Identification of subsurface basement rock using geoelectrical resistivity method in development area (campus 2 UIN Sunan Gunung Djati Bandung)

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Abstract. The foundation is one of the important elements in the process of building a multi-story building, where the foundation serves as the basic building that will support the main building weight above it. The foundation must be built and placed on a hard surface below the ground surface, this aims to avoid the shifting of the foundation which will cause damage to the building above it. One method that can identify hard layers is a type resistivity geolistrik method, which uses different rock resistivity parameters depending on the type of rock. To then be interpreted into a 2D geological section according to the state of the lithology of the area rocks. From the research data obtained, from 3 paths (L.1, L.2, and L.3) using the average Wenner configuration of the identified hard layers starting at a depth of 11.9 meters identified as a tuff stone layer (100-250 Ωm). Tufaan gravel layer and contains a little tufaan sand (250-400 Ωm) at a depth of 16.1-20.7 m, Tufaan gravel layer with breccia stone insect (400-600 Ωm) at a depth of 20.7-25.8 m, and the last of the basic constituent layers allegedly dominated by limestone (> 600 Ωm) at depths above 25.8 meters. While the position of the presence of an average hard layer is 96-144 meters from the starting point of measurement for each trajectory.

1. Introduction
Construction of a graded building or other large-scale building requires careful planning both in terms of technology and security [1]. In the field of civil engineering is known as the term foundation, which is a basic building built as a support of the main building [2]. In general, to build a high-rise building requires a solid and stable foundation and built on a layer / hard rock structure with a certain depth and in accordance with the capability of the soil to the weight of the building to be built, it aims to ensure the stability of the foundation that will directly affect the durability of the building itself [3]. Laying the foundation on an unstable soil surface can lead to cracks in buildings even collapsing, this is due to a decrease in a ground level beyond the limit [4]. In principle, the foundation should reach the hard layer of soil and if no hard layer is found then soil compaction/improvement should be done [5].
To investigate the subsurface conditions associated with the foundation construction, investigation and identification of lithologic rocks of the region concerned [6] are required. The methods that can be done to identify lithologic structures of rocks are to use the geolistik method [7] resistivity to obtain a two dimensional lithologic cross-sectional shape of rocks based on variations in the measured resistivity value of rocks [8].

The geolistrik resistivity method is based on an electrical resistivity measurement of a material: [9]

\[ \rho = \frac{1}{\sigma} = \frac{R}{l} \]

Where R is the electrical resistance of the material (Ω); (rho) is the electrical resistivity of a material that depends on the geometry of the material (Ω.m); \( \sigma \) is the conductivity of the material (1 / Ω.m); A is the cross-sectional area of material (m); l is the material length (m). Since the subsurface potential distribution forms a semi-spherical geometry [10], it is obtained.

\[ V(r) = \frac{\rho}{2\pi} \]

with \( V(r) \) is the potential distribution as a function \( r \) (distance from the source center on the earth's surface to the geometry range of the half-spherical a point arising at a point in the earth). For the actual case where the use of earth current electrode is two (C1 and C2) then its current propagation pattern is as follows [11].

**Figure 1.** Current flow patterns and equipotential fields for two current sources (Loke & Barker, 1996).

\[ V_1 = \frac{I}{2\pi r_1} \quad V_2 = \frac{I}{2\pi r_2} \]

then the inter potential difference and written as:
\[ V = \frac{l_1}{2\pi l} \left( \frac{1}{r_1^2} - \frac{1}{r_2^2} \right) - \left( \frac{1}{r_3^2} - \frac{1}{r_4^2} \right) = \frac{l_1}{k} \]

or

\[ \iota = k \frac{V}{I} \rightarrow k = \frac{2\pi l}{\left( \frac{1}{r_1^2} - \frac{1}{r_2^2} \right) - \left( \frac{1}{r_3^2} - \frac{1}{r_4^2} \right)} \]

where \( k \) is a geometrical factor that depends on the arrangement of the electrode.

The configuration used in this study is the Wenner configuration, where the potential electrode is located between an electrode current composed of C1-P1-P2-C2 by geometry factor. In addition, this configuration is more sensitive to lateral and shallow resistivity changes than any other configuration dependent on the position of its electrode [12].

2. Method

This research was conducted in the construction area of Campus 2 UIN Sunan Gunung Djati Bandung, located at Jalan Cimencrang, Bandung. The specific location of the measurement is located on a vacant lot that is currently used as a soccer field by surrounding villagers and students as shown in Figure 2.

The number of paths measuring 3 paths (L.1, L.2, and L.3) using Masagi Resistivity meter Multichannel with the number of electrodes as much as 32 pieces and spaces between electrodes of 6 meters so that each track measurement has a length of ± 192 meters.

![Figure 2. Location of geoelectric data retrieval](image)

The geoelectric measurement method applied in this study is the geometrical configuration of Wenner to search for substrate hard zones which will then be interpreted into 2D and 3D cross-sections. The 2D cross-sectional results of the 3 trajectories will be interpolated into the 3D cross-section to facilitate the identification of the subsurface hard zone layer at the study site.

3. Results and Discussion

Based on the data collection that has been done at the location of the research, the 2D geology section of the three trajectories are as follows:
Figure 3. 2D Geological Section (a) Path one (L.1), (b) Path two (L.2), (c) Path three (L.3)

The 2D geological cross-sections show the structure of the constituent rocks of the three paths not much different from one another, indicating the structure of the rock layers having the identities identified at the study site. In terms of determining the type of rock layers suspected to be the subsurface substrate, it can be seen from its high resistivity value ranges above 100 Ωm. From the 2D cross-section, the structural boundary between the weak layer of soil with the suspected layer as the hard layer is indicated
by a black dashed line. The following is the description of the lithology of rock layers at the research site.

| No | Depth (m) | Resistance Value Type (Ωm) | Types of Soil / Rock Layers | Color Index |
|----|-----------|-----------------------------|-----------------------------|-------------|
| 1  | 0.00 – 11.9 | < 100 | This layer is dominated by a pile of soil (Gravel) and Tufaan Clay. |            |
| 2  | 11.9 – 16.1 | 100 – 250 | Sedimentary rocks are composed of sandstone tufaan |            |
| 3  | 16.1 – 20.7 | 250 – 400 | Sedimentary rocks are composed of tufaan gravel and contain little sand tufaan |            |
| 4  | 20.7 – 25.8 | 400 – 600 | Sedimentary rock consisting of gravel tufaan and a little insertion of breccia rocks. |            |
| 5  | > 25.8 | > 600 | Hard rocks are identified as layers of limestone (Gamping) |            |

Based on the results of the research, rock layers suspected to act as substrate hard layers are identified as tuffaan sandstone layers (100 - 250 μm) at a depth of 11.9 - 16.1 meters, a tufaan and gravel layer containing a small amount of tufaan sand (400 - 600 Ωm) at a depth of 16.1 - 20.7 m, a layer of gravel tufaan with breccia stone insect (400 - 600 Ωm) at a depth of 20.7 - 25.8 m, and lastly the basic constituent layer is thought to be dominated by limestone (> 600 Ωm) at depths above 25.8 meters. From the data obtained the position of hard layers that are on average at a distance of 96 to 144 meters from the starting point of measurement for each geoelectric track.

4. Conclusion
Based on the results of research in the area of development of Campus 2 UIN Sunan Gunung Djati Bandung area in order to find the hard layer of the subsurface for the initial study of the development of the area obtained the result that is the hard layer of 3 paths measurement (L.1, L.2, and L.3) on average found starting at a depth of 11.9 meters identified as a tuffestone sandstone layer (100 - 250 Ωm). Tufaan gravel layer and contains a little tufaan sand (250 - 400 Ωm) at a depth of 16.1 - 20.7 m, Tufaan gravel layer with breccia stone insect (400 - 600 Ωm) at a depth of 20.7 - 25.8 m, and the last of the basic constituent layers allegedly dominated by limestone (> 600 Ωm) at depths above 25.8 meters.

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