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Experimental Study of Soil Compaction with Proctor Standard Test Equipment

Nur Addin Fatkunada[1], Agata Iwan Candra [2*], Dodi Setiawan[3]
[1,2,3] Universitas Kadiri, Jawa Timur, Indonesia
[*]Corresponding author, e-mail: iwan_candra@unik-kediri.ac.id

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ABSTRACT

Soil is the surface layer of the earth which consists of minerals, organic materials, air, living things. Clay soil is one type of soil that is important in determining the bearing capacity of subgrade required for construction. The bearing capacity of the soil is obtained by compacting it, using the TS-365 Automatic Standard Proctor. Soil compaction is the process of removing air from the pores of the soil, and is effective for improving soil properties in order to increase the density (density) of the soil so that shear strength increases, soil settlement decreases, and soil permeability decreases. The standard proctor test uses 5 separate soil samples weighing 2 kg, with a mixture of 16%, 19%, 22%, 25% and 28% air respectively. The test results show that the soil obtained from the Pojok sub-district area. Mojoroto, East Java obtained the results of soil compaction data using a standard proctor test, it was obtained that the optimum dry volume weight of the soil was 1,630 gr/cm3 and the optimum water content was 32%. So that the results of soil testing in the laboratory can be used as a reference for controlling soil compaction in construction.

Keywords: *Clay Soil, Compaction, Proctor Test.*

INTRODUCTION

Soil is the surface layer of the earth which consists of minerals, organic materials, air, living things [1]. Soil is a natural material that has an important role in construction and is used as the base or foundation of buildings [2]. The soil must have the strength and stability to support the building structure. Soil conditions, including the amount and nature of organic matter, greatly determine the biochemical, physical and fertility properties of the soil, and help determine the direction of the soil formation process[3]. Soil types vary and depend on the geological factors of each location [4]. Soil can be divided into several criteria such as rock, sand, clay and dust [5]. Soil acts as the core foundation of a building [6].

Clay is a type of soil commonly used in construction [7]. The clay soil compaction process plays an important role in determining the bearing capacity of the subgrade required for construction [8]. The addition of air in the process of compacting clay soil in the field has a significant impact on various technical parameters, such as CBR (California Bearing Ratio) value, soil strength and soil density.[9]. To determine soil stability, a soil compaction test is carried out [10]. The compaction test was carried out using the TS-365 Automatic Standard Proctor [11]. Soil compaction is the process of removing air from the soil pores, and is effective in improving soil properties [12]. Compaction will increase the density (density) of the soil, so that shear strength increases, soil settlement decreases, and soil permeability decreases. [13].

Compaction is the process of compressing soil grains due to the release of air from soil pores. Expansive clay soil is a type of soil that has the potential for very large expansion and shrinkage due to the influence of changes in water content. High water content in clay soil can cause damage to the building structure above it. If the local soil does not have a good bearing capacity, then the effort that can be taken is to mix the existing base soil with additional material called stabilization. Soil stabilization is defined as changing the properties of the original soil by adding certain materials or special treatment which results in improvements in the properties of the original soil. Compaction of clay soil can be done by compacting the soil with tools or machines, such as a roller compactor or bulldozer. The compaction process can be measured by measuring the level of soil density, which can be determined by looking at the dry weight of the soil. The addition of air will greatly affect soil compaction, because the presence of air in the soil functions as a lubricant. Compaction of clay soil can be done before and after it has been stabilized with a stabilizing agent, such as tests carried out with a standard Proctor test equipment, and soil consolidation can be done in the laboratory.

The standard proctor test uses 5 separate soil samples, each weighing 2 kg. The first soil sample was mixed with 16% water, then mixed until evenly distributed, the next samples contained 19%, 22%, 25% and 28% water. Soil samples are stored for approximately 24 hours until a completely even water content is obtained. The aim of this research is to observe and determine the optimal water content and maximum dry matter mass, determine the addition of water in the field during soil compaction, and determine the level of soil density.[14]. The importance of this study is to serve as a reference for construction in strengthening soil, increasing soil shear strength, reducing load loss, or reducing swelling and shrinkage of clay soil. [15].

METHOD

Research sites
Research location is the place or area where research is conducted. The research location that served as a reference for taking soil samples was Pojok Village, Mojoroto District, Kediri Regency, East Java Province. This research study was carried out at the Civil Engineering Laboratory at Kadiri University.

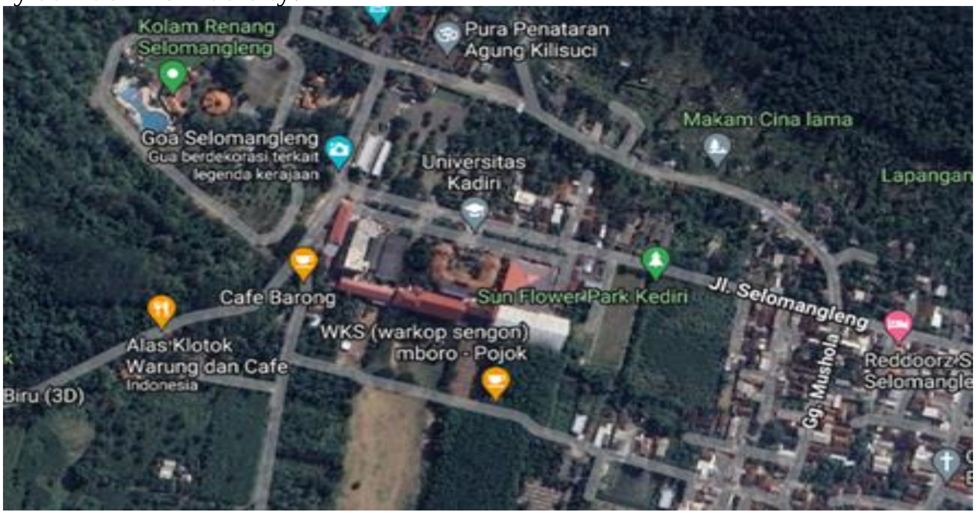

Figure 1. Research Location
Source: Google Maps Sampling

The soil samples taken were soil that was still in its natural state and did not experience interference from external factors, by digging to a depth of 2 meters for 15 kg. Sampling was carried out after conducting observations and site surveys, where the sampling location was considered to be an adequate representation of the entire research zone.

Research Process
The soil samples that have been taken are dried using an oven at 110° for 24 hours to remove the water contained in the soil. Pound the soil sample with a rubber mallet until it is smooth and passes through a size 40 sieve to find the appropriate soil grain gradation, and divide it into 5 samples weighing 2 kg each.

Figure 2. Drying of Soil Samples

To each soil sample, water samples were added in a predetermined percentage of soil weight, namely 16%, 19%, 22%, 25% and 28% of 2000g. Pour water over the sample and mix thoroughly (try to ensure the water does not evaporate).

Figure 3. Mixing Soil Samples

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Testing was carried out using the TS-356 Automatic Proctor Test tool. Identify the mold first to find out the inner diameter, outer diameter, height and weight of the mold. The mold is smeared with lubricant and placed in the test tool, then the soil sample is inserted into the mold by filling it 3 times to 1/3 of the height of the mold (standard). The pounding was carried out for each layer with a total of 25 collisions.

Figure 4. Sample pounding

The test sample is taken out and trimmed to ensure precision with a mold, then weighed to determine the wet weight of the sample.

Figure 5. Sample Weighing

The test sample is put into the oven to dry and weighed so that the dry weight of the test sample is known.

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Figure 6. Sample Results

RESULTS AND DISCUSSION

This test aims to understand the correlation between water content and the volume of soil to be tested. This is useful for determining the optimum water content (Optimum Moisture Content) and maximum density of the clay soil sample being tested. The laboratory testing process involves adding water to the original soil at certain intervals to obtain optimum water content and maximum dry volume. If the addition of water at certain intervals causes a decrease in the sample, this is caused by the pore cavities which were previously filled with solid soil grains, which are now filled with water. It is important to establish the relationship between water content and bulk density to evaluate the soil for compliance with density requirements. In this context, there is a certain optimum water content value that needs to be achieved to achieve the maximum dry volume, in accordance with the standard (ASTM D-698 of 1998).
This concentration test is carried out by heating the test material at a temperature of 1100 C for 18-20 hours. The following Table 1 presents the results of water content testing:

Tabel 1. Hasil Water Content Testing

TEST WEIGHT	**SAMPLE**				
	16%	**19%**	**22%**	**25%**	**28%**
MOLD WEIGHT (gr)	1678	1678	1678	1678	1678
WEIGHT OF WET SOIL+MOLD (gr)	3173	3365	3446	3473	3417
WET SOIL WEIGHT (W) (gr)	1494	1684	1768	1791	1736
OVEN DRY SOIL WEIGHT (Ws) (gr)	1263	1390	1438	1431	1363
WATER WEIGHT (Ww)= W-Ws (gr)	320	380	440	500	560
Water Content (Wc) = Ww/Ws*100 (%)	25%	27%	31%	35%	41%
MOLD VOLUME (V)= π .r2 . T (cm3)	882,48	882,48	882,48	882,48	882,48
WEIGHT VOLUME (ɣ) = W/V (cm3)	1,693	1,908	2,003	2,030	1,967
DRY VOLUME WEIGHT (ɣd) = Ws/V (cm3)	1,431	1,575	1,630	1,622	1,545

Table 1 presents the results of soil compaction tests from samples taken from the Kadiri University area. Compaction was carried out using a standard Proctor tool on sample 1 by adding water equal to 16% of the weight of the test material, we obtained a wet soil weight of 1494 grams with a wet volume weight of 1.693 gr/cm3 then dried so that a dry weight of 1263 grams with a dry volume weight of 1.693 grams was obtained. 1.431 gr/cm3, so it is known that the water weighs 320 gr with a water content of 25%. Next, adding water to sample 2 was 19% of the weight of the test material, we got a wet soil weight of 1684 grams, we got a wet volume weight of 1.908 gr/cm3, then dried it so that the dry weight was 1390 grams with a dry volume weight of 1.575 gr/cm3, so it was known water weight 380 grams with a water content of 27%. Followed by sample 3 with additional water of 22% of the weight of the test material, we got a wet soil weight of 1768 grams, so it was found that the wet volume weight was 2.003 gr/cm3, then dried to get a dry weight of 1438 grams with a dry volume weight of 1.630 gr/cm3, so it was known water weight 440 grams with a water content of 31%. Furthermore, in sample 4, with the addition of water of 25% of the weight of the test material, we obtained a wet soil weight of 1791 grams so that the wet volume weight was 2,030 gr/cm3, then dried so that the dry weight was 1431 grams with a dry volume weight of 1,622 gr/cm3. so it is known that the weight of water is 500 grams with a water content of 35%. Followed by sample 5 with additional water of 28% of the weight of the test material, we got a wet soil weight of 1736 grams, so we got a wet volume weight of 1.967 gr/cm3, then heated it so we could get a dry weight of 1363 grams with a dry volume weight of 1.545 gr/cm3. so it is known that the weight of the water is 560 grams with a water content of 41%. The results of the calculations produce a graph which is presented in the following figure:

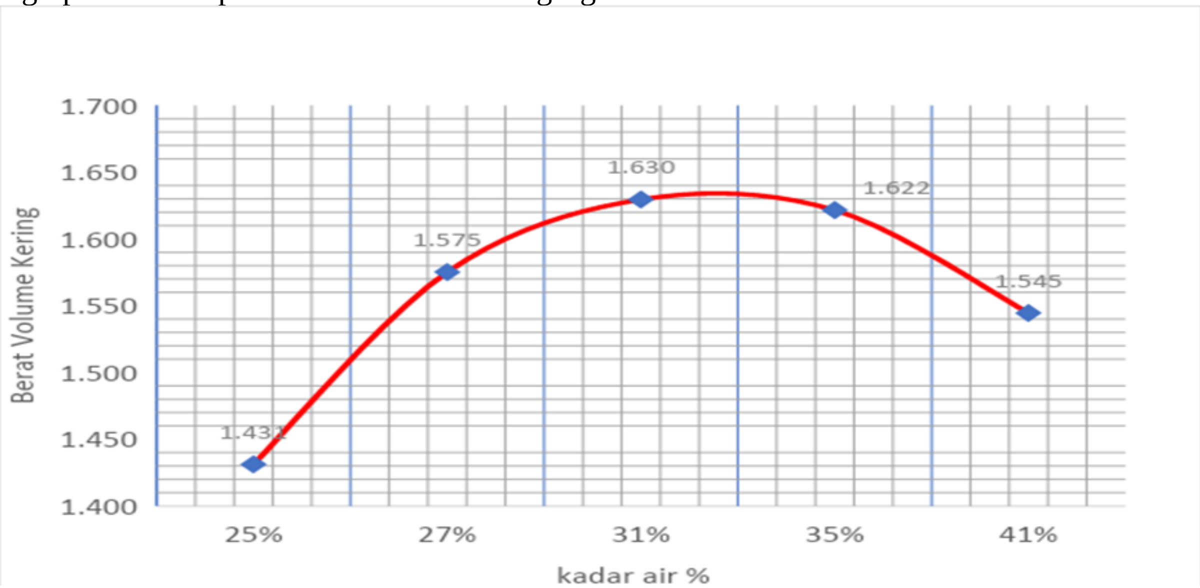

Figure 7. Soil Compaction Graph

Displays a bell shaped graph of dry volume weight against optimum water content. So it is known that the optimum water content is 32% with a dry volume weight of 1,630 gr/cm3.

CONCLUSION

Based on the results of tests and discussions that have been carried out, the land obtained from the Pojok area sub-district. Mojoroto, East Java obtained the results of soil compaction data using a standard proctor test, it was obtained that the optimum dry volume weight of the soil was 1,630 gr/cm3 and the optimum water content was 32%. So that the results of soil testing in the laboratory can be used as a reference to control soil compaction in the field.

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