International Journal of Technology and Education Research

https://e-journal.citakonsultindo.or.id/index.php/IJETER

E-ISSN: 2986-0733

Identification Structure Layer Land And Rock In Land Peat Use Geoelectric Method And Mechanical Test For Infrastructure Planning In Nagasaribu Village

Juliper Nainggolan[1], Santi Lorensa Junita Sianturi[1], Juniar Hutahaean[2]

[1]Pendidikan Fisika, Fakultas Keguruan dan Ilmu Pendidikan, Universitas HKBP Nommensen Pematangsiantar, Indonesia
[2,3] Jurusan Fisika, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Negeri Medan,Indonesia

Corresponding Author: santisianturi078@gmail.com

Abstract

Peatlands with complex physical and mechanical characteristics, such as low bearing capacity, high compressibility, and high water content, peat layers can cause problems in infrastructure planning and development. Consequently, to enable safe and sustainable infrastructure planning, a thorough study of the structure of the soil and subsurface rock layers is required. This study aims to determine the resistivity values of soil layers, rocks and soil shear strength tests in the peatlands of Nagasaribu Village and then relate them to the feasibility of infrastructure development in Nagasaribu Village. This study was carried out using the geoelectric method using the ARES-G4 v4.7 SN: 0609135 tool with a Schlumberger configuration. Furthermore, the results of the geoelectric interpretation were linked to soil mechanical test data, which include cohesion and friction angle of the peat soil. The results of the identification of soil and rock layer structures along the first, second, and third routes are dominated by Peat, Sand, Lanau Rock, Claystone, Alluvium, Sandstone, and Gravel, Shale, and Limestone. Based on the soil and rock layer structures along the first, second, and third routes, it is suitable to construct buildings according to local geological conditions. From the soil shear strength test results, soil samples from the first route fall into the very loose category, the second route into the somewhat dense category, and the third route into the very dense category. The information obtained can be used as a reference to determine the appropriate type of foundation to reduce the possibility of damage to buildings in peatland areas.

Keywords: Peatland, Resistivity, Schlumberger Configuration, Direct Shear Test

INTRODUCTION

Peat soil is soil that is formed due to the accumulation of degraded organic material, some parts may still be recognizable, while others have changed (Alfaiz & Hutahaean, 2017). until resemble fossil. This matter shows the presence of a combination of organic material

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

fragments originating from plants that have undergone chemical changes in properties and transformed into fossils (Hartini et al., 2022).

According to Muliadi et al. (2020), Indonesia has a large amount of peatland, making it an important ecosystem that stores a lot of carbon and helps maintain environmental balance. In Indonesia, peatland is very widespread, estimated at 14.9 million hectares. Of the total 14.9 million hectares of peatland, 43% are in Sumatra, 32% in Kalimantan, and 25% in Papua. Peatland in Sumatra has an estimated area of between 7.3 and 9.7 million hectares, this amount is equivalent to a quarter from overall wide tropical peat (Muhjad & Redhani, 2023).

Village Nagasaribu Which located in North Sumatra, specifically in Humbang Hasundutan Regency, Lintong Nihuta District, the research location, has a fairly extensive peatland area of approximately 100 hectares. However, the peatland in this area has not been optimally utilized by the community and the government, as development in this area faces challenges due to a lack of data on subsurface structures. Uncertainty regarding the thickness and arrangement layer land And rock in landPeat can lead to planning errors, which ultimately impact the quality and sustainability of infrastructure (Muliadi, 2019).

The foundation of a building is the lowest part from structure building Which The foundation serves as the primary support. It supports the entire building load and safely transfers it to the ground. If the foundation is weak, the building can easily crack, subside, or even collapse. When discussing subsidence, the bearing capacity of the soil and foundation settlement are typically considered, as they are closely related. with structure building Which built above it. Peat soil is a type of soil formed from a collection of organic material that has not yet fully decomposed. Its main characteristics are numerous pores, abundant water, and low bearing capacity (Rashita & Wulandari, 2025). This condition makes peat soil susceptible to subsidence, both naturally due to the decomposition of organic material and due to drying and the weight of the soil above it. This subsidence makes peat soil unstable and less suitable for development. Therefore, the people of Nagasaribu Village, which has a peatland area, are reluctant to build buildings or houses. in land the. Foundation something A building is considered suitable if there is a layer of bedrock Which the crack filled land dry with a resistivity value above 300 Ω m. After that, the soil compaction process is carried out to increase the strength of the soil as a support for the building foundation ("Building Foundation Construction Activities," 2020)

The geoelectric method is one of the geophysical techniques. Which used For know The electrical properties of rock layers beneath the ground surface. This method works by passing an electric current into the ground (Tampubolon, 2023). Variations in resistivity values can be used to determine the type of layer, the thickness of the peat soil, and the presence of underlying mineral layers (Tampubolon, 2023).

The Schlumberger configuration has a weakness in measure different potential which tends to be lower, especially when the current electrode distance is greater (Chen, 2020). However, its advantage is its ability to detect uneven rock layers on the surface by comparing apparent resistivity values when the current electrode distance is changed. The geoelectric

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

method with the Schlumberger configuration is the most frequently used technique for know thickness And mark resistivity of rocks below the surface (Alfaiz & Hutahaean, 2017). Although the geoelectric method is very effective in identifying the structure of soil and rock layers in peatlands, soil mechanical testing is also needed, namely the Direct Shear Test, to demonstrate the soil's ability to withstand shear forces due to building loads ("South Kalimantan's Economy Grew 4.81 Percent in the First Quarter of 2025," 2025).

Testing strength shift direct Shear Test) is carried out in the laboratory to determine the ability of the soil to withstand pressure without cause collapse (Schlichting et al., 2002). Cohesion (c) and the internal friction angle (ϕ) are parameters obtained from the direct shear strength test (Rashita & Wulandari, 2025). Data test strong Direct shear can be used as a basis for evaluating soil stability before construction and as a reference for improving land If parameter strong the shear is not sufficient to support the planned structural load (Abdel-Salam, 2018).

Infrastructure development in the form of buildings on peatlands can utilize currently unproductive peatlands, particularly due to their geostrategic location along the North Sumatra highway (Min et al., 2017). Infrastructure development can provide residential and business space for the community, potentially supporting local economic activity (Sikumbang, 1994).

METHOD STUDY

This research was conducted in Nagasaribu Village, Lintong Nihuta District, Humbang Hasundutan Regency, North Sumatra Province. The peatland covers an area of approximately 100 hectares, located between 2.24° N and 98.90° E. The research procedure is as follows:

1. Conduct a direct review of the location to be researched.
2. Determine 3 paths (2 parallel, 1 cross), set coordinate points with GPS, and install measuring stakes with a spacing between electrodes of 5 meters.
3. Prepare acquisition forms for field data recording.
4. Install 32 electrodes on the stakes according to the configuration, then connect them to the Resistivity Meter terminals.
5. Conducting data collection using the ARES-G4 V4.7 tool with the Schlumberger configuration geoelectric method .
6. Stream current electricity For measure the potential value (V) and current strength (I), then record the results on the form (Morishita & Kawahigashi, 2016).
7. Repeat the measurement process systematically until all over point on the track is finished being taken.
8. Download all raw data from the ARES-G4 tool to the computer.
9. Exporting measurement data into Res2Dinv software.

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

International Journal of Technology and Education Research

https://e-journal.citakonsultindo.or.id/index.php/IJETER

E-ISSN: 2986-0733

10. Processing data using Res2Dinv to produce a 2D subsurface resistivity cross-section model.
11. Do analysis to model cross section For interpreting subsurface structures in the area study.

Next is the taking of soil samples at each geoelectric method track as many as 3 samples by digging the soil to a depth of 20 cm at the sampling location point, then the samples are taken (Olatinsu et al., 2025). with use pipe PVC measuring 4 inches and then closed using a pipe cap at the end of each pipe to keep the sample structure unchanged. Sample Which Already taken next will be done test strong shift (direct shear test). The results of the soil shear strength test analysis are used as a consideration for interpretation analysis (Kurlov & Marcovic, 2023).

The data that has been obtained is then analyzed And interpreted For to obtain appropriate results. At this stage, the interpretation of the geoelectric data is correlated with the geological map and the material resistivity table. Data sample land Which has analyzed using shear strength tests used to support data interpretation results (Indahyani et al., 2017).



Picture 1. Diagram Flow Retrieval Geoelectric Method Data

RESULTS AND DISCUSSION

Results of Analysis and Interpretation of Geoelectric Trajectory Data

Has done data retrieval with tools geoelectricity (Resistivity Meters), ARES-G4 v4.7 SN:0609135 (Automatic Resistivity System) and by using GPS (Global Positioning System) in every track Which Already determined (Comas et al., 2005). To determine the distribution model of subsurface resistivity values in the research area, done processing dataRes2DINV software to obtain a two-dimensional cross-sectional model that describes the depth and distribution of actual resistivity values (Wahyunto & Subagjo, 2004).

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

International Journal of Technology and Education Research

https://e-journal.citakonsultindo.or.id/index.php/IJETER

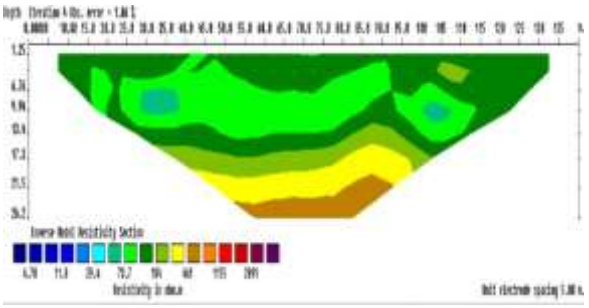
E-ISSN: 2986-0733

Table 1. Position Coordinate Third Track

Information	Latitude	Longitude	Elevation (masl)
Track 1			
Electrode 1	2.252047	98.892128	1410
Electrode 32	2.251733	98.893650	1414
Track 2			
Electrode 1	2.252019	98.892131	1417
Electrode 32	2.252056	98.893711	1419
Track 3			
Electrode 1	2.251847	98.892814	1418
Electrode 16	2.25258	98.89273	1413

After the measurement data is processed using Res2dinv software and produces cross section 2 dimensions next to be done method analysis with using color gradation. Two-dimensional cross-section of the results of data processing with Res2dinv software show mark prisoners type which is visualized in different colors to show the resistivity values in each subsurface layer (Samuel Obeng et al., 2023).

Based on the results of 2D modeling on the first track, there was an error value of 1.86% with a track length of 155 meters and a depth of 26.2 meters. The results of data processing using software Re2dinv obtained Resistivity values range from 4.70 Ω m to 2891 Ω m. Data on the first track were inverted using Re2dinv software. which produces a pseudosection in Figure 2 (Phiranram et al., 2024).



Picture 2. Cross-section 2D Track 1

At a depth of 6.76 meters to 9.94 meters Which own mark resistivity 4.70 – 29.4, which is most likely claystone and alluvium, while at a depth of 1.25 meters to 17.3 meters, it is likely peat, sand, and siltstone. At a depth of 17.3 meters to 26.2 meters, it is likely sandstone, gravel, and shale. According to the measurement data, this first track is dominated by layers estimated

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

International Journal of Technology and Education Research

https://e-journal.citakonsultindo.or.id/index.php/IJETER

E-ISSN: 2986-0733

to be peat, siltstone, and sand.

Based on the results of the interpretation of geoelectric data, not all areas are suitable for infrastructure development, so development is only recommended at certain distances. On track 1, a resistivity value of 461 Ω m - 2891 Ω m was obtained, allowing for the construction of buildings at a distance of 40 m -100 m (Maulida, 2022).

On the second track there was an error value of 13.7% with a track length of 155 meters and a depth of 17.3 meters, with the resistivity value of the second track consisting of eight layers. that is 4.70 Ω m, 11.8 Ω m, 29.4 Ω m, 73.7 (Deshmukh, 2021).

Ω m, 184 Ω m, 461 Ω m, 1155 Ω m, 2891 Ω m which are visualized by different colors at each resistivity value.

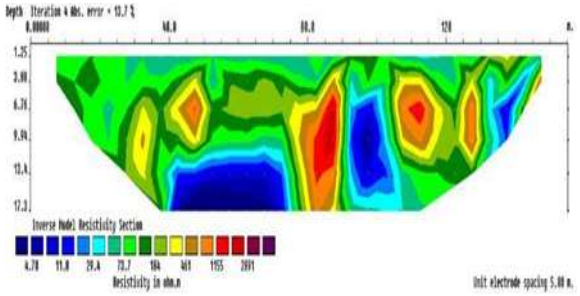


Figure 3. 2D Cross-section of a 2-Layer Track with mark resistivity between 4.70 Ω m, 11.8 Ω m, 29.4 Ω m Which located

The depth of 3.88 meters – 17.3 meters is interpreted as claystone. Meanwhile, the next layer with a resistivity value of 73.7 Ω m, 184 Ω m located at a depth of 1.25 meters – 17.3 meters is interpreted as claystone. as land peat And siltstone (Iqbal et al., 2021). Whereas on layer with mark 461Ω m, 1155 Ω m, 2891 Ω m located at a depth of 3.88 meters – 17.3 meters are interpreted as Sandstone, Gravel, Shale, Limestone (Mirwan et al., 2019).

Based on the results of the interpretation of geoelectric data, No all over area worthy Forinfrastructure development, so that construction is only recommended at certain distances. On route 2, a resistivity value of 461 Ω m - 2891 Ω m was obtained, allowing for the construction of buildings. on distance 30 m - 50 m, 75 m – 90 m, 105 m – 135 m (Maysarah et al., 2021).

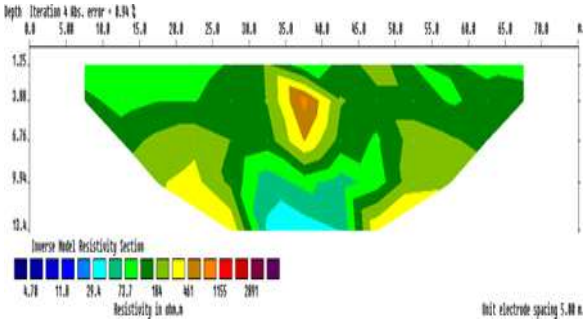
Based on the results of 2D modeling on the second path, there are The error value is 0.94% with a track length of 155 meters and a depth of 13.4 meters. The results of data processing using software Re2dinv obtained Resistivity values range from 4.70 Ω m to 2891 Ω m. Data from the first trajectory were inverted using Re2dinv software, resulting in the pseudosection in Figure 4.

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

International Journal of Technology and Education Research

https://e-journal.citakonsultindo.or.id/index.php/IJETER

E-ISSN: 2986-0733



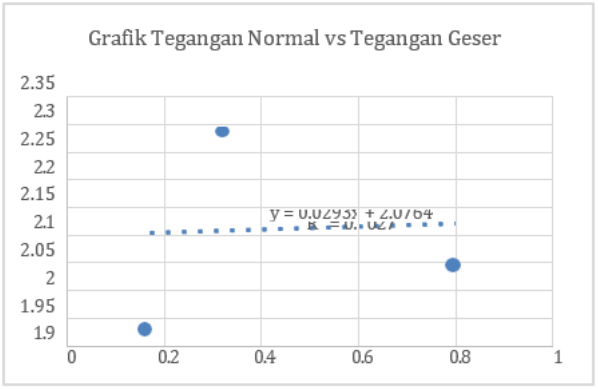
Picture 4. Cross-section 2D Track 3

At a depth of 9.94 meters to 13.4 meters Which own mark resistivity 4.70 – 29.4 meters, which is most likely claystone and alluvium, while at a depth of 1.25 meters to 9.94 meters, it is likely peat, sand, and siltstone (Akinyemi et al., 2022). At a depth of 3.88 meters to 13.4 meters, it is likely sandstone, gravel, shale, and limestone. According to the measurement data, this first track is dominated by layers estimated to be sandstone and siltstone (Dirga Subardi et al., 2022).

Based on the results of the interpretation of geoelectric data, not all areas are suitable for infrastructure development, so development is only recommended at certain distances. On route 3, a resistivity value of 461 Ω m - 2891 Ω m was obtained, meaning that buildings can be constructed at a distance of 2891 Ω m. 18 m -28 m, 34 m – 42 m (Kanyawan & Zulfian, 2020).

Results Test Strong Shift Direct

Testing swipe directly (Direct Shear) produces a shear strength value from the relationship between normal stress and soil shear stress. For produce corner shift Which precisely, each sample was tested three times with loadsof 5 kilograms, 10 kilograms, and 25 kilograms (Safrizal et al., 2017).



Picture 5. Chart Connection Voltage Normal and Shear Stress of Line 1

The results of the shear strength test on the first path of peat soil showed a cohesion value (c) of 1.984 kg/cm2. and angles internal friction of 1.66°. These values indicate that the

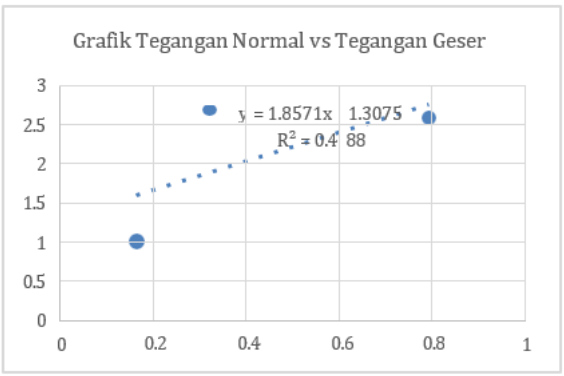
Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

International Journal of Technology and Education Research

https://e-journal.citakonsultindo.or.id/index.php/IJETER

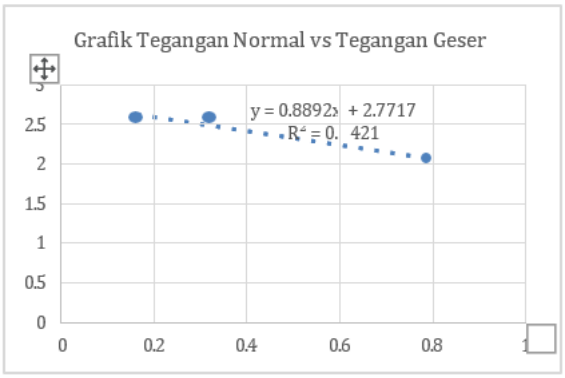
E-ISSN: 2986-0733

soil in the first pass has a low internal friction angle and frictional force interparticle low land (Huda et al., 2022).



Picture 6. Chart Connection Voltage Normal and Shear Stress of Path 2

The results of the direct shear strength test conducted on the second track showed an internal friction angle (ϕ) of 61.69° and a cohesion (c) of 1.857 kg/cm2. These friction angle and cohesion values are quite high, indicating that the soil has good interparticle friction capacity to withstand shear forces (Razmyar & Eslami, 2017).



Picture 7. Chart Connection Voltage Normal and Shear Stress of Path 3

Based on the results of the direct shear strength test, the internal shear angle (ϕ) value was 41.64° and the cohesion (c) was 2.768 kg/cm2. The magnitude of the soil shear strength parameters in the third track sample was classified as high (Agus et al., 2016).

CONCLUSION AND SUGGESTION

Peatlands own resistivity value between 4.70 Ω m – 2891 Ω m. On resistivity 4.70 Ω m – 29.4 Ω m is dominated by a layer structure of Claystone, Alluvium for a resistivity value of 73.7 Ω m – 184 Ω m dominated by Peat, Sand, Siltstone and... 461 Ω m – 2891 Ω m dominated as sandstone, gravel, shale, and limestone. Based on the structure of the soil and rock layers on the first, second, and third passes, it is suitable for building construction based on local

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

geological conditions.

Based on the results of the peat soil shear strength test on the first track, the value obtained was cohesion 1,984 kg/cm2 And corner shift in 1.66° including in category very off. On the second track, the cohesion value was 1.857 kg/cm2 and the internal friction angle was 61.69° including in category very congested and for the third path, the cohesion value obtained was 2.768 kg/cm2 and the internal friction angle was 41.64°, which is included in the slightly dense category It is recommended that peat soil mechanical tests be combined with other laboratory tests, such as consolidation and permeability tests, to determine the physical and mechanical characteristics. land peat can known in a way comprehensive For help infrastructure planning

REFERENCE

Abdel-Salam, A. E. (2018). Stabilization of Peat Soil using Locally Admixture. HBRC Journal, 14(3), 294–299. https://doi.org/10.1016/j.hbrcj.2016.11.004

Agus, F., Anda, M., Jamil, A., & Masganti. (2016). Indonesian Peatlands: Formation, Characteristics and Potential to Support Food Security. Indonesian Agency for Agricultural Research and Development Press.

Akinyemi, S. A., Adebayo, O. F., Madukwe, H. Y., Aturamu, A. O., & OlaOlorun, O. A. (2022). Mineralogy and Geochemistry of Shales of Mamu Formation in Nigeria: Effects of Deposition, Source Rock, and Tectonic Background. In H. M. Saleh & A. I. Hassan (Eds.), Geochemistry and Mineral Resources. IntechOpen. https://doi.org/10.5772/intechopen.102454

Alfaiz, A., & Hutahaean, J. (2017). Determination of Hard Layers for the Feasibility of Multi-Storey Building Construction Using the Geoelectric Resistivity Method on the Kanoha Coast, Central Tapanuli Regency. Einstein Journal, 5(3), 1–7.

Building Foundation Construction Activities. (2020). Journal of Applied Physics, 3(1), 99–106.

Chen, X. (2020). Diatom-Based Water-Table Reconstruction in Sphagnum Peatlands of Northeastern China. Water Research, 174. https://doi.org/10.1016/j.watres.2020.115648

Comas, X., Slater, L., & Reeve, A. (2005). Geophysical and Hydrological Evaluation of Two Bog Complexes in a Northern Peatland: Implications for the Distribution of Biogenic Gases at the Basin Scale. Global Biogeochemical Cycles, 19(4). https://doi.org/10.1029/2005GB002582

Deshmukh, C. S. (2021). Conservation Slows Down Emission Increase from a Tropical Peatland in Indonesia. Nature Geoscience, 14(7), 484–490. https://doi.org/10.1038/s41561-021-00785-2

Dirga Subardi, F., Yusa, M., & Darmayanti, L. (2022). Study of the Physical Properties of Peat Land Against Electrical Resistivity using Geoelectrical Instruments (Case Study: Lukun Village, Tebing Tinggi Timur District, Meranti Islands Regency). Sainstek (e-Journal), 10(1), 60–66. https://doi.org/10.35583/js.v10i1.217

Hartini, Sutejo, Y., & Hadinata, F. (2022). Shear Strength of Fibrous Peat Soil in Ogan Ilir Regency.

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

Syntax Literacy: Journal Scientific Indonesia, 7(9), 13497–13508.

Huda, N., Mariana, Z. T., & Ifansyah, H. (2022). Characteristics of Transitional Peat and Inland Peat of South Kalimantan at the Hemic Decomposition Level. Acta Solum, 1(10), 36–40. https://doi.org/10.20527/actasolum.v1i1.1385

Indahyani, S., Sumawinata, B., & Darmawan, D. (2017). Measuring Peat Soil Water Retention using a Combination of Three Phase Meters and Ceramic Plates. Buletin Tanah Dan Lahan, 1(10), 9–14.

Iqbal, O., Padmanabhan, E., Mandal, A., & Dvorkin, J. (2021). Characterization of Geochemical Properties and Factors Controlling the Pore Structure Development of Shale Gas Reservoirs. Journal of Petroleum Science and Engineering, 206. https://doi.org/10.1016/j.petrol.2021.109001

Kanyawan, O. E., & Zulfian, Z. (2020). Identification of Subsurface Layer Structure using Geoelectric Resistivity Method as Initial Information for Building Foundation Design. PRISMA FISIKA, 8(3). https://doi.org/10.26418/pf.v8i3.43675

Kurlov, D., & Marcovic, T. (2023). Experimental Study of Improving The Physical Properties of Peat Soil using Sand and Bio-Grouting Techniques with the Assistance of Bacillus Subtilis Bacteria. Journal of Geoscience, Engineering, Environment, and Technology, 8(1), 69–76. https://doi.org/10.25299/jgeet.2023.8.1.13464

Maulida. (2022). Not Just Once, here's a List of Buildings in South Kalimantan That Suddenly Collapsed. Peristiwa Online.

Maysarah, S., Nugroho, Y., & Susilawati, S. (2021). Analysis of Physical Properties of Soil on Peat Land in Liang Anggang District, Banjarbaru City, South Kalimantan Province. Jurnal Sylva Scienteae, 4(1). https://doi.org/10.20527/jss.v4i1.3104

Min, X., Li, Y., Ke, Y., Shi, M., Chai, L., & Xue, K. (2017). Fe- FeS2 Adsorbent Prepared with Iron Powder and Pyrite by Facile Ball Milling and its Application for Arsenic Removal. Water Science and Technology, 76(1), 192–200. https://doi.org/10.2166/wst.2017.204

Mirwan, A., Putra, M. D., & Lestari, R. A. (2019). Potential Peat Clay for Minerals Source Utilized as Adsorbent and Catalyst. MATEC Web of Conferences, 280. https://doi.org/10.1051/matecconf/201928004003

Morishita, M., & Kawahigashi, M. (2016). Heterogeneity in Peat Decomposition Evaluated by Fourier Transform Infrared Micro-spectroscopy. 15th International Peat Congress, 132–135.

Muhjad, H., & Redhani, M. (2023). Peat Ecosystem Protection and Management Law. CV. Star Universe Media.

Muliadi, M. Z. (2019). Identification of Peat Soil Thickness Based on 3D Resistivity Values: A Case Study of the Batu Layang Final Disposal Area in Pontianak City. Positron, 9(2), 86–94.

Olatinsu, O. B., Olawusi, S. O., & Ogieva, M. O. (2025). Electrical Resistivity Characterization of Peat and Clay Profiles at a Suburb of Ota, Southwest Nigeria. Communication in Physical Sciences, 12(1), 84–102. https://doi.org/10.4314/cps.v12i1.8

Phiranram, T., Chenrai, P., Jirapinyakul, A., & Rachukarn, N. (2024). Geophysical and Chemical

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

Characteristics of Peatland in Coastal Wetland, Southern Thailand. Frontiers in Marine Science, 11. https://doi.org/10.3389/fmars.2024.1287362

Rashita, R., & Wulandari, S. (2025). Analysis of Clay Soil Stability Using Xanthan Gum Additives. Journal Technique Civil, 21(1), 158–173.

Razmyar, A., & Eslami, A. (2017). Geotechnical Characterization of Soils in the Eastern and Western Areas of Tehran. Engineering, Technology & Applied Science Research, 7(4), 1802–1810. https://doi.org/10.48084/etasr.1200

Safrizal, S., Oksana, O., & Saragih, R. (2017). Analysis of the Chemical Properties of Peat Soil in Three Types of Land Use in Pangkalan Panduk Village, Kerumutan District, Pelalawan Regency. Jurnal Agroteknologi, 7(1). https://doi.org/10.24014/ja.v7i1.2461

Samuel Obeng, A., Dunne, J., Miltrap, M., & Tian, F. (2023). Soil Organic Matter Carbon Chemistry Signatures, Hydrophobicity and Humification Index Following Land Use Change in Temperate Peat Soils. Heliyon, 9(9). https://doi.org/10.1016/j.heliyon.2023.e19347

Schlichting, A., Leinweber, P., Meissner, R., & Altermann, M. (2002). Sequentially Extracted Phosphorus Fractions in Peat-Derived Soils. Journal of Plant Nutrition and Soil Science, 165(3), 290–298. https://doi.org/10.1002/1522-2624(200206)165:3<290::AID-JPLN290>3.0.CO;2-A

Sikumbang, R. H. N. (1994). Geological Map of the Banjarmasin Sheet, Kalimantan. Geological Research and Development Center.

South Kalimantan's Economy Grew 4.81 Percent in the First Quarter of 2025. (2025). Antara News.

Tampubolon, R. (2023). Analysis PrisonerTypes of Rock and Soil for Multi-Storey Building Design Using Geoelectric Methods on the Edge of Lake Siais. State University of Medan.

Wahyunto, S. R., & Subagjo, H. (2004). Map of Peatland Distribution Area and Carbon Content in Kalimantan 2000-2002. Wetlands International.

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.