The Effect of Rija-rija Lignocellulose Addition on Compressive Strength and Absorbility of Composite Bricks

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The Effect of Rija-rija Lignocellulose Addition on Compressive Strength and Absorbility of Composite Bricks

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Abstract: - Composite materials have excellent potential for construction and building applications, especially from an environmental and economic perspective. The need to replace hazardous materials with environmentally friendly products is a growing concern worldwide. Composites based on natural fibers have become popular because of their superior sustainable features. Along with various innovations made in the field of materials, natural fibers are being developed again by researchers to be used as composite reinforcement materials. The formation of lignocellulosic using the chlorination method in this stage is used 5% $NaClO_2$ resulting in the formation of white lignocellulose while the addition of distilled water results from the process shows the desired formation of lignocellulose with the formation of fibers, strong tensile strength, colorless. In the process of making bricks, two methods are used, namely the mix and sandwich methods. The success of making lignocellulosic is confirmed through FTIR (Fourier transform infrared) spectroscopy analysis. SEM analysis results show that lignocellulose is in the form of fibers with a size of 50 m. The EDS results showed a C content of 85,265, 78,000 an O content of 11,241, 13,000 EDS spectrum. In the process of making bricks using the sandwich method, they are not homogeneous or even fused. Further research is needed to use this method; apart from using the sandwich method, researchers use a mix, and the results of the bricks obtained are homogeneous or even fused. There is an effect of the addition of lignocellulosic material on the compressive strength of bricks. This is indicated by a decrease in the compressive strength of the bricks with increasing lignocellulosic substitution in the bricks.

Keywords: lignocellulose, compressive strength, hazardous materials, FTIR Fourier transform infrared spectroscopy
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1 Introduction

Cement is one of the world's most consumed binders, with global production reaching 4.1 billion tons in 2016.[1] the amount of cement produced by PT Semen Indonesia (Persero) Tbk. in 2016. The results of cement production in 2016 were 15048 (in thousands of tons).[2]

Bricks are building elements used for walls made of concrete and formed in a certain way and size. Bricks are made by mixing sand and cement with water, then stirring until homogeneous and then molding. In addition to cement and sand, lime can also be added as a brick building material. Lignocellulosic as a filler for brick making is a form of fiber-concrete application used as a non-structural building material. The impetus for applying lignocellulose as a filler for brick making in the manufacture of non-structural building materials is the advantage gained by adding fiber, namely in the form of improving some of the properties of concrete. [3]

Along with the various innovations made in the field of materials, natural fibers are being developed again by researchers to be used as composite reinforcement materials. This is because natural fibers have the advantages of being elastic and strong, abundant in nature, environmentally friendly, and having lower production costs. Natural fibers are fibers that are directly obtained from nature. Natural fibers are produced by animals, plants

and geological processes. Indonesia, as a country with wide biodiversity, has a great opportunity to explore the use of natural fiber as a reinforcement for composite materials.[4]

Composite materials have excellent potential for construction and building applications, especially from an environmental and economic perspective. The need to replace hazardous materials with environmentally friendly products is a growing concern worldwide. Natural fiber-based composites have become popular because of their superior sustainability features.[5]

Lignin shows many advantages, such as abundant functional groups, good biocompatibility, low toxicity, and a high carbon content that can be converted into composites and carbon materials. Lignin-based materials are usually environmentally friendly and low cost, and they are widely used in energy storage, environmental technology, electronic devices, and other fields. In this review article, pre-treated separation methods such as the hydrothermal process are briefly illustrated, and the technical properties and categories of lignin are introduced. Then, the recent advances of lignin-based composites and lignin-derived carbon materials [6]

The strength of composite bricks is affected by the lignin-to-cellulose ratio and its uniform distribution. Lignocellulose in composite bricks is arranged randomly and intermittently. A composite brick is made from lignocellulosic rija-rija, which is treated to obtain higher strength compared to concrete bricks. This is due to fiber treated for all types of composites giving high tensile strength values superior to bricks without fiber rija-rija Fiber treated with alkali helps improve mechanical interlocking and chemical bonding between cement and fiber, resulting in better mechanical properties. superior to rija-rija Lignocellulose has the potential to strengthen the stiffness of composite bricks due to its superior toughness. Furthermore, [7]

The purpose of this review is to collect available data literature on the use of lignocellulosic fibers, especially those from rija-rija grass. This can be used as a guideline for our future research on the utilization of lignocellulosic fibers derived from rija-rija grass into composite bricks.

2 problem formulation

2.1 definition of natural lignocellulose

The concept of biomass was first rooted in ecology but is now increasingly being defined in terms of resource utilization and industrialization. According to the definition of the US national energy safety regulations, "biomass" refers to renewable organic matter, including agricultural products and agricultural waste, wood and wood waste, animal waste, municipal waste, and aquatic plants. [8]

2.2 Rija-Rija (Scleria sumatrensis retz)

The common name of this weed is rijarija or krisan. The characteristics of the rijarija or krisan weed are that it is a chronic grass with sturdy stems, triangular leaves, smooth or slightly rough surfaces, and sharp leaves. The rija-rija/krisan weed thrives in dry areas and swamps.[9]

2.3 lignocellulosic manufacturing process

Grass samples are cut using scissors and washed or cleaned using water to remove dirt on the grass, and then dried in the sun for 7 days after drying. The next step is milled using a grinding machine to make it easier to filter after grinding. The sample must be sieved using a sieve measuring 18 mesh. The brick sample mold (measuring 39 cm long, 10 cm wide and 9 cm high), digital scales, functions to measure the mass of the brick sample material, the tool used to test the compressive strength of brick samples is a test kit Forney's compressive strength; scissors cut grass samples; a grinding machine functions to smooth the weeds; a sieve functions to filter material size; Measuring cup, Sieve functions to filter material, Lignocellulose, cement sand, and water.

2.4 Concrete brick

Adobe is a type of brick-shaped building element made from the main ingredients of Portland cement, water, and aggregate; it is used for wall mounts. Bricks are divided into solid bricks and hollow bricks. Solid bricks are bricks that have a solid cross-section of 75% or more of the total cross-sectional area and a solid volume of more than 75% of the total brick volume. Hollow bricks are bricks that have a hole cross-sectional area of more than 25% of the cross-sectional area of the brick, and the volume of the holes is more than 25% of the total boundary volume. [10]

2.5 brick making materials

2.5.1 Portland cement

Cement is the most widely used binding material in the physical construction of the civil construction sector. Cement is a binder that hardens when it reacts with water and produces water-resistant products. When Portland cement is mixed with water, the constituent chemical compounds undergo a series of chemical reactions that cause it to harden. These chemical reactions all involve the addition of water to basic chemical compounds. This chemical reaction with water is called hydration. Each of these reactions occurs at a different time. Together, the results of these reactions determine how Portland cement hardens and gains strength.[11]

2.5.2 Aggregate

Sand is ubiquitous in construction and industrial production because it is cheap, versatile, and easy to acquire. Yet, all indications are that we are approaching a future where access to this resource is a critical barrier to sustainability and the full costs of uncontrolled sand extraction come due.[12]

2.5.3 Water

Water is needed in brick making to trigger the cement chemical process, wet the aggregate, and provide ease of work. Clean, drinkable water can generally be used as a mixture of bricks. Water containing dangerous compounds that are contaminated with salt, oil, sugar, or other chemicals when used in a mixture of bricks will reduce the quality of the concrete and can even change the properties of the bricks produced.[13]

Table 1. Size and tolerance

Type	Size mm			Minimum hole seal wall thickness	
	long	wide	thick	outside	In
1. Solid	390 + 3-5	90 ± 2	100 ± 2	-	-
2. hollow					
a. small	390 + 3-5	190+3-5	100 ± 2	20	15
b. big	390 + 3-5	190+3-5	200 ± 2	25	25

Source:[14]

Table 2. Composite bricks were made by adding 3% and 6% processed lignocellulosic rija-rija.

Brick	Cement (L)	Sand (L)	Lignocellulose %	water (L)
control	0.702	2.63	0	0.175
Brick 1	0.69	2.6	3	0.174
Brick 2	0.172	0.172	6	0.172

2.6 brick making process

In the process of making bricks, two methods are used, namely the mix and sandwich methods. Provide mixed brick materials, namely cement, sand, and water. The best mixed brick composition is 75% sand, 20% cement, and 5% water. This composition is a standard set by the Ministry of Public Works in 1986. Clean all tools that will be used so that there are no other ingredients that can affect the brick mixture. Mix all the ingredients for the brick mixture that have been measured. Pouring the dough into the mold leveling the surface of the mold. The molds that have been filled with the brick mixture are stored in the curing room for 34 days until the bricks harden.

2.7 Manufacture of test objects

The test object produced is a solid cube-shaped brick with a size of 10.5 x 9, which will be tested for its compressive strength, and a block-shaped brick measuring 390 x 10.5 x 9, which will be tested for its absorption.

2.8 press hard

The compressive strength of bricks is the magnitude of the load per unit area that causes the brick specimen to crumble when loaded with a certain compressive force, which is generated by the Compression Testing Machine (CTM) tool. The amount of compressive strength can be calculated through equation (1).[15]

$$\text{Compressive Strength (P)} = \frac{F}{A} \quad (1)$$

Information:
F = Pressure Force (N)
A = Cross-sectional Area (m 2)

If the compressive force F = 1 N acts on a surface area A = 1 m2, then according to equation (1) the compressive strength is

$$p = \frac{F}{A} = \frac{1N}{1m^2} = 1^{N}/m^2 \quad (2)$$

2.9 Water absorption testing

The bricks are dried indoors for 34 days to avoid direct sunlight. The bricks were weighed for dry weight (a) and soaked in water for 1 hour, then removed and weighed (b). Water absorption capacity is calculated through equation (3)

$$\text{Water absorption} = \{(ba)/a\} \times 100\% \quad (3)$$

Information:
a = dry weight
b = weight after soaking for 2 hours

3 Problem Solution

3.1 results and Discussion

The formation of lignocellulosic using the chlorination method in this stage is used 5% $NaClO_2$ resulting in the formation of white lignocellulose while the addition of distilled water results from the process shows the desired formation of lignocellulose with the formation of fibers, strong tensile strength, colorless.
Lignocellulose is synthesized from rija-rija grass by the following process:

Fig.1 In the picture above is rija-rija grass and the cleaning and cutting process so that it can be easily milled.

Fig.2 The drying process after being washed is cleaned using water to remove dirt on the grass.

Fig.3 Milling process Rija-rija fiber is micron-sized and pre-treated with an acid solution.

Fig.4 The immersion process uses 5% $NaClO_2$ and lignocellulosic results.

Characterization of lignocellulose
The success of lignocellulosic production was confirmed through FTIR (Fourier Transform Infrared) spectroscopic analysis. The results of the FTIR spectroscopy analysis are shown in Figure IR (Fourier Transform Infrared) spectroscopic analysis. The results of the FTIR spectroscopy analysis are shown in Figure 5.

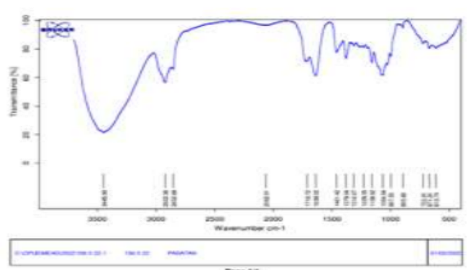


Fig.5 shows the results of the FTIR analysis.

The characterization of the FTIR spectrum of rija-rija grass was carried out at wave numbers 600–3500 cm1. Figure 5 shows that the presence of lignocellulose is indicated by its appearance; the peak around 1064 cm-1 corresponds to C–H aromatic deformation (present in lignin), C–O deformation in primary alcohols, and stretching of unconjugated C–O bonds (in lignin and hemicellulose). The band around 1639.02 cm1 corresponds to unconjugated C–O stretching (present in lignin), and the band around 2922.36 cm1 indicates the C–H stretching of the lignin polymer. The band with strong intensity around 3444.50 corresponds to stretching O–H lignin.[16] Lignocellulosic surface morphology is known through SEM-EDS analysis. Scanning Electron Microscopy and Energy Dispersive X-Ray.

Spectroscopy (SEMS-EDS) The SEM micrograph is shown in Fig. 6.

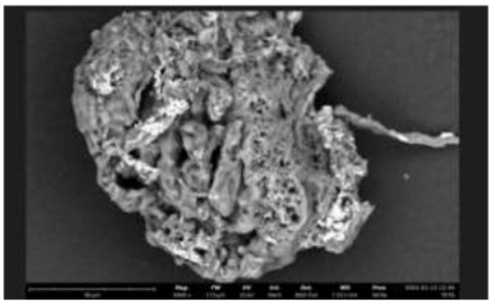
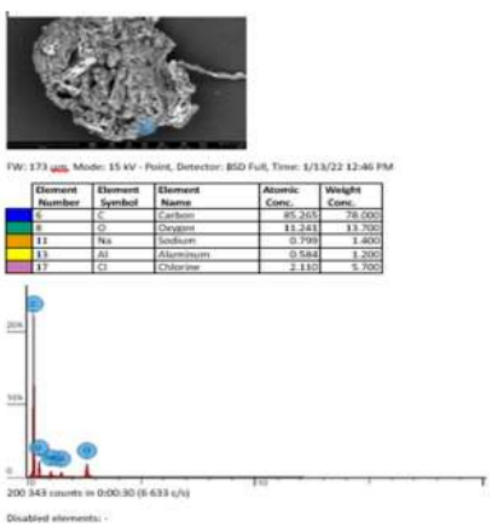


Fig.6 SEM image of lignocellulosic (magnification: 3000 x).

SEM analysis results show that lignocellulose is in the form of fibers with a size of 50 m. EDS results show C levels of 85,265.78,000 and O levels of 11,241. The EDS spectrum is shown in Figure 7.



Element Number	Element Symbol	Element Name	Atomic Conc.	Weight Conc.
6	C	Carbon	85.265	78.000
8	O	Oxygen	11.241	13.700
11	Na	Sodium	0.799	1.400
13	Al	Aluminium	0.584	1.200
17	Cl	Chlorine	2.110	5.700

Fig.7 SEM analysis results.

The high level of carbon in the synthesized lignocellulose indicates that lignocellulose can be used as fiber reinforcement in composite bricks.

Tabel. The results of the brick absorption test

Sample code	Lignocellulose%	Dry brick weight (kg)	Wet brick weight (kg)	Absorption
Control	0%	6.33	7.15	13%
Brick 1	3%	6.14	7.17	17%
Brick 2	6%	6.07	8.1	33%

3.2 Data on the results of the brick absorption test.

Based on table 3. Above, a graph of the influence of the percentage yield of lignocellulosic on the absorption value of bricks can be obtained, namely as follows:

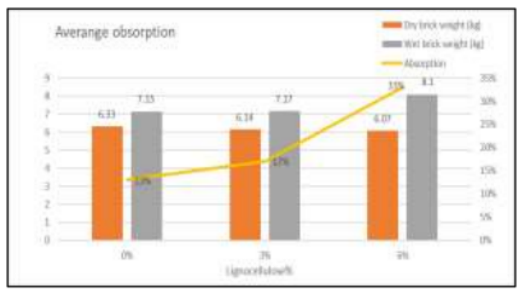


Fig.8 Graph of the effect of adding lignocellulosic material to the absorption capacity of bricks.

The more lignocellulose is added, the greater the water absorption capacity of the bricks. Based on the test results, the bricks with 0% lignocellulosic composition have a water absorption capacity of 13%, while bricks with 3% lignocellulosic composition have a water absorption capacity of 17%. Then, bricks with a 6% lignocellulosic composition have a water absorption capacity of 33%.

Tabel 4. Brick compressive test result

No	code	cross-sectional area	cast date	test date	age	weight (kg)	load p (kN)	compressive strength(kg/cm2)
1	control	p=10,5 x 9 cm	8/25/2022	9/28/2022	34	1.56	66	71.19
2	variation 3%					1.52	37	39.91
3	variation 6%					1.47	12	12.94

3.3 Results of brick compressive strength testing.

The measurement process for testing the compressive strength of bricks uses the parameters of the area and load of the Compression Testing Machine (CTM). press. Based on table 4. It is possible to obtain a graph of the influence of the percentage of lignocellulose on the compressive strength of bricks as follows

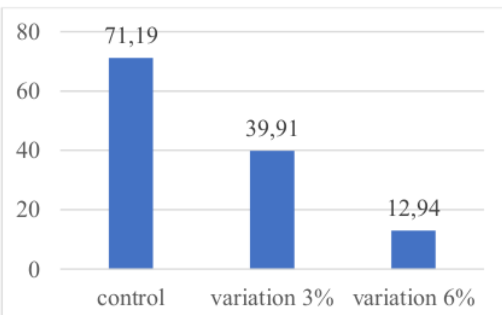


Fig.9 Graph of the effect of the addition of lignocellulose with variations in its composition on the compressive strength of bricks.

The addition of fiber will significantly reduce its compressive strength. The decrease in compressive strength occurs because the fiber will reduce the density level of the brick so that it can affect the ability of the brick to distribute the compressive force to the aggregate grains.[17], based on SNI standard No. 03-0349 (1989). Bricks with 0% lignocellulosic composition had a pressure of 71.21 kg/cm2, while bricks with 3% waste composition had a pressure of 39.91 kg/cm2. Then, bricks with a waste composition of 6% have a pressure of 12.94 kg/cm2.

4 Conclusion

From the results of the research and discussion above, it can be concluded as follows:
SEM analysis results show that lignocellulose is in the form of fibers with a size of 50 µm. EDS results showed C levels of 85,265.78,000 O levels of 11,241, 13,000 EDS spectrum. In the process of making bricks using the sandwich method, they are not homogeneous or fused. Further research is needed to use this method; apart from using the sandwich method, researchers also use the mix method, and the results of the bricks obtained are homogeneous or fused.

There is an effect of the addition of lignocellulosic material on the compressive strength of bricks. This is indicated by a decrease in the compressive strength of the bricks with increasing lignocellulosic substitution in the bricks, based on SNI standard no. 03-0349 (1989). Bricks with a composition of 0% lignocellulosic have a pressure of 71.21 kg/cm2, making the class II quality level of 70 kg/cm2 feasible, while bricks with a waste composition of 3% have a pressure of 39.91 kg/cm2, making the class IV quality level of 25 kg/cm2 feasible. Then, a brick with a waste composition of 6% has a pressure of 12.94 kg/cm2, which is not feasible.

The more lignocellulosic mixture in the brick, the greater the water absorption capacity. The brick with 0% lignocellulosic composition has a water absorption capacity of 13%, while the brick with 3% lignocellulose composition has a water absorption capacity of 17%. Then, bricks with a 6% lignocellulosic composition have a water absorption capacity of 33%. However, the addition of water content in the brick still complies with the requirements of SNI 03-0349-1989 concerning concrete bricks for wall pairs, which require the maximum water content of class I bricks to be 25%

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