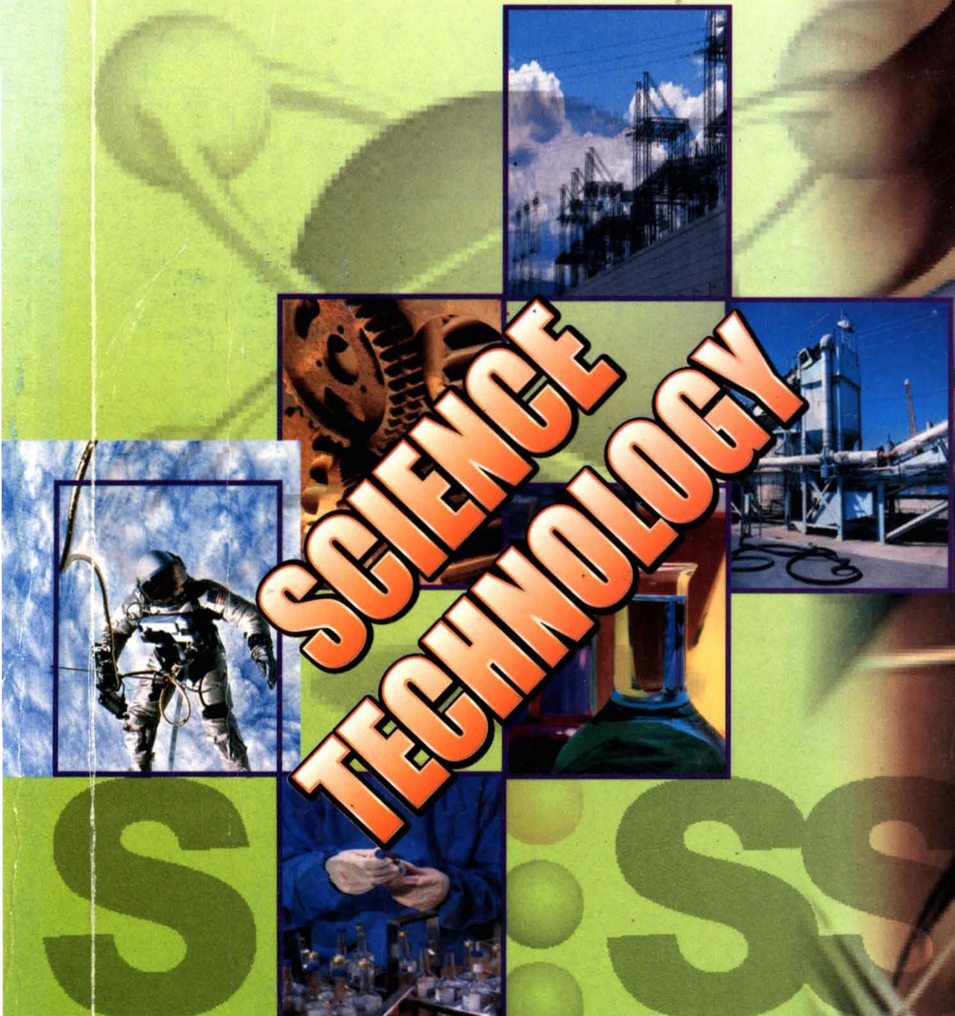
UNIVERSITI TEKNOLOGI MARA

ISO 9001:2000 No Sijil :0500132

Globalising Knowledge and Information



NATIONAL SEMINAR ON SCIENCE TECHNOLOGY & SOCIAL SCIENCES 2006

30-31 May 2006

Swiss Garden Resort & Spa
Kuantan, Pahang

A Study on Soil Engineering Compositions of Tropical Residual Soils of Peninsular Malaysia

Khairul Nizar Mohd Yusof
Lee Cheong Lun

ABSTRACT

Malaysia is situated at the equator line where the tropical climate existing the tropical residual soils and received average rainfall between 1778 mm to 3659 mm. Soil erosion and slope instability have lately become very serious problem in the tropical region. Therefore, many researches from the various government and the private agencies had been studied regarding the soil erosion issues. Meanwhile, the objectives of the study are to determine the soil engineering composition of tropical residual soils at central and southern Peninsular Malaysia, There are 10 undisturbed samples taken at shallow depth (< 0.5 m) and all tests had been conducted at the Geotechnical Laboratory, Fakulti Kejuruteraan Awam dan Alam Sekitar (FKAAS), Kolej Universiti Teknologi Tun Hussein Onn. The soil particles from tested samples show 3.15 % to 12.77 % of clay, 50.81 % to 88.3 % of silt, and 0.15 % to 44.9 % of sand. The natural moisture content, w, is in the range of 13 % to 38 %. The specific gravity, G_s, values are found to be in the range between 2.3 and 2.89. Plastic limit, w_p, is in the range of 18 % and 37.47 %. While liquid limit, w_L, values in between 33.6 % and 50 % and the plasticity index, I_P, is in range of 11 % to 23.9 %. The results show that the w values are influenced by the percentage of clay. High percentage of moisture content values can restore more water than soil which has lower percent of clay. While lower percent of clay can generate lower values of I_P. The generated correlations will become a reference to the geotechnical design and adding information on potential future in the study area. This indication can assist engineers to the better understanding of the soil engineering compositions and also can predict the possible properties of destruction and loss of life that could be encountered.

Keywords: *soil engineering, residual soil, index properties*

Introduction

Residual soils are formed from weathering process of rocks. In Malaysia, specifically, climate conditions, high temperature and extreme distribution of rainfall expedite the formation of residual soils via chemical and physical weathering.

Regarding of the research which has been done by Mohd Fairus (2003), where he stated that the weather in Malaysia is a tropical climate. It is because Malaysia is a humid tropical climate that prevail in Malaysia which characterized by high temperatures and heavy rainfall. Malaysia is situated at the equator line where it have tropical climate existing the tropical residual soils where it receives average rainfall between 1778 mm to 3659 mm. Due to heavy rainfall and high temperature whole year, the main rock in its surface become cracking from year on and the weathering have inspired it to become tropical residual soils. Figure 1 shows the distribution of tropical residual soils in Malaysia.

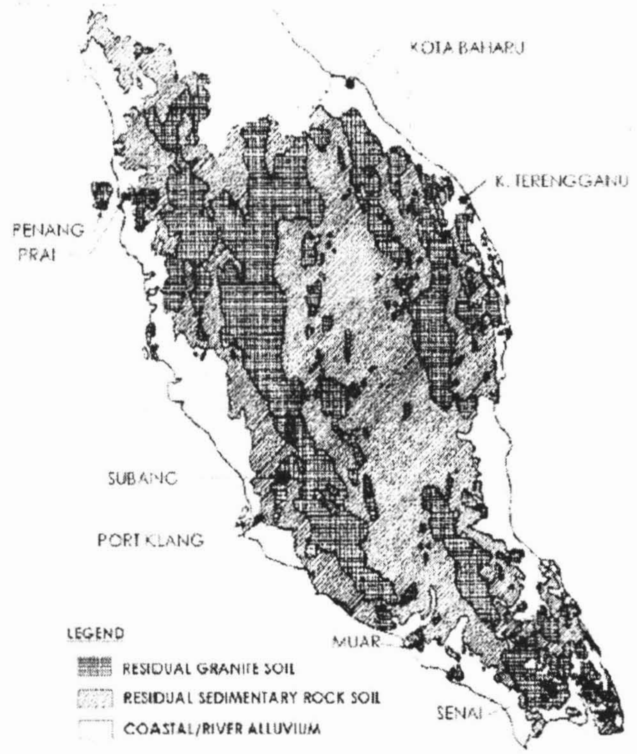


Fig. 1: Distribution of Tropical Residual Soils in Malaysia (Ting and Ooi, 1976)

Background and Literature Review

The scope of study had been identifying. Only granite residual soils were focused due to this study. The undisturbed samples had been taken in a few locations in Central and Southern Peninsular Malaysia using the core cutter. The undisturbed samples were taken at shallow depth (< 0.5 m) and safely transfer from location to Kolej Universiti Teknologi Tun Hussein Onn in carefully condition (by wrapping and less vibration). All the index tests had been conducted at the Geotechnical Laboratory, Fakulti Kejuruteraan Awam dan Alam Sekitar (FKAAS), Kolej Universiti Teknologi Tun Hussein Onn according to Head (1986).

In geotechnical engineering, the index properties testing which included the plastic limit, w_p liquid limit, w_L, moisture content, w, specific gravity, G_s, and particle size distribution. w_p define the low water content at which the soil exhibits plastic behavior. While w_L is the upper boundary of the plastic behavior and at this w the soil behaves as a viscous liquid, flows under its own weight and will not hold a specific shape. Table 1.0 shows the past researchers result of particle size distribution. One of the behaviors of the tropical residual soils is affected by drying. Index properties of tropical residual soils may change drastically even by partial drying. It could be due to alteration of the clay minerals on partial dehydration or due to form larger particles which remain bonded together even on re-wetting. Table 2.0 and Table 3.0 shows the past researchers result of index properties.

Table 1: Particle Size Distribution from Past Researchers

Parent Material	Clay (%)	Silt (%)	Sand (%)	Location	Researchers
Granite	52	4	5	Malaysia	Pushparajah *et al.* (1977)
Granite	28	17	48	Malaysia	Ting *et al.* (1982)
Granite	42	23	35	Malaysia	Taha *et al.* (1999)

Table 2: Index Properties from Past Researchers

Location	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Clay (%)	Silt (%)	Sand (%)	Researchers
Jalan Gurney Kuala Lumpur	10 – 48	25 – 90	18 - 38	-	75 – 90	10 – 20	Komoo (1989)
Senawang Negeri Sembilan	8 - 43	37 – 95	11 – 41	3 – 31	27 – 68	21 - 57	Ting *et al.* (1990)
Gopeng Perak	43 – 52	-	-	-	-	-	Singh *et al.* (1990)
Kuala Lumpur	10 – 20	-	10 – 20	< 20	< 40	-	Wong *et al.* (1996)

-: nil / no researchers been conducted

Table 3: Index Properties from Past Researchers

Location	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)	Clay (%)	Silt (%)	Sand (%)	Specific Gravity	Researchers
Sg. Besi Kuala Lumpur	20 - 30	-	-	29 – 59	-	38 – 64	2.62 – 2.64	Ting *et al.* (1972)
Federal Highway Kuala Lumpur	24 – 31	33 – 50	12 – 16	35 – 53	28 – 40	9 – 25	2.64 – 2.72	Chan *et al.* (1972)
Karak Highway Selangor	15 – 25	20 – 60	4 – 20	< 15	< 20	< 60	-	Komoo (1985)
Petaling Jaya Selangor	-	-	-	40 – 50	25 – 40	< 20	-	Komoo (1989)
Cheras Selangor	12 – 99	27 – 78	-	20 – 40	30 – 60	< 25	-	Komoo (1989)
Bukit Lanjan Kuala Lumpur	10 - 30	20 - 55	5 – 30	< 20	15 – 20	40	2.6 – 2.7	Singh *et al.* (1993)

-: nil / no researchers been conducted

Methodology

The methodology has been identified and organizes to ensure that the process of the study will run smooth until achieving its objectives and finally having a good result. There are few important stages which need to be carried out to determine the residual soil's behavior. The first stage is to prepare soil sample. After that laboratory tests for those soil samples will be carried out. After completed all tests, the results, data and graph will be analysis.

Most of the samples were taken along Serernban - Ayer Keroh highway, while other samples each at Ampang and Ayer Hitam. The tests include sieving test, moisture content, atterberg limit and specific gravity. Basically, the study about tropical residual soils on granite based must first be well understand and well organized so that it can fix with time, laboratory apparatus and the locations to achieve its objectives. Standard device used for the tests based on BS 1377: Part 2:1990. All tests were held at Geotechnical Laboratory, Fakulti Kejuruteraan Awam dan Alam Sekitar (FKAAS), Kolej Universiti Teknologi Tun Hussein Onn. Figure 2.0 show the flow chart of methodology used to achieve the objectives.

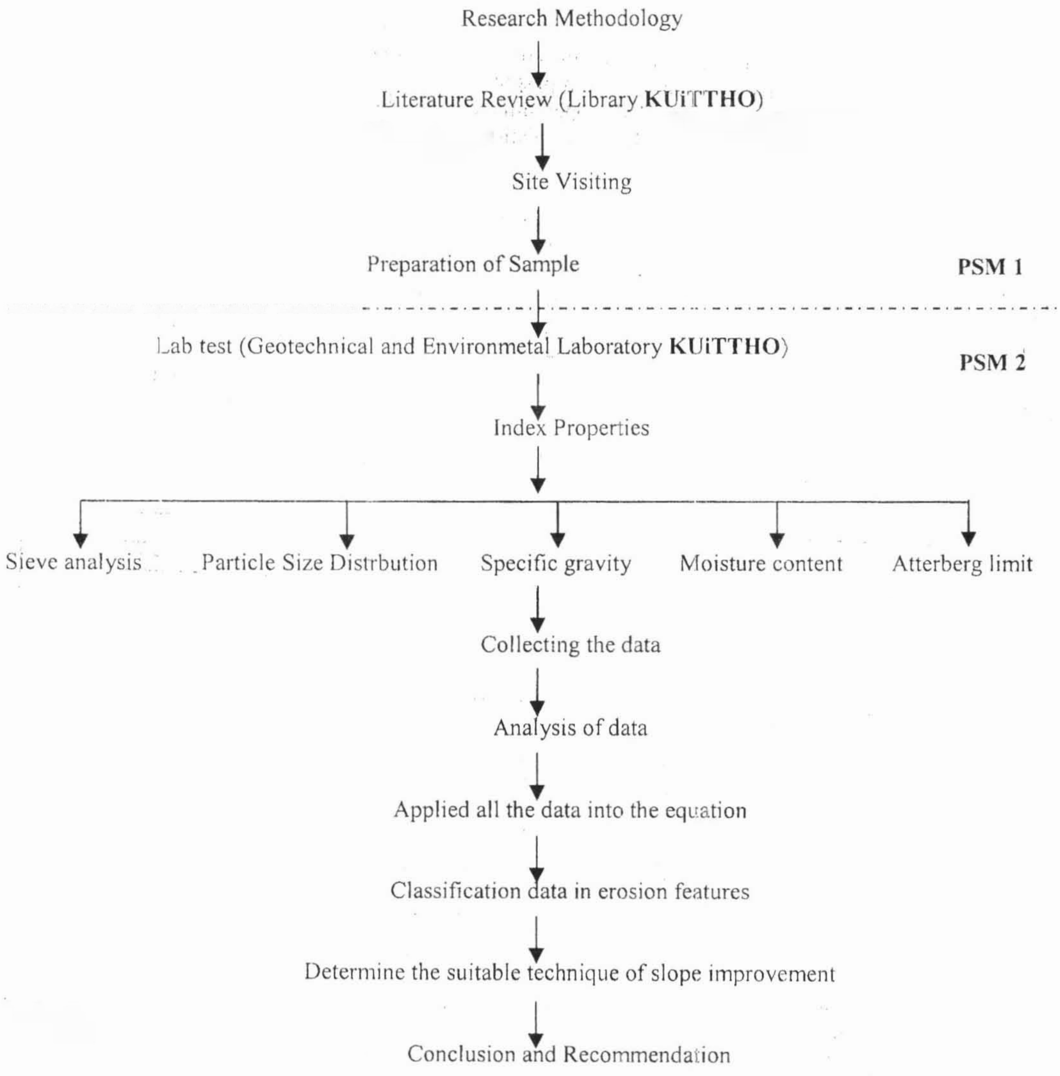


Fig. 2: Flow Chart of Methodology

Result and Discussion

The results of particle size test are shown in Table 4.0 and Figure 3.0. According to the results obtained, these samples consists a high percentage of fine particles; silt and sand. The soil particle contains about, clay ranges 3.15 % - 12.77 % and silt ranges 50.81 % - 88.3 % and sand ranges 0.15 % - 44.9 %, respectively. Study made by the Ting, *et al.* (1990) showed almost same range from the results where 3 % - 31 % of clay, 27 % - 68 % of silt and 21 % - 57 % of sand. Result by Komoo (1989) also had almost same results but the percentage of sand is higher than Ting, et al. (1990). Based from this study, it can be concluded that these samples can be defined as sandy silt. Table 5.0 shows all the laboratory test result.

Percentage of clay have made huge influenced to moisture content. High percentage of moisture content values can restore more water than soil which has lower percent of clay. More percentage of clay exist in the soil will increase the percentage of moisture content. Figure 4.0 shows the correlation between moisture content and clay. When the soil particle became smaller, the surface of soil particle will increase respectively. This will enhance the percentage of the liquid limit as the moisture content also increase. Meanwhile, the specific gravity value decrease due to the increasing of clay. Plasticity index also increase due to the increasing of clay. Low percentage of clay will result low percent of plasticity index. Figure 5.0 shows the correlation between plasticity index and clay. Most of the samples can be categorized as clays of low and medium plasticity. To determine the classification soil, the method British Soil System (BS 5930.1981) is used. The upper limit and the lower limit given gave the range of the correlation published and shown in Table 6.0. All the correlations were referring to Table 5.0 which showed all the results obtained from the laboratory tests.

Table 4.0: Distribution of Soil Particle

Location	**% Sand**	**% Silt**	**% Clay**
Hulu Klang	32.75	62.73	4.52
Ampang	2.1	88.37	8.17
km 254.1	8.5	85.51	5.98
km 250.4	8.01	83.22	8.77
km 247.9	0.22	87.01	12.77
km 244.3	44.9	50.81	4.29
km 243.5	0.15	88.51	11.34
km 231.3	18.96	7.89	3.15
km 222.7	5.56	88.3	6.14
Ayer Hitam	7.49	85.18	7.33

Table 5.0: Laboratory Test Results

Index Properties	**Unit**	**Ayer Hitam**	**Hulu Klang**	**Ampang**	**km 244.30**	**km 254.1**	**km 243.5**	**km 231.3**	**km 247.9**	**km 250.4**	**km 222.7**
Moisture content, w	%	24.00	13.00	13.00	13.00	23.00	28.00	15.00	38.00	17.00	9.70
Sand, S	%	7.49	32.75	2.10	44.90	8.5	0.15	18.96	0.22	8.01	5.56
Silt, M	%	85.18	62.73	88.37	50.81	85.51	88.51	77.89	87.01	83.22	88.30
Clay, C	%	7.33	4.52	8.17	4.29	5.98	11.34	3.15	12.77	8.77	6.14
Specific Gravity, Gs	nil	2.54	2.56	2.51	2.45	2.30	2.45	2.54	2.47	2.89	2.43
Plastic Limit, w_p	%	24.11	20.40	22.64	18.45	37.47	22.04	18.00	23.82	19.94	27.47
Liquid Limit, w_L	%	42.50	35.00	33.60	36.00	50.00	39.00	36.60	47.70	40.60	45.80
Plasticity Index, I_p	%	18.40	14.60	11.00	17.60	12.50	17.00	18.60	23.90	20.70	18.30

Table 6.0: Correlation Summary

No.	Correlation	Upper limit	Lower limit
1	Moisture content, w, & clay, % L	% w= 0.3527(%L) + 3.8845	% w=0.422(%L) - 6.936
2	Specific gravity, G_s, & clay, % L	G_s = 10(%L) - 15	Gs = 6.7308(%L) - 12.711
3	Liquid limit, w_L, & clay, % L	% w_L = 0.436(%L) - 6.1781	% w_L = 2.8947(%L) - 128.98
4	Indeks plastik, I_p, & clay, % L	% I_p = 0.5243(%L) + 2.7024	% I_p = 0.9821(%L)- 14.373
5	Indeks plastik, I_p, & moisture content, % w	% I_p = 0.3288(%w) + 15.111	% I_p = 0.76(%w) - 4.98

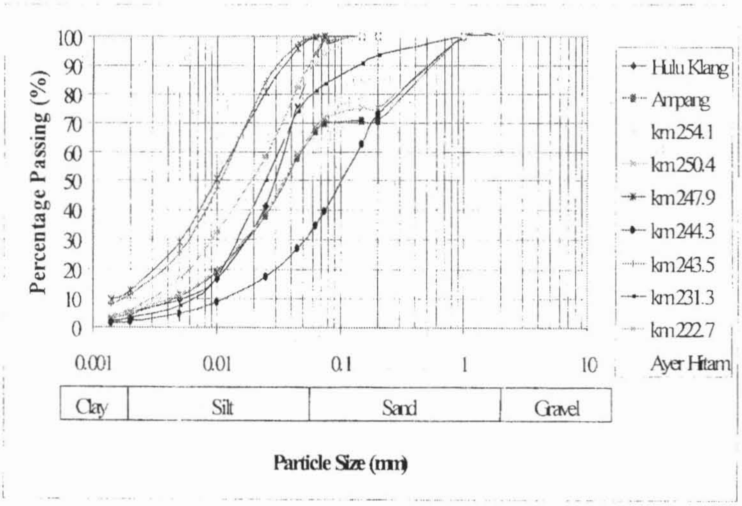


Fig. 3: Distribution of Soil Particle

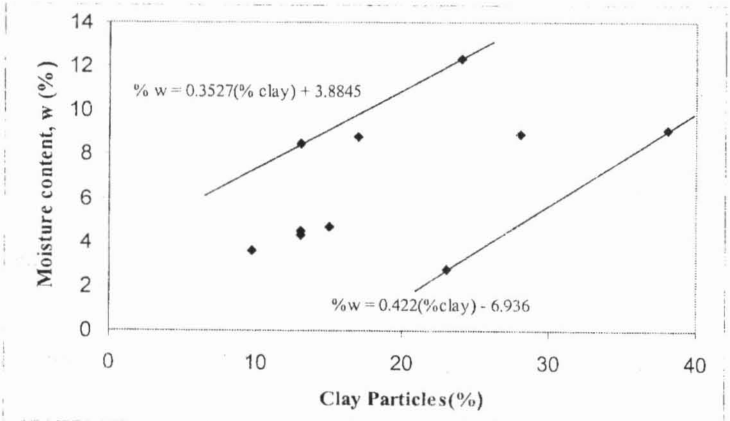


Fig. 4: Correlations between Moisture Content and Clay

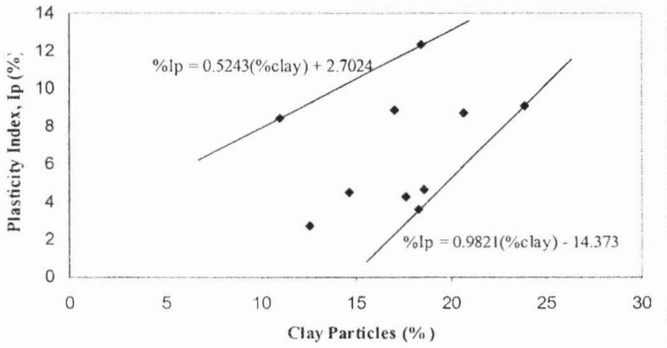


Fig. 5: Correlations between Plasticity Index and Clay

Conclusion

The results show that the moisture content values are influenced by the percentage of clay. High percentage of moisture content values can restore more water than soil which has lower percent of clay. While lower percent of clay can generate lower values of plasticity index. The generated correlations will become a reference to the geotechnical design and adding information on potential future in the study area. This indication can assist engineers to the better understanding of the soil engineering compositions and also can predict the possible properties of destruction and loss of life that could be encountered.

References

Chan, S.F. & Chin F.K. (1972). Engineering Characterization of the Soils along Federal Highway in Kuala Lumpur. *Proceedings of the Third Southeast Asian Conference in Soil Engineering*, Hong Kong.

Fajaruddin bin Mustakim. (1999). *Soil Erodibility Potential at ITM Shah Alam Campus.* Institut Teknologi Mara: Bachelor Project. Not Published. 12-18

Head, K. H. (1992). *Manual of Soil Laboratory Testing.* 2nd ed. London: Pentech Press Ltd.

JKR (1985) in Bambang I. Siswosoebrotho. Stabilization of Tropical Residual Soils. *Journal of Geology Engineering*, 2003:pp. 137-157.

Khairul Nizar. (2002). *Mineralogi, Mikrostruktur dan Komposisi Kimia Tanah Baki Granit di Semenanjung Malaysia.* University of Technology Malaysia: Master Project. Not Published. 12-80

Komoo, I. (1985). Engineering Properties of Weathered Rock Pro-files in Peninsular Malaysia. *Proceedings of the Eighth Southeast Asian Conference Geotechnical Conference*, Kuala Lumpur.

Komoo, I. (1989). Engineering geology of Kuala Lumpur, Malaysia. *Proceedings of the International Conference on Engineering Geology in Tropical Terrains*, Bangi, Malaysia.

Mohd Fairus Yusof. (2003). *Ciri-Ciri Kejuruteraan Tanah Baki Granit di Semenanjung Malaysia.* University of Technology Malaysia: Master Project. Not Published: pp.122-144.

Ong T.H (2000). *Kegagalan Cerun – Punca dan Cara Mengatasinya.* University of Technology Malaysia: Degree Project. Not Pubished: pp. 36-69.

Pushparajah, E. & Amin, L.L. (1977). *Soils Under Hevea in Peninsular Malaysia and Their Management.*Rubber Research Institute of Malaysia.

Roslan Z.A & Mukri M. (2001). *Relationship between Soil Grading Characteristic and Soil Erosion Risk.* Geotropika 2001 Conference, 2001: pp. 107-115

Roslan Z.A & Tew K.H.(2002). *Soil Erosion and Sedimentation Assessment, Control and Management Plan for the Tropical Region.* Tropical Residual Soils, 2004: pp. 183-192.

Singh, M. & Ho, H.S. (1990). *Strength Testing of Residual Soils.* Seminar on Geotechnical Aspects of the North South Expressway, Kuala Lumpur.

Singh, M., Ismail, P. (1993). *Site Investigation Works Related to Engineering Geology for Urban Geology.* Forum on Urban Geology and Geotechnical Engineering in Consruction, Petaling Jaya, Malaysia.

Taha, M.R, Hossain, M.K, Chik, Z. & Nayan, K.A.M. (1999). *Geotechnical Behaviour of a Malaysian Residual Granite Soil.* Pertanika J. Sci. & Tehnology: pp.151-169.

Ting, W.H. & Ooi, T.A. (1972). *Some Properties of a Malaysian Residual Granite Soil.* Third Southeast Asian Conference on Soil Engineering.

Ting, W.H., Mun, K.P. & C.T, Toh. (1982). Characteristics of a Composite Residual Granite Soil. *Proc. 7th SEA Geotechnical Conference*, Hong Kong.: pp. 879 – 887.

Ting, W.H., Gasib, Z. & Ramanathan, N. (1990). *Study on the Stability of Slopes along the Seremban- Ayer Keroh Expressway.* Seminar on Geotechnical Aspects of the North South Expressway, Kuala Lumpur

Wong, J. & Singh, M. (1996). Some Engineering Properties of Weathered Kenny Hill Formation in Kuala Lumpur. *Proceedings of the Twelfth Southeast Asian Geotechnical Conference*, Kuala Lumpur.

KHAIRUL NIZAR MOHD YUSOF & LEE CHEONG LUN, Department of Transportations, Geotechnics and Geomatics Engineering, Faculty of Civil and Environmental Engineering, Kolej Universiti Teknologi Tun Hussein Onn.