ZIBELINE INTERNATIONAL PUBLISHING

Geological Behavior (GBR)

DOI : http://doi.org/10.26480/gbr.01.2018.29.31

ISSN: 2521-0890 (Print)
ISSN: 2521-0491 (online)

CODEN : GBEEB6

CrossMark

SUITABILITY OF DBELA METHODS AS SEISMIC VULNERABILITY ASSESSMENT FOR BUILDINGS IN KOTA KINABALU, SABAH

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ARTICLE DETAILS

Article History:

Received 12 November 2017
Accepted 12 December 2017
Available online 1 January 2018

ABSTRACT

Sabah experienced moderate seismicity in the active fault zones located in Kundasang, Ranau of 6.0 MW within minor damage recorded at Sabah recently. The damage following the earthquake and more than 100 aftershocks affected 61 buildings such as schools, hospital and mosque, 22 roads and 22 slopes. Over the past 114 years, a total of 124 with magnitudes ranging from 2.9 to 6.0 are known to have occurred. The earthquake in Sabah that struck Ranau, carrying a moment magnitude of 6.0 on 5 June recently lasted for 30 seconds. This earthquake was the strongest to affect Malaysia since 1976 in Lahad Datu. The latest thesis in the Sabah region had been carried out in Kundasang, Kudat and two buildings in KK city. The objective was to presents the evaluation of soil sample taken in Kota Kinabalu (KK) city that could possibly subjected to low intensity earthquake effects. The evaluation of determination of the soil amplification factor is used to determine the influence of soil condition on buildings in KK city. With the input motion of Whittier Narrows (6.0 Mw, ts = 0.005 s) and KKM Ranau (5.9 Mw, ts = 0.01 s), the analysis of the maximum acceleration for PGA and PSA will be varies with the use on program of NERA and DEEPSOIL V5.1. From the appendixes as shown in appendix, it is known that most of their soils are consisting of a surface alluvium layer varying the thickness in between of approximately 5 m and 20 m in refer to some researcher. Most of the soil condition is reviewed that there are soil type of B, C, D and E in according to (Technical Committe B/525, 2005). This study shows that the soil amplification factors for each location in KK city are various with the input motion of 5.9 Mw, ts = 0.01 s and 6.0 Mw, ts = 0.005 s.

KEYWORDS

Seismic Vulnerability Assessments, DBELA Methods, Ground Response Analysis

1. INTRODUCTION

Sabah's geological data has much on younger Tertiary sedimentary rocks such as sandstone and shale dominant areas. For example, at the Trusmadi Formation, Ranau has the major cut-slopes were made into the hills with black, carbonaceous shale [1-3]. Other than that, it is also believed that the black shale produced very weak materials on weathering which it cannot sustain even gentle slopes [4]. As the result of major slope failures within the deterioration of material shear strength, time in according to geotechnical engineering study [5]. It is reported that Ranau area has a high tetanised region with heaves at two different localities at the North Slope. The localities have their ground surface of the area are featured with many clusters of large granitic boulders, where there is grey shale (Trusmadi Formation) and red shale (Crocker Formation) which can be refer to figure 1 and figure 2 from the Appendices. It is believed that the Ranau area is unsuitable for construction and therefore it requires very intensive site investigations, thus incurring very high development cost [6].

2. MATERIALS AND METHODS

Among the materials used in this study include the soil sample data of Standard Penetration Test (SPT) is obtained from the UMS Engineering Administration. Each sample is to be list up the locations in KK district, soil types based on EN 1998-1. There are approximately 20 numbers of soil samples data taken in the whole KK district. The soil classification can be refer based from the Eurocode 8 (EN 1998-1) [4]. The classification of soil type A, B, C, D and E is referring to every soil layer of the sample.

Each soil sample is to be determined of their soil profile by using the program NERA. The input data that is to be needed is the desired maximum acceleration which can be found in the input motion data selected as shown in the table 1.

Table 1: Input motion data obtained from a study [7]

Input Motion Name	Magnitude	Distance to Fault Rupture (km)	USGS Site Class	PGA (g)	Time step, Ts (s)
Whittier Narrows	6.0	21.2	A	0.186	0.005
KKMRanau	5.9	62.6	A	0.135	0.01

The soil sample information such as the depth of soil layers and the type of soil such as clay, silt, sand and etc are to be computed in the soil profile. The figure 3 from the Appendices shows the soil profile is produced from the computation of NERA program. From the result obtained from the program NERA, the maximum spectral acceleration is known as peak ground acceleration (PGA) is obtained.

Table 2: The output values for the soil sample at the location profile of CBB with program of NERA

Location profile =	CBB
Number of sublayer =	2
Ratio of critical Damping (%) =	5
Depth at top of sublayer (m) =	6.970000267
Maximum Spectral Acceleration (g) =	0.263
Maximum Spectral Velocity (cm/s) =	27.25

Hence, the amplification factor is the ratio of PSA and PGA based from a study [2].

$$\textit{Soil amplification factor} = \frac{PSA\,(g)}{PGA\,(g)} \quad \text{(Equation 1)}$$

The interpolation of mapping on the KK district is being computed by using the program of ArcGIS. The map is shows in figure 4 from the Appendices.

3. RESULTS AND DISCUSSION

Table 3: The summary of soil profile and the amplification factor, f for the following locations in KK city.

Profile	Location	Bedrock	Ground Type	PGA (g)	5.9 Mw, 0.01 s		6.0 Mw, 0.005 s	
					PSA (g)	f	PSA (g)	f
CBB	Condominium Development at Jalan Bukit Bendera	Sandstone	E	0.263	0.504	1.919	0.390	1.484
DKM	Development at Karamunsing	Sandstone	C	0.489	0.144	0.295	0.058	0.118
EKM	Extension & Conversion of Existing Shops on Hotel & Associated Facilities at Sadong Jaya, Karamunsing	Sandstone	D	0.585	0.345	0.589	0.779	1.330
HTA	Harbour City at Tj Aru, Sembulan, Jln Pantai Baru	Sandstone	E	0.521	0.244	0.468	0.347	0.666
HHS	Hotel Development at Jalan Haji Saman	Sandstone	E	0.309	0.445	1.439	0.684	2.214
MGT	Housing at Mengatal	Sandstone	D	0.261	0.161	0.617	0.129	0.497
HKN	Housing Development at Kg Nunton, Adjacent SMK Kolombong	Shale	B	0.218	0.463	2.124	0.233	1.066
KTA	Kudat Property at TANJUNG ARU	Siltstone	E	0.145	0.401	2.768	0.385	2.657
LHDK	Pembinaan Bangunan LHDN KK	Sandstone	E	0.187	0.290	1.552	0.250	1.342
HKK	Proposed Commerical Development & Corporate Office at Coastal Highway	Gravel	E	0.215	0.058	0.272	0.048	0.222
TA	Proposed Intergrated Commercial Development at Tanjung Aru	Silt	E	0.902	0.053	0.058	0.043	0.048
DBKK	Proposed New 4-Storey Extension to DBKK HQ Ofiice Building at Jalan Bandaran	sandstone	D	0.201	0.562	2.797	0.776	3.865

The locations of soil sample are to be discussed that they have various range of f values. From the table 3, it is known that most of their soils are consisting of a surface alluvium layer varying the thickness in between of approximately 5 m and 20 m in refer to a research paper [4]. As most of the locations such as CBB, DKM and HTA are consisting of a surface alluvium layer, there are some locations in KK district with rock or other rock-like geological formation as same as Ranau district [8]. The hypocenter distance (Rhypo) between fault rupture between KK and Ranau are mostly in approximately 60km of distance. So, the possibility of the locations at KK district could prone to earthquake damage with low to medium range of earthquake magnitude.

4. CONCLUSION

This research described the study of dynamic soil properties for locations of KK city in Sabah, Malaysia. Ground response analyses were performed using 1-D shear wave propagation analysis. The analysis was performed with the input motion of 5.9 Mw, ts = 0.01 s and 6.0 Mw, ts = 0.005 s. In this study, the analysis was performed using nonlinear approach in order to consider the actual nonlinear response of a soil deposit. From the results obtained, the soil amplification factors for each location in KK city are various. These values were produced for each location in KK city in this research that can be used as input for seismic design, land use management, and estimation of potential liquefaction and landslides. The results of ground response analysis show that both the time histories and local soil conditions (soil stiffness, stratigraphy and ground water level) are critical to the results of ground response analysis. Generally, time histories affect the amplitude of peak ground acceleration, whilst the soil conditions influence the frequency content of the spectrum. Therefore, these two subjects should be considered and determined carefully in ground response analyses in further study of this paper.

ACKNOWLEDGEMENT

The author thanks the unit from Universiti Malaysia Sabah. This support is gratefully acknowledged.

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APPENDICES

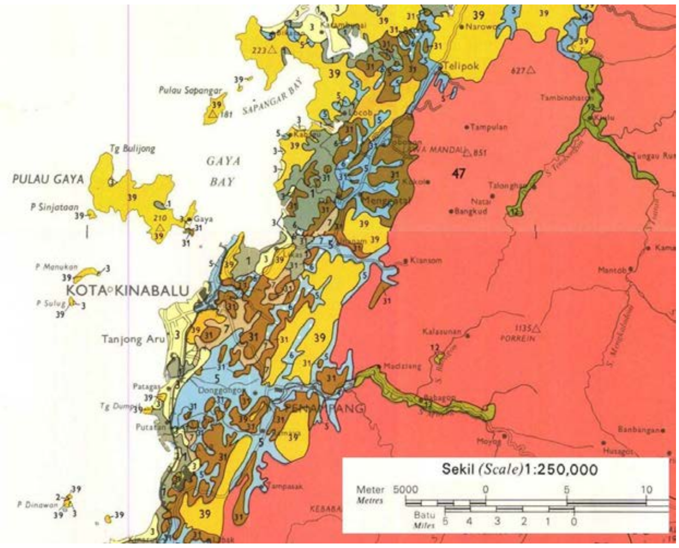

Figure 1: The soils of KK district of Sabah published for Land Resources Division, Overseas Development Administration of England on 1974 [8].

Key	Landform	Parent materials	Main soil units
1	Tidal swamps	Sulphidic alluvium, sulphidic peat and alluvium	Thionic Fluvisol; Dystric Histosol; Thionic Gleysol
3	Beaches	Alluvium	Dystric and Eutric Regosols; Humic, Dystric and Eutric Gleysols; Gleyic Podzol
5	Floodplains	Alluvium	Gleyic Acrisol; Gleyic Luvisol; Humic, Dystric and Eutric Gleysols
6	Swamps	Alluvium and peat	Humic, Dystric and Eutric Gleysols; Dystric Histosol
7	Swamps	Peat and alluvium	Dystric Histosol; Humic Gleysol
30	Moderate hills: slopes >25°	Mudstone and sandstone	Orthic Acrisol; Dystric Cambisol
31	Moderate hills and minor valley floors: slopes 0-20°	Sandstone, mudstone and alluvium	Orthic, Ferric and Gleyic Acrisols
32	Moderate hills and minor valley floors: slopes 0-20°	Sandstone, mudstone and alluvium	Ferric, Orthic and Gleyic Acrisols
33	Moderate hills: slopes 0-20°	Mudstone, sandstone and miscellaneous rocks	Ferric and Orthic Acrisols; Ferric, Chromic and Orthic Luvisols
34	High hills: slopes 15-25°	Basic igneous rocks	Ferric Acrisol; Orthic Luvisol
35	Moderate hills: slopes 10-20°	Tuffaceous rocks, mudstone and sandstone	Chromic and Orthic Luvisols; Orthic Acrisol
36	High hills: slopes >25°	Sandstone, mudstone and igneous rocks	Ferric Acrisol; Chromic and Orthic Luvisols; Dystric and Eutric Cambisols
37	Very high hills: slopes >25°	Basic igneous rocks	Chromic and Eutric Cambisols
38	Very high hills: slopes >25°	Limestone	Calcic Luvisol; Rendzina
39	Very high hills: slopes >25°	Sandstone and mudstone	Orthic Acrisol; Dystric Cambisol

Figure 2: The soil types legend for the KK district of Sabah published for Land Resources Division, Overseas Development Administration of England on 1974 [8].

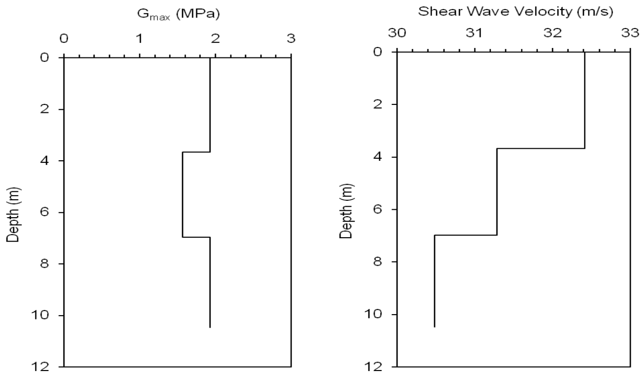

Figure 3: The soil profile for the location profile CBB

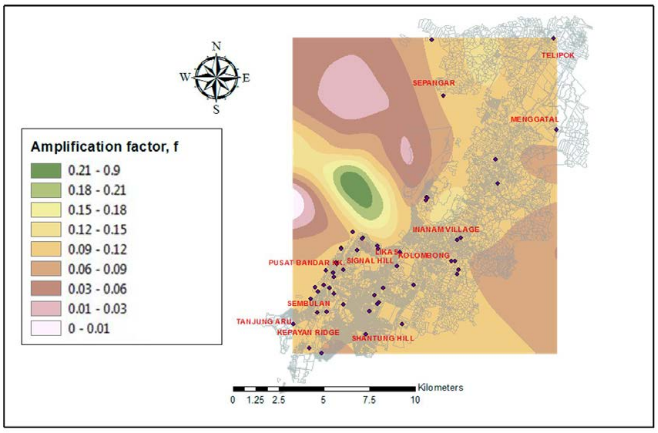

Figure 4: Contour of soil amplification factor under Time History and Ground Motion of KKMRanau (5.9 Mw, ts = 0.01 s)