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EFFECT OF FLY ASH TO IMPROVE CLAYSTONE CHARACTERISTIC AS ALTERNATIVE EMBANKMENT MATERIAL

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ABSTRACT

According to Data Project Construction TPA Regional Banjarbakula, in project location found Claystone material more than 8000 m^3. Based on initial testing of physical dan mechanical characteristic Claystone obtained result that CBR and Plasticity Index not fulfill embankment material spesification. So it can not utilized as embankment material. The use of coal fuels in power plants and industries including the Asphalt Mixing Plant (AMP) unit leaves a lot of coal ash waste and becomes a problem for the environment. This research attemps to know combination of soil, Claystone and Fly Ash which can be used as a mixture of embankment so make soil characteristic better.

In this research done soil testing of physical and mechanical charateristic Soil, Claystone, and Fly Ash by making three types of mixtures, Mixture Type A composed by Claystone 60%, Fly Ash 10%, and Soil 30%. Mixture Type B composed by Claystone 50%, Fly Ash 20%, and Soil 30%. Mixture Type C composed by Claystone 40%, Fly Ash 30%, and Soil 30%. Based on testing result of three mixtures obtained its CBR and PI value not fulfilled embankment spesification, that CBR value minimum 6%. From three mixtures above, Mixture Type B potential to be alternative embankment material due to biggest improvement of CBR and PI value. CBR improve to 4,5% and PI to 16,31.

Keywords: Claystone, Fly Ash, Soil Stability, Embankment

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1. INTRODUCTION

Soil is one of construction materials that must be considered its role. Soil embankment, river embankment, and pile of highways all of it use soil that is expected to be economical value as a construction material. However, new soil will be able to be used after going through the quality control process. Soil that can be used as a pile material for example must meet certain technical criteria to be used as soil embankment.

At Project Construction TPA Regional Banjarbakula site found quite a lot of Claystone materials, which there are more than 8000 m^3 of Claystone (Project Construction TPA Regional Banjarbakula Data). Visually Claystone looks like a very hard rock. And when exposed to claystone water will turn into a soft soil. Based on Claystone characteristics initial test also obtained results that the value of CBR and its plasticity not fulfilled the criteria of soil embankment. So based on the characteristics of Claystone can not be used as a material embankment.

To improve the characteristics of Claystone in order to be utilized as soil embankment it can be added to other materials while maintaining its economic value. Additional alternative material that may be used is the utilization of fly ash waste.

1.1 Formulation Problem

Formulation problem of this research is are

1. How are the physical and mechanical characteristics of Claystone, and how far are these characteristics different from ordinary clay type?
2. How characteristic of the combination of Clay, Claystone, and Fly Ash as a mixture of soil embankment?
3. Can Claystone and Fly Ash be used as a mixture of soil powders to make soil characteristics better?

1.2 Research Objectives

The purpose of this study is to

1. Determine the physical and mechanical characteristics of Claystone, and the difference of these characteristics to the type of common clay soil.
2. Know the characteristic value of each combination of Clay, Claystone, and Fly Ash as a mixture of soil embankment.
3. Know the combination of soil mixture, Claystone, and Fly Ash that can be used as a mixture of soil embankment material to make the soil characteristics better.

1.3 Problem Limits

1. Fly Ash that will be used only sourced from the Regional Development Project Banjarbakula and Claystone Landfill used only sourced in PLTU Asam-asam.
2. In this research, there is no testing on the environmental impact caused by the combination of soil mixture, Clay Stone and Fly Ash as a mixture of soil layers.

2. REFERENCES

2.1 Soil Stabilitation

Stabilization is an attempt to improve soil properties. The widely used stabilization methods are mechanical stabilization and chemical stabilization. Mechanical stabilization is the addition of strength or carrying capacity of the soil by adjusting the gradation of the soil in question. This business usually uses a compacting system. Compaction is mechanical soil stabilization, compaction can be carried out with various types of mechanical equipment such asroller, heavy object dropped, explosion, static pressure, etc. Whereas chemical stabilization is the addition of stabilizing materials which can change the properties less profitable than land. Usually used on fine-grained soils. The material used for soil stabilization is called stabilizing agent.

2.2 Claystone

According to Pettijohn (1975) is rock generally plastic, composed of hydrous aluminum silicate (2H2OAL2O3.2SiO2) or clay minerals having fine grain size (claystone is a sedimentary rock having grain size less than 0.002 or 1/256 mm).

Pettijohn, 1975 defines a clay stone as a massive rock with a greater composition than silt. Meanwhile, according to William et al., 1954, claystone is a clastic sedimentary rock having a clay grain size, including granules having a diameter of less than 1 or 2 microns and is predominantly composed by silica.

2.3 Fly Ash

SNI 03-6414-2002 defining fly ash / fly ash:

Fly Ash is waste burning coal in a steam power plant furnace in the form of smooth, round and are pozolanic fly ash as an ingredient, is :

- materials containing silica or silica + alumina compounds
- independently of very little or no non-cementitious ability
- in a very fine form can react with calcium hydroxide (with sufficient moisture & at room temperature) to form a materials that have cementitious properties.

The advantages of using Fly Ash in Geotechnical Engineering applications, such as soil improvement for road construction are economic, environmental, and reducing shrinkage problems on the use of cement as stabilization materials. One of the handling environments that can be applied is to utilize fly ash waste for civil engineering building materials. However, the utilization of fly ash waste is still not maximally done.

2.4 Soil Embankment Specifications

Based on the General Specification of Division 3 of DGH, the soil embankment material selected as a regular heap should not include high-purity soils classified as CH in Unified or Casagrande Soil Classification System. And the embankment for this layer when tested with SNI 93-1744-1989 shall have a CBR value not less than the baseline carrying capacity characteristic for design or not less than 6% (CBR after 4 days immersion).

3. RESEARCH METHODOLOGY

At this research work will use primary and secondary data. Primary data obtained from laboratory testing using materials Claystone, and Fly Ash. While secondary data needed in this research is secondary data of Ordinary Clay. Each of these materials is taken from different locations, Claystone taken from the Banjarbakula Regional TPA Construction Project, and Fly ash is taken from the Asam-asam Steam Power Plant.

Combination of Mixture of Materials

The three combinations of material mixtures used in this experiment are shown in the following table

Table 3.1 Combination of Mixtures Type A, B and C

No.	Name	Number of Sample	Composition		
			Claystone	Fly Ash	Clay
1	Type A	3 Specimens	60%	10%	30%
2	Type B	3 Specimens	50%	20%	30%
3	Type C	3 Specimens	40%	30%	30%
Total		9 Specimens			

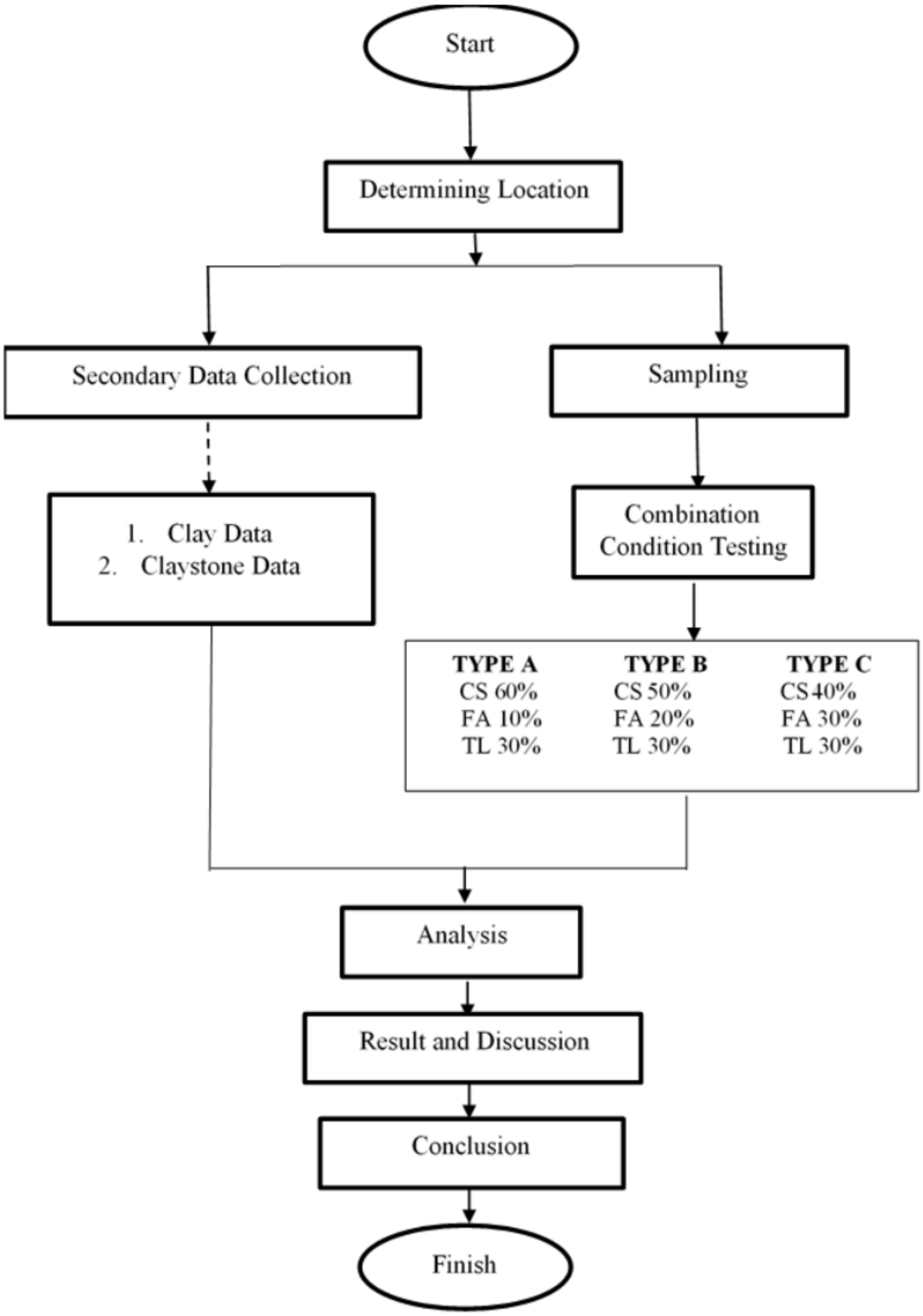


Figure 3.1 Research Flowchart

4. RESULTS AND DISCUSSION

4.1 Characteristics of Physical and Mechanical Clay, Claystone and Fly Ash

a. Clay

Results of testing physical characteristics and mechanical Clay (Soil Clays First) can be seen in the following table.

T able 4.1. Characteristics of Clay

No	Kind of Test				Test Result
1	Water Content		$\omega_{natural}$	(%)	
2	Compaction		$\omega(opt)$	(%)	18,00
			$\gamma dry(maks)$	(gr/cm3)	1,69
3	CBR		CBR Soaked	(%)	4,40
4	Spesific Gravity		Gs		2,55
5	Liquid Limit		LL	(%)	33,40
	Plastic Limit		PL	(%)	19,87
	Plasticity Index		PI		13,53
6	Sieve Analysis				% Lolos
		2"	50	mm	100,00
		1 1/2"	37,5	mm	100,00
		1"	25	mm	100,00
		3/4"	19,1	mm	100,00
		3/8"	9,5	mm	99,72
		4	4,75	mm	98,23
		10	2	mm	92,87
		40	0,43	mm	89,48
		100	0,15	mm	88,18
		200	0,075	mm	86,53
8	Soil Classification		AASHTO		A - 6
			USCS		CL

b. Claystone

As described in Table 4.2 the value of the physical and mechanical characteristics are as follows Claystone

Table 4.2 Characteristics of Claystone

No	Kind of Test				Test Result
1	Water Content		$\omega_{natural}$	(%)	5,90

2	Compaction		$\omega(opt)$	(%)	16,00
			$\gamma dry(maks)$	(gr/cm3)	1,79
3	CBR		CBR Soaked	(%)	0,9
4	Specific Gravity		Gs		2,63
5	Liquid Limit		LL	(%)	28,20
	Plastic Limit		PL	(%)	21,90
	Plasticity Index		PI		6,30
6	Sieve Analysis				
		# 10	2,000	mm	100,00
		# 40	0,425	mm	99,99
		# 200	0,075	mm	98,87
		Gravel			0,00
		Sand			1,13
		Silt			87,67
		Clay			11,20
7	Activity				0,56
8	Soil Classification		AASHTO		A-4
			USCS		CL - ML

c. Comparison of Mixed Type A, B and C

Based on the testing of physical characteristics and mechanical on the mix of types A, B and C, obtained the following results:

Table 4.7 Value Characteristics of Mixed Type A, B and C

No	Kind of Test	TYPE A	TYPE B	TYPE C
1	Specific Gravity (Gs)	2,64	2,62	2,58
2	Liquid Limit (LL) %	42	36	39
3	Plastic Limit (PL) %	18,92	19,69	18,52
4	Plasticity Index (PI)	23,08	16,31	20,48
5	Sieve Analysis			
	Gravel (> 2 mm)	2,76	8,29	7,18
	Course sand (0.6-2.0 mm)	5,30	5,19	3,97
	Medium sand (0.2-0.6 mm)	2,10	1,56	1,31
	Fine sand (0.05-0.2 mm)	10,94	9,10	7,27
	Silt and Clay (0.002-0.05)	38,63	35,93	35,86
	Clay (<0.002mm)	40,28	39,93	44,40
6	Activity	0,29	0,22	0,26
7	Optimum Moisture Content	14,06	13,87	14,6
8	Maximum Dry Density	1,56	1,6	1,58

9	CBR Laboratorium (Soaked 4 days)	2	4,5	3,1
10	Soil Classification (USCS)	CL	CL	CL
	(AASHTO)	A-7-6	A-6	A-6

Relationship between Fly Ash with specific gravity of type mixed soils are described in Figure 4.1. The specific gravity of Soils obtained for Type A, B and C are 2.64, 2.62 and 2.58. Based on this result can be seen that the higher level of mixture of Fly Ash hence value of type gravity tend to lower. This may be caused by the weight value of Fly Ash itself, which tends to be smaller than that of the clay and claystone so that it affects the mixed weights.

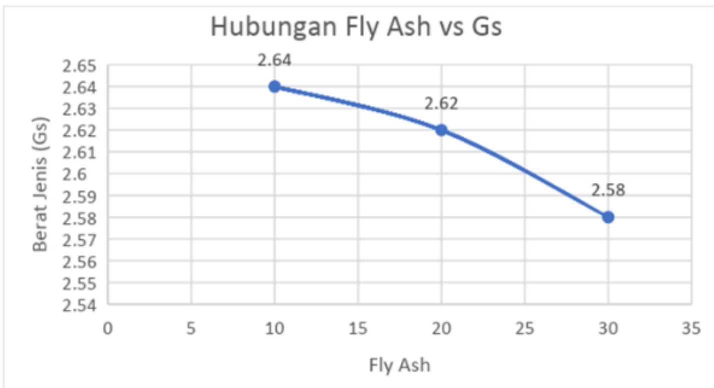


Figure 4.1. Graph of Relation Fly Ash with Specific Gravity

Relationship Fly Ash Mixture with Atterberg Test Result is shown in Figure 4.2. In Atterberg testing, the Liquid Boundaries for Type A, B and C were 42%, 36% and 39%, respectively. And the plastic limit is 18.92%; 19.69%; and 18.52%. So that the value of Plasticity Index is 23,08%; 16.31%; and 20.48%:

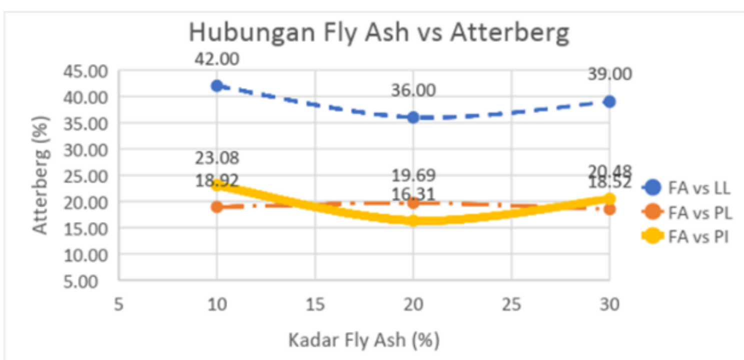
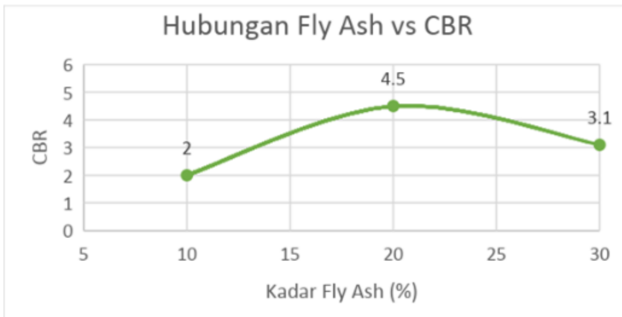


Figure 4.2. Graph of Relationship Fly Ash with Atterberg Limit

In Figure 4.2 it can be explained that in Fly Ash content level of 10% to 20%, the higher Fly Ash value of Liquid Limit and Plasticity Index decreases, while Plastic Limit value is increasing. As well as the condition of Fly Ash content of 20% to 30% then the higher levels of Fly Ash Liquid Boundary value and Plasticity Index is increasing, while the value of Plastic Limit is decreasing.

Based on Figure 4.4 which explains the relationship of Fly Ash content with CBR value of density testing, get the optimum water content for Type A, B and C mixture of 14.06%; 13.87%; and 14.6% and maximum dry weight of 1.56 gr / cm3, 1.6 gr / cm3, 1.58 gr / cm3. And the CBR value for mixed soil types of Type A, B and C is 2%; 4.5%; and 3.1%. Here is a graph of content relationship Fly Ash with laboratory CBR results.



4.2 Potential Mixture as Soil Embankment Material

Based on the General Specification of Division 3 of Bina Marga, soil embankment material selected as a regular heap should not include high-purity soils classified as CH in Unified or Casagrande Soil Classification System. And the embankment for this layer when tested with SNI 93-1744-1989 shall have a CBR value not less than the baseline carrying capacity characteristic for design or not less than 6% (CBR after 4 days immersion).

CBR values for mixed soil types A, B and C show 2%; 4.5%; and 3.1%. And the plasticity index value is 23.08; 16,31; and 20.48. Based on these results, CBR and PI values have not fulfilled the General Specification of Division 3 of Bina Marga, namely CBR value of at least 6%. As shown in Table 4.2 CBR value Claystone is 0.9% and the PI value is 6.3, when Fly Ash content is mixed by 20% in the B-type mixture, the CBR value increases to 4.5% and the PI value is equal to 16.31. Of the three mixtures, the B-type mixture, which is a mixture of 20% Fly Ash, Claystone 50% and Clay 30%, has the potential to become an embankment alternative due to the greatest increase in CBR and PI values. Table 4.8 shows that all mixed types have an increase in the value of CBR and PI, but the increase in the greatest CBR value and the most optimum PI value increase is in the B type mix.

From three mixtures of types A, B and C no one can be recommended to be soil embankment material because no one fulfilled Specification of Soil Embankment. Type B mixture has potential to be an alternative to soil embankment material but further research is needed in order to meet the Specification of Soil Embankment.

Table 4.8 The increase value of CBR and PI mixture of type A, B and C

No.	Name	Composition			CBR	PI (Plasticity Index)	Increase CBR (fold)	Increase PI (fold)
		Claystone	Fly Ash	Clay				
1	Type B	50%	20%	30%	4.5	16.31	5	2.5
2	Type C	40%	30 %	30%	3.1	20.48	3	3
3	Type A	60%	10%	30%	2	23,08	2	3,5

5. CONCLUSION

5.1 Conclusions

1. Soil physical test results show that Claystone is included in low plastic clay with PI 6.32. Claystone Classification according to AASHTO indicates that this land belongs to the A-4 classification, and according to USCS this soil belongs to CL-ML classification of low-plastic inorganic clay soils with gravel clay, sandy clay, clay clay, thin clay.
2. Based on the test results, Claystone characteristics differ greatly with Claystone especially the value of CBR conditions immersion. Claystone CBR value of soaking condition is very low that is 0,9% compare to CBR value of Tanah Lempung soaking condition that is 4,4%. This corresponds to the conditions in the field that Claystone in the form of chunks of stone will turn into mushy when mixed with water.
3. The results of physical test of mixed soil showed that the specific gravity value decreased with the addition of Fly Ash presentation level of 10%, 20%, and 30%. Plastic Limit values have increased with the addition of 20% Fly Ash content and 30%. while the Liquid Limit Value, Plasticity Index, and Activity decreased with the addition of Fly Ash 10% and 20%. Soil classification according to USCS, mixed soil types A, B and C belong to the CL group. According to AASHTO, mixed soil type A belongs to groups A-7-6. The mixed soil types B and C belong to groups A-6.
4. The result of the compacted soil solidification test showed that the maximum dry volume weight increased with the addition of Fly Ash 10% and 20%, and decreased the Fly Ash content of 20% and 30%. The optimum water content decreased with the addition of 10% and 20% Fly Ash presentation and increased for Fly Ash 20% and 30%.
5. CBR value of soaked condition increased by 2% to 4.5% from Fly Ash presentation level of 10% and 20% and decreased the value of CBR by 4.5% to 3% for Fly Ash content of 20% and 30%.
6. Based on the physical and mechanical characteristics test of the three mixtures of types A, B and C, none meet the Specification of Soil Dumps. The B-type mixture is a mixture of the 30% Fly Ash combination, 30% Claystone Claystone, and Claystone 40% has the potential to become an embankment alternative due to the greatest increase in CBR and PI values compared to other mixtures.

5.2 Suggestion

1. There is a need for further research, especially on the variation of Fly Ash presentation with other mixed materials to make Claystone more useful.

2. Further research needs to be done on the environmental impact of the mixture of Fly Ash and Claystone on soil and crop conditions in Banjarbakula Regional TPA.
3. Need for further analysis on field method that allows mixing 3 (three) types of soil into a material embankment in Banjarbakula Regional Disposal Site

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