Study of CBR (California Bearing Ratio) value on peat soil of Asahan Regency Sumatera Utara Province

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Abstract. Peat soil is a type of soil within condition dominated by the litter of remaining plants which dead and rotten by nature so enrich with organic structure and water content in high concentration. This type of soil usually found in saturated water areas like swamp and basin. Called peat soil if organic structure content inside soil more than 30%, but swamp forests in Indonesia usually have more than 65% and more than 50cm depth. This research goal was to know the physical character (index properties) from peat soil and also the classification, to know the CBR (California Bearing Ratio) value of laboratory test and to know the CBR value after soaking the samples for 3 days. From this research it was found that peat soil from Pertanahan village, Sub-district Sei Kepayang Asahan Regency had 518.090% water content, 1.302 specific gravity, 3.672 void ratio, 0.454gr/cm³ moist unit weight, 0.098gr/cm³ dry unit weight, 45.032% ash content, 54.968% organic content, and it was classified as High Ash Peat. The peat soil had acidity pH of 4 and it was classified as Highly Acidic Peat with a pH less than 4.5. The CBR unsoaked value of peat soil was 6.750 % and the CBR soaked in three days was 2.800%.

1. Introduction
Almost similar to compost, peat soil is a type of soil that contains organic and high water content [1-5]. The carrying capacity of peat soil is low. The California Division of Highways in 1929 devised a means of classifying the suitability of a soil for use as a subgrade or base course material in highway construction. The method is a test known as the California Bearing Ratio (CBR) [6]. CBR is defined as the ratio of the unit load required to effect a certain depth of penetration of the penetration piston into a compacted specimen of soil to the standard unit load required to obtain the same depth of penetration on a standard sample of crushed stone [7]. The method of the CBR laboratory test is based on SNI 03-1744-1989 [8]. The CBR number is used to rate the performance of soils primarily for use as bases and subgrades of roads and airfields. The CBR value of 0-3 is rated as very poor subbase and the CBR value of 3-7 is rated as poor to fair subgrade [7]. The purposes of this research were to identify the index properties of peat soil, to determine the classification of peat soil, and to determine the strength of the soil from the CBR test.

2. Method
The research used experimental method which was done in the Soil Mechanics Laboratory, Department of Civil Engineering University of Sumatera Utara for index properties, compaction test and California Bearing Ratio test. For testing the element of minerals of peat soil was carried out at the Research and Standardization Office industry of Medan (BARISTAND). The research samples were
peat soil from Pertahanan Village, Sub-district of Sei Kepayang Asahan Regency. These samples were assumed to be representative of peat soil that was in Asahan Regency Sumatera Utara Province.

There was one sample to be used for the determination of ash content and organic content based on ASTM D2947-87 [9] and 6 samples for CBR tests. Proctor standard tests were executed to obtain the optimum water content and the maximum dry density and for CBR laboratory tests. All data were analyzed and would be presented in the form of tables, graphs, and explanations. The flow diagram of the research could be seen in Figure 1.

Start

1. Find a peat soil location
2. Sampling undisturbed soil and disturbed peat

Prepare to sample

Index properties of peat soil:
1. Ash content and organic content (1 disturbed sample)
2. Specific gravity (3 disturbed samples)
3. Water content (2 undisturbed samples)
4. Wet unit weight and dry unit weight (2 undisturbed and disturbed samples)
5. Void ratio (2 disturbed samples)
6. pH (1 undisturbed samples)
7. Mineral elements (1 disturbed sample)

Classification of peat soil

Data analysis

Discussion

Conclusion

End

Standard Proctor test

1 sample

CBR test:
1. 3 soaked samples
2. 3 unsoaked samples

Figure 1. The flowchart of the research.
3. Result and discussion

3.1. Index properties data
Index properties of the peat soil of the Pertahanan Village Sub-district Sei Kepayang Asahan Regency were shown in Table 1.

| No | Test                      | Result   | Index properties |
|----|---------------------------|----------|------------------|
| 1  | Water content             | 518.090% | 100-1300 %       |
| 2  | Specific gravity          | 1.302    | 1.25-1.80        |
| 3  | Void ratio (e)            | 3.672    | 5-15             |
| 4  | Moist unit weight (γ_m)   | 0.454    |                  |
| 5  | Dry unit weight (γ_d)     | 0.098    |                  |

3.2. Classification of peat soil
The result of ash content, organic content, and acidity content (pH) of peat soil were presented in Table 2.

| No | Test         | Result   | Peat classification based on ASTM D 4427-92 (2002) [5] |
|----|--------------|----------|------------------------------------------------------|
| 1  | Ash content  | 45.032 % | High Ash-Peat                                        |
| 2  | Organic content | 54.968 % |                                                     |
| 3  | pH           | 4        | Highly Acidic Peat                                   |

3.3. Mineral elements of peat soil
Mineral elements of peat soil were displayed in Table 3.

| Mineral elements | Unit | Result |
|------------------|------|--------|
| Silica (SiO_2)   | %    | 0.02   |
| Aluminum (Al_2O_3) | %    | 0.03   |
| Ferrum (Fe_2O_3) | %    | 0.40   |
| Calcium (CaO)    | %    | 0.29   |
| Magnesium (MgO)  | %    | 0.16   |
| Potassium (K_2O) | %    | 1.58   |
| Natrium (Na_2O)  | %    | 0.61   |
3.4. Compaction test

The standard Proctor test result was shown in Figure 2. It was concluded that the optimum water content was 34% and the maximum dry unit weight was 0.518 gr/cm$^3$.

![Figure 2. Correlation of optimum water content and dry unit weight.](image)

3.5. Correlation of water content with California Bearing Ratio value

The correlation of water content with the CBR was seen in Figure 3. It can be deduced that the CBR value decreased as the water content increased.

![Figure 3. Correlation of the CBR value with the moisture content.](image)

3.6. Correlation of moist unit weight with CBR value

The correlation of moist unit weight with the CBR was seen in Figure 4. It can be inferred that the CBR value decreased as the moist unit weight increased.

![Figure 4. Correlation of the CBR value with the moist unit weight.](image)
3.7. Correlation of water content with the dry unit weight
The correlation of water content with the dry unit weight was seen in Figure 5. The addition of water content caused the dry unit weight decreased.

![Figure 5. Correlation of the water content with the dry unit weight.](image)

3.8. Correlation of curing time with swelling
The correlation of the curing time with the swelling was shown in Figure 6. It can be deduced that the longer the curing time the greater the swelling of peat soil.

![Figure 6. Correlation of the curing time with the swelling.](image)

3.9. Correlation of curing time with California Bearing Ratio value
The correlation of curing time with the California Bearing Ratio value was shown in Figure 7. It was seen that the longer the curing time the smaller the CBR value.

![Figure 7. Correlation of the curing time with the CBR value.](image)
3.10 Correlation of curing time with void ratio
The correlation of curing time with the void ratio was presented in Figure 8. It was seen that the longer the test material is soaked than the higher the void ratio.

![Figure 8. Correlation of the curing time with the void ratio.](image)

3.11 Correlation of void ratio value with water content
The correlation of the water content with the void ratio was shown in Figure 9. Figure 9 explained if the water content increased then the void ratio increased.

![Figure 9. Correlation of the water content with the void ratio.](image)

3.12 Correlation between California Bearing Ratio and void ratio
The correlation between the CBR and the void ratio was shown in Figure 10. It was seen as the void ratio increased then the CBR decreased.

![Figure 10. Correlation of the CBR value with the void ratio.](image)
4. Conclusion
The output of the research could be concluded as follows:
1. Peat soil from Pertahanan village Sub-district Sei Kepayang Asahan Regency had water content \((w)\) of 518.090%, specific gravity \((G_s)\) of 1.302, moist unit weight \((\gamma_b)\) of 0.454 gr/cm\(^3\), dry unit weight \((\gamma_d)\) of 0.098gr/cm\(^3\), and void ratio of 3.672.
2. The peat soil had 45.032 % ash content and based on ASTM D4427-92, the peat soil was classified as High Ash-Peat with more than15% ash.
3. The peat soil had acidity pH of 4 and based on ASTM D4427-92, the peat soil was classified as Highly Acidic Peat with pH less than 4.5.
4. Based on the Standard Proctor test, the optimum water content was 34 % and the maximum dry unit weight was 0.518 gr/cm\(^3\).
5. The CBR soaked in three days and CBR unsoaked was 2.800 % and 6.750 % respectively. It can be concluded that the peat soil is rated as very poor for subgrade material.

Reference
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