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Soil Compaction in Highway Construction Design: An Assessment

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Abstract- Soil's carrying capacity is crucial, since it determines whether or not it may be used as a structural material. The criteria for strength and deformation change depending on the dry density. Soil stabilization and compliance with technical requirements for construction. Good embankment condition, like a solid foundation, requires compaction. This study compared the current proctor technique to the traditional proctor test for measuring soil compaction energy. The design process must take into consideration the soil's compaction energy, which is an important aspect in determining the soil's intensity. The results of the laboratory's Standard Proctor density were found to be 1.63 g/cm3, whereas the modified Proctor density came in at 2.18 g/cm3. The sand cone test for soil density yielded a result of 97.31 percent, indicating that the soil density had been achieved and the soil embankment should be used; however, when the standard proctor test process was applied to the soil density in the laboratory, the result was 73.54 percent lower.

Keywords— Soil, Standard Proctor, Stabilization.

I. INTRODUCTION

The foundation load from above-ground construction is supported and distributed by the soil used in the construction of buildings, roadways, and dams. When a task is scheduled to be completed, A building's foundation can only support as much weight as the earth can handle, hence the soil's bearing capacity must be greater than the building's total weight [1].

When the soil is compacted, which is one of the mechanical attempts to bring the soil grains together, the volume of the soil and the pore volume both decreases. However, the grain volume did not alter [2].
Many engineers factor in grinding or grinding in soil compaction when planning construction projects. There are key points to expose soil attributes (density, CBR, consolidation, permeability, shear strength, etc.) that may be influenced by the amount of water and dry soil present. Soil compaction plays a significant part in the construction of buildings, highways, airports, and other infrastructures.

Soil compaction is affected by a number of additional elements, some of which are context-specific. Proctor (1933) provided a graph showing the correlation between soil density and water content [3]–[5].

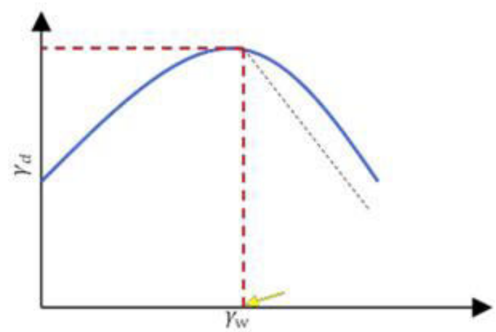

Figure 1: The relations between density (Y_d) and water content (Y_w)

One common laboratory experiment used to determine the optimal moisture content and maximum dry volume weight is the Proctor Compaction Test [6, 7]. There are two types of proctor compaction tests: the traditional proctor exam and the proctor compaction test with modifications. The studies were carried out [8]–[10]. Laboratory findings from the standard proctor test and the modified proctor test are compared to field results from the sand cone test for the purpose of determining how well the material compacts [11],[12]. When compacting earth, a certain amount of force yields a specific density. Optimal Moisture Content = OMC = Wopt is the optimal moisture content for achieving a high density. Maximum Dry Density (MDD) is another name for the highest density.

Table 1: Shows the size limitations for soil types that have been developed by several organizations that are experts in their fields

Name of organization	Gravel	Sand	Silt	Clay
Massachusetts Institute of Technology (MIT)	>2	2 to 0.06	0.06 to 0.002	<0.002
U.S. Department of Agriculture (USDA)	>2	2 to 0.05	0.05 to 0.002	<0.002
American Association of State Highway and Transportation Officials (AASHTO)	76.2 to 2	2 to 0.075	0.075 to 0.002	<0.002
Unified Soil Classification System (U.S. Army Corps of Engineers, U.S. Bureau of Reclamation)	76.2 to 4.75	4.75 to 0.075	Fines (i.e., silts and clays) <0.075	

Figure 2: Land Class Size Limits

II. METHOD AND MATERIAL

Soil compaction was carried out to find the optimum moisture content and maximum dry weight. This study used soil samples that passed sieve no. 4 and have been oven dry. To get the optimum moisture content (OMC) curve and maximum dry weight (MDD), From the results of soil properties testing, data can be seen in the table

Figure 3: Compaction in the laboratory

Sand Cone Testing

From the results of soil density testing in the field using a sand cone, it aims to directly check the soil density in the field. From the soil weight and soil volume, the density/weight volume of the soil will be obtained (γt), then the soil is ovalized and the moisture content (w) is obtained, and the density/volume weight of the dry soil (γd). From field d and soil d, the laboratory test results obtained the degree of density.

Figure 4: Field testing of sand cones

III RESULT AND DISCUSSION

The maximum dry soil weight value (Maximum Dry Density = γd_{max}) obtained from the standard test proctor test on the soil in Sijan Tung Village was 1.64 gram / cm3, which is less than the test results; dmax modified proctor test of 2.18 gr / cm3, or an increase of 32.92% from the density value with the standard proctor test. Maximum moisture content (Wopt) or Optimal Moisture Content (OMC) reduced by 13.8 percentage points is less than the Wopt standard set with a moisture content value of 15.0 percentage points, a reduction of 8.0 percentage points. According to the hypothesis, when soil is compacted using either conventional or altered procedures, the same soil is produced in both cases:

a) (MDD) γd_{max} modified > γd_{max} standard

b) (OMC) W_{opt} modified < W_{opt} Standard

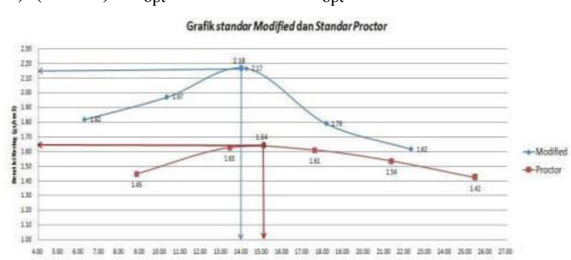

Figure 5: Modified Proctor Compaction Graph Proctor Standard

The necessary density has been met as determined by the results of field density testing conducted using a sand cone, which shows a density value of 97.31% in compaction with the standard proctor test. It's attained, and the soil may be put to use in stockpile applications, although the density figure of 73.54% is 23.77% lower than the density measured in a laboratory using a conventional proctor.

Table 2: Comparison of compaction results of Standard proctor test with Modified proctor test

Value compaction	Standard proctor test	Modified proctor test
MDD (gr/cm^3)	1.64	2.18
OMC (%)	15	13.8
Degree of field density (%)	97.31	73.54

Consolidation

The purpose of this test is to ascertain how quickly settlement occurs. The consolidation coefficient (C_v) is calculated as follows, based on the results of a laboratory consolidation test:

Table 3: Calculation results of laboratory consolidation coefficient (Cv)

Pressure (kg / cm2)	Consolidation coefficient (cm2 / minute)
0.5	0.013
1	0.016
2	0.029
4	0.039

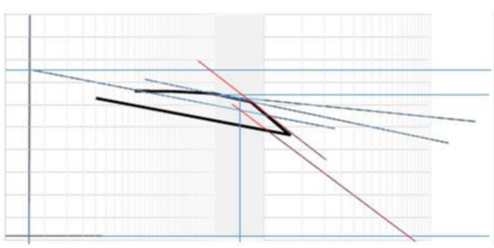

Figure 6: The graph of e log p

Conversion of pressure data (P) to pore count (e): Graph 43 shows that the land is Overconsolidated (OC) since the extension line crosses e0 at the correct coordinates for point A. Hardiyatmo (2012) states that OC soil has been subjected to pre-consolidation pressure, followed by the demolition of the ground above it and a gradual decrease in load until it reaches overburden pressure (Po').

IV. CONCLUSIONS

The following findings are drawn from an examination of data collected from a compaction experiment using a vibrating plate compactor and Klatak sand.

a) After performing a Standard Proctor compaction test on soil that has been mixed with sand, we find that the soil's maximum density is 1.14 g/cm3 when 30% Jebrod sand is added.

b) Obtained by conducting a vibrating plate compaction test while including 30% sand.

In the 8 mills, the density/CBR value peaked at 17.99%.

The soil moisture content was determined to be 17.38% based on the findings of the property index test. 2.57 percent soil density. The Atterberg limit test for Sijantung Sei Gong - Batam returned a liquid limit of 41.67 percent. There is a 13.42% plasticity index and a 28.25% plastic limit. The outcomes of Atterberg's analysis. The shrinkage rate of the soil is mild, at 41.18 percent, in the settlement of Sijantung, Sei Gong - Batam. Sixty-nine-point two percent of the dirt made it through all 200 sieves in the test.

According to the AASHTO criteria, the soil samples utilized in this investigation fell under categories A-7-5 (clay soil). The CL group (Inorganic clays) in the USCS soil classification system is reserved for clay soils due to their plastic nature and very substantial changing characteristics. The land exhibits similarities in categorization if the two soil categories are compared using the unified soil classification with AASHTO.

Laboratory standard proctor test soil density is 1.64 g/cm3, whereas modified proctor test soil density is 2.28 g/cm3, and the corresponding OMC values are 15% and 13.8%, respectively. Field testing using the Sand Cone tool yielded a degree of density of 97.31% (eligible because the value is> 95%), while the degree of density obtained using the modified proctor yielded a value of 73.54% (does not meet the standard because the value is 95%). Field compaction test results may indicate that a landfill is suitable for subgrade planning and road foundations, but these results will not be adequate for basic dam planning, which typically employs a modified proctor test. A higher density is the consequence of increased compaction energy. The following are some directions that might be taken in future studies:

a) It may be looked for with the use of a compacting load.

b) With the addition of more than 30% sand.

c) A stamper, a stoom wall, etc., are all valid options for conducting compaction tests.

d) Sandcone and rubber ballon tests are available for comparison.

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