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LAND SUBSIDENCE INVESTIGATION AND HANDLING METHODS (CASE STUDY: BUILDING OF BPJS KETENAGA KERJAAN SORONG CITY SOUTH WEST PAPUA PROVINCE)

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ABSTRACT

Penelitian ini merupakan investigasi komprehensif terkait penurunan permukaan tanah dan cara penanganannya di Dinas BPJS Ketenagakerjaan (eksisting) di Kota Sorong, Provinsi Papua Barat. Penelitian dilakukan dengan pendekatan komprehensif yang meliputi observasi, pengambilan sampel tanah, pengujian komponen struktur, dan analisis struktur bangunan. Hasil penyelidikan geoteknik dan struktur bawah menunjukkan adanya hubungan antara daya dukung tanah dengan data sondir atau nilai tahanan konus (qc). Berdasarkan hasil sondir, tanah di lokasi tergolong sangat keras dengan nilai qc >150 kg/cm2. Investigasi geolistrik menunjukkan indikasi adanya lapisan tanah lunak atau aliran air tanah pada kedalaman tertentu. Lebih lanjut, dari hasil pengujian tanah dan geolistrik, disarankan untuk merencanakan dan melaksanakan rekayasa geoteknik dengan menggunakan perbaikan tanah dan/atau perkuatan tanah. Hal ini bertujuan untuk meningkatkan daya dukung tanah dan mengatasi potensi penurunan lebih lanjut.

Keywords: *Investigation, Subsidence, Handling methods, Soil improvement.*

1. INTRODUCTION

This study specifically investigates the phenomenon of land subsidence and various methods of handling it at the BPJS Manpower Office in Sorong City, West Papua Province. As an institution that plays an important role in employment services, this office has infrastructure that must be maintained. Land subsidence is becoming a critical issue, and therefore, this study aims to provide a deep understanding related to the causes, impacts, and appropriate solutions.

In an effort to achieve these goals, a comprehensive research approach is applied, involving steps such as field observation, soil sampling, structural component testing, and structural analysis of buildings. The results of geotechnical and lower structure investigations bring emphasis to the relationship of soil carrying capacity with sondir data and conus resistance (qc) values. The soil at this location is classified as very hard with significant qc values, and geoelectric studies show indications of soft soil layers or water flow at certain depths.

As a next step, the study recommends planning and implementing geotechnical engineering using improvement soil and/or

reinforcement soil. The focus is on increasing the carrying capacity of the soil and addressing the potential for further decline. In the context of portal structures, research reveals several findings related to the quality of concrete, the existence of portal systems without prior planning in the upper buildings, and uncertainty about the depth of the existing foundation in the lower buildings.

The results of this study are expected to provide a better understanding of the soil conditions around the BPJS Manpower Office, guide the implementation of effective handling strategies, and correct deficiencies in the existing portal structure. The implications of these findings have a positive impact on the sustainability of this office infrastructure and are relevant for similar geotechnical engineering and construction projects in regions with similar challenges.

2. LITERATUR REVIEW

Land Subsidence and Its Causative Factors

Explain various factors that cause land subsidence such as geological composition, human activities, and environmental changes. References may include similar case studies in various locations.

Sondir Soil Test Method with "Dutch Cone Penetrometer"

Presenting the theoretical and applicative foundations of soil testing methods using the "Dutch Cone Penetrometer," covering basic principles, data interpretation, and their relevance in foundation planning.

Geotechnical Investigation Methods

Discusses geotechnical investigation methods commonly used to identify soil properties, such as sondir, geoelectric, and soil testing. Presents related literature that discusses the advantages and disadvantages of each method.

Geotechnical Engineering and Land Subsidence Management

Presents literature that discusses geotechnical engineering techniques for handling land subsidence, including soil improvement and soil reinforcement. Detailing case studies that have successfully implemented the method.

Soil Bearing Capacity and Foundation Construction

Review the concept of soil carrying capacity and how data from sondir testing can be used for building foundation planning. Refer to relevant structural engineering theory and practice.

Latest Investigative Tools and Technologies

Displays the latest developments in tools and technologies for soil investigations, including the use of PQWT TC-300. Details the superiority and possible relevant applications.

Risk Management in Geotechnical Engineering

Explain how the literature on risk management can be applied in the context of geotechnical engineering, particularly related to handling land subsidence.

Related Regulations and Standards

Review regulations and standards related to geotechnical engineering and building construction, and how these standards can be a guide in handling land subsidence.

3. METHOD

Location and Layout

The location of the investigation is located in the BPJS Employment Office Building. Geographically, the investigation area is at coordinates: -0.904589

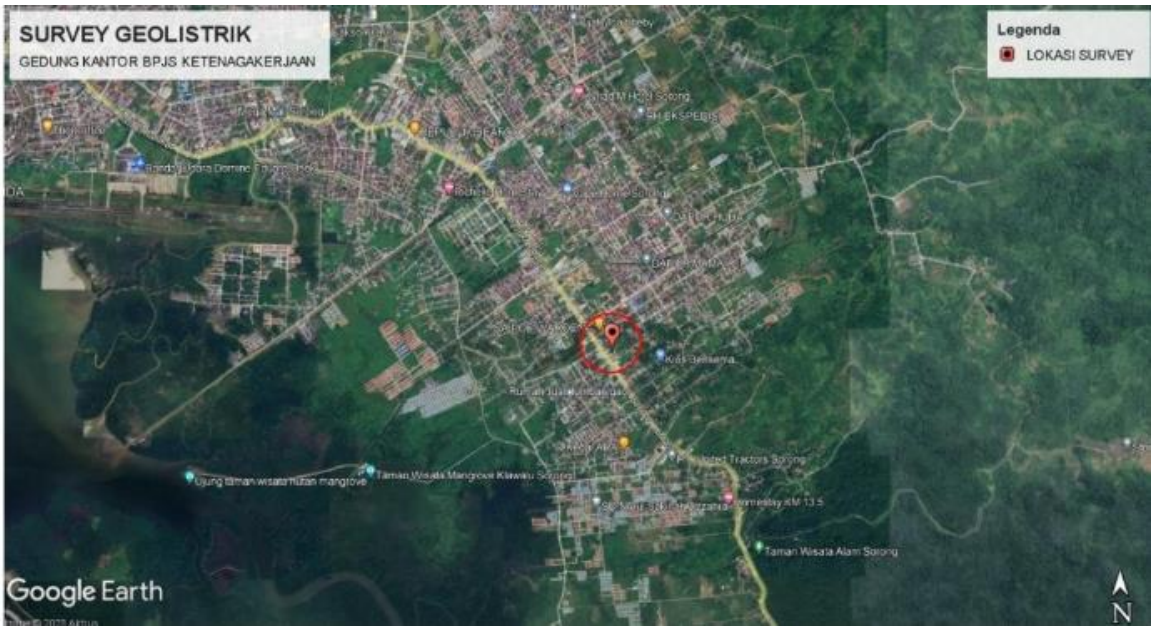

Figure 1. Research Location

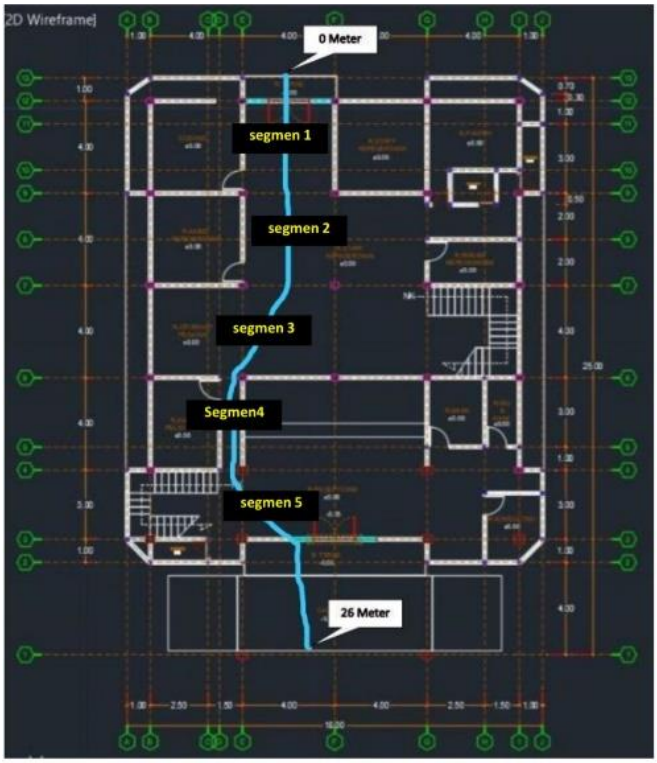

Figure 2. Layout Test

Data Retrieval

This study used 2 data collection methods, each of which has a significant function, namely:

The Sondir Soil Test method using the "Dutch Cone Penetrometer" with a capacity of 2.5 tons, was carried out with the aim of evaluating the consistency and relative density of each layer of soil at two planning

site points, as illustrated in the sketch of the investigation site. The results of this insinuation not only provide information about the properties of the soil, but can also be used to calculate the carrying capacity of the soil required for the construction of the foundation of the building. Readings are taken every 20 cm interval, and the measured conus resistance value must exceed 150 kg/cm2 to obtain valid data.

Geoelectric method by taking data directly in the field using the PQWT TC-300 tool. After the data is collected, the next step is the processing and creation of images according to the results. The purpose of this method is to determine the recommended depth and consistency of soil layers and rocks at the investigation site. By combining these two methods, this research can provide a thorough understanding of soil characteristics and geotechnical conditions in the area of research focus.

Work Steps Cone Penetration Test (CPT)

- Clean the experimental area from grass or dirt.
- Install the anchor according to the sondir foot.
- Set the position of the sondir using the waterpass.
- Fill the distillation chamber with oil.
- Install the conus on the handlebar and place it under the oil chamber.
- Biconus is marked every 20 cm using a marker.
- Perform penetration by turning the turning crank.
- Read the manometer to measure the resistance of the conus.
- Continue pressing every 20 cm to a depth of 1 meter.
- After reaching hard ground (conus pressure > 150 kg/cm2), the experiment was stopped.

Geoelectric Operation Process

Install the Electrode rod at a distance of 10 meters and mark the starting point at a distance of 0 meters. M N two electrodes equal distance rod is 10 meters, both M N will move 1 meter after finishing measuring point 1. Same distance wiring of M N electrodes as below:

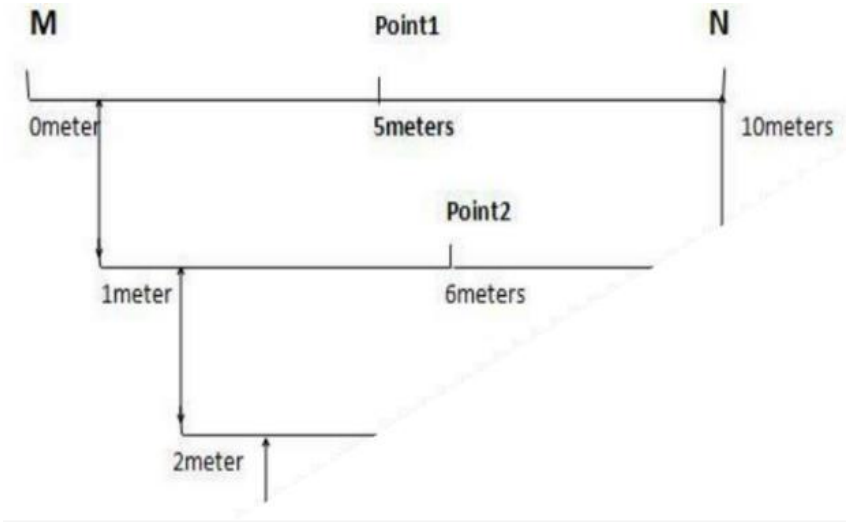

Figure 3. Equal distance cable of electrode M N

Geoelectric Data Analysis Process

Once finished detecting, how to analyze the curve chart and profile map to show drilling locations for reference.

Step 1: Observe the curve to find "V" "L" "W" "A" (display the regular measurement point of many descending curves, lower the potential difference data, and mark the

position number. (The horizontal line of the curve is the measurement point, The vertical line of the curve is below ground material potential difference data (can be thought of as resistivity value) From the curve below, find the "V" that goes down a lot, the low value is the low potential difference data and the probability is high Soft soil/water flow. The cases below are in point 4 and point 8.

Step 2: We will observe the profile map, (The horizontal line of the profile map is the measurement point, The vertical line of the profile map is the measurement depth)

4. RESULT AND DISCUSSION

Step 2: We will observe the profile map, (The horizontal line of the profile map is the measurement point, The vertical line of the profile map is the measurement depth)

Regarding soil conditions, foundation problems, permissible soil carrying capacity and the amount of settlement due to the burden of foundations and buildings that stand on it.

The processing data is interpreted and studied based on the geological and hydrogeological conditions of the study location. Geological data is useful as supporting data to determine the regional condition of rocks in the area. Hydrogeological data is useful as supporting data to determine the water-carrying layer at the research site. The expected end result is a cross-section of resistance of the subsurface type, to determine the structure of the soil layer at depth, especially the soft soil layer and groundwater flow.

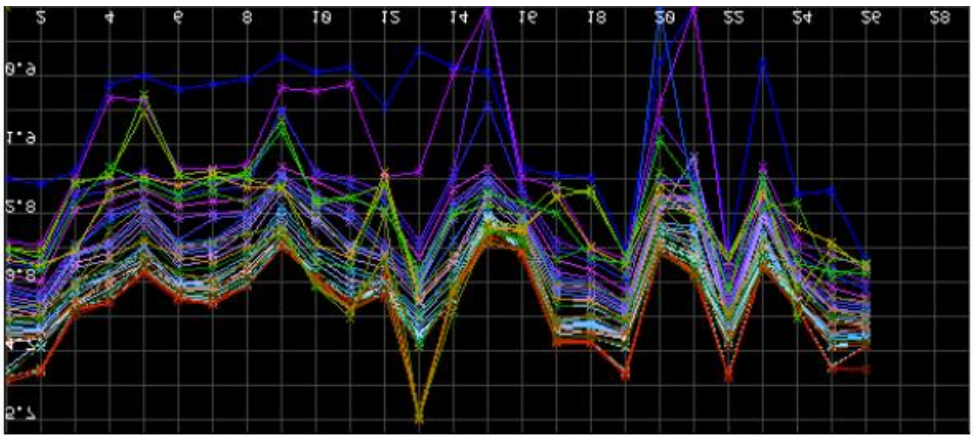

Figure 4. Lay Out Line Survey

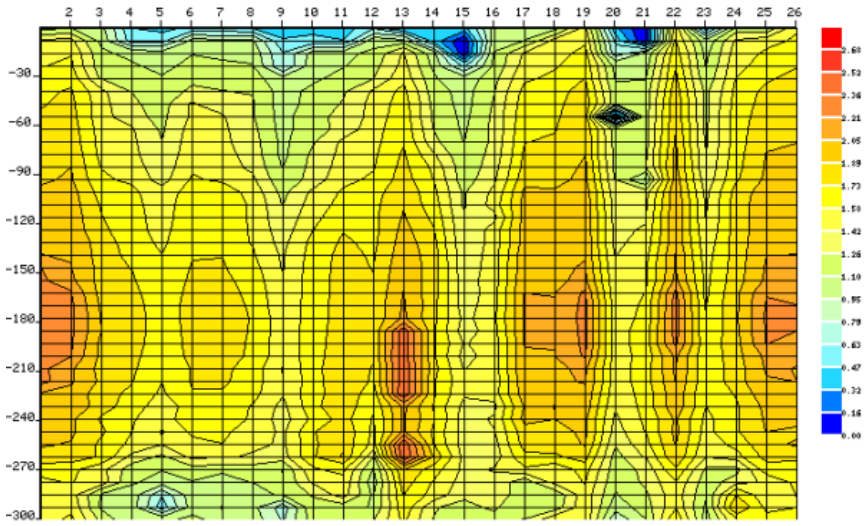

Figure 5. Line Survey Curve Graph

Figure 6. Profil Line Survey Map

Sondir Test

The data obtained from the test results with alan Sondir which is the match of the end of the cones (End Resistance, Cone Resistance) with the Cr/Qc symbol is expressed in the unit kg/cm2 and the Total resistance is expressed in the unit kg/cm2, also performed the calculation of the sticky barrier (skin friction) of the SF symbol is expressed in kg/cm units, and is further illustrated in the form of a sondir graphic (graphic sondir test). The results of the Research with this sondir are expressed in the form of a graph of the relationship between the depth with the value of the pressure of the end of the cones qc and the amount of adhesive barrier (JHP).

Tabel 1. The value of the match ends the chorus qc/cr.

No Test	Depth (m)	Qc/Qr (Kg/Cm2)	JHP/TSF (Kg/Cm)
S1	5.00	250	117
S2	8.00	250	1442

The soil plays a major role in construction, serving as the basis of the foundation and building materials. Evaluation of the foundation becomes critical, considering the bearing capacity of the soil and safety factors. Analysis of the bearing capacity of the soil is carried out with the Dutch Cone Penetration Test (Sondir), considering the type of shallow and deep foundation. The choice of the type of foundation depends on the structure and soil layer.

Analysis of the carrying capacity of shallow foundations involves calculations based on field data with empirical equations. For deep foundations, such as piles, the magnitude of the bearing capacity value is obtained from the results of sondir and laboratory analysis. Settlement analysis is carried out with due regard to soil consolidation. Details about the Dutch Cone Penetrometer Test (DCPT) work carried out in this study.

Analysis Results

From the results of investigations and assessments carried out thoroughly starting from observation, sampling, structural component tests and structural analysis of existing BPJS Labor buildings, the following are some of the results of the analysis obtained.

Geotechnical and Lower Structure The relationship between soil carrying capacity with sondir data or conus resistance (qc) value, to soil consistency, as follows:

- Very soft soil, QC < 5 kg/cm2 , soft, QC = 5-10 kg/cm2.

- firm soil, QC = 10-20 kg/cm2 ; chewy, QC = 20-40 kg/cm2 ; very chewy, QC = 40-80 kg/cm2 ; hard, qc= 80-150 kg/cm2

The results of sondir testing in the field obtained a value of resistance at the end of the conus qc > 150 kg / cm2, including very hard soil types, . Based on the results of Geoelectric investigation, it can be concluded that

- Based on the results of the interpretation of the 2D resistivity cross-sectional image above, indications of soft soil layers / groundwater flow at points of 15 meters and 21 meters with a depth of up to 20 meters.
- based on CPT data conducted in point 8 there is a match with geoelectric data and indications of a soft soil layer under the floor surface with a depth of 2.5 meters.

After carrying out the recommended handling analysis process in the form of soil improvement, the type of soil improvement method according to the Indonesian National Standard, SNI 8460-2017 Geotechnical Design Requirements, 2017.

From the results of sondir and geoelectric soil testing, then it can be planned (simplified-design) and carried out geotechnical engineering with soil improvement and / or soil reinforcement.

5. CONCLUSION

From the results of investigations and assessments carried out thoroughly starting from observation, sampling, structural component tests and structural analysis of existing BPJS Manpower buildings, Sorong City, Southwest Papua Province, it can be concluded as follows:

1. Geotechnical and Lower Structure The relationship between soil carrying capacity with sondir data or conus resistance (qc) value, to soil consistency, as follows:
   - Very soft soil, QC < 5 kg/cm2 , soft, QC = 5-10 kg/cm2.
   - firm soil, QC = 10-20 kg/cm2 ; chewy, QC = 20-40 kg/cm2 ; very chewy, QC = 40-80 kg/cm2 ; hard, qc= 80-150 kg/cm2
2. The results of sondir testing in the field obtained a value of resistance at the end of the conus qc > 150 kg / cm2, including very hard soil types, . Based on the results of Geoelectric investigation, it can be concluded that
3. Types of soil improvement methods according to the Indonesian National Standard, SNI 8460-2017 Geotechnical Design Requirements, 2017. From the results of sondir and geoelectric soil testing, then it can be planned (simplified-design) and carried out geotechnical engineering with soil improvement and / or soil reinforcement.

REFERENCES

[1] ASTM International. (2019). "ASTM D5778-12 Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils." ASTM International.

[2] Das, B. M. (2008). "Principles of Geotechnical Engineering." Cengage Learning.

[3] Das, B. M. (2017). "Principles of Geotechnical Engineering." Cengage Learning.

[4] Holtz, R. D., Kovacs, W. D., & Sheahan, T. C. (2011). "An Introduction to Geotechnical Engineering." Prentice Hall.

[5] ISO 31000:2018. (2018). "Risk management – Guidelines.

[6] Lunne, T., Robertson, P. K., & Powell, J. J. M. (1997). "Cone Penetration Testing in Geotechnical Practice." CRC Press.

[7] Lunne, T., Robertson, P. K., & Powell, J. J. M. (1997). "Cone Penetration Testing in Geotechnical Practice." CRC Press.

[8] Mitchell, J. K., & Soga, K. (2005). "Fundamentals of Soil Behavior." John Wiley & Sons.

[9] Schmertmann, J. H. (1978). "Guidelines for Cone Penetration Test (CPT) and Soil Boring (SB) in Offshore Geotechnical Engineering." Offshore Technology Conference.

[10] Terzaghi, K., Peck, R. B., & Mesri, G. (1996). "Soil Mechanics in Engineering Practice." John Wiley & Sons.

[11] Tomlinson, M. J. (2001). "Foundation Design and Construction." Pearson Education.