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The Effect of Cracks Propagation on Cohesion and Internal Friction Angle for High Plasticity Clay

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Abstract

Slope events usually precede the occurrence of small cracks in soil on the slopes. The small cracks become deep crack and will be a potential landslide. If the potential landslide plane is getting longer, the slope will occur sliding. The small cracks in the soil are usually not visible so the soil is still considered to be intact, not cracked. At the time of soil sampling in the field and testing in the laboratory, the soil is regarded as intact soil and not cracked. This research aims to determine the effect of crack propagation in the soil against changes in cohesion values and internal shear angle in laboratory testing. A series of laboratory tests using a modified shear test apparatus was performed. Direct shear testing using a modified shear test apparatus was carried out on a high plasticity clay soil. The crack propagation given is 25%, 50%, 75% against the diameter of the specimen. The results showed that crack propagation occurring in the soil is very influential on cohesion. In a crack condition of 100% then the value of soil cohesion becomes zero. Other results showed that crack propagation did not affect the internal shear friction angle. Regardless of the length of the crack that occurs, the internal friction angle remains as in the conditions have not been cracked.

Keywords: slope, shear strength, cracks, cohesion, internal friction angle

INTRODUCTION

In most cases of lanslide in Indonesia, the facts indicate that landslide generally occurs under the following conditions [1]:

a) Sliding occurs during heavy rains up to very heavy, both during rainy season and shortly after the rain

b) Landslide occur at any time during the rainy season, either at the beginning, in the middle or at the end of the rainy season; so landslide not a function of the duration of the rain but the intensity of rain, heavy or not.

c) Landslides occur in certain places on the slopes along the sides of a highway in the mountains; it does not occur on all the slopes along the road, although the soil conditions, slope and rainfall are relatively similar

Even though landslide events caused by heavy rainfalls has done a lot of research but the mechanisms of how the heavy rainfalls may cause the slope to slide are not yet entirely understood [4] [5] [6].

The observations result in the field found that the most likely assumption for the occurrence of field slump phenomenon as described above, is that in the soil layer within the slope there has been previous cracks as shown in Figure 1. Initially, small and shallow cracks has occur in soil on the slope. The cracks propagate deeper when the rainfall is heavy. If the rain intensity is high and the rainfall occurs in many hours, the cracks in soil become deeper and the crack will become a sliding plane [2]. The cracks determine the stability of the slope

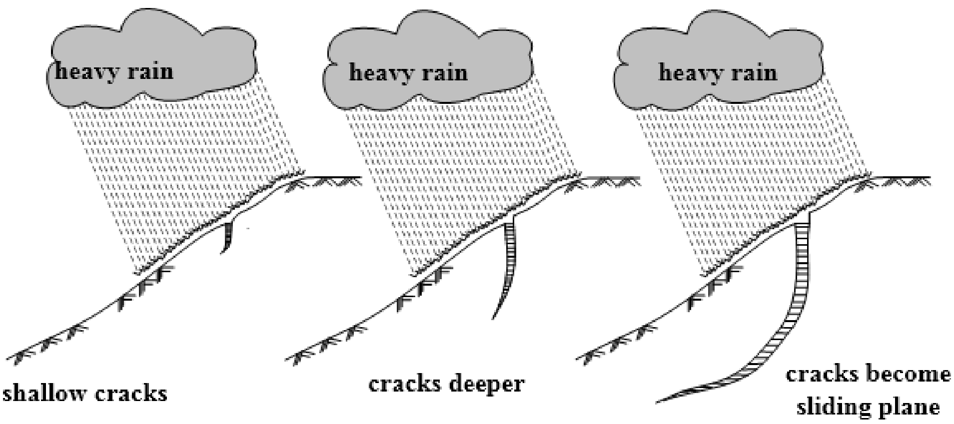

Figure 1. Cracks propagation on heavy rain

MATERIALS AND METHODS

Lok Buntar clay used in this study has volume weight (γ_m) = 1.67 - 1.73 kg / cm3 and natural moisture content (w_n) = 51.25% - 62.84%. Visually, Lok Buntar clay color dominant yellow with a little black color. Clay dominates the volume of the soil and hardly any coarse grains in the soil. Fine grains have a content of more than 95%, and coarse grains have a content of less than 5%. Based on Atterberg Limit Test, the clay from Lok Buntar village is including clay with high plasticity. This clay is catorized as CH (Inorganic clay or high plasticity fat clays) in plasticity chart with plasticity index value (IP) = 28.15.

This clay is tested using a Direct Shear Modified Test with a crack propagation length of 25%, 50%, 75% of the specimen diameter [7]. Schematic of the Modified Direct Shear apparatus can be seen in Figure 2 [3]. Shear box on Direct Shear Modified Test connected to water pressure apparatus.

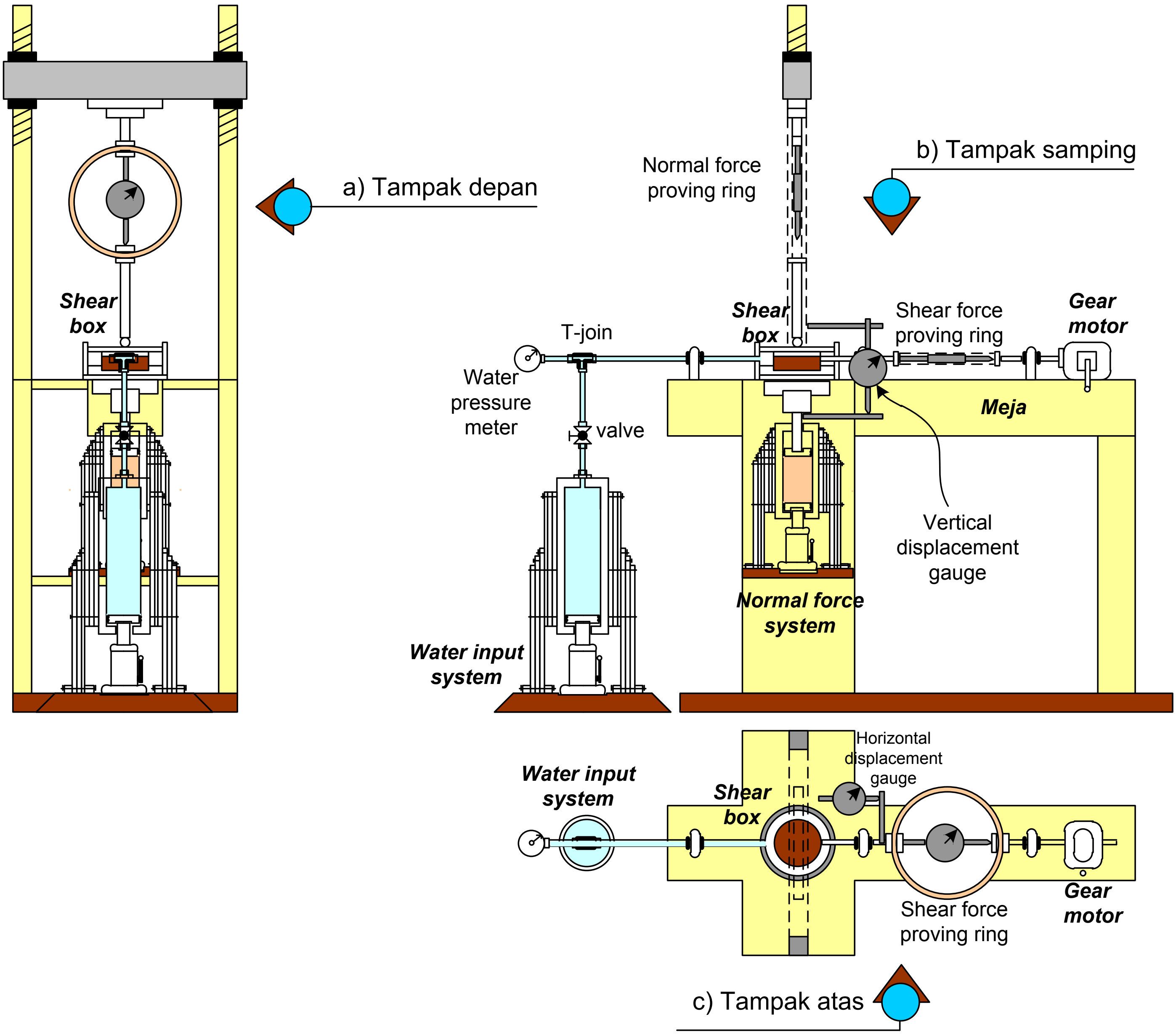

Figure 2. Schematic of the Modified Direct Shear Test apparatus

RESULTS AND DISCUSSION

The value of cohesion and internal friction angle for Lok Buntar clay is generated from the calculation based on Figure 3. The value of cohesion is the intersection point between the curve line on the vertical axis whereas the internal friction angle is the angle of the slope of the line on the curve τ vs. σ. According to Fig. 3, the cohesion values (c) is 0.2122 kg / cm2 and internal friction angle (θ) is 25,36°.

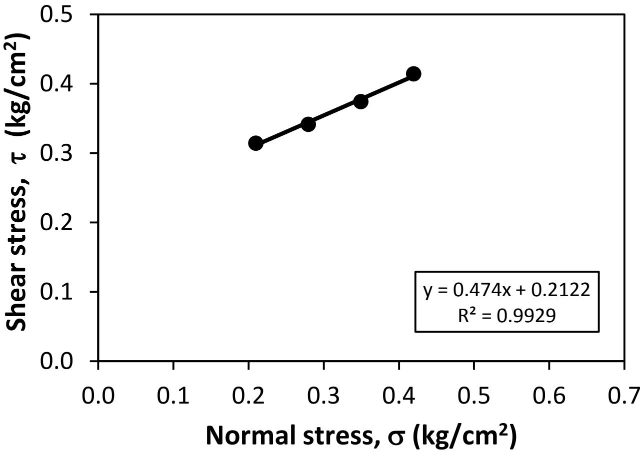

Figure 3. τ vs σ curve for Lok Buntar clay

The results shown in Fig. 4 show that the increasing propagation of the crack plane it will decrease the soil cohesion value. Lok Buntar Clay which originally had cohesion (c) = 0.2122 kg / cm2 under non cracked conditions, its cohesion decreased to (c) = 0.1943 kg / cm2 at crack 25%, its cohesion decreased to (c) = 0 , 1746 kg / cm2 at 50% crack condition, and the cohesion decreased to (c) = 0,1063 kg / cm2 at 75% crack condition. After the correction of the cross-sectional area, the cohesion value decreases again to (c) = 0.1707 kg / cm2 at 25% crack condition, the cohesion value decreases to (c) = 0.1061 kg / cm2 at 50% cohesion decreases to (c) = 0.0415 kg / cm2 at 75% crack condition. The results of this study prove that the propagation of cracks in the soil will greatly affect the value of soil cohesion. The longer the spreading field, the soil cohesion value will be smaller.

The cohesion value of the direct shear test results shown in Figure 4. The lower curve needs to be corrected again because the cohesion value is a apparent cohesion. The result of correction to the apparent cohesion value is given in Figure 5. After corrected the cohesion value shows the actual value of cohesion (c) = 0.2122 kg / cm2

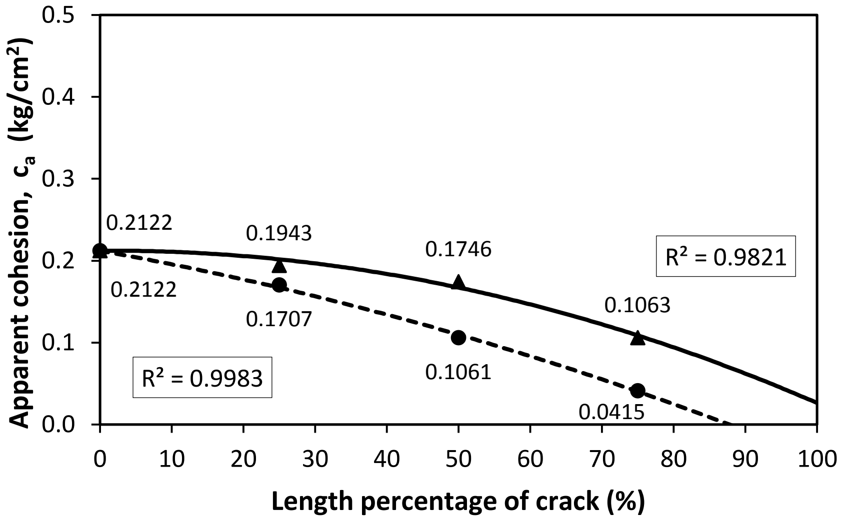

Figure 4. Apparent cohesion on crack plane in soil

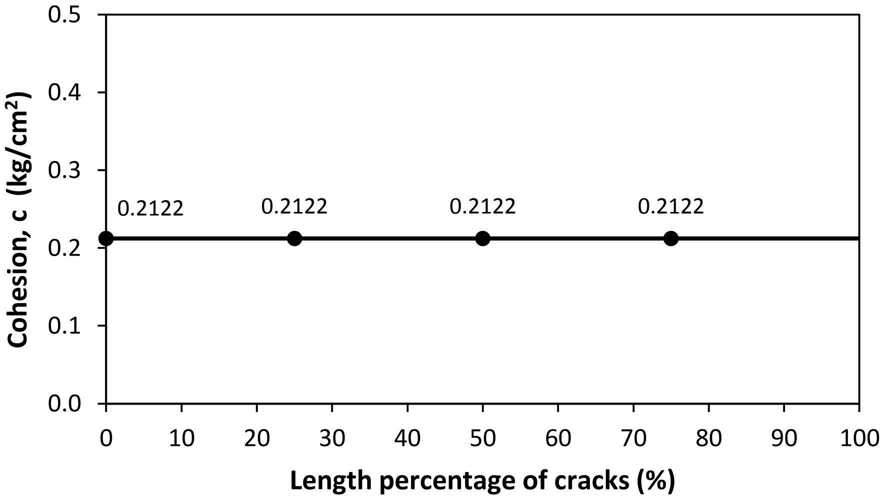

Figure 5. Cohesion of soil

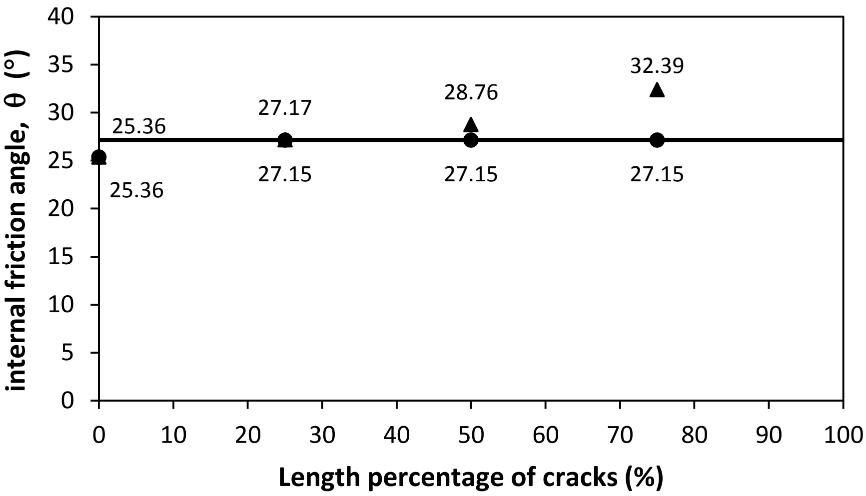

Figure 6. Internal friction angle

The same with cohesion, internal shear angle values should also be corrected against non-cracked cross-sectional areas. The result of correction of the non-cracked cross-sectional area is shown in Fig. 6. For Lok Buntar clay the condition is not soaked, the actual internal friction angle value of the soil is (θ) = 27.15°. This value is fixed and is not affected by the length of the crack propagation in the soil. This results are very much in agreement with the drained strength behavior of shearing strength alongside of model pile in Kaolinite Clay [8]

CONCLUSIONS

Based on the results of research can be concluded that the crack field length greatly affect the value of soil cohesion. The longer the crack field in the soil will further lower the value of soil cohesion. At the time the crack field reaches 100% the cohesion of soil becomes lost. The opposite occurs at the internal friction angle, the crack field length does not affect the internal friction angle value. Regardless of the length of the crack field, the internal friction angle remains as it has not been cracked.

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