

WHITE LAND BRICKS COCONUT FIBER AS ALTERNATIVE BUILDING MATERIALS IN KUPANG NTT

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ABSTRACT

Kupang Regency, NTT is an area that has the potential for white soil and abundant coconut husk waste. The white soil of Kupang has a textured physical character, contains sand and coral floss and a little clay and has adhesiveness when water is added. Meanwhile, coconut coir is a natural fiber which is coconut fruit waste. Natural fibers such as coconut coir, apart from being able to lighten the weight of the bricks, are also expected to strengthen the bricks. In certain compositions, coco fiber can be used as an added material in brick making because it reduces cracking. (Mulyono 2004). The research method used is experimental research methods. The results of the measurement of the compressive strength of bricks added with coconut coir fiber, with a ratio of 1 coconut fiber: 1 cement: 7 white soil reached 147 kg / cm², this is much higher than previous studies using 1 cement: 7 white soil reaching 51.9 kg. / cm² and smaller than white earth bricks mixed with rice husks which reaches 83.7 kg / cm² (Bebhe, 2020). In addition, in the compressive strength test, the bricks with a mixture of coconut fiber after the test did not experience total destruction but only cracked on the edges of the brick.

Keywords: White earth brick, cement. coconut fiber, compressive strength, strong shattering

INTRODUCTION

The Kupang area, which is located on Timor Island, NTT Province, is a unique area because the soil is calcareous soil or in the local language referred to as white soil. Kupang white soil is used by local people as fill material and additional material in making bricks. Meanwhile, coconut coir is a waste material that is easily found in the coconut stripping area. Utilization of white soil in the manufacture of solid bricks is a new thing that researchers have done, because the people of Kupang only know bricks and bricks as wall materials. In addition to making white clay bricks, researchers are also interested in adding coconut fiber as a natural fiber to increase the strength of this brick.

Coconut coir itself, is durable, ductile, strong against friction, strong against fracture, waterproof, does not rot (Elhusna, Suwandi, 2012). Coconut coir fiber is used as an added material in the manufacture of this white clay brick because of its properties that can reduce cracks (Mulyono 2004) and can strengthen and lighten the weight of the brick.

In this study, it is hoped that there will be variants of solid white soil bricks and their respective characters will be observed, both in terms of weight and strength. Temporary suspicion, coconut coir fiber white soil brick has a weight and compressive strength that meet the requirements to be used as building materials. In this study, its strength is expected to meet SNI 03-0349-1989.

Based on the background above, the formulation of the problem is; (1) Is there any effect of adding coco fiber in white soil brick on its weight and compressive strength?, (2) Does the coconut coir fiber white earth brick meet the standards of SNI 03-0349-1989.

The objectives to be achieved in this research are (1) To get new alternative wall materials that come from the surrounding environment and are easy to work with. (2) To determine the effect of adding coconut coir fiber to the brick on its weight and compressive strength. (3) To find out whether the coconut coir fiber white soil brick has properties and strength that meet the standards for use in construction according to the demands of the SNI 03-0349-1989 standard requirements.

And then, the benefits of research are (1) Can be input for the community, contractors and architects to take advantage of the wealth of white soil and coconut husks to be used as wall materials. (2) Be an input for students, especially students of Architecture and Civil Engineering regarding the utilization of the natural potential of white soil and coconut coir waste as building materials.

In this research on white soil bricks, the community can be invited to make their own building materials from local natural potential, namely coconut fiber white soil bricks, with easy manufacturing steps, using simple technology but producing bricks with accountable strength.

THEORETICAL FRAMEWORK

A. Kupang White Land Character

Kupang white soil has a physical character. Textured, contains sand and coral grit and a little clay, has adhesion when added to water, has a yellowish white color and is slightly brownish depending on the content of its constituent elements. ± 30 cm or more (Bebhe, 2018)

B. Character of Coir Fiber

Coconut coir fiber is a natural fiber that comes from coconut waste. Utilization of coco fiber has a very real effect on decreasing water absorption and increasing the compressive strength of concrete (Pendung, 2017). The compressive strength of concrete bricks increases and cracks decreases, due to the strength of coconut coir fibers added to the bricks (Zulkifli, and Asward 2013). According to Dr Rilya Rumbayan, ST, M.Eng (Rumbayan, 2017) from Manado Polytechnic, "Coconut coir contains the dominant chemical composition of cellulose, hemicellulose and lignin. Coconut coir lignin content is higher than other natural fibers. The high lignin content causes coconut fiber to be less brittle, the bond becomes weaker and more ductile. Dr. Rilya Rumbayan ST. M.Eng explained, from a technical point of view, coconut coir has beneficial properties, including being 15-30 cm long, resistant to micro-organisms attack, weathering and mechanical work (rubbing and hitting) and being lighter than other fibers. Coconut coir fiber also has ductile properties, can absorb water, and has a good level of durability if it is not directly related to the weather (Mulyono, 2004). In certain compositions of coco fiber in the research of Dr. Rilya Rumangun, ST. M.Eng can be used as an additional material in the manufacture of concrete bricks (brick). In addition, this brick made of coco fiber has the advantage of being more economical and lighter.

C. Suitable Soil Particle Size For Brick

Good soil for wall materials is soil that has good gradations with grain sizes of 0 - 20 mm. As much as possible the soil should contain sand and gravel, where these components function as fillers that can strengthen the wall material because it will become more stable” (Nande M. M and Lasino in Bebbe, 2018)).

To find out which soil raw materials are suitable for certain uses, based on the distribution of grains suitable for certain types of building materials, you can use the Winkler Triangle Diagram (Suripto, in Bebbe, 2018). Based on the minimum number of granular fractions for various building material products are as follows:

Table 1: Soil grain fraction for various products

Grain Fraction	Product Type				
	Solid brick			Roof tile	
< 2 , min %	20	24	28	25	30
< 20, min %	50	59	60	45	50

D. Moisture Content or Soil Plasticity

Plasticity Limit (PL) is a condition that indicates a certain amount of water added, where the white soil mass cannot maintain its shape after being subjected to pressure. While the Liquid Limit (LL) is a condition where the white soil cannot hold its plasticity because it has started to melt. Plasticity Index (IP) is the difference in water content between the liquid limit and the plastic limit (from the Atterberg experiment). (Suripto in Bebbe, 2018) . The Plastic Index which shows the plasticity of a soil is as follows:

Table 2: Plasticity Index and Soil Plasticity Sifat

Plasticity Index	Plasticity Properties
< 10 %	not plastic
10 – 20 %	a bit plastic
20 – 30 %	plastic
> 30 %	very plastic

For testing the allowable liquid limit is less than 40% (Bebbe, 2018). In this study, it will be seen how big the plasticity is.

E. Brick Making Equipment

a. Sieve

Sieve using a sieving machine (Shieve Shaker) or manually. The white soil and rice husk ash to be sifted are put into the test sieve arrangement, then locked so that it does not come off. The sieve machine is driven by turning the crank clockwise and the sieving time is as needed. The arrangement of the sieves with a hole diameter of 0.15; 0.3; 0.6; 1.18; 2.36; 4.75; and 9.5mm. In this study, adapted to the sieve facilities in the field, namely a manual sieve with a

sieve diameter of 5 mm. With this sieve, it is hoped that the grains of soil and rice husk ash of various sizes can pass through the sieve.

b. Weighers/Measuring

Weighing or measuring, can use weighing tools such as: (1) Scales brand Fleet with a capacity of 25 kg and 0.1 kg accuracy. (2) O'HAUS brand scales with a capacity of 2610 gr with an accuracy of 0.1 gr. Apart from that, it is also possible to measure using tools such as measuring cups, buckets, shovels, etc., which are adjusted to the facilities that allow in the field.

c. Printing Equipment

The shape of the printing equipment determines the shape of the brick. In this research proposal, using a manual printing tool used to print red bricks. Printing equipment uses boards to produce bricks with a size of 11cmx24cmx6cm.

F. Requirements for compressive strength of bricks

The compressive strength test is carried out to see how much the compressive strength of each brick is and using a compressive strength measuring machine complete with a compressive strength indicator.

Table 3. Physical Requirements of Concrete Brick

Physical requirements	Unit	Quality			
		I	II	III	IV
Gross compressive strength	Kg/cm ²	90	65	35	21

Source: SNI 03-0349-1989

METHODS

A. Place and Time of Research

The research was conducted in Kupang, NTT. The brick-making test was carried out at the brick-making site on Jln San Juan Penfui, while the brick-making material test and the brick-lab test were carried out at the Materials Testing Laboratory of the Department of Public Works, NTT Province. Research time Jan-July 2020

B. Researched material

1. The basic ingredients for making bricks are white soil, cement, and coconut fiber
2. The experimental result brick is the white soil brick of coconut coir fiber.

C. Research Method

The method used is the Experimental Method. The research was conducted by experimenting with making bricks, namely white soil bricks with coconut fiber.

D. Research Stages

- a. Examining the content of brick-forming materials, namely white soil (TP), rice husk ash and coconut fiber. The test is carried out to test the feasibility of whether this material is suitable for use as a brick-forming material or not.
- b. Brick making experiment with mixed ratio variations, namely 1PC:7TP; 1PC: 7TP:1 SSK; and 1PC:7TP:2 SSK (PC=Portland cement/cement, TP= Tanah Putih and

SSK=Coconut fiber). The coconut coir fiber white soil brick experiment has 3 variations in the mixture ratio.

- c. Observing the physical properties (shape, color, weight), and testing the compressive strength of all bricks at the age of 28 days.
- d. Analyzing the results of the compressive strength test for use in construction, according to the requirements of SNI 03-0349-1989, for compressive strength and thickness measurements.

E. Design of Test Objects and Formula for Compressive Strength

Mixed and Test object comparison plan

Table 4: Mixed Comparison Plan

	BATA	PC	TP	SSK	Total
1	BTPSSK0	1	7		5
2	BTPSSK1	1	7	1	5
3	BTPSSK2	1	7	1,5	5

Note: TP = Tanah Putih/White Land

PC = Portland Cement

SSK = Coconut coir fiber

BTPSSK=Cococo fiber white earth brick

Compressive Strength Test Formula

Compressive Strength = F/A ,

Where, F = crushing load (kg)

A = Area of compression (cm²)

F. Data Collection Techniques.

After the experimental results have been made and tested, data can be collected about the physical shape, weight, other properties including compressive strength. In general, the data collection techniques; (1) Record the results of observations and measurements on experimental bricks so that they can be analyzed for their quality and use in buildings, (2) Documentation of the working process, physical form and the compressive strength test process.

G. Method of Quality Analysis of Experimental Brick

Using concrete brick requirements based on SNI 03-0349-1989

Table 5. Physical Requirements of Concrete Brick

No	Quality	Compressive strength kg/cm2	Experimental brick
1	I	90	
2	II	65	
3	III	35	
4	IV	21	

Source: SNI 03-0349-1989

H. Usage Analysis Methods in buildings

1. Using the requirements for Blocking (Heinz Frick, LMF. Purwanto, 1997) and based on SNI 03-0349-1989

Table 6: Analysis of the use of bricks based on the terms of compressive strength

Type of Construction	Minimum compressive strength	Brick used
Loaded and unprotected construction	66,30 kg/cm ²	
Loaded and shielded construction	45,90 kg/cm ²	
Unencumbered and unshielded construction	30,60 kg/cm ²	
Unencumbered and shielded construction	17,34 kg/cm ²	

2. Using brick thickness requirements (DK. Ching, Adam CF, 2008)

Table 7: Analysis of the use of bricks based on thickness

Type of wall	Thickness	Brick used
Non-supporting interior walls	12 cm - 20,5 cm	
Single-story retaining wall up to 3.66	15 cm - 30,5 cm	
The walls of the first and second floors of a two-story building	45.5 cm for the 1st floor and 30.5 cm for the 2nd floor	

DISCUSSION

1. Brick-forming material test

White Soil Material Test

Tests on white earth material in the Lab, obtained the following data:

Table 8 : Kupang white soil test data

No	Kind of Test	Result Test	Terms
1	Consistency of granular shape	No crack	
3	Binding time x 24 hours	3 x 24 hours	
4	Average density	2,626 gr/cm ³	
5	Compressive strength,.....kg/cm ² a.) 7 days old,..... b. Age > 7 days,.....	13,04 kg/cm ²	
6	Grains retained on the sieve: > 2,00 cm 2,00 cm – 0,850 mm 0,850 – 0,425 mm 0,250 – 0,150 mm > 0,075 mm	5% 10% 1% 3,5 % 3,0%	

Source: Lab examination results

Based on research data, Kupang white soil or lime contains coral sand grains between 30-65%. Sand on the white soil of Kupang is a reinforcing material for brick making. The binding time and its compressive strength are sufficient to meet the requirements as a building material.

2. Brick Making Experiment

Equipment Setup

The equipment used in this research include: (a) A simple sieve with a diameter of 3 mm, for sifting white/lime soil with too large a grain size.(b) Iron brush to brush the coconut coir into a coconut coir fiber. Brushing is assisted by hand power to shred the coir.(c) Scales, measuring cups, shovels for measuring, bats for beating white soil that are still in large sizes, buckets, carts for transporting dough (d). A wood mold that can produce 7 bricks with a size of 5x23x11 cm

Figure 1 Brick mold



Preparation of Compiling Materials

- The white soil is transported from the quarry to the workshop. This white soil is then spread to reduce its moisture and break up the sand in the large white soil. After drying, this material is sieved with a 3 mm diameter sieve.
- The coconut coir is torn and then combed using an iron brush, then shredded again, so that it becomes coconut coir fiber.
- The Kupang cement used is Type 2 Cement which is available in building material shops



Figure 2: White Soil, Cement, Coconut fiber

1. Mix ratio

In the experiments carried out, using 3 different types of mixture ratios to see the comparison of their strengths. The comparison is, as follows;

Table 9: Comparison of the mixture used

No	BATA	PC	TP	SSK	Total
1	BTPSSK0	1	7		5
2	BTPSSK1	1	7	1	5
3	BTPSSK2	1	7	1,5	5

The materials/materials that have been prepared, namely white soil, must be measured according to the comparison plan that has been made. All ingredients, except water, are mixed evenly to make a homogeneous mixture using a shovel and hands. After mixed evenly, add clean water until it thickens

Brick Dough Printing

- The materials/materials that have been prepared, namely white soil, coconut fiber and cement are measured according to the comparison plan that has been made. All ingredients, except water and coconut fiber, are mixed evenly to make a homogeneous mixture using a shovel and hands. After mixed evenly, add clean water until it thickens
- Next, the molded mall is placed on top of the cement sack made of sacks. The dough is poured into the molded mall, while interspersed with coconut coir fibers which are placed alternately. The pouring must be pressed, so that the density is the same. In one print can produce 3 bricks. After pressing, and compacted by hand the dough is flattened. Once leveled, the mall is lifted very carefully.
- After being printed, the bricks are placed on the floor that has been covered with sacks. Between the bricks are given a space of 2-5 cm. These bricks are placed under the roof without walls. The drying process is only from wind and ambient temperature. In this experiment the bricks were ripened for 28 days.

Physical Form and Compressive Strength Test of Bricks

1. Shape, Size and color

The experimental bricks are rectangular in shape, with a size of 5x11x23 cm. The experimental bricks are light gray to dark gray. Brick made from a mixture of white soil and cement, is lighter in color than the one added with rice husk ash. The outer texture of the brick is quite smooth, while the texture of the shards on the inside is rough.



Figure 3: Experimental bricks



Figure 4: Cross-section of the face and side of the brick

2. Measurement of Brick Weight and Compressive Strength

The compressive strength test of bricks was carried out after 28 days of age. Tests in the lab get data on weight and compressive strength which are quite varied, as follows:

Table 10: Compressive strength measurement results at the age of 28 days

No	Test object	Weight (gr)	Compressive strength Kg/cm ²
1	BTPSSK01	2600	44,3
2	BTPSSK02	2600	41,5
3	BTPSSK03	2590	33,9
4	BTPSSK04	2570	51,9
5	BTPSSK05	2630	39,5
6	BTPSSK11	2286	121
7	BTPSSK12	2251	139,6
8	BTPSSK13	2240	147
9	BTPSSK14	2251	135,2
10	BTPSSK15	2255	139,6
11	BTPSSK21	2254	89,9
12	BTPSSK22	2172	109,7
13	BTPSSK23	2138	84,6
14	BTPSSK24	2254	90
15	BTPSSK25	2213	105,7

Description:

BTSSK0=1PC :7TP

BTPSSK!= 1PC : 7TP : 1SSK

BTPSSK2= 1PC:7TP:1.5 SSK

PC: Portland cement/cement

TP: White Land

SSK: Coconut Coir Fiber

Discussion of Compressive Strength Test Results of Brick

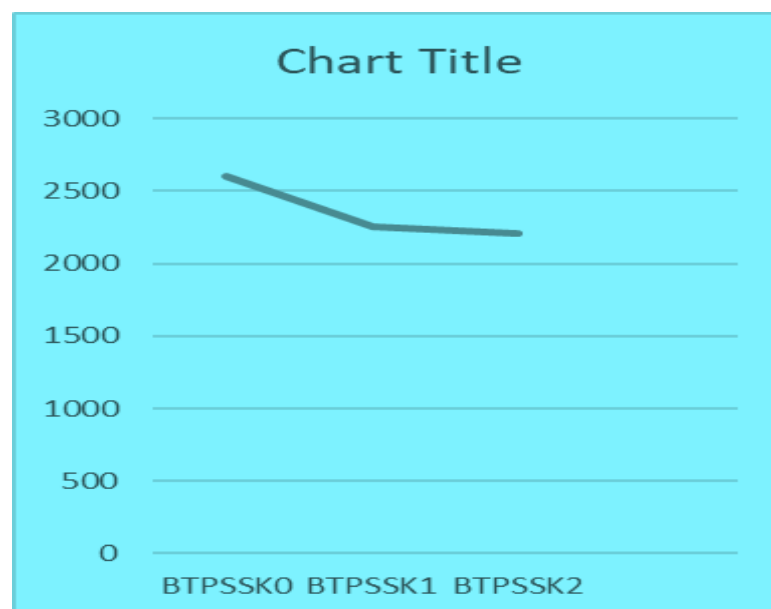


Figure 5 Compressive strength test

From the results of the measurement of weight and compressive strength, several things were obtained:

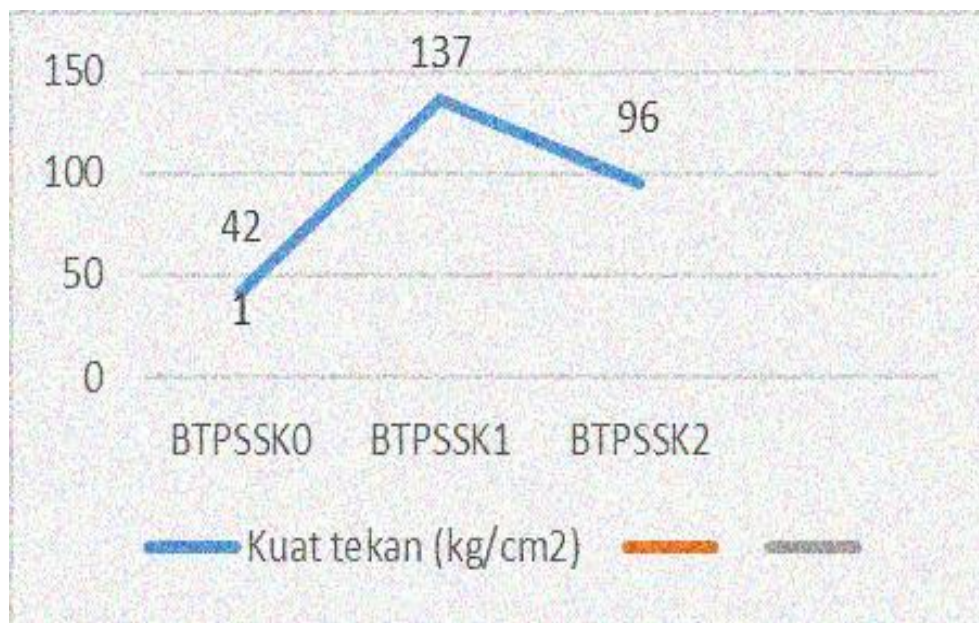
- a. BTPSSK0 brick weighs at the age of 28 days on average 2600 grams, and in this case is heavier than BTPSSK1 brick 2257 grams, BTPSSK2 brick 2208 grams. In this case, it means that the addition of coconut coir fiber lightens the brick weight.

Diagram 1: Average weight of bricks aged 28 days



- b. The compressive strength of bricks made of white soil and cement at the age of 28 days, 1PC:7TP or BTPSSK0 is an average of 42.22 Kg/cm² smaller than BTPSSK1 136.5 Kg/cm² and BTPSSK2 96 Kg/cm²

Diagram2: average compressive strength of 28 days old



- c. After the compressive strength test was carried out, the white soil brick with a mixture of cement alone (BTPSSK0) was destroyed, while the brick with the addition of coconut fiber (BTPSSK1 and BTPSSK2) only cracked.



Figure 5: BTPSSK0 after being tested for compressive strength. Looks broken



Figure 6: BTPSSK1 and BTPSSK2 which only had cracks after the compressive strength test

Recommended Use of Brick in Buildings

1. Analysis of the use of bricks based on the compressive strength requirements
According to SNI 03-0349-1989, the test results brick which is 28 days old, turns out to be in the category of quality I brick where the quality I requirements are 90kg/cm. cm², which uses coconut fiber, namely BTPSSK1 136.5 Kg/cm² and BTPSSK2 96 Kg/cm²

Table 11 : Analysis of the use of bricks in construction based on the requirements of the compressive strength of the blocks

	Type of Construction	The minimum compressive strength required	the brick used
1	loaded and unprotected bearing walls.	6,5 N/mm ² atau 66,30 kg/cm ²	BTPSSK 1 and BTPSSK2 bricks are used
2	loaded and shielded constructions	4,5 N/mm ² atau 45,90 kg/cm ²	BTPSSK1 and BTPSSK2 bricks can be used.
3	unencumbered and unshielded construction.	3,0 N/mm ² atau 30,60 kg/cm ²	All test bricks can be used
4	unencumbered and shielded construction	1,7 N/mm ² atau 17,34 kg/cm ²	All bricks can be used

2. Analysis of the use of bricks based on the requirements for thickness and properties of white soil bricks.

Type of wall	Minimum thickness requirement	Test brick used
Non-supporting interior walls	Minimum 12 cm, 8" or 20,5 cm	Semua bata bisa dipakai dengan pemasangan sistem ½ bata
One-story retaining wall up to 12" (3.66 m) high	Minimum 15,0 cm and maximum 12" atau 30,5 cm	All bricks can be used with brick system installation
The walls of the first and second floors of a two-story building	18" or 45.5 cm for the 1st floor and 12" or 30.5 cm for the 2nd floor.	All bricks can be used. On the 1st and 2nd floors using a brick system, the important thing is to pay attention to the max wall distance. 300 cm.

Table 12: Table of analysis of the use of bricks based on wall thickness requirements

CONCLUSION

1. The addition of coconut coir fiber lightens the weight of the bricks. The weight of white earth bricks mixed with 1PC Cement: 7TP or BTPSSK0 aged 28 days on average 2600 gr, while BTPSSK1 2257 gr and BTPSSK2 2208 gr
2. The compressive strength of bricks at the age of 28 days, bricks with the addition of coconut fiber are stronger than those without coconut fiber added. compressive strength results. BTPSSK0 (without fiber) compressive strength, 42.2 Kg/cm², BTPSSK1 136.5 Kg/cm² and BTPSSK2 96 Kg/cm².
3. BTPSSK bricks have sufficient strength to be used in construction, namely construction that is loaded for BTPSSK1 and BTPSSK2 bricks and construction with supports/reinforcements can use all bricks
4. Based on the results of research, Kupang White Land contains 30-65% coral sand, so that when used as a brick, there is no need to add sand
5. From the results of the compressive strength test, the bricks with fiber content (BTPSSK1 and BTPSSK2) did not experience total destruction, because the coconut fiber fibers make these bricks breakable.
6. White soil brick is a material that has sustainable properties because it is environmentally friendly, the production process and its use use simple technology and can be done by the community.

SPECIAL THANKS TO

Thanks are conveyed to the 2018 Unwira Architecture Students who have worked on making this brick. There are brick variants, namely: Brick with the addition of coconut fiber and brick with the addition of rice husk ash. Thank you also to the Head of the Material Testing Laboratory of the NTT Provincial Public Works Office for allowing researchers to conduct tests in the Lab.

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