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Analysis of Kinang Jingkion Material as Road Subbase Layer Using Soil Cement Method

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ABSTRACT

This research aims to analyse the California Bearing Ratio (CBR) and Unconfined Compressive Strength Test (UCS) values as road foundation layers using local materials, namely Kinang Jingkion. The study's soil and Kinang Jingkion materials were taken from the Apalapsili quarry in Yalimo Regency. Additionally, the additive or soil stabiliser used was Matos, which was obtained from testing soil characteristics, including sieve analysis or gradation, Standard Proctor Test for light density, and liquid limit test. After testing, it was found that the soil from the Apalapsili quarry is granular and can be categorised as A-1-a according to SNI 03-6797-2002. According to SNI 6887-2012, the compressive strength value after seven days of immersion should be within 25-35 Kg/Cm², while other Mix Designs met the criteria of SNI 6887-2012. CBR testing also utilised the same Mix Designs, and the highest CBR result was obtained from the Mix Design with compositions of Kinang Jingkion, soil, and cement at 8% and Matos at 2%, with a CBR value of 112%. According to the 2018 Revised General Specifications, a CBR value of 112% indicates a Class A Foundation Layer.

Introduction

Indonesia is a country that has many islands, languages, tribes, and cultures. Indonesia also has a variety of tribes, with about 1,340 tribes in Indonesia, according to the Statistics Agency in 2010 (Pompana, Tasik, & Kawung, 2023). Indonesia is also rich in abundant natural products in the mining and marine sectors. Indonesia's sea area reaches 3,257,357 km² based on the results of the International Convention on the Law of the Sea on December 10 in Montego Bay (Ardi, 2014).

Indonesia's natural wealth has a variety of them, one of which is from Papua, more precisely from Yalimo Regency. Yalimo is a district located in Papua Province and situated at 3.86037°S 138.47305°E. It was formed on January 4, 2008, based on Law Number 4 of 2008, with a total area of 1,253 km² and a population of 103,714 consisting of 5 districts and 300 villages (Paulus Kurniawan & Hadimuljono, 2020). The natural product of Yalimo Regency is jinking lining material, a chunk of hard natural stone used as a substitute for asphalt in Yalimo Regency. It encourages researchers to research so that the material can be used with better quality so that it can make it easier for the surrounding community to travel from one place to another, to help the local community economy by reducing the price of goods, and support access to health and education in the Yalimo area (Nugroho & Satibi, 2022).

Government efforts have been made by opening roads in Yalimo, but due to geographic conditions, the cost needed to build road access in Yalimo is very expensive, so it costs a lot to build roads (Fauzano, Dwina, & Alfernando, 2023). So the local government has to spend + 12 billion to make 1 kilometre of road while the allocation of funds is very limited. Both special allocation funds and the regional budget itself.

In addition, the Yalimo Regency government has also made innovations through the Yalimo Regency public works office by using jinking king as material in road pavement. By using local materials, it is estimated that the costs incurred are lower than those of conventional materials. The purpose of this study is to analyse the feasibility of jingkion kinang material to obtain UCS value by soil cement method and analyse the aggregate composition of jingkion kinang with cement binder to obtain CBR value that meets the requirements as a pavement layer.

This research is expected to provide benefits to all readers in increasing knowledge and insight. It is expected to support jinking lining material as a material that can replace conventional materials with better quality.

Based on the research of (Razali & Wijaya, 2016), CBR value on soil stability with cement road Budi Utomo Unib front; Research on the value of CBR on soil stabilisation with cement on Jalan Budi Utomo Unib Front to obtain the influence of soil properties and the CBR value of native soil, after stabilisation with cement. The test was conducted at the Geotechnical Lab of the Faculty of Engineering UNIB. Laboratory soil test properties include Specific gravity, moisture content, sieve analysis, Proctor standard tightening testing, Zetterberg limits, and laboratory CBR (California Bearing Ratio) value experiments. Stabilisation of soft soil was carried out with cement with the addition of cement content of 0%, 2%, 4%, 8%, and 12%. Based on the results of soil properties testing and laboratory CBR value, the maximum CBR value on the addition of cement content was 12%, the CBR value increased by 144.21% from the original soil condition, dry volume weight increased by 3.85%, from original soil, optimum moisture content decreased by 13.75% from original soil, PI value decreased by 50.42% from original land, soil Gs value increased by 1.93% from original land (Fitriani, Dwina, & Alfernando, 2023).

Likewise with the results of research from Burhanudin, (Hafram, 2018) about Analysis of thickness and composition in cement soil construction (case study: PT. Sagarmatha - Merauke elevation); Soilcement in construction layers is widely used as a lower foundation layer (LPB) or even for the upper foundation layer (LPA). The position on the pavement layer depends on the CBR value and the composition of its mixing material or the given Portland cement grade. The purpose of this study is to analyse the application of soil cement at airports related to the carrying capacity value required for each pavement layer and the percentage of the right added material composition in order to obtain a CBR value that meets airport engineering specifications. The data collected in this study consisted of direct information from the airport operator and research data from the soil mechanics laboratory of the Public Works Office of Highways Merauke Regency. The results of the analysis describe the composition of 12% Portland cement, 21%, and the CBR value obtained for 12% Portland cement is 98% CBR, and for 21% Portland cement, 115% CBR. The layer thickness plan implemented in the field is 50cm for 12% Portland cement and 30 cm for 21% Portland cement. The research methods used are the trial error method and the CBR method, with CBR values of 82% for 12% composition and 101% for 21% composition.

Analysis of the foundation layer on road pavement using soil cement stabilisation for district roads in the Sekadau Regency area (Ardi, 2014). This study aims to determine the feasibility of utilising excavated soil for the Balai Sepuak - Pakan - Pakit - Antu River road section as a soil cement stabilisation material for the road foundation layer by comparing the results of excavated soil testing against the conditions specified in the technical specifications, the cost required for bending pavement work using a cement soil stabilisation foundation layer against rigid pavement and the time required To carry out bending pavement work by using a foundation layer of cement soil stabilisation against rigid pavement (Arif Kurniawan, Alwi, & Bachtiar, 2019). The results of this study are expected to determine the type of pavement that is in accordance with the location conditions of the Balai Sepuak - Pakan - Pakit - Sungai Antu road section or other district roads so that road construction can be more efficient and effective. Research methodology uses a comparative experiment methodology, which is carried out to make comparisons by comparing treatments and comparing the effects of these treatments. In this case, variations in cement content are carried out in cement soil stabilisation so that selected cement levels are obtained that meet the General Specifications of 2010. Based on the chosen cement content received, the calculation of the cost budget and time of work implementation is carried out, then compared with the pavement that is commonly implemented in Sekadau Regency, namely rigid pavement (Paat, Sendow, & Lalamentik, 2019). From the experimental results, the composition of a mixture of 70% soil and 30% sand was obtained, then mixed with 8.5% cement using 13.6% moisture content for soil cement stabilisation on the foundation layer (base). Surface coating using HRS-WC (Lataston Lapis Aus) on Balai Sepuak - Pakan - Pakit – Sungai Antu road section can meet the General Specifications Year 2010 (UCS > 20 kg / cm2 and CBR > 100%), cost-saving 50.08% and faster implementation time 78.26% than rigid pavement, making it more efficient and effective and feasible to be used as road pavement on Balai Sepuak - Pakan - Pakit - Antu River road.

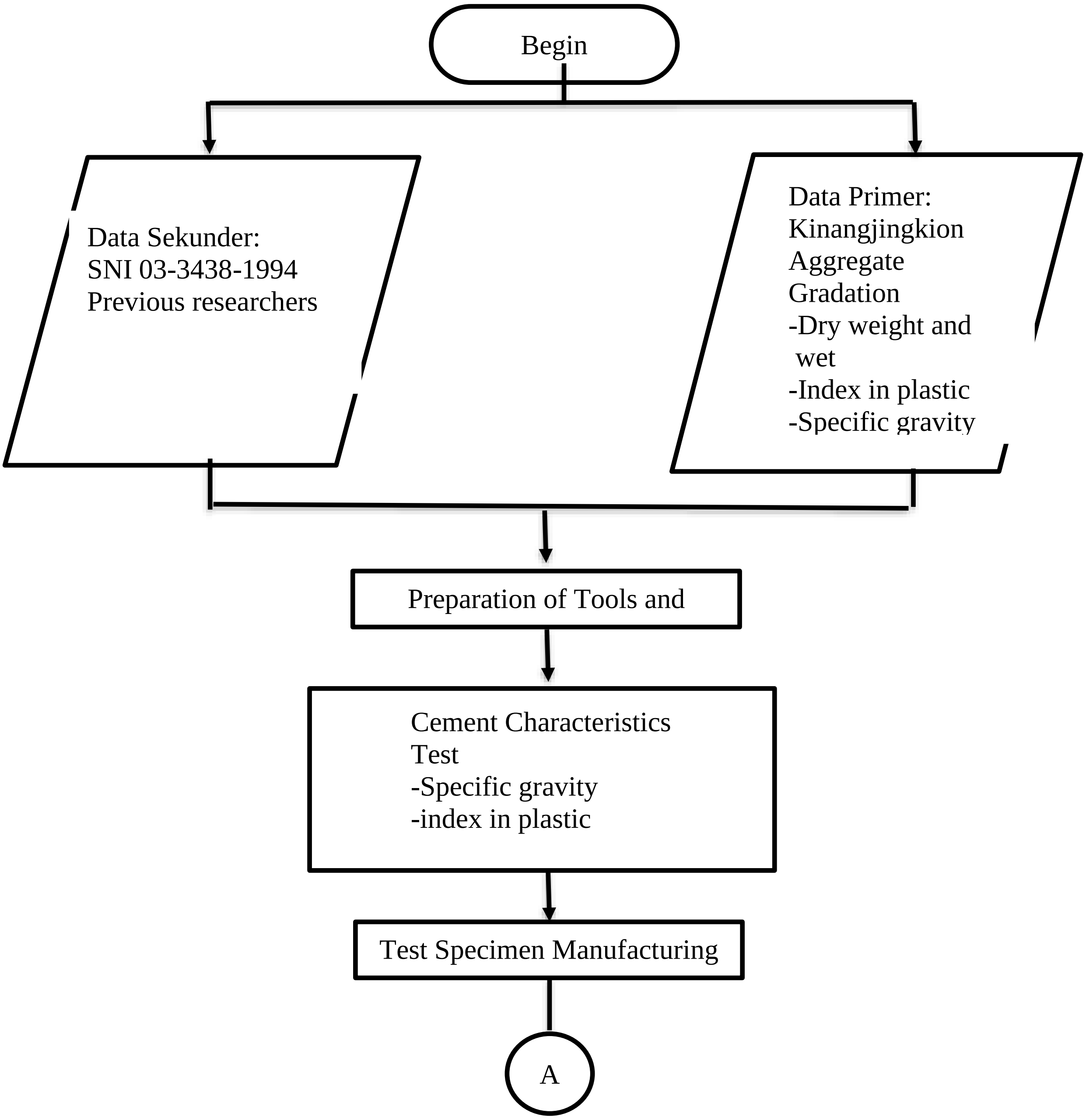
The effect of plastic material content on the CBR value of grade aggregate foundation layers: The study was conducted on one type of selected material sample that has often been used from the Lolan source location and a mixture of soil samples containing plasticity. The study began by examining the properties of the materials used by referring to the requirements of the 2010 Highways Engineering Specification. Furthermore, test objects are made on aggregates with variations in soil mixture mixed in such a way as to obtain variations in plasticity content with a PI value of 0%, 4,72%, 5,33%, 6,62%, and 7,86%. The specimen is compaction tested to obtain optimum moisture content and maximum dry weight, and then CBR testing is carried out. The results obtained are as follows, PI 0% □opt 7.17% □d(max) 2.259 (gr/cm3) CBR value 99%; PI 4.72% □opt 7.62% □d(max) 2.244 (gr/cm3) CBR value 90%; PI 5.33% □opt 8.01% □d(max) 2.240 (gr/cm3) CBR value 74%; PI 6.62% □opt 8.97% □d(max) 2.237 (gr/cm3) CBR value 60%; PI 7.86% □opt 9.53% □d(max) 2.227 (gr/cm3) CBR value 47%. The results of an examination of aggregate material with Lolan source location mixed with soil containing plasticity show that the content of plastic material influences the CBR value. Thus, it can be concluded that those that meet the requirements in the sample examined are only material content with a PI value between 4.72% and 6.62%, which gives a CBR value of ≥ 50%. In contrast, for materials that do not have a PI value, a high CBR value is obtained, but the requirements of the Plasticity Index do not qualify for the Grade Aggregate Foundation Layer□S. It can be seen that for material content with a larger PI value, even if it is smaller than the maximum limit of 15%, it cannot be used because the CBR value < 50%.

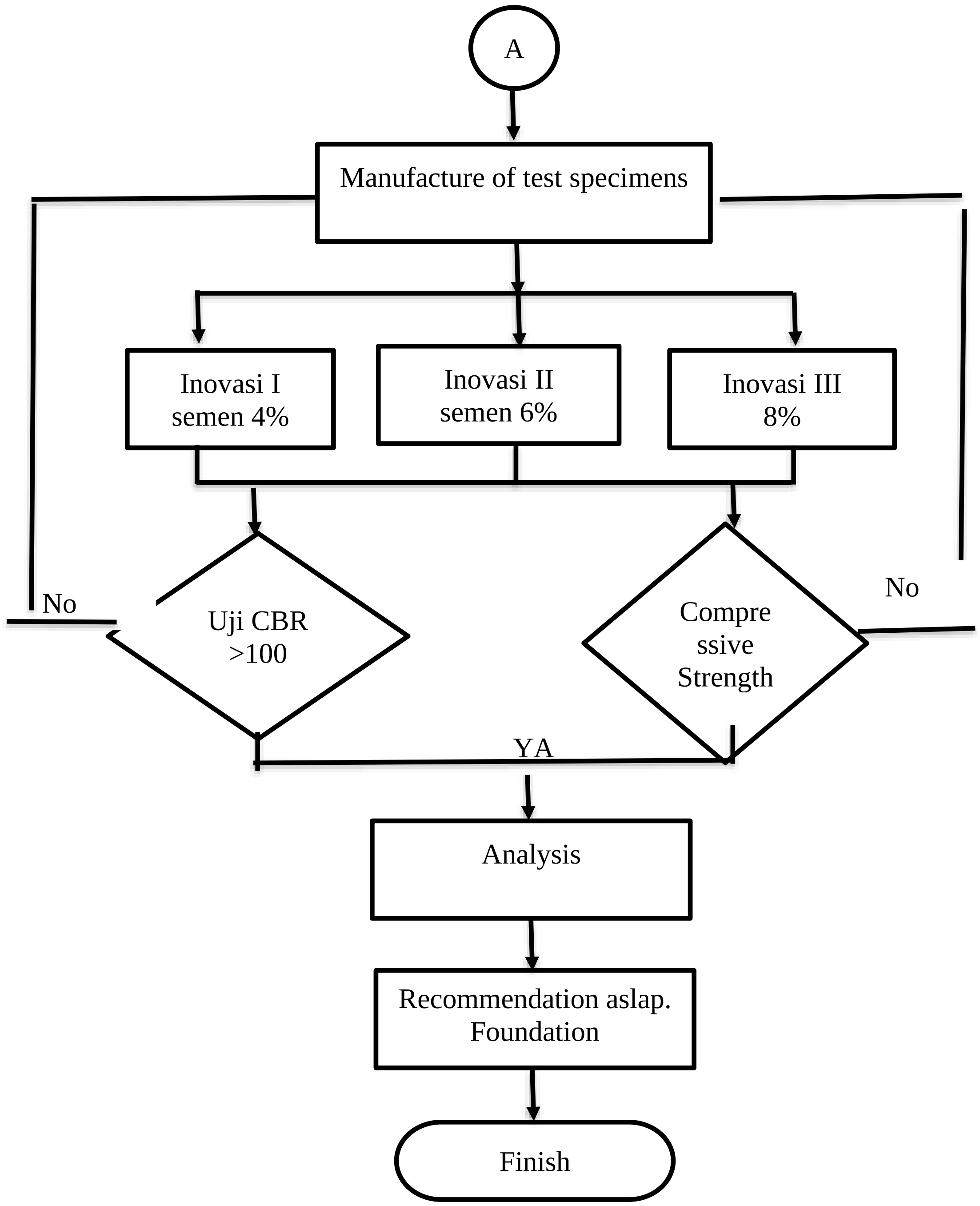
Analysis of increased cbr value of stabilised high plasticity clay of cement and base ash: The study aims to determine the effect of coal combustion waste (bottom ash) combined with cement in the improvement of high plasticity clay on improving the physical and mechanical properties of high plasticity (CH) clay soil. CBR and permeability testing in the laboratory are carried out to examine the changes. Several variations in basic ash content (5%/10%/15%) and semen (3%/5%) were selected in this study. 7-day and 28-day soaking processes are performed prior to CBR and permeability testing. CBR test results and native soil permeability were 0.78% and 6E-09 m/s, respectively. The addition of 3% cement and 5% base ash does not qualify as road sub-grade material due to CBR grades.

Research Methods

The location of this study is located in Yalimo Regency, Papua. This research data consists of primary data, namely the aggregate gradation of the jinking king that passed filter no.4, and secondary data is data taken from previous studies, namely SNI 03-3438-1994, namely making soil stability plans with Portland cement, as well as previous researchers.

Flow chart


Begin
Data Sekunder:
SNI 03-3438-1994
Previous researchers
Data Primer:
Kinangjingkion
Aggregate
Gradation
-Dry weight and
wet
-Index in plastic
-Specific gravity
Preparation of Tools and
Cement Characteristics
Test
-Specific gravity
-index in plastic
Test Specimen Manufacturing
A



Hold the research carried out by literature review, soil sampling, property testing, soil PI checking, mixture variation planning, soil mixing, sample printing, sample printing, seven days immersion, four days immersion, UCS testing, data analysis, conclusions and suggestions.

Results and Discussion

CBR 65 Results

Jingkion lining material from Apalapsili quarry, Apalapsili soil, cement, 2% matos with a total weight of 6 kg, mixed with water and allowed to stand for 24 hours in a sealed bag. The material is then divided into three parts and gradually put into moulds, ground

65 times for each layer. The material inside the mould is weighed to gain weight before immersion. After soaking for four days, the material in the mould is weighed again to gain weight after washing; the results are shown in Table 4.90 below:

Table 1
Closely Packed Material Before and After Immersion (Primary Data Analysis, 2023)

	Fill Weight	Before soaking	After soaking
A	Mold Weight	7403,5	7403,5
B	Ground Weight + Print	11980,4	12056,9
C	Wet Soil Weight	4576,9	4653,4
D	Mould Volume	2176,4	2176,4
And	Wet Soil Fill Weight (C / D)	2,103	2,138
F	Dry Soil fill weight (E/(100+L)x100)	1,901	1,901

CBR 10 result

Jingkion lining material from Apalapsili quarry, Apalapsili soil, 6% cement, and 2% matos with a total weight of 6000 grams, mixed with water and allowed to stand for 24 hours in a sealed bag. The material is then divided into three parts and gradually fed into moulds, ground ten times for each layer.

CBR 35 result

Jingkion lining material from Apalapsili quarry, Apalapsili soil, cement, 2% matos with a total weight of 6000 grams, mixed with water and allowed to stand for 24 hours in a sealed bag. The material is then divided into three parts and gradually put into moulds, ground 35 times for each layer.

CBR 65 Results

Jingkion lining material from Apalapsili quarry, Apalapsili soil, cement, 2% matos with a total weight of 6 kg, mixed with water and allowed to stand for 24 hours in a sealed bag. The material is then divided into three parts and gradually put into moulds, ground 65 times for each layer. The material inside the mould is weighed to gain weight before immersion.

CBR 10 result

Jingkion lining material from Apalapsili quarry, Apalapsili soil, 8% cement, and 2% matos with a total weight of 6000 grams, mixed with water and allowed to stand for 24 hours in a sealed bag. The material is then divided into three parts and gradually fed into moulds, ground ten times for each layer. The material inside the mould is weighed to gain weight before immersion.

CBR 35 result

Jingkion lining material from Apalapsili quarry, Apalapsili soil, cement, 2% matos with a total weight of 6000 grams, mixed with water and allowed to stand for 24 hours in a sealed bag. The material is then divided into three parts and gradually put into moulds, ground 35 times for each layer. The material inside the mould is weighed to gain weight before immersion. After soaking for four days, the material in the mould is weighed again to gain weight after washing; the results are shown in Table 4,110 below:

Table 2
Material Weight Before and After Immersion (Primary Data Analysis, 2023)

	Fill Weight	Before soaking	After soaking
A	Mold Weight	7791,5	7791,5
B	Ground Weight + Print	11926,0	12120,6
C	Wet Soil Weight	4134,5	4329,1
D	Mould Volume	2176,4	2176,4
And	Wet Soil Fill Weight (C / D)	1,900	1,989
F	Dry Soil fill weight (E/(100+L)X100)	1,736	1,787

CBR 65 Results

Jingkion lining material from Apalapsili quarry, Apalapsili soil, cement, 2% matos with a total weight of 6 kg, mixed with water and allowed to stand for 24 hours in a sealed bag. The material is then divided into three parts and gradually put into moulds, ground 65 times for each layer. The material inside the mould is weighed to gain weight before immersion. After soaking for four days, the material in the mould is weighed again to gain weight.

UCS Test Results

Compressive strength testing was carried out on apalapsili quarry material that had been mixed with soil, cement, and additives, namely MATOS, with a content of 2%. Meanwhile, cement content of 4%, 6%, and 8% is expected to increase the value of free compressive strength of apalapsili quarry material that has been mixed with the cement.

UCS Test Results of Apalapsili Soil and Cement 4%

Compressive strength testing of Apalapsili soil material weighing 600 grams and cement with 4% content mixed with an optimum moisture content of 10% and watered for seven days.

Soil mixture of Apalapsili and Semen 4%

The first compressive strength test for samples is compressive strength testing on soil and cement samples with 4% content and 0% matos without adding additives. The composition of the mixture in samples with cement content of 4% and 0% MATOS can be seen in Table 4.80.

Making apalapsili quarry material with a mixture of 4% cement and 0% additives made as many as three samples. UCS test results of a mix of 4% cement and 0% matos can be seen in Table 4.118. The relationship of compressive strength and strain in a blend of 4% cement and 0% matos can be seen in Figure 4.40.

Table 3
Composition of Soil and Cement Mix

No	Bahan	Sum
1	Soil	472 gr
2	Semen	24 gr
3	NAILS	0 gr

4	Air	61,2 cc

The weight of the soil used is adjusted to the volume of the mould (cylindrical mould), for the weight of cement used is taken 4% of the weight of the soil in a dry state. For Matos, 0% of the weight of cement is taken, and the added moisture content is taken from the optimum moisture content of the soil property. Test results show that 10.2% of the weight of the soil is added to cement. The sample weight for a mixture of 4% cement and soil can be seen in Table 3.

Table 3
130 Sample Weight Mixture of 6% Cement, Soil, and Jingkion Kinang

Sample	Sample weight(gr)
1	532,2
2	534,7
3	527,7

Making apalapsili quarry material with a mixture of 6% cement, soil, and jinking king made as many as three samples. UCS test results of a mix of 6% cement, soil and jinking can be seen in Table 4,131. The relationship of compressive strength and strain in a mixture of 6% cement, soil, and jingkion can be seen in Figure 4.

Table 4
131 UCS Test Results on a Mixture of 6% Cement, Apalapsili Soil, and Kinang Jingkion

Sample	Status UKS (KG/CM2)
1	26
2	24
3	22,7

After testing the free compressive strength in the three samples that were made, the UCS value was shown in Table 4.131, and the greatest compressive strength value was in sample number 1, 26 kg / cm2. UCS test results for a mixture of 6% cement, soil, and jingkion kinang. Obtained an average compressive strength value of 24.23 kg/cm2. According to the Specification, the Soil Cement Foundation Layer requires that the minimum result of UCS testing after seven can reach 20 kg/cm2. Thus, for a mixture sample of 6% cement, soil and jinking king meets the specifications for the soil cement foundation layer and, with the addition of 2% cement content, increases the compressive strength value of the soil sample.

8% Cement, Soil, and Jingkion Kinang Mixture

The first compressive strength test for samples is compressive strength testing on samples with 8% cement content, Apalapsili soil, and Kinang Jingkion. The cement content is 8% of the weight of the soil that has been mixed with the jinking king. The composition of the mixture in samples with a cement content of 8%, soil and jinking king is seen in Table 5.

Table 5.
132 Composition of 8% Cement, Soil, and Jingkion Kinang Mixture

No	Bahan	Sum
1	Land and Kinang Jingkion	472
2	Semen	48 gr
3	NAILS	0 gr
4	Air	61,2 cc

The weight of the soil used is adjusted to the volume of the mould (cylinder mould) to be used, and the weight of cement used is taken 8% of the weight of the soil in a dry state. The added water is taken from the optimum moisture content of soil property testing results of 10.2%.

In accordance with the requirements of SNI 6887-2012 Compressive Strength Test Method of cylinders, Soil Cement Foundation Layer that the compressive strength value (UCS) test carried out after curing for seven days can reach 20-35 kg/cm2 has met the specifications. From the results of tests that have been carried out in the laboratory of the Jayapura National Road Development Center, with soil samples and jinking king from the Apalapsili Quarry, Yalimo and the addition of matos additives with a variation of 2%, the compressive strength value that meets the requirements is a soil sample added with 8% cement. 6% cement, soil, and jingkion kinang. 8% cement, soil, and jingkion kinang. 6% cement, soil, jingkion kinang, and addictive. 8% cement, soil, jingkion kinang, and addictive.

The compressive strength value was 23.66 kg/cm2 for 8% cement and soil, respectively. 24.23 kg/cm2 for 6% cement, soil, jingkion kinang. 8% cement, soil, and jingling with a compressive strength value of 32.73 kg/cm2. 6% cement, soil, jinking king, Matos 2% with a compressive strength value of 22.76 kg/cm2. 8% cement, soil, jinking king, Matos 2% with a compressive strength value of 30.33 kg/cm2. As shown in Table 4.144. A graph of the average compressive strength value based on the addition of jinking king and 2% Matos can be seen in Figure 6.

In the UCS test at the laboratory of the Jayapura National Road Implementation Center, the tool used has been calibrated to a certain limit, namely with a dial of 8 Kn so that in the UCS test, the mixture of jinking, cement, soil, and 2% matos can no longer be read so that the value of free compressive strength looks lower than the mixture of jinking, cement, and soil, which assumes that the UCS value of jinking, cement, soil, and 2% matos additives should be higher than the mixture of jinking, soil and cement.

Table 6
144 Average UCS Test Results

No.	Sample	UCS average score (kg/cm2)	SNI 6887-2012	Result
1	4% cement + soil	9,26	20 kg/cm²-35 kg/cm²	Non-Compliant
2	6% cement + soil	17,4	20 kg/cm²-35	Non-

			kg/cm²	Compliant
3	8% cement + soil	23,66	20 kg/cm²-35 kg/cm²	Meet
4	4% cement + soil + jingkion kinang	16,06	20 kg/cm²-35 kg/cm²	Meet
5	6% cement + soil + jingkion kinang	24,23	20 kg/cm²-35 kg/cm²	Meet
6	8% cement + soil + jingkion kinang	32,73	20 kg/cm²-35 kg/cm²	Meet
7	4% cement + soil + jingkion minang + matos 2%	15,86	20 kg/cm²-35 kg/cm²	Meet
8	6% cement + soil + jingkion minang + matos 2%	22,76	20 kg/cm²-35 kg/cm²	Meet
9	8% cement + soil + jingkion minang + matos 2%	30,33	20 kg/cm²-35 kg/cm²	Meet

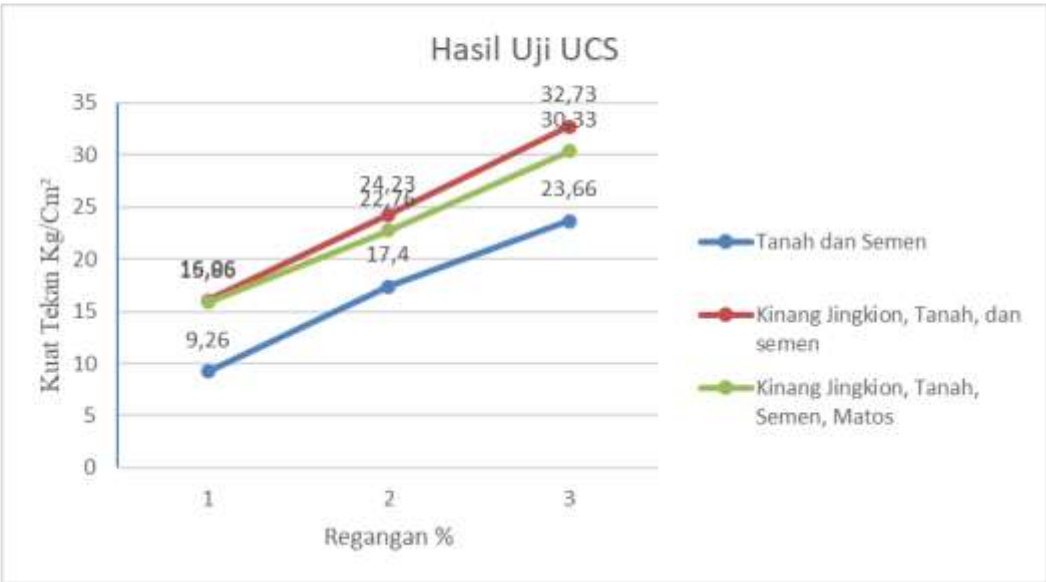


Figure 1

49 Graph of Average Compressive Strength Value Based on Matos Addition

In Figure 4. It can be seen that the addition of jinking king and Matos additives is able to increase the compressive strength, which was initially low and able to travel 20-35 kg / cm2 and according to SNI 6887-2012 specifications Cylinder Compressive Strength Test Method, for road construction in Yalimo regency can be used to add jinking and Matos king as much as 2%.

CBR Discussion

General Specification 2018 Revision II of the Directorate General of Highways is a reference in analysing the material mixture that has been implemented; the following results are obtained:

Table 7.
145 Comparison of CBR Test Results of 3 Material Mixture Variations (Primary Data Analysis, 2023)

No.	Mixed Type	CBR 10X COLLISION (%)	CBR 30X COLLISION (%)	CBR 65X COLLISION (%)	CBR Yd
1	Soil + Cement 4%	4,2	11	23	**17,0**
	Soil + Cement 6%	7	22	37	**31,5**
	Soil + Cement 8%	26	51	63	**58,0**
2	Land + Cement 4%+ Kinangjingkiong	27	49	61	**54,0**
	Land + Cement 6%+ Kinangjingkiong	28	63	84	**74,0**
	Land + Cement 8%+ Kinangjingkiong	32	76	109	**96,0**
3	Land + Cement 4%+ Kinangjingkiong+ Additive	47	82	120	**99,0**
	Land + Cement 6%+ Kinangjingkiong+ Additive	73	93	124	**105,0**
	Land + Cement 8%+ Kinangjingkiong+ Additive	83	102	125	**112,0**

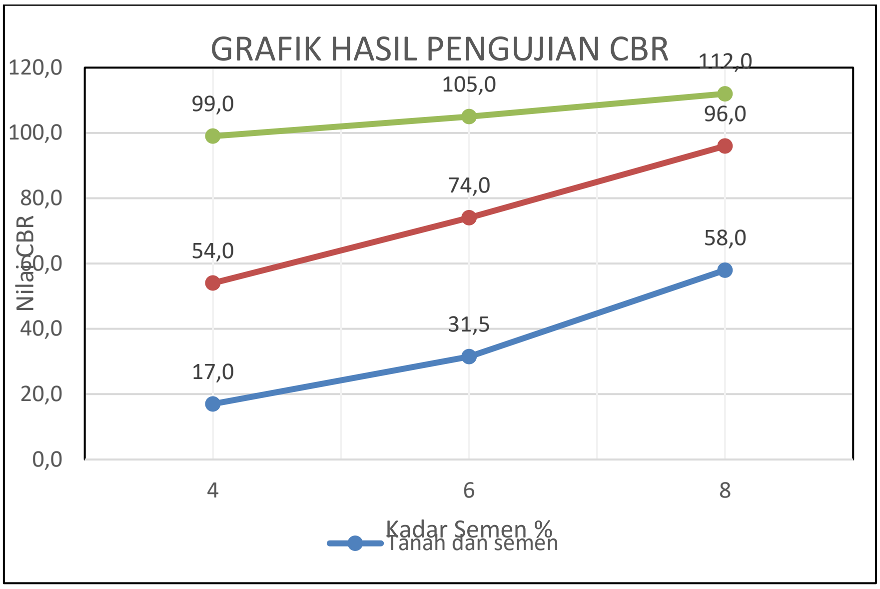


Figure 2
Graph of CBR values based on test mixture

From Table 8 and Graph 2 above, it can be seen that the addition of jinking king and additives to soil and cement affects the CBR value, which initially could only be as a selection stockpile, but with the addition of jinking king, the CBR value in the mixture increased to class A foundation layer with the required CBR value of 90% in the General Specification 2018 Revision II of the General Specification of General Highways.

Conclusion

Kinang Jingkion local material from the Apalapsili quarry originating from Yalimo Regency that does not meet the requirements of 20 Kg/Cm² for UCS testing is a mixture of apalapsili soil and cement with levels of 4% and 6%. The addition of jinking king from the Apalapsili quarry and Matos with a content of 2% meets the requirements of 20 Kg / Cm². An experiment was carried out by mixing Kinang Jingkion material from the Apalapsili quarry. Then, the CBR value for jinking kiang, soil, cement and additives is the highest and can be used as a class A foundation layer in accordance with the General Specification 2018 Revision II of the Directorate General of Highways.

Bibliography

Ardi, Muhammad Wahyu. (2014). Analisis Lapisan Fondasi Pada Perkerasan Jalan Dengan Menggunakan Stabilisasi Tanah Semen (Soil Cement Stabilization) Untuk Jalan Kabupaten Di Wilayah Kabupaten Sekadau. *Jurnal Teknik Sipil*, *14*(1).

Fauzano, Hilmi, Dwina, Dila Oktarise, & Alfernando, Oki. (2023). *Pemanfaatan Campuran Limbah Palm Oil Fuel Ash (Pofa) Lolos Saringan No. 50 Tertahan No. 100 Untuk Pengujian Stabilitas Tanah Gambut Ditinjau Berdasarkan Nilai Cbr Test*. Universitas Jambi.

Fitriani, Annisa Rizki Sulardi, Dwina, Dila Oktarise, & Alfernando, Oki. (2023). Penggunaan Campuran POFA (Palm Oil Fuel Ash) Dan Gypsum Sebagai Stabilisasi Tanah Gambut Ditinjau Dari Nilai CBR (California Bearing Ratio). *Teknika Sains: Jurnal Ilmu Teknik*, *8*(1), 73–83.

Hafram, St Maryam. (2018). ANALISIS KETEBALAN DAN KOMPOSISI PADA KONSTRUKSI SOIL SEMEN (Studi Kasus: PT ELEVASI SAGARMATHA-MERAUKE). *UnderUNDERPASS Journal of Civil Engineering, Applied Sciences, and Technology*, *2*(2), 119–125.

Kurniawan, Arif, Alwi, Abubakar, & Bachtiar, Vivi. (2019). Stabilisasi Tanah Lunak Dengan Abu ampas Tebu, Fly Ash, Kapur Dan Semen Terhadap sifat Mekanis Tanah. *JeLAST: Jurnal PWK, Laut, Sipil, Tambang*, *6*(3).

Kurniawan, Paulus, & Hadimuljono, Basuki. (2020). *Applied Geotechnics for Engineers 2* (Vol. 2). Penerbit Andi.

Nugroho, Soewignjo Agus, & Satibi, Syawal. (2022). Analisis Peningkatan Nilai Cbr Lempung Plastisitas Tinggi Terstabilisasi Semen Dan Abu Dasar. *Prokons: Jurnal Teknik Sipil*, *16*(1), 26–33.

Paat, Geraldo Niki Imanuel, Sendow, Theo K., & Lalamentik, Lucia G. J. (2019). Uji Laik Fungsi Jalan secara teknis pada ruas jalan Manado–Tomohon (Segmen Batas Kota Manado–Kota Tomohon). *Jurnal Sipil Statik*, *7*(10).

Pompana, Eben Handris, Tasik, Femmy C. M., & Kawung, Evelin J. R. (2023). Kearifan Lokal Budaya Perkawinan Suku Saluan di Desa Honbola Kecamatan Batui Kabupten Banggai Provinsi Sulawesi Tengah. *JURNAL ILMIAH SOCIETY*, *3*(3).

Razali, Makmun R., & Wijaya, Olandri. (2016). Nilai Cbr Pada Stabilisasi Tanah Dengan Semen Jalan Budi Utomo Unib Depan. *Inersia: Jurnal Teknik Sipil*, *8*(2), 67–76. https://doi.org/10.33369/ijts.8.2.67-76