CORRELATION BETWEEN CBR WITH PHYSICAL PARAMETERS OF RECLAMATION EMBANKMENT SOIL

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Abstract— The high population growth causes residence area to become narrower and narrower, so it is required to develop the area. One of the several ways for developing the area is reclamation. Reclamation is soil embankment with very large scale of volume and width in an area or free and watery zone, such as coastal area, swamp, river, lake and a location in sea.

In coastal reclamation, it is required a great deal of embankment material. There are prerequisites that have to be fulfilled as embankment material. The general prerequisites are 80% minimum sand and 20% maximum silt-clay. Whereas another prerequisite is compaction. Contractor as a reclamation implementer on site that wants to know embankment material fastly and easily is only by conducting CBR test a kind of density test, it is without conducting other types of density test. By using this test, it is known other parameters of soil density, such as dry density, void ratio and porosity.

This research is carried out by means of laboratory test for studying correlation between CBR with physical parameter of reclamation embankment soil. This test uses embankment materials, namely: clay-silt (sieve releasing No.200 or material with diameter 0.075 mm) and sand (sieve releasing No.10 or material with diameter 2 mm). There are 5 samples with composition of sand : clay-silt. The test is conducted with the following steps. The first step is modified proctor compaction with 60 total samples (6 variations x 5 samples/variations x 2 samples saturated-unsaturated of condition). The next step is CBR value test using 60 samples (6 variations x 5 samples/variations x 2 samples of saturated-unsaturated condition) with saturated condition (soaked) and unsaturated condition (unsoaked). The last step is volumetric-gravimetry and specific gravity tests using 120 samples (6 variations x 5 samples/variations x 2 saturated condition samples – 2 unsaturated condition samples).

The result of this research indicates that the larger of CBR value, the heavier the weight of dry volume ($\gamma_d$), the less of void ratio ($e$) and porosity ($n$), and on the contrary. The largest $\gamma_d$ value is obtained from mixture of 90% sand and 10% clay-silt where in unsaturated condition with CBR value (CBR = 44.068 %) and in saturated condition with CBR value (CBR = 21.3099 %), it is obtained the same $\gamma_d$ value ($\gamma_d = 2 t/m^3$). The research result is also indicated with correlation between $\gamma_d$ with CBR, that in linear regression, unsaturated soil is (CBR = 31,989. $\gamma_d$ -20,096) and saturated soil is indicated with (CBR = 58,014. $\gamma_d$ - 92,613). The equation between these parameters is valid whenever it is used for reclamation material with 80% minimum sand and 20% maximum clay-silt compositions.

Keywords— embankment, reclamation, physical parameters , CBR.

1. INTRODUCTION

The high population growth causes residence area to become narrower and narrower, so it is required to develop the area. According to the
definition, a type of reclamation is soil embankment with large scale of volume and width in an area or free area and watery zone such as coastal area, swamp, river, lake, and a location in sea. Reclamation is an appropriate way for overcoming high cost as an effort of releasing area or location when the area that is densely populated has to be built.

There are prerequisites that have to be fulfilled as embankment material. The general prerequisites are sand 80% minimum and clay-silt 20% maximum. Whereas another prerequisite is compaction (Wahyudi, H, 1997). Contractor as a reclamation implementer on site that wants to know embankment material fastly and easily has to check the sand and clay-silt composition. From this composition it can be determined whether the material fulfills the prerequisite or not for embankment material, based on the compaction required without conducting the compacting test such as sand cone or on site CBR test.

Beside that compaction is also influenced by water content. In site, the water content is influenced by wet season while reclamation is always related with the rise and fall of the tides of water environment. This soaked and unsoaked conditions influence compacting process

By looking this condition, the problems of the research are:
- How does the sand and clay-silt composition influences the unit weight of dry soil ($\gamma_d$).
- What is the correlation between soil compaction ($\gamma_d$) and CBR value.
- How does the water content ($w_c$) influences CBR value.
- What is the correlation between void ratio and porosity of embankment soil with CBR.

This research is expected to become a solution in handling the problem of selecting embankment material in coastal reclamation. It is also expected to determine the composition and physical parameter of embankment material required based on CBR expected.

2. LITERATURE REVIEW

2.1. Physical Parameters of Soil

- **Volume Weight ($\gamma$)**
  \[ \gamma = \frac{W}{V} \]

- **Dry unit weight of soil ($\gamma_d$)**
  \[ \gamma_d = \frac{W_s}{V_s} \]

- **Saturated degree (Sr)**
  \[ S_r = \frac{V}{V_v} \times 100\% \]

- **Void Ratio ($e$) and porosity ($n$)**
  \[ e = \frac{V_f}{V_s} \]
  \[ n = \frac{G_s}{(1 + w_c)\gamma_t} \]
2.2. Compaction

Lee and Suedkamp (1972) studied the compacting curves from 35 types of soil. They concluded that the soil compacting can be classified into only four general types. The results can be seen in Figure 1. The type A compacting curve has bell shape. This shape is usually found in all of clay with the value of liquid limitation (LL) between 30 – 70. The type B curve has one half peak shape. This shape is usually found in sand with LL < 30. The result of type B curve is more appropriate than another type curve for our sample condition that also uses samples dominated with sand. The type C curve has double peaks shape. This shape is found in soil with LL < 30 or LL > 70. The type D curve has queer shape, and this shape is usually found in soil with LL > 70.

2.3. Swelling

Swelling calculation can be determined by using the following equation:

\[ \varepsilon_1 = \left( \frac{\Delta H}{H_0} \right) \times 100 \% \quad \text{with:} \]

- \( \varepsilon_1 \): vertical axial strain (\%)
- \( \Delta H \): increase in test material (mm)
- \( H_0 \): early height of test material (mm)

The previous research conducted for predicting the swelling value occurred in a type of soil was as a research carried out by Seed et al, 1962 that was the discussion about correlation between plasticity indexes (PI) with swelling potency. This research was focused on material testing with clay percentage of clay from 8 – 65 %, then test material was to be compacted by using modified proctor test; and after the compacting process, material test was loaded in the amount of 5 kg. This research result was stated in the form of equation and correlation table. This correlation used plasticity index as a comparing. The equation resulted were \( \varepsilon_s = 1.10^{2.24} \text{Ip} \), whereas correlation table between Ip (%), \( \varepsilon_1 \) (%), and swelling potency such as the following:

As a comparison, the research of swelling potency was also carried out by Williams & Donaldson (1980). This research was almost similar with Seed et al's research, the only difference is in its rate of equation, if the rate of Seeds et al is \( \varepsilon_1 \) (%), the rate of Williams & Donaldson is clay percentage (%) contained in a test material. This following graph is the correlation graph result between clay percentage (%), plasticity index (PI), and swelling potency.

2.4 CBR Test

The CBR testing is a penetrating test that is when a cylinder piston is compacted in soaked soil with constant loading velocity. A load curve toward penetration can be made and this curve is compared with standard curve obtained from crush rock. For many cases, CBR test value is determined by comparing the load of the piston at 0.1 inch (2.5 mm) in soil with crush rock, and this is stated in percentage.

In Figure 3. Curve 1 is a standard curve for CBR=100%. Curve 2 is a CBR experiment curve conducted with the following explanation:

- P: vertical stress needed
- Ps: stress occurred in decreasing 0.1 inch (2.54mm).

3. RESEARCH METHODOLOGY

The research that will be implemented in Soil Mechanics Laboratory-Civil Engineering ITS Surabaya is carried out on an experimental way. The testing material is soil embankment.
that has variated composition based on sand and clay-silt.

3.1. Material Used

Material composition and sample quantity of this research can be seen in the following table 2.

From the embankment material conditioned, it is conducted the following steps:

a. Compacting is conducted with Modified Proctor Test, with the assumption that in implementing the reclamation work and operational, we used a number of heavy equipment. Material test is made by using mold with diameter 15.2 cm and height = 12.7 cm, it is needed the volume 2303.35 cm³. From Modifier Proctor Test, it is obtained 5 test material variations with different water content (Wc) and unit weight of dry soil (γd).

b. CBR testing is conducted with 50 test material variations as the result of Modified Proctor. The testing of compaction force using CBR and CBR value is obtained from soaked and unsoaked CBR testing, with 4 days of soaked period. For soaked CBR, it is assumed as soaked condition and unsoaked CBR as unsoaked condition.

c. For swelling test it is conducted in the same time with soaked CBR by dail swelling reading for every 24 hours during 4 days. And we add a load of 5 kg to the mold CBR.

d. The next step after CBR test, it is conducted Volumetric-Gravimetric test for obtaining physical parameters of soil, such as the density of granule (γt), water content (Wc) and specific gravity (Gs) in the soaked and unsoaked conditions.

For understanding the testing steps, it can be seen in the following flowcharting figure 4:

4. THE RESEARCH RESULT AND DISCUSSION

In this research, tests are conducted toward two testing materials, soaked and unsoaked conditions, these tests are generally Modified Proctor, CBR, and Volumetric-Gravimetric with sand and clay-silt material compositions that have the following percentage: 100% : 0%, 95% : 5%, 90% : 10%, 85% : 15%, 80% : 20%.

4.1. Correlation between unit weights of dry soil (γd) with Water Content (w_c) from Modified Proctor Test

4.1.1. Unsoaked Condition

In Figure 5, it is seen that there is a tendency in all sand and clay-silt compositions, the larger the water content (Wc), the larger the weight of dry volume (γd), but in certain water content the γd value will decrease. This is caused by the large amount of water percentage filling pores between granular, so solid granular percentage that fills in pores is not maximum. In Figure 5, it is also seen that the larger the clay-silt percentage in mixture, the larger the optimum water content (Wc). This is caused by the large amount of clay content (SiO₂), and it can absorb a large amount of water (H₂O).

When it is seen from compaction aspect (γd_max), the larger clay-silt percentage, the larger the compacton (γd_max), but in mixture with 15% and 20% clay-silt, the compaction (γd_max) decreases. This is caused by large amount of clay which can cause instability such as low carrying capacity and large decreasing. The largest γd value occurred in the compositions of 90% sand and 10% clay-silt.

4.1.2. Soaked Condition

In Figure 6, it is seen that all of sand and clay-silt compositions are dominant. The increasing of water content (w_c) will be followed by the
increasing of the $\gamma_d$ value, but in a certain water content, the decreasing of the $\gamma_d$ value will occur. This is happening because of the smallness of void ratio and porosity, so the compaction increases. In Figure 6, it is also seen that the increasing of clay-silt percentage will be followed by the increasing of optimum $w_c$. This is occurring because of clay content (SiO$_2$) increasing in the same time as water absorbed is increasing (Mitchell, 1976). From the compaction aspect ($\gamma_{d_{\text{max}}}$) it is observed that, the increasing of clay-silt percentage will cause the increasing the compaction ($\gamma_{d_{\text{max}}}$), but in mixture materials with 15% dan 20% clay-silt, it will decrease the compaction ($\gamma_{d_{\text{max}}}$). This is caused by instabilities (low carrying capacity and large settlement) happening in material with high clay content, but the value of $\gamma_{d_{\text{max}}}$ in soaked condition is smaller than in unsoaked condition, the example is in 90% sand, 10% clay-silt compositions in soaked condition $\gamma_{d_{\text{max}}}=2,09$ t/m$^3$ and $w_{c_{\text{opt}}} = 11,14 \%$ whereas in unsoaked condition $\gamma_{d_{\text{max}}}=2,05$ t/m$^3$ and $w_{c_{\text{opt}}} = 14,76 \%$.

4.2 Correlation between Swelling Value with Water Content in Soaked Condition

It is important to know that swelling test conducted belong to non free-swelling category, where testing material is given a loading as big as 5 kg after compacting process of modified proctor.

4.2.1 Testing Material with 95% Sand and 5% Clay-Silt Compositions

In Figure 7 above, it is seen that there is a tendency in 95% sand and 5% clay-silt compositions, the higher the water content percentage in ripening, the smaller the swelling value in soaked period. This is caused by testing material with high water content percentage, the swelling process occurs earlier in ripening period.

4.2.2 Testing Material with 90% Sand and 10% Clay-Silt Compositions

In Figure 8 above, it is seen that there is a tendency in 90% sand dan 10% clay-silt compositions, the higher the water content percentage, the smaller the swelling value. This is caused in testing material with high water content, the swelling process occurs earlier in ripening period. It is important to know that in the percentage of water content (14,60% and 18,25%), the decreasing process is occurring in early observation until 24 hours. This is caused by the resistance of clay-silt and water mixing that is not completely able to restrain the loading cell in the above testing material.

4.2.3 Testing Material with 85% Sand and 15% Clay-Silt Compositions

In Figure 9 above, it is seen that there is a tendency in 85% sand and 15% clay-silt compositions, the higher the water content percentage, the smaller the swelling value. This is caused in testing material with high water content percentage, the swelling process occurs earlier in ripening process. It is important to know that it is different in 90% sand and 10% clay-silt compositions; in 85% sand and 15% clay-silt compositions, the percentage of water content (14,60% and 18,25%) in early observation does not decrease. This is caused by the resistance of clay and water mixture that is able to restrain the loading cell in the above testing material.

4.2.4 Testing Material with 80% Sand and 20% Clay-Silt Compositions

In Figure 10 above, it is seen that there is a tendency in 80% sand and 20% clay-silt compositions, the higher the water content percentage, the smaller the swelling value.
This is caused in testing material with high water content percentage, the swelling process occurs earlier in ripening period. It is important to know that the same with 85% sand and 15% clay-silt compositions, testing material with 80% sand and 20% clay-silt compositions, the percentage of water content (14.60% and 18.25%) in early observation is not decreasing. This is caused by the resistance of clay and water mixture that is able to restrain the loading cell in the above testing material. Swelling Value in 80% sand and 20% clay-silt compositions is higher than another composition. This is caused by the large number of clay-silt percentage that increases swelling value.

4.3. Correlation between CBR with Compaction ($\gamma_d$)

4.3.1. Unsoaked Condition

In Figure 11, the linear regression lines indicate the valid zone. Valid Zone is the regression result from compaction versus minimum water content until optimum water content (dry side).

In Figure 11, it is seen that there is a tendency in all sand and clay-silt compositions, the larger the compaction ($\gamma_d$), the higher the CBR value. This is caused by the large compaction ($\gamma_d$) means the soil is more compacted so the carrying capacity of the soil is larger; it is indicated by the larger CBR value.

4.3.2. Soaked Condition

In Figure 12, it is seen that there is a tendency in all sand and clay-silt compositions, the larger the compaction ($\gamma_d$) the higher the CBR value. But their gradient and CBR value are smaller than in unsoaked condition. This is caused in soaked condition by compacting penetration which is earlier received by water and then is received by solid granule soil, so the increasing CBR value is more sloping than in unsoaked condition that is steeper slope and its CBR value range is also larger than in soaked condition.

4.4. Correlation between CBR with Void Ratio ($e$)

4.4.1. Unsoaked Condition

In Figure 13, valid zone is represented by linear line equation. Valid zone is the equation result from soil compaction started from minimum water content until optimum water content (dry side).

In Figure 13, it is indicated that in all sand and clay-silt compositions, the increasing CBR value will cause the void ratio ($e$) to become small. This is caused by the increasing of CBR value, the soil will be granular repositioned (granular position recovery) that cause the void ratio to become small.

4.4.2. Soaked Condition

In Figure 14, it is indicated that in all sand and clay-silt compositions, the increasing CBR value will cause the void ratio ($e$) to become small. This phenomenon is occurring because of the increasing of CBR value, so the soil will become granular repositioned (granular position recovery) that will cause the void ratio to become small.

It is important to know that void ratio in soaked condition is larger than in unsoaked condition, the cause is the large amount of water penetration that flows into soaked condition so there is much air pore space that is filled by water in soaked condition.

5. CONCLUSION

In this research for the sand used during the tests or the sand having the same characteristics it can be concluded:

- In all sand and clay-silt compositions, the higher the water content ($w_c$), the larger the dry density ($\gamma_d$), but in certain water content the $\gamma_d$
will decrease. Because the water percentage filling pores between large granules, solid granule percentage that fills in is not maximum. The larger the percentage of clay-silt in mixture, the larger the optimum $w_c$, because of the large clay content ($\text{SiO}_2$) that absorbs the large amount of water ($\text{H}_2\text{O}$). If it is seen from the compaction factor ($\gamma_{d_{\text{max}}}$), the bigger the clay-silt percentage, the larger the $\gamma_{d_{\text{max}}}$, but in mixture with more than 10% clay-silt, the $\gamma_{d_{\text{max}}}$ will decrease, because the large clay content can cause instabilities such as low carrying capacity and large decreasing.

- To determine swelling potency of testing material, we use correlation of research result from Seed et al (1962) and Williams & Donaldson (1980). By looking at the table of correlation between swelling ($\varepsilon_1$) and plasticity index ($Ip$) about correlation between plasticity index ($Ip$), $\varepsilon_1$ (%) with swelling potency, it can be concluded that from the four testing materials with axial strain ($\varepsilon_1$) < 2 %, it produces the estimation of plasticity index value about 0 – 10%. Then the plasticity index estimation is used for predicting swelling potency occurs, so it is used correlation curve’s Williams & Donaldson (1980). By looking the correlation curve between clay percentage (%), Plasticity Index ($Ip$) and Swelling Potency observed by Williams & Donaldson (1980), it can be concluded that in Ip 0 – 10% range and percentage of clay-silt < 20%, it produces low swelling potency (faible). Because the swelling potency of testing material with clay-silt content< 20% is low, the influence on CBR value is to be ignored.

- There is a tendency in all sand and clay-silt compositions, the higher the water content percentage, the smaller the swelling value. Because the swelling process early occurred in ripening period, except in 90% sand and 10% clay-silt compositions.

- The larger the $\gamma_d$, the larger CBR value and the smaller the void ratio value ($e$) and porosity ($n$). Because the higher the compaction ($\gamma_d$), the more compact the soil, so the carrying capacity of the soil is larger. This is indicated by the large CBR value and the soil becomes granular repositioned so the pores between granules become smaller. And it can be seen from the $e$ and $n$ values that become smaller. In soaked condition CBR value is smaller than in unsoaked condition, because in soaked condition the strain penetration is early received by water, and then it is received by solid granule soil so the increasing of CBR value is more sloping than in unsoaked condition that is more steep-slope and the CBR value range is to become larger.

- Correlation between $\gamma_d$, $e$, $n$ with CBR (Figure 15 & 16)

### a. Unsoaked Condition

<table>
<thead>
<tr>
<th>Composition</th>
<th>CBR</th>
<th>$\gamma_d$</th>
<th>$e$</th>
<th>$n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand 100% dan Silt-Clay 0%</td>
<td>29,583</td>
<td>35,98</td>
<td>40,175</td>
<td>0.9821</td>
</tr>
<tr>
<td>Sand 95% dan Silt-Clay 5%</td>
<td>37,386</td>
<td>36,258</td>
<td>59,569</td>
<td>0.9173</td>
</tr>
<tr>
<td>Sand 90% dan Silt-Clay 10%</td>
<td>31,989</td>
<td>20,096</td>
<td>60,134</td>
<td>0.9961</td>
</tr>
<tr>
<td>Sand 85% dan Silt-Clay 15%</td>
<td>38,524</td>
<td>46,992</td>
<td>39,851</td>
<td>0.9977</td>
</tr>
</tbody>
</table>

### b. Soaked Condition

<table>
<thead>
<tr>
<th>Composition</th>
<th>CBR</th>
<th>$\gamma_d$</th>
<th>$e$</th>
<th>$n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand 100% dan Silt-Clay 0%</td>
<td>134,95</td>
<td>214,94</td>
<td>67,337</td>
<td>0.9788</td>
</tr>
<tr>
<td>Sand 95% dan Silt-Clay 5%</td>
<td>134,95</td>
<td>214,94</td>
<td>67,337</td>
<td>0.9788</td>
</tr>
</tbody>
</table>
CBR = 55,967. \( \gamma_d - 90,89 \) (\( R^2 = 0.9453 \))
CBR = -66,287. \( e + 51,681 \) (\( R^2 = 0.9699 \))

Sand 90% dan Silt-Clay 10%

CBR = 58,014. \( \gamma_d - 92,613 \) (\( R^2 = 0.9969 \))
CBR = -70,884. \( e + 56,679 \) (\( R^2 = 0.9998 \))

Sand 85% dan Silt-Clay 15%

CBR = 37,995. \( \gamma_d - 54,207 \) (\( R^2 = 0.9685 \))
CBR = -42,771. \( e + 40,517 \) (\( R^2 = 0.9884 \))

Sand 80% dan Silt-Clay 20%

CBR = 61,895. \( \gamma_d - 102,47 \) (\( R^2 = 0.9995 \))
CBR = -88,835. \( e + 61,256 \) (\( R^2 = 0.9994 \))

From this research result, it can be concluded that the optimum composition of reclamation embankment material toward compaction is material with 90% sand and 10% clay-silt composition. Whether the clay content quantity increases (>10%) or increases (<10%), the compaction will decrease.

The research result indicates that CBR value, physical parameters and material compaction in unsoaked condition are more optimum than in soaked condition.

It can be concluded that the most dominant influence of soil parameter toward CBR value is soil compaction parameter (\( \gamma_d \)). This is caused by the increasing of CBR value and it will be obtained when the soil compaction increases.

REFERENCES


Figure 1. Types of Compacting Curve Usually Found in Soil

Figure 2. Curve of Correlation between Clay Percentage ( % ), Plasticity Index ( PI ), and Swelling Potency ( Williams & Donaldson )
Figure 3. Example of CBR Test

Figure 4. Flowchart of Steps and Testing Type Conducted

Figure 5. The Influence of Water Content (wc) with unit weight of dry soil (γd) in Unsoaked Condition

Figure 6. The Influence of Water Content (wc) with unit weight of dry soil (γd) in Soaked Condition

Figure 7. The Influence of Water Content (wc) with Swelling Value for 95% Sand and 5% Silt-Clay

Material and Equipment Preparation

Embankment Material Composition, with Limitations:
- Sand (min. 80%)
- Clay-Silt (max.)

One Day for Test Material

Modified Proctor Testing

Soaked Condition (4 Days of Soaked)

Swelling test every 24 hours

CBR For Establishing CBR Value from Water Content

Volumetric-Gravimetric (Gs n) Testing

Corelation between CBR with Physical Parameters (γd, e, n)

Conclusion and Suggestion of Correlation between CBR with Physical Parameters

Equipments
- Balance
- cup
- Flask
- Oven
- Vacuum
- CBR
- Modified Proctor

CBR For Establishing CBR Value from Water Content Variation

Corelation between CBR with Physical Parameters

Embankment Material Preparation

Swelling test every 24 hours

CBR For Establishing CBR Value from Water Content

Volumetric-Gravimetric (Gs e n) Testing

Correlation between CBR with Physical Parameters (γd, e, n)
Figure 8. The Influence of Water Content (w_c) with Swelling Value for 90% Sand and 10% Silt-Clay

Figure 9. The Influence of Water Content (w_c) with Swelling Value for 85% Sand and 15% clay-Silt

Figure 10. The Influence of Water Content (w_c) with Swelling Value for 80% Sand and 20% Silt-Clay

Figure 11. Correlation between Compaction (γ_d) with CBR in Unsoaked Condition, Dry Side.

Figure 12. Correlation between Compaction (γ_d) with CBR in Soaked Condition, dry side.

Figure 13. Correlation between Void Ratio (e) with CBR value in Unsoaked Condition, dry side
Figure 14. Correlation between Void Ratio (e) with CBR in Soaked Condition, dry side.

Figure 15. Correlation between $\gamma_d$ and e with CBR in Unsoaked Condition, Dry Side

Figure 16. Correlation between $\gamma_d$ and e with CBR in Soaked Condition, Dry Side

Table 1 Table of Relation between Swelling ($\varepsilon_1$) and Plasticity Index (Ip) (Seed et al, 1962)

<table>
<thead>
<tr>
<th>Ip [%]</th>
<th>$\varepsilon_1$ [%]</th>
<th>Potential de gonflement</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 10</td>
<td>0 – 1,5</td>
<td>Faible</td>
</tr>
<tr>
<td>10 – 20</td>
<td>1,5 – 5</td>
<td>Moyen</td>
</tr>
<tr>
<td>20 – 30</td>
<td>5 – 25</td>
<td>Élevé</td>
</tr>
<tr>
<td>&gt; 35</td>
<td>&gt; 25</td>
<td>Très élevé</td>
</tr>
</tbody>
</table>

Table 2. Material Composition and Sample Quantity

<table>
<thead>
<tr>
<th>code</th>
<th>sampel N</th>
<th>Sand [%]</th>
<th>Clay-silt [%]</th>
<th>Compaction</th>
<th>CBR</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>1</td>
<td>100</td>
<td>0</td>
<td>Modified proctor in soaked and unsoaked condition (Every test material is made in 5 modified proctor samples)</td>
<td>CBR in soaked condition (Every test material is made in 5 samples)</td>
</tr>
<tr>
<td>A2</td>
<td>2</td>
<td>95</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>3</td>
<td>90</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td>4</td>
<td>85</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5</td>
<td>5</td>
<td>80</td>
<td>20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Σ= 50 Sampel | Σ= 50 Sampel