ANALYSIS OF SOIL BEARING CAPACITY TO SUPPORT SUSTAINABLE DEVELOPMENT AROUND CISUMDAWU TOLL ROAD, SUMEDANG REGENCY, WEST JAVA, INDONESIA

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Abstract

The Cisumdawu toll road will be constructed to have 60 kilometers length, as a part of Java Toll connecting Dawuan-Sumedang-Cileunyi region. This, toll road will have a tunnel for the first time in Indonesia. The toll road will pass nearby Jatinangor which has a predicate of eco-campus region. Impact of development toll road toward Jatinangor is soil degradation. Besides that, characteristics of soil physics can be a parameter degradation of soil. The aim of this research is to recognize soil bearing capacity value along Cisumdawu Toll Road. Method in this study is using basic properties of soil, and mechanical properties consists of water content, weight of soil content, porosity, specific gravity, Atterberg limit, size particle distribution, cohesion, permeability, pre-consolidated force, angle of internal friction, index of compression, index of expansion and consolidated coefficient. Soil constituent of around research area are size soil fine, which dominated by silt soil with characteristics related to engineering high compression. Then, overburden loading can be triggers soil degradation in big scale. Soils in the research area belong to CH (Clay High Plasticity) and MH (Silt High Plasticity) type. The value of soil bearing capacity calculated on surface is 35.44 kg/cm^2 – 319.505 kg/cm^2 for CH soil type, and 108.69 Kg/cm^2 – 1004,467 Kg/cm^2 for MH soil type. The recommended foundation type is square.

Keywords: Jatinangor, Soil Bearing Capacity, Cisumdawu Toll Road, Foundation

1. INTRODUCTION

Background

Toll Road Cisumdawu which has length 60 kilometers, a part of Java Toll connecting Dawuan-Sumedang-Cileunyi region, this road has tunnel also, for the first time in Indonesia, passed along Jatinangor Subdistrict which become an education area. There are four college around Jatinangor area such as IPDN, IKOPIN, ITB and UNPAD. In this region, the development building infrastructure and housing or apartment are needed every year including Cisumdawu Toll Road as function to make shorter time passed this road, which impact for bussiness, school, citizen Jatinangor activity or other factors **(Figure 1).**

Soil is an important role to determine safety factor level infrastructure, which built on it. Soil has capability limit for support build loading, so it can be prevented not to be degradation of soil in big scale (Faizah, 2017). Soil activity value has characterize swelling of soil. Expansive soil behaviour can cause has a geological weak factor which can be impact on other environment such as building and road damage (Sophian, 2007). The aim of this research is to know soil bearing capacity

along Cisumdawu Toll Road based on mechanical properties and basic properties testing data, so it can be analyzed for type of foundation suitable applied in Jatinangor area.

2. LITERATURE REVIEW

a) Regional Geology

Regional Geology based on stratigraphy Jatinangor area and surrounding consists of five units (Frini, 2015) are : Tuff Unit (Qt), Flow Pyroclastic Breccia Unit (Qbap), Fall Pyroclastic Breccia Unit (Qbjp), Sand Unit (Qp) which has soil non-cohession strength with loose condition. This unit was deposited in lake environment (Silitonga, 1973), and Lava Unit (Q1) which composed of andesitic lava lithology, probably was deposited by Manglayang Mountain effusive eruption **(Figure 2).**

b) Soil Condition of Surrounding Jatinangor Area

Condition of soil research area in general is volcanic quarter weathering deposits, which consist of volcanic breccia, tuff, sandstone and lava. Sample was taken on Lapili Tuff Unit (Frini, 2015). Weathering soil deposits in Jatinangor area are silt with high plasticity (MH) and clay with high plasticity (CH) (Irvan, S 2007). Weathering zone from top to bottom in Jatinangor area are :

1) Completely weathering zone. A part of soil on top level wheter physical, chemical or biological are factor influence of weathering. This soil has brown color untill old-brown which thickness 20 – 30 centimeters, type of organic (OH).
2) Strongly weathering zone. Consists of fine sand anorganic clay, silt clay, sand clay, gravel clay (CH – CL), with has a little tuffaceous characteristic, partly layering of soil granules, pebbles and boulder content. It has also reddish brown color and moderate untill high degree of plasticity.
3) Moderately weathering zone. Consist of mixed both of fine sand and coarse sand. There are very fine sand and silt, anorganic, very fine untill very coarse sand. Composed of gravel, pebble and boulder from andesitic igneous rock. In general condition, the colour is yellowish brown untill reddish brown with low plasticity. Two meters untill more than four meters clay sand was found in subsurface condition.
4) Partly weathering zone. It has characteristic reddish brown colour untill yellowish brown breccia deposit weathering, show that several point location around IPDN untill UNPAD hill. The matrix is coarse sand. In wet condition of soil are high plasticity soil, type of moisture content is MH, partly composed of organic material (OL). In dry condition of soil are friable soil, loose, sand silt, nonplastic (ML or OL).
5) Fresh rock of breccia. It has characteristic black untill gray fresh colour, hard and solid, angular untill subangular component of sphericity. That can be showed at riverbed and hill around of Jatinangor area.

3. METHODOLOGY

An Object of this research involve engineering geology study. Stage the first of research was taken undisturbed sample by shelly tube tool. Then laboratorium stage, physical and mechanical characteristic testing. Water physical characteristic can be described with moisture content presence, unit weight of soil, specific gravity, atterberg limit, sieve analysis and hydrometer analysis. All of laboratory testing was done with ASTM standard. After that processing and analysis stage data, was done by previous research, finally analyzed to know soil bearing capacity value and determination of type foundation suitable for research area.

4. RESULT AND DISCUSSION

Based on bore data, compose layering of soil which consist of silt sand, and clay sand are :

1) At depth 0-5, 7 m: clay sand with reddish brown, plasticity, grain size : fine sand – clay, solid characteristic.

2) At depth 5,7 – 11,5 m : silt sand with yellowish brown, a little loose particle, plasticity, grain size : coarse sand – silt, tuffaceous sand weathering deposit characteristic.

On mechanical soil laboratorium testing obtained are : disturbed sample which consist of CH type. Undisturbed sample can be classification are : 1) MH, silt with high plasticity it has a moisture content value (ω) 41.29%, spesific gravity value (Gs) 2.74. Liquid limit value 55.00%. Plastic limit value 36.40 %. Plasticity index value 18.59%. The density value of type silt soil is 1,85 g/cc and cohession value (c) 0,333 Kg/cm^2. Angle of internal friction testing value is ɣ 32°. 2) CH, clay with high plasticity it has a moisture content also (ω) 45.04 % untill 63.02 %, specific gravity (Gs) 2.64 untill 2.82. Liquid limit value 62.00 % untill 83.00 %. Plastic limit value 24.30% untill 49.10%. Plasticity index value 26.40% untill 57.60%. The density value of type clay soil (CH) is 1,76g/cc and cohession value (c) 0,90 Kg/cm^2. Angle of internal friction testing value is ɣ 10°**(Table 1 & Table 2)**.

Soil bearing capacity shallow foundation value obtained from calculation using Terzaghi equation. This calculating was applied for three foundation of type are continues foundation, square foundation and circular foundation. Width of foundation was used 1,00 meter. Soil bearing capacity calculating in research area was done at 20 meters depth, in general-shear condition the type of suitable foundation is square foundation. While type of foundation given as a smallest soil bearing capacity is continues foundation (Das, 1999).

For the biggest value with square foundation in clay soil with high plasticity (CH). It has value 106.32 Kg/cm^2 untill 958.51 Kg/cm^2. Limit bearing capacity value 35,44 Kg/cm^2 untill 319,505 Kg/cm^2 for allowed bearing capacity. While in silt soil with high plasticity (MH). It has value 108.69 Kg/cm^2 untill 1004,467 Kg/cm^2 for limit bearing capacity. And allowed for bearing capacity value 36,23 Kg/cm^2 untill 334.82 Kg/cm^2 **(Table 3 & Table 4).**

5. CONCLUSION

Distinction of soil bearing capacity influenced by physical and mechanical characteristic of soil such as origin of rock, content of water, cohession, angle of internal friction, weight of soil content, grain size distribution, and degree of weathering. According to calculating of soil bearing capacity shallow foundation in general-shear condition, soil bearing capacity value of the research area has variation. The suitable type of foundation is square foundation because the type foundation of continues and circular show that soil bearing capacity smaller than square foundation. For allowed soil bearing capacity square foundation ranging from 34,60 Kg/cm^2 – 318,673 Kg/cm^2. While Circular and continues foundation ranging from 35.40 Kg/cm^2 – 319.47 Kg/cm^2 and 35,44 Kg/cm^2 – 319.47Kg/cm^2.

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Attachment of figure and table sheets

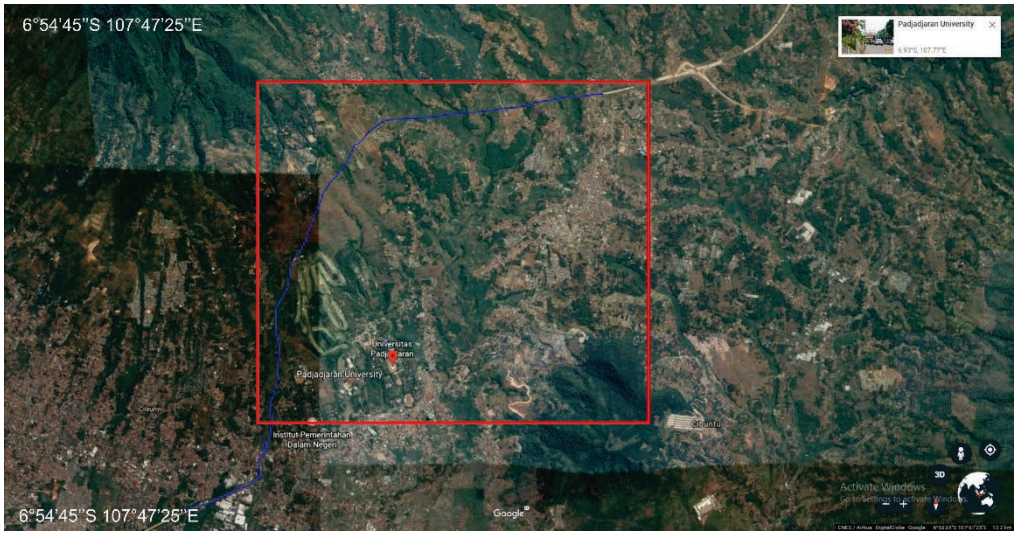

Figure 1. Research of area location

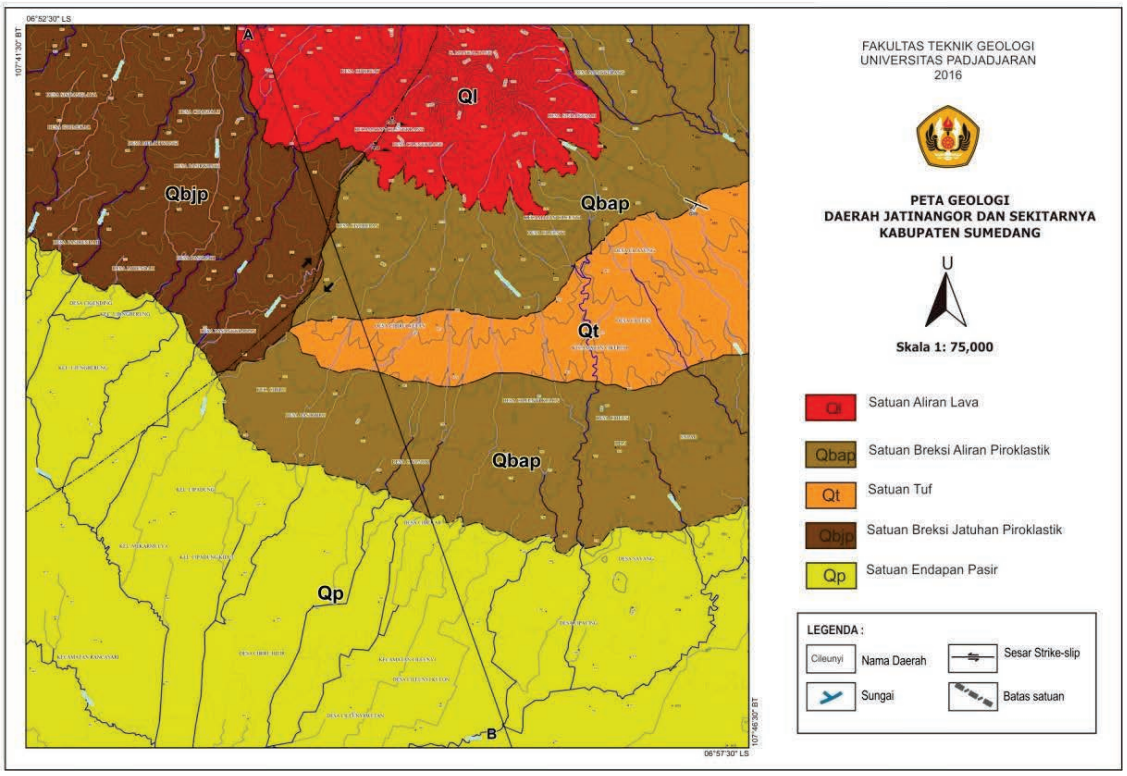

Figure 2. Geological map and surrounding (Frini, 2015)

Type of soil layering	Depth (m)	G_s	W (%)	LL (%)	PL (%)	PI (%)
Clay Sand	0 – 0.34	2.82	46.34	82.00	24.30	57.60
	1.02 – 1.36	2.82	47.75	72.00	42.30	28.80
	2.04 – 2.34	2.72	63.02	83.00	49.10	33.94
	3.74 – 4.14	2.64	53.02	66.50	39.48	27.01
	5.50 – 5.84	2.77	45.04	62.00	35.60	26.40
Silt Sand	5.84 – 6.18	2.74	41.29	55.00	36.40	18.59

Table 1. Show that result phyiscal index properties of soil (Khoiri Suganti, 2012)

Type of soil layering	Weight of soil content (γ) Gr/ml	Cohession (c) Kg/cm^2	Angle of internal friction (ϕ)°
Clay Soil	1.76	0.900	10
Silt Sand	1.85	0.336	32

Table 2. Show that parameter in soil bearing capacity analysis (Khoiri Suganti, 2012)

Depth (cm)	General-shear condition (limit of bearing capacity q_{ult}) Kg/cm^2					
	Clay Sand			Silt Sand		
	Square	Circle	Continues	Square	Circle	Continues
20	106.32	106.22	103.82	111.18	111.08	108.69
40	201.01	201.91	198.51	210.71	210.61	208.22
60	295.70	295.60	293.20	310.24	310.14	307.75
80	390.38	390.29	387.89	409.77	409.67	407.28
100	485.07	484.97	482.58	509.30	509.20	506.81
120	579.76	579.66	577.26	608.83	608.73	606.34
140	674.45	674.35	671.95	708.36	708.26	705.87
160	769.14	769.04	766.64	807.89	807.79	805.40
180	863.82	863.73	861.33	907.42	907.32	904.93
200	958.51	958.41	956.02	1006.95	1006.85	1004.46

Table 3. Show that result of limit soil bearing capacity

Depth (cm)	General-shear condition (Allowed of bearing capacity q_a) Kg/cm^2					
	Clay Sand			Silt Sand		
	Square	Circle	Continues	Square	Circle	Continues
20	35,44198	35,40913	34,60993333	37,0627	37,02817	36,23233333
40	67,00464667	66,97179	66,1726	70,2393667	70,20483	69,409
60	98,56731333	98,53446	97,73526667	103,416033	103,3815	102,5856667
80	130,12998	130,0971	129,2979333	136,5927	136,5582	135,7623333
100	161,6926467	161,6598	160,8606	169,769367	169,7348	168,939
120	193,2553133	193,2225	192,4232667	202,946033	202,9115	202,1156667
140	224,81798	224,7851	223,9859333	236,1227	236,0882	235,2923333
160	256,3806467	256,3478	255,5486	269,299367	269,2648	268,469
180	287,9433133	287,9105	287,1112667	302,476033	302,4415	301,6456667
200	319,50598	319,4731	318,6739333	335,6527	335,6182	334,8223333

Table 4. Show that allowed of soil bearing capacity calculating