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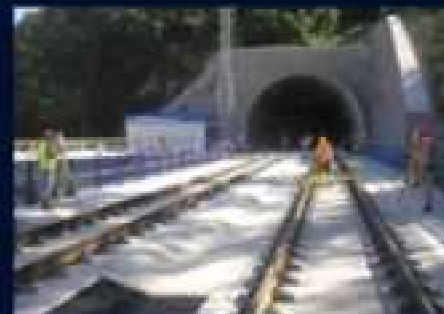

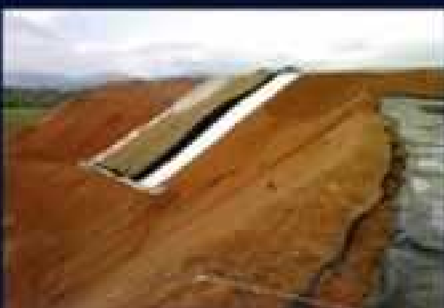

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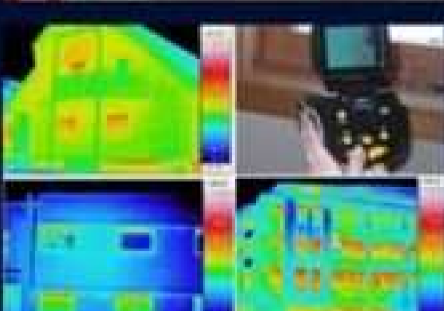

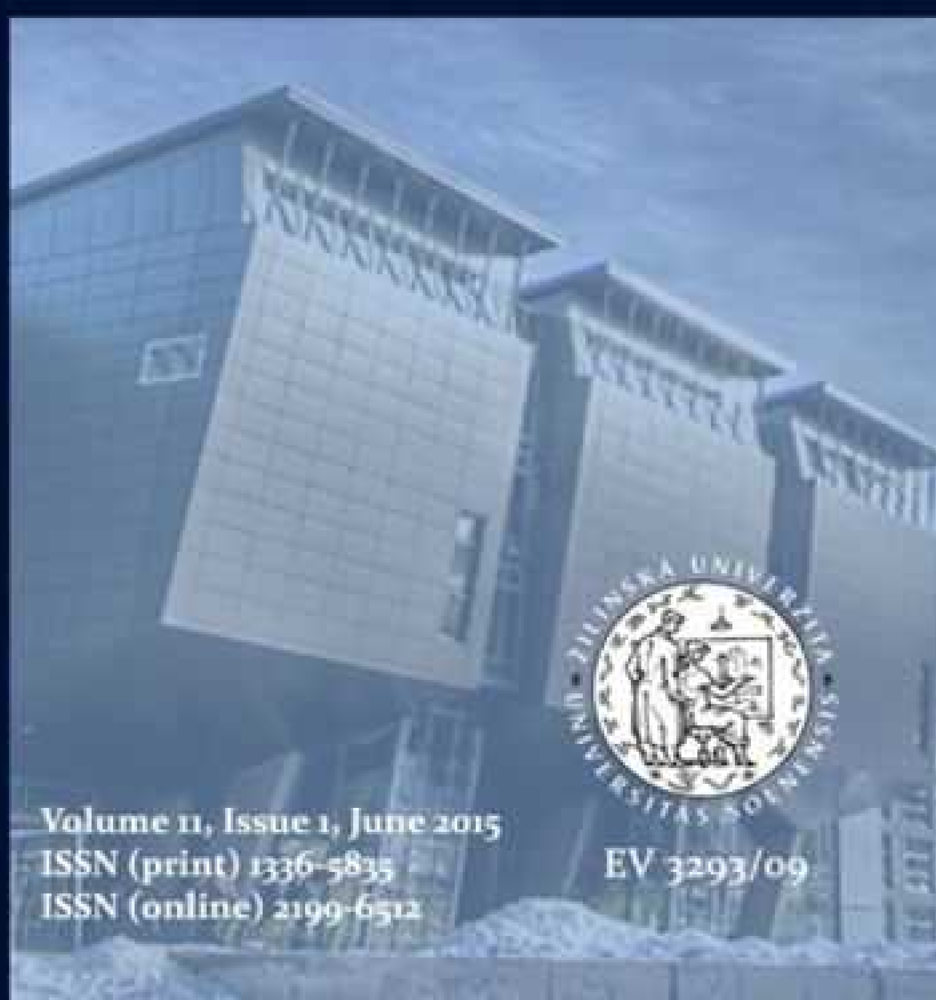

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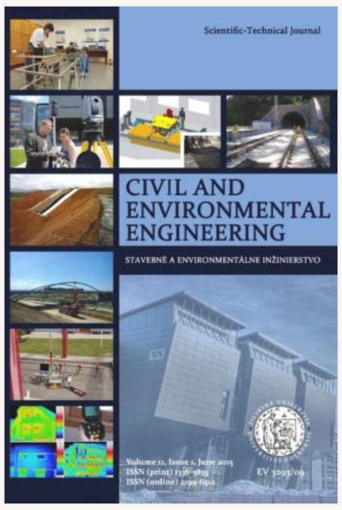

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IMPROVEMENT OF CLAY SOILS USING CEMENT AS A ROAD PAVEMENT SUB GRADE (CASE STUDY: KUTA-TANAH LOT ROAD)

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Abstract

Clay soil processing using cement is widely done but it is difficult to find studies that fit this topic, because the case study conducted is on the famous transportation route, namely Jalan Kuta – Tanah Lot in Bali, Indonesia. Pavements at this location are often damaged. In the dry season the road here is often cracked, while in the rainy season there is a decrease in certain parts or potholes occur that endanger users. Therefore it is necessary to conduct an analysis. This research aims to obtain the right formula of the ideal mixture of cement and clay, through mechanical tests i.e. compressive strength. Some results that are in accordance with the research conducted have been contained in the literature review, especially density and compressive strength testing. The use of cement as a stabilizer in clay is successful, as well as for other types of soil. The method used is soil sampling directly at the site, then mixed cement with various variations (treatment). This study discusses the success of cement to stabilize clay soils, especially increasing compressive strength and decreasing plasticity index. According to the results obtained that using cement as a soil stabilizer shows significant strength results, especially in ideal mixtures. This research is believed to be able to answer the obstacles that exist in clay soils to function as sub grade.

Keywords:

Clay;
Cement;
Sub grade;
Pavement.

1 Introduction

1.1 Background

The calculation in Civil Engineering structural planning is to maintain a balance of working forces so that the building becomes sturdy and safe. The forces acting are always taken into account, there must be a balance so that in the calculation at one point of the review always the number of moments that occur is equal to zero ($\Sigma M = 0$). In highway pavement planning, the ability of basic soil is needed to carry the burden of vehicles on it. This large enough vehicle load must be able to be balanced by the carrying capacity of the basic soil which in this case is played by native land or in several locations in the form of filled soil. Sub-grade soil in the form of clay soil often finds obstacles, namely during the dry season there is shrinkage and vice versa during the rainy season the clay soil expands. This condition certainly has a detrimental impact on the flexible pavement above it. This incident is often seen on Kuta - Tanah Lot Road, Bali, Indonesia, especially the Canggu - Tanah Lot road section / package. A similar study has been conducted by Wiraga [1], who conducted an analysis of the causes of damage to the Munggu – Kerobokan road, resulting in damage to the road body during the rainy season.

In a dry state, clay soil can be hard soil with a very high carrying capacity, while vice versa when wet it becomes soft and sticky, and if the moisture content is excessive it can become mud so that it has no carrying capacity at all. According to Sukirman [2], the minimum CBR value that must be owned by basic soil is 6%. During the rainy season the basic soil in the form of clay the value of CBR (California Bearing Ratio) is below 2% [1]. Thus it can be understood that in the rainy season roads built on clay soils often break down even though at that time there is no overload of vehicles, or there is no maximum load that exceeds the planned load.

Improvement efforts made to obtain maximum carrying capacity from the base soil are often carried out by compacting it layer by layer and testing the density achieved. Meanwhile, specifically for clay soils in order to obtain maximum and stable carrying capacity, treatment is carried out by mixing certain materials on clay soils to achieve stabilization. The best material to stabilize clay soils is lime containing calcium hydroxide (Ca (OH) 2), or calcium oxide (Ca O) [3]. Lime in addition to reducing plasticity, can also reduce moisture content, and facilitate the compaction process, so as to increase the carrying capacity of the soil itself. According to Jawad et al [4], soil stability using ordinary Portland Cement leads to a significant improvement in soil engineering characteristics in both the short and long term. In this study tried to dump clay soil with cement, the first assumption is that soil grains can be bound by cement, and when dry water cannot enter the soil so that the soil moisture content does not change.

In an effort to find out how much improvement in the carrying capacity of clay soil after mixing with cement so that it can function as a sub-grade soil layer, this research really needs to be done by mixing cement on clay soil using several variations of the mixture in order to obtain the required strength. Furthermore, it is expected to be used as a reference in the use of clay soil as a *sub-grade* for road pavement.

1.2 Problem Statement

Based on the background description of the problem above, the following problem formulation can be prepared: What is the variation in the ratio of cement mixture with clay soil to obtain strength in accordance with the requirements?

1.3 Research Objectives

The general and specific objectives in this study are: To obtain a mixture ratio between cement and clay soil in order to obtain the strength as required.

2 Literature Review

2.1 Clay Soil

The characteristic of clay soil is brownish-red and classified as expansive soil, that is, if the water content in the soil rises, the soil will expand, and vice versa if the water content decreases the soil shrinks. The physical appearance of expansive soil is very easy to know and recognize, because it is characteristic of it. When there is shrinkage on the surface appears polygon-shaped crack patterns, with the depth of these crack patterns can reach 80 cm, or more.

Soils that have the potential for shrinkage are soils that have a Plasticity Index (IP) greater than 15, and a Liquid Limit (LL) greater than 40. If these LL and IP values are included in Casssagranda's plasticity chart, then this soil includes finely granular soils that can be included in the CL (Clay Low plasticity) and CH (Clay High plasticity) groups [5]. The CL soil group is inorganic loam soils that have high plasticity. In Civil Engineering engineering what is meant by clay is soil containing clay minerals, is plastic and cohesive [6].

Research on clay soil conducted by Horpibulsuk, et al [7], by collecting several clay soil samples to analyze the development of strength after adding cement ranging from 0 to 10% to its dry weight. The tested samples are prepared in different moisture content, and tests are also performed at different sample ages. The results of his research are the increasing cement content, the drying time is getting longer, and good compaction energy is obtained by the strength of Unconfined Compression Stress (UCS) which increases. The strength and stiffness obtained are in cement clay samples whose water content is prepared the same as the initial moisture content, which is 1.2 OWC (Optimum Watter Content).

A study conducted by Hasan, M., D., M. [8], mixed clay taken from three different locations with cement whose contents ranged from 25 to 150 kg/m^3. Permeability tests are carried out using flexible wall permeameters, the results obtained show that there is a decrease in permeability. This decrease in clay permeability is associated with the ratio of adding cement and after the compaction process or the occurrence of the drying process.

The mineral elements found in clay soils which are the basic element arrangement are: silicon, aluminum, oxygen, and several other metals. The most important metals in the preparation of clay are:

Fe, Mg, Ca, K, and Na. These elements form a layer of tetra hedra and octa hedra. The tetrahedra layer is described as an elongated trapezoid, while the octahedra layer is aluminum, hence the gibbsite layer and if the magnesium atom is dominant, it is called brucite [6].

2.2 Sub Grade

The strength and durability of a construction, especially highway bending pavement, is largely determined by the nature and carrying capacity of its base soil (sub grade). The basic soil layer is a layer of soil 60 to 90 cm thick under the bottom foundation (sub base) which is compacted so that its carrying capacity can be improved [9]. The bottom soil layer in this case can be compacted native soil, and soil imported from another place is then compacted, as well as stabilized soil. Sub grade must be prepared very well, so that it can serve as a foundation for the structure of the pavement layer above it. Some problems that are often found related to basic soil include: changes in shape that occur due to traffic loads, shrinking properties due to changes in water content, uneven carrying capacity of sub-grades due to different types / types of soil, different local subsidence due to the presence of soft soil layers below sub-grade and geological conditions due to faults that cause friction. All of these problems can cause cracks in the surface layer of the road pavement. Studies conducted by Aiban, et al [10], to stabilize marl soils that represent most of the sub-grade road soils in Eastern Saudi Arabia, show that the strength of the soil in this area is highly dependent on its moisture content.

Research conducted by Jauberthie, et. al., [11], to be used as a sub-base of local roads, is carried out by stabilizing silt soil obtained from the Rance River. The stabilization materials used are portland cement, lime, and lime cement. The addition of cement starts from: 1.5%, 3.0%, 4.0%, 5.0%, and 7.0% to the weight of dry soil. The results improved after testing, where a significant increase occurred in the addition of 7% cement and 7 days drying time, obtained UCS of 1.7 MPa. This value rose to 2.3 MPa after testing at 28 days.

The performance of the sub-grade depends on three basic interrelated properties, namely:

• The carrying capacity, the load received by the road pavement structure is forwarded to the sub-grade, therefore the carrying capacity is greatly influenced by the degree of density, moisture content, and soil type. Research conducted by Deboucha, et. al [12], that stabilization of peat soil using cement produces maximum dry density along with the optimal decrease in moisture content. A good sub-grade is soil that is able to carry the load without excessive deformation, therefore improvements to the sub-grade are very necessary. In a study conducted by Pakbaz and Alipour [13], changes in the geotechnical properties of clay improved after the addition of cement.

• Water content, the ability to bear the load is greatly influenced by the moisture content in the sub grade. Moisture content is affected by the groundwater table, drainage conditions, surface water infiltration, and porosity of the pavement layer. The geotechnical properties of soils with high water content, interventions carried out with the addition of cement. The result is an increase in optimal moisture content along with increasing cement content [14].

• Soil development and shrinkage, some types of soil experience development and shrinkage due to changes in water content. This shrinkage event can cause damage to the road pavement structure above it. Conducted a shrinkage test on soils that have a moisture content of 15% and 17%, given cement ranging from 2% to 25% [15]. The result is an increase in earthworks in the addition of cement 4% to 6%, but development begins to stop after adding cement above 6%.

2.3 Soil compaction

Sub grade will increase in strength along with compaction, both layer by layer and by paying attention to the addition of moisture content. Compaction can also improve the stability of the pile slope, and reduce the magnitude of the drop after loading. The degree of soil compaction is measured by the weight of the dry volume of compacted soil. The addition of water to the soil that is being compacted is to function as a lubricant for soil particles, so that soil particles easily move with each other to form a denser position. At the time of compaction, it is usually done to increase the moisture content gradually, therefore the weight of the soil grain unity volume will also increase gradually. After reaching a certain moisture content, the addition of moisture content actually tends to reduce the weight of the dry volume of the soil [5]. This event is caused by water occupying the pores of the soil, where it should be occupied by soil grains. When the soil moisture content is reached at the weight of the dry volume of the soil reaches the maximum value, then the condition is called the optimum moisture content. Compaction of soil samples mixed with cement ranging from 1%, 2%, 3%, and 5% to the dry weight of the soil, the result is a slight increase in maximum dry density [16]. According Parson and Milburn [17], tested soil samples compacted to 92% of maximum dry density and showed that volume changed over a 4-Day period, and decreased when compared to native soils.

2.4 Stabilization

Stabilization is an attempt to make the soil more stable. Stabilization can be in the form of efforts to improve the physical and mechanical properties of the soil such as: strength, stiffness, compressibility, permeability, expansion potential, and sensitivity to changes in moisture content [3]. Stabilization methods can be divided into two, namely mechanical stabilization, and chemical stabilization. Mechanical stabilization is carried out by compaction, the goal is to close the distance between soil grains so as to increase strength and reduce the occurrence of decrease. While chemical stabilization is by mixing the soil using stabilizers / additives such as: salt, lime, fly ash, cement, and bitumen asphalt. The goal is to form larger lumps of soil grains and smaller surface charges. Soil improvement using additives makes physical changes in soil behavior such as: fibers, fillers, geogrids, etc., while some other additives induce chemical reactions with soil minerals that lead to improved properties of soil engine rings [18]. The most popular and traditional chemical stabilizers are lime and cement [19].

For soils with little pozzolan content, such as silt or sand, whose clay content is less than 12%, artificial pozzolan can be added to lime such as fly ash, which is fine gray ash resulting from coal burning. This fly ash is formed by very fine silica and aluminum particles and a small amount of oxide left over from burning carbon. Its qualities as a pozzolan are greatly influenced by the fineness of its grains and its carbon content. Good fly ash is one whose 80% of particles pass sieve No. 325, and the carbon content is less than 10%. Tensile tests were performed on pure sand and clay soils, and in comparison with the addition of cement, the results showed that the tensile load decreased only by adding 5% cement. In addition, the stability of the soil-cement mixture is significantly improved compared to pure soil when exposed to earthquake shocks [20]. Soil compaction methods should be detected as done by Decky, M., Drusa, et al. [21], conducting testing Methods to detect degree of compaction used in Slovak Republic including: Static load test, Radio matric method, Dynamic plate load test, dynamic method of compaction control, and Penetration tests.

2.5 Cement

Cement is generally used in concrete mixtures, which are used to bind fine aggregate, coarse aggregate and water into one unit. The use of cement to be mixed in clay means that cement as a binder is hydraulic, which means that cement will function or harden if it has reacted with water. Cement that has hardened will bind the clay grains so that they become hard. Types of cement can be obtained by varying the relative proportions of its characteristic components [22].

Conducted tests of well-graded granular soil types, sand and gravel with maximum sizes of 0.9 cm and 1.9 cm respectively [23]. The result is that the soil is stable with the addition of cement by 4%, 5%, and 6%, and the optimum moisture content is greater than that of the original soil with a significant amount and less maximum dry density. Other researchers [24] [25], also obtained similar results that with the addition of cement around 4% to 6%, significant clay stability was obtained. The cement used in this study is Semen Brand Gresik type I, in accordance with what is regulated in cement regulations in Indonesia [26].

3 Research Methods

This research was conducted at the Laboratory of the Faculty of Engineering, Mahasaraswati University Denpasar, with clay sampling on Jalan Kuta - Tanah Lot, in the Canggu - Tanah Lot section.

3.1 Research Design

This type of research is experimental research, in simple terms the research design can be described as follows:

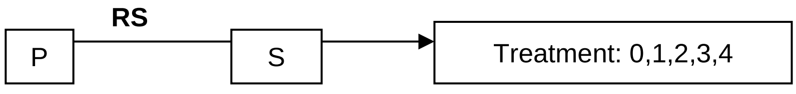


Fig. 1: Research Design.

where:
P – Population,
RS – Simple random Sample Selection (Random),
S – Research Sample,
Treatment: 0,1,2,3,4 – Treatment with variations of cement used.

3.1 Population, Sample, and Research Variety

The study population was a test specimen made (cube 5 x 5 x 5 cm), printed from clay dough mixed with cement with a ratio of the planned mixture according to the treatment given. Type I cement is used as stated in the Indonesian National Standard SNI: 2049: 2015, About Portland Cement. The clay used is clay extraction directly at the site, but in this case basic properties testing was not carried out because it was a limitation in this study, and the expected results were only compressive strength that occurred.

The sample in this study is a population of test specimens that meet the following criteria:

- Printed using a special cube-shaped reference.
- Smooth surface (not deformed).
- The shape is symmetrical.
- It has been 7 days old since it was casted [27].

In general, research variables are independent variables, dependent variables, and if the research is broader, there are usually control variables (control), and rambang variables [28] [29]. In this study the independent variable is Treatment 0 (Research samples that are not carried out adding cement), while the variable depends on the treatment carried out (adding cement according to the planned percentage).

3.2 Operational Definition

The operational definition related to this research can be described as follows:

- Treatment 0 is the testing of cube test specimens made of soil without added cement.
- Treatment 1 is the testing of cube test objects made of soil mixed with cement with a ratio of cement: soil = 1: 2.
- Treatment 2 is the testing of cube test objects made of soil mixed with cement with a ratio of cement: soil = 1: 4.
- Treatment 3 is the testing of cube test objects made of soil mixed with cement with a ratio of cement: soil = 1: 6.
- Treatment 4 is the testing of cube test objects made of soil mixed with cement with a ratio of cement: soil = 1: 8.

Mixing clay with cement as a stabilizer, is done like mixing concrete by using water as a mixing agent. The viscosity of the mortar in this case is not tested, but all specimens use the same composition of the water mixture.

3.3 Compressive Strength Testing

Soil stabilization testing can be performed by CBR (California Bearing Ratio) examination, or obtained density. In this case, only compressive strength testing is carried out, no measurement of other parameters such as stiffness or modulus of elasticity is performed. Therefore, there is an opportunity to conduct further research. To determine the amount of compressive strength of each test object according to the variation of the treatment performed, then at the age of 7 days a compressive strength test is carried out using a special pressure machine, and the compressive strength data is calculated using the following formula:

$$\sigma = \frac{P}{A} \tag{1}$$

$$\sigma m = \frac{\Sigma\,\sigma}{N} \tag{2}$$

where:
σ – Tension occurring (kg/cm²),
P – Maximum pressure load (kg),

A – Area of the test specimen's compressive field (cm²),
σm – Average tension (kg/cm²),
N – Number of specimens.

From the compressive strength test which is then calculated voltage, average voltage (σm), then is research data analyzed as a result of research and so on discussion.

4 Results And Discussion

4.1 Research Results

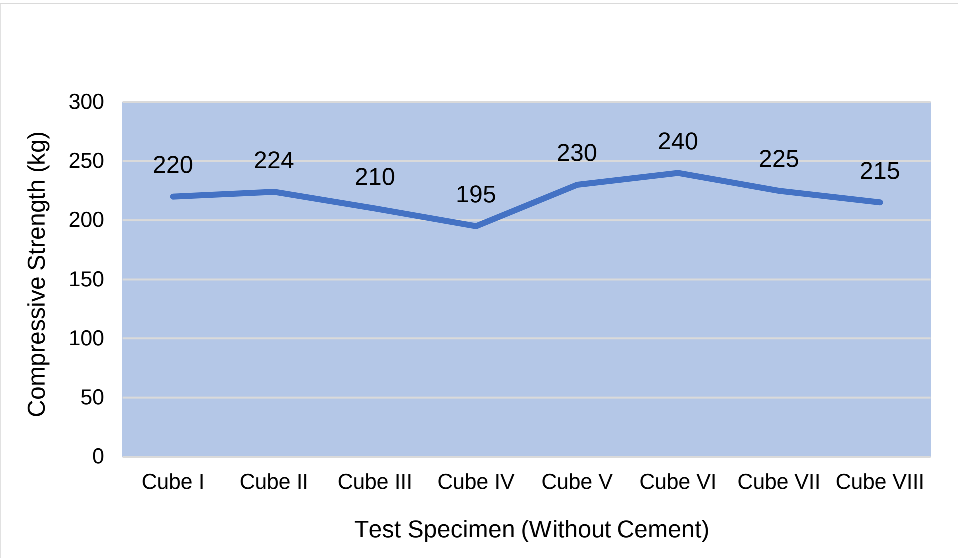
Compressive strength testing of cube test objects with dimensions of 5 x 5 x 5 cm that have been selected is not deformed and smooth, with various treatments carried out in the laboratory after 7 days old, and then calculated by the stress formula obtained the following research results:

1) Testing treatment 0 (without mixed cement)

Table 1: Testing Compressive Strength Treatment 0.

No	Test Specimen (c)	Compressive Strength (kg)	Tension (kg/cm²)
1	Cube I	220	8.80
2	Cube II	224	8.96
3	Cube III	210	8.40
4	Cube IV	195	7.80
5	Cube V	230	9.20
6	Cube VI	240	9.60
7	Cube VII	225	9.00
8	Cube VIII	215	8.60
		Average tension	8.795

Furthermore, the results of compressive strength testing based on the treatment carried out (without cement), a graph is made like the display of Graph 1.

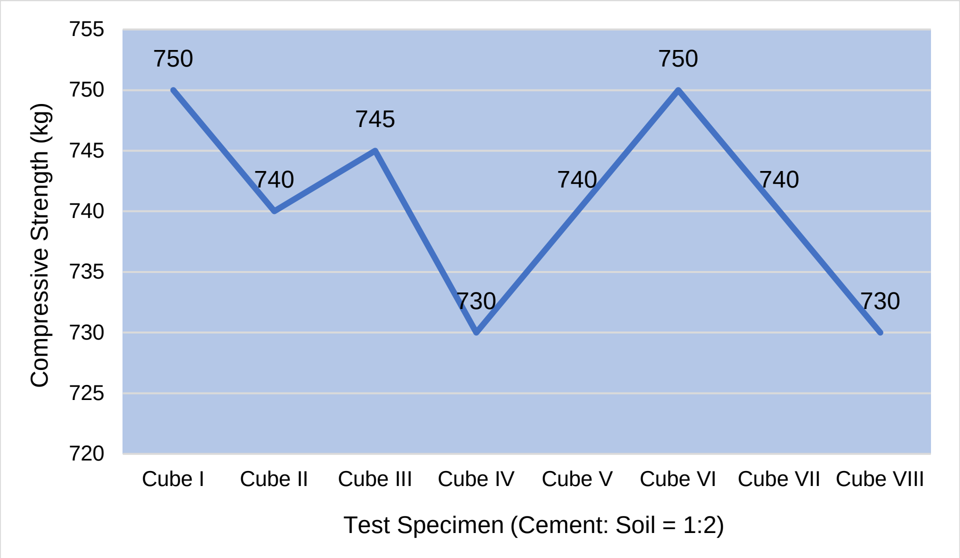


Graph 1: Compressive Strength Treatment 0.

2) Treatment testing 1 (cement mixture: soil = 1: 2)

Table 2: Testing Compressive Strength Treatment 1.

No	Test Specimen (Cement: Soil = 1:2)	Compressive Strength (kg)	Tension (kg/cm²)
1	Cube I	750	30.00
2	Cube II	740	29.60
3	Cube III	745	29.80
4	Cube IV	730	29.20
5	Cube V	740	29.60
6	Cube VI	750	30.00
7	Cube VII	740	29.60
8	Cube VIII	730	29.20
		Average tension	29.625

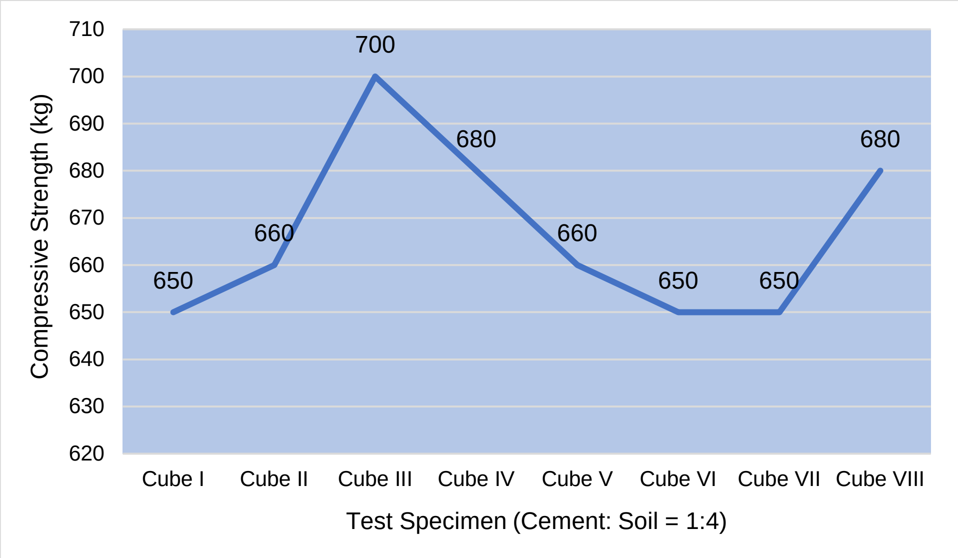


Graph 2: Strong Compressive Treatment 1.

3) Treatment testing 2 (cement mixture: soil = 1: 4)

Table 3: Compressive Strength Testing Treatment 2.

No	Test Specimen (Cement: Soil = 1:4)	Compressive Strength (kg)	Tension (kg/cm²)
1	Cube I	650	26.00
2	Cube II	660	26.40
3	Cube III	700	28.00
4	Cube IV	680	27.20
5	Cube V	660	26.40
6	Cube VI	650	26.00
7	Cube VII	650	26.00
8	Cube VIII	680	27.20
		Average tension	26.65

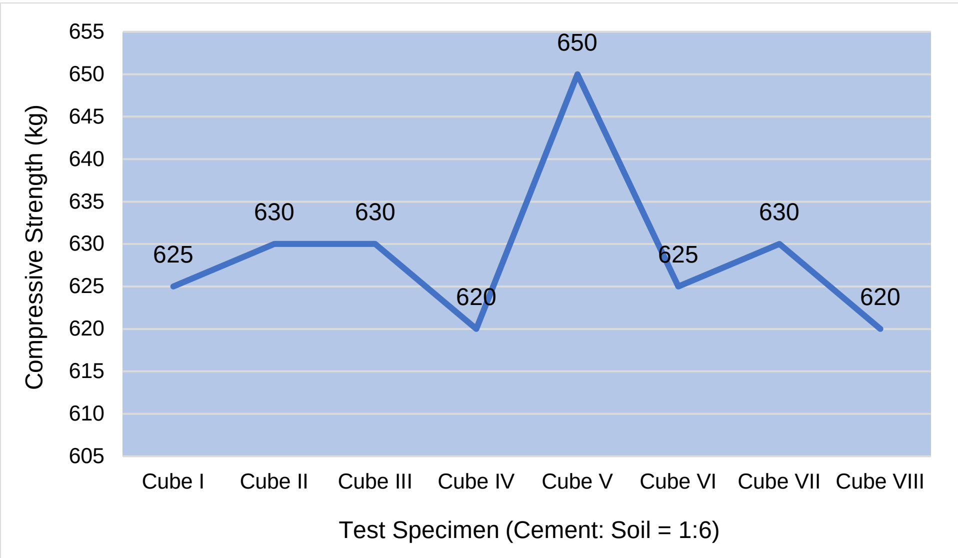


Graph 3: Strong Compressive Treatment 2.

4) Treatment testing 3 (cement mixture: soil = 1: 6)

Table 4: Testing Compressive Strength Treatment 3.

No	Test Specimen (Cement: Soil = 1:6)	Compressive Strength (kg)	Tension (kg/cm²)
1	Cube I	625	25.00
2	Cube II	630	25.20
3	Cube III	630	25.30
4	Cube IV	620	24.80
5	Cube V	650	26.00
6	Cube VI	625	25.00
7	Cube VII	630	25.20
8	Cube VIII	620	24.80
		Average tension	25.63

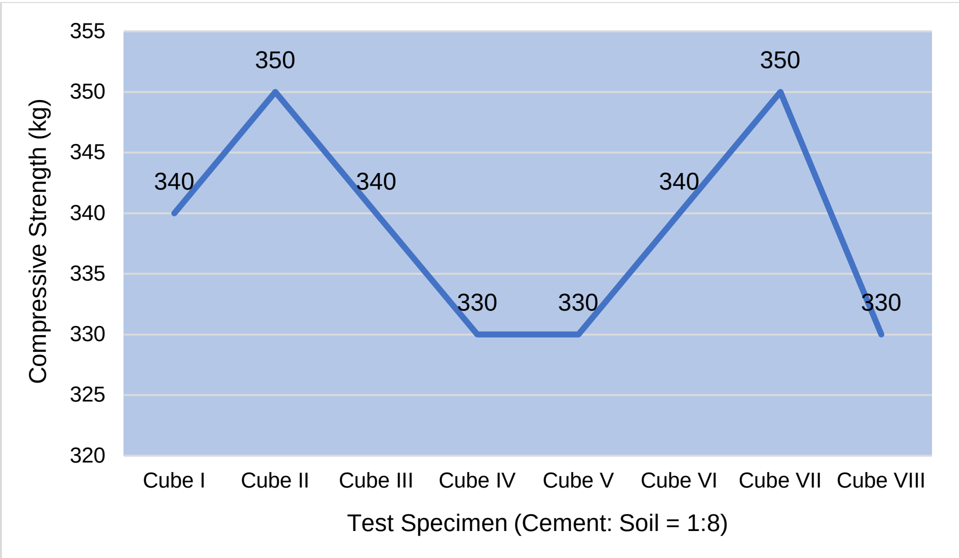


Graph 4: Compressive Strength Treatment 3.

5) Treatment testing 4 (cement mixture: soil = 1: 8)

Table 5: Testing Compressive Strength Treatment 4.

No	Test Specimen (Cement: Soil = 1:8)	Compressive Strength (kg)	Tension (kg/cm²)
1	Cube I	340	13.60
2	Cube II	350	14.00
3	Cube III	340	13.60
4	Cube IV	330	13.20
5	Cube V	330	13.20
6	Cube VI	340	13.60
7	Cube VII	350	14.00
8	Cube VIII	330	13.20
		Average tension	13.55



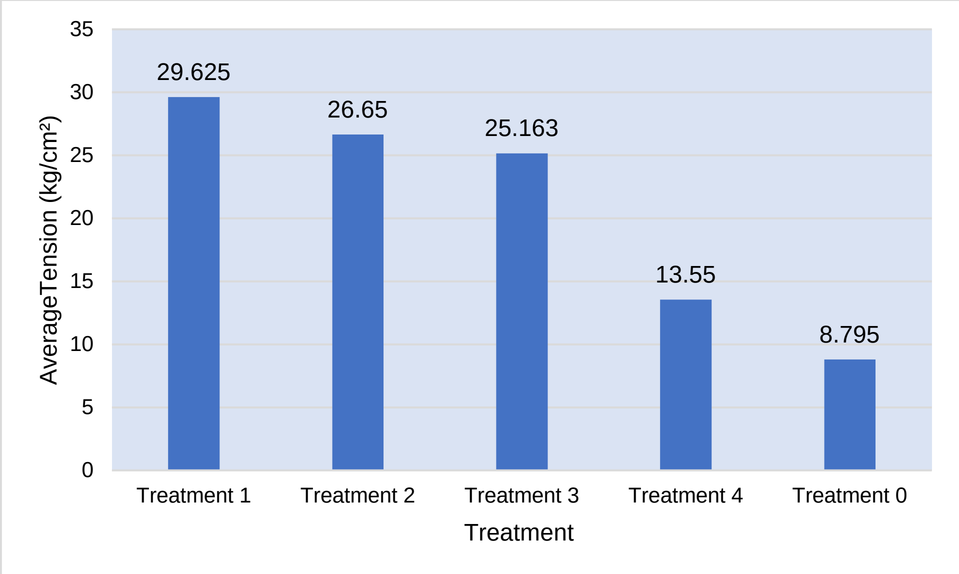
Graph 5: Compressive Strength Treatment 4.

The following is a combined table of compressive strength and tension test results that occur from all treatments performed, as shown in Table 6.

Table 6: Combined Tension from all Treatments.

No	Treatment	Average Tension (kg/cm²)	Information
1	Treatment 1	29.625	Exceeding Specifications
2	Treatment 2	26.65	Exceeding Specifications
3	Treatment 3	25.163	Meet Specifications
4	Treatment 4	13.55	Does not meet specifications
5	Treatment 0	8.795	Does not meet specifications

The results of the calculation of concrete stress that occurs, a graph is made according to the display in Graph 6.



Graph 6: Combined Tension That Occurs.

4.2 Discussion

As a follow-up step of this research, it is very necessary to discuss the results of the research that has been obtained. The initial step was a discussion on obtaining research results that were in accordance with the chronology, and then a discussion was carried out by linking to existing regulations, and comparisons were made with previous similar research. Because the coating is done only at compressive strength, visual observation can be reported that there is a discoloration of the soil that is dumped with cement, and the surface looks smoother and denser. The addition of cement makes a whitish discoloration caused by changes in moisture with the dissolution of alkalis (such as Na) to the surface of the specimen where they carbonize [30].

4.3 Soil Testing

In accordance with the necessary requirements for the soil as a highway subgrade, it is necessary to test mainly its basic properties. The usual checks are: specific gravity, water absorption, and gradation. Furthermore, if the soil functions as a subgrade, but due to the limitations of the study the examination was not carried out, compaction is carried out using special compaction tools according to the type and condition of the soil. In this study, testing the compressive strength of soil mixed with cement, did not test its basic properties. There is a significant increase in UCS value to stable soils and this increase changes proportionally to the cement content [13]. Soil samples were directly taken at a predetermined location, namely the Kuta - Tanah Lot Road Section, especially on the Canggu - Tanah Lot Road Package. Soil samples were taken at the initial end, in the middle of as many as two locations of the collection point, and at the end. Through this sampling method, it is expected that all road sections / packages studied are represented. So the point of taking is four points, with two specimens each made, so that the number of test objects from each treatment is eight pieces. The standard specifications for sample compressive strength testing in this study refer to the Indonesian National Standard (SNI)

4.4 Compressive Strength

The strength of highway pavement construction is very dependent on the type of soil and the supporting subgrade conditions, so before making this subgrade pavement construction must really get attention. Soil type is an important factor for the selection of the right stabilizer, cement is better used for soils with high sand content, an adequate stabilizer for soil is cement [31]. If the location of the dirt road is not good, cutting is usually done or the original soil (humus) is peeled first, then according to the required elevation it can be directly compacted or stockpiled using more qualified soil. An alternative that can also be taken is to improve the properties of the original soil by intervening such as adding certain materials such as cement, asphalt emulsion, limestone, and other materials.

In this study, stabilization of clay soil using cement was carried out, it is hoped that this intervention can change the nature of clay soil for the better. Mixing cement on clay soil is expected to make the soil grains tighter, so that water can no longer enter the soil grains which means there is no increase in plasticity. Plasticity Index decreased significantly when soils were treated by Portland Sement [14]. Maintaining plasticity in the soil can cause the ability of the soil to bear compressive loads to increase. Clay soil that functions as basic soil can be stabilized using cement, quality control can be done by conducting CBR testing, density with Sand Cone test whose density should not be less than 95%. Another test that can be done is on the compressive strength, with the amount of tension that occurs ranging from 20 to 35 kg/cm², but the most ideal is 24 kg/cm² [27] [32]. As explained in the previous chapter that CBR testing can also be done, but in this case it is not done. CBR testing is less accurate due to field conditions, so it is recommended that testing the compressive strength be used.

Based on the results of research that the compressive strength obtained, then calculated The tension that occurs obtained for soil that is not mixed with cement is 8.795 kg/cm², this is very far from the required there is 20 kg/cm², and the most ideal is 24 kg/cm² [32]. While in clay soil mixed with soil with a ratio of 1: 8 (1 cement: 8 soil) obtained a Tension of 13.550 kg/cm², for mixed treatment with a ratio of 1: 6 obtained a Tension of 25.163 kg/cm², a mixture with a ratio of 1: 4 obtained a Tension of 26.650 kg/cm², and for a mixture of 1: 2 obtained a Tension of 29.625 kg/cm². For treatment 1 (mixture 1:2), and treatment 2 (mixture 1:4) The tension that occurs exceeds the specification, while treatment 4 (mixture 1:8) results are below the specification. Treatment 3 (a mixture of 1:6) is the most ideal result that meets the specification of obtaining a Tension of 25.163 kg/cm², slightly above the specification of 24 kg/cm².

5 Conclusions And Advice

5.1 Conclusion

Based on data mining and the results of the analysis carried out, it can be concluded as follows:

1) Original soil (clay), is not good to be used as a subgrade because the compressive stress obtained is very much smaller than the specification requirements, that is SNI-3-3438-1994, concerning Procedures for Making Soil Stabilization Plans with Portland Cement for Roads.

2) Treatment 3 (a mixture of 1 cement: 6 soils) obtains the most ideal compressive stress, meeting the specifications of SNI-3-3438-1994 even slightly above it. This research is very appropriate to be applied, especially to the location of the case study: Jalan Kuta – Tanah Lot.

5.2 Advice

From the red thread of research, that in accordance with the problem of how much cement-soil mixture meets the specifications, and the results of the study were obtained, namely in treatment 3 with a mixture of 1: 6 obtained the most ideal results, it can be suggested as follows:

1) It is important to know the type and condition of the basic soil that will be used as a subgrade, because its main function is to bear all the load passed on by the pavement construction on it.

2) The use of cement as a stabilitator in clay soils is very appropriate, because compressive strength and tension are obtained that meet engineering specifications. Therefore, the results of this study are confident that they can be applied to the Kuta – Tanah Lot Road.

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