

Bearing Capacity of very Expansive Soils at Jatinangor Area, West Java, Indonesia

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Abstract. Expansive soil is a kind of soil that has ability to shrinkage and swelling. According to Ronny (2014) Jatinangor area has expansive soil that is so very influential in the planning of infrastructure construction. This research aimed to measure the bearing capacity of the very expansive soils in Jatinangor area and to determine the correlation between activity number of soil and its bearing capacity. The method used is to collect the soil physics and mechanics data. Based on the soil mechanics data, the research location is divided into three zones of allowable bearing capacity, those are zone with allowable bearing capacity < 4 T/m², zone with allowable bearing capacity 4-7 T/m², and zone with allowable bearing capacity > 7 T/m². The correlation between activity number and bearing capacity of soil follows the equation $q_a = -1.9505(A) + 6.957$ with correlation coefficient is -0.7911.

1 Introduction

Expansive soil is a kind of soil that has ability to shrinkage and swelling. in relation to changes in water content. Soils that exhibit swelling and shrinking behavior contain expansive clay minerals, such as smectite, that absorb water, the more of this clay a soil contains the higher its swell potential and the more water it can absorb (Jones and Jefferson, 2012). The behavior of swelling on the soil can result in the differential settlement of the foundation resulting in damage to the infrastructure.

Jatinangor is an area that has rapidly developed into regional education, industry, government and commerce. It can be seen with a lot of infrastructure construction in this area. Jatinangor region is geologically composed of young volcanic rocks, so the soil produced from weathering is loose. This thing causes landslide around Jatinangor area. In addition, swelling of clay minerals on soil from weathering also influences the frequency of soil movement.

This research is located around Padjadjaran University, Jatinangor District, Sumedang, West Java. Ronny (2014) has classified soils at Jatinangor to four classes based on its expansiveness, which are low expansive soil, medium expansive soil, high expansive soil and very high expansive soil. This research aimed to measure the bearing capacity of the very expansive soils

in Jatinangor area and to determine the relation between activity number of soil and its bearing capacity.

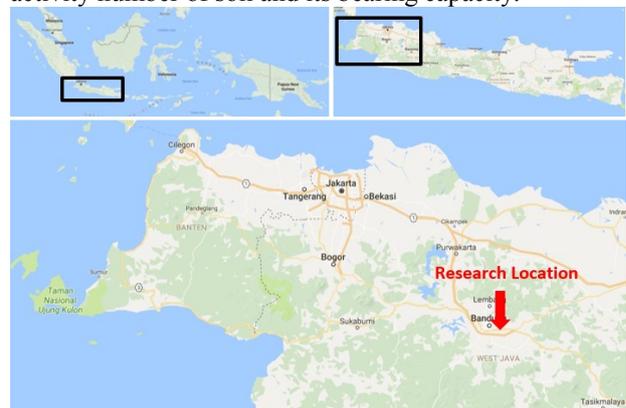


Figure 1 Research Location (June,2017)

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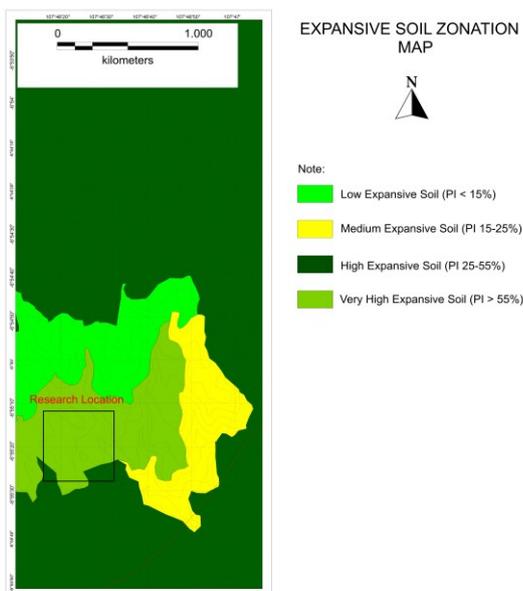


Figure 2 Expansive Soil Zonation Map at Research Location (Ronny, 2014)

1.1 Regional Geology

Based on the regional geological map of Bandung (Silitonga, 1973), the research location is composed of young volcanic rocks, tuffaceous sand, Lapilli, Lava, and agglomerat originating from Mount Tangkuban Parahu and Mount Tampomas. These rocks belong to the Quarternary volcano rocks.

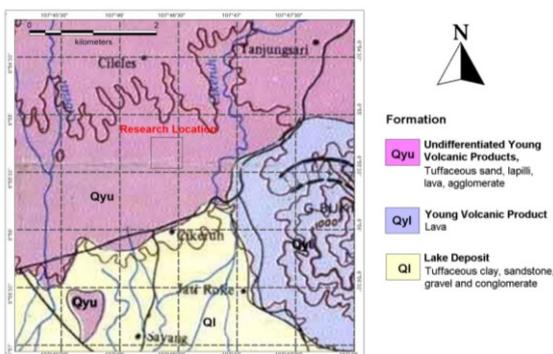


Figure 3 Regional Geology Map of Research Location (Silitonga,1973)

2 Methodology

The method used in this paper is to collect the secondary data consists of the soil physics data such as weight of soil content (γ), plasticity index, clay content in percent and soil mechanics data such as cohesion (c) and friction angle (ϕ) of very expansive soils at research location. The expansiveness of the soil can be known through the calculation of activity number (A). The activity number (Skempton, 1958 in Das, 1988) was formulated as a

comparison of plasticity index (PI) and clay grain percentage (<0.002 mm) as follows:

$$A = \frac{PI}{\%clay} \tag{1}$$

Unit weight (γ), cohesion (c) and friction angle (ϕ) then used to calculate the allowable bearing capacity of very expansive soils on a continuous foundation with the following equation based on Terzaghi (1943, in Zakaria, 2014):

$$q_{ult} = c.Nc + \gamma.D.Nq + 0,5\gamma.B.N\gamma \tag{2}$$

$$q_a = \frac{q_{ult}}{F} \tag{3}$$

From these data, the zonation map of bearing capacity of very expansive soils is made using Surfer 11 software, where column A is X coordinate, column B is Y coordinate, and column C is the bearing capacity of soils. The graph of the relationship between the activity number and the bearing capacity of soils is made using Microsoft Office Excel 2016 software.

3 Result and Discussion

The research area is a very expansive soil zone based on an expansive soil zonation map by Ronny (2014). This very expansive soil zone has a plasticity index value ranged from 24.63% to 69.67%, whereas the more plastic a soil sample, the higher the expansive of the soil. Activity number (A) from soil samples ranged from 0.44 to 1.37 where the soil is thought to contain the minerals of illite clay, kaolinitic and montmorillonite.

Table 1 Table of Activity Number and Allowable Bearing Capacity

Sample	USCS Classification	Coordinate X	Coordinate Y	IP (%)	%clay	A	Allowable bearing capacity (T/m ²)
Z1aBT1	CH	107.772265	-6.923446	33.3	58.39	0.57	5.57
Z1aBT2	CH	107.771761	-6.923107	50.16	46.72	1.07	4.46
Z2aBT1	CH	107.773038	-6.922692	58.6	48.58	1.21	4.97
Z2aBT3	CH	107.772639	-6.922679	69.67	50.67	1.37	4.33
Z2bBT1	CH	107.772628	-6.92175	60.41	56.08	1.08	4.08
Z2bBT2	CH	107.772276	-6.921537	57.64	55.4	1.04	5.33
Z3BT2	MH	107.775193	-6.924046	24.63	55.77	0.44	6.31
Z3BT3	MH	107.775415	-6.923594	45.65	55.9	0.82	5.16
Z3BT4	MH	107.775005	-6.923444	49.54	54.7	0.91	5.81

From the various samples contained in the research area, the bearing capacity of very expansive soils is calculated with the type of continuous foundation, the depth of 1 meter and width of 1 meter as follows:

- A bearing capacity zonation map of very expansive soils is constructed with the following range of values:
- Zone with allowable bearing capacity $< 4/m^2$. This zone is scattered in the northwest, north and southeast of the research area.

- Zone with allowable bearing capacity 4-7 T/m². This zone is scattered almost throughout the research area.
- Zone with allowable bearing capacity > 7 T/m². This zone is scattered in the southern part of the research area.

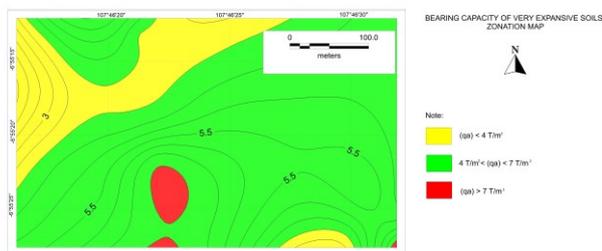


Figure 4 Bearing capacity zonation map of very expansive soils

The correlation between activity number and bearing capacity of very expansive soils in research area is shown in graph with equation $q_a = -1.9505(A) + 6.957$ with $R = -0.7911$. Based on the value of negative correlation coefficient, it can be interpreted that the bearing capacity of the soil will decrease as the activity rate increases. This is due to the value of the activity number is affected by the value of the plasticity index. The higher the plasticity index, the higher the activity number.

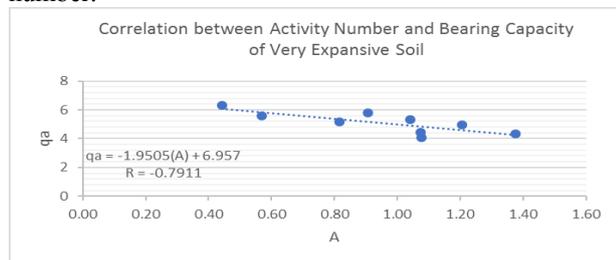


Figure 5 Correlation between activity number and Bearing capacity

The correlation between plasticity index and soil bearing capacity at research area shows correlation with equation $q_a = -0.041(PI) + 7.162$ with $R = -0.783$. It also can be interpreted that the soil bearing capacity will decrease when the plasticity index increases.

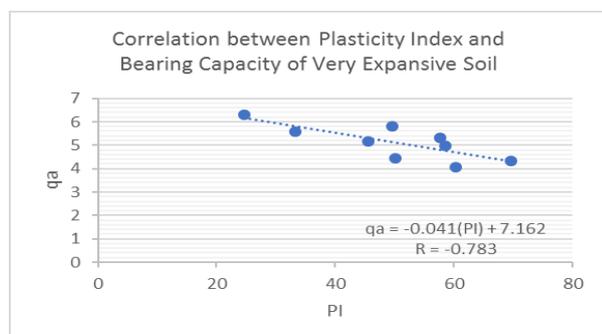


Figure 6 Correlation between plasticity index and bearing capacity

4 Conclusion

A bearing capacity zonation map of very expansive soils consists of three zones based on the value of allowable bearing capacity, which are zone with allowable bearing capacity < 4 T/m², Zone with allowable bearing capacity 4-7 T/m², and zone with allowable bearing capacity > 7 T/m².

The correlation between activity number and bearing capacity of very expansive in research area is shown in graph with equation $q_a = -1.9505(A) + 6.957$ with $R = -0.7911$. Based on the value of negative correlation coefficient, it can be interpreted that the bearing capacity of the soil will decrease as the activity number increases. To build infrastructure on expansive soils, stabilization is required. Stabilization on expansive soils can be divided into 3 types: mechanical stabilization, physical stabilization, and chemical stabilization (Ingles and Metcalf, 1972).

- Mechanical stabilization is done by increasing the strength and carrying capacity of the existing soil by increasing its density.
- Chemical stabilization by adding certain chemicals resulting in chemical reactions.
- Physical stabilization is by adding geomembrane over expansive soil.

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5 Nomenclature

- A = Activity Number
- B = width of foundation (m)
- c = cohesion (T/m²)
- D = depth of foundation (m)
- F = Factor of Safety = 3
- N_c, N_q, N_γ = factor of bearing capacity that depends on friction angle
- PI = plasticity index
- q_{ult} = ultimate bearing capacity (T/m²)
- q_a = allowable bearing capacity (T/m²)
- R = correlation coefficient
- γ = Unit weight (T/m³)
- φ = friction angle (o)
- % clay = percentage of clay content

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