Currently there is a site which has been proposed for this project, which is in the vicinity of radioactive waste storage facility which is known as Block 33 in Malaysian Nuclear Agency – Main Complex.

Therefore, studies need to be carried out to select the suitable site out of these two sites which suits the borehole disposal concept. Before the borehole disposal can be constructed at the proposed site, the site should be investigated in whether the site is in stable condition. The site should be in firm condition for a long period of time. Block 33 area is located at the top ridges. It is very important that all the slopes surround the area are stable.

Geostudio Slope W software is one of the geotechnical analyses that are used in the slope stability study based on soil composition of the materials below ground and the geometry of the slope. Slope W can be used to analyze the stability of the slope within the study area and to have general baseline factor of safety (FOS) data on the stability of the slope.

PROCEDURES

Soil Investigation was carried out by Kumpulan IKRAM Sdn Bhd in 2004 at Block 11. The boreholes were sunk by rotary drilling and standard penetration test (SPT) was performed. Table 1 shows borehole depths, instrument and piezometric level at block 11.

Table 1: Borehole depths at Block 11

Borehole No.	Instruments Level (m)	Depth of Boreholes (m)	Depth of water from top of tube (m)	Piezometric Level (m)
ABH 4	38.1	15	7	31.1
ABH 6	37.99	15	6	31.99

While site characterization works was carried out by Hatrick Multirich Sdn Bhd at block 33. The boreholes were sunk by rotary drilling and standard penetration test (SPT) was performed. Table 2 shows borehole depths, instrument and piezometric level at block 33.

Table 2: Borehole depths at Block 33

Borehole No.	Instruments Level (m)	Depth of Boreholes (m)	Depth of water from top of tube (m)	Piezometric Level (m)
BHM 1	73	102	30	43

Based on the borehole logs done by Hatrick Multirich (2013), the subsurface profile can be categorized as follows:

i) Residual Soil
ii) Highly to completely weathered (Grade IV to Grade V)
iii) Bedrock

Obrzud. R. Truty,A (2012) stated that the typical value for friction angle ranging from 27° to 33° for loose silty sand that suit the residual soil and 30° to 34° for dense silty sand that suit the hard layer

analysis parameter. Meyerhoff (1956) stated that 4 – 10 numbers of SPT blows per 0.3m are classified as loose soil and 30-50 blows per 0.3m classified as dense soil. Due to the variability in the parameters obtained from various geotechnical articles. The lowest parameter values are taken into the analysis to estimate the lowest factor of safety. Table 3 shows the soil parameters value set for the analysis.

Table 3: Soil parameter value for the analysis

Decsription	Unit weight, γ	Cohesion, C	Friction Angle , ϕ
Set 1 – Residual Soil	14	27	22
Set 2 –Hard Layer	20	30	20
Set 3 – Bedrock	Impermeable		

Note: All sets of parameters are assumed from geotechnical article; not from laboratory tests.

RESULT AND DISCUSSION

The stability of a slope is usually assessed on the basis on its factor of safety (FOS) against slope failure. A stable slope would have a factor of safety greater than 1.4. (Slope Engineering Branch, 2010).

Locations of cross section overlapped with digital elevation model for analysis are shown in Figure . For each section, the subsurface profile for the analysis was simplified to a three-layer material. All slope stability analyses were carried out using a well-established computer program SLOPE/W v.7. The Morgenstern-Price method with half-sine side function was used for all analysis in this report. 3D view with 30° angle from the ground illustrates the geometry of slope and cross section lines are shown in Figure .

Figure shows the schematic diagram of the stability analysis carried out for cross section A-A' which is east face of the hill. Figure shows the analysis carried out for cross section B-B' which is the southwest face of the hill. Figure shows analysis carried out for cross section C-C' which is the west face of the hill and Figure 61 shows analysis carried out for the cross section D-D' which is the northwest of the hill.

Figure 1: Cross section for the slope stability analysis

Figure 2: 3D view of the slope and analysis lines

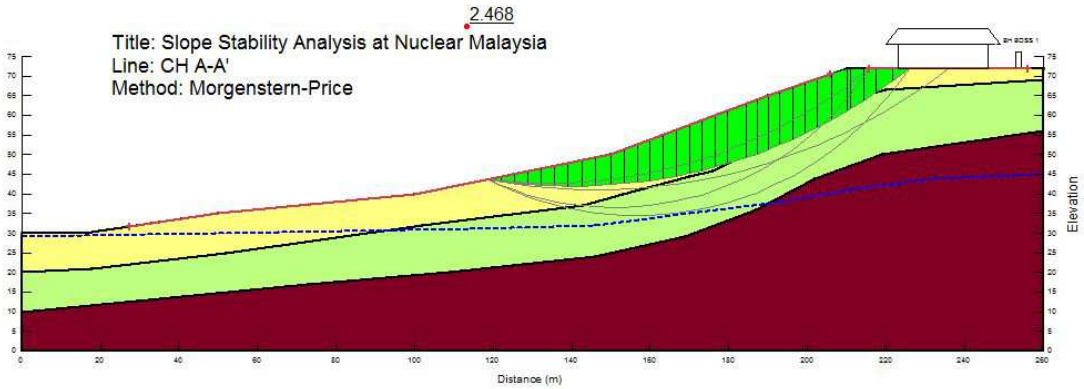

Figure 3: Stability Analysis of CH A-A'

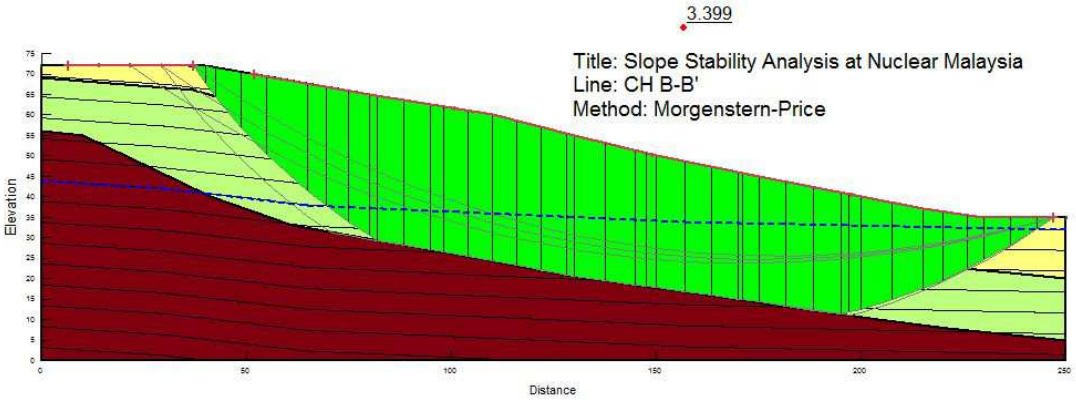

Figure 4: Stability Analysis of B-B'

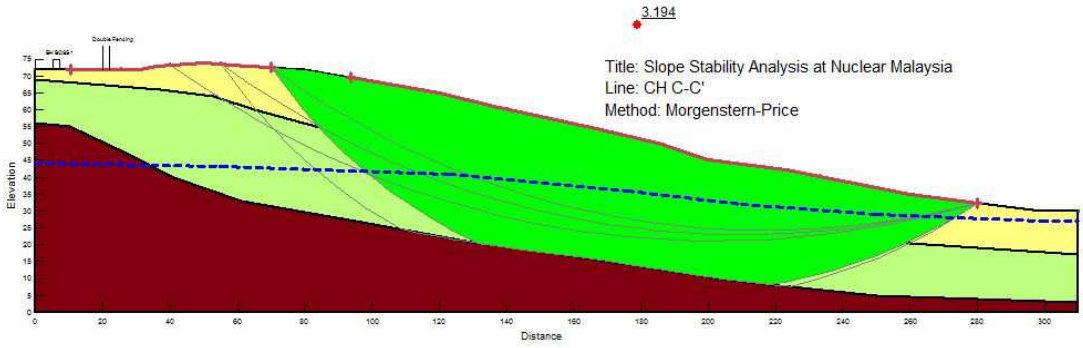

Figure 5: Stability Analysis of C-C'

Figure 61: Stability Analysis of D-D'

The results of the slope stability analyses are tabulated in Table 4. As explained before, a stable slope would have a factor of safety greater than 1.4. All slope analyses show FOS greater than 1.4.

Table 4: Result of slope stability analyses

Slope Analysis	
Cross Section	Minimum Faactor of Safety (FOS)
A-A’	2.468
B-B’	3.399
C-C’	3.914
D-D’	3.906

CONCLUSION

The slopes are in natural shape and the water table within the slope is far below the ground. The factor of safety (FOS) for A-A’, B-B’, C-C’ and D-D’ is respectively 2.468, 3.399, 3.914 and 3.906. The geometry and water table of the area can achieve factor of safety of not less than 1.4 and this is deemed acceptable.

It is recommended that the a geotechnical investigation shall be carried out to ascertain the geometry of the slope and to comprehend the nature of the slope in terms of the geology, engineering properties of the subsurface materials and the ground water regime. The data obtained from the field and laboratory investigation can be used to perform more refined and detailed slope stability analyses.

REFERENCES

Hatrik Multirich Trading. 2013. *Soil Investigation Report For Kerja-Kerja Pembinaan Lubang Gerudi Untuk Penyiasatan Tapak Di Agensi Nuklear Malaysia (Nuklear Malaysia) Selangor Darul Ehsan – NM : SH51/2013*, Selangor.

Kumpulan IKRAM Sdn Bhd. 2004. *Laporan Akhir Kajian Lanjutan Dan Menyeluruh Kestabilan dan Keutuhan Bangunan Di Blok 11, Institut Penyelidikan Teknologi Nuklear Malaysia (MINT)* Jilid II. RD/03/B21/019. Selangor.

Meyerhoff.G . 1956. Penetration Tests and Bearing Capacity of Cohesionless Soils. *J. Soils Mechanics and Foundation Division ASCE*, 82 (SMF).

NavFAC Design Manual 7.2 – *Foundation and Earth Structures*, SN 0525-LP-3007071, Revalidated by chance 1 Sept 1986

Obrzud. R. Truty,A. 2012. The Hardening Soil Model. *A Practivcal Guidebook Z Soil*. PC 100701 Report.

Slope Engineering Branch. 2010.*Guidelines for slope design*. Public Works Department. pg 8. JKR 21500-0011-10.

Swiss Standard SN 670010b, *Characterisitc Coefficient of Soils*, Assoiciation of Swiss Road and Traffic Engineering.