International Journal Of Latest Technology In Engineering & Management (IJLTEM)
Volume 8 - Issue 1 {Jan-Feb. 2023} {Page: 11-15}

THE CORELATION BETWEEN THE CBR OF THE DYNAMIC CONE PENETROMETER (DCP) AND THE DIRECT SHEAR PARAMETER IN SOIL

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ABSTRACT: *Soil is a very important parn in a civil engineering construction work. Soil has an important role in holding the load above it so that shear failure and excessive settlement do not occur. To determine the bearing capacity of the soil, the parameters of the bearing capacity of the soil and the parameters of the shear strength are needed. The soil has a bearing capacity parameter, namely the CBR value, and a shear strength parameter, namely cohesion (c) and internal failure angle ( ). The purpose of this study was to determine the relationship between the CBR value and the DCP tool to the value of the shear strength in the soil. This study used disturbed soil samples. The study began by testing the physical properties, then the mechanical properties, namely DCP and direct shear strength with samples of the test object that had been compacted in the mold with different additions of water. The CBR values resulted from 5 conditions of addition of water were 52.94%, 55.02%, 59.10%, 47.21%, and 43.34%. While the resulting cohesion values are 0.7002 kg/cm2, 0.114 kg/cm2, and 0.1005 kg/cm2, and the failure angles are 45.96º, 35.32º, and 23.06º. The CBR value obtained from the DCP tool creates a non-linear relationship to the value of the shear strength in the soil. The higher the CBR value, the lower the shear strength of the soil.*

Keywords: *CBR, Direct Shear DCP,*

Introduction

Soil is a very important part of civil engineering construction work [1]. Soil has an important role in withstanding the load on it to avoid shear failure and excessive settlement. To determine the bearing capacity of the soil, soil bearing capacity parameters and shear strength parameters are needed. In general, soil bearing capacity parameters include cohesion and angle of collapse (c and φ), and density (γ) [2][3]. One of the soil bearing capacity parameters is the CBR value. CBR is conducted to determine the level of soil density and soil bearing capacity. There are two types of CBR testing, namely field CBR and laboratory CBR. The laboratory CBR value takes time to get the results, while the CBR value is obtained easily using the Dynamic Cone Penetration (DCP) tool [4].

Shear strength parameter is one of the parameters that can affect the bearing capacity of soil. Soil shear strength is the resistance force exerted by soil grains against pushing or pulling [5]. There are two parameters of soil shear strength, namely cohesion (c) and angle of collapse (φ) [6]. From these two parameters, the shear strength value of the soil can be determined. There are several ways that can be done to obtain the value of soil shear strength parameters, one of which is the Direct Shear Test method [7] [8] [9].

Based on this explanation, the author is interested in conducting research on the extent of the relationship between the CBR value of the DCP tool and the shear strength value of the soil as a parameter of soil bearing capacity [10] [11].

The purpose of this study is to determine the extent of the relationship between CBR value and shear strength value as a parameter of soil bearing capacity. While the objectives of this research are:

1. To determine the effect of density on the CBR value generated from the DCP tool.
2. To determine the relationship of CBR value with DCP tool to soil shear strength parameters (cohesion and angle of collapse).
3. To determine the relationship between the CBR value of the DCP tool and the shear strength value of the soil.

Methods

Before determining the sampling location, a site survey was first conducted to obtain the type of soil used in the study, where the type of soil used was coarse-grain dominant soil. After conducting surveys in several locations, the soil that meets the criteria as a research soil sample comes from Belabori Village, Parangloe District, Gowa Regency, South Sulawesi.After determining the location, soil collection was then carried out. Soil samples were taken in a disturbed state (Disturbed Soil). After that, the soil samples were brought to the research location at the Soil Mechanics Laboratory, Faculty of Engineering, Universitas Muslim Indonesia.

Figure. 1 Sampling Location (Google Earth, 2022)

Physical testing or preliminary testing to determine the physical properties of the soil samples used. Physical properties testing carried out by researchers, namely [12] [13]

- Specific Gravity
- Sieve Analysis
- Consistency Limits (Atterberg Limit)

The soil used is disturbed soil, so it needs to be compacted first and then formed the test object. Compaction is done using a mold with a volume of 2159.58 cm3 and a hammer weighing 2.5 kg. In 1 mold consists of 3 layers, where each layer is given 56 times the impact. In this test, 5 soil sample specimens were used where each sample was given different water additions. The addition of water used is 650 ml, 550 ml, 450 ml, 350 ml, and 250 ml. After passing the compaction process in the mold, the sample was molded using a Direct Shear ring measuring 5.95 cm x 2 cm. Making specimens is done every layer from the compaction results in the mold, where each layer produces 3 specimens. While the test specimens for DCP are soil samples compacted in the mold [14].

Testing with the DCP tool will determine the CBR value in construction planning in civil engineering. The correlation between the number of impacts and the penetration of the conus tip of the DCP tool into the soil will provide an explanation of the strength of the soil. The cones used in this research are 60º cones. The DCP tool is placed on the surface layer of the test specimen sample that has been compacted in the mold, after which the pounder is released until it falls freely and is stuck on the anvil, then readings are taken on the depth gauge every 1 impact, the reading is taken until the tip of the conus reaches the bottom of the test specimen (mold). Tests were carried out on 5 specimens of test objects according to the addition of different water.

This test is usually performed on at least 3 identical specimens with different normal loads to complete a series of direct shear tests. The direct shear strength method with vertical and horizontal loading determines the shear strength parameters obtained. The test was conducted 3 times with different specimens and normal loads. The normal loads used in this study are [15]:

1. The first specimen with a load of 6.31 kg
2. The second specimen with a load of 8.18 kg
3. The third specimen with a load of 12.25 kg

Results and Discussion

This research is divided into two testing properties, namely physical and mechanical properties. The samples used in the study consisted of 3 samples, where for testing the physical properties of each sample consisted of 3 specimens while for testing the mechanical properties of each sample consisted of 5 specimens according to the addition of water.

Based on the results of the sieve analysis, it can be seen that the soil used is more dominant in coarse grains compared to fine grains. In this research, the USCS (Unified Soil Classification System) soil classification system is used. Based on the physical properties test data, the samples used are classified as Silty Sands. It is known that sand has a low cohesive value. When the soil sample is given a certain addition of water (minimal water), the soil condition becomes loose. This causes the soil to be difficult to form as a test piece.

The CBR value increases as the soil density value increases. The increase in CBR value reaches 59.10% at a density of 1.3413 gr/cm3. However, in certain conditions there is a decrease in CBR value as the soil density value decreases. This is because the soil density increases and the distance between particles becomes smaller. If the soil density is low, the CBR value decreases, which indicates that the soil's ability to withstand loads is lower. The relationship can be seen in the figure 2 below.

The first paragraph under each heading or subheading should be flush left, and subsequent paragraphs should have a five-space indentation. A colon is inserted before an equation is presented, but there is no punctuation following the equation. All equations are numbered and referred to in the text solely by a number enclosed in a round bracket (i.e., (3) reads as "equation 3"). Ensure that any miscellaneous numbering system you use in your paper cannot be confused with a reference [4] or an equation (3) designation.

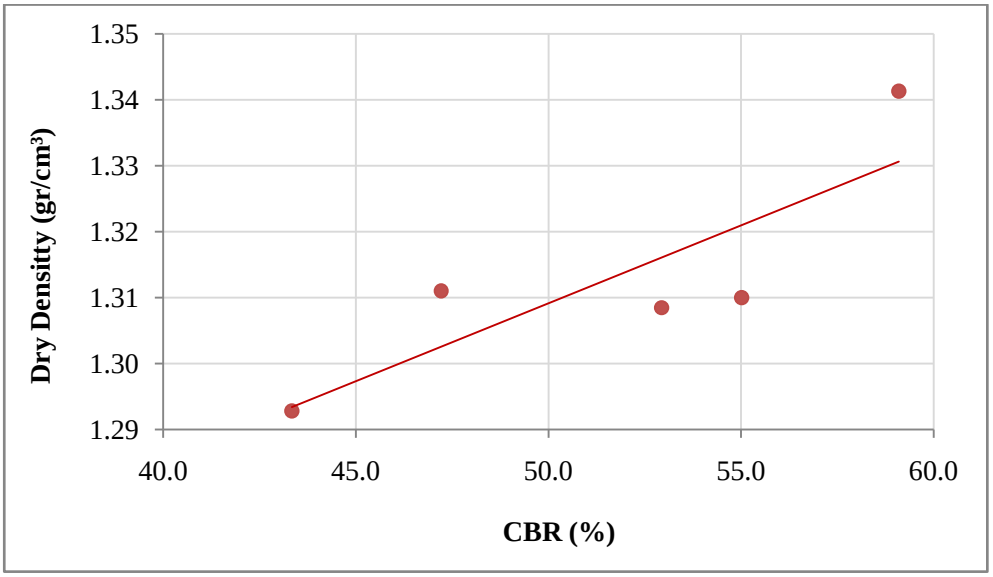

Figure. 2 Graph of the Relationship Between Soil Density and CBR Value

The higher the CBR value, the higher the cohesion value. At CBR values of 43.34%-59.10%, the soil cohesion value is 0.1055 kg/cm3-0.7002 kg/cm3. This is because the increased cohesion indicates that the attraction between particles in the soil is high so that the CBR value indicates that the value of the bearing capacity parameter owned by the soil is good. The relationship can be seen in the figure 3 below.

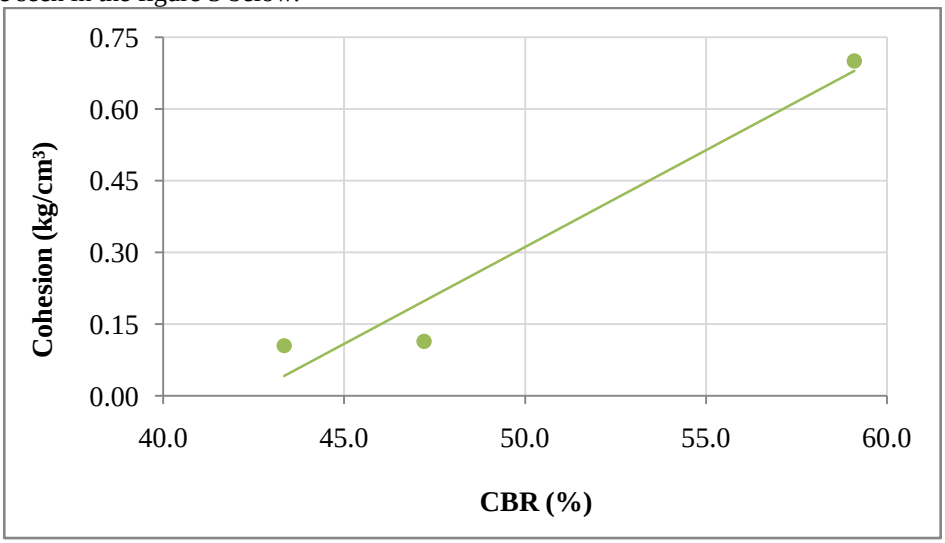

Figure. 2 Graph of the Relationship Between CBR Value and Soil Cohesion Value

The value of the angle of collapse in the soil decreases as the CBR value decreases. At a CBR value of 43.34%, the angle of collapse = 23.06º, at a CBR value of 47.21%, the angle of collapse = 35.32º, and at a CBR value of 59.10% the angle of collapse = 45.96º. This is because the CBR value shows the parameters of the bearing capacity of a soil in good condition so that the angle of collapse that occurs will be smaller. The relationship can be seen in the figure below.

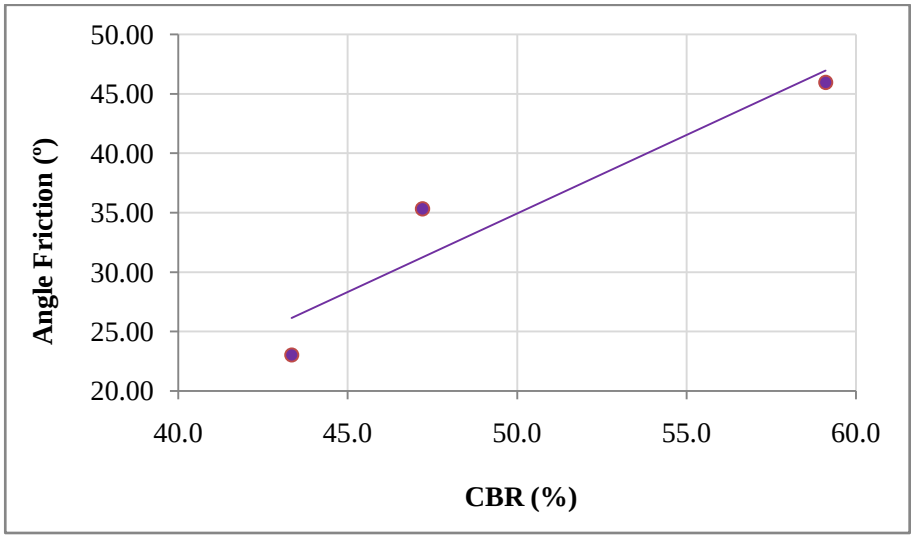

Figure 4 Graph of the Relationship Between CBR Value and Soil Collapse Angle

The value of soil shear strength decreases as the CBR value increases. At a CBR value of 43.34%, the shear strength = 1.32 kg/cm2, at a CBR value of 47.21% the shear strength = 1.46 kg/cm2, and at a CBR value of 59.10% the shear strength = 1.89 kg/cm2. This is because the CBR value shows the quality of a soil. A high CBR value indicates a good soil bearing capacity so that the shear strength that occurs will be smaller. If this condition is achieved, the soil will not be easily deformed. The relationship can be seen in the figure 5 below.

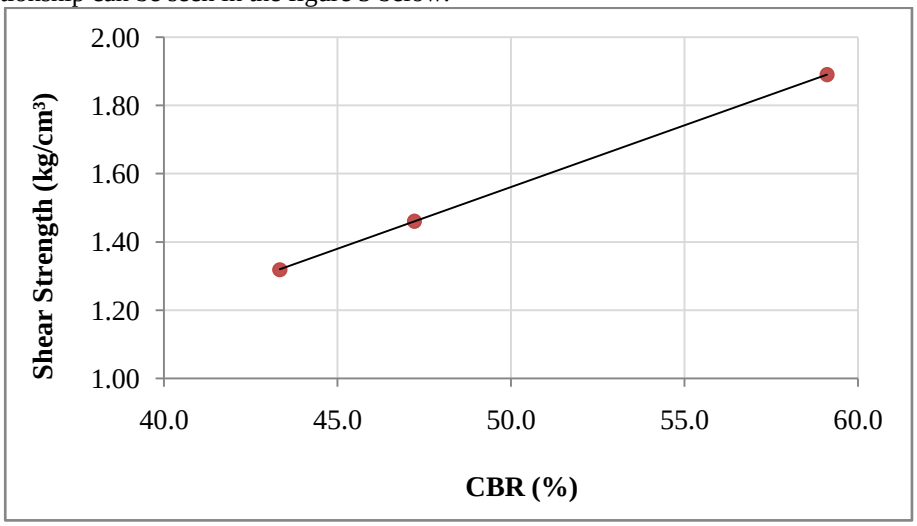

Figure 5 Graph of the Relationship Between CBR Value and Soil Shear Strength

Conclusion

Based on the results and discussion of this research, the author can draw several conclusions, namely:

1. Changes in soil density values can affect the CBR value generated from the DCP tool.
2. The CBR value from the DCP tool and shear strength parameters, namely cohesion and angle of collapse, can be used in determining the value of soil bearing capacity parameters.
3. Sandy silt soil has a low cohesion value at minimum water conditions but has a fairly good CBR value. This makes this type of soil good enough to be used for civil engineering construction planning such as foundation and highway design.

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