SOIL BEARING CAPACITY OF SHALLOW FOUNDATION BASED ON TERZAGHI METHOD IN CIPATAT, WEST BANDUNG, WEST JAVA

Kintan Adelia Arum Wicaksana[1], Zufialdi Zakaria[2], Dicky Muslim[2], and Nur Khoirullah[2]

[1]Undergraduate Student, , Faculty of Geological Engineering, Universitas Padjadjaran

[2]Department of Applied Geology, Faculty of Geological Engineering, Universitas Padjadjaran

Corresponding author: kintan16004@mail.unpad.ac.id

ABSTRACT

One of the important factors in lower construction is a foundation. Shallow soil bearing capacity is one of an assessment used to calculate foundation planning. This paper aimed to calculate the shallow bearing capacity of soil using the Terzaghi's method and determine the bearing capacity classes. The data was obtained by taking the disturbed sample from three different locations in Cipatat, West Bandung. This area is currently covered by housing and limestone industrial building. These samples were tested by a direct shear test and physical laboratory test in a laboratory. Based on the calculation, the soil bearing capacity value range between 5.47 ton/m^2 to 26.52 ton/m^2. Based on these values, the soil bearing capacity is categorized as low to moderate bearing capacity.

Keywords: Soil Bearing Capacity, Shallow Foundation, Terzaghi Method, Cipatat

INTRODUCTION

Infrastructure development is growing in the research area. Cipatat is located on West Bandung. This area is covered by housing and limestones industrial buildings. Construction of a building is an important factor. The constructions are divided into two types, the upper construction and lower construction. In lower construction, the foundation plays an important role to stabilize the building. In foundation planning, a factor that needs to be focused on is the value of soil bearing capacity that hold some loads above it. The value of soil bearing capacity must be higher than the loads that are held by the foundation (Zakaria, 2006). Soil bearing capacity's value can be obtained from some physical and mechanical properties of soil characteristics such as cohesion (c), friction angle (φ), and unit weight (γ).

Several soil bearing capacity known as Terzaghi Method, Meyerhof Method, Hansen Method, Ohaski Method, Vesic Method, etc. (Martini, 2009). From that several methods, the most frequently used method is the Terzaghi Method as used in this paper.

Regional Geology

The research area is covered in two different formation, they are Batuasih Formation and Rajamandala Formation. By using Regional Geological Map modified from (Sudjatmiko, 1972; Koesoemadinata and Siregar, 1984; Stiady, 1995) we know that in the research area has two different lithologies, the first one is claystone from Batuasih and the second one is limestone from Rajamandala Formation. According to (Soejono, (1994) inside Zakaria, (2005)), limestone position from Rajamandala Formation is prop up above claystone from Batuasih Formation. There is East Cimandiri fault (Haryanto et al, 2017) with Meratus Pattern that makes Claystone from Batuasih Formation is exposed (Zakaria, 2005).

Regionally, geology structures like fault and fracture developed in the research area. There are two directions of fault, such as southwest-northeast, west-east, and there is a strike-slip fault with direction northwest-southeast that cut out those two faults (Martodjojo, 1984 in Gunawan et al., 2017).

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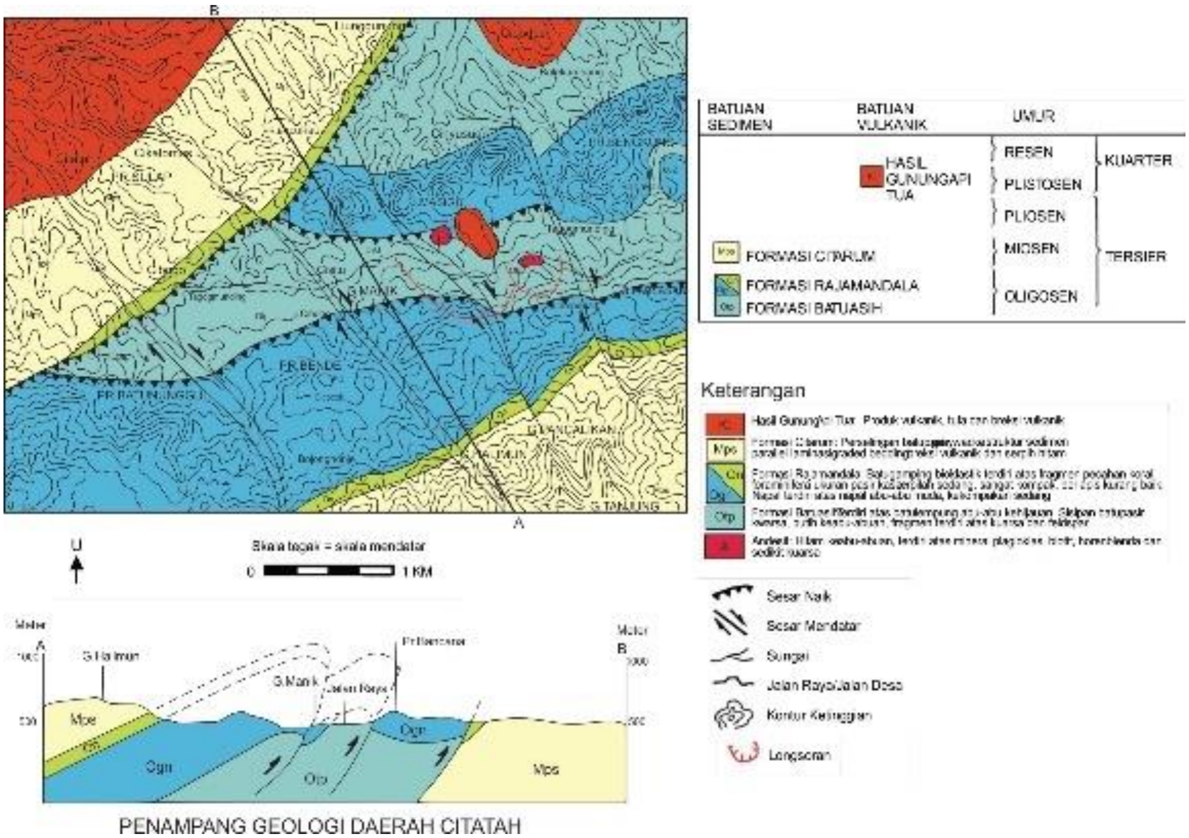

Figure 1. Regional Geological Map modified by (Sudjatmiko, 1972; Koesoemadinata and Siregar, 1984; Stiady, 1995).

Research Location

This research has been done around Cibogo Sawo street, Citatah, Cipatat, West Bandung, West Java that close to PPSDM GEOMINERBA (Tekmira College). There are three locations sample with coordinates GT-1: 6°49’55” 107°26’37”; GT-2: 6°49’57” 107°26’41”; GT-3: 6°49’53” 107°26’41”.

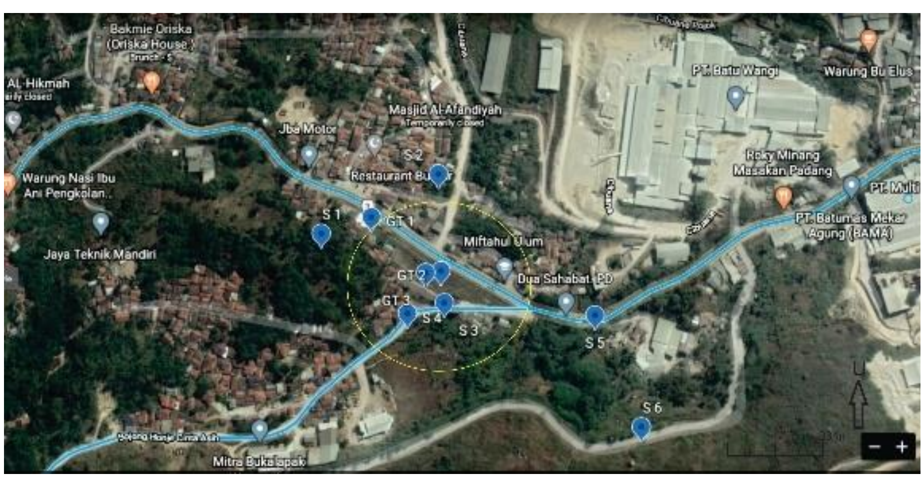

Figure 2. Research Location.

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Shallow Foundation

Foundation is one of the engineering systems that connects the loads to the ground and transfer it from the structure to the ground. Foundation's classification is based on where the loads were sustained by the soil under it, there are the shallow foundation and deep foundation (Bowles, 1997).

The shallow foundation often referred to as a base, bottom part, or raft foundation and has a ratio between the depth (Df) and wide (B) is ≤ 1. The type of shallow foundations that often found (Figure 3) are the bottom part foundation, elongate foundation, and raft foundation.

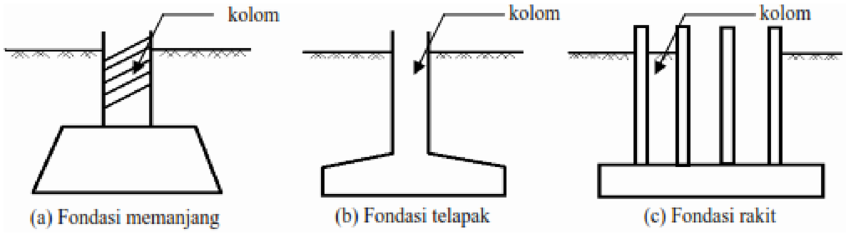

Figure 3. Types of Shallow Foundation.

METHOD AND MATERIALS

The disturbed samples are obtained from three different locations they are GT-01, GT-02, and GT-03. Those samples are tested in a laboratory using a direct shear test.

Direct Shear Test

The purpose of this test is to determine the weak spot from the soil. This test is easy to use according to ASTMD 3080, and this test is using a ring. Normal weight (N) of the sample is decreased in Δv value, then the impact of the shear load (F) make Δh of the sample shifting. From this test, we get cohesion(c), friction angle(φ), and unit weight (γ) (Lai, 2004).

Soil Bearing Capacity with Terzaghi Method

Soil ability to receive pressure or loads and change it into a stable phase is the meaning of soil bearing capacity according to Zakaria (2006). The general equation for soil bearing capacity is:

$$\mathbf{qa} = \frac{q_{ult}}{F} \quad \text{...(1)}$$

Explanation:

q_a = Allowable bearing capacity (ton/m^2 or kg/cm^2)

q_{ult} = ultimate bearing capacity (ton/m^2 or kg/cm^2)

F = Safety Factor (F = 2 - 5)

The bearing capacity method that introduced for the first time is the Terzaghi Method by Terzaghi in 1943 (Bowles, 1997). This method is suitable if we use a horizontal base with a horizontal load, not for a load that inclines because we don't use that factor in it.

The equation for bearing capacity in elongate foundation is:

$$\mathbf{q_u = c.N_c + Df.\gamma.N_q + 0.5B.N_\gamma} \quad \text{..............................(2)}$$

Explanation:

q_u = ultimate bearing capacity (kg/cm^2)

c = soil cohesion (kg/cm^2)

Df = foundation's depth (m)

γ = unit weight (kg/cm^3)

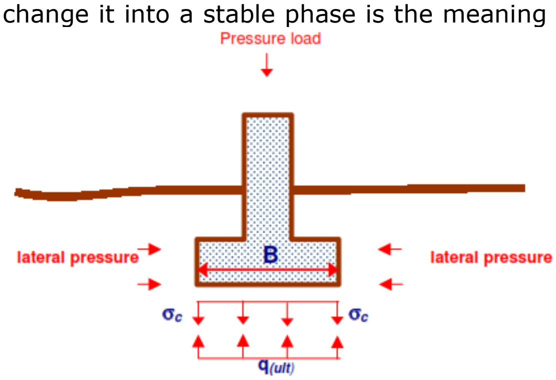

Figure 4. The force that happens in Terzaghi Method (Zakaria, 2006).

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N_c, N_q, N_γ = Terzaghi's bearing capacity factor that influenced by friction angle

$$\mathbf{N_q} = \frac{e^{(0.75\pi - \frac{\varphi}{2})\tan\varphi}}{2\cos^2(45° + \frac{\varphi}{2})} \quad \text{......(3)}$$

$$\mathbf{N_c = (N_q - 1)\cot\varphi} \quad \text{......(4)}$$

$$\mathbf{N_\gamma} = \frac{\tan\frac{\varphi}{2}}{2}\left(\frac{K_{p\gamma}}{\cos^2\varphi}\mathbf{1}\right) \quad \text{......(5)}$$

When there are several forms of foundation, Terzaghi makes another factor in the equation, such as for square foundation and circle foundation:

1. Square Foundation

   $\mathbf{q_u = 1.3c.N_c + Df.\gamma.N_q + 0.4B.N_\gamma}$ ....(6)

2. Circle Foundation

   $\mathbf{q_u = 1.3c.N_c + Df.\gamma.N_q + 0.3B.N_\gamma}$..........(7)

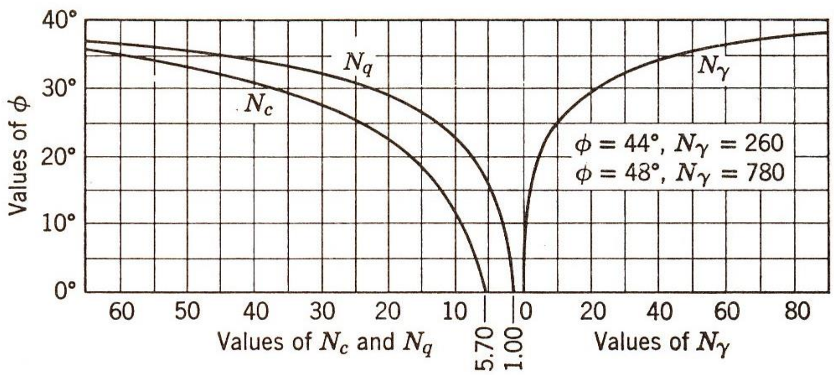

Figure 5. Value of Terzaghi's bearing capacity factor based on (Terzaghi, 1943 in Zakaria, 2006).

The data from the test is collected and to sort which data that we can use to process and analyze. The data is processed with Microsoft Excel because it contains equations. We need mechanic properties from the sample to get bearing capacity's value.

RESULT AND DISCUSSION

Geological Condition

Based on the geological regional map, that research area is form by Batuasih Formation, proven by the discovery of claystone with a flakey structure (Figure 6) that have grey – brownish-grey color, have clay particles, the hardness is brittle and the thickness is 2m. In the south part of the area we have limestone with brownish-white – brownish-yellow color, it's component or grain are separated, grain dominated, the limestone is called grainstone with the thickness is 2m – 10m. Unfortunately, the geological structure indication didn't find clearly during the mapping process.

(a)

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(b)

Figure 6. Flakey claystone (a) located near GT-02 (b) located near GT-01.

Laboratory Test Result

From the laboratory test, the cohesion, friction angle, and unit weight are determined and can be seen in table 1. The result for GT-01 we get cohesion 0.1584 kg/cm^2, friction angle 9.74^o, and unit weight 1.794 gr/cm^3. On GT-02 we get cohesion 0.1091 kg/cm^2, friction angle 7.47^o, and *unit weight* 1.604 gr/cm^3. On GT-03 we get cohesion 0.058 kg/cm^2, friction angle 17.15^o, and *unit weight* 1.747 gr/cm^3.

Table 1. The result of the direct shear test.

DIRECT SHEAR		GT - 01	GT - 02	GT - 03
-	*Cohesion (C) (kg/cm^2)*	0.1584	0.1091	0.058
-	*Angle of Internal Friction (φ) (°)*	9.74	7.47	17.15
-	*Unit Weight (gr/cm^3)*	1.794	1.604	1.747

The calculation using Terzaghi Method resulting ultimate bearing capacity (q_{ult}), for GT – 01 range between 17.47 ton/m^2 – 39.27 ton/m^2, GT – 02 range between 10.94 ton/m^2 – 26.42 ton/m^2, and GT – 03 range between 13.78 ton/m^2 – 53.05 ton/m^2.

The allowable bearing capacity (qa), is GT – 01 between 8.74 ton/m^2 – 19.63 ton/m^2, GT – 02 between 5.47 ton/m^2 – 13.21 ton/m^2, GT – 03 between 6.89 ton/m^2 – 26.52 ton/m^2. This value is categorized into low to medium bearing capacity of soil.

CONCLUSION

Based on the result we get ultimate bearing capacity (q_{ult}) range between 10.94 ton/m^2 - 53.05 ton/m^2 and the allowable bearing capacity (q_a) 5.47 ton/m^2 - 26.52 ton/m^2. The soil bearing capacity's values are categorized as low to moderate class. Further analysis such as groundwater condition, seismic load condition are need for advance foundation planning on this area.

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