Multidisciplinary Applied Research and Innovation Vol. 3 No. 2 (2022) 169-183
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MARI

Homepage: http://penerbit.uthm.edu.my/periodicals/index.php/mari
e-ISSN : 2773-4773

Factor Influencing the Shear Strength Parameter

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DOI: https://doi.org/10.30880/mari.2022.03.02.020
Received 31 March 2022; Accepted 31 May 2022; Available online 28 July 2022

Abstract: Many engineers confront with some issue when dealing with peat soil which is one of the problematic soils. Peat soil has a low value of shear strength and also would cause some problem in construction such as landslide and building fail. Researchers also have been run several test on the peat soil to increase its shear strength by manipulating the parameters. The objectives for this study is to observe the value of shear strength from direct shear test, to identify the value of shear strength of original peat and to study the effect of various parameter of peat to the shear strength value. The factor such as type of peat, moisture content, organic content, void ratio and pH value were discussed in this study. There were three steps used in this project to collect the data for factor influencing the shear strength parameter which are identification, screening and eligibility. Systematic literature review (SLR) method has been used in this project to collect the data and the results from previous study. This project has been through some process which is started from the process of identification the journals that related to the topic. The next step is process of screening which is to export the important data with suitable criteria and most related to this project. The final process of this project would be eligibility which is vital to achieve the objectives of this project. From the result, the effect of each peat parameters on shear strength could be observed. It can be seen that the type of peat would affect the value of shear strength. For example, hemic and fibric peat have a higher shear strength value than sapric peat. Other than that, it also can be concluded from the results that the values of shear strength decrease when moisture content, void ratio and pH values increase. Lastly, it can be observed from the result that value of friction angle decrease as the organic content increase.

Keywords: Peat, shear strength, parameter

1. Introduction

Peat is defined as a soft soil that is produced by partial decomposition and disintegration of sedges, mosses, and trees. It is from plants that grow in marshes and other wet places that have a lack of oxygen. Peat also contains high fibrous organic matters. There are 100% of pure organic materials which have

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65% organic matter or less than 35% mineral content in peat [1]. Besides, peat has its characteristics which is low shear strength and great compressibility which will lead to geotechnical problems. It is important to study the shear strength of peat because it can determine bearing capacity, cuts and slope stability and also retaining wall and foundation. Other than that, shear strength is also vital in construction because it helps to support the construction structures and equipment. There are various testing techniques that geotechnical engineers have discovered either in laboratory or in-situ to develop minerals in the peat soil to increase the shear strength of peat. This research is focused on peat samples from Malaysia state and the experiment was conducted using direct shear test. Some parameter that influencing the value of shear strength are type of peat, moisture content, organic content, void ratio and soil pH. Peat is known as a soft and weak soil. In geotechnical engineering, peat is known as high void soils which make the water easier to absorb into the soil and make the soil to become moisture [2].

Furthermore, some problems in construction can be occurred when dealing with problematic peat soil. For example, ditch or drain is easy to erode due to lack of stability. This is because the bearing capacity of peat is 0.5 [3], which is below in value of the safety factor which is in the range of 2.5 to 3.5 [4]. In addition, a serious problem also can occur which is landslide in the slope areas can give effect to fatal injuries especially in Sarawak. Landslides also happened due to the shear strength of peat is 5-20 kPa which is at a low level [5]. This is because, the higher the shear strength at the ground slide, the stronger it is to resist soil from movement. One of the factors is heavy rain can make soil be more moisture and easily eroded. The objectives of this study are to observe the value of shear strength from direct shear test, identify the value of shear strength of original peat and study the effect of various parameter of peat to the shear strength value.

2. Methodology

This project has been through systematic literature review (SLR) to collect some data and results from past research. The flowchart shown that three process would be used in this project which is identification, screening and eligibility process. Flow diagram in **Figure 1** below was construct consisting all the process taken.

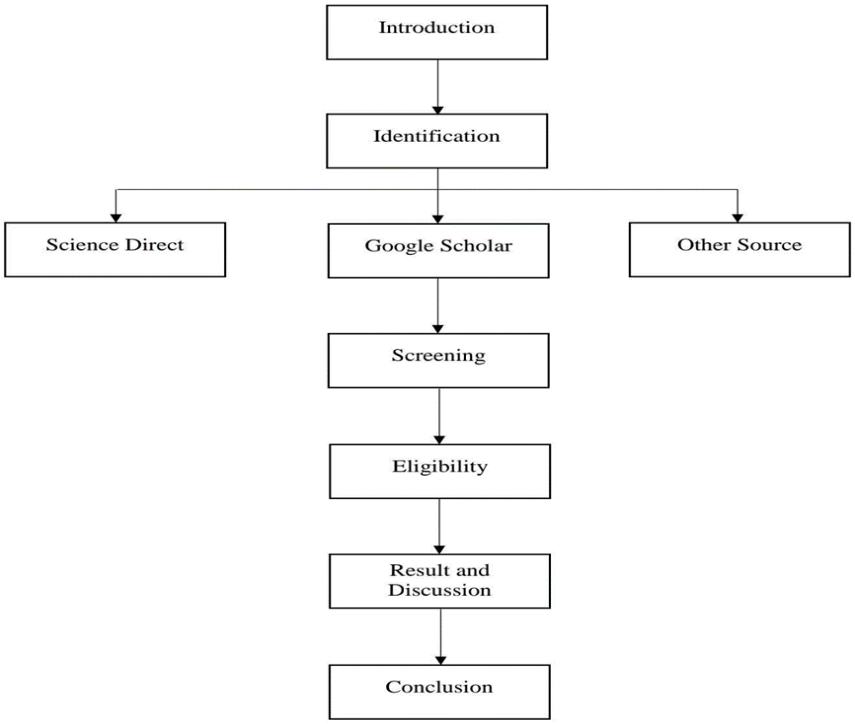

Figure 1: Flowchart

2.1 Resources

Several platforms used in this study to achieve the information as well as the objectives of this project. Among the platforms used are science direct, google scholar and others. Science direct is a good platform and most of them are journals from Q1, Q2 and Q3. Google scholar is also an easy-to-use platform to find information related to the study conducted. In addition, other sources also help to find additional information in this study.

2.2 Research question

In this project, research question has been determined and identified to accomplish the objectives in this study. Some of the question will guide and assist in collection the data and result that related in this project. The research question that has been addressed in this project were:

Q1 – What is the factors that influencing shear strength of peat soil?

Q2 – How the factors affecting the shear strength?

Q3 – What is the reason of changing in value of shear strength of peat?

Q4 – What is the conclusion for the factors that have been studied to the shear strength of peat

With respectively, Q1 is to determine the parameters that affect the value of shear strength while Q2 is to observe the value of shear strength collected from data whether it is affected by the factors or not. These questions will help in determining the factors influencing shear strength that suitable and related to this project. To make the data collected more solid, Q3 is to proving the factors that have been chosen with some valid reason. Lastly, Q4 will let this SLR proving that these parameters were the elements that affecting shear strength of peat.

2.3 Search process

Search process is the vital process in this project. This step is to find data, result and also reason from past research to support the statement that has been concluded in the result. This process will go through some steps to collect all of the data. Which are to find the related past research using Google Scholar, screening the data that suitable for this project and studied and conclude the data that has been collected.

2.4 Identification

Journal searches are performed on the google scholar, science direct and the others platform. The search of the journal with the main topic is Influence Factor of Shear Strength.

Table 1: Selected journals and conferences proceedings

Item	Source	Quartile
1	Journal of physical sciences	Q1, Q2
2	Pertanika Journal of science & technology	Q1
3	Geotechnical and Geological Engineering	Q1
4	ICE publishing	Q1, Q2
5	Journal of engineering and applied science	Q1
6	Geosciences journal	Q4
7	American journal of engineering and applied science	Q3
8	International peat congress	Q2

Table 1 show that the journal selected by finding.The keyword used in the search is shear strength. This because, shear strength is the main source in this research to know the influencing factors in shear strength. In this part, it is necessary to read the abstract in each journal to identify the journal related the keyword, then open in Mendeley to pass screening.

2.5 Screening

The screening phase is the phase in which the criteria are selected to find a suitable journal in a systematic literature review. All journals are observed through abstracts and small reviews. Next, the journal will be reviewed and divided into several items that have to do with this project as well as be able to answer questions for this project as in appendix 1.

Table 2: Journal related to the objectives

References	Type of Peat	Moisture Content	Organic Content	Initial Void Ratio	pH
Investigation on the shear strength characteristic at Malaysian peat [6]	✓				
Deformation and Shear Strength Characteristics of Some Tropical Peat and Organic Soils [5]	✓	✓			
A state of art review of peat: Geotechnical engineering perspective [1]		✓	✓		
A study of the effect of various curing techniques on the strength of stabilized peat [20]			✓		✓
Shear strength parameters of peat soil of district of Asahan by direct shear test [14]			✓		
Effect of compaction and direct shear test values on peat soil of Batubara Regency, Sumatera Utara Province [15]			✓		
Classification and effect of compaction on soil shear strength by direct shear test on peat soil of Tapanuli Utara Regency, North Sumatera Province [16]			✓		
Malaysian Experiences of Peat Stabilization, State of the Art [17]			✓		
Cement and Silica Fume Treated Columns to Improve Peat Ground [18]			✓	✓	✓
Comparison of Shear Strength Properties for Undisturbed and Reconstituted Parit Nipah Peat, Johor [19]				✓	
Sarawak Hemic Peat Consolidation Settlement And Shear Strength Behaviour [10]				✓	✓
Effect of Cement Additive and Curing Period on Some Engineering Properties of Treated Peat Soil [13]					✓

Table 2 shows the focused screening phase for the objectives of this study. The selected journal were collected from various medium and the screening process was conducted to achieve the objective of this study.

2.6 Eligibility

This phase is the phase for all the selected data to be studied to achieve the objectives of the study. This phase differs from the screening phase in that the screening phase will exclude some journals that do not meet the criteria. Each data needs to be studied to obtain appropriate parameters to find out the effect behind the shear strength of peat. All data studied are in the appendix.

3. Results and Discussion

This part of project performed all the data that have been collected in graph diagram. The chosen data and results were categorised into five parameter that would influenced the shear strength of peat such as different type of peat, moisture content, organic content, void ratio and pH value.

3.1. Effect of different type of peat to shear strength

Figure 2 show the relationship between type of peat and shear strength. From the result, it can be seen that fibric peat has the highest value of shear strength. In general, the high fibrous or fibric (H1 - H3) peat has higher shear strength than the medium fibrous or hemic (H4 - H6) peat and the low fibrous or sapric (H7 – H10) peat [5]. Also, This happens because of the shearing mechanism that imposed to specimen or due to the size of the specimen and the specimen handling manner [6].

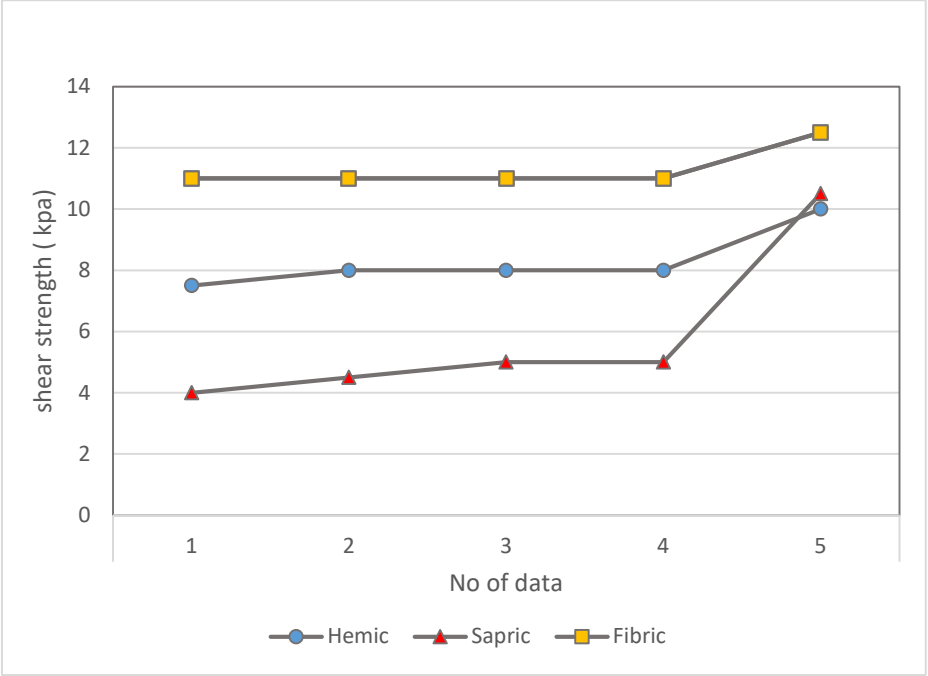

Figure 2: Relationship between different type of peat and shear strength of peat soil [5][6]

3.2 Effect of moisture content to shear strength

Figure 3 shows the effect of moisture content to the shear strength at different places. Each place had three original peat samples. This indicates that the moisture content has influenced the shear strength results. The value of shear strength decreases as the moisture rate increases. This is because the soil has a large space that makes it easier for water to enter. When water can get into the soil, it will result in the soil becoming more moist and the strength of the soil will decrease. The plot of moisture content against the shear strength of a propeller also has similar results [5]. Moisture content is one of the effect that influencing the shear strength. moisture content is one of the parameters that can affect the strength of the shear soil. Based on the previous studies, the peat soils have a high moisture content up to 1000%. Researcher stated that peat soils and organic soils could not do the hydration process due to the moisture content for this type of soil being relatively low. Such a thing will cause the shear strength to be affected by several parameters. It is also can be concluded that the higher the moisture content and decomposition, the less the soil shear strength [7]. Therefore, the shear strength is inversely proportional to the moisture content [1].

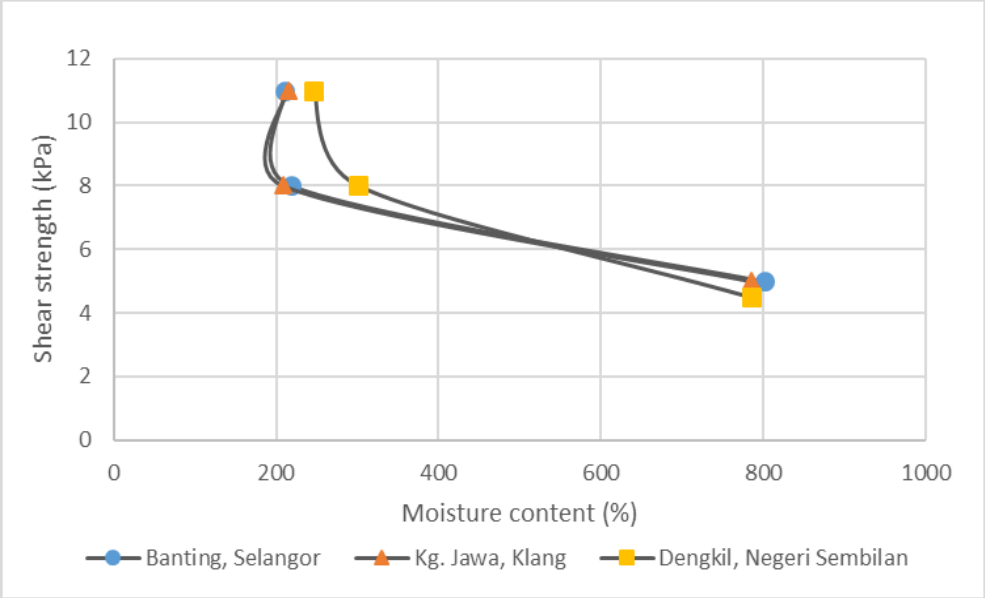

Figure 3: Relationship between moisture content and shear strength of peat soil [1][5]

3.3 Effect of organic content to friction angle

Figure 4 show relationship between organic content and friction angle.Based on the graph, it can be concluded that organic content with value lower than 100%, resulting in increasing of friction angle value while for the value of organic content more than 100%, the friction angle values tend to decrease. This is because the shear resistance of soil is a result of friction and interlocking of particles, and possibly cementation or bonding at particle contacts [8]. The angle of internal friction, ranges from 3°to 20°. The internal friction values are generally lower with increasing degree of humification [5]. So, it can be concluded that the value of friction decrease when percentage of organic content increase.

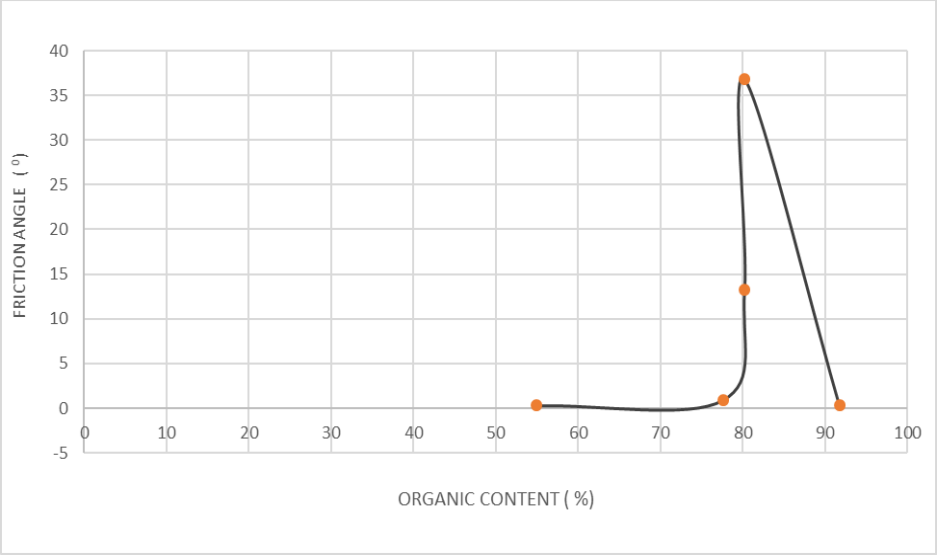

Figure 4: Relationship between organic content and friction angle [1][5][14-18]

3.4 Effect of initial void ratio to shear strength

Based on **Figure 5**, it shows the graph of initial void ratio against shear strength value. From the graph, it can be seen that the value of shear strength for peat is decreasing when the values of initial void ratio increase. This is because the peat with higher void ratio is more porous and high moisture content. This may cause in low value of shear strength since it has more space for water to fill in it [9]. It is also stated that due to large void ratios, peat has poor engineering qualities such as high compressibility and low shear strength, resulting in greater values of compression index and secondary compression in comparison to other soils [10]. The void ratio is the ratio of the volume of voids in the soil to the volume of solids. Peat has a larger vacancy ratio than organic soils in general, indicating that it has a high compressibility capability. It also stated that a natural void ratio of about 25 for fibrous peat, which usually varies from 5 to 15 [8]. When peat dries, it shrinks to half its original volume. The dried peat, on the other hand, will not swell up when re-saturated. However, because dried peat cannot absorb as much water as fresh peat, it will not swell upon re-saturation; only 33 to 55 percent of the water may be reabsorbed [11]. It is also stated that large pore gaps collapse during decomposition, and the void ratio decreases [8]. According from past research, the photographs that show the hollow structures of fibres by scanning electron micro-photographs, the peat sample has large pores that make the sample spongy and can hold a significant amount of moisture content in their structures that can reach up to 1000 percent, resulting in a high initial void ratio. The more the fibre content, the greater the moisture content and void ratio [5]. In conclusion, value of shear strength is inversely proportional to value of initial void ratio.

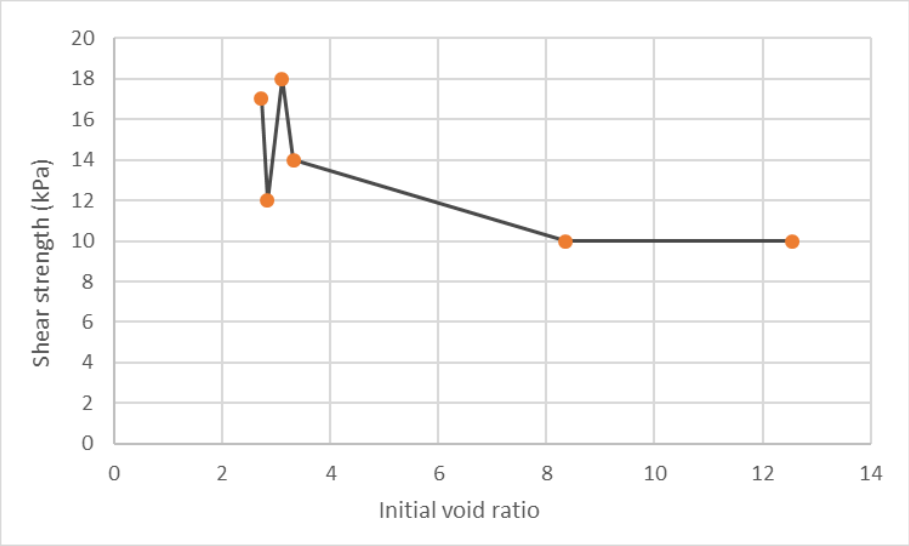

Figure 5: Relationship between initial ratio and shear strength of peat soil [10][18][19]

3.5 Effect of pH to shear strength

Based on **Figure 6**, it shows graph of pH value against shear strength of peat soil. There are five data of pH and shear strength values of original peat from different past research. From the graph, it can be seen that the value of shear strength is decreasing while pH value is increasing. This is because acids in the peat would reduce mineral and organic content. This has been proven as stated that pH for peat in their research which is Sarawak peat is reduced to range of 3 to 4 that is acidic and less in organic content [10]. Other than that, it is also stated that when the pH value rise, the value of shear strength will decrease as the particle is aggregated from charge of neutralization [12]. Peat soil's extremely acidic character results from the breakdown of organic matter, which is responsible for the release of organic and humic acids into the soil [13]. Furthermore, West Malaysian peats have relatively low pH values ranging from 3.0 to 4.5, and in some situations when sulphide elements are present within the profile, pH values can be lower than 3.0. Peat's acidity decreases with depth, and the drop may be significant towards the bottom layer depending on the kind of underlying soil. Besides, peats have a high capacity for ion exchange (CEC). The functional acid groups, often known as humic acids, are the major exchangeable sites. Ca2+, Mg3+, Al3+, K+, Na+, and (NH4)+ are the most frequent exchangeable cations in peats. Aho (1986) discovered that increasing the pH value and the exchangeable cation concentration increases the CEC. The CEC for fibrous peat is higher than that of other peats [11]. It also stated in past research that the value of shear strength would be influenced by the increasing of pH value [12]. In conclusion, value of shear strength is inversely proportional with pH value.

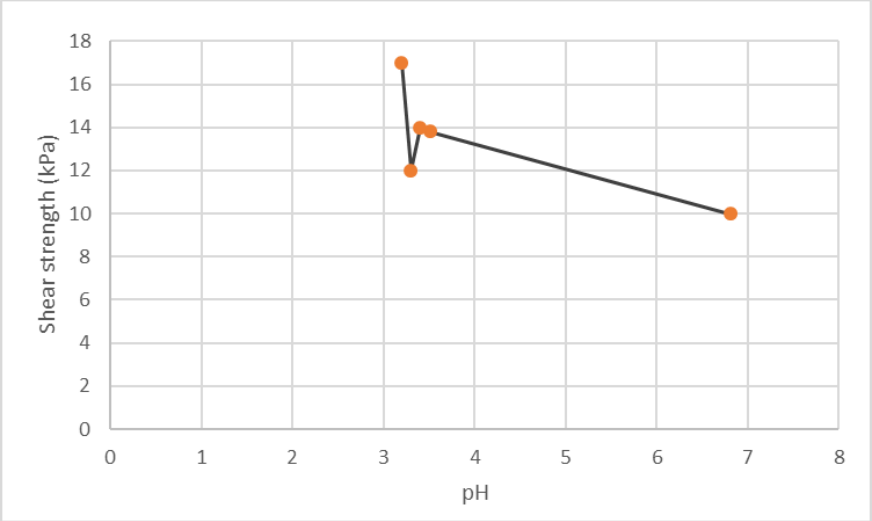

Figure 6: Relationship between pH value and shear strength of peat soil [10][13][18]

4. Conclusion

This project has studied the journals and articles to collect some data related to parameter of peat shear strength. Hence, the objectives of this project have been successfully accomplished. For the first objective, the value of shear strength could be obtain from past research that related to direct shear test study. This is because direct shear test would resulting in output of shear strength, τ and cohesion of soil, c. Other than that, the second objective is also achieved because all data that has been collected is from peat that has not been treated or stabilized by any binder. So, the peat can be classified as original peat and the value of its shear strength is valid to be used in this project. Lastly, the factors that affecting the shear strength of peat could be identified which is different type of peat, moisture content, organic content, void ratio and pH value. From the results, it can be concluded that the type of peat would influence the value of shear strength. For instance, hemic and fibric peat have a higher shear strength value than sapric peat. Furthermore, it also can be concluded from the results that the values of shear strength decrease when the moisture content, void ratio and pH values increase. Lastly, it can be determined from the result that value of friction angle decrease as the organic content increase. In conclusion, it is important to identify the parameters of peat soil that affecting the shear strength value to strengthen the peat soil.

Acknowledgement

The authors would like to thank the Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia (UTHM) for its support.

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Appendixes

Item		Researcher															
	(Kalantari & Prasad, 2014)	(Razali et al., 2018)	(Zainorabidin & Mansor, 2016)		(O'Kelly & Sivakumar, 2014)	Nima Latifi,Sumi Siddiqua and A. Marto3	Bujang B. K. Huat			Roesyanto* and A. S. Ritonga	Roesyanto* and Vini Rizki Eka Putri	Roesyanto and T Tarigan	Behzad Kalantari, Bujang B.K. Huat	ATS Azhar et al, 2016	Z.A. RAHMAN*, N. SULAIMAN, S.A. RAHIM, W.M.R. IDRIS & T. LIHAN	(Boobathiraja et al., 2014)	Sa'don, N. M., A. R. Abdul Karim, Z. Ahamad, and A. Mariappan. 2016.
Location	-	Parit Nipah, Johor	Penor, Pahang	Pontian, Johor	-	Kampung Bahru, pontian	Banting, Selangor	Kg. Jawa, Klang	Dengkil, N9	Asahan district, Sumatera Utara province	Paya Pinang Plantation, Sub-District of Laut Tador, Batubara Regency	Tapanuli Utara Regency	Kg. Jawa, Klang	Parit Nipah Darat, Batu Pahat, Johor	Kg. Tumbuk Darat, Sepang, Selangor	-	Matang
																	batu kawa
																	kota samarahan
Moisture content	417	605	-	-	1140	150	211	215	246	726.34	752.833	729.33	198-417	545	470-560	-	594
					590		219	209	301								856
					1065		802	786	786								607
					672		195	680	-								426
					-		832	747	-								-
					-		225	720	-								-
organic content	80.23	66	>75	>75	-	80	85	78	98	54.968	77.576	91.74	80.23	-	97.42	-	95
							94	89	98								-
							83	85	83								95

							79	85	-								89
							84	93	-								-
							85	83	-								-
pH	6.4	3.75	-	-	5.4	5.3	-	-	-	4	6	5.5	6.81	-	3.51	4.98	3.2
					3.8												3.3
					3.7												3.4
					3.6												-
Initial void ratio	12.55	-	-	-	-	11	-	-	-	3.672	3.908	5.604	12.55	8.36	-	-	2.72
																	3.104
																	2.83
																	3.318
Type of Peat	-	-	Hemic	Sapric	-	-	Fibric	Fibric	Fibric	high ash peat	high ash peat	medium ash peat	-	Hemic	Hemic	-	H4
							Hemic	Hemic	Hemic								H5
							Sapric	Sapric	Sapric								H4
							Fibric	Fibric	-								-
							Hemic	Hemic	-								-
							Sapric	Sapric	-								-
Shear strength (kPa)	14	-	11.527	9.015	-	-	10-12	11	9-13	-	15.4	-	-	-	13.8		-
			14.562	11.241			7-9	8	6-10		15.5						
			20.631	15.692			4-6	5	3-6		15.6						
			32.771	24.594			11	10-15	-		-						
			-	-			10	5-10	-		-						
			-	-			4	9-12	-		-						
cohesion (kPa)	0.5	-	8.259	6.79	-	-	9-11	10-12	13-17	19	15	19	10	10	-	-	17
							11-12	12-14	11								18
							6-10	7-11	8-9								12

							6-11	11-12	-							14
							8-10	10-12	-							-
							8-12	7-9	-							-
Internal friction angle (φ) (°)	36.6	-	22.6	21	-	-	9-20	6-14	3-12	0.295	0.885	0.375	13.31	16	-	-	25
							9-12	7-25	13-15								25
							12-20	8-13	12-20								32
							9-16	10-15	-								33
							7-10	5-10	-								-
							6-11	9-12	-								-