JURNAL MULTIDISIPLIN MADANI (MUDIMA)

Homepage: https://journal.formosapublisher.org/index.php/mudima

ISSN: 2808-5639 (Online)

Research Article

Volume 4, No 6, June (2024)	DOI: https://doi.org/10.55927/mudima.v4i6.10011	Page: 898-907

Subgrade Soil Improvement Using Local Domato (Limestone) Material from North Sulawesi

Chris Hombokau[1], Novriana Pangemanan[2], Rudolf Mait[3], Don Kabo[4*]

Department of Civil Engineering, Manado State Polytechnic

Corresponding Author: Don Kabo donkabo74@gmail.com

ARTICLE INFO

Keywords: Soil Stabilization, Domato, CBR Value

Received : *4 April*
Revised : 20 *May*
Accepted : 25 *June*

ABSTRACT

Damaged and potholed roads are often caused by poor subgrade conditions. Clay subgrade cannot withstand the loads applied on it, leading to the deterioration of the pavement structure. Soil stabilization is one way to address poor subgrades. Stabilization can be done by compacting the soil or mixing it with other materials that can improve its properties. This research aims to determine the effect of mixing domato on the soil at the Final Waste Disposal Site (TPA) in Pandu Village, which is clayey, by looking at the increase in the CBR (California Bearing Ratio) value of the clay soil after stabilization with domato. This research was conducted in the soil testing laboratory of the Civil Engineering Department at Manado State Polytechnic using experimental methods by stabilizing the existing soil with the addition of sand with variations of 10%, 15%, and 20%, and testing based on ASTM (American Society For Testing and Materials) and AASHTO (American Association Of State Highway and Transportation Officials) standards. The soil samples for testing were taken from TPA Pandu, and domato was sourced from the Talaud Islands, North Sulawesi. After testing, the original soil CBR value was found to be 3.70% without being mixed with domato. Then, after stabilization using domato with a 10% mixture variation, the CBR value was 5.20%. With a 15% domato mixture variation, the CBR value was 11.80%, and finally, with a 20% variation, the CBR value was 15.50%. From the test results, it can be seen that domato significantly affects the increase in CBR value

INTRODUCTION

A highway is a strip of land on the earth's surface made by humans with specific shapes, sizes, and types of construction, allowing it to be used for channeling vehicle traffic, such as transporting goods from one place to another more quickly and easily (Dimas Satya Dwinka, 2024).

Soil is the foundational layer for placing a construction structure, which must have good properties and bearing capacity. Therefore, the strength of the structure will be directly influenced by the subgrade's ability to receive and transmit the loads applied to it. Not all soil types have good properties and bearing capacity because the soil is heterogeneous and anisotropic (Sartika et al., 2023).

Soil is a material consisting of aggregates or grains of solid minerals that are uncemented (chemically unbonded) to each other, and organic materials that have weathered with solid particles accompanied by liquid and gas substances. Clay soil (clay) is a mineral particle that is smaller than 0.002 mm. These particles are the primary source of cohesion in cohesive soils (Ramadani et al., 2024).

The soil condition in the field along the road segment shows several points where the road is damaged and potholed. This is often caused by poor subgrade conditions. For example, the clay subgrade cannot withstand the heavy loads applied to it, causing the pavement structure to deteriorate (Hidayat & Putra, 2024). To anticipate the weaknesses of natural subgrade soil, which usually has highly variable mineral content, making it unsuitable for direct use as a subgrade layer. Therefore, the subgrade needs to be properly prepared, including soil improvement.

Soil stabilization is one way to address poor subgrade conditions. Stabilization can be done by compacting the soil or mixing it with other materials that can improve its properties. There are several ways to improve the engineering properties of clay soil, one of which is stabilization. Soil stabilization can consist of one or a combination of mechanical works with certain admixtures (Irwansyah & Wahyudi, 2024). The development of road pavement science and technology allows the use of additional material Domato from the Talaud Quarry.

Domato or limestone is part of carbonate rocks that are predominantly composed of carbonate minerals (Manoppo et al., 2016). Domato/limestone itself consists of non-classic limestone and classic limestone. Non-classic limestone consists of colonies of marine animals such as Coelenterata, Mollusca, Protozoa, and Foraminifera. This type of limestone is often referred to as coral limestone because its primary constituent is coral.

This research aims to determine the effect of adding domato soil on the characteristics of subgrade soil bearing capacity, assess the bearing capacity of clay soil after mixing with domato soil based on CBR values, and ascertain whether there is an improvement in domato soil bearing capacity as indicated by CBR values.

METHODS

This research was conducted using an experimental method. The testing, which includes physical and mechanical properties of soil, was carried out in the laboratory. The research covers moisture content tests, unit weight tests, sieve analysis, hydrometer tests, Atterberg limits tests, direct shear tests, soil compaction (modified compaction), California Bearing Ratio (CBR) tests, and unconfined compression strength (UCS) tests. All tests were based on AASHTO and ASTM standards. The results of the physical and mechanical properties tests of the original soil were used as a comparison with the results of the physical and mechanical properties tests of the stabilized soil.

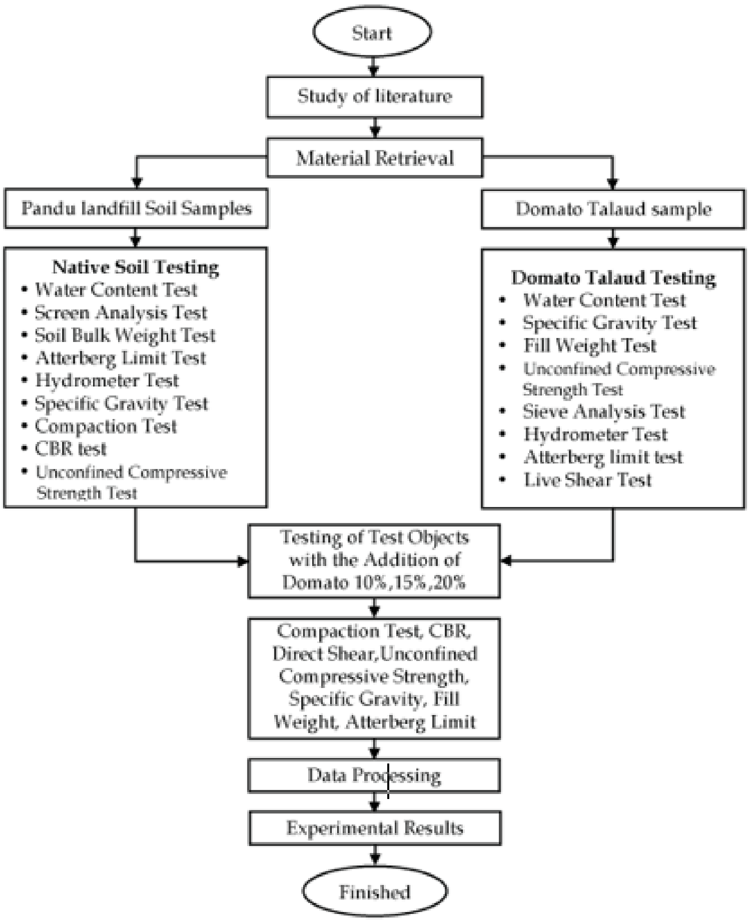

Figure 1. Research Flow

RESULTS AND DISCUSSION

Characteristics of Pandu Landfill Land

To find out the properties and characteristics of the soil of the Pandu TPA (Final Disposal Site), several laboratory tests were carried out so that the characteristics of the soil in the Pandu TPA could be known and the results of the tests were as follows:

Table 2. Soil Test Results

Testing		Unit	Basic Soil	Domato	Basic Soil + Domato			Information
					10%	15%	20%	
Water Content	ω	%	45.29	17.9				
Soil Content	γ	gr/c	1.931	1.945				
Soil Specific	Gs		2.58	2.097	2.633	2.641	2.657	
Atterberg Limit	LL	%	32.1					
	PL		20.08					
	PI		12.02					
	LS		6.8	8				
Sieve Analysis	4	%	99.89	100	100.00	99.996	100	Presentase Lolos
	10		97.82	81.61	96.89	96.344	94.564	
	20		96.11	72.20	94.98	93.904	91.68	
	40		92.69	63.50	86.24	85.476	85.112	
	60		89.29	60.29	78.66	77.932	78.036	
	100		81.44	56.40	71.32	71.008	70.44	
	200		71.42	53.27	68.32	68.196	67.044	
Compression	ωOpt	%	33.5		31.5	29	28.5	
	γdmax	gr/c	1.437		1.445	1.47	1.49	
CBR Design		%	3.8		6.7	12	15.1	

Based on the soil test results which can be seen in Table 2, they can be described as follows:

1. Water content
   From testing the initial water content of the original soil, the soil water content value was 45.29%. As seen in table 8.
2. Specific gravity
   From the results of testing the specific gravity of the soil, the results were 2.492%.
3. Content weight
   From the results of testing the original soil, it was found that the bulk density of the soil was 1.931 gr/cm3
4. Atterberg limits
   a. From the graph results of the relationship between the number of taps and water content, the liquid limit (LL) value is 32.1%.
   b. The plastic limit (PL) in the test resulted in the plastic limit (PL) = 20.08%.
   c. The plasticity index is obtained from the difference between the liquid limit and the plastic limit, with the formula PI = LL – PL, the Plasticity Index (PI) value is obtained = 12.02%
5. Grain size analysis in carrying out the gradation test which was carried out using sieve analysis and hydrometer testing showed that the soil was 89.60% which passed sieve No. 200, then the soil is included in category A-7 (clay soil) according to the AASHTO soil classification standard, which is shown in Figure 2.

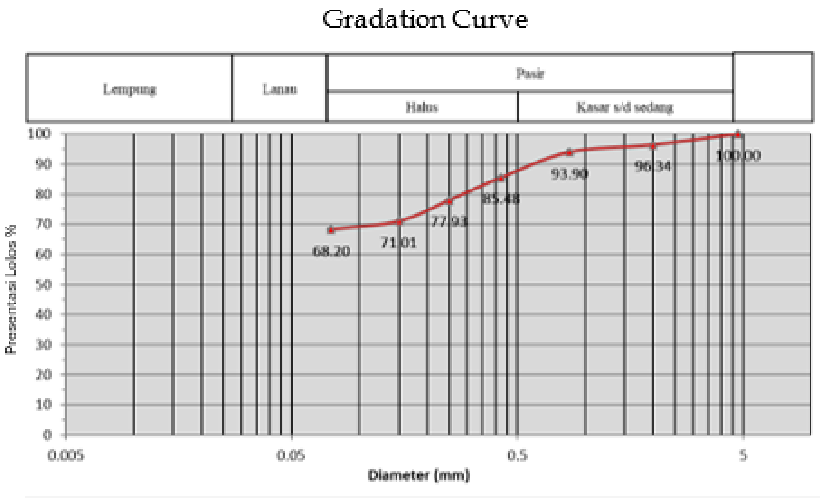

Figure 2. Grain Size Analysis Graph

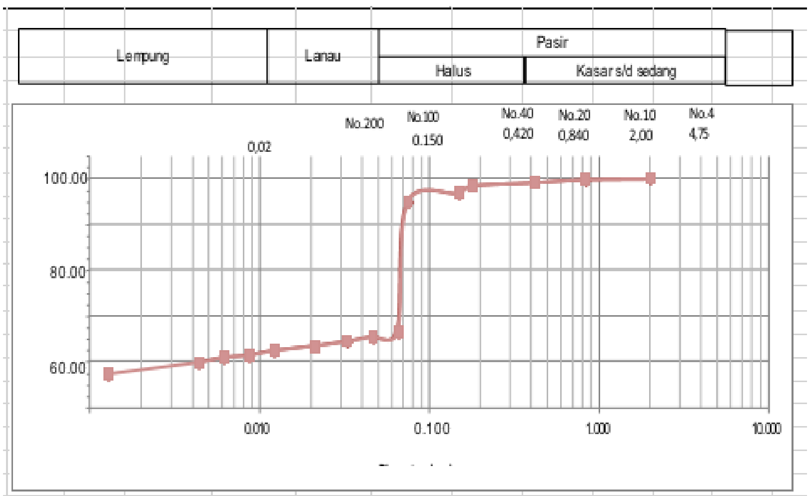

Figure 3. Hydrometer Analysis

From the results of the hydrometer analysis, it can be seen in the graph when entering the No.200 filter that the graph line is in free fall, indicating that the dominant material is silt and clay.

6. Compression

Modified compaction testing aims to determine the optimum water content of soil samples with the relationship to maximum dry unit weight, and after carrying out the test the results obtained are shown in Table. 3.

Table 3. Compaction of Each Mixture Variation

Variation	W_{opt}	Y_{dry}
Soil	33,50%	1,437 gr/cm^3
Soil + 10% Domato	31,50 %	1,445 gr/cm^3
Soil + 15% Domato	29,00 %	1,470 gr/cm^3
Soil + 20% Domato	28,50 %	1,490 gr/cm^3

7. Graph of the relationship between Dry Content and Compaction Weight.

Based on the graph of the relationship between dry unit weight, the original dry unit weight is 1,437 gr/cm3 and the 10% mixture variation is 1,445 gr/cm3, the 15% variation is 1,470 gr/cm3 and the 20% mixture variation is 1,490 gr/cm3 can be seen from Figure 50 graph of the relationship between dry weight contents between variations.

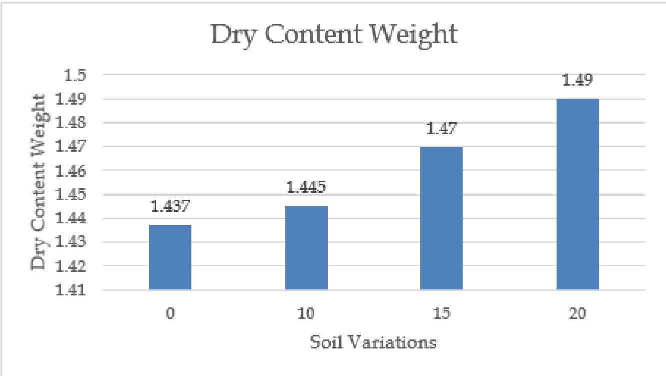

Figure 4. Dry Content Weight Relationship Graph

8. Compaction Optimum Water Content Relationship Graph

Based on the graph of the relationship between each variation, namely on original soil it was found to be 33.5%, and there was a decrease in the 10% variation by 31.50%, in the 15% mixed variation there was a decrease of 29.00% and also in the 20% mixed variation there was a decrease of 28.50%. In Figure 5 it can be seen from the graph of the optimum water content for compaction.

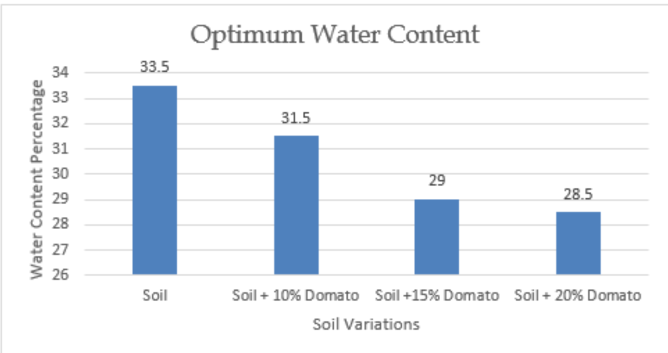

Figure 5. Graph of the Relationship Between Optimal Water Content

9. The CBR of variations in the domato mixture in each collision is 15x, the CBR results of the mixture are obtained in each 15x collision, on the original soil for 0.1 inch the CBR value is 0.56 and on 0.2 inch the CBR value is 0.98, on the variation soil 10% mixture, the CBR value of 0.1 inch is 1.3 and at 0.2 inch the CBR value is 1.34, on soil variations of the 15% mixture the CBR value of 0.1 inch is 4.94 and at 0.2 inch the CBR value is obtained 5.02, on soil variations of 20% the CBR value of 0.1 inch was obtained 7.14 and at 0.2 inch the CBR value was 7.79. See Figure 6 graph of the CBR 15x collision relationship.

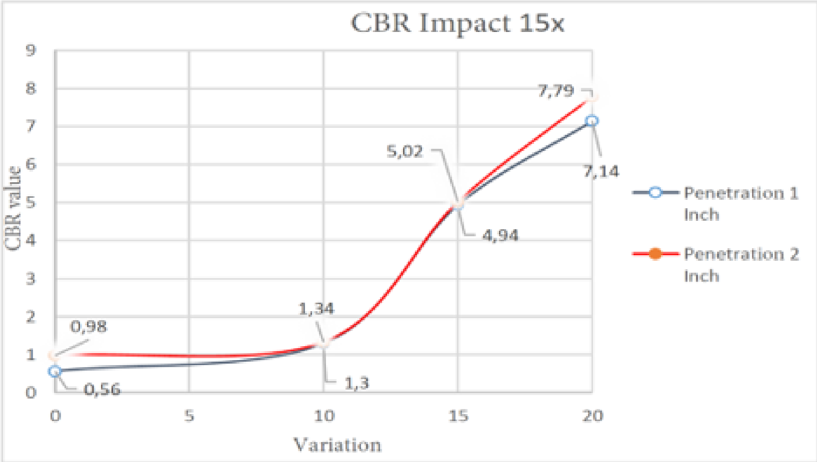

Figure 6. Graph of CBR Relationship 35x Impact in Each Variation

10. The CBR variation of the domato mixture in each collision is 35x, the CBR result of the mixture is obtained in each 35x collision, in the original soil for 0.1 inch the CBR value is 1.30 and at 0.2 inch it is 2.08, in the soil the variation is 10% The CBR value of 0.1 inch is 3.25 and at 0.2 inch the CBR value is 3.46, on soil variations of 15% the CBR value of 0.1 inch is 8.18 and at 0.2 inch the CBR value is 8.23. , on soil variations of 20% the CBR value of 0.1 inch is 11.04 and at 0.2 inch the CBR value is 11.26. In Figure 7 you can see a graph of the relationship between CBR 35x collisions in each variation.

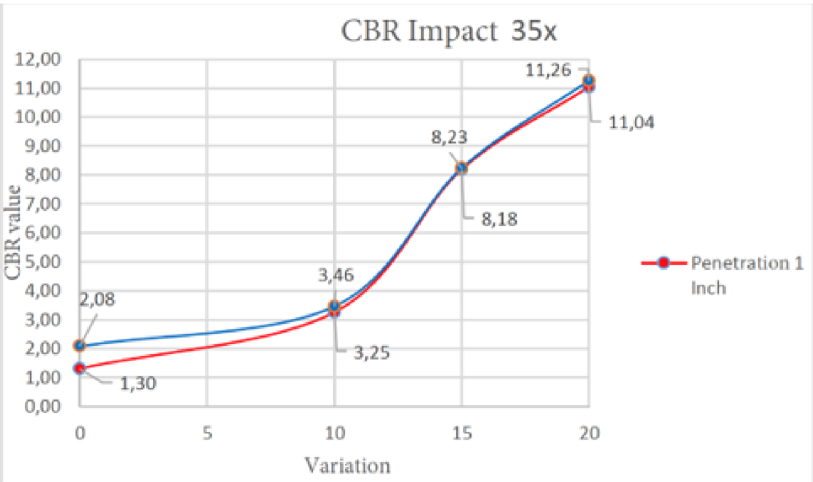

Figure 7. Graph of CBR Relationship 35x Impact in Each Variation

11. The CBR variation of the domato mixture in each collision is 56x the original soil for 0.1 inch the CBR value is 2.73 and at 0.2 inch the CBR value is 3.90, for the 10% mixed variation soil the CBR value of 0.1 inch is 5.85 and at 0.2 inch the CBR value is 6.06, on 15% mixed soil the CBR value of 0.1 inch is 12.34, and at 0.2 inch the CBR value is 12.56, on 20% soil the CBR value is 0 .1 inch gets 16.24, and at 0.2 inch the CBR value gets 16.46. In Figure 8 you can see a graph of the relationship between CBR 56x collisions.

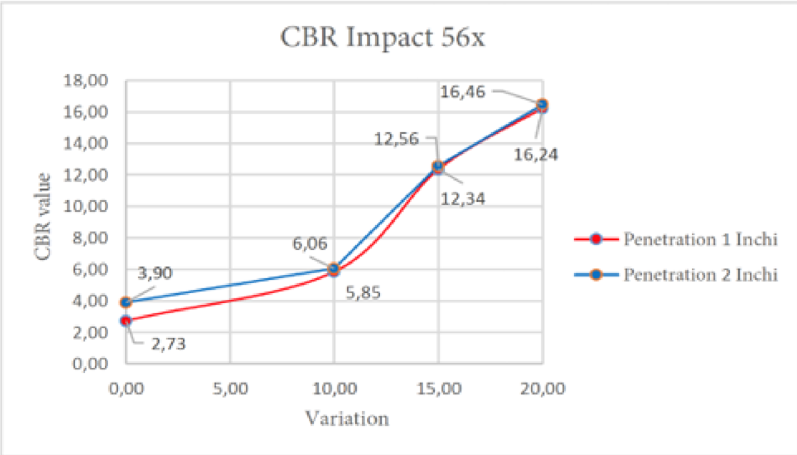

Figure 8. Graph of CBR Relationship 56x Collisions in Each Variation

12. CBR Design

1. Soil and 0% Mixed Variations

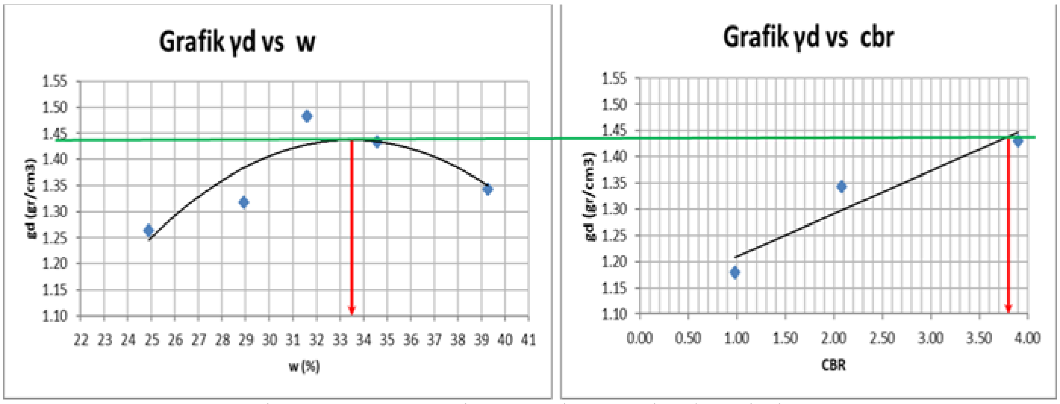

Figure 9. CBR Design Graph 0% Mixed Variation

The relationship between the original soil compaction and the original soil CBR was found to be a design CBR of 3.80%. Look at Figure 9 CBR Design Graph 0% Mixture Variation.

2. Soil and 10% Mixed Variations

The results of the relationship between 10% compaction and 10% CBR mixture obtained a value of 6.70% and the design CBR in Figure 10 Graph of CBR design for soil + 10% domato.

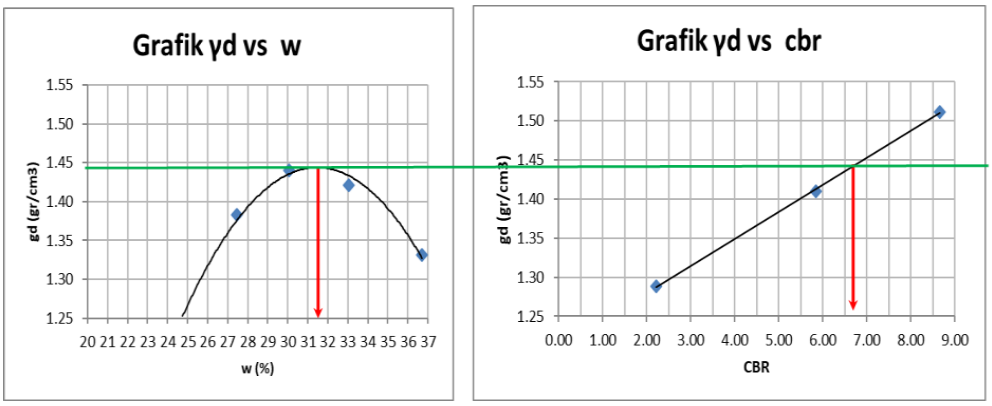

Figure 10. CBR Design Graph 10% Mixed Variation

3. Soil and 15% Mixed Variations

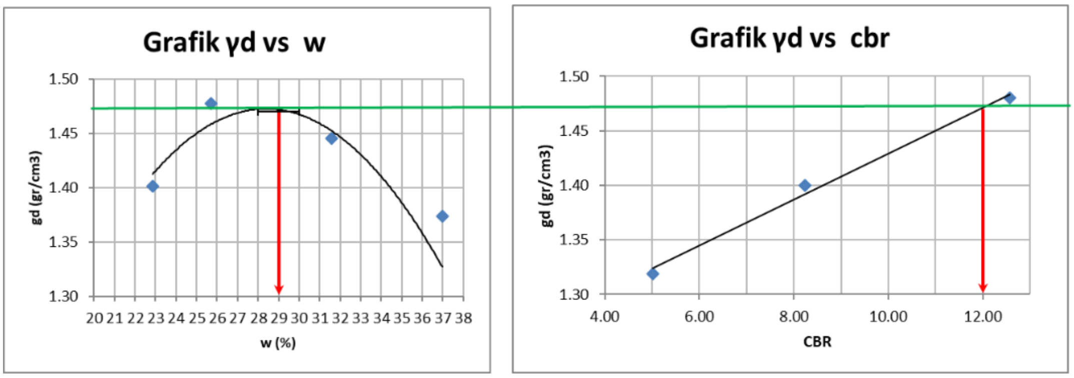

Figure 11. CBR Design Graph 15% Mixed Variation

The results of the relationship between 15% compaction and soil CBR + 15% mixture, obtained a design CBR value of 12.00%.

4. Soil and 20% Mixed Variations

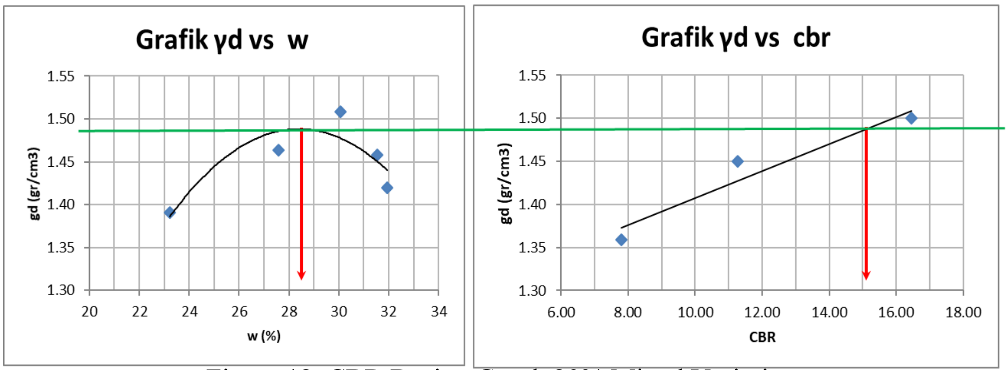

Figure 12. CBR Design Graph 20% Mixed Variation

5. The results of the relationship between compaction of 20% domato and CBR of 20% mixed soil, obtained a design CBR value of 15.10% and the design CBR in Figure 58 graph of CBR design of soil + 20% domato mixture

CBR Design each variation that meets Bina Marga specifications

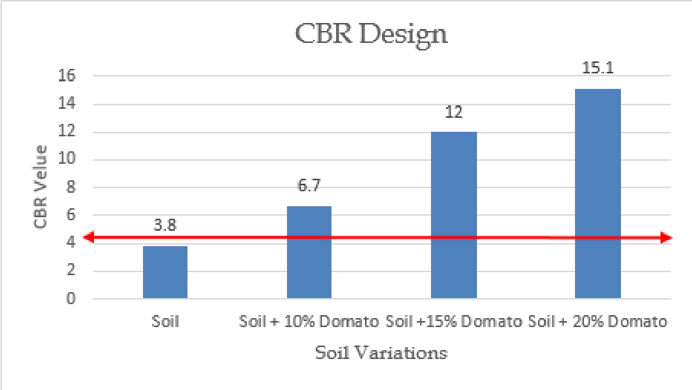

Figure 13. CBR Design Adding 15% and 20% Domato

After looking at the CBR design graph above, the higher the domato addition, the higher the CBR design value, the addition of 10%, 15% and 20% has reached the local development specifications for basic earthworks.

CONCLUSION

Based on the results of the tests that have been carried out, it can be concluded as follows:

1. The results of this research show that by substitution with domato in stabilized clay soil, the UCS value increases the qu value in the original soil by 0.186 kg/cm2. When mixed with 10% domato it was 0.105 kg/cm2, 15% was 0.283 kg/cm2, and 20% was 0.450 kg/cm2.
2. The results of stabilization with domato substitution showed an increase in the CBR value for each variation. The CBR value for the original soil was 3.80%, for the 10% domato mixture variation it was 6.70%, for the 15% mixture variation it was 12.00%, and for the 20% mixture variation it was 15.10%. The CBR value obtained from each mixture increases with each variation of the mixture by 15%, and is 20% greater than the minimum CBR value for subgrade soil.

The significant increase in the CBR value in the 15% and 20% domato variations was caused by the increased composition of the domato so that the water content of the clay soil decreased so that the existing mixture became easy to solidify and bind together.

REFERENCES

Das, B. M. (1995). Mekanika Tanah (Prinsi-prinsip Rekayasa Geoteknis).

Dimas Satya Dwinka. (2024). Perencanaan Jalan Wisata Tebat Gelumpai. http://scholar.unand.ac.id/462386/6/COVER%26 ABSTRAK.pdf

Fahruddin, M. B., & Fatmawati, L. E. (2024). Stabilisasi Tanah Lempung Ekspansif Menggunakan Bahan Stabilisator Abu Serabut Kelapa dan Semen. Jurnal Review Pendidikan Dan Pengajaran, 7(3), 7829–7835. https://doi.org/https://doi.org/10.31004/jrpp.v7i3.29935

Hidayat, M. I., & Putra, N. E. (2024). Pengaruh Beban Berlebih Terhadap Umur Rencana Perkerasan Jalan (Studi Kasus Jalan Cemara Medan). Journal of Multidisciplinary Research and Innovation (JMRI), 2(1), 24–34. https://doi.org/10.61240/jmri.v2i1.61

Irwansyah, M. T., & Wahyudi, C. (2024). Uji Cbr Stabilitas Tanah Di Desa Baharen Kecamatan Sidamanik Dengan Penambahan Serat Bambu. Jurnal Dunia Pendidikan, 4(2012), 1818–1828. https://doi.org/https://doi.org/10.55081/jurdip.v4i3.2160

Manoppo, M. R. E., Dapas, S. O., & Walangitan, D. R. (2016). Pemanfaatan Tanah Domato Sebagai Filler Dalam Campuran Aspal Panas HRS-WC. Jurnal Sipil Statik, 4(11), 695–700.

Nasution, D. W., Hastuty, I. P., & Anisa, S. (2023). Stabilisasi Tanah Lempung Menggunakan

Palm Oil Fuel Ash (POFA) dan 20 % Kapur Dolomit (CaMg (CO 3) 2) Ditinjau dari CBR dan Kuat Tekan Bebas. Blend Sains, 2(3), 218–227. https://doi.org/https://doi.org/10.56211/blendsains.v2i3.397

Pahrida, A., Suradji Gandi, & Sarie, F. (2021). Pengaruh Penambahan Bubuk Arang Kayu Pada Tanah Lempung Terhadap Nilai Indeks Plastisitas Dan Nilai CBR. JURNAL KEILMUAN TEKNIK SIPIL, 4(1), 223–233. https://doi.org/http://dx.doi.org/10.31602/jk.v4i1.5271

Ramadani, A., Amiruddin Hi, M., Husain, T., & Altarans, I. (2024). Analisis perhitungan daya dukung tanah pada lapisan jalan. DINTEK, 17(1), 27–33. https://journal.ubb.ac.id/snppm/article/view/4824/2323

Sartika, T., Apriyanti, Y., & Indra Gunawan. (2023). Pengaruh Penambahan Fly Ash dan Limbah Karbit Terhadap Pemadatan dan Kuat Geser Tanah Lempung. In Yayuk Apriyanti (Ed.), Seminar Nasional Penelitian dan Pengabdian Pada Masyarakat 2023 (pp. 27–31). Fakultas Teknik Bangka Belitung. https://journal.ubb.ac.id/snppm/article/view/4824/2323