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Influence use of Clay Soil with Additions *Fly Ash* (Rock Ash) Against Soil Classification Properties and CBR

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ABSTRACT

Soil is the basis of a road foundation, building and also in a civil work where the material consists of an aggregate (granules) or solid minerals that are cemented (chemically bound) to each other from organic materials that have weathered (which particulate matter accompanied by liquid and gas that fills an empty space between the solid particles) The additive used in this research is fly ash. The method used in this research is the experimental method, namely a method carried out by conducting an experiment to obtain data. Based on the results of research testing on the use of clay soil and the addition of fly ash, the CBR value was obtained after being corrected with a percentage of 100% clay soil, and 0% fly ash obtained a CBR value of 6.06% with a soil classification of A-7-6. The use of 75% clay soil and 25% fly ash obtained a CBR value of 15.20% with soil classification A-5. The percentage of use of 50% clay soil and 50% fly ash results in a CBR value of 18.15% with classification A-4. The CBR value and soil classification are better for 50% clay soil and 50% fly ash.

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1. INTRODUCTION

Land is defined as materials consisting of from a aggregates (grains) of solid minerals that are not cemented (bound) in a way chemistry) one each other (Archibong *et al.,* 2020) and from ingredients organic that has decaying (particles) solid) accompanied by with substance liquid and gas that fill room empty between particles congested the (Amran & Sadiya, 2019) .

In the field technique civil , land own influence big to all type the building above it , therefore That land made into as necessary components get attention special in do a planning construction (Frapanti, 2018) . According to Surmaini & Syahbuddin, 2016, conditions the climate in Indonesia is always experience season rainy and dry season , then potential big will happen change water level starts from optimum to minimum (Ariyanto, 2020) .

According to Kusuma (2019), When the season drought land experience shrinkage , low water content , power support height , and strength slide it high , but in the season rain happen development , high water content , power support low and strength slide it low (Liu *et al.,* 2021) . According to Afrin, (2017) , When a construction built on land clay so will happen various damage like the occurrence cracks and waves in the pavement road , crack in the wall building , land collapse and so on (Kusuma, 2019) .

One of type land that is often become problem in a project construction is land clay that has characteristic cohesive (Ningrum, 2020) . Clay soil (Hangge *et al.,* 2021) can shared into two groups

, namely non- expansive clay and clay expansive (Hangge *et al.,* 2021) . Clay soil expansive is land that has characteristic flower large shrinkage . Large expansion and shrinkage of the land clay expansive usually uneven from One point to another point , so that cause the occurrence difference height from the surface that was originally flat becomes uneven , and will result damage to structure above it , therefore That For handle land problems that is one of the the way that can done is with do stabilization land use material added (*additive*) (Musianirudin, 2022) .

fly ash is a materials that can be an alternative to increase Power support land (Frida & Yulianti, 2022) with mix it up to land in need treatment the specifically to land clay expansive Because size particle relative fly *ash* small so that Can fill in pores contained in land mentioned . Use of *fly ash* as substance additives are also possible reduce coal waste that causes impact pollution sufficient environment big (Nugroho *et al.,* 2022) . *Fly ash* is used For mixing is common class -C *fly ash* used public as substance plus For cement mixture (Savaş *et al.,* 2018) .

are many types and qualities of bad soil , so on the contrary must known moreover formerly type the land to be made under layer base building construction then on the ground clay This must moreover formerly tested in the laboratory . For reduce weakness in the soil clay , so that it becomes more strong used mixture land clay with material certain (Riwayati & Yuniar, 2018) . Clay soil and loamy soil cohesive others are greatly influenced by water content . The index plasticity and liquid limit can used for determine characteristics development . Characteristics development only can estimated with use with plasticity .

Clay minerals very small in size (less from 2 microns) and is active particles in a way electrochemical which is only can seen with microscope electrons . Clay minerals show characteristics Power tug-of-war with water and produce plasticity that is not shown by other materials though maybe that material size clay or more small (Apriyanti & Hambali, 2014) .

Classification Properties this land system submitted first by casagrade and then developed by *the United State Bureau Of Reclamation* (USBR) and *the United State Army Corps Of Engineer* (USACE) (Nasrani *et al.,* 2020) . Then *The American Society for Testing Materials* (ASTM) has using USCS as method standard use classify land. In its current form, this system Lots used in various work geotechnical that is land grainy coarse (*coarse-grained soils*) and soil grainy fine - *grained soil.*

2. RESEARCH METHOD

Research methods is method implementation used in find answer from the problem that will be researched. The research method used in this research this is method quantitative, or method purposeful experiment for know use land clay with addition *Fly Ash* to characteristic classification land and CBR.

Study This conducted in the Laboratory land at PT. Rapi Arjasa, Jl. Megawati, Binjai. Using appropriate equipment with SNI (Indonesian National Standard).

Subject study is a person or the thing that will made into sample in A research. Research This subject technique taking sample in the form of data with consideration certain know best about what to expect so that make it easier study explore object / situation being studied. Retrieval Fly Ash samples in Dusun II Tetegawa'ai Ehomo, Mazo District, Regency South Nias, North Sumatra Province.

2.1 Research Design

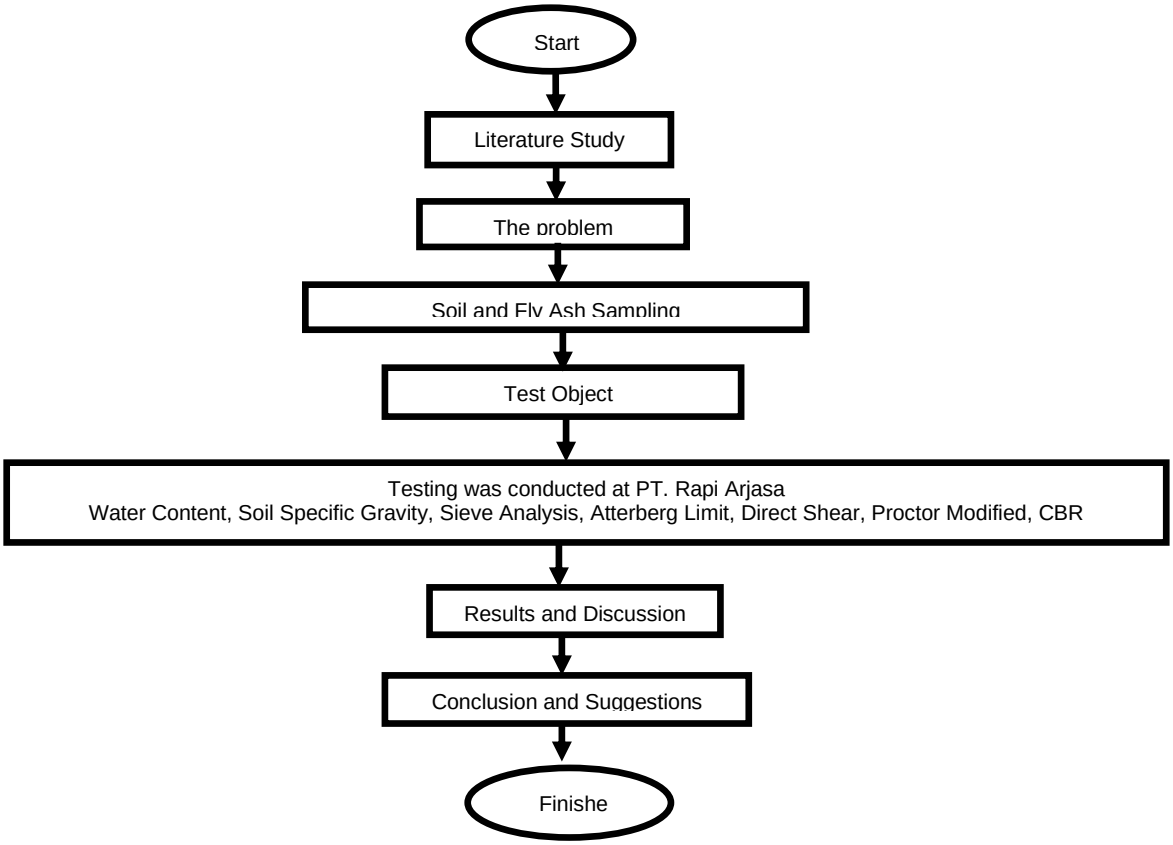

Figure 1. Draft / design study

2.2 Data collection technique

Data collection techniques are technique or the method used for collect data that will be studied. This means that the technique This need step strategic and also systematic for get valid and appropriate data with the reality besides that, technique or method this data collection usually used for researchers for the sake of collecting data that refers to one the city that is not realized in thing, but can seen its use.

There are some technique data collection used in research This namely: nature physical, atterberg limit, weight type, weight type combined, att combination, compaction (proctor), CBR.

2.3 Data Analysis Techniques

From testing water content of sample land, obtained groundwater level in percentage. From testing heavy type sample land, obtained heavy type of soil. From the Atterberg limits test, the liquid limit, plastic limit and index were obtained. plasticity (plastic index) used for classify land with system unified classification. From testing analysis sieve analysis, obtained percentage distribution size grains land, which will used for classify land with system unified classification. From testing permeability in the laboratory, obtained mark coefficient permeability (k) laboratory.

3. RESULTS AND DISCUSSIONS

3.1 Soil Properties Test Results

On the results of the trait test land This done with test characteristic physical and index characteristic land. Where the data has been obtained from each index characteristic land then processed and analyzed for determine type the land. Testing zero land this consists of testing analysis filter, testing heavy type, testing water content, testing atterbeg limit, testing density light (proctor), and CBR testing. Testing done based on provision limitation usage parameter issue land clay and fly ash. Here This results the test:

3.1.1 Analysis Size Soil Grain

On testing analysis size grains land This done based on provisions of SNI 3423: 2008. Where the purpose is analysis size grains This is determine gradation grains from aggregate fine (soil) including aggregate mixture.

Figure 2. Result value rudeness First

Table 1. Analysis Test Results Size Soil Grains With Clay Soil Percentage 100% And Fly Ash 0%

Land				Oven Dry Sample Mass		=	303	Gram
Size Filter		Retained Mass	Retained Mass Amount	Amount		Specification		
				Stuck	Past			
ASTM	mm	grams	grams	%	%			
2"	50.00	-	-	-	-			
1½"	37.50	-	-	-	-			
1"	25.00	-	-	-	-			
3/8"	9.50	-	-	-	-			
No. 4	4,750	1.72	1.72	0.57	99.43			
No. 10	2,000	9.21	10.93	3.61	96.39			
No. 40	0.425	26.02	36.95	12.19	87.81			
No. 200	0.075	113.10	150.05	49.52	50.48			
Fine Modulus				0.16				

Based on results from a testing study use land clay , with addition of fly ash, obtained CBR value after corrected with presentation use land 100% clay and 0% fly ash were obtained CBR value of **6.06%** with classification land **A-7-6 (Clay Soil)** , usage land 75% clay and 25% fly ash were obtained CBR value of **15.20%** with classification land **A-5 (Ground Soil) ,** usage land 50% clay and 50% fly ash were obtained CBR value of **18.15%** with classification land **A-4,** usage land 100% clay and 0% fly ash were obtained CBR value of **18.15%** with classification land **A-4.**

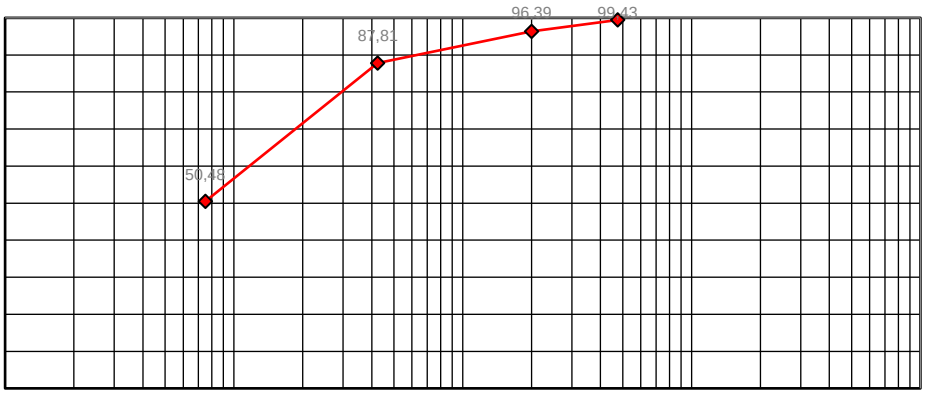

Figure 3. Chart analysis size grain land 100% clay and 0% fly ash

The graph above show mark percentage material that passes through the filter every faction aggregate. The value is soil material 100% clay and 0% Fly Ash.

Table 2. Analysis Test Results Size Soil Grains With Clay Soil Percentage 75% And Fly Ash 25%

Land				Oven Dry Sample Mass	=	351	Gram
Filter Size		Retained Mass	Retained Mass Amount	Amount		Specification	
				Stuck	Past		
ASTM	mm	grams	grams	%	%		
2"	50.00	-	-	-	-		
1½"	37.50	-	-	-	-		
1"	25.00	-	-	-	-		
3/8"	9.50	-	-	-	-		
No. 4	4,750	-	-	-	100.00		
No. 10	2,000	24.76	24.76	7.06	92.94		
No. 40	0.425	65.26	90.02	25.68	74.32		
No. 200	0.075	118.97	208.99	59.62	40.38		
Fine Modulus				0.33			

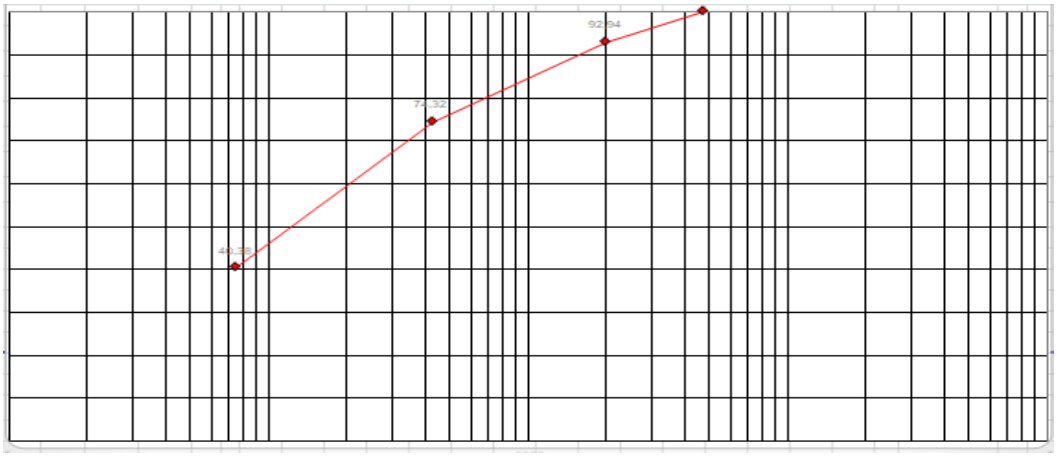

Figure 4. Chart analysis size grain land 100% clay and 0% fly ash

The graph above show mark percentage material that passes through the filter every faction aggregate. The value is soil material 75% clay and 25% Fly Ash.

3.1.2 Soil Specific Gravity Test

On testing heavy type land This will use provision from SNI 1964:2008 with objective For get comparison mass land to the volume of water, besides That testing This aiming For look for mark heavy type rainfall dry , heavy type fed up surface (JKP), weight type pseudo , and absorption heavy type pseudo , and water absorption in aggregates .

Figure 5. The process of issuing bubble air in pycnometer

Table 3. Results of Soil Specific Gravity Testing With Clay Soil Percentage 100% And Fly Ash 0%.

Number example / depth		Landfill common		Unit
Number pycnometer		P4	J5	-
Pycnometer mass + example	w_1	117.00	118.24	grams
Pycnometer mass	w_2	85.44	86.38	grams
Land mass	$w_t = w_1 - w_2$	31.56	31.86	grams
Temperature	°c	25.00	25.00	°C
Mass of pycnometer + water + soil at °C	w_3	352.80	353.73	grams
Mass of pycnometer + water at °C	w_4	334.41	335.14	grams
$W5 = W1 - W2 + W4$	$w_5 - w_3$	365.97	367.00	grams
Land Contents	$w_5 - w_3$	13.17	13.27	cm^3
Specific gravity	$\frac{w_t}{w_5 - w_3}$	2,396	2,401	grams/ cm^3
Average		2,399		grams/ cm^3

Table 4. Results of Soil Specific Gravity Testing With Clay Soil Percentage 75% And Fly Ash 25%

Number example / depth		Landfill common		Unit
Number pycnometer		Y4	C1	-
Pycnometer mass + example	w_1	115.30	113.99	grams
Pycnometer mass	w_2	87.02	86.15	grams
Land mass	$w_t = w_1 - w_2$	28.28	27.84	grams
Temperature	°c	25.00	25.00	°C
Mass of pycnometer + water + soil at °C	w_3	352.82	351.83	grams
Mass of pycnometer + water at °C	w_4	335.70	335.00	grams
$W5 = W1 - W2 + W4$	$w_5 - w_3$	363.98	362.84	grams
Land Contents	$w_5 - w_3$	11.16	11.01	cm^3
Specific gravity	$\frac{w_t}{w_5 - w_3}$	2,534	2,529	grams/ cm^3
Average		2,531		grams/ cm^3

This table (Table 4 & 5), Percentage 100% land use clay, and fly ash 0% gain CBR value of 6.06% with classification land A-7-6 (land muddy).

3.2 Atterberg Limit Test

3.2.1 Liquid Limit

In liquid limit testing will use provisions of SNI 1967:2008. The purpose is For to determine consistency material behavior and its properties in soil cohesive , consistency land depends from its liquid limit value . Besides That liquid limit value This will used For to determine index plasticity land namely the liquid limit reduced with plastic limit value .

Table 5. Atterberg Limit Consistency Test Results With Percentage 100% And Fly Ash 0%

Liquid Limit (L L)			Plastic Limit		
Many Punches		25.00			
Cup Number		U1	H	A4	Average
Sample Mass Wet + Cup	(grams)	27.34	29.02	28.54	
Sample Mass + Cup	(grams)	22.60	25.25	24.70	
Water Mass	(grams)	4.74	3.77	3.84	
Mass of the Cup	(grams)	13.01	14.55	13.76	
Dry Sample Mass	(grams)	9.59	10.70	10.94	
Water content	%	49.43	35.23	35.10	35.17

Liquid limit results at 50% soil percentage clay and fly ash 50% of 36.38% liquid limit value related with determine a classification land .

Table 6. Atterberg Limit Consistency Test Results With Percentage 75% And Fly Ash 25%

Liquid Limit (L L)			Plastic Limit		
Many Punches		24.00			
Cup Number		T5	Z	U	Average
Sample Mass Wet + Cup	(grams)	42.09	31.21	30.70	
Sample Mass + Cup	(grams)	34.86	27.57	27.02	
Water Mass	(grams)	7.23	3.64	3.68	
Mass of the Cup	(grams)	17.80	16.55	15.90	
Dry Sample Mass	(grams)	17.06	11.02	11.12	
Water content	%	42.38	33.03	33.09	33.06

In accordance with the provisions of SNI 1744:2012 are contained mark CBR correction based on graphics, the existence of CBR correction due to existence error factor when do testing . After done CBR correction obtained mark amounting to 19.15% at 100% density and 15.04% at 95% density. In accordance SNI 1744:2012 provisions on the CBR value used is mark CBR correction.

3.3 Compaction Test Light Soil

3.3.1 Liquid Limit

In liquid limit testing will use provisions of SNI 1967:2008. The goal is For to determine consistency material behavior and its properties in soil cohesive, consistency land depends from its liquid limit value.

3.3.2 Compaction Test Light Soil

Testing compaction light on the ground will use provision from SNI 1742:2008. Where is the purpose? is for get mark from optimum and dry levels the maximum that will be used in CBR testing.

Table 7. Test Results Compaction Light With Percentage 100% Clay, Fly Ash 0%

Preparation Test Example						
Wet Land Mass	(grams)	2,500	2,500	2,500	2,500	2,500
Initial Water Content	(%)	3.61	3.61	3.61	3.61	3.61
Adding Water	(%)	18.00	21.00	21.00	27.00	30.00
Adding Water	(grams)	450.00	525.00	600.00	675.00	750.00
Density						
Wet Soil Mass + Mold	(grams)	4.945	5.130	5.223	5.209	5,080
Mold Mass	(grams)	3,510	3,510	3,510	3,510	3,510
Wet Land Mass	(grams)	1,435	1,620	1,713	1,699	1,570
Print Contents	(^{cm3})	943	943	943	943	943
Density Wet	(grams/cc)	1,522	1,718	1,817	1,802	1,665
Dry Density	(grams/cc)	1,256	1,383	1,430	1,385	1,251

The table values above show results testing test compaction land 100% clay and 0% fly ash in each sample sample material test consisting top 5 samples testing, thing This aiming get mark density dry maximum and optimum levels will be used in manufacturing laboratory CBR test objects. Based on results addition water content and after done compaction light . From the results soil mass scale wet + mold and moisture content after compaction so optimum water content used or making CBR test objects as many as **19.09%.**

4. CONCLUSION

Percentage 100% land use clay , and fly ash 0% gain CBR value of 6.06% with classification land A-7-6 (land muddy). Percentage 75% land use clay , and fly ash 25% gain CBR value 15.20% with classification land A-5 (land 3. Percentage 50% land use clay, and fly ash 50% gain CBR value 18.15% with classification land A-4 (land turbidity).

According to the research results, a percentage of 100% clay and 0% fly ash produced a CBR value of 6.06% with soil classification A-7-6 (muddy soil). Then, with 75% clay and 25% fly ash, the CBR value increased to 15.20% with soil classification A-5. While a mixture of 50% clay and 50% fly ash produced a CBR value of 18.15% with soil classification A-4. From these results, it can be seen that increasing the proportion of fly ash in the clay mixture significantly increases the CBR value and improves soil classification. Future research can test the effects of using other additional materials, such as lime, fiber, or cement, on the clay and fly ash mixture to further improve soil stability. In addition to the CBR test, triaxial and shear strength tests can be carried out to obtain a more comprehensive mechanical analysis of the stabilized soil mixture.

ACKNOWLEDGEMENT

For use land clay, and fly ash can used in construction for improvement Power support more land stronger and more Good. The use of fly ash is increasing Lots cause CBR value and classification land more good and recommended in construction can used. For development study furthermore need done fly ash study further from 50% to get mark density, CBR value, classification land and power support more land Good.

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