Testing of the California Bearing Ratio (CBR) on the Bottom Foundation (LPB) Airport of Okaba District

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Abstract

Okaba Airport is one of the airports situated in Okaba District, Merauke Regency. The soil conditions in the Okaba District are soft. This airport requires the development and construction of airport amenities, including runway extension, taxiway development, and airport apron enlargement, in this instance the runway. This research utilized Okaba District subbase material. This study uses local materials to determine how much the CBR value is at LPB Okaba Airport. This research uses using experimental method. The tests included testing the physical properties of the original soil and local sand mixture from the Okaba district, including specific gravity, water content, bulk density, and grain distribution, and testing the mechanical properties of the original soil, including compaction testing and testing the California Bearing Ratio laboratory using local sand added materials. In the CBR test, the mixed soil is examined immediately, without curing. Based on the results of evaluating the physical qualities of the soil type at the location of the Okaba Kampung Wambi District, in accordance with AASTHO's hand drill results. The soil is class A-3, with fine sand as the predominant material, and the CBR value of the original soil load value of 0.1 in is 5% and the load value of 0.2 in is 4%; the results of the original soil CBR test added 10% sand added 10%, then 10% sand added material and 5% PC was 36%, then 10% sand added material, and 7% PC by 80%, and finally 10% sand and 9% PC by 85%.

Keywords: *Bottom Layer, Sand, California Bearing Ratio.*

A. INTRODUCTION

The pavement layer is essential in transmitting the load directly to the subgrade. The pavement layer's thickness and thinness affect the subgrade's ability to bear the load. If the pavement layer is thick, the power of the subgrade to bear the load is more significant. This is because the subgrade bears the entire pavement structure. Based on these conditions, it is necessary to evaluate the subgrade in planning the pavement thickness (Bado & Casas, 2021).

Okaba Airport is one of the airports found in the Okaba District in the Merauke Province. The Okaba District is characterized by soft soil conditions. This airport requires runway extension, taxiway development, and airport apron expansion, in this case runway extension (Tascon & Olariaga, 2021).

This study used subbase material from Okaba District, Merauke Regency, to construct the runway. To find out changes in the CBR value of this sub-base, we will try using sand from Okaba District. According to their origin, fine aggregates such as sand can be distinguished, namely excavated sand, river sand, or beach sand. Sand that is often found in Indonesia is beach sand. In all construction, sand is never separated from the work because sand is always used for mixtures or other uses such as embankments (Kusumaningrum et al., 2021). Research studies on soil have been carried out previously in an attempt to determine the physical properties and mechanical properties of the soil. To pay attention to changes in soil properties, the soil is usually added or mixed with other materials such as sand. The results show a difference in the value of both physical and mechanical properties (Spohn et al., 2018).

In road construction, one of the road layers is often referred to as a substructure or base layer. This sub-base is very important to support the highway structure in capacity. The soil layer consists of fine-grained and coarse-grained aggregates. Poor results are obtained when compaction is carried out on coarse-grained materials. To replace coarse aggregate, replace by adding sand. The reason for using local sand as an option for mixing the sub-base material is that we know that local sand is a readily available and economical material (Ramdas et al., 2021).

This research aims to study and deepen the Science of Soil Surveying as a field application of the fundamental theories of Soil Surveying obtained by the author in colleges, such as polygons, tools, and measurements, to map making.

B. LITERATURE REVIEW

1. Soil

Soil is a material composed of solid mineral grains that do not have a chemical bond between the particles and is a material formed from the weathering of organic matter and has a substance in the form of gas and liquid which is filled in the space between the particles (Wagai et al., 2020).

According to the engineering view, soil is a solid material. It can be organic, mineral, or loose sediments above the surface, where mutations occur because they are influenced by essential components such as organisms, time, weather, and the environment. Ordinary soils are generally distinguished by grain and can be grouped as clay or silt, sand, and gravel, depending on the grains that stand out from the soil type (Lin et al., 2022). Soil has three basic materials or main elements as its constituent structure: air, water, and grains. The air in the soil-forming composition does not significantly affect the technical condition of the soil, the most concerning the properties of the soil is water. The space between the grains in the soil component can be partially filled with air or water. If the empty spaces contain water, it is referred to as soil (partially saturated) or partially saturated soil (Eckertova et al., 2022).

There are 3 (three) phases of the elements of the soil itself, such as grains, air, and water. The three compositions of the soil can be seen in Figure 1. It has two elemental phases in saturated soil, namely, only water and grains. The phase diagram of the soil can be seen in Figure 1.

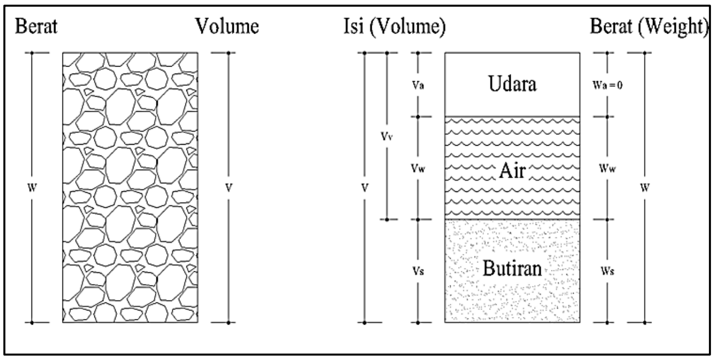

Figure 1. Soil Element in Its Original State and Three Phases Soil Diagram

Caption:
V = *Volume* (cm^3)
V_a = *Volume of air* (cm^3)
V_w = *Volume of water* (cm^3)
V_v = *Volume of void* (cm^3)
V_s = *Volume of solid* (cm^3)
W = *Weight* (gr)
W_s = *Weight of air* (gr)
W_w = *Weight of water* (gr)
W_s = *Weight of solid* (gr)

To find out (W) or soil weight and (V) volume, the following equation is used:
$V = V_s+V_v = V_s+V_w+V_a$ (1)

Assuming the existing air has no weight, the equation used to determine the total Weight is: $W = W_s+W_w$ (2)

a. **Sand**

Sand is a component of soil consisting mainly of the minerals quartz and feldspar. The properties of sandy soil are as follows:

1) The grain size is between 0.075 mm – 2 mm.
2) Non-cohesive.
3) Low capillary water rise, between 0.12 – 1.2 m.
4) Has a coefficient of permeability between 1.0 – 0.001 cm/sec.
5) The descent process is moderate to fast.

In sandy loam, the percentage is dominated by clay and sand particles, although sometimes there is also a small amount of gravel or silt.

Based on the AASHTO classification system, sand is rock particles measuring 0.075 mm to 2 mm, while according to the Unified classification system, sand consists of rock particles ranging in size from 0.075 mm to 4.75 mm. Sand can be described as finely graded, poorly graded, uniformly graded, or gaped. Sand is a type of soil that is not cohesive (non-cohesive soil) (Paulmichl et al., 2020). Non-cohesive soils have loose intergranular properties. This is indicated by the soil grains, which will separate when dried and only stick when in a state caused by surface tension. Non-cohesive soils do not have a boundary line between plastic and non-plastic states because this type of soil is not plastic for all water content values (Che et al., 2022).

b. Cement

Cement is a material that has properties that can harden and bind when mixed with water. The reaction caused by water and cement will produce a hard and robust material called hydraulic cement. Cement is obtained by crushing clinker, which consists of hydraulic calcium silicate minerals and gypsum as an additive. Cement itself consists of mostly silicate (SiO2), lime (CaO), aluminum (AI2O2), and iron oxide (Fe2O3) (Zhang et al., 2022).

Cement has a grain size ranging from 0.0 to 100 microns, with an average diameter of about 20 microns. For cement that has a grain size more significant than this, the cement cannot be completely hydrated. Therefore, cement must be finer to be profitable because the dehydration process can be fast. Because fine cement has more strength, using fine cement can increase the bearing capacity of the soil as an added stabilizing agent (Gottlieb et al., 2018). The cement, generally used as a construction material, uses type I portland cement. However, four types of cement are usually used in certain conditions. A brief description of the types of cement can be seen as follows:

1). Portland cement type I is a general-purpose cement usually used in ordinary construction works.

2). Portland cement type II has a relatively moderate heat of hydration and has unique properties for sulfates that are required for this type of cement. This type of cement is usually used for coastal buildings such as ports.

3). Portland cement type III in an emergency and in areas that have cold weather, this type of cement is highly recommended for use because this type of cement has a faster hardening process.

4). Portland cement type IV is usually used in buildings with low heat or hydration, such as large and thick concrete buildings. This type of cement is very good at preventing cracking.

5). Portland cement type V this type of cement has sulfate resistance, and this cement is usually used for tunnels and offshore drilling sites.

c. Testing the Physical Properties of Soil

Water content (water content, W) is a ratio of the Weight of the grains and the Weight of the water contained in the soil, expressed in units of percent, which can be seen in the equation:

$$W(\%) = \frac{W_w}{W_s} \times 100 \qquad (3)$$

Where:

W = Water content (%)

Ww = Water weight (gr)

Ws = Grain weight (gr)

The Weight of the soil is defined as the ratio between the total content of the soil and the Weight of the soil. The formula can calculate it:

$\gamma = \frac{Ws}{V}$ (4)

Information:

γ = Soil weight (gram/cm³)

V = Ring Volume (cm³)

Ws = Soil weight (grams)

The specific gravity of the soil (Specific Gravity) or commonly called the specific gravity of the soil (Gs), is a comparison between the Weight of solid grains (γs) and the Weight of the Volume of water (γw) at a temperature of 4○. The value of the specific gravity of the soil has no units or is dimensionless (Bhandari & Dhakal, 2020). The equation can be stated as follows:

$G_s = \frac{\gamma_s}{\gamma_w}$ (5)

Where:

Gs = Specific Gravity

γw = Solid volume weight (gr/cm3)

γs = Water volume weight (gr/cm³)

Table 1. Soil Density

Type of Soil	Specific Gravity Value
Gravel	2.65 – 2.68
Sand	2.65 – 2.68
Non-organic silt	2.62 – 2.68
Organic clay	2.58 – 2.65
Non-organic clay	2.68 – 2.75
Humus	1.37
Peat	1.25 – 1.80

The size of the soil grain dramatically affects the properties of the soil. The size of a soil grain is also used as a basis for classifying the soil and for giving the name and type of soil. The size of the soil grains is usually depicted in a graph so that the size of the grains and soil types can be known. The graph used is in the form of a curve or a grain divider curve graph. Soil is considered uniform graded because the gravic is almost vertical in size. If the curved line on the graph spans a large area, the soil is well-grained (Yudina et al., 2018).

There are two types of tests to determine the size of the soil grains, which can be seen below:

1). Sieve analysis

The grain analysis is usually used for coarse-grained soils (diameter grain size > 0.075 mm). The soil tested was using a standard sieve which can be seen in table 2.

Table 2. Sieve Size

Sieve number	Hole Diameter (mm)
3	6.350
4	4.750
6	3.350
8	2.360
10	2.000
16	1.180
20	0.850
30	0.600
40	0.425
50	0.300
60	0.250
70	0.210
100	0.150
140	0.106
200	0.075
270	0.053

2). Hydrometer Analysis

The main principle of the hydrometer analysis test is sedimentation or deposition of soil grains in water. This test is usually used for soils that have refined grains. To get the value of this test, it is simplified, and it is assumed that all soil particles have a spherical shape (Al-Hashemi et al., 2021). According to Stokes' law, the rate of grain deposition can be determined by the following equation:

$$V = \frac{\gamma_s - \gamma_w}{18\eta} D^2 \qquad (5)$$

Where:

V = Speed (L/t)

γw = Water volume weight (gr/cm3) γw = 1 gr/cm3

γs = Solid grain volume weight (gr/cm3) γs = Gs. γw

η = Absolute water viscosity (gr.det/cm2)

D = Soil grain diameter (mm)

2. CBR (California Bearing Ratio) Testing

The California Division of Highways introduced California Bearing Ratio (CBR) in 1928. Then the California Bearing Ratio method was popularized by O.J Porter. California Bearing Ratio is a load ratio that is for soil penetration of 0.1"/0.2" with the load retained by standard crushed stone at the penetration of 0.1"/0.2" (Kuttah, 2019)

So, the California Bearing Ratio results are defined as the comparison value between the standard load and the test load, whose value is displayed in percent. The purpose of CBR testing is to determine the value of the quality of the subgrade compared to standard materials in the form of crushed stone, which has a CBR value of 100% to carry the load from traffic movements (Bardhan et al., 2021).

There are two kinds of CBR testing methods: field CBR testing (in-place CBR) and laboratory CBR testing. Field CBR testing is used to obtain the original CBR value in the field according to the soil conditions in the area.

CBR (California Bearing Ratio) testing in the laboratory is divided into two types of testing methods, namely:

a. California Bearing Ratio test (soaked design CBR)
   Research is carried out more time, significantly, and somewhat more complicated. Compared with the California Bearing Ratio study without immersion (Kurnaz & Kaya, 2019).
b. Unsoaked Design CBR Testing
   The soil's bearing capacity results are better/more significant in this test from the California Bearing Ratio experiment than in the immersion CBR test. In this test, the Unsoaked Design CBR (Unsoaked Design CBR) test was used to obtain the results of the soil bearing capacity before and after stabilization (Yorulmaz et al., 2021).

Determine the Field CBR Test, carried out directly on the spot through the comparison step of the penetration stress in the tested soil layer with the penetration stress of the standard material. The field CBR test was carried out to determine the structural strength of the subgrade and the strength of the sub-base layer and the foundation layer used in a pavement thickness plan (Mendoza & Caicedo, 2019).

As for the processing data obtained simultaneously, namely, soil water content and soil compaction. Through the processing stage, following the standard for testing soil moisture content, the tool used is speedy, SNI 03-1965.1-2000, and the field density testing method uses the tool used, namely cone sand, SNI 03-1744-1989 (Kardani et al., 2022).

If field CBR testing is not possible to carry out in the field, then laboratory CBR testing will be carried out to obtain results. The laboratory CBR testing tool is the undisturbed test tool. The testing phase follows laboratory standards, SNI 03-1744-1989 (Singh et al., 2020).

If field CBR testing is not possible to carry out in the field, then laboratory CBR testing will be carried out to obtain results. The laboratory CBR testing tool is the undisturbed test tool. The testing phase follows laboratory standards, namely SNI 03-1744-1989 (Sevelova et al., 2021).

Dynamic Cone Penetrometer (DCP)

DCP is a tool used to measure the subgrade's bearing capacity, carried out directly. The bearing capacity of the soil is calculated based on the field DCP test results based on depth (mm), where the more profound the tip of the cone enters each collision, the softer the subgrade. After testing using the DCP tool in the field, the CBR results for the subgrade field will be obtained (Encinares et al., 2022).

The equations used to calculate the DCP test are:

$$\text{Log10 (CBR)} = 2.555 - 1.145 \, Log_{10} \, DN \quad (8)$$

3. AASHTO Classification System

In 1929 the American Association of State Highway Transportation Officials, commonly called AASHTO, developed a soil classification system for public road classification. Then in 1945, the Committee of Classification of Materials for Subgrade and Granular Type Road of the Highway Research Board made improvements to this system (Heinimann, 2021). This classification system divides soils into seven major groups, namely A-11 to A-7. Soil with the same grain size that passes the No. 200 sieve by 35% or less is grouped into groups A-1 to A-3. Meanwhile, soils classified as A-4- to A-7 are soils whose grain size passes the sieve number 200 as much as 35%.

Land grouping in this system is seen from left to proper readings in the existing table or chart. To find the first group of this system, we must first test to find out which group the soil belongs to. Tests carried out include:

a) Gradation analysis of grain size.
b) Shrinkage limit.
c) The plastic limit, liquid limit, and calculated IP.

Especially soils that have refined grains should be investigated further, according to the group. Soil classification in the AASHTO system can be seen in table 3:

Table 3. AASHTO Classification System

General Classification	**Granular Soil**	**Soil containing silt-clay**				
Group	A-3	A-4	A-5	A-6	A-7	
	A-2-7				A-7-5b	A-7-5c
	Percent Passing Filter					
No. 10						
No. 20						
No. 200	35 Max	36	36	36 Min	36	36 Min
Liquid Limit 2	41 Min	40	41	40 Min	40	41 Min
Plasticity Index 3	11 Min	10 Min	10	10 Min	10	11 Min
Soil Faction	Gravel and Sand		Silt		Clay	
Strength Condition	Very good		Not Good To Bad			

C. METHOD

The research was conducted in Okaba District, Merauke Regency. The location of Okaba airport is in the middle of Okaba village. Geographically, Okaba District is located at 8005′43″ south latitude and 139043′19″ west latitude.

Figure 2. Image of research location

Research on laboratory CBR (California Bearing Ratio) test on subbase layer material is a study to test soil strength by adding sand content. Where soil samples were taken around the location, which is the area of Okaba Airport, to stabilize it, it was tried to use sand following the material requirements for the sand category.

The characteristics of the soil parameters obtained, both in the original soil condition and in the addition of sand, were directly tested with a free laboratory CBR tool following existing procedures. However, before testing, calibration of the test equipment is carried out, this is done so that the specified standard specifications can be maintained.

The implementation procedure for both the manufacture of soil samples (test objects) and testing of soil samples follows the test procedures issued by AASTHO (American Association of State Highway and Transportation Officials) and ASTM (American Society for Testing Materials). The test results are recorded for each parameter obtained and analyzed following the intended purpose. Before preliminary testing and testing of the carrying capacity of the sub-base material is carried out, the preparation of tools and materials that will be used in testing is first carried out.

This research was conducted using local materials from the Okaba District, Merauke Regency, Papua Province. Sampling was taken in good condition, put in place, and then taken to the laboratory for analysis.

The freshly taken samples were dried in the sun for 1-2 days to achieve air-dry conditions. Furthermore, the soil is crushed from lumps using a rubber mallet so that the original grains do not break. Then the dry soil is sifted through a sieve. The sand used is river sand. Where the sand is sieved using sieve no. 40 and no. 80. Where the sand taken passes the sieve no. 40 and stuck no.80.

D. RESULT AND DISCUSSION

1. Soil Physical Properties Testing

Testing soil physical properties were carried out in the Civil Engineering Laboratory, Faculty of Engineering, Musamus University, Merauke. From the results of testing, the physical and mechanical properties of the soil obtained the following values.

Table 4. Recapitulation of laboratory test results

No	**Type of Examination**		**Symbol**	**Examination Results**
Native Soil Characteristic Test				
1	Water Content (w)		Wc	5.10 %
2	Specific Gravity (Gs)		Gs	2.62 %
3	Sieve Analysis Check			
	a.	Clay		4 %
	b.	Silt		20 %
	c.	Sand		76 %
	d.	Gravel		0 %
4	Fill Weight		γ	1.60 gram/cm^3
Additive Sand Test				
5	Water Content (w)		Wc	4.22 %
6	Specific Gravity (Gs)		Gs	2.67 %
7	Additive Sieve Analysis			
	a.	Clay		3 %
	b.	Silt		5 %
	c.	Sand		89 %
	d.	Gravel		3 %
8	Fill Weight		γ	1.85 gram/cm^3

Testing the soil water content is obtained by using equation 2 on page 13, namely:

From the results of laboratory water content testing for handbook samples, the following data were obtained:

$w = \frac{Ww}{Ws} \times 100\%$

Ww = 2.20 gram, Ws = 37.70

$w = \frac{2.20}{37.70} \times 100 = 5.84\ \%$

Testing the moisture content (Wc) of the original soil of Okaba Airport was carried out one time, from the results of the test, the water content value can be taken so that it can be concluded that the original soil of Okaba Airport has a moisture content of 5.10%.

Testing the specific gravity of the soil is calculated by equation 4, page 14, namely:

Volume weight of soil (γs) = W2 – W1

= 124.50 – 78.10

= 46.40 gram

Water volume weight (γw) = (W4-W1) – (W3-W2)

= (171.90 – 78.10) – (200.50 – 124.50)

= 17.80

Specific gravity (Gs) = 2.61

The results of testing the specific gravity (Gs) of the original soil of Okaba airport were carried out once. Based on the laboratory testing results, the specific gravity value of 2.62% means that the original soil is fine-grained sandy soil.

The handbook sample from the test results data is obtained:

Ws = (ring weight + soil) - (ring weight)

Ws = 152.9 – 56.6 = 96.30 gram

Ring volume = 63.39 cm³

$\gamma = \frac{Ws}{V} = \frac{96,30}{63,39} = 1.60$ gram/cm³

This test aims to obtain the percentage of soil grains in one filter unit. The required sample weight is 500 grams. The sieve analysis test can be calculated using the following equation:

The percent left behind the filter Ø sieve 0.075 = $\frac{371.8}{500}$ x 100% = 74.36%

Table 5. The results of the sieve analysis test

Ø Sieve (Mm)	Lagging Weight (Gram)	% Left behind	Cumulative Pass (%)
4.760	0.00	0.0	100
2.380	0.04	0.04	99.96
2.000	0.06	0.02	99.94
1.190	0.08	0.02	99.92
0.600	0.10	0.02	99.90
0.245	0.22	0.12	99.78
0.300	0.26	0.04	99.74
0.250	0.28	0.02	99.72
0.177	0.34	0.06	99.66
0.075	74.70	74.36	25.30

a) Additive Soil Test

The percent left behind the filter Ø sieve 0.075 = $\frac{126.1}{500}$ x 100% = 25.22%

Table 6. Test Results of Added Material Filter Analysis

Ø Sieve (Mm)	Lagging Weight (Gram)	% Left behind	Cumulative Pass (%)
4.760	1.68	1.68	98.32
2.380	4.36	2.70	95.62
2.000	6.24	1.68	93.76
1.190	9.90	3.66	90.10
0.600	19.58	9.68	80.42
0.245	24.62	5.04	75.38
0.300	32.58	7.96	67.42
0.250	46.24	13.66	53.76
0.177	66.30	20.06	33.70

0.075	91.52	25.22	8.480

Table 7. Recapitulation of Laboratory Test Results

No	Type of Examination		Symbol	Examination Results
Soil Mechanical Properties Testing				
1	Compression			
	a.	Optimum Moisture Content	γd	6.500%
	b.	Optimum Dry Weight	Wopt	1.800 gr/cm³
2	Direct Slide Strong			
	a	Sliding Angle	φ	44°.
	b	Cohesion	c	0.003 kg/ cm³
3	CBR Laboratory			
	CBR Real Soil			
	a	Rated Load 0.1		5 %
	b	Rated Load 0.2		4 %
	CBR Original Soil + 10% Sand			
	a	Rated Load 0.1		10 %
	b	Rated Load 0.2		7 %
	CBR Real Soil + 10% Sand + 5% PC			
	a	Rated Load 0.1		36 %
	b	Rated Load 0.2		33 %
	CBR Real Soil + 10% Sand + 7% PC			
	a	Rated Load 0.1		80 %
	b	Rated Load 0.2		76 %
	CBR Real Soil + 10% Sand + 9% PC			
	a	Rated Load 0.1		85 %
	b	Rated Load 0.2		78 %
4	Field DCP			
	Average CBR			15.44%

b) Dynamic Cone Penetrometer Test

From the results of the field DCP testing carried out at point 1, the following DCP data were obtained:

$\mathrm{Log}_{10}(\mathrm{CBR}) = 2.555 - 1.145\ \mathrm{Log}_{10}(\mathrm{DCP})$

$= 2.555 - 1.145\ \mathrm{Log}_{10}(4{,}55)$

$= 63\ \%$

Table 8. Recapitulation of Dynamic Cone Penetrometer (DCP) test results

C	Test point	Penetration Depth (mm)	CBR value	Average CBR (%)
a	b	c	d	e
1	1	227	43.27	15.44

2	2	312	22.91	
3	3	327	8.410	
4	4	306	10.31	
5	5	368	13.76	
6	6	454	11.33	
7	7	415	12.49	
8	8	444	8.630	
9	9	452	9.410	
10	10	426	13.16	
11	11	451	11.28	
12	12	486	7.120	
13	13	482	14.12	
14	14	371	21.23	
15	15	377	22.96	
16	16	424	13.64	

Table 9. Recapitulation of Laboratory CBR test results

Load		Examination Results
CBR Soil Native		
a	0.1 in	5 %
b	0.2 in	4 %
CBR Original Soil + 10% Sand		
a	0.1	10 %
b	0.2	7 %
CBR Original Soil + 10% sand + 5% cement		
a	0.1 in	36 %
b	0.2 in	33 %
CBR Original Soil + 10% sand + 7% cement		
a	0.1 in	80 %
b	0.2 in	76 %
CBR Original Soil + 10% sand + 9% cement		
a	0.1 in	85 %
b	0.2 in	78 %

2. Discussion

Based on the recapitulation of the results of soil laboratory testing at Okaba Airport, the fraction of soil that passed the No. 200 sieve was 25.30%. Based on the AASHTO classification, if the soil that passes the No. 200 sieve is less than 35%, the soil is sandy and fine-grained, classified in group A-3. Based on the recapitulation of the results of the local soil laboratory testing in the Okaba district, the soil fraction that passed sieve No. 200 was 8.48 %. Based on the AASTHO classification, if the soil that passes the No. 200 sieve is less than 35%, the soil is sandy and fine-grained, which is classified in group A-3, with the most dominant type of material being fine with excellent quality. The soil shear strength test results obtained cohesion (c) = 0.003 kg/cm^3 and the value of the shear angle (φ) = 44°. Based on the compaction test results, the optimum moisture content of Wopt = 6,500% and the optimum dry weight d = 1,800 gr/cm^3 were obtained. Based on the results of laboratory CBR testing, the original soil CBR value was 0.1 in = 5% and the load value was 0.2 in = 4%, the original soil plus sand was 10%, the load value was 0.1 in = 10% and the load value was 0.2 in = 7 % of the original soil CBR test results plus 10 % sand added material, 5 % PC load value 0.1 in = 36 % and 0.2 in = 33% load value, 10 % sand added material, 7 % PC load value 0.1 in = 80 % and load value 0.2 in = 76 %, added material 10 % sand, 9 % PC load value 0.1 in = 85 % load value 0,2 = 78 %.

Based on the test results on 0.1 inch penetration at the time of mixing the original soil; obtained CBR value of 5% for native soil + 10% local sand by 10%, original soil + 10% local sand + 5% cement by 36% for native soil + 10% local sand + 7% cement by 80% then decreased CBR value on the original soil + 10% local sand + 9% cement by 85%.

Based on the test results at 0.2 inch penetration at the time of mixing the original soil, the CBR value was 4% for the original soil + 10% local sand, 7% native soil + 10% local sand + 5% cement, 33% for native soil + 10% local sand + 7% cement by 76% then increased CBR value on the original soil + 10% local sand + 9% cement by 78%.

Based on the results of the California Bearing Ratio (CBR) test, the original soil laboratory of Okaba Airport has a penetration value of 0.1 inches, which is 5%, and a penetration value of 0.2 inches by 4%, the smallest CBR value is taken, which is 4%. The CBR value of the original land shows that the land's value is not good. The CBR value tested using locally added sand, and cement increased in the percentage of each sample. From the test results, the CBR value of the original soil experienced a significant increase from the original soil and after adding added materials to get a better CBR value.

Based on the DCP data from the nineteen points, it can be analyzed that the bearing capacity of the subgrade obtained from the field testing results obtains an average CBR value of 15.44% of the airport soil layer, which is dominated by fine-grained sand to a depth of 7 meters. With the same layer of soil as fine-grained sand.

Based on the examination (Validation) of the DCP field test data and the CBR laboratory test data, the results of the DCP and laboratory CBR data tests can be analyzed that the original soil CBR gets a value of 5%. The average CBR field DCP is 15.44% after testing by adding sand and cement, where the CBR value obtained increases by obtaining the test result is 85%.

E. CONCLUSION

Based on the results of the study and discussion, it is possible to infer that the type of soil on local materials according to AASTHO in the Hand drill results is soil class A-3, with fine sand as the predominant material, and the value of local laboratory

CBR testing is 10%. Based on the results of research conducted in the laboratory, the values obtained do not meet the requirements or requirements in table 4 of the gradation of the subbase layer and table 5 of the properties of the subbase layer. After testing the addition of cement to the local material of the Okaba district, it can increase the CBR value of the local material of the Okaba district.

Okaba airport fine-grained sand soil tested for laboratory CBR with the addition of local materials from the okaba district and cement can increase the CBR value. The original soil CBR value of 0.1 in is 5%, and the load value of 0.2 in is 4%, then the results of the original soil CBR test plus 10% sand added 10% then 10% sand and 5% PC added 36 %, then 10% sand, and 80% PC 7% then added 10% sand and 85% PC 9% PC.

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