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Research Paper

Analysis of The Effect Of The Addition of Fly Ash and Petrsoil on The Soil Shear Strength of The Swamp Area

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Abstract
The existence of irrigation canals greatly supports the production of rice produced, where irrigation channels will be equipped with embankment to protect irrigation channels. Existing soil must certainly be able to withstand shear strength to withstand embankment, while the soil in the South Sumatra region, especially the swamp area has a low shear power so it cannot hold back the shear strength from the embankment. For this reason, it is necessary to research the shear strength of the soil in the swamp area by adding fly ash and petrasoil in order to get the effect of increasing the value of the soil shear strength in the swamp area. A mixture of fly ash and petrasoil was chosen because the shear strength of the soil could be increased by the addition of fly ash, whereas petrasoil was used because in some road works using petrasoil to increase the carrying capacity of the soil. Fly ash are used because in previous research with the addition of fly ash it will cause an increase in shear strength. The tests consists of the seive analysis, index properties, atterberg limits, soil compaction, and shear strength testing, based on SNI and ASTM. Mixed variations consist of 5, namely: (i) soil + petrasoil; (ii) soil + 10% fly ash + petrasoil; (iii) soil + 15% fly ash + petrasoil; (iv) soil + 20% fly ash + petrasoil; (v) soil + 20% fly ash; all variations without ripeningThe highest soil cohesion value is 20.21 Kpa in the variation of the mixture of 10% fly ash + petrasoil, while the Thighest shear angle value is 32.38o on the variation of the mixture of 20% fly ash + water. This means that the pozzolanic content of ash fly in the soil causes an increase in the value of cohesion and shear angle, while the use of petrasoil as a mixture must be with other additives.

Keywords
Shear Strength, Fly Ash, Petrasoil

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1. INTRODUCTION

To support the rice granary program in Indonesia the South Sumatra provincial government and supported by the city and district governments continue to work on building irrigation channels that can irrigate existing rice fields, so that the water needs for farmers to irrigate the fields are fulfilled and to protect irrigation channels from flooding due to overflowing river water, a embankment was built. The main function of the dike construction is to protect the existing irrigation channels, therefore the strength and security of the dike must be well planned. One of the factors that must be considered in the planning of embankments with soil material is the condition of the existing soil stability, where soil conditions in swamp areas have low stability. Embankments made from the soil will certainly easily experience landslide on the embankment slope due to natural conditions or human activities or other living things, so the stability of the slope is certainly very necessary in the planning of an embankment.

Many studies have been done to improve soil stability, including by Wibawa (2015), the study resulted in an increase in the shear strength value of clay with the addition of gypsum waste. The other research conducted by Indrayani et al. (2018), the research results show that there is an increase in the carrying capacity of the soil using fly ash. Research related to increasing the carrying capacity of the soil and the shear value of the soil have also been carried out using other materials such as lime and petrasoil (Herius et al., 2019; Hakam et al., 2010; Phanikumar, 2009; Brooks, 2009). It was from this background that this research was carried out, ie by adding fly ash and petrasoil to the soil in the swampy area to increase the shear strength of the soil. Because South Sumatra has a lot of fly ash which is the remains of burning from coal so fly ash is used as addition material, while petrasoil is an added material in the form of powder which is often used in construction projects to increase the carrying capacity of the soil. The addition of these two materials is expected to increase the shear strength of the soil in the swamp area so that the embankments that are built can function well in protecting irrigation canals.

2. EXPERIMENTAL SECTION

2.1 Location of study

All tests in this study were conducted at the Sriwijaya State Polytechnic Materials Testing Laboratory while soil sampling was carried out at one of the swampy locations in South Sumatra Province, namely in Tanjung Lago Sub District, Banyuasin Regency. Soil sampling locations can be seen in Figure 1.

Figure 1. Sampling Location

The fly ash added material used in this study was taken from the coal burning residue of PT. Tanjung Enim.

2.2 Classification method

The tests include sieve analysis using a vibrator machince and a glass hydrometer, index properties using a 50 ml pic-nometer tube, atterberg limit testing using a cassagrande bowl, compaction testing using a compactor, and shear strength testing using a shear test machine. Atterberg limit testing and shear strength were carried out in 6 variations, namely: (i) soil + petrasoil; (ii) soil + 10% fly ash + petrasoil; (iii) soil + 15% fly ash + petrasoil; (iv) soil + 20% fly ash + petrasoil; (v) soil + 20% fly ash + water; (vi) normal soil. The ratio variation of petrasoil to water is 1 kg : 1000 liters. The fly ash does not get special treatment, but petrasoil is dissolved into water with a ratio of petrasoil to water is 1 kg: 1000 liters. All testing and analysis methods carried out refer to the ASTM and SNI guidelines, both of which are standards issued in every test in a soil laboratory.

2.3 Analysis method

This research starts from: (i) soil sampling in swampy areas, (ii) specific gravity testing to get the soil classification to be tested, (iii) atterberg boundary testing to get the liquid limit and plastic limit of all variations of soil mixture, (iv) sieve analysis and hydrometer test to get soil roughness, the higher the soil roughness, the better the soil, (v) compaction testing to obtain optimal water content, where the optimal water content will be used to make soil shear strength test samples, and (vi) and (vi) testing the shear strength of the soil to get the effect of the addition of fly ash and petrasoil to the shear strength of the soil in the swampy area.

3. RESULTS AND DISCUSSION

3.1 Testing of the Properties Index

Property index testing includes specific gravity testing, sieve analysis and atterberg limits, where the samples in this test use native soil. From the result of specific gravity test obtained a soil specific gravity value of 2.60, while from the result of sieve analysis test results obtained by soil that passes the filter # 4 (4.75 mm) by 100% and soil that passes the filter # 200 (0.075 mm) by 79.98%. From the test results of atterberg limit was obtained liquid limit value of 63%, 43% plastic limit, and plasticity index 20%. From the results of property index testing was obtained the soil classification is of clay soil, which has a grain size between <0.002 mm to 2.00 mm.

3.2 Compaction Testing

The compaction test was conducted in 6 conditions, namely (i) soil + petrasoil; (ii) soil + 10% fly ash + petrasoil; (iii) soil + 15% fly ash + petrasoil; (iv) soil + 20% fly ash + petrasoil; (v) soil + 20% fly ash + water; (vi) normal soil. Compaction test was carried out to obtain the weight of the dry soil contents and the optimum water content percentage. The result of the compaction test can be seen on the Tabel 1, while the optimum moisture content graph can be seen in Figure 2 and the dry weight content graph can be seen in Figure 3.

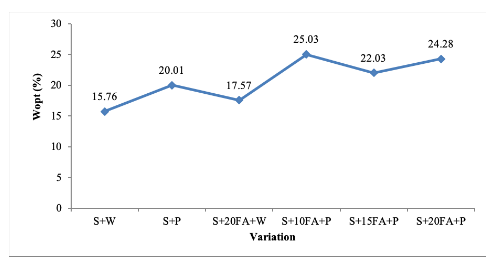

Figure 2. The optimum water content percentage (%)

The graph in Figure 2 shows that the highest optimum moisture content in the variation of the mixture of 10% fly ash + petrasoil, this means the effect of adding petrasoil causes an increase in water content. The higher the soil water content, the easier it is to compact the soil.

The graph in Figure 3 shows that the highest dry weight content of the soil is in the variation of the mixture of 20% fly ash + water. It can also be seen from the graph that the addition of petrasoil results in a decrease in the dry weight of the soil, this shows that petrasoil can result in a decrease

Table 1. Test results and analysis of compaction test

No	Variation	The optimum water content (%)	The weight of the soil dry contents (gd max) (gr/cm^3)
1	Soil + Water (S+W)	15.76	1.286
2	Soil + Petrasoil (S+P)	20.01	1.264
3	Soil + 20% Fly Ash + Water (S+20FA+W)	17.57	1.65
4	Soil + 10% Fly Ash + Petrasoil (S+10FA+P)	25,03	1.193
5	Soil + 15% Fly Ash + Petrasoil (S+15FA+P)	22,03	1.178
6	Soil + 20% Fly Ash + Petrasoil (S+20FA+P)	24.28	1.182

Table 2. Test results and analysis of shear strength

No	Variation	Cohesion value (C) (Kpa)	Shear angle ∅) (°)
1	Soil + Water (S+W)	18.35	16.45
2	Soil + Petrasoil (S+P)	8.5	20.16
3	Soil + 20% Fly Ash + Water (S+20FA+W)	6.85	32.38
4	Soil + 10% Fly Ash + Petrasoil (S+10FA+P)	20.21	19.02
5	Soil + 15% Fly Ash + Petrasoil (S+15FA+P)	12.5	24.34
6	Soil + 20% Fly Ash + Petrasoil (S+20FA+P)	8.2	27.83

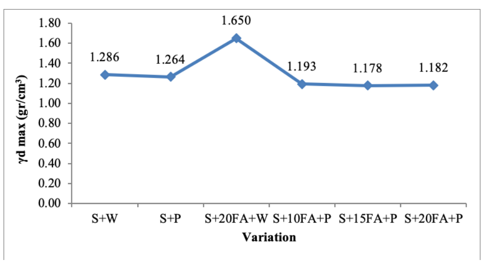

Figure 3. The weight of the soil dry contents

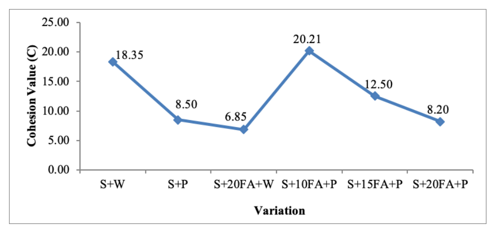

Figure 4. Cohesion Value (C)

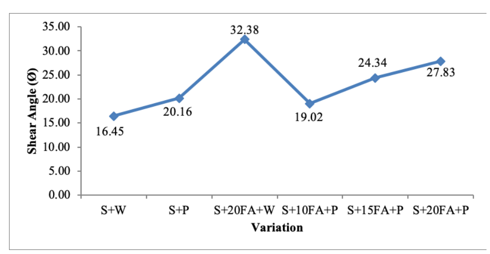

Figure 5. Shear angle value (°)

in the dry weight of the soil, where the lower the dry weight of the contents, the greater pore space in the soil causing the soil to become less dense.

3.3 Shear strength test results

Soil shear strength testing is done in 6 variations as in compaction testing. For the value of cohesion normal soil was taken from the results of research conducted by Polii et al. (2018), that is 25.219 Kpa. The results of the soil shear strength test can be seen in Table 2, while the graph of cohesion value can be seen in Figure 4 and the graph of shear angle values can be seen in Figure 5.

From Figure 4 it can be seen that there is the highest cohesion value on the variation of the mixture of 10% fly ash + petrasoil, this shows that the addition of 10% fly ash + petrasoil increases the soil cohesion value. Increased cohesion value will increase the value of the soil shear strength due to the attachment between soil particles that are getting stronger. Pozzolan in the fly ash can bind to the soil particles that exist, so that the bond with soil particles increases. The addition of petrasoil can increase bonds between soil particles, but the more fly ash is mixed, the ability of petrasoil to bind soil particles and fly ash is lower. This can be seen in the graph that the higher the addition of fly ash will cause a decrease in the value of cohesion in the soil.

From Figure 5, it can be seen that the highest shear angle value on the mixture variation 20% fly ash + water, where the higher the angle of shear, the greater the contact area so that the ability to withstand the shear also increases.

Pozzolan content in fly ash can increase the density of the soil, this causes an increase in the shear angle of the soil.

From the shear strength test results on variations in the addition of petrasoil without fly ash shows that there is a decrease in the value of cohesion and shear angle values, this shows that the addition of petrasoil without other added ingredients can reduce the value of shear strength, this statement is reinforced from the results of research conducted by Herius et al. (2019), which states that the addition of petrasoil without other additives can reduce the value of the carrying capacity of the soil, for that in construction projects that use petrasoil as added material must mix it with other added ingredients. Until now there has not been obtained a definite reference about content of petrasoil, but petrasoil has been used in several construction projects. For this reason, further research needs to be done on the content in petrasoil so that it is not wrong in its use in construction works.

4. CONCLUSIONS

The highest soil cohesion value is 20.21 Kpa in the variation of the mixture of 10% fly ash + petrasoil, while the highest shear angle value is 32.38° on the variation of the mixture of 20% fly ash + water. The addition of fly ash to the soil causes an increase in the value of cohesion and shear angle, while the petrasoil used as a mixture in the soil cannot be used without the help of other added ingredients.

5. ACKNOWLEDGEMENT

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REFERENCES

Brooks, R. M. (2009). Soil stabilization with fly ash and rice husk ash. *International Journal of Research and Reviews in Applied Sciences*, **1**(3); 209–217

Hakam, A., R. Yuliet, and R. Donal (2010). Studi pengaruh penambahan tanah lempung pada tanah pasir pantai terhadap kekuatan geser tanah. *Jurnal Rekayasa Sipil (JRS-Unand)*, **6**(1); 11–22

Herius, A., I. I. Indrayani, A. Hasan, and A. Mirza (2019). Addition Effect of Petrasoil Additive Material on CBR Value of Soil in Swamp Areas. *Indonesian Journal of Environmental Management and Sustainability*, **3**(2); 67–70

Indrayani, I., A. Herius, A. Hasan, and A. Mirza (2018). Comparison Analysis of CBR Value Enhancement of Soil Type in Swamp Area by Addition of Fly Ash. *Science and Technology Indonesia*, **3**(2); 73–76

Phanikumar, B. (2009). Effect of lime and fly ash on swell, consolidation and shear strength characteristics of expansive clays: a comparative study. *Geomechanics and Geoengineering: An international journal*, **4**(2); 175–181

Polii, S. N., O. Sompie, and L. D. Manaroinsong (2018). Pengaruh Penambahan Abu Batu Bara Terhadap Kuat Geser Tanah Lempung. *TEKNO*, **16**(69)

Pratama, A. W., I. Iswan, and M. Jafri (2015). Korelasi Kuat Tekan dengan Kuat Geser pada Tanah Lempung yang Didistribusi dengan Variasi Campuran Pasir. *Jurnal Rekayasa Sipil dan Desain*, **3**(1); 157–170

SNI (1990). SNI 03-1964-1990: Testing Methods About Specific Gravity

Wibawa, A. and E. S. Hisyam (2015). Pengaruh Penambahan Limbah Gypsum terhadap Nilai Kuat Geser Tanah Lempung. In *FROPIL (Forum Profesional Teknik Sipil)*, volume 3. pages 65–71

