STUDY OF PHYSICAL AND MECHANICAL SOIL PARAMETERS AS IN-SITU EMBANKMENT MATERIALS ON DOUBLE TRACK RAIL ROAD CONSTRUCTION PROJECT BETWEEN BATU TULIS – CIOMAS STATION, BOGOR.

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ABSTRACT

A utilization of in-situ soil as embankment material in civil construction must pay attention to the physical characteristics and mechanical parameters of the soil, in its function to support the load acting on it. In the construction of a double-track rail between Batu Tulis station at Bogor City, and Ciomas station, 3 (three) samples of local soil parameters were investigated as embankment material. Laboratory investigations were carried out, including tests of physical parameters (Atterberg limits, soil density, and grain size distribution), and test of mechanical properties, in the form of direct shear tests, compaction test, and laboratory CBR. From the test results on soil samples, soil can be classified as loose silty sand with low plasticity to well graded sand (SM-SW), with dry density (γ-dry), 1.26 – 1.42 gr/cm^3, $CBR_{0.1}$ value of 47.5 – 76.4%, and soaked $CBR_{0.1}$ value of 31.67 – 34.6%. From the tests that have been carried out, it can be concluded that the in-situ soil has high potential as embankment material, by taking into account the impacts arising from the on-site excavation, and compaction process.

Keywords*: embankment material, physical properties, soil classification, soil compaction, CBR.*

1. INTRODUCTION

Soil is a place to build a structure and building construction, both building construction and road construction. According to Das (2004), soil can also be used as construction material. Soil is one of the materials that are readily available in the field which is very economical and easy to obtain.

Although it has economic properties and is easy to obtain, the quality of the soil must also be tested before being used as a construction material to avoid construction failure. The problem that often arises when erecting a construction on the ground is the poor physical properties of the soil. So in construction planning, the magnitude of the influence of soil parameters needs to be carefully calculated. (Fathurrozi & Rezqi, 2016; Prasetio et al., 2019)

Embankment works aim to increase the elevation of the land to make it look flat or flat to get a better surface. Embankment activities usually use soil or coarse aggregate as the main material. The problem that is often encountered in embankment work is the failure of the desired job specifications. This failure can occur in the embankment itself. One of the most important elements that must be considered in stockpile soil is the characteristics of the soil and the way of stabilization of the soil itself. The determination of soil characteristics must go through research because the soil in one location has different characteristics from the soil in another location. (Alwi et al., 2016; Nenny & Imran, 2015).

This study aims to determine the physical parameters of in-situ soil as railroad embankment material in the double-track railway construction project between Batutulis and Ciomas Stations, Lintas Bogor - Sukabumi. This soil parameter study is used to assess the potential of the soil as embankment material at the site.

2. RESEARCH METHOD

2.1 Research Sites

The research is located in a double-track railway construction project between Batutulis and Ciomas Stations, Lintas Bogor - Sukabumi. Testing locations are shown in Figure 1 and Figure 2, whereas the typical cross section of double-track is shown in Figure 3.

Figure 1 Research Location
(*Source: private documentation*)

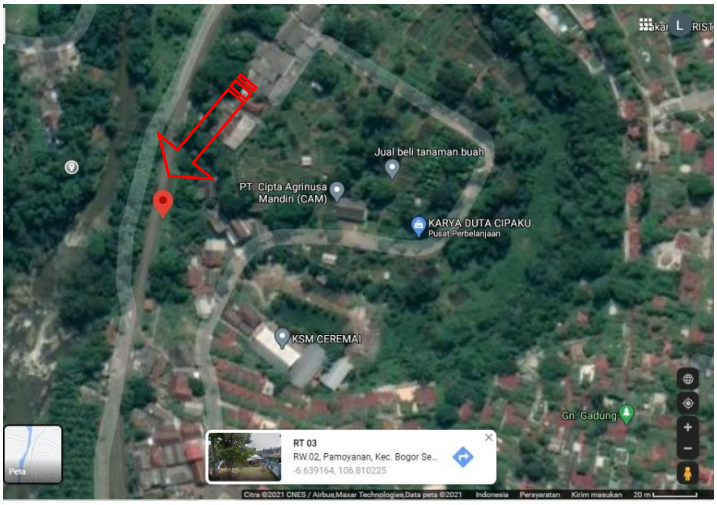

Figure 2 S-2 sampling point
(*Sumber: google maps*)

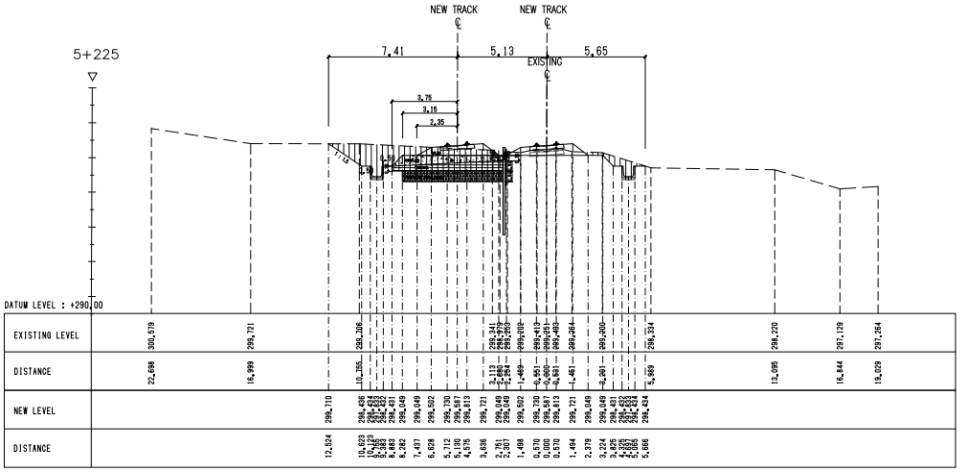

Figure 3 Double-track cross section profile
Sumber: Dokumentation of PT. Nindya Karya (Persero), 2020

Soil samples came from 3 (three) points, shown in Table 1 below.

Table 1. Coordinate of sampling point

No. Sample	Location	Coordinate
S – 01	Cipaku, Bogor Selatan district	S: 6°38'14.80" E: 106°48'42.70"
S – 02	Kertamaya, Bogor Selatan	S: 6°39'49.82" E: 106°49'01.58"

No. Sample	Location	Coordinate
	district	
S – 03	Cipaku, Bogor Selatan district	S: 6°39'49.82" E: 106°49'01.58"

Sumber: Test Result, 2021

2.2 Tests of physical parameters of soil

Tests of physical parameters of soils is intended to determine whether the in-situ soil is a suitable soil type for embankment. (Dapena & Tobarra, n.d.; Perangin-angin, 2009; Sa'pang et al., 2015).

The physical parameter tests carried out were the natural water content test (SNI 03-1965-2008), the specific gravity test (SNI 03-1964-2008), the grain-size analysis (SNI 03-3423-2008), as well as the Atterberg limit test, consists of liquid limit test (SNI 03-1967-2008), plastic limit test and Plasticity Index (SNI 03-1966-2008).

The soil classification method according to the grain fraction and its use as a road embankment material refers to the AASHTO and USCS methods. (Das, 2004)

2.3 Tests of mechanical parameters of soil

Tests of mechanical parameters of soil in the laboratory consists of direct shear test (SNI 03-2813-2008), compaction test (SNI 03-1742-2008) and Laboratory Californian Bearing Ratio (CBR) test (SNI 03-1744-2008) (Norhadi et al., 2018; Taqwa et al., 2019).

3. RESULTS AND DISCUSSION

3.1 Results of physical parameters test

The results of soil physical parameters test are shown in **below.**

Table 2 below.

Table 2. The test results of soil physical parameters in the laboratory

No.	Type of test	No. Sampel		
		S-01	S-02	S-03
1	Natural Water Content (%)	47,44	59,85	57,70
2	Atterberg Limits (%)			
	Liquid Limits (*LL*)	55,93	55,53	35,46
	Plastic Limits (*PL*)	45,63	48,02	N/A
	Plasticity Index (*PI*)	10,30	7,51	NP
3	Specific Gravity (*SG*)	2,62	2,24	1,70
4	Sieve Analysis			
	No.#40 passed	48,95	28,07	35,45
	No.#200 passed	3,42	3,96	4,17
	Uniformity coefficient (*Cu*)	4,72	9,51	8,65
	Gradation coefficient (*Cc*)	0,79	1,05	11,32
5	Soil Classification			
	- AASHTO	A 2-4	A 2-5	A 3/ A2-4
	- USCS	SM/SC	SM/SC	SW-SM

Sumber: Test result, 2021

From **below.**

Table 2 above, it can be shown that the soil pile in the test location is well graded sand soil types, with slightly lower plasticity silt fraction (SW-SM) or can be classified as well as A-2-4 and A-2-5 soil type. The type of soil at the location of S-3 have different classes, namely class A-3, where the type of soil classified as well graded sand soil.

3.2 Direct shear test result

The result of direct shear test shown on table below.

Table 3. Result of direct shear test

No. Sample	Cohesion (kg/cm^2)	Friction Angle (^{o})
S – 01	0,38	14,1
S – 02	1,10	49,4
S – 03	1,59	39,8

Source: Test result, 2021

From table 3 above, it can be seen that the soil cohesion value ranges from 0.38 - 1.5 kg/cm^2, and the inner shear angle ranges from 14.1 - 49.4o. Thus, the three soil samples are classified as sandy soil.

3.3 Proctor standard compation test result

The results of soil density testing using the Standard Proctor method on 3 (three) soil samples are shown in the table below.

Table 4. Result of *compaction test*

No. Sample	Dry density (gr/cm^3)	Optimum water content (%)
S – 01	1,36	36,6
S – 02	1,42	29,9
S – 03	1,26	35,8

Source: Test result, 2021

From table 4 above, it can be seen that soil dry density (γ_{dry}) ranged from 1,26 – 1,42 gr/cm^3.

3.4 Laboratory CBR test result

The results of Laboratory CBR test on 3 (three) soil samples are shown in the table below.

Table 5. Laboratory CBR test result

No. Sample	CBR un-soaked (%)		CBR soaked (%)	
	$CBR_{0,1}$	$CBR_{0,2}$	$CBR_{0,1}$	$CBR_{0,2}$
S – 01	47,48	41,48	31,67	38,29
S – 02	46,27	49,85	31,67	35,60
S – 03	76,45	69,78	34,67	43,71

Source: Test result, 2021

From table 5 above, it can be seen that soil samples have sufficiently high bearing capacity, with $CBR_{0,1}$ ranged from 46,3 – 76,4%.

3.5 Consolidation test result

The results of consolidation test on 3 (three) soil samples are shown in the table below.

Table 6. Consolidation test result

No. Sample	p'_c (kg/cm^2)	C_c	C_s
S – 01	0,48	0,086	0,029
S – 02	0,76	0,023	0,019
S – 03	2,50	0,20	0,020

Source: Test result, 2021

From table 5 above, it can be seen that the soil has a low level of compressibility. Especially in the S-03 sample, where the soil has a much higher pre-consolidation stress when compared to other soil samples. This can occur because the S-03 soil sample was taken in a compressed state due to long term loading.

4. CONCLUSION

From the research that has been done, it can be concluded that the local soil is classified as a well-graded sandy soil type, with a low silt fraction of low plasticity (SM-SW), or it can also be classified as A-2 soil. Thus, in-situ soil has a high potential to be used as a railroad embankment material.

Recommendations that can be applied at the time of compaction is using staged construction method, especially at the initial embankment stage, to avoid changes in total stress and excess effective stress during the primary consolidation period. And it is necessary to carry out long-term monitoring of subsidence rate at the work site.

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SNI 03-1966-2008 Cara Uji Penentuan Batas Plastis dan Indeks Plastisitas Tanah

SNI 03-1967-2008 Cara Uji Penentuan Batas Cair Tanah

SNI 03-2813-2008 Cara Uji Kuat Geser Langsung Tanah Terkonsolidasi dan Terdrainase

SNI 03-2812-2011 Cara Uji Konsolidasi Satu Dimensi

SNI 03-3423-2008 Cara Uji Analisis Ukuran Butir Tanah