THE EFFECT OF VULCANIC ASH AND TAILING AS STABILIZATION MATERIALS IN SOIL CLAY ON CBR VALUE

Achmad Abrar Haziri *[1], Syahril [2]

[1]*Civil Engineering, Politeknik Negeri Bandung, Jalan Gegerkalong Hilir, Kec. Parongpong, Jawa Barat 40559*
E-mail : ahmad.abrar.mtri18@polban.ac.id
[2]*Civil Engineering, Politeknik Negeri Bandung, Jalan Gegerkalong Hilir, Kec. Parongpong, Jawa Barat 40559*
E-mail : Syahril@polban.ac.id

ABSTRACT

Soil is the sub structure for supporting the upper structure (e.g., road constructions, etc), often it causes problems if it has poor physical and low mechanical properties. Two main problems in soft soils are excessive settlement and low bearing capacity. Soil stabilization is one of methods used to improve the physical properties and bearing capacity or shear strength of road subgrade, so that this process can increase the bearing capacity of the subgrade to support the upper structure. This paper will discuss the enhancement of bear capacity of soft clay soil using the addition material, such volcanic ash (AGV) and tailing (TL) deposits as a substitute material likes cement. The material composition variables are 8 % volcanic ash (AGV) and mixed by 4%, 5%, 6% tailings (TL) and curing time for 3 days, 7 days and 14 days.

Keywords: CBR; Soil clay; Stabilization; Tailing; Volcanic ash.

1. INTRODUCTION

Soft clay soil and peat soil exist in around 20 million hectares or more than 10% of the land area in Indonesia Soft soil has low shear strength, large compressibility, high permeability coefficient (not small) and low bearing cape [2]. Subgrade in a road construction must be capable to support upper structure in accordance with the technical requirements and specification. Soil stabilization is an attempt to improve soil properties in order to fulfil of bot requirements [3]. Soil improvement needs to make some solutions of these problems in order to make stable and safer the upper structure [4]. Stabilization method, which is wide used in previous studies, related to soft soil improvement in chemical stabilization method. Chemical stabilization is the improvement of the soil by addition chemical materials [5] Low soil bearing capacity can be increased with volcanic and tailings [6]. These materials are expected to produce better bearing capacity and increase the CBR value. The high CBR value shows the high ability of interlock between the surface grains.

2. METHODS

Research flow chart shows in Figure 1.

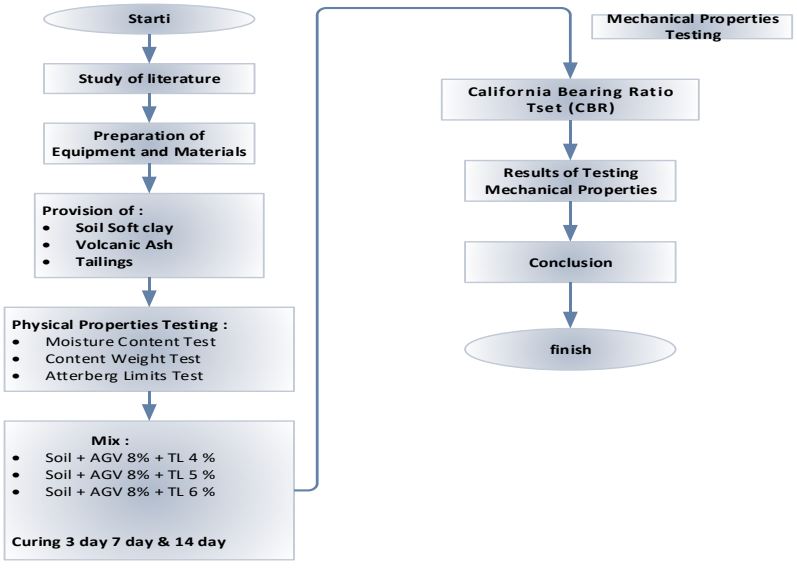

Figure 1. Research flow chart

This research will do subgrade stabilization with a mixture of volcanic ash with the addition of tailings, the initial stage carried out in this study is subgrade sampling at the Gedebage location which according to previous research is soft soil type, this research will start with physical properties test then soft soil will mixed with volcanic ash and tailings, where the mixture is divided into 3 mixture that is AGV 8% + TL (4%,5%,6%). After that, a mechanical properties test is carried out where the results of the CBR value will be obtained.

2.1. Soil Clay

In general, soft soil layer is clay or silt has a standard penetration test value smaller than 4 or soil organic such peat which has a very high natural water content [7]. The are many problems of settlement found in soil clay. Soil clay has a large shrinkage, high moisture content and low bear capacity [8]. Soft soil in road construction often makes some problems. Soft soil has low bearing capacity and requires expensive construction costs to stabilize from potential to collapse occurred. Soft soil generally has also low shear strength, high compressibility and high (not small) permeability or hydraulic conductivity. A road structure constructed on soft soil usually it has a field CBR value less than 2%. Soft soil can be defined as soil which is have most of the grain sizes are very fine or pass No. 200. When the construction loading is exceeded critical bearing capacity will occur some damages or create the sliding potential, especially for foundation soil. One of the best ways is to replace the subgrade with soil which is quite good or by the method of soil stabilization.

Problems prevention must be created at road subgrade, the existing subgrade must have minimum standard as a pavement coating material. The following in Table 1 below describes the minimum standard of subgrade material used as a pavement layer.

Table 1. Minimum Standard of Subgrade Material in Road Pavement Layer

Parameter	Minimum Standard	Unit	Source
Plasticity Index (PI)	< 18	%	*Holz & Gribbs (1956)*
Activation (PA)	≤ 1,25	-	Pd T-10-2005-B
CBR	≥ 6	%	Pavement Design Manual

2.2. Soil Stabilization

Improvement method of soft soil is one part of the structure construction, such as: soil stabilization method. Soil stabilization can improve the soil and strength properties to fulfil the technical requirement and specification [9]. Soil Stabilization is a soil improvement effort making possible to improve soil that has a low bearing capacity. The method of soil stabilization can be performed mechanically, such as: grinding and chemical machines using additives (cement, lime, gravel, and granular soil). thickness of the stabilization layer allowed is at least 1000mm thick and compacted every layer of 150 - 200 mm [10].

2.3. Physical Property Test

- Moisture Content Testing (SNI 1965:2008)
  Moisture Content Testing is applied to determine consistency of behaviour material and its properties, in cohesive soil the consistency of the soil depends on the grade value the water. In addition, this moisture content value can be used for other tests such as in testing the determination of the liquid limit and the plastic limit of the soil.
- Specific Gravity Testing (SNI 1964:2008)
  Soil specific gravity or Specific Gravity (Gs) is the ratio between the weight of soil grain and the weight of distilled water at temperature and the same volume
- Atterberg Limits Testing (ASTM D4318).
  is a test method to determine the consistency of fine-grained soil (silt or clay) by providing a different water content for each sample to be tested.

2.4. Mechanical Properties Test

- Compaction Test (ASTM D698).
  Compaction is a process of increasing soil density by reducing the distance between particles so that there is a reduction in air volume or there is no significant change in the volume of water on the soil.

- California Bearing Ratio (ASTM D 1883).
  CBR testing is a comparison between the penetration load of a layer of soil or pavement against standard materials carried out with the same penetration depth and speed.

3. RESULT AND DISCUSSION

Table 2 and 3 shows the test results of physical and mechanical properties of soil sample and after mixing.

3.1 Test Results of Mixed Subgrade Physical Characteristics

Table 2. Test Results of Subgrade Physical Characteristics

Laboratory Test Resume							
Index Properties		**symbol**	**unit**	**Value on the mix**			
				0	1	2	3
				Soil	Soil + 8% ABVK + 4% TL	Soil + 8% ABVK + 5% TL	Soil + 8% ABVK + 6% TL
1.	Moisture Content		%	41,65			
2.	Specific Gravity	Gs	-	2,59	2,62	2,64	2,71
3.	Atterberg Limits						
3.1	Plastic limit	PL	%	30	41	47	50
3.2	Liquid limit	LL	%	73	69	65	64
3.3	Plasticity index	PI	%	43	28	18	14

In Table 2. the values of Atterberg boundaries, there are several criteria that can be used to identify the properties of soft clay based on the Atterberg upper-boundary value, based on the Pd T-10-2005-B criteria, it shows that the original soil is taken in the Gedebage area with a percentage of PI (Plasticity Index) of 43% in mixture 0 and classified as soft clay which has low shear strength and high compressibility properties, but in mixed soil% ABVK which is constant and% TL increases, the percentage of PI (Plasticity Index) decreases by 83% in mixed soil 3 and is classified as silt-loamy because the finer portions of the soil have a plastic index of 11 or more.

3.2 Test Results of Mixed Subgrade Physical Characteristics

Table 3. Test Results of Subgrade Mechanical Characteristics

Technical Properties		**symbol**	**unit**	**Value on the mix**			
				0	**1**	**2**	**3**
				Soil	Soil + 8% ABVK + 4% TL	Soil + 8% ABVK + 5% TL	Soil + 8% ABVK + 6% TL
1.	Compaction	γd	$gr\backslash cm^3$	1,203	1,260	1,356	1,400
		w_{opt}	%	26,50	24,45	24,35	23,70
2.	Unsoaked		%	3,6			
2.1	CBR Curing 3 Day	CBR_{design}	%	-		5,9	7,4
2.2	CBR Curing 7 Day	CBR_{design}	%	-		6,4	7,2
2.3	CBR Curing 14 Day	CBR_{design}	%	-		7,8	9,2
3.	Soaked		%	0,8			
3.1	CBR Curing 3 Day	CBR_{design}	%	-		2,2	3,2
3.2	CBR Curing 7 Day	CBR_{design}	%	-		2,4	3,9
3.3	CBR Curing 14 Day	CBR_{design}	%	-		3,0	5,1

CBR tests (2 and 3 types) has the lowest PI value. For the CBR test results, the CBR percentage value of unsoaked soil sample in 3 days shows lower than 2 and 3 type. Soaked CBR percentage value in soil sample is smaller than 2 and 3 types and tends to increase at curing time for 3 days, 7 days and 14 days. The test results are also shown in Figures 2 and 3.

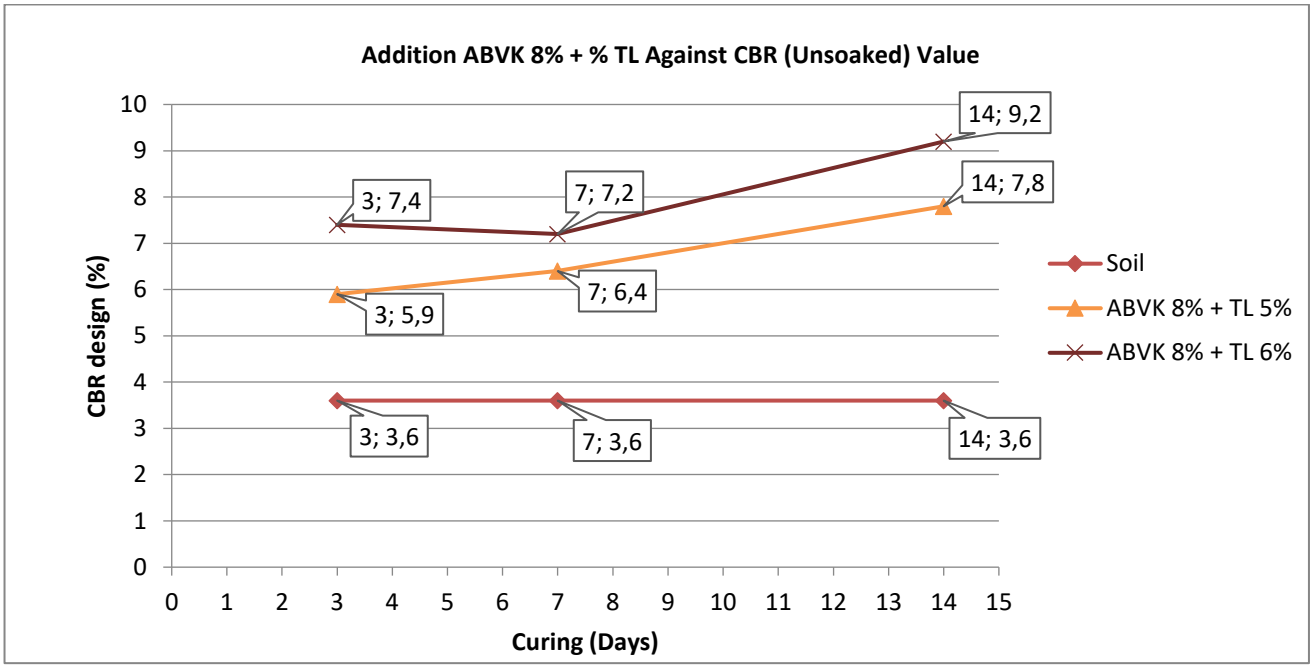

Figure 2. CBR value and Curing Time on Unsoaked to TL% increase

From Figure 2, the results of the CBR in unsoaked test shows the percentage value of C curing 3 days to 14 days tends to increase with the increasing percentage of the tailings mixture.

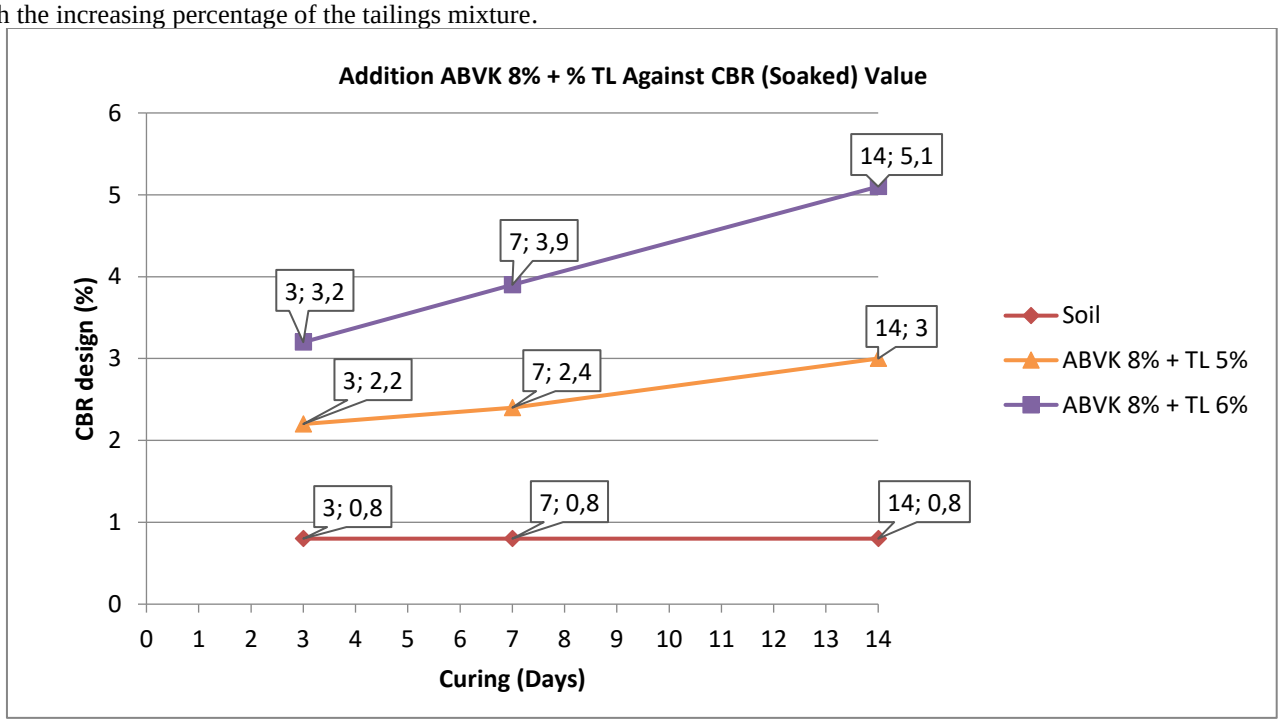

Figure 3. CBR value and Curing Time on Soaked to TL% increase

From Figure 3, the results of the CBR in soaked test show the percentage value of CBR curing 3 days to 14 days tends to increase with the increasing percentage of the tailings mixture but does not increase significantly as in CBR in unsoaked test.

4. CONCLUSION

Based on several tests, it can conclude that:

- Stabilization using volcanic ash (AGV) and tailing (TL) at soil sample will decrease the plasticity index (PI).

- CBR value will decrease in curing time for 2 and 3 type However, CBR value will increase during the 3 days in curing time with of 3 types around 6.0 % and 9.2 % at the 14-hour curing time or increase 2.2% from 3 type.
- Increasing CBR value submerged in curing time for 2 type and 3 type are also indicated by high CBR value for 3 days soaked for 3 types around 2.7% and increases 5.1% for 14 or enhancement of CBR value around 2.5%.

5. ACKNOWLEDGMENT

On this occasion, the author would like to express his gratitude to the Department of Civil Engineering, Bandung State Polytechnic, Technician of the Laboratory of Mechanical Engineering Civilians of Bandung State Polytechnic, and related friends who have helped the smooth process of this soil research.

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