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Relation Plasticity Index with Settlement (Case Study Development in Campus Lipi Karangsambung, Kebumen Regency, Central Java)

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Abstract. The building is stable if it's able to withstand the load above and slightly decreasing soil. In development planning it is necessary to the condition of the soil to avoid building construction failure so it needs to be tested first. Plasticity soil can have high expansive or shrinking properties depend on the amount of water content and the type of soil minerals contained. The level of expanding and contracting the soil will have an impact on soil subsidence. The velocity of the land subsidence is calculated using the consolidation coefficient results from the consolidation test. Consolidation is a process of slowing down the volume slowly on perfectly saturated soils with low permeability due to pore drainage. The study aims to determine the bond of the plasticity index with the consolidation coefficients of the samples obtained.so that it is known the speed of land settlement due to the burden borne by the soil. Soil samples were taken by maintaining the original properties (undisturbed sample), then tested the physical properties and mechanical properties of the consolidation test. Based on the results of the processing of index plasticity and consolidation coefficient it is found that the greater the plasticity index, the smaller the coefficient of consolidation. So that the magnitude of the plasticity index has a proportional bond to the speed of land subsidence. Keywords: consolidation, plasticity index, velocity settlement soil.

1. Introduction

LIPI Campus in Karangsambung Village is undergoing further development of Karangsambung geopark. In development planning, it is necessary to know the soil conditions at these locations to avoid building construction failure. A soil is said to be good if it is able to withstand the load that is above it and has decreased slightly. Imposing above the ground can cause the soil layer beneath it to be compressed. This compression is caused by the pore water contained in the soil will flow out of the layer and the volume will increase smaller due to the pore water flow process which depends on the magnitude of the permeability coefficient, the event as a consolidation process.

According to Das [1], giving overburden pressure within a certain period and magnitude will affect the speed of soil compression known as the consolidation coefficient (Cv). But the consolidation coefficient in each additional overburden pressure is not linear, even in a number of experiments it is fluctuating. One factor that causes other differences in the consolidation coefficient is the plastic properties of clay minerals in the soil. The greater the liquid limit on the ground, the consolidation coefficient will decrease [2].

Clays as cohesive soils will have great strength if they are dry, plastic on water content according to their plastic limits, and are sticky (cohesive) and very soft at higher moisture content. This plastic

property which causes fluctuations in the consolidation coefficient of each additional overburden pressure.

Looking at the basis of the theory, this study aims to determine the relationship of the plasticity index with the speed of land subsidence at the Karangsambung LIPI Campus which is expected to be known to the relationship and the time or duration of land subsidence. This research is divided into four examples of soil that has a relatively close range of land around 10-20 meters per sample with a depth of 75-80 cm and has different elevations. Then the soil samples are examined for their physical and mechanical properties to be able to see the coefficient of consolidation ratio.

2. Literature Review

According to Hardiyatmo [3], soil is a set of minerals, organic matter, and relatively loose deposits which are located on base stones. Soil types that have very high organic and clay mineral content will have large shrinkage characteristics. Clay cohesion properties indicate that the clay parts can be attached to one another and the nature of plasticity in the clay allows the shape of the material to be altered without undergoing changes in content [4]. The clay will have great strength if it is in a dry condition and when mixed with water that exceeds the permissible water content, the strength of the clay will decrease.

According to Das [1], the USCS (Unified Soil Classification System) classification system divides land into two groups, including:
- Coarse-grained soil is soil that has large gravel and sand grains, less than 50% of the soil sample weight passes no.200 filter.

Fine-grained soil is soil that has a large amount of silt and clay grains, more than 50% of the soil sample weight passes no.200 filter.

Apart from grain size distribution, USCS is also classified based on the Atterberg limits of water content in a soil mass consisting of:
- Liquid Limit is the lowest water content in a soil mass that can cause the soil to be liquid.
- Plastic Limit is the lowest water content in a soil mass that can cause the soil to be plastic.
- Shrinkage Limit is the maximum water content that causes changes in volume to stop when it is dried continuously.

Plasticity index is the water content interval, that is the soil is still plastic. Therefore, the plasticity index shows the plasticity of the soil.

This plasticity index has an influence on the type of clay minerals contained in the soil and the expanding properties of the soil. The types of clay minerals and the level of expansion on the soil are carried out through a formula approach that has been carried out by researchers previously based on Chen's criteria (1988) , in Yahya [5] , and Seed et al (1962) , in Yuliet [6] of the magnitude of the plasticity index and Skempton (1953) in Alifahmi, [7] from the activity value, the results of the comparison of the plasticity index with the percentage of clay.

2.1 Consolidation Soil

According to Das [1], consolidation is a process of slowly reducing volume in perfectly saturated soils with low permeability due to partial drainage of pore water. This volume reduction is due to the operation of the load so that there is a decrease in the soil.

According to Hardiyatmo [3], the rate of decline in consolidation can be calculated using the consolidation coefficient (Cv). The initial load has an effect on the consolidation coefficient value, because the greater the load and the initial loading time, the pore water discharge process is fast (Cassiophea, 2014). The consolidation coefficient is calculated through the consolidation equation of the root time method (Taylor, 1948 in Hardiyatmo, [3]) as follows:

$$C_v = \frac{T_v . H_t^2}{t_{90}}$$

Cv is the coefficient of consolidation, Tv is the time factor, Ht is the thickness at time t, and t_{90} is the 90% decrease time.

3. METHOD

3.1 Investigation Soil in The Field
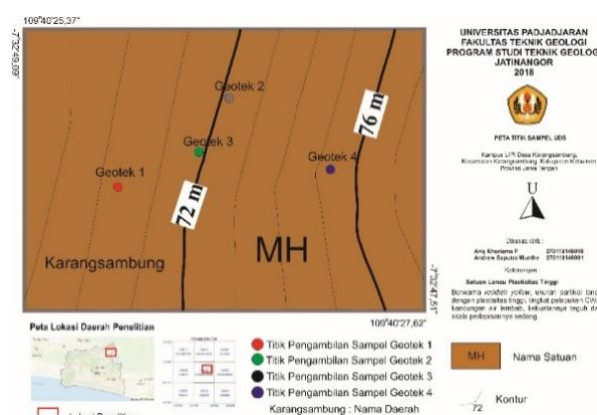a.   Hand Auger
b.   Undisturbed sample

3.2 Investigation Soil at The Laboratory
a.   Investigation physical properties of soil
   - Test of ground water content is intended to determine soil water content. Groundwater content is the ratio of the weight of water contained in the soil mass, to the weight of soil grains (dry soil) and expressed in percent.
   - The soil weight test aims to determine the unit weight (γ). The weight of the content of a soil mass is the ratio between the total weight of the land to the total content of the soil, and expressed in notation γ (gram / cm3)
   - The soil density test aims to determine the specific gravity (Gs) of the soil. The specific gravity of the soil is the ratio between the weight of soil grains and the weight of distilled water in the air with the same volume at a certain temperature
   - Atterberg Limit aims to determine the plasticity index value. The plasticity index is obtained from the difference between the liquid limit value and the plastic limit.
   - Sieve analysis aims to determine the distribution of grain or coarse aggregate gradation and fine aggregate using sieving shaker. Hydrometer analysis aims to determine the distribution of fine soil grains.
b.   Investigation mechanical properties of soil
   - Mechanical properties of soil to determine the ability of the soil to hold and carry the burden by conducting a consolidation experiment.

4. Result

The soil sample in this study was taken from the results of hand auger at the location of Geotek 1, Geotek 2, Geotek 3, and Geotek 4 research in the LIPI campus area. Field description results have a reddish yellow color, cohesive appearance, high plasticity, and moisture content.

Figure 1 Peta Titik UDS

4.1 Soil Classification

The physical properties of the soil from the results of laboratory tests can be described in detail in table 1 below:

Table 1 Physical Properties of Soil

Kode Sampel	Atterberg Limit		Hidrometer & Sieve					Nama Sampel
	Plastic Limit (%)	Liquid Limit (%)	Plastisity Index (%)	Kerikil (%)	Pasir (%)	Lanau (%)	Lempung (%)	
Geotek 1	36,32	65,64	29,32	0,04	3,52	61,09	35,35	MH
Geotek 2	37,92	66,5	28,58	0,1	4,54	59	36,36	MH
Geotek 3	36,65	66,82	30,17	0	7,84	62,87	29,29	MH
Geotek 4	36,36	67,44	30,23	0,14	11,76	63,86	24,24	MH

Based on the above data, refer to the USCS system soil classification where the land is included in high plasticity silt or in a unified soil classification system called MH (Mo High Plasticity)

4.2. Mineral Types and Expansive Soil

Based on the results of testing the Atterberg limit that have been carried out, obtained activeness values and potential expansive soil

Table 2 Mineral Types

Kode Sampel	Indeks Plastisitas (%)	Persentase Lempung (%)	Aktivitas (A)	Mineral (Skempton, 1953)	Keaktifan
Geotek 1	29,32	35,35	0,829	Illitik	Normal
Geotek 2	28,58	36,36	0,786	Illitik	Normal
Geotek 3	30,17	29,29	1,03	Illitik	Normal
Geotek 4	30,23	24,24	1,247	Illitik	Normal

Source: Skempton (1953) from Hunt 2007
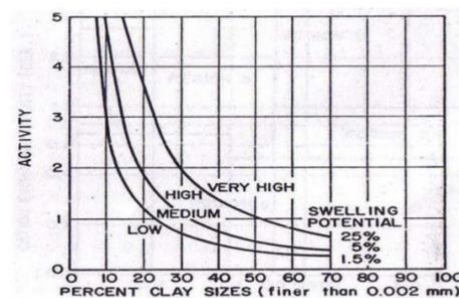
Table 3 Expansive Soil

Kode Sampel	Indeks Plastisitas (%)	Derajat Pengembangan (S) %	Kriteria Seet et al (1962)	Chen (1988)
Geotek 1	29,32	8,209	Tinggi	Tinggi
Geotek 2	28,58	7,713	Tinggi	Tinggi
Geotek 3	30,17	8,802	Tinggi	Tinggi
Geotek 4	30,23	8,845	Tinggi	Tinggi

Source: Chen (1988) dan Seed *et al* (1962) [8]

From the tables above it can be seen that the soil in the area has an illite clay mineral type with the potential to expand from medium to high.

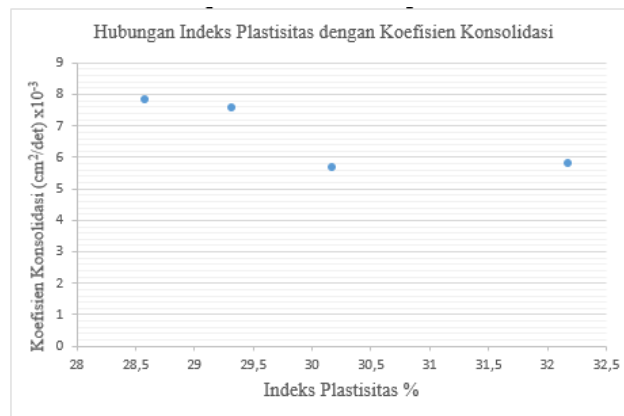**Figure 2** Relation of the percentage of clay to the activity number

Source: Seed *et alI* (1962) from Zakaria [8]

Seeing the extent of the relationship between the plasticity index and the consolidation coefficient, the need for mechanical testing is done so that the relationship between each other is known.

Table 4 Plasticity Index and Coefficient of Consolidation

Kode Sampel	Indeks Plastisitas (%)	Koefisien Konsolidasi (cm²/det)
Geotek 1	29,32	7,57 x 10⁻³
Geotek 2	28,58,	7,83 x 10⁻³
Geotek 3	30,17,	5,68 x 10⁻³
Geotek 4	30,23	5,81 x 10⁻³

Figure 3 Relation of Plasticity Index with Consolidation Coefficient

Through figure 3 it can be interpreted that the higher the plasticity index value, the lower the coefficient of consolidation so that the longer the time of the land decreases. Soil with saturated conditions means that it has passed its plastic boundary conditions so that the decline will last until the volume of the soil returns to its original volume and then the soil will begin to expand and slow down the process of land degradation.

5. Conclusion

Materials from the samples obtained are silt with high plasticity of reddish yellow, cohesive, high plasticity, and moisture content. From the physical properties of the soil that have been carried out, the values of the Atterberg consistency limits with a plasticity index ranging from 28.58% to 30.23% and obtained by mineral illite types with medium to high swelling potential. In the mechanical properties of the soil through a consolidation test obtained the consolidation coefficients range from 0.00568 cm²/sec to 0.00783 cm²/sec.

From the results of the plasticity index and consolidation coefficient, it is found that the greater the plasticity index, the smaller the coefficient of consolidation, so that the speed of land subsidence will be longer. This is because when the saturated soil is given a load, the pore water comes out, the soil water content will reach plastic conditions so that the soil will tend to expand which results in slowing down the process of soil degradation.

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