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Soil Classification Analysis Using the USCS Method on Cikombong Merauke Road

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ABSTRACT: Soil is the most important part in a construction such as buildings, roads and traffic loads because the soil functions as a support for construction. Soil consists of minerals, organic materials, and relatively loose deposits located above bedrock. In planning a construction, an investigation must be carried out on the soil classification, especially on the soil properties that can affect the bearing capacity of the soil, especially on the properties of the soil that support the construction load above it. This study aims to determine the classification, type and nature of the soil found on the Cikombong Merauke road using the USCS method. (Unified Soil Classification System). This study uses soil samples from 3 points (spots) located in the development area, especially in terms of construction so that an initial study is needed regarding soil classification so that the strength of the construction can be in accordance with local soil conditions. From the results of this study, fine grains were obtained from sample 1 which were retained in the pan with a retained weight of 12.35 grams, a retained cumulative of 100.00 grams and a retained cumulative value (%) of 100.00 grams. Sample 2 obtained a retained weight value in the pan of 25.40 grams and a cumulative (%) retained of 100.00 grams. And at point 3 obtained a retained weight of 27.75 grams and a cumulative retained of 100.00 grams. These values can be stated that the classification of the soil is silty sand and very poorly graded, gravelly sand contains little or no fine grains at all which is given the symbol SP.

KEYWORDS: Soil, USCS Method, Atterberg Limits, Cikombong Merauke

INTRODUCTION

Paving blocks are building materials used to pave road surfaces, whether for courtyards, parking lots, highways, or for decorative purposes in gardens. Paving blocks are made using water and aggregates, with or without other additives, that do not compromise their quality. Paving blocks are a building material also known as concrete bricks.

In the modern era, manufacturing tends to produce products in plastic packaging for marketing. Plastic is considered the most effective material for packaging food and other products. Human demand for plastic has resulted in a large amount of waste from products using plastic packaging. Plastic waste is a disaster that is difficult to overcome and must be managed properly. Utilizing plastic waste not only reduces environmental pollution but also serves as an alternative to building materials. The potential for utilizing plastic waste still really needs to be developed, by conducting research on plastic waste to be substituted into paving blocks, by replacing some of the sand function in normal paving blocks, the plastic waste is first melted to form plates and then smoothed to resemble the physical form of sand, so that later the plastic waste can be substituted to replace some of the sand in making the paving blocks. The purpose of this study was to determine the effect of the compressive strength of paving blocks by mixing plastic waste of 2.56%, 5.26%, 8.11%, and 10.11%.

RESEARCH METHODOLOGY

The research method used was an experimental method. This test was intended to verify a treatment of a research object. In this test, test specimens were made by adding plastic waste as filler/mixture to the paving block mixture.

The paving blocks were then tested for compressive strength at 28 days, when they were likely to have reached their maximum compressive strength.

1. Research Materials
   The materials used in the manufacture of the paving block test specimens were:
   a. Sand (fine aggregate)
   b. Cement: Gresik PPC cement in 50 kg packages
   c. Clean water
   d. Plastic waste: HDPE (High Density Polyethylene)
2. Research Process
   The research process used an experimental method. This study aimed to examine the influence of mixture composition factors. In this study, test specimens were made by adding plastic additives while reducing the amount of sand as filler/mixture in the paving block mixture. The paving blocks were then tested for compressive strength at 28 days, when the concrete blocks had reached their maximum compressive strength. This study was conducted using the following steps:
   a. Preparation of tools and materials

b. Inspection and testing of base materials
c. Mix design and material requirements
d. Preparation of test specimens
e. Weighing of materials
f. Mixing and molding of test specimens

This process was carried out in a systematic manner using pre-placement, where the pre-formed plastic mixture was first placed into the paving block mold according to the required thickness of the outer layer. The cement and sand mixture was then poured around the surrounding outer layer. The steps were:

a. Mixing and molding of the inner layer
b. Mixing and molding of the outer layer
c. Test specimen care stage

Test specimen care can be performed by placing the specimen in a humidified chamber within the laboratory.

3. Population and Sample

The population is all test objects related to the research conducted at the Civil Engineering Laboratory of Musamus University, Merauke.

The samples tested were 25 paving blocks made from a mixture of plastic waste at 28 days. The sample ratios were:

a. 1 Pc: 5 Ps: 0% plastic waste
b. 1 Pc: 4.875 Ps: 2.56% plastic waste
c. 1 Pc: 4.75 Ps: 5.26% plastic waste
d. 1 Pc: 4.625 Ps: 8.11% plastic waste
e. 1 Pc: 4.5 Ps: 10.11% plastic waste

4. Data Types and Sources

This study used two data sources:

a. Data Source

The data source for this study was the results of compressive strength tests on a number of test specimens, consisting of 28-day-old plastic paving blocks.

b. Data Collection Technique

To obtain data on compressive strength, a compressive strength test was conducted. The specimens were paving blocks with plastic waste added as a material, with a mixture of 5% sand and 1% cement. The planned stages of this study are outlined in several stages, as follows:

Phase I: Preparation of equipment and materials, including checking equipment availability and procuring paving block molding equipment, including material testing.

Phase II: Preparation of paving block mixtures with variations, followed by preparation of paving block mix, and testing of plastic waste added as a material.

Phase III: Curing of the paving block test specimens by allowing them to dry open in a room for 28 days.

Phase IV: Analysis of the results obtained from the compressive strength of paving blocks with plastic waste added as a material to determine the values needed to draw conclusions regarding the presented problem formulation.

Phase V, drawing conclusions from the results of the research data analysis.

5. Analysis Techniques

The thickness requirements for paving blocks are based on SNI-03-0691-1996.

The following formula is used for fine aggregate testing:

a. Fine aggregate water content testing

$$\text{Water content} = \frac{\text{Wa-W1}}{\text{Wa}} \times 100\%$$

Where:
Wa = Natural sample weight
W1 = Constant sample weight

b. Fine Aggregate Silt Content Test

$$\text{Silt Content} = \frac{\text{W1-W2}}{\text{W1}} \times 100\%$$

Where:
W1 = Sample weight at constant weight → (grams)
W2 = Dry sand weight after washing → (grams)

c. SSD absorption and fine aggregate specific gravity testing

$$\text{Water absorption} = \frac{\text{Bj-Bk}}{\text{Bj}} \times 100\%$$

Where:
Bj = SSD sample weight
Bk = dry SSD sample weight

$$\text{SSD specific gravity } \frac{\text{Bj-Bk}}{\text{(Bj+Bp)-(Bj)}} \quad gr/cm^3$$

Where:
Bj = SSD sample weight
Bp = Weight of measuring cylinder + water

RESULTS AND DISCUSSION

RESULTS

1. Material Quality and Requirements

a. Material Quality

Fine Aggregate

In this study, the fine aggregate was subjected to several tests, including water content, silt content, SSD absorption, specific gravity, and fine aggregate gradation. The test results are presented in Table 1.

The results of the fine aggregate gradation test produce an image in the form of a graph curve and the gradation limits required by SK.SNI T-15-1990-03 as in Figure 1.

Table 1. Fine Aggregate Test Results

No.	Test Types	**Test Results**
1.	Natural Fine Aggregate Moisture Content	1,523 %
2.	SSD Fine Aggregate Water Absorption	3,644 %
3.	SSD Fine Aggregate Specific Gravity	2,598 gr/ml

4.	Fine Aggregate Silt Content	4,399 %
5.	Fine Aggregate Gradation	Zona 1

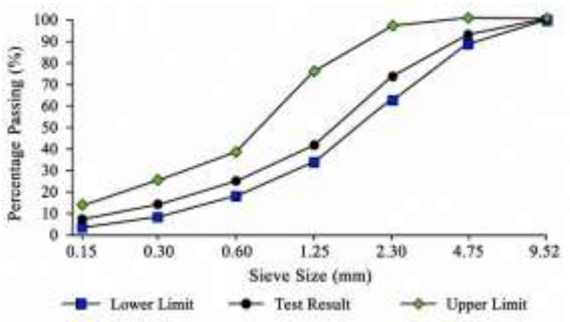

Figure 1. Fine Aggregate Gradation Graph Curve (Sand) Figure 1 above shows that the fine aggregate (sand) falls into zone 1 (coarse sand).

Plastic waste

In this test, plastic waste was used as a partial substitute for sand. The plastic waste tested in this study was a plastic waste gradation test. Data from similar tests was used to determine the specific gravity of the plastic. The test results are shown in Table 2 below.

Table 2. Plastic Waste Test Results

No.	Types of Testing	**Test Results**
1.	Plastic Waste Gradation	Zona 1
2.	Genetic Gravity of Plastic Waste	0,91 gr/ml

The results of the fine aggregate gradation test produce an image in the form of a graph curve and gradation limits as in graph 2 below.

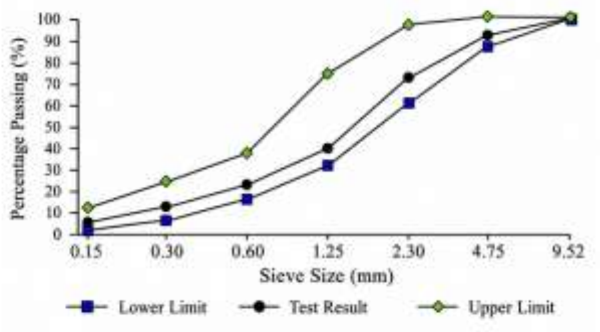

Figure 2. Plastic Waste Gradation Graph Curve

b. Paving Block Material Requirements

The test specimen manufacturing process begins by calculating the weight requirements for the materials required: Portland cement, sand, plastic waste, and water. To calculate the requirements for each material, the specific gravity (SG) of each material is first examined. The following are the specific gravities of each material after laboratory testing.

Cement Specific Gravity = 3.02 g/ml
Sand Specific Gravity = 2.598 g/ml
Plastic Specific Gravity = 0.91 g/ml

The material requirements for one paving block are calculated as follows:

Volume : 6 x 10 x 20 = 1200 cm3

For the mixing proportions of paving blocks without adding plastic waste:

Cement volume = 1/6 x 1200 = 200 cm3
Sand volume = 5/6 x 1200 = 1000 cm3
Weight = volume x specific gravity
Cement weight = 200 x 3.02 = 604 g
Sand weight = 1000 x 2.598 = 2589 g

The results of the material requirement calculations for each material weight ratio are presented in table 3.

Table 3. Results of Comparison of Proportion to Weight of Test Material

Mixture Proportion	**Weight of Material Per Test Specimen (gr)**		
	Plastic	Sand	Cement
1 PC : 5 Ps : 0 % PL	604	2589	0
1 Pc : 4,875 Ps : 2,56 % PL	604	2533	22,75
1 Pc : 4,75 Ps : 5,26 % L	604	2468	45,5
1Pc : 4,625Ps : 8,11 % PL	604	2403	68,25
1Pc : 4,5Ps : 10,11% PL	604	2338	91

2. Unit Weight Inspection

The following are the results of the average weight inspection of paving blocks with various plastic waste mixture compositions and the planned paving block sizes of 10 cm x 20 cm x 6 cm, which have the following weights:

Paving blocks with a mixture of 1pc: 5ps: 0% PL have an average weight of 2421.3 g and a volumetric weight of 1.99 g/cm^3.

Paving blocks with a mixture of 1pc: 4.875ps: 2.56% PL have an average weight of 2410.8 g and a volumetric weight of 1.8 g/cm^3.

Paving blocks with a mixture of 1pc: 4.75ps: 5.26% PL have an average weight of 2597.4 g and a volumetric weight of 2.16 g/cm^3.

Paving blocks with a mixture of 1pc: 4.625ps: 8.11% PL have an average weight of 2301.3 g and a volumetric weight of 1.9 g/cm^3.

Paving blocks with a mixture of 1pc: 4.5ps: 10.11% PL have a weight of the average is 2405.5 g, and the volume weight is 2 g/cm^3.

a. Compressive Strength Testing

The compressive strength of paving blocks increases with age. Therefore, the standard strength of paving blocks is set at 28 days for compressive strength testing. Compressive strength is calculated based on the load per unit area, with the load applied until the test specimen collapses under the maximum load generated by a hydraulic press.

From the compressive strength test data, a graph was obtained depicting the comparison of the compressive strength of paving blocks from the results of the test involving the replacement of fine aggregate with plastic waste at 28 days. This graph can be seen in Figure 3 below:

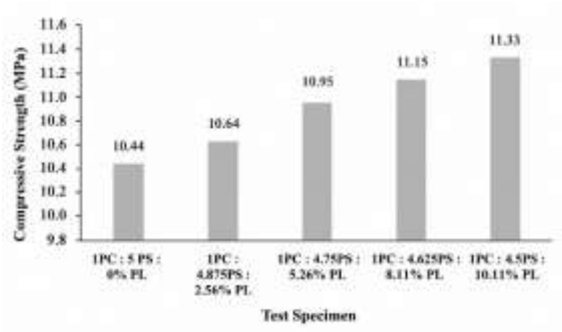

Figure 3. Average compressive strength comparison graph

The graph in Figure 3 above shows that the compressive strength of paving blocks increases with increasing plastic content in the mixture. The highest compressive strength was found in paving blocks with a 10.11% plastic waste mixture, with a compressive strength value of 11.33 MPa.

Figure 3 shows a comparison of the compressive strength of paving blocks with plastic waste mixture percentages of 0%, 2.56%, 5.26%, 8.11%, and 10.11% at 28 days. Based on SNI-03-0691-1996 for Concrete Bricks (Paving Blocks), the details are presented in Table 4. The comparison of average compressive strength with paving block quality requirements is as follows:

Table 4. Comparison of Average Compressive Strength with Quality Requirements

Mixture Composition	verage Compressive Strength (MPa)	Quality Level
1 PC : 5 Ps : 0 % PL	10,44	D
1 Pc : 4,875 Ps : 2,56 % PL	10,64	D
1 Pc : 4,75 Ps : 5,26 % L	10,95	D
1Pc : 4,625Ps : 8,11 % PL	11,15	D
1Pc : 4,5Ps : 10,11% PL	11,33	D

If classified according to SNI-03-0691-1996 paving blocks with a mixture proportion of 1Pc: 5Ps: 0%PL with a compressive strength of 10.44 MPa are included in quality level D, a mixture of 1Pc: 4.875Ps: 2.56%PL with a compressive strength of 10.64 MPa are included in quality level D, a mixture of 1Pc: 4.75Ps: 5.26%PL with a compressive strength of 10.95 MPa are included in quality level D, a mixture of 1Pc: 4.625Ps: 8.11%PL with a compressive strength of 11.15 MPa are included in quality level D, a mixture of 1Pc: 4.5Ps: 10.11%PL with a compressive strength of 11.33 MPa are included in quality level D. Concrete bricks with quality level D can be used for gardens.

CONCLUSION

From the results of the compressive strength test of paving blocks with a mixture of 0%, 2.56%, 5.25%, 8.11%, and 10.11% plastic waste, the compressive strength was obtained at 10.44 MPa, 10.64 MPa, 10.95 MPa, 11.15 MPa, and 11.33 MPa, respectively. Based on the test results, it can be concluded that there is an effect of the compressive strength of paving blocks according to the increasing percentage of plastic mixture. The increase in the compressive strength of normal paving blocks (0% plastic waste mixture) against paving blocks with a mixture of 2.56%, 5.26%, 8.11%, and 10.11% plastic waste obtained an increase of 1.83%, 4.6%, 6.35%, and 7.86%, respectively. The highest compressive strength occurs in paving blocks with a mixture percentage of 10.11% plastic waste, according to the SNI-03-0691-1996 standard, this compressive strength is included in the D quality level which can be used for gardens and other uses.

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