Engineering Geological Mapping in Jatinangor Area

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Abstract

Engineering geological mapping takes a role in regional development stage. The research area located in Jatinangor education region has developed significantly in regional development. This research aimed to provide information on geology and engineering geology characteristics that can be used to support this development. This research method used laboratory testing based on ASTM and field study. The results showed the research area were dominated by young volcanic breccia and tuffs and generate residual soils that devided into silt low plasticity (ML), silt high plasticity (CH), and clay high plasticity (MH) according to USCS. Based on engineering geological data, the ML unit showed unit weight (γ_m) value from 1,462–1,850 gr/cm^3, plasticity index (PI) value from 7,643–17,452 %, cohesion value from 0,118–0,438 kg/cm^2, and angle of internal friction value from 18,188–33,539°. In MH unit showed unit weight (γ_m) value from 1,508–1,881 gr/cm^3, plasticity index (PI) value from 7,217–69,667 %, cohesion value from 0,058–0,264 kg/cm^2, and angle of internal friction value from 3,552–6,146°.In CH unit showed unit weight (γ_m) value 1,606–1,870 gr/cm^3, plasticity index (PI) value from 17,522–62,507 %, cohesion value from 0,062–0,256 kg/cm^2, and angle of internal friction value from 3,431–4,826 °.

Keywords: *engineering geology, engineering geological mapping, properties of soil*

1. Introduction

Engineering geological mapping takes a role in regional development stage. The research area located in Jatinangor education region has developed significantly in regional development.

Jatinangor, located in Sumedang District, West Java Province Indonesia (figure 1), is well known as a small education city, consist of few national university. The increasing of land using needs a further study for obtainin more information based on soil characteristic.

Djadja and Herawan (1996) resulted soil characteristic in Jatinangor area in small scale. This research aimed to provide information on geology and engineering geology characteristics that can be used to support this development in large scale.

2. Literature Review

Geological Background

Based on Silitonga (1973), the stratigraphy of Jatinangor area from the oldest to the youngest as follows (figure 2) :

1. Undifferentiated Young Volcanic Products (Qyu) in the form of tuffaceous sand, lapili, lava, agglomerate mostly from Mt. Tangkubanparahu and Mt. Tampomas. Between Bandung and Sumedang this unit expressed as a flat or low hill area covered by yellowish gray to reddish gray soil,
2. Lava of Young Volcanic Products (Qyl) in the form of lava,
3. Lake Deposits (Ql) in the form of tuffaceous sand, sandstone, gravel and conglomerate. Locally form horizontal layers. Contains

limestone concretions, plant remains, fresh water molluscs, and bones of vertebrates. Locally also intercalated by breccia.

In the field, the outcrop condition already highly weathered.

Soil Characteristic

Djadja and Herawan (1996) had completely doing engineering geological mapping in Bandung area. And concluded Jatinangor area into silty clay and sandy silt soil. This soil is residual soil as resulted weathered of tuffaceous sandstone, tuff, conglomerate, agglomerate, lappili, and breccia. The thichness range from 2 – 20 m, reddish brown in colour, moderate to high plasticity, low permeability, firm to moderate consistency, low to moderate bearing capacity, easy to rather difficult to be excavated by non mechanical equipment and depth to free groundwater table is deep.

Activity

Das (2006) exlpained the plasticity of soil is caused by the adsorbed water that surrounded the clay particles. Thus can expect that the type of clay minerals and their proportional amounts in a asoil will affect the liquid limit and plastic limit. Skempton (1953, in Das 2006) defined a quantity called activity (A), which is slope of the line correlation PI (plasticity index) and % finer than 2µm as axpressed as

$$A = \frac{PI}{\%\ of Clay-size, by weight}$$

Furthermore, Seed, et al (1964, in Das 2006) redifined this equation by adding C'; a constant = for given soil, C' = 9.

$$A = \frac{PI}{\%\ of Clay-size, -C'}$$

Furtermore, Das (2006) give a correlation table below from the activity value to the type of its clay minerals

Tabel 1, type of values of Activiy of some clay minerals

Mineral	Activity
Kaolinite	0.3 - 0.5
Illite	0.5-1.2
Montmorilonite	1.5-7.0
Halloysite (hydrated)	0.1-0.2
Halloysite (dehydrated)	0.4-0.6
Attapulgite	0.4-1.3
Allophane	0.4-.13

3. Research Method

The research is done by using guide based on engineering geological mapping,as the definition by Dearman (1991), engineering geologicalmapping is one of discipline of geology applied tocivil engineering, particularly to the design, constructionand performance of engineering structure interacting withthe ground in, for example, foundations, cuttings, and othersurface excavations, and tunnels.

The basic map information is needed to assess the feasibility of a proposed engineering construction. Map type that used in this research is lithological type (LT). Typically the scale of such mapping is 1 : 5000 to 1 : 10.000.

Engineering geological mapping aimed to obtain information on the development based on soil characteristics of Unified Soil Classification System (USCS). This mapping can be tentative or provisional because the field description of soil dominated by subjective approaches.The correction will be obtained by conducting laboratory tests on undisturbed samples. All methods of undisturbed soil sampling adapted from ASTM D 1452.

Types of laboratory tests conducted to determine the physical properties of soil including the moisture content test, unit weight test, specific gravity test, the liquid limit test, plastic limit test, hydrometer analysis and sieve analysis. And the mechanical properties test of the soil is a triaxial UU test and Direct Shear test. All laboratory tests adapted from ASTM (American Standard Testing and Materials).

4. Results

Based on the results of geological mapping techniques and laboratory testing with reference USCS, the study area can be divided into five engineering geological units (figure 3) as follows :

1. Silt with High Plasticity (MH)
2. Silt with Low Plasticity (ML)
3. Clay with High Plasticity (CH)

The ML unit consist of fine grain soil with moderate plasticity, dominated by dark red colour, cohesive. This unit has gravel precentage from 0 – 8,38 %; sand precentage from 7 – 50,64 %; dan clay-silt percentage from 39,66 - 92,3 %. The basic properties are, Specific Gravity value (Gs) range from 2,355 – 2,701; unit weight value (γ_m) from 1,462 – 1,850 gr/cm^3; pore number (e) from 0,556 – 0,909; porosity value (n) from 35,722 – 49,391 %; liquid limit (LL) from 37,090 – 48,732 %; plastic limit (PL) from 27,696 – 37,722 %; and plasticity index (PI) from 7,643 – 17,452 %. The mechanical properties result from direct shear test, cohesion value (c) from 0,118 – 0,438 kg/cm^2; and angle of internal friction value (φ) from 18,188 – 33,539°.

The MHunit consist of fine grain soil with high plasticity, dominated by dark reddish brown colour with few white fragment colour, cohesive. This unit has gravel precentage from 0 – 8,38 %; sand precentage from 4,86 – 46,12 %; dan clay-silt percentage from 50,14 – 93,76%. The basic properties are, Specific Gravity value (Gs) range from 2,528 – 2,698; unit weight value (γ_m) from1,508 – 1,881gr/cm^3; pore number (e) from0,573 – 1,687; porosity value (n) from36,437 – 62,789 %; liquid limit (LL) from52,732 – 127,310 %; plastic limit (PL) from 24,790 – 61,790 %; and plasticity index (PI) from 7,217 – 69,667 %. The mechanical properties result from direct shear test, cohesion value (c) 0,226 – 0,517 kg/cm^2; and angle of internal friction value (φ) from16,621 – 34,148°, and from triaxial test, cohesion value (c) from 0,058 – 0,264 kg/cm^2; andangle of internal friction value (φ) from 3,552 – 6,146°.

The CHunit consist of fine grain soil with high plasticity, dominated by dark reddish brown colour, cohesive soil dominantly. This unit has gravel precentage from 0,02 – 2,70%; sand precentage from 6,49 – 30,78%; dan clay-silt percentage from 67,54 – 93,27%. The basic properties are, Specific Gravity value (Gs) range from 2,655 – 2,708; unit weight value (γ_m) from 1,606 – 1,870gr/cm^3; pore number (e) from 0,660 - 1,723; porosity value (n) from 39,742 – 63,277%; liquid limit (LL) from 54,048 – 88,450 %; plastic limit (PL) from 10,123 - 42,741%; and plasticity index (PI) from 17,522 – 62,507 %. The mechanical properties result from direct shear test, cohesion value (c) 0,013 – 0,498kg/cm^2; and angle of internal friction value (φ) from 24,188 – 34,75 °, and from triaxial test, cohesion value (c) from 0,062 – 0,256 kg/cm^2; andangle of internal friction value (φ) from3,431 – 4,826 °.

The calculation of activity number from 38 samples, shown that 45% from the samples are kaolinite clay mineral, 32% are halloysite clay mineral, and 23% are illite clay mineral.

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5. Conclusion

The results shown a detail soil characteristic in Jatinangor Area and shown differences from the earlier research by Djadja and Herawan (1996). This result could give additional information to the local government for guiding the land using by its geotechnical properties of soil. However, further research is needed for obtain the specific clay mineral from XRD or SEM. For obtaining more data, the wider area of the research is need also. The rapid growth development in the nothern and southern area is recommended for further research.

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References

Das, Braja M.(2006) *Principles of Geotechnical Engineering Fifth Edition,* Canada: Thomson.

Djadja and Herawan (1996) Engineering Geological Map of Bandung Quadrangle, West Java, Directorate of Environmental Geology

Dearman W.R. (1991) Engineering geological mapping. Butterworth-Heinemann, Oxford, 387 pp

Silitonga, P.H. (1973). Systematic Geologic Map, Jawa, Bandung Quadrangle Scale 1 : 100.000. Geological Research and Development Centre, Bandung.

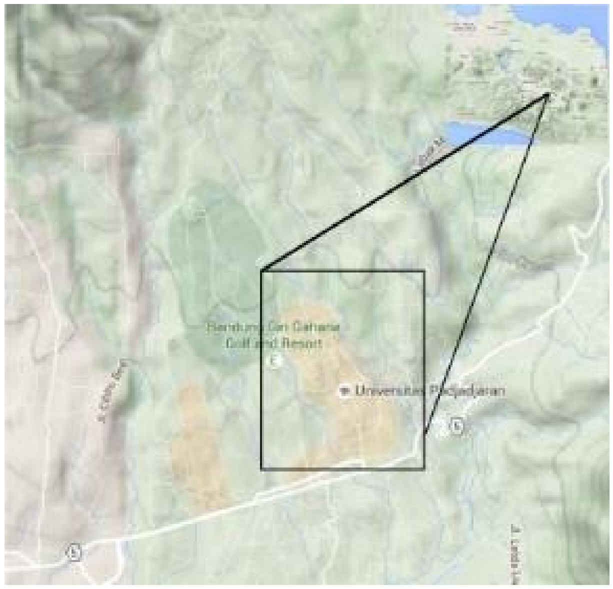

Figure 1, Research Area

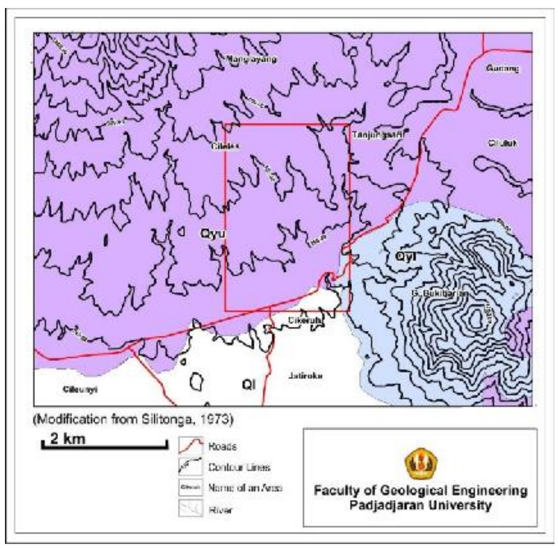

Figure 2, Geological Map of Jatinangor Area (modified from Silitonga, 1973)

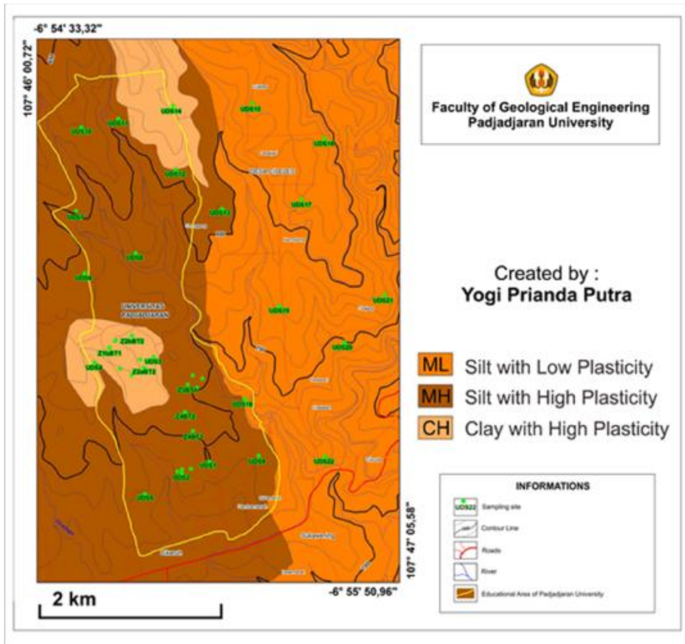

Figure 3, Engineering Geological Map of Jatinangor Area