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Experimental Study of The Addition of Palm Fiber (Arenga Pinnata) as Fiber Against The Compressive Strength of Pozzolan Bricks

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Abstract. Brick is a building material widely used as a construction material for walls and fences, one of which uses Pozzolan brick. Pozzolan brick is made from Trass, lime, or cement. A local material that can be used as an additional fiber in the mixture of Pozzolan brick making is fibers, because it has been proven that the addition of fibers in concrete can improve its physical and mechanical properties, in addition, the fibers also have a hard rotten nature because there is no decomposer that can decompose them. Thus, it is necessary to investigate the addition of fibers as fiber in Pozzolan bricks. The experimental method was used in this study. The purpose of this study is to find out whether Pozzolan bricks with the addition of a mixture of fibers have better compressive strength and to find out whether they meet the requirements to become bricks according to SNI 15-2094-2000 and PUBI-1982. From the results of research and analysis that has been done regarding the addition of fiber fibers (Arenga pinnata) as a fiber to the compressive strength of pozzolan bricks, it is found that the compressive strength of pozzolan is 4.99 Mpa with a porosity value of 3.24%, thus pozzolan bricks can provide economic value for the wider community. Based on the compressive strength and porosity, pozzolan bricks also meet the requirements to become bricks according to SNI 15-2094-2000 and PUBI-1982 in grade III.

Keywords: *Pozzolan Brick, Thatch Fiber, Press Strength, Porosity*

INTRODUCTION

The very high rate of population growth results in a high need for residential facilities. The further development of residential areas and the development of industrial areas have also spurred the increasing need for building materials. Such materials should be provided in large quantities from natural as well as artificial sources. The increasing demand will also increase its price. One of the building materials that are often used is bricks which function as a material for wall construction. The bricks used are like *Pozzolan bricks*. When natural pozzolans containing active silica are mixed with lime extinguished, a cementation process will occur [1]. With the advancement of technology, many ways are used to make bricks more efficient in terms of the cost, strength, and weight of the bricks themselves.

In Indonesia, many local ingredients can be used as an additive to the *Pozzolan* brick-making mixture, one of which is by using palm fiber as fiber. The addition of coax fibers in concrete mortar can increase tensile strength, and bending strength and the resulting concrete is lighter Palm fibers are also proven to improve their physical and mechanical properties [2]. The choice of Palm fiber as a fiber is because the material is easy to obtain, durable, and has a relatively cheap price. Palm fiber is a natural fiber at the base of Palm fronds (Arenga pinnata) which has sufficient tensile ability that it is expected to reduce wall cracks due to loads, Palm fiber fibers prove that light bricks do not experience shock fractures when given weights [3]. Palm fiber has the advantage of being resistant to acidic liquid including salt-containing seawater and slowing weathering and preventing termites [4]. Palm fiber as an added material seen from its availability is easy to obtain and has economic value, so the addition of palm fiber in making bricks does not have much effect on the production cost [5].

The addition of palm fiber greatly affects the tensile strength of the brick itself, the tensile strength will increase if it is at the smallest percentage [6]. The most important characteristic of palm fiber is if the fiber can be optimized for its use as a composite reinforcement [7]. The addition of palm fiber greatly affects the value of the tensile strength of the split brick itself, the tensile strength will increase if it is at the smallest percentage [8]. In contrast to the above, other studies [9] revealed that with the addition of a large fiber, the compressive strength is also greater. In contrast to the results of previous research regarding the addition of mixed fiber fibers to determine the compressive strength of red bricks, there is a tendency to decrease the compressive strength with the addition of fibers [10]. While in paving blocks the addition of fiber fibers to cement paving blocks does not meet the requirements for strength, compressive strength, flexural strength, and water absorption [11]. The results of other studies showed that the addition of fibers to concrete bricks cannot be used as an added material in their manufacture, and cannot produce BBK 10 class quality according to SNI 03-1570-1989 [12]. Based on the description above, it is necessary to investigate the addition of palm fiber to pozzolan bricks to find out and prove its compressive strength and it is hoped that the addition of palm fiber can also improve the quality of pozzolan bricks. In addition, this additional material is also very abundant in Indonesia.

METHODOLOGY

The experimental method was used in this study. The purpose of this method is to investigate the presence or absence of causation by giving a certain treatment to an object [13]. The research sample to be made is listed in the table below.

TABLE 1. Pozzolan brick research samples

No.	Number of Samples	Sample Size	Percent (%) Palm fiber Mix
1.	3 samples	23 cm x 11.5 cm x 5 cm	0.00 against cement volume
2.	3 samples	23 cm x 11.5 cm x 5 cm	0.25 against cement volume
3.	3 samples	23 cm x 11.5 cm x 5 cm	0.50 against cement volume
4.	3 samples	23 cm x 11.5 cm x 5 cm	0.75 against cement volume
5.	3 samples	23 cm x 11.5 cm x 5 cm	1.00 against cement volume
6.	3 samples	23 cm x 11.5 cm x 5 cm	1.25 against cement volume

The materials used in this test are cement, Pozzolan-type trass, water, and palm fiber. Before testing, first, a material inspection was carried out to find out the characteristics of good quality for use in mixed planning and ensure that the materials have met the requirements that have been set. In this study, mixed planning was used based on the volume ratio between cement and trass, which is 1: 2 with a composition of reference every 0.00%, 0.25%, 0.50%, 0.75%, 1.00%, 1.25% to the volume of cement, for example, the volume of cement was calculated in grams of ratio with trass, meaning 1000 grams cement then the trass needed was 2000 grams, while the palm fiber was 0 grams, 2.5 grams, 5 grams, 7.5 grams, 10 grams and 12.5 grams in the planned Pozzolan brick composition. The pozzolan brick mix design can be obtained using the following formula.

$M = p\ x\ V$

Information:

m = Mass of the object (kg)

p = Type period (kg/m^3)

V = Volume of water (m^3)

The density of Portland cement in SNI DT-91-0008-2007 is 1506 kg/m3 while the density of soil trass based on PPUPG 1983 is 1700 kg/m3 and the specific gravity of water is 1000 kg/m3, for the specific gravity of the palm fiber itself in the study [10] is1136 kg/m3. Therefore, the need for trass, cement, water, and palm fiber for Pozzolan brick 0.23 x 0.05 x 0.115 = 0.0013225 m^3 is:

$m = \rho\ trass\ x\ V$

= 1700 kg/m3 x 0.0013225 m3

= 2.24825 kg or 2248.25 gr

$m = \rho\ semen\ x\ V$

= 1506 kg/m3 x 0.0013225 m3

= 1.991685 kg or 1991.69 gr

$m = \rho\ air\ x\ V$

= 1000 kg/m3 x 0.0013225 m3

= 1.3225 kg or 1322.5 gr

The 24 pieces of samples were used in this study, therefore the traffic requirement was 53,958 kg, cement 47. 800 kg and water 31.74 kg. as for the need for the reference are:

addition of palm fiber 0.25% = 1.991685 x 0.25%
= 0.004979 x 24
= 0.119501
addition of palm fiber 0.50% = 1.991685 x 0. 50%
= 0.009958 x 24
= 0.239002 kg
addition of palm fiber 0.75% = 1.991685 x 0.75%
= 0.014938 x 24
= 0.358503 kg
addition of palm fiber 1.00 % = 1.991685 x 1.00%
= 0.019917 x 24
= 0.478004 kg
Addition of palm fiber 1.25% = 1.991685 x 0.75%
= 0.024896 x 24
= 0.597506 kg

The manufacture of test objects is carried out after the results of basic testing of the material are obtained. Curing time is carried out until the life of the pozzolan brick compressive strength test plan reaches a lifespan of 28 days by storing the test object at a humid room temperature. Here are some photos of documentation conducting the test.

FIGURE 1. Palm fiber cleaning process

FIGURE 2. Pozzolan brick molding process.

RESULTS AND DISCUSSION

Trass Quality Analysis

The table below is trass quality testing data

TABLE 2. Trass quality testing

Subtleties of Trass		Testing Time
Sieve Size	Fineness	
Sieve 2.5	Pass 100% (500 g)	1 x 24 hours printed
Sieve 0.21/0.18	Pass 50% (250 g)	

After conducting trass quality testing based on ASTM C 618-78, the trass quality was obtained, namely with the quality I (one). The smoothness of the soil passed through a sieve of 0.18 mm and can harden within 1 x 24 hours with the ratio of a mixture of lime and trass being 1:2

Water Absorption Inspection of Palm fiber Mixed Pozzolan Bricks

The results of the examination of the water absorption of pozzolan bricks with a mixture of palm fibers are as follows.

$$\text{Porosity } (0{,}00\%) = \frac{2075{,}6 \times 2053{,}4}{1265} \times \frac{1}{100}\ \% = 3{,}40\ \%$$

$$\text{Porosity } (0{,}25\%) = \frac{2136{,}02 \times 2109{,}4}{1265} \times \frac{1}{100}\ \% = 3{,}56\ \%$$

$$\text{Porosity } (0{,}50\%) = \frac{2027{,}67 \times 2001{,}3}{1265} \times \frac{1}{100}\ \% = 3{,}21\ \%$$

$$\text{Porosity } (0{,}75\%) = \frac{2113{,}93 \times 2095{,}5}{1265} \times \frac{1}{100}\ \% = 3{,}50\ \%$$

$$\text{Porosity } (1{,}00\%) = \frac{2065{,}09 \times 2045{,}2}{1265} \times \frac{1}{100}\ \% = 3{,}35\ \%$$

$$\text{Porosity } (1{,}25\%) = \frac{2171{,}78 \times 2092{,}4}{1265} \times \frac{1}{100}\ \% = 3{,}59\ \%$$

Pozzolan Brick Weight Inspection for Compressive Strength of Bricks

The table below is an examination of the weight of the Pozzolan brick after 28 days and is ready to be tested for compressive strength.

TABLE 3. Weight pozzolan brick

No.	Kind	Sample	Dimension Sample (cm)	Weight (gr)	Average (gr)
1.	Pozzolan Brick 0%	I	23 x 11.5 x 5	2373	
		II	23 x 11.5 x 5	2336	2339.67
		III	23 x 11.5 x 5	2310	
2.	Pozzolan Brick 0.25%	I	23 x 11.5 x 5	2326	
		II	23 x 11.5 x 5	2278	2303.67
		III	23 x 11.5 x 5	2307	
3.	Pozzolan Brick 0.50%	I	23 x 11.5 x 5	2306	
		II	23 x 11.5 x 5	2303	2353.67
		III	23 x 11.5 x 5	2452	
4.	Pozzolan Bricks 0.75%	I	23 x 11.5 x 5	2265	
		II	23 x 11.5 x 5	2436	2338.67
		III	23 x 11.5 x 5	2315	
5.	Pozzolan Brick 1.00%	I	23 x 11.5 x 5	2195	
		II	23 x 11.5 x 5	2282	2223.33
		III	23 x 11.5 x 5	2193	
6.	Pozzolan Brick 1.25%	I	23 x 11.5 x 5	2209	
		II	23 x 11.5 x 5	2210	2183.67
		III	23 x 11.5 x 5	2132	

Pozzolan Brick Compressive Strength Test Results

After checking the weight of the pozzolan brick, the next thing was to conduct a press test with a compressive strength machine and obtain the following results.

TABLE 4. Compressive strength of pozzolan brick control (0%)

Samples	Maximum Load (kgf)	Cross-Sectional Area (cm^2)	Result (kgf/ cm^2)	Results (MPa)
I	2180	132,25	16,48	1,65
II	6940	132,25	52,44	5, 24
III	5120	132.25	38.74	3,87
Average				3,59

TABLE 5. Compressive strength of pozzolan brick control (0.25%)

Samples	Maximum Load (kgf)	Cross-Sectional Area (cm^2)	Result (kgf/ cm^2)	Results (MPa)
I	5840	132,25	44,12	4,41
II	5450	132,25	41,19	4,12
III	6330	132,25	47,85	4,79
Average				4,44

TABLE 6. Compressive strength of pozzolan brick control (0.50%)

Samples	Maximum Load (kgf)	Cross-Sectional Area (cm^2)	Yield (kgf/ cm^2)	Results (MPa)
I	5330	132,25	40,27	4,03
II	5750	132,25	43,50	4,35
III	4970	132,25	37,61	3,76
Average				4,05

TABLE 7. Compressive strength of pozzolan brick control (0.75%)

Samples	Maximum Load (kgf)	Cross-Sectional Area (cm^2)	Yield (kgf/ cm^2)	Results (MPa)
I	5520	132,25	41.75	4,18
II	5180	132,25	39.16	3,92
III	5410	132,25	40.94	4,09
Average				4,07

TABLE 8. Compressive strength of pozzolan brick control (1.00%)

Samples	Maximum Load (kgf)	Cross-Sectional Area (cm^2)	Yield (kgf/ cm^2)	Results (MPa)
I	6410	132,25	48,48	4,85
II	6980	132,25	52,80	5,28
III	6380	132,25	48,27	4,83
Average				4,99

TABLE 9. Compressive strength of pozzolan brick control (1.25%)

Samples	Maximum Load (kgf)	Cross-Sectional Area (cm^2)	Yield (kgf/ cm^2)	Results (MPa)
I	5100	132,25	38,56	3,86
II	3560	132,25	26,91	2,69
III	4970	132,25	31,37	3,14
Average				3,23

The average compressive strength of all pozzolan bricks with the addition of palm fiber fibers is presented on the graph below.

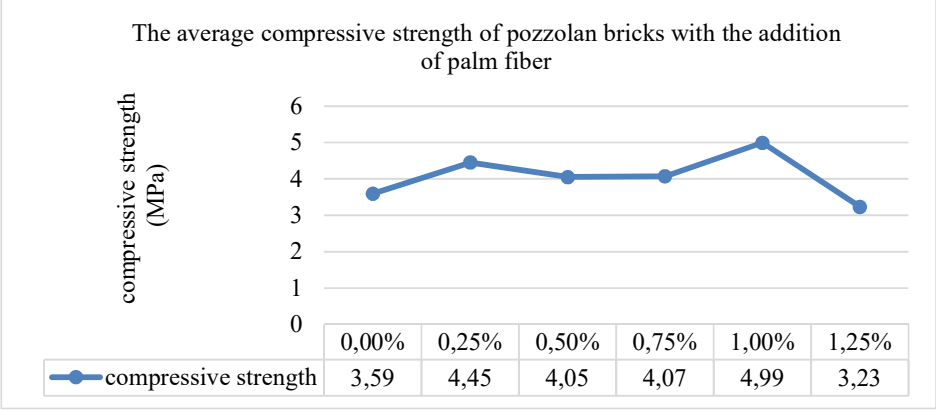

FIGURE 3. Graph of the average compressive strength of pozzolan bricks with the addition of palm fibers

The image below is documentation when conducting a compressive strength test of the pozzolan brick

FIGURE 4. Pozzolan brick compressive strength test process

The pozzolan brick as a test object with the best addition of palm fiber is with the addition of 1.00% palm fiber with an average strength result of 4.99 Mpa. The results of the test show the density of pozzolan bricks greatly affects their compressive strength, therefore in making them, the mixture must be be as dense as possible. According to research [14], the quality of the brick or its compressive strength will increase at the age of 28 days. In line with this, the amount of paste (trass + cement + water) also affects the percentage of water absorption [15], which can be seen with an average porosity value of 3.42% which means that the absorption of water in pozzolan bricks with the addition of this coax fiber is good and can be used because it meets predetermined material requirements.

CONCLUSION

The results of research and analysis on the addition of palm fibers (Arenga pinnata) showed that the compressive strength of pozzolan is 4.99 Mpa with a porosity value of 3.24%, thus pozzolan bricks can provide economic value for the wider community. Based on the compressive strength and porosity, pozzolan bricks also meet the requirements to become bricks according to SNI 15-2094-2000 and PUBI-1982 in grade III.

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