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Resistivity and Physical characteristic of Meranti's Peat

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Resistivity and Physical characteristic of Meranti's Peat

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Abstract. Peat physical properties (e.g. unit weight, water content, ash and fibre content) are different from mineral soil due to it high water and organic content. Traditional method requires laboratory test which is time consuming and costly. This study attempted to estimate peat physical properties based on its resistivity value. Peat samples were obtained from several locations and various depth using peat sampler in Lukun village at Meranti Distric, Riau Province. The resistivity value measured in the field using 4 pin soil resistance meter along with the determination of moist weight and unit weight. Laboratory tests were conducted on the sample. Statistical analysis was then performed to check whether there is correlation between field resistivity value and peat physical parameters. The result revealed that water content and dry unit weight are correlated to some degree with resistivity value but not for other parameters i.e. wet unnit weight, specific gravity and ash content.

1. Introduction

Peat is accumulation of partially decomposed vegetation and organic materials. Peat initially formed in basin or shallow lake which slowly filled with organic material from dead plant. Other peat areas could be developed in former river bed (usually has a high variability of peat depth) and the subsoil could still have trace of meandering river.

Peat soil has different physical properties compared to mineral soils e.g. sand, clay, silt. Water content (w) of peat soils could range 100->1000% while those of mineral soils usually less 100%. Carbon content of peat range from 18-60% whereas those of mineral soils range in 0.5-6% in upland areas, 8-20% in submerged wetland areas. Dry unit weight (γ_{dry}) of peat usually ranges 0.03-0.3 gr/cm3 whereas those of mineral soils range 0.6-1.6 gr/cm3. Typicall specific gravity (G_s) of peat is less than 2 whereas those of mineral soils usually range 2.65-2.8. Table 1 shows some of Indonesia's peat physical properties.

Peat physical properties are usually determined in the laboratory. For example ash fibre, content determination of peat are arranged in American Standard Testing Material (ASTM) D 1997 and D2974 respectively. The conventional method of laboratory work is time consuming and costly. This study is a preliminary work to estimate peat physical proprieties based on its resistivity value. Electrical resistivity has been used for successfully to determine peat thickness [1,2,3] thus reduce the number of traditional boring which in turn save time and cost.

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Table 1. Example of Indonesia's peat physical properties

Parameter	Sumatra			Borneo		Java
	Bolungkut [4]	Bagansiapiapi [4]	Bengkalis [5]	Tapanuli selatan [6]	Palangkaraya [7]	Rawa Pening [8]
G_s	1.38	1.81	1.64	1.74	1.37	1.67
γ_{wet}(kN/m3)	14.26	11.30	11.46	12.84	9.72	9.60
γ_{dry}(kN/m3)	2.34	1.57	-	3.63	1.36	4.61
w(%)	511.95	624.33	191.73	251.81	670	279.70
Ash (%)	1.46	5.46	53.33	52.73	2	28.38
Fibre (%)	5.12	30.99	69.77	57.80	59.6	39.272
Organic (%)	20.62	94.54	-	47.27	98	71.62

2. Methodology

2.1. Location

The location of this study is in Tebing Tinggi Island, Meranti distric, Riau Province-Indonesia which is closely border with Malaysia and Singapore. Tebing Tinggi island is located at eastern coastal of Sumatra Island with coordinate about 0° 42′ 30″ – 1° 28′ 0″ N, dan 102° 12′ 0″ – 103° 10′ 0″E . Figure 1 shows the location of the study. Based of the geological map, the lithology of the location is quatenary alluvial composed of clay, silt, clean gravel, vegetation raft and peat swap.Aquifer can be classifed as moderate to low transmissivity, depth to water table varies and well generally yield less than 5 liter/sec[10].

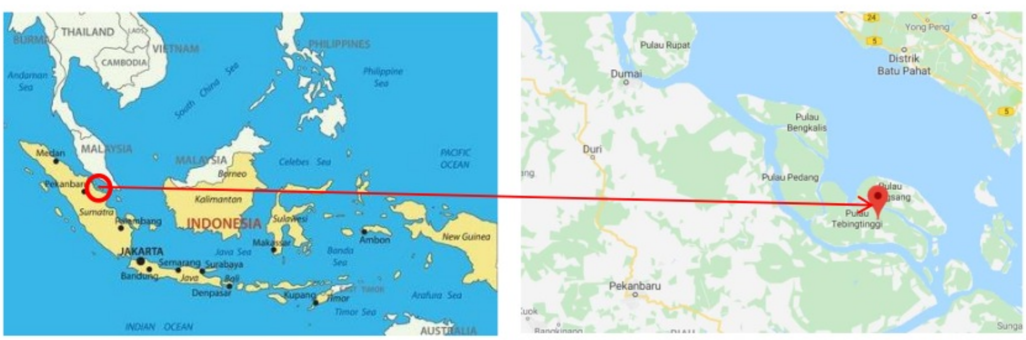


Figure 1. Location of study

2.2. Equipment

There are three main equipment used in this study i.e. peat sampler, soil resistance meter and laboratory apparatus. More information about the equipment is described in the following sub section.

2.2.1. Peat Auger. Russian type peat auger "Eijkelkamp' was used in this study as shown by Figure 3. It consists of peat sampler, extension rods and rotating handle. The peat sampler consists of hooked blade(fin) and half cylindrical tube (gouge) that has sharp edge to cut peat. Initially gouge is open and when the rod handle is rotated it close and cover the cut peat sample . Sample was obtained at interval 50cm.

Figure 2. Peat auger Russian type

2.2.2. Soil resistance meter. The 4 pin soil resistance meter used in this study is Nilsson S400 with 12 V battery, sample box, electrode for current and voltage and cable.Two electrode used to inject current to the soil sample in the box and two electrode is used to measure the voltage.

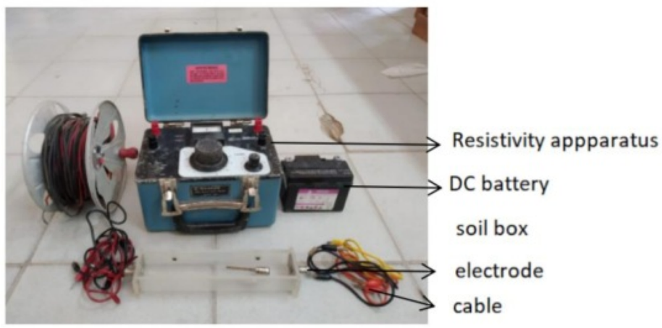


Figure 3. Soil resistance meter Nilsson S400

2.2.3. Laboratory apparatus. Laboratory apparatus used in this study are pocket and laboratory scale to weight sample, oven to measure water content, furnace to measure ash content.

2.3. Procedure
The locations of peat sampling were chosen close to observational wells used to monitor the ground water level as part of larger project to investigate the effectivenes of canal blocking. Once the sample is taken to the surface (interval 50 cm), the soil box is carefully pressed down into the soil so it fill the volume of soil box. The cable and electrode then are connected to the soil box and resistivity apparatus and battery. Resistivity value then is measured so the voltage reading is zero. The sample then transferred to a labeled plastic bag. A small sample is taken from the peat sampler using plastic ring (known volume), weigh it using pocket scale, thus the moist weight can be measured which later oven in the laboratory to get the moist unit weight and water content. The leftover sample is put in the labelled platic bag for other laboratory test e.g. specific gravity, ash content, fibre content.

3. Results
In total boring using peat auger were conducted at nine (9) locations with depth range from 0- 4.5m. Visual observation from peat samples from all locations can be classified as fibric (young degree of decomposition) as we can still some trace of plant material (Figure 4).

Figure 4. Peat sample

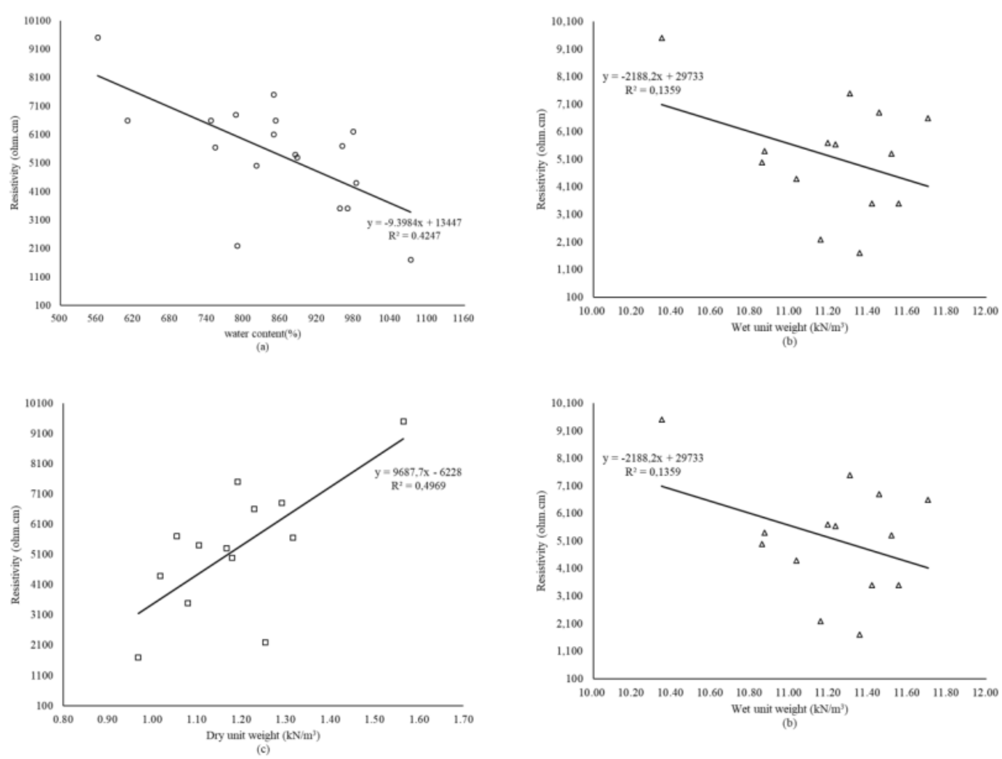
Table 2 shows results from 8 locations of field resistivity tests along with their physical properties. The table shows that resistivity values range from 670-14000 ohm cm. Those values are comparable with values from previous researcher [1,3]. It can be seen also that generally resistivity values decreases with depth. Specific value ranges from 1.29-1.69. The majority of ash content values are less than 10% (0-8.3%) indicating relatively high organic content. This results in inline with visual observation that generally the peat is fibric.

Table 2. Results

ID	Depth (cm)	Resistivity (ohm.cm)	Water content (%)	Wet unit weight (kN/m^3)	Dry unit weight (kN/m^3)	Spesific Gravity	Ash content (%)
BH-1	0 - 50	12000	405.48	na	na	1.56	1.56
	50 - 100	6600	609.51	na	na	1.44	1.89
	100 - 150	6600	745.80	na	na	1.44	2.35
	150 - 200	6900	1014.43	na	na	1.50	8.33
	200 - 250	6200	978.08	na	na	1.63	1.36
	250 - 300	6100	847.85	na	na	1.62	2.99
BH-2	0 - 50	11100	545.71	8.42	1.30	1.45	1.83
	50 - 100	14000	629.70	9.16	1.25	1.59	1.35
	100 - 150	5000	820.00	10.86	1.18	1.47	0.94
	150 - 200	5000	3010.34	11.21	0.36	1.51	0.00
BH-3	150 - 200	5650	752.83	11.23	1.32	1.63	7.41
BH-4	50 - 100	5500	523.74	10.77	1.73	1.67	5.56
	100 - 150	4400	982.93	11.03	1.02	1.69	2.15
	150 - 200	4950	455.29	11.73	2.11	1.58	2.17
BH-5	0 - 50	9500	561.11	10.35	1.57	1.69	3.25
	200 - 250	5700	960.00	11.19	1.06	1.59	2.04
	250 - 300	2200	789.11	11.16	1.25	1.60	3.73
	300 - 350	670	892.05	10.85	1.09	1.57	5.65
BH-6	250 - 300	6600	851.52	11.70	1.23	1.58	3.33
	300 - 350	3500	968.97	11.55	1.08	1.45	2.86

	350 - 390	1700	1071.79	11.35	0.97	1.40	5.00
BH-7	300 - 350	5400	883.15	10.87	1.11	1.60	1.40
	350 - 400	3,500	956.32	11.42	1.08	1.60	2.65
	400 - 450	1,500	1095.00	11.88	0.99	1.82	41.01
BH-8	250 - 300	5,300	886.17	11.52	1.17	1.34	0.98
BH-9	350 - 400	7,500	847.92	11.30	1.19	1.48	6.67
	400 - 450	6,800	786.54	11.45	1.29	1.29	8.11

Statistical analysis then was performed on table 2. Outlier data were removed using outlier function in microsoft excel. Statistical result is visualized in Figure 5. Linier regression was chosen due to its simplicity and practility in addition higher coefficient determinnation R^2 that other regression model. In general intermediate correlations with R^2>0.4 found between water content and dry unit weight and resistivity values. The relatively low R^2 might be due to fact that the majority of the peat in this study has same degree of decomposition i.e. fibric thus less variation. Figure 4a shows that increasing water content decreases resistivity value. This is reasonable considering that water has a good electrical conductor. Similar trend was found also in mineral soils. Figure 4c higher dry unit weight increases resistivity value. This may be explained that solid material of peat (including fibrous material) has relatively large resistance. On the other hand there are weak or no correlation between resistivity value with other physical parameters i.e. wet unit weight, specific gravity and ash content.



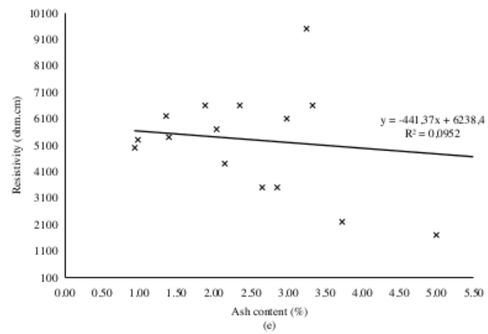


Figure 5. Resistivity value versus peat physical properties

4. Conclusions

An attempt to estimate physical peat properties from field resistivity value has been conducted. It was found the water content and dry unit weight has some degree of correlation with resisitvity value. Whereas weak correlation is found with wet unit weight specific gravity, ash content. Further study i.e. more data is required to make more useful correlation between resistivity value and peat physical properties. Other hipotesized physical parameters such pH will be investigated later.

Acknowledgments

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