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Scenario of Distabilization Soil Strength Study on Inspection Road in Merauke Region

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ABSTRACT

This study intends to investigate the usage of some soil strengthening stabilization methods on some soil conditions as well as different type of soil. The methodology consists of macro and micro test. Macro test is as soil physic characteristic test which includes soaked CBR (soaked during 72 hours), unsoaked CBR, and undrained consolidated triaxial shift test (CU). However, micro test consists of X-Ray Diffraction (XRD) Test, Scanning Electron Microscope (SEM) photo, and chemical analysis. Compactibility of clay is as the function of pressure level which is loaded on soil. Results is hoped that on the low pressure level, compacted clay on optimum dry condition has the compactible characteristic. In addition, the effort of bigger compact will produce the bigger optimum CBR. On the contrary, on optimum wet condition, it can produce the smaller CBR.
KEYWORDS: soil compact, clay, CBR

INTRODUCTION

The region of South Papua Province is as the plain land with the elevation between 0 – 50 m above sea level with the area number is very wide and almost of the region is closed by secondary forest and swamp. One of government policies in regional spatial usage is by planning as the centre of agricultural yield production such as rice and sugar reed in this region. In this region, there is planned to be going to be opened the millions hectares of area for supporting food self program. Therefore, it is nacessary to be built the infrastructure facility of transportation [1] aw well as irrigation infrastructure and the other supporting infrastructure. The descending of big dyke construction will influence the descending or horizontal moving of other construction that is built in the dyke as water gate, bridge abutment or soil holder wall. Therefore, on dyke development, there is needed to be prepared the determination about dyke dimension and the descending effect of surrounded foundation soil [2]. If the road dyke body is built over a soft soil layer, the different descending will cause road waves that it has tobe repared by the end. On the high road dyke, traiffic load is averagedly distributed on dyke body, so the effect to soft base layer is so small. However, on the low road dyke, the effect of traffic load to the soil bed layer is big enough. In addition, on the low dyke, shift strength of dyke body will be decreasing by the rising up of groundwater level, so the differece between descending and deformation is relatively big [3].

The field problem is related with soil handling or bad material in order to be able to be used as strengthening material. The soil strengthening stabilization can be meant as the improvement of different on available strengthening material so it can be used as the layer of under or abaove foundation or even as surface layer material [4][5]. Strengthening performance is not anly related with strengthen in selecting the accurate stabilization method, but it is nacessary to be known the reason of why it needs the stabilization. Some conventional reasons which are as the background why there is needed stabilization are as follow: 1) The condition of soil bed is bad: stabilization of soil bed for increasing the quality, so strengthening depth can be reduced; 2) Material of foundation layer is limited: as there is known that on radius of 500 km from project area, there is not seen stone, so there has to be carried out the optimization of local soil usage as foundation layer material; 3) Control of water content: some chemical materials can hold water in soil, so in dry season there is possible for soil to be easily compacted. In addition, for some cases, the soil condition is very wet so it is difficult to be compacted. For this condition, it is needed the stabilization material for drying the soil; and 4) to obtain the more special of foundation layer material: the usage of special foundation layer such as the foundation layer that is distabilizationed with cement (cement treated base) and foundation layer of asphalt concrete [6]. This foundation layer can contribute the meningful strengthen, so the strengthening is more held to the tired sliding.

The objectives of this study are as follow: 1) to compare the usage result of certein material for stabilization of soil strengthening; 2) to be more accurately mapping the material usage of stabilization, it is related with the soil type as well as chemical unsure of soil forming; 3) to evaluate and detailly describ of the

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new material as enzym that is as break-through product which has high effeciency of material usage without adding other material. .

MATERIALS AND METHODS

This research will be self limited on stabilization handling of soil strengthening in Merauke. It is assumed that observed soil type on the road segment is homogen. The use of work equipment is assumed the same one. Micro test is only carried out maximum for 4 days. Stabilization material which is used is PC additive Smelling and Enzym. However, macro test is as soil physic character which includes soaked CBR (soaked suring 72 hours), unsoaked CBR, and indrained consolidated triaxial shift (CU) test. Micro test includes X-Ray Diffraction (XRD) test, Scanning Electron Microscope (SEM) photo, and chemical analysis. The selection of stabilization method by using certain material has to attend soil type and chemical composition of the soil forming material because the success of stabilization process on soil strengthening is very determined by this factor. According to the description as above, the problems can be formulated as follow:

- From the research result in laboratory of macro test, there will be obtained soaked and unsoaked CBR result in each region with different soil characteristic type.
- The behaviour of compacted soil shift strength is observed thorugh undrained consolidated triaxial (CU) test on the test material with the different soil characteristic.
- The variation of stewing period is conducted during 1 and 4 days before compaction and compaction method based on the atandard proctor of T90-AASHTO
- The limitation of material swelling and strengthening value can be seen through CBR test.
- XRD test, SEM photo, and chemical analysis for material stewing period maximum 4 days.
- The percentage of Portland Cement is determined as 0%, 10%, 20%
- The percentage of material usage on Additive Smelling is 0%, 2%, 3%, 5%
- The percentage of material usage on Enzym is $0.3‰_0$ and $0.4‰_0$

Compaction can be carried out with some manners. For the compaction of clay soil in field can be used some equipments included steel wheel roller, wheel roller, and sheeps foot roller, etc. For compacting uncohession soil such as sand and gravel, the best equipment is vibrator tool.

Level of soil compaction is measured from dry volume-weight of compacted soil (γd). If water is added to the soil that is being compacted, the water will be functioned as wetter unsure (plasterer) on the soil particles, because by the water, the soil particles will be easier move and shift one and another and forms crowded position. For the same effort of compaction, dry volume-weght of soil will be rising if water content in soil (when compaction) rises [7]. This condition is presented as in Figure 1 below.

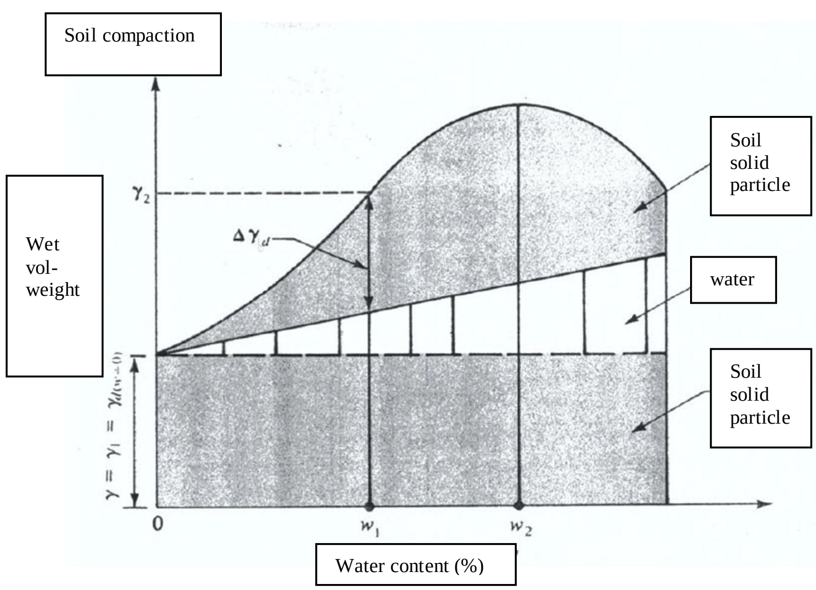

Figure 1 Principal of compaction

Compaction or dry volume-weght is as follow [8]:

$$\gamma\ d = Ws / V$$

Note :

Ws = particle weght
V = total volume
If water content = 0 (W = 0), wet volume-weght of soil (γ b) = dry volume-weight of soil (γ d) , or:

$$\gamma b(w=0) = \gamma d = \gamma 1$$

If water content is gradually added (with the same compaction), solid soil particle weight per-unit volume (γ d) is also increasing. Dry volume-weight (γ d) on the water content is [9][10]:

$$\gamma d (w = wl) = \gamma d (w = 0) + \Delta \gamma d$$

On the water content that is bigger than certain water content such as w =w2 (optimum water content), the increasing of water content will reduce the dry volume-weight because water fills the voids which is filled by solid particle before. Water content when dry volume-weght reachs maximum condition (γ dmax) is mentioned as optimum water content (wopt).

Dry volume-weght is presented as dry volume-weght without air hollow or dry volume-weight when soil is saturated (γ zav) can be calculated with the formula as follow [11]:

$$\gamma Zav = \frac{Gs \quad \gamma w}{1+ w \ Gs}$$

When soil is saturated (S=1) and e = w G, so :

$$\gamma Zav = \frac{Gs \quad \gamma w}{1+ e}$$

Dry volume-weght (γ d) after compaction on thw water content of w with air content A (A = Va / V = volume of air /total volume) can be calculated with the equation as follow:

$$\gamma d = \frac{Gs \ (1-A) \ \gamma w}{1+ w \ Gs}$$

The relation between dry volume-weght on certain air content with water content from the result of Proctor Standard dan Proctor is modified for soil with volume-weght Gs = 2,65 is presented as in Figure 2.

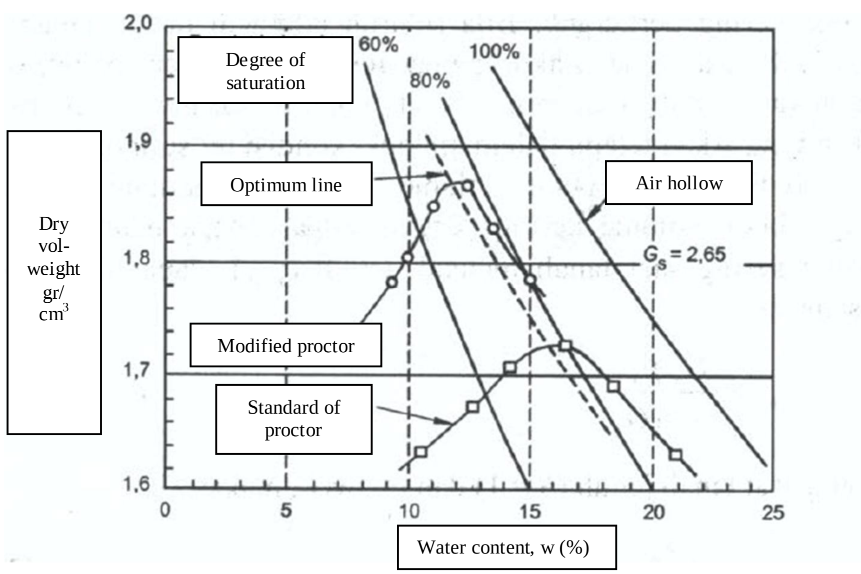

Figure 2 Relation between dry volume weght and water content

Characteristic of compacted clay soil

Figure 3 presented the effect of compaction on soil set. It indicated that soil set on point C is more regulated than point A.

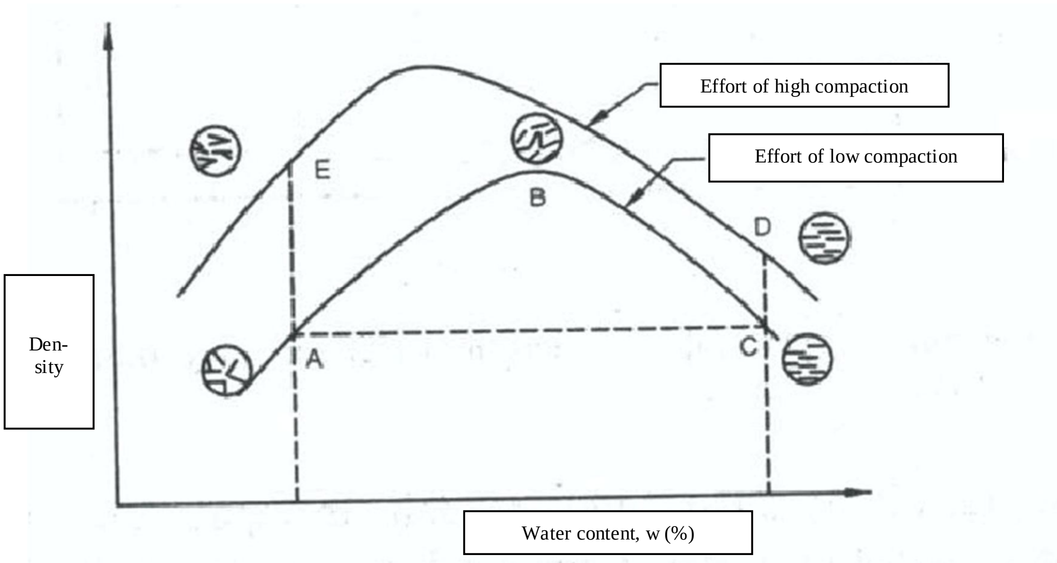

Figure 3 Effect of compaction to soil set

On the same compaction, water adding will cause the reducing of soil permeability [12][13]. If compaction is increased, coefficient of permeability will be reducing because voids number is decreasing. The change of permebility is presented as in Figure 4.

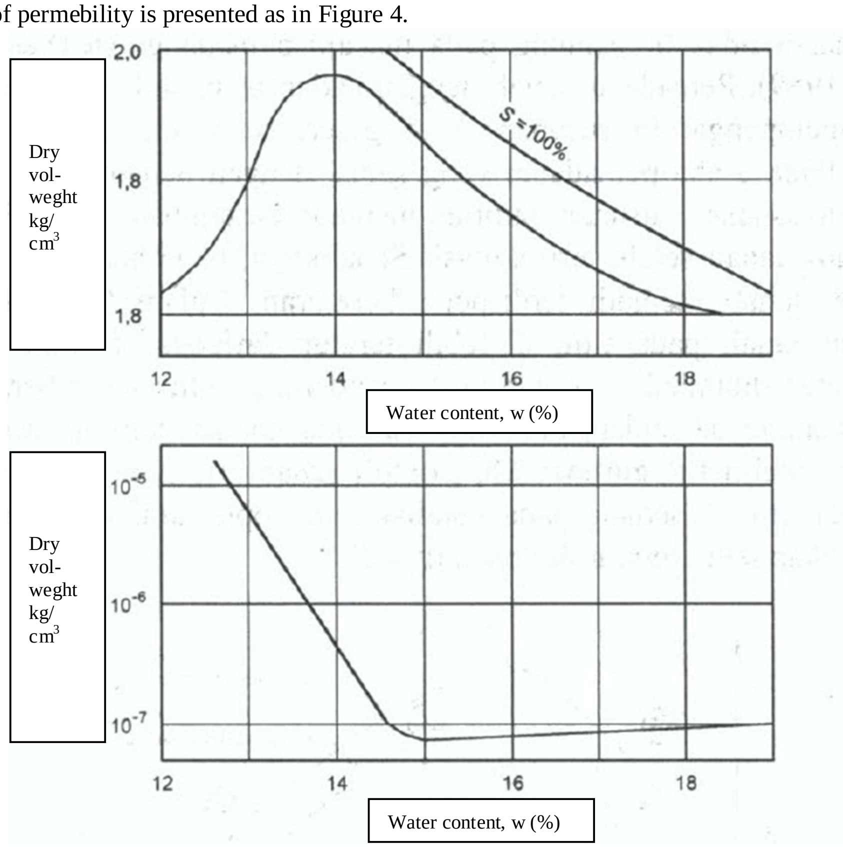

Figure 4 Permeability change with water content

Compressibility of compacted clay is as the function of pressure level which is loaded to soil [14]. On the relative low level of pressure, compacted clay on optimum wet condition will have the characteristic of compressible. However, on the high level of pressure is imcompressible. This characteristic is presented as in Figure 5 below.

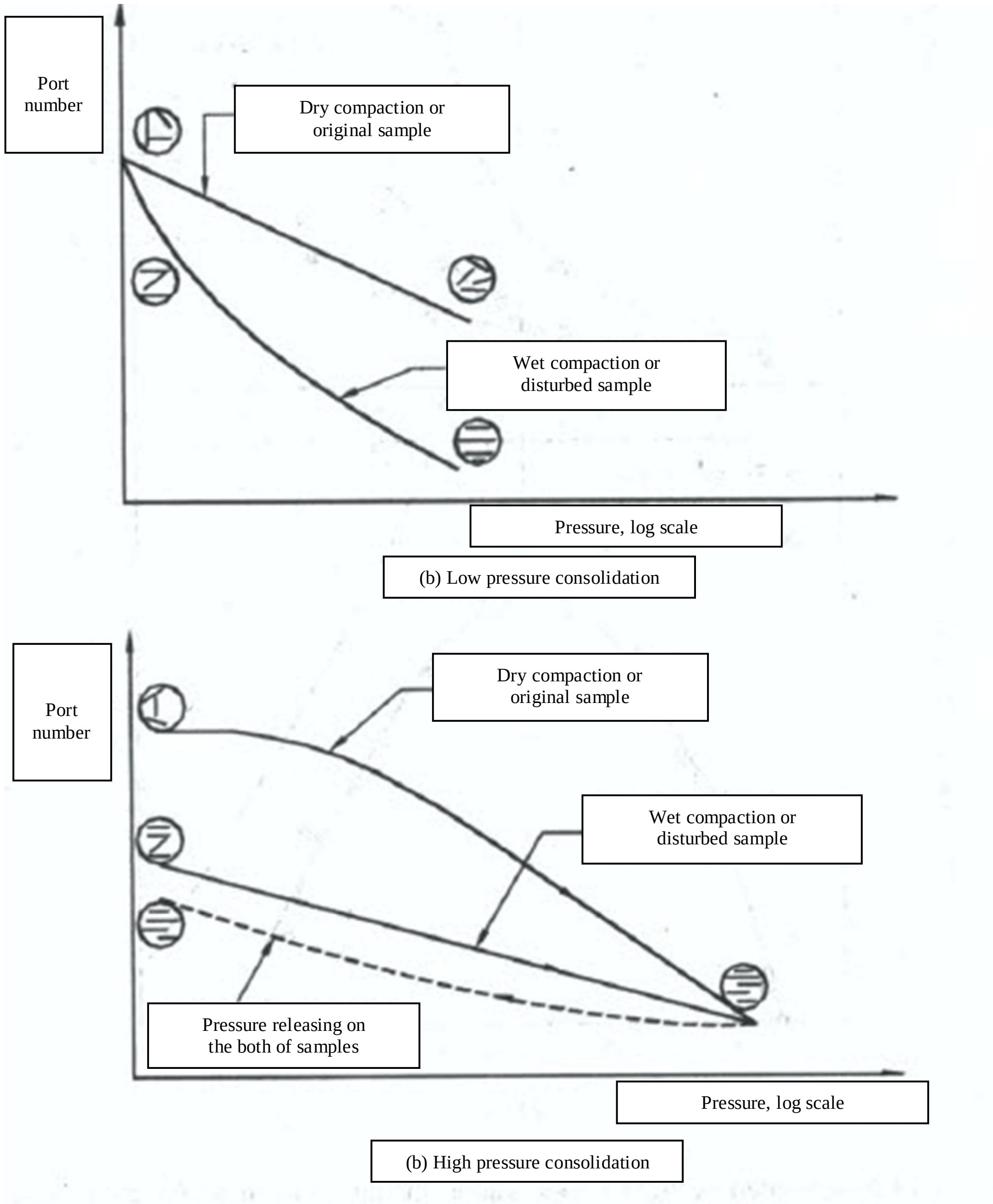

Figure 5 Compaction change on the giving water content

Limitation of Atterberg

Water content is expressed on percentage where there is happened the transition from solid condition into semi-solid condition or it is known as shrinkage limit. Water content which ia happened the transition from semi-solid condition into plastic condition is named as plastic limit. Water content which is happened the transition from plastic condition into liquid condition is named as liquid limit. These limits are known as Atterberg Limit [10][11].

Liquid limit (LL) is defined as soil water content on the limit between liquid and plastic condition such as upper limit of plastic area. Liquid limit generally is determined from Casagrande test such as water content on

13 mm with 25 cycles, but plastic limit is remained as water content which soil can be rolled until the minimum diameter of 3 mm without cracking. Scrolling with diameter less than 3 mm will cause the soil roll is breaking.

Based on the Atterberg Limit, Casagrande developed a diagram which was known as plasticity diagram as presented in Figure 6.

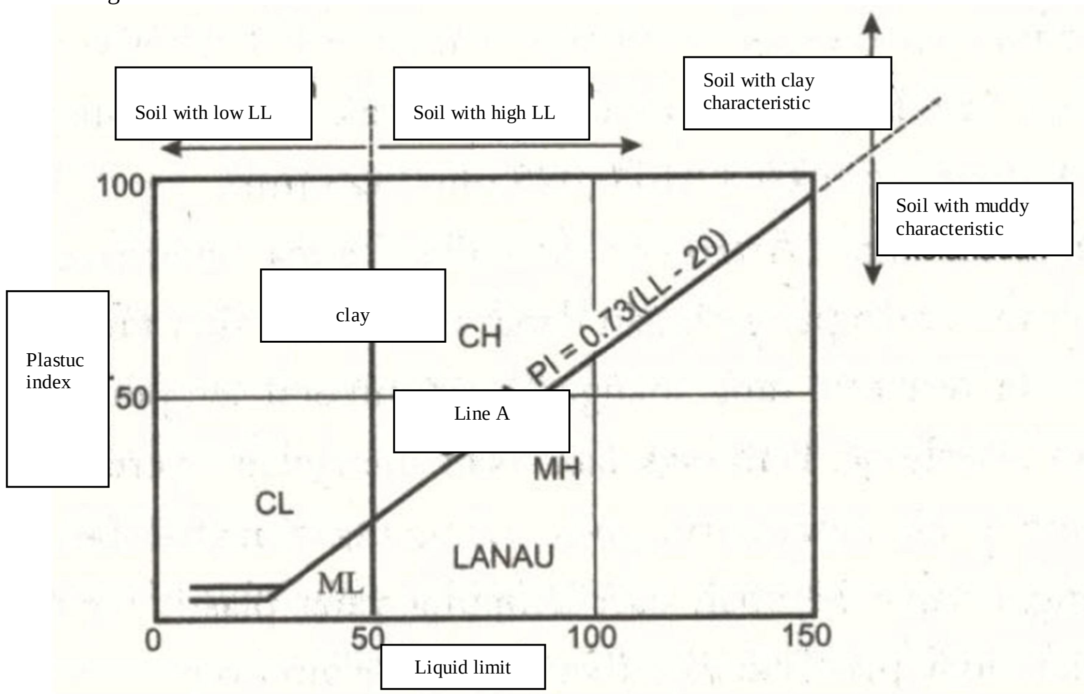

Figure 6 Plasticity Diagram

Plasticity diagram is functioned for distributing soft granulair soil into group of the similar technical characteristic. Plasticity index is plotted against liquid limit on this diagram.

Soil shift strength

According to Mohr, sliding condition of a material is occured by the combination between critical condition of normal tension and shfit tension which is presented in equation as follow;

$$\tau = f(\sigma)$$

with τ is shift tension when sliding or failure condition, and σ is normal tension on this condition.

Coulomb (1776) defined $f(\sigma)$ as follow [10] :

$$\tau = c + \sigma \text{ tg } \phi$$

dengan:

τ = soil shift strength (kN/m2)
c = soil cohession (kN/m2)
ϕ = shift angle in soil (°)
σ = normal tension on sliding area (kN/m2)

Effective tension in soil is very influenced by voids pressure. Concept of Terzaghi (1925) indicated that shift tension in soil could only be held by solid particles tension. Terzaghi has changed Coulomb formula in the form of effective tension as follow:

$$\tau = c' + (\sigma - u) \text{ tg } \phi'$$

because $\sigma' = (\sigma - u)$, so:

$$\tau = c' + \sigma' \text{ tg } \phi'$$

Note:

c' = effective soil cohession (kN/m^2)
σ' = effective normal tension (kN/m^2)

u = voids water pressure (kN/m^2)
ϕ' = shift angle in effective soil (°)

Sliding will be happened on the point which has critical condition that is caused by the combination between shift tension and effective normal tension. Evaluation of shift strength which is frequently used and suitable for any kinds of soil is triaxial test.

RESULTS AND DISCUSSION

All kinds of soil generally consists of 3 materials such as soil granulair itself, water, and air which are placed in the space among the granulairs. This space is mentioned as voids. If soil is really dry, there is no water in the voids. This condition is seldom found in the soil which is original in the field. Water will only be able to be lost from soil if there is carried out a special action for this aim such as there is heated in oven [15]

The function of soil becomes very important in design as well as implemantation of building because soil is functioned for supporting construction that has to be formerly prepared before it is used as subgrade. If soil in field needs improvement for supporting building over it or soil will be used as piling, however the compaction is frequently carried out with the objectives as follow:

- To make higher soil shift strength
- To reduce the compressible characteristic
- To reduce permeability
- To reduce the volume change as the reason of water content change and others.

The objectives as above can be reached by selecting the soil of piling material, method of compaction, selection of compaction tool machine, and number of suitable route.

Compacted clay soil with the right method will be able to give high shift strength. Stability to the shrinked –swelled is depended on the type of its mineral content. For example, monmorilonite clay will have a bigger trend to volume change than kaolinite clay. Solid clay has low permeability and this soil cannot be well compacted when it is very wet (saturated). Working with very wet clay soil will get some difficulty because when clay is compacted, water is difficult to flow outside the clay voids hollow. Water that does not go out from voids hollow will cause the granulair is difficult to crowd among one to another when there are compacted.

On the low water content, for most of soil, soil has a stiff characteristic trend and it is difficult to be compacted. After adding water content, soil becomes softer. On the high water content, dry volume-weight is decreasing. If the whole air in soil can be to make going out when compaction time, soil will be on saturated condition and the value of dry volume-weight will be maximum.

Technical characteristic of clay soil after compaction is very depended on the compaction method, type of soil, and water content. The bigger effort of compaction will cause soil compaction becomes higher. Based on the investigation of compacted clay soil, it is seen that compacted clay on optimum dry condition causes soil set will not depend on compaction method. Soil compaction on optimum wet will influence the setting of shift strength and compressibility of soil compressibility.

On the same compaction with adding water content, the suitability of granulair setting becomes increasing. On the optimum dry, soil is always floculated. On the contrary, on optimum wet, soil setting becomes regulated dispersioned. Swelling characteristic of compacted clay soil indicated that on optimum dry condition will be bigger on optimum wet condition. It is due to that optimum dry clay soil generally is more sensitive to the environmental change like water content. This condition is opposited with shrinking condition such as compacted soil on optimum wet will have bigger shrinking characteristic.

Shift strength of compacted clay soil on optimum wet condition has the strength higher than on the optimum wet condition. Shift strength of compacted clay soil on optimum wet condition is rather depended on the type of compaction because the happened difference on soil setting. If soil has soft granulair soil, it can be remolded withour cracking. The cohessive character is caused by observed water in surrounded surface of caly particles.

According to the method which was developed by Attergerg, he described about soil consistence characteristic such as soil with soft granulair in variety of water content. If water content is high, soil will very soft even like liquid. Based on the water content in soil, soil can be classified into 4 groups such as solid, semi-solid, plastic, and liquid. On the higher water content, it can be made roll with smaller diameter and on the lower water content, the roll will be breaking before it reachs the diameter of 3 mm. The other parameter which has to be determined is plasticity index. This parameter is the range of water content which the soil has plastic characteristic such as PI = LL – PL.

Soil shift strength is as against force which is implemented by soil granulair to the pushing and pulling. If soil has losding, it is held by soil cohession which the strength is depended on soil and compaction type. Shift between soil granulai is straight compared with normal tension on shift space.

CONCLUSION

1. If compaction is added, soil setting has a trend of more regulated suitability even it is fitted on optimum dry condition.
2. Compressibility of compacted clay is the function of loaded pressure level on soil. On the relative low pressure level, it will have the easier compressible characteristic.
3. Bigger compaction will produce bigger CBR on optimum dry condition, but on the contrary, CBR has a smaller trend on optimum wet condition.
4. Liquid limit is generally determined from Casagrande test such as water content of 13 mm with 25 cycles. However, plasticity limit is determined as water content which soil can be rolled untik minimum diameter of 3 mm withour cracking. Roll with diameter smaller than 3 mm will cause soil roll is breaking.

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