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 <https://doi.org/10.30736/cvl.v2i2>



Maximum Utilization of Cocopeat Waste as a Substitute Material for Fine Aggregates On Paving Blocks Was Engineered

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ARTICLE INFO

Article History :

Article entry : 2022-02-03
Article revised : 2022-03-05
Article received : 2022-03-11

Keywords :

Cocopeat, Compressive tes, Paving blocks, Percentage, Waste.

IEEE Style in citing this article :

D. Kurniati, "Maximum Utilization Of Cocopet Waste As A Substitute Material For Fine Aggregates On Paving Blocks Was Engineered", *CIVILA*, vol. 7, no. 1, pp. 77-86, 2022.

ABSTRACT

Waste utilization can be done in various ways, one of the wastes used in this study is cocopeat waste. Cocopeat is a coconut pulp powder commonly used to cultivate plants. But this time, this waste is processed into a paving block mixture. The goal is to find out the strong press and quality resulting from the utilization of cocopeat in the manufacture of paving blocks. The method used refers to SNI 03-0691-1996. The first step of coconut pulp is destroyed, then used as a paving block mixture as a sand substitution. Cocopeat substitution paving block testing with percentages of 0.6%, 0.8%, 1%, 1.2%, 1.4%, 1.6%, 1.8%, 2%, and 2.2%. The total compressed strong test sample conducted amounted to 90 pieces with a test object size of 150x100x60 mm. The average compressive force generated by each percentage is 0.6% of the 14.71 MPa, 0.8% of 13.56 MPa, 1% of 13.76 MPa, 1.2% of 14.74 MPa, 1.4% of 14.13 MPa, 1.6% of 13.08 MPa, 1.8% of 12.43 MPa, 2% of 13.22 MPa, and 2.2% of 10.33 MPa. In conclusion from the test results, cocopeat substitution paving blocks have an average grade C quality that can be used for pedestrians, so this mixture can be recommended.



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1. Introduction

Infrastructure development in Indonesia from agricultural areas to industrial areas. For most Indonesians, coconut is a multi-use tree with high economic value [1]. According to Indonesia's plantation statistics, in 2015, Indonesia had 3.58 million hectares with a production of 2.92 million tons of coconuts, 98% of which were community-owned plantations. So from the results of the use of all parts of the coconut will produce waste [2]. The utilization of waste has not been widely used. If not managed properly, it can impact the environment [3], so this research was conducted so that the utilization of coconut fiber waste is more beneficial for the community, especially in the construction sector, as well as the surrounding ecosystem [4].

Concrete brick (paving block) is a composition of building materials consisting of a mixture of portland cement [5] or similar hydraulic binders, water and aggregates [6] with or without other additives that do not reduce the quality of the concrete bricks [7]. Based on the quality of concrete bricks (paving blocks) can be used as roads [8], parking equipment, pedestrians, and parks as well as other uses. Another function of the use of concrete bricks

Description and Technical

Please explain clearly the methodology, covering some technical work as follows :

(paving blocks) is better than other pavements in terms of economical maintenance [9], the artistic aspect of the exterior of a building, does not require heavy equipment in the construction/installation, and can be mass-produced [10]. Structurally, concrete brick (paving block) has considerable strength, especially in terms of compressive strength, but as a concrete brick (paving block) it usually has the weakness of low flexural strength and fragility and is brittle and easy to crack or crumble [11]. The addition of additive materials is one way to produce concrete with certain properties, such as workability, strength [12], and setting time [13].

Concrete bricks (paving blocks) have a reference, namely SNI 03-0691-1996 regulations, with different f'c provisions according to the classification of the concrete bricks (paving blocks). The method of execution of the manufacture is divided into method 2, the first is the conventional method which is carried out using a geblokan tool whose compressive load is influenced by the strength of the person working on it. Furthermore, the mechanical method or by means of a press carried out by a machine (compression apparatus). The manufacture is quite easy and the materials are not too difficult to find [14], so that many concrete bricks (paving blocks) are produced by factories and home industries. Installation is also relatively easy compared to other ground coatings such as asphalt and concrete [15]. Concrete bricks (paving blocks) have various shapes such as: square, rectangle, triangle, pentagon, hexagon and many more. According to SNI-03-0691-1996, Paving Blocks must have a compressive strength between 10 MPa to 40 MPa, a wear resistance of 0.09 mm/minute to 2,219 mm/minute and a water absorption of 3% to 10%. Based on SNI 03-0691-1996, the classification of paving blocks is distinguished according to the class of use, namely: Concrete brick (paving block) quality A: used for roads. Concrete brick (paving block) grade B: used for the parking lot. C quality paving block: used for pedestrians D quality paving block: used for gardens and other uses [16].

In many studies, the addition of cocopeat to concrete can increase the compressive strength and tensile strength of the test object [17]. However, for paving blocks [18], the effect of the addition of cocopeat is not widely known, therefore the update made is to find out more about adding cocopeat to paving blocks. Cocopeat has a length of 1530 cm and a thickness of ± 0.2 mm, and has properties, among others, resistance to attack by microorganisms, weathering

and mechanical work (rubbing and blowing), as well as being lighter than other fibers [19]. So that it is possible to be used as an additional material for paving blocks.

The mixture of other additives in the production of concrete bricks (paving blocks) with coconut fiber waste (Cocopeat) will be carried out in as many as 9 experiments. Each trial will have a percentage of 0.6%, 0.8%, 1%, 1.2%, 1.4%, 1.6%, 1.8%, 2%, and 2.2%. The purpose of this study was to determine the visible test results, dimensions (measurements), and compressive strength values for each test result obtained and concluded according to the classification determined by SNI 03-0691-1996. The hope is that this research can trigger the emergence of interest in making block paving by utilizing waste, so that a lot of waste in our region becomes useful and of high economic value [20].

2. Research Method

The research flow chart is a diagram that explains the research steps. The flow chart can be seen in Figure 1. Concrete brick testing (paving block) is done in accordance with SNI 03-0691-1996, which specifies three things that will be tested.

Visible Concrete Brick Testing

SNI 03-0691 of 1996 explained in the test of visible or physical concrete brick (paving block) carried out by way of bricks placed on a flat surface like the actual installation with reference to item 5.1 that the visible nature with the condition of the quality of the concrete brick must have a flat surface.

Concrete Brick Dimensional Testing

SNI 03-0691 in 1996 explained in testing the size of concrete bricks (paving blocks) using caliper equipment or the like with an accuracy of 0.1 mm with measurements of thickness carried out in three different places and taken the average value. Concrete Brick size testing was conducted on 10 test samples with a minimum nominal dimension requirement of 60 mm concrete brick with a tolerance of + 8%.

Research Stages:

- a. Prepare tools and materials to carry out research
- b. Material testing of Water, Cement, and Sand.
- c. Doing Mix Design or percentage testing 0.6%, 0.8%, 1%, 1.2%, 1.4%, 1.6%, 1.8%, 2%, and 2.2%.
- d. Tests on all paving block samples that have been made with Visible Test, Dimensional Test and Compressive Strength Test.
- e. Checking and discussing the results that have been carried out.
- f. Provide research conclusions.

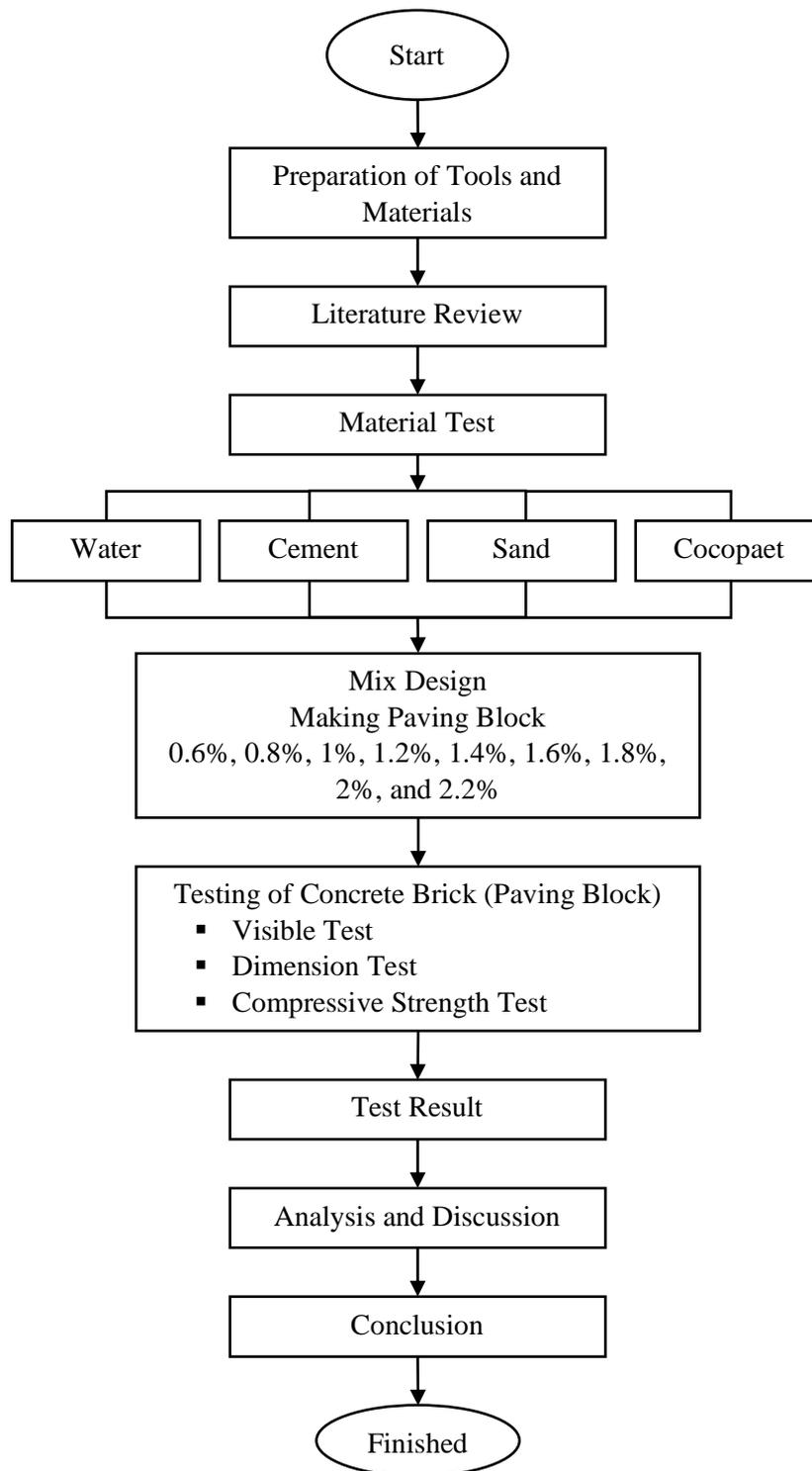


Figure 1 Research Flow Chart
Source: Research

3. Results and Discussions

Material Test

The results of the aggregate material test were obtained from material testing carried out at the Materials Technology Laboratory. From the results of testing the material [21], in the form of data needed in the manufacture of test objects.

a. Checking the Content of Mud in Sand (Equivalent)

The data is obtained from the results of the tests that have been carried out, resulting in:

$$\begin{aligned} \text{The content of silt in the surrounding sand} &= \frac{V_L}{V_P} \times 100\% \\ &= \frac{13}{450} \times 100\% \\ &= 2.89 \% \text{ (qualify) Because Less than } 5\% \end{aligned}$$

b. Checking the Content of Mud in Sand

The data is obtained from the results of the tests that have been carried out, resulting in:

$$\begin{aligned} \text{The content of silt in the surrounding sand} &= \frac{B1-B2}{B2} \times 100\% \\ &= \frac{500-488.1}{500} \times 100\% \\ &= 2.38 \% \text{ (qualify) Because Less than } 5\% \end{aligned}$$

c. Examination of Organic Content in Sand

The color of the water on the sand is lighter than the standard color. The results were obtained after testing after the sand was allowed to stand for 1 x 24 hours. Then meet the standard

d. Sand SSD Check

The sand is ideal/SSD so it doesn't require drying or watering.

e. Sand Density Test

According to the specific gravity and good sand SSD is 2.4-2.9. So the results obtained from this test are 2.5. The test object meets the requirements.

f. Unit Weight Test for Fine Aggregate (Sand)

The results of the Unit Weight Test for Fine Aggregate (Sand) are 1.97 kg or 7970 gr.

g. Cement Unit Weight Test

The results of the Cement Unit Weight Test weighing 6.61 kg or 6610 gr.

h. Sand Grain Fine Modulus Inspection

Based on the results of the tests carried out, the sand gradation is in a rather rough area.

Mix Design Planning

Mix design planning aims to figure out how much material (sand, cement, water, and other ingredients like coconut fiber) is needed to make mortar mixes. The field analysis approach was employed in this study to create the mix design.

Testing of Concrete Brick (Paving Block)

According to SNI 03-0691 (1996), there are three types of concrete bricks (paving blocks) tests: visual qualities, dimensions and sizes, and compressive strength. These three tests are

governed by an item in SNI 03-0691 from 1996, and concrete bricks (paving blocks) must adhere to the specifications outlined in it [22].

Discussion

Concrete brick testing (Paving Block), which includes visible testing, dimensional testing, and compressive strength testing on 10 samples of the test object per percentage, equals a total of 90 samples, carried out in accordance with SNI 03-0691 of 1996 and yielding results in accordance with SNI 03-0691 of 1996.

a) Discussion on Testing the Visible Properties of Concrete Brick (Paving Block)

SNI 03-0691 from 1996 has the test. It is determined that the concrete brick (paving block) must have a level surface, be free of cracks and faults, and be difficult to trim with finger strength at the corners and ribs.

According to the requirements of SNI 03-0691 (1996), the visual test performed on a level surface yielded satisfactory results, and every surface of the concrete brick (paving block) has good flatness.

b) Discussion of Dimensional Testing of Concrete Brick (Paving Block)

In assessing the specifications of the concrete brick (paving block), it was established that it must have a minimum nominal thickness of 60 mm with an 8 percent tolerance, according to SNI 03-0691-1996. Table 1 summarizes and describes the following discussion. Each % of the experiment is carried out on ten test objects in this exam, resulting in a total of 90 test objects.

Table 1. Dimension Test Results

Presentase	Measurement Results	Information
	(mm)	
0.60%	61.8	Satisfy
0.80%	61.1	Satisfy
1.00%	61.4	Satisfy
1.20%	60.3	Satisfy
1.40%	60.7	Satisfy
1.60%	60.5	Satisfy
1.80%	61.3	Satisfy
2.00%	60.9	Satisfy
2.20%	61.4	Satisfy

(Source: Dimension Test Results)

The following are the results:

- i. Testing the Dimensions of Concrete Brick (Paving Block) with the percentage of cocopeat mixture of 0.6%, the results obtained are 6.8 mm, so that it meets the applicable requirements of SNI 03-0691-1996.
- ii. Testing the Dimensions of Concrete Brick (Paving Block) with the percentage of cocopeat mixture of 0.8%, the results obtained are 61.1 mm, so that it meets the applicable requirements of SNI 03-0691-1996.
- iii. Testing the Dimensions of Concrete Brick (Paving Block) with the percentage of cocopeat mixture of 1.0%, the results obtained are 61.4 mm, so that it meets the applicable requirements of SNI 03-0691-1996.
- iv. Testing the Dimensions of Concrete Brick (Paving Block) with the percentage of cocopeat mixture of 1.2%, the results obtained are 60.3 mm, so that it meets the applicable requirements of SNI 03-0691-1996.

- v. Testing the Dimensions of Concrete Brick (Paving Block) with the percentage of cocopeat mixture of 1.4%, the results obtained are 60.7 mm, so that it meets the applicable requirements of SNI 03-0691-1996.
- vi. Testing the Dimensions of Concrete Brick (Paving Block) with the percentage of cocopeat mixture of 1.6%, the results obtained are 60.5 mm, so that it meets the applicable requirements of SNI 03-0691-1996.
- vii. Testing the Dimensions of Concrete Brick (Paving Block) with the percentage of cocopeat mixture of 1.8%, the results obtained are 61.3 mm, so that it meets the applicable requirements of SNI 03-0691-1996.
- viii. Testing the Dimensions of Concrete Brick (Paving Block) with the percentage of cocopeat mixture of 2.0%, the results obtained are 60.9 mm, so that it meets the applicable requirements of SNI 03-0691-1996.
- ix. Testing the Dimensions of Concrete Brick (Paving Block) with the percentage of cocopeat mixture of 2.2%, the results obtained are 61.4 mm, so that it meets the applicable requirements of SNI 03-0691-1996.

So, in the table above it can be concluded that all the percentages of experiments resulted in dimensional tests that all met.

c) Discussion of Compressive Strength Test of Concrete Brick (Paving Block)

In SNI 03-0691-1996, the compressive strength of concrete bricks (paving blocks) is tested using a cube with a total of 10 test items. The compressive strength of ten specimens was investigated in this investigation at various percentages of coconut fiber replacement (cocopeat). This compressive strength test necessitates the use of a total of 90 test items in order to obtain the following results:

- i. The results of testing the compressive strength of concrete bricks (Paving Block) with 0.6% Cocopeat substitution on 10 test objects, the highest compressive strength results were 18.49 MPa on test object number 6.
- ii. The results of testing the compressive strength of concrete bricks (Paving Block) with 0.8% Cocopeat substitution on 10 test objects, the highest compressive strength results were 18.25 MPa on test object number 9.
- iii. The results of testing the compressive strength of concrete bricks (Paving Block) with 1.0% Cocopeat substitution on 10 test objects, the highest compressive strength results were 17.07 MPa on test object number 9.
- iv. The results of testing the compressive strength of concrete bricks (Paving Block) with 1.2% Cocopeat substitution on 10 test objects, the highest compressive strength results were 15.43 MPa on test object number 2.
- v. The results of testing the compressive strength of concrete bricks (Paving Block) with 1.4% Cocopeat substitution on 10 test objects, the highest compressive strength results were 14.97 MPa on test object number 1.
- vi. The results of testing the compressive strength of concrete bricks (Paving Block) with 1.6% Cocopeat substitution on 10 test objects, the highest compressive strength results were 14.08 MPa on test object number 5.
- vii. The results of testing the compressive strength of concrete bricks (Paving Block) with 1.8% Cocopeat substitution on 10 test objects, the highest compressive strength results were 13.87 MPa on test object number 4.
- viii. The results of testing the compressive strength of concrete bricks (Paving Block) with 2.0% Cocopeat substitution on 10 test objects, the highest compressive strength results were 14.74 MPa on test object number 5.

- ix. The results of testing the compressive strength of concrete bricks (Paving Block) with 2.2% Cocopeat substitution on 10 test objects, the highest compressive strength results were 11.81 MPa on test object number 9.

Table 2. Compressive Strength Test Results

No.	0.6%	0.8%	1.0%	1.2%	1.4%	1.6%	1.8%	2.0%	2.2%
	MPa								
1	14.25	10.15	12.35	14.59	14.97	12.73	12.25	12.88	10.78
2	15.50	11.72	11.38	15.43	13.72	13.31	11.80	13.33	11.45
3	16.20	12.76	14.06	14.89	14.08	12.70	12.50	11.65	9.73
4	12.35	13.91	13.81	13.50	14.03	13.61	13.87	12.80	10.60
5	13.21	12.37	10.25	14.39	14.54	14.08	13.23	14.74	8.97
6	18.49	14.80	12.60	14.84	13.75	12.50	12.67	12.75	11.31
7	14.48	12.30	13.90	15.11	13.76	13.34	12.97	13.68	9.77
8	10.15	14.80	15.99	14.96	14.65	11.67	10.77	14.66	10.34
9	15.40	18.25	17.07	15.31	13.65	13.72	11.56	11.73	11.81
10	17.11	14.55	16.20	14.35	14.19	13.19	12.67	13.97	8.54
Rata-rata	14.71	13.56	13.76	14.74	14.13	13.08	12.43	13.22	10.33

Source: Compressive Strength Test Results

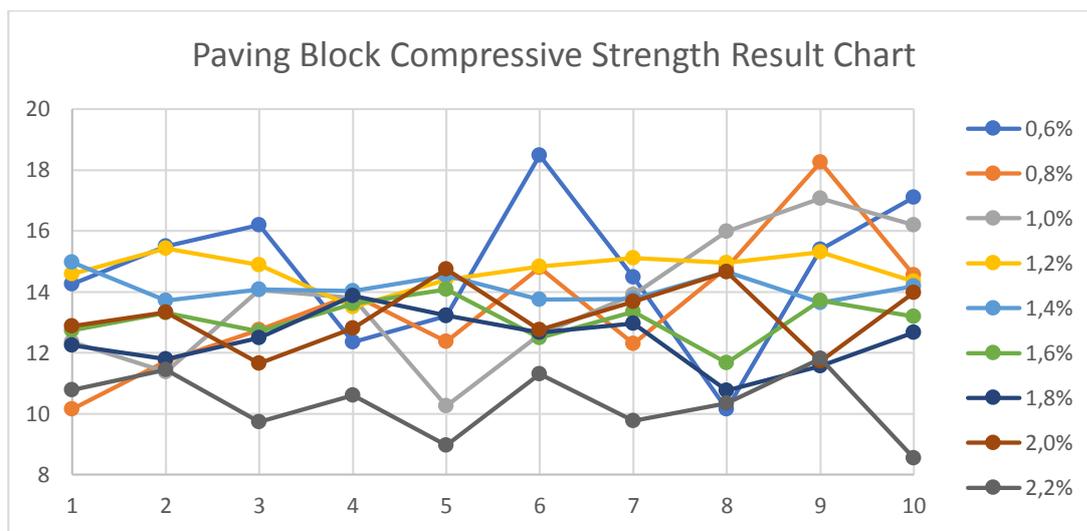


Figure 2. Paving Block Compressive Strength Result Chart

Source: Compression Test Accumulation

In table 2 shows the results of the compressive strength test of each percentage of the experiment and in Figure 2 there is a graph that is known as a comparison of each percentage of the experiment.

4. Conclusion

It can be concluded as follows, based on the results of research and data analysis on the compressive strength of concrete paving block substitution of coconut fiber (Cocopeat) with percentages of 0.6 %, 0.8 %, 1 %, 1.2 %, 1.4 %, 1.6 %, 1.8 %, 2 %, and 2.2 %:

- a) The test results show that the concrete brick (Paving Block) with the substitution of coco fiber (Cocopeat) has an even appearance, there are no holes and there are no hair cracks in accordance with the provisions of SNI 03-0691-1996.

- b) The results of dimension testing on concrete bricks (Paving Block) with coconut husk substitution (Cocopeat) 0.6% are 61.6mm, 0.8% are 61.1 mm and 1% are 61.4mm, 1.2% are 60.3 mm, 1.4% i.e. 60.7 mm, 1.6% i.e. 60.5 mm, 1.8% i.e. 61.3mm, 2% i.e. 60.9 mm, and 2.2% i.e. 61.4 had the appropriate thickness with the provisions in SNI 03-0691 1996, namely 60 mm with a tolerance of 8%.
- c) The results of the tests carried out in the Materials laboratory obtained the average compressive strength with the substitution of coconut coir fiber (Cocopeat) 0.6% of 14.71 MPa, 0.8% of 13.56 MPa, 1.0% of 13.76 MPa, 1.2% of 14.73 MPa, 1.4% of 14.13 MPa, 1.6% of 13.08 MPa, 1.8% of 12.45 MPa, 2.0% of 13.22 MPa, 2.2% of 10.33 MPa. The conclusion from the test results has an average grade C quality that can be used for pedestrians.

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