PURUN TIKUS (ELEOCHARIS DULCIS) FIBER COMPOSITION AS CEMENT BOARD COMPOSITE MATERIAL

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Purun tikus (*Eleocharis dulcis*) fiber composition as cement board composite material

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Abstract

Various types of fiber plants thrive in Indonesia, such as kenaf (*Hibiscus canabinus*), alang-alang (*Imperata cylindrical*), and purun tikus (*Eleocharis dulcis*). The existence of purun tikus is still not utilized optimally. The objective of this research is to determine the right mixture of purun tikus fiber and composition effect from the mixture on physical and mechanical properties of the composite cement board. The results show that all composite cement boards made from purun tikus fiber with the composition of 75g fiber and 100g fiber have fulfilled the requirements of SNI 03-2104-1991 on physical and mechanical properties. Based on Anova statistical analysis and Duncan analysis, the mixture materials composition of 75g and 100g purun tikus fiber affects on physical properties (moisture content, density, thickness increment), and mechanical properties (MoR) of composite cement board. In general, the addition of fiber will increase moisture content, thickness, and MoR of composite cement board, except thickness increment. The composition of the 100g purun tikus fiber with the matrix intensified form is an elected composition to be used as a composite cement board.

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Introduction

Various types of fiber plant thrive in Indonesia, such as kenaf, reeds, and purun tikus. Purun tikus or its scientific name *Eleocharis dulcis,* in the taxonomy it was classified as cyperaceae which is a typical plant of swamplands. Throughout the year or for a long period of time in a year this land always waterlogged or stagnated. [http://www.indo-peat.net] Purun tikus is a wild plant that is classified as weeds in open locations. The purun tikus plant can be called specifically as sulphate acid land, because its resistance to high acidity (pH 2.5 -3.5). Therefore, this plant can be used as vegetation indicator for acid sulphate soil. [Steenis, C. G. G. J, Van. 2006., Brecht, J.K. 1998]. This water plant is mostly found in acid sulfate soil with clay soil type or humus. Usually it can be found in open area or burned land. Ecologically, purun tikus acts as biofilter plant which can neutralize toxic elements and acidity in acid sulphate field by absorbing Fe for 80.0-1,559.5 ppm and SO_4 for 7.88-12.63 ppm (Noor, M. 2004). Purun tikus can grow at pH 3, with soluble sulfate content (SO_4^{2-}) of 0.90 me /100 g, and soluble iron content (Fe^{2+}) of 1,017 ppm (Jumberi *et al*, 2004).

In terms of availability raw materials from natural fiber, in South Borneo province has abundant of purun tikus raw materials. Data from Dinas Perindustrian Perdagangan dan Penanaman Modal (Disperindag dan PM) or Industry, Trade and Investment Service of Barito Kuala in 2006, the distribution of purun plant species reached + 713 Ha, including purun danau + 641 Ha and purun tikus + 73 Ha (Rahadi, 2007). From the chemical analysis of purun tikus that has been conducted it obtained water content (9.50% at shoot), extractive level (4.45% at base) and low cellulose holo (52.62% on shoot) and moderate lignin content (25.80% in the stem), therefore purun tikus is allowed to be used as a natural fiber material in the manufacture of construction materials. [Wardhana, H. *et al.* 2015].

The cement board composite is a panel product made by using particles or fibers of lignisellulose material as raw material and Portland cement as a binder. The ratio between particle and cement in particle-cement board manufacture is 1.00: 2.75. The board has several advantages such as moisture resistant, fire resistant, fungus, and insect destroyer. [Suhasman. 2012] Composite cement board has better characteristic than particle board which are more resistant to mold, waterproof and heat resistant [Maloney, T.M. 1977]. Composite cement board is also more resistant to termite attacks than its raw materials [Sukartana, P, 2000], therefore the composite cement board is one of the most durable building materials. A research has been conducted on the characteristics of cement boards made from purun tikus particle. From the test results of purun tikus particle has fulfilled the requirements of SNI 03-2104-1991 on water content, density, thickness increment, MoR. the highest MoR value is 16.44 kg / cm^2. [Wardhana, H *et al*, 2017].

The existence of purun tikus is still not utilized as composite materials, especially composite cement board. The mild nature from purun tikus is inline with the philosophy of composite materials engineering, which is resulting a lightweight design. The use of lightweight materials such as purun tikus is expected to reduce the weight; in addition the purun tikus is useful to improve the flexural strength, thus the deflection due to the assessment can be reduced, while other benefits are the easiness to obtain and growing wild in the swamp. The utilization of purun tikus as an intensified ingredient (fiber) in the material is expected to replace the use of more expensive synthetic imported intensified ingredient. Purun tikus which was believed as the one among the high fiber content plant, is expected to be utilized for the development of cement board composite materials, therefore the research needs to be conducted.

Material and method

Material

Material which is used is purun tikus as an intensified ingredient (fiber) based on test result characteristics that is reviewed from its chemical, physical and mechanical properties from previous research. [Wardhana, H. *et al*. 2015]. The Binder or matrix are cement and water. Cement that is used is Pozolan Portland Cement (PPC) from 3 Roda Indocement, meanwhile the water is from Perusahaan Daerah Air Minum (PDAM) based on Standar Nasional Indonesia (SNI).

Method

Composite cement board manufacturing method is based on mixture of A factor (ingredient) and B factor (intensified form). A factor is purun tikus fiber which is cut to maximum length 2cm, then gets blended to become thin fibers. The size of composite cement board is 25 x 25 x 1cm³, meanwhile test material's weight is 625g, with A1 = 75g of purun tikus + 550g of PPC, A2 = 100g of purun tikus + 525g of PPC. B factor is intensified form with 1cm gap from intact purun tikus for strengthening composite cement board, B1 = without intensified form and B2 = intensified form matrix. The mixture compositions are A1 + B1; A1 + B2; A2 +B1 and A2 + B2 with 5 times experiment for each composition. The experiment includes physical properties (water content, density, thicknes increment) as well as mechanical (MoR) from produced composite cement board, that refers to SNI 03-2104-1991.

Result and discussion

Result

Based on mixture composition, cement board's physical properties are obtained that include water content, density, thickness increment as well as mechanical property (MoR), as stated at table 1.

Tabel 1. Composite Cement Board Test Result.

Test	Factor B	Factor A		SNI 03-2104-1991
		A1	A2	
Water Content (%)	B1	4,09	6,78	Maximum 14%
	B2	4,11	7,07	
Density (kg/cm3)	B1	0,82	0,91	Minimal 0,57 kg/cm3
	B2	0,82	0,92	
Thickness Increment (%)	B1	0,6	0,52	Maximum 12%
	B2	0,61	0,53	
MoR (kg/cm²)	B1	21,68	23,14	Minimal 17 kg/cm²
	B2	24,03	25,15	

Note: The test result is based on average result.

In general, the test result against water content (%), density (kg/cm3), thickness increment (%), dan MoR (kg/cm²) has met standardization from SNI 03-2104-1991, that is shown at Table 1. The lowest water content is found at A1B1 (4,09%). The highest density is found at A2B2 (0,92 g/cm3). The lowest thickness increment is found at A2B1 (0,52%). The highest MoR is found at A2B2 (25,15 kg/cm²).

The influence of purun tikus fiber material (factor A) and intensified form (factor B) mixture against physical and mechanical properties of composite cement board is shown at Image 1, Image 2, Image 3 and Image 4.

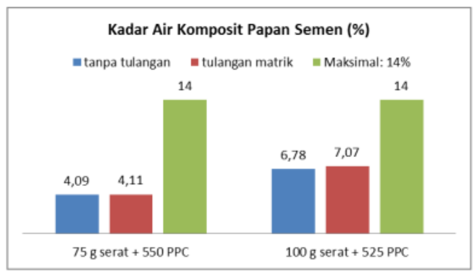

Image-1. Water Content (%).

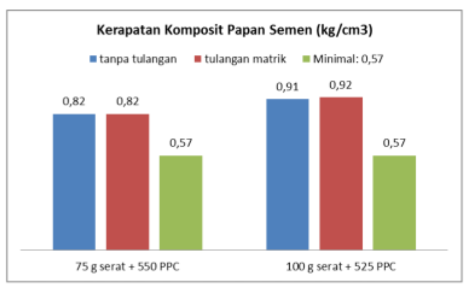

Image-2. Density (kg/cm3).

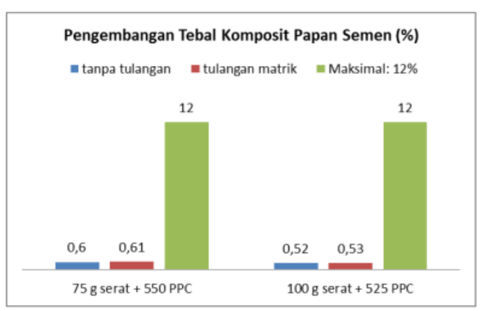

Image-3. Thickness Increment (%).

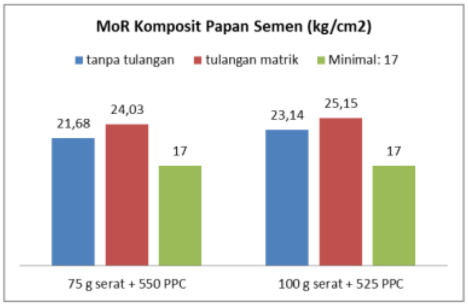

Image-4. MoR (kg/cm²).

From Image-1, Image-2, and Image-4, it is shown that density and MoR values from composite cement board with purun tikus fiber 100g, higher intensified matrix if it is compared to composite cement board from purun tikus fiber 75g, without intensified form. The highest density and MoR value is obtained by composite cement board with intensified form matrix and purun tikus fiber 100g, which is 0,92kg/cm^3 for the density and 25,15 kg/cm^2 for MoE.

Discussion

The morphological characteristics of purun tikus plant such as straight stem, not branched, gray to shiny green with a length of 50-200cm and thickness of 2-8 mm. While the leaves narrow down to the basal, midrib thin as membrane, the tip is asymmetrical, reddish brown. [Noor, M. 2004., Astuti *et al* 2008]

Composite in macro scale is a combination of two materials or more that physically and mechanically can be separated from one and another. Constituent materials (matrix and intensified ingredient) will determine final property of the composite. On mechanical property, during composite material assessment, matrix has main function to transfer the load into the intensified ingredient and intensified ingredient has main objective to bear that load. Hence it can be concluded that type of matrix will be impactful towards physical property, meanwhile intensified ingredient is impacting to mechanical property of overall composite material. Composite material property is affected by its constituent material's property and distribution, as well as their interaction. [Bhagwan D, Agarwal, 1980] Other important parameters that might affect property of composite material are shape, size, orientation and distribution of the intensified ingredient (filler) and various matrix's characters. [Mathew, F. L, *et al*, 1994].

Physical and mechanical properties of composite particle board are influenced by the shape and size of the particles. The thickness of the particles is recommended in particle board manufacture is between 0.025-0.030cm. [Dirhamsyah, M., 1995] The manufacture of composite particle cement board is resulting particle with size of 30-40 mm long and with a thickness of 0.2-0.3mm. There are two alternatives of the panel size: 1,220 x 2,440mm and 1,250 x 2,800mm. The thickness ranges from 8-40 mm and maximum density 1,250kg / cm3 for particle comparison: cement is 1: 2.75. [Bison. 1975]

From composite cement board manufacture research with purun tikus fiber, intensified ingredient (fiber) : matrix (cement) composition for A1 is 1 : 7.33 and A2 is 1 : 5.25, with A1 MoR is lower than A2's.

On composite material, indirect load is charged against fiber, however on matrix, transfer happens on fiber through interface sector afterwards. This interface sector functions as load transmitter from matrix to fiber which provides major contribution on composite's intensified ingredients. In order to provide contribution towards composite' strength, fiber must be tied tightly to matrix. Composite material with weak interface sector has lower strength yet has high durability against fracture. Composite material with stronger interface sector has higher strength yet has lower durability against fracture otherwise. [Bhagwan D, *et al*, 1980, Mathew, F. L, *et al*, 1994].

Based on Anova statistical analysis, two intensified forms (B factor) composite cement board based on that purun tikus fiber gives insignificant influence towards water content, density, thickness increment, yet gives significant influence towards MoR. Aside from that, assessing from material (A factor), therefore two ingredient compositions of that purun tikus fiber provides significant influence towards water content, density, thickness increment, and MoR. This is in-line with Image-1 (water content), Image-2 (density), Image-3 (thickness increment) and Image-4 (MoR). Based on Duncan analysis, ingredients composition variable (A factor), is concluded that purun tikus fiber composition 75g + PPC 550g is significantly different than purun tikus fiber composition tikus 100g + PPC 525g towards water content, density, thickness increment and MoR.

Based on Image-1 and Image-2, it is shown that the increment of purun tikus fiber mixture composition (100 g) will increase composite cement board's water content and density. This applies for composite cement board without intensified form or matrix form.

For thickness increment (Image-3), increment of purun tikus fiber mixture composition (100g) on composite cement board without intensified form and with matrix form, will decrease the thickness increment. Therefore when composite cement board density gets higher, then its thickness increment is getting lower.

Meanwhile for MoR (Image-4), when purun tikus fiber mixture composition gets higher (100g), then MoR is increasing as well. Intensified form impacts MoR, intensified form gives higher MoR value.

Research result shows, in general fiber increment will increase water content, density and MoR of composite cement board, except at thickness increment. With lower fiber, it causes lower bond between fiber (purun tikus) with matrix (cement) and fiber distribution on matrix will affect MoR value.

If A's main factor affects significantly while B's factor affects insignificantly or vice versa, meanwhile its interaction affects insignificantly, hence recommendation from research result is only applying A factor in case A factor affects significantly or only applying B factor in case B factor affects significantly. [Hanafiah, A.K. 2014]. This research result shows factor function of only Ingredients Composition that is applied to show water content value, density, thickness increment.

Aside from that, in case A and B's main factors affect significantly, yet their interaction do not, then recommendation from research result advises A and B's factor to be applied separately or one over the other. [Hanafiah, A.K. 2014]. This research result shows that Intensified Form and Ingredients Composition are same or antagonist property (pressing each other influence), thus it will harm if they are implemented together for assessing MoR value.

MoR value affects significantly to composite cement board's quality, hence Duncan differences test result can be utilized as a benchmark for future research. Inspecting Duncan differences test at the Intensified Form, thus between each factor level provides significant differences, meaning it can be selected one from the others depends on ingredients efficiency and production time when it's proceeded as manufactured cement board. Meanwhile Duncan differences test at Ingredients Composition factor, in order to continue to the next research, one of those compositions can be selected, because they are totally different. From ingredients usage and manufacturing time efficiency point of view, the most profitable ingredients composition can be chosen from further production process creating manufactured cement board.

Based on research result on physical and mechanical property of composite cement board as well as statistical analysis that has been done, it is recommendable that purun tikus fiber composition of 100gr by using intensified matrix (test material A2B2) is the selected and used composition. Test material A2B2 has the highest density value (0,92g/cm^3), as well as the highest MoR value (25,15 kg/cm^2).

Conclusion

Based on research result on physical and mechanical property, all purun tikus fiber compositions have passed standardization SNI 03-2104-1991 as cement board composite material. Based on Anova statistical and Duncan analysis, the mixture of purun tikus fiber ingredients composition that 75g and 100g gives impact and difference significantly towards physical (water content, density, thickness incremental), and mechanical (MoR) element of composite cement board. Research result shows, in general fiber addition will increase water content, density, and MoR of composite cement board, except on thickness increment. Based on test result and analytical analysis on the physical and mechanical property, hence purun tikus fiber composition 100g + PPC 525g with intensified matrix form (A2B2) is selected composition which can be used as cement board composite material.

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