THE EFFECT OF NAOH IMMERSION TIME TO PHYSICAL PROPERTIES OF PURUN TIKUS (ELEOCHARIS DULCIS) CEMENT BOARD COMPOSITE

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Abstract. A research in cement board composite made from *purun tikus* (Eleocharis dulcis) has been conducted. The aims are to determine its physical properties as variations of *purun tikus* fibers mass and NaOH immersion time. The results were yielded 5.00 - 15.15%, 0.52 - 0.76 g / cm3 and 0.05 - 0.18%, respectively for water content, density and thickness development. For moisture content and density values, the results were not met the standard of SNI 03-2104-1991, while for thickness development of all samples met the standards. The results showed fluctuating changes in water content, density and thickness development, which were influenced by the immersion time and mass of *purun tikus* fibers. From the results, it can be concluded that shorter immersion time and less *purun tikus* fibers yielded a smaller value of water content and thickness development, while density was become higher.

Keywords: *purun tikus*, NaOH, cement board composite, water content, thickness development

1. Introduction

At present, the use and utilization of natural fibers as material reinforcement were growth continuously and very much in demand by the industrial world. the natural fibers have low density, biodegradable, recycled easily, low energy production, have good mechanical properties and could be renewed as they come from nature [1]. besides that, the basic advantages of natural fibers are their abundant quantities and low costs. composite materials with natural fiber reinforcement such as bamboo, hemp, and banana have been applied to the automotive world as panel reinforcement for doors, rear seats, dashboards, and other interior devices [2].

Indonesia has a wide range of biodiversity so it has a great opportunity to explore the use of natural fiber materials. In terms of the availability of raw materials for natural fiber, in South Kalimantan the raw material of *purun tikus* plants (*Eleocharis dulcis*) is quite abundant. *Purun tikus* are wild plants that lead to weeds in open locations. These *purun tikus* plants can be said to be acid sulphate-specific, because they are resistant to high acidity (pH 2.5 -3.5). Therefore these plants can be used as indicator vegetation for acid soils [3, 4]. The morphological characteristics of *purun tikus* plants are straight stems, no branched, gray to shiny green with a length of 50-200 cm and thickness of 2-8 mm. While the leaves shrink to the basal, thin midrib like a membrane, the ends are asymmetrical, reddish brown [5]. Based on data from Industry and Investment Office of Barito Kuala in 2006, the distribution of purun plants has an areas about 713 Ha, covering purun danau ± 641 Ha and *purun tikus* ± 72 Ha [6].

To get high tensile strength properties, natural fibers are usually given a variety of treatments. The treatment given was alkaline immersion which aims to improve adhesive properties. Adhesiveness is the attachment of the interface surface of the elements that are joined together. The interface referred to in the composite is a surface formed by a joint bond between the reinforcement (fiber) and the matrix that forms the intermediate bond needed for load transfer. *Purun tikus* fiber is a cellulose material, so it has a complex structure. For this reason additional special treatment is needed to remove lignin. Alkaline ingredients, such as NaOH, are expected to eliminate the content that binds to cellulose in *purun tikus* fibers.

Cement board composite is a panel made from particles of ligni-cellulose and Portland cement as a binder. The comparison between particles and cement in board fabrication is 1: 2.75. The board has several advantages, which are, resistance to moisture, fire, mold and destructive insects [7]. Research in the fabrication of cement board composites made from *purun tikus* fiber with no immersion treatment was already carried out. The chemical analysis of *purun tikus* such as, water content (9.50% on shoots, extractive content (4.45% at base), low holo-cellulose content (52.62% on shoots) and moderate levels of lignin (25.80% on the stem) were already obtained [8]. From the test of the mechanical properties of *purun tikus*, the samples from the bottom of *purun tikus* were yielded diameter of 2.158 mm and tensile strength of 3.63 Mpa. While samples of the top of *purun tikus* were yielded 2.064 mm in diameter and tensile strength of 4.21 Mpa. The *purun tikus* is possible to be used as natural fiber material in the manufacture of construction materials. It is recommended to use the top of *purun tikus* because of its tensile strength is 116.15% more compare to the bottom of the *purun tikus* [9]. Wardhana, H and Ninis H Haryanti (2017) did a research on the characteristics of cement boards made from *purun tikus* particles without immersion treatment. From the results of testing of *purun tikus* particles, they have met the requirements of SNI 03-2104-1991 on moisture content, density and thickness development. The composition of *purun tikus* fiber 100 g in the form of matrix reinforcement is the right composition to be used as cement board composite material [10].

Purun tikus fiber as a strengthening material would greatly determine the properties of the cement board composite because it would continue the load that distributed by the matrix. *Purun tikus* fiber with alkali immersion treatment (NaOH) is expected to produce maximum physical properties of cement board composites, therefore research were needed. In this research, the physical properties of cement board composite as the effect of immersion time and *purun tikus* composition would be investigated. The expected benefit is *purun tikus* can be used as natural fiber in making cement boards. It is useful for building planners to reduce the construction burden.

2. Research Method

This research is a continuation of previous research. The results from the previous study which are *purun tikus* characteristic test in terms of chemical, physical and mechanical properties were used as the basis for this study [8, 9]. Besides that the composition of the materials used is also based on the results of previous studies [10, 11].

Purun tikus in the form of fibers was used as material for manufacturing the Cement Board composites. *Purun tikus* were immersed in 50 ml of NaOH 5% solution mixed with 1 liter of distilled water. The immersed time were varied for 1 hour, 2 hours, 4 hours and 6 hours. Then *purun tikus* were mixed with PPC Cement (Pozolan Portland Cement). The variation of *purun tikus* fibers mass used were 50 gr and 100 gr while PPC Cement (Pozolan Portland Cement) were 575 gr and 525 gr. Besides that, 110 mL Aquades and 10 mL Adhesives (Addition H.E, ASTM (494-81, Type A) were also added. Then the mixture was poured in composite board mold of 25 cm x 25 cm x 1 cm in size. The investigation parameters were water content, density and thick development. In measuring the physical properties of the cement board, the sample used was 5 cm x 5 cm x 1 cm. The result would be compared to Indonesian National Standards 03-2104-1991.

3. Results and discussions

The most problem of natural fiber composites is the lack of good bonding between the matrix and the fiber resulting in poor composite properties. This deficiency is caused by the nature of natural fibers which could still absorb water. The water would enter the bond between the matrix and fiber. In turn, it would be affecting the physical properties of the composite. The right chemical treatment could increase the bond between fiber and matrix, so that the composite properties are getting better.

Kuncoro conducted a study to increase the bond between fiber and matrix (adhesive) where the clean fibers were soaked in alkaline solution (NaOH 5%). The immersion time variations were 0, 2, 4, and 6 hours. As the results, the optimal tensile strength was yielded by composite materials which are reinforced by hemp fiber with a 2-hours alkali treatment [12].

The water content of the cement board composite as a function of the variations of immersion time and *purun tikus* mass was shown in Figure 1. It can be seen that the immersion time and composition of *purun tikus* and cement could affect the water content. The water content of the cement board composite has increased as the immersion time increased. As can be seen in the graph, for samples with 100 grams of *purun tikus* and 525 grams of cement have higher water content as compare to samples with 50 grams of *purun tikus*. This was caused by the composite would absorb water when it was immersed in distilled water and increased the thickness. Therefore the composition which has more fiber would have more water content.

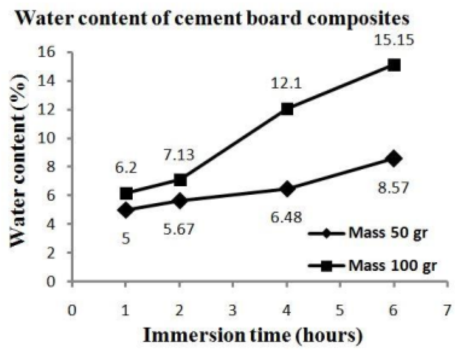

Figure 1. The Water content of composite to immersion time and purun mass variation.

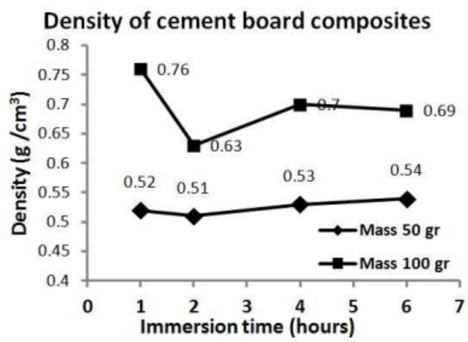

Figure 2. The composite density to immersion time and purun mass variation.

The water content of the cement board composite obtained was in the range of 5.00 to 15.15%. The highest value of water content was obtained for 100 grams of *purun tikus* and 525 grams of cement with 6-hours immersion time, which was 15.15%. While the lowest water content value was obtained for 50 grams of *purun tikus* and 575 grams cement with immersion time 1 hour, which was 5.00%. According to Purwanto [13], the water content value of cement board composite is influenced by several factors. Firstly, the condition of the storage because the cement board has hygroscopic properties towards the surrounding water vapor, the others are influenced by the composition of cement used and particle size. Research conducted by Violet in 2012 said that the use of more cement can cause particle cell cavity filled with less water because the cavity has been filled with cement that has hardened. It is presumed that more cement would cause the water evaporated easily thus produced lower water content. From the results, it can be seen that not all samples were met the requirements of SNI 03-2104-1991 which has the maximum value for water content of 14% [14]. A good cement composite board should have low water content. The results of the water content of samples show that for short immersion time and light *purun tikus* fibers mass would has a low water content value. Therefore the composite board with 50 grams of *purun tikus* fibers and 575 grams of cement was a good composite board. In this study, the best composite board was made from 50 grams of *purun tikus* and 575 grams of cement with 1 hour immersion time which has the smallest water content, about 5.00%.

The density of cement board composite as variations of immersion time and *purun tikus* mass is shown in Figure 2. From Figure 2, the density of the cement board composite is obtained in the range of 0.52–0.76 g / cm^3. Based on SNI 03-2104-1991 the minimum value for density is 0.57 g / cm^3, thus not all samples meet SNI requirements. The cement board composite was thicker than expected. It is assumed that when the composite released from molds and clamps, the particles that were not perfectly bound with the cement were detached. As a result, the arrangement of material components

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in the board is not tight and allows the existence of pores. This causes the board's volume becomes larger and the density becomes smaller.

The highest density value was the sample of 50 grams of *purun tikus* and 575 grams of cement at 1 hour immersion time, which was 0.76 g / cm^3. While the lowest density value was obtained for 100 grams of *purun tikus* and 525 grams of cement with 2 hours immersion time, about 0.51 g / cm^3. If the cement composition is getting higher, the density would also become higher. It was caused by the composite has a lot of binding material, which is cement. It allows the formation of good bonds. This is in line with Simbolon et al. higher cement composition would give higher density, because the weight of the cement board would be increased as factor of the amount of cement used [15]. Purwanto said that a high density of cement board can be attributed to the properties of the raw materials of particles used which could increase bonding with cement [16].

It can be seen from Figure 2, all cement board composite samples with 50 grams of *purun tikus* and 575 grams of cement at immersion time of 1 to 6 hours obtained high density, which were 0.69-0.76 g / cm^3. While the minimum value of SNI standard for density is 0.57 g / cm^3. Whereas for 100 grams of *purun tikus* and 525 grams of cement with immersion time of 1 to 6 hours obtained average density of 0.5 g / cm^3. From the results of the density test, it was found that shorter of immersion time and smaller the mass of the purun fiber (higher cement mass) gave higher density. The highest density value was yielded by cement board composites with 50 grams of *purun tikus* and 575 grams of cement. So, the board composites, which met the minimum standard of SNI in density, were the mixture of 50 grams of *purun tikus* and 575 grams of cement at immersion time of 1 to 6 hours.

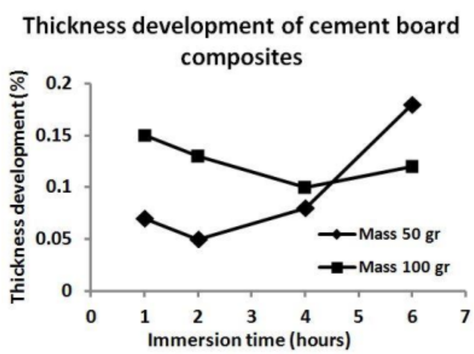

Figure 3. The results of thickness measurement to immersion time and purun mass variation.

The measurement of cement board composite thickness as variations of immersion time and *purun tikus* mass is shown in Figure 3. The values of the development of the cement board composite thickness were 0.05–0.18%. Based on SNI 03-2104-1991 the maximum thickness development (swelling) is 12%. Thus, all cement board composite samples meet SNI standards. The highest thick development value was obtained for 50 grams of *purun tikus* and 575 grams of cement with immersion time of 6 hours, which was 0.18%. While the lowest thick development value was obtained for 50 grams of *purun tikus* and 575 grams of cement with 2 hours immersion time, which was 0.05%. The thickness development value after 2 hours of immersion is smaller than the 6 hours immersion. This is due to the immersion time affecting the amount of water that could be penetrated through the pores of composite board.

Based on the results, there was a tendency that the thickness development was decreased as the cement composition increased. This is due to the increase of ratio cement used makes the particles able to be tied better and makes the board structure denser so the physical properties of the board increase. As a result, when the board was immersed, water is hard to penetrate into the pores of the board, causing low thick development values. This is in line with Simbolon et al. (2015) which states that the more cement composition is in used, the more particles could be bound by the cement [15].

Olufemi et al (2012), said that the development of cement board thickness was also influenced by the comparison of the mixture of raw materials with cement [17]. The greater cement content on the board will reduce thick development, also the use of a mixture of raw materials [17].

As can be seen from Figure 3, there was a decrease in the thickness of the *purun tikus* mass 50 and 100 grams at immersion times of 2 and 4 hours, but increased at 6 hours immersion time. From the results, the thickness development would become higher when samples have longer immersion time and smaller purun mass. Theoretically, smaller value of thickness development would give better cement board composite. From the results, cement board composites of 50 grams of *purun tikus* and 575 grams of cement at 2 hours immersion time was the best composite obtained. It has the smallest thickness development which was equal to 0.05%.

The nature of *purun tikus* as natural fibers is hydrophilic. The effect of alkali treatment on the nature of the surface of natural fibers, the optimum content of water can be reduced so that the nature of hydrophilic fibers can provide interfacial bonds with the matrix optimally. NaOH is an alkaline solution that is classified as easily soluble in water and is a strong base that can be ionized perfectly. NaOH is also moist liquid and spontaneously absorbs carbon dioxide from free air.

Alkalinization of fiber is a process of modifying the fiber surface by immersing fiber into alkaline bases. The following reaction describes the process that occurs at the alkali treatment of fibers:

$$\text{Fibers-OH} + \text{NaOH} \text{ ----- } \text{Fibers-O-Na}_{+} + \text{H2O}$$

The purpose of the alkalization process is to reduce the fiber constituent components which are less effective in determining interface strength, which are hemicelluloses and lignin or pectin. As the components of lignin and hemicelluloses were reduced, it would produce a better fiber surface structure and easier to be moistened by resin, resulting in better mechanical interlocking. When there is a chemical reaction between fiber and alkali, a reaction time is needed, if the reaction time is less than is required the reaction is not optimal while if the reaction time is excessive, the fiber would be damaged. The process of immersion treatment has an influence on the surface of the fiber, the length of time will make the fiber surface cleaner and the surface of the fiber becomes more rough so that the fiber bond with the matrix will be better (more adhesive), increasing the physical properties of the composite formed.

4. Conclusions

Cement boards composite made from *purun tikus* fibers were successfully fabricated. The physical properties of water content, density and thickness development were yielded 5.00 - 15.15%, 0.52 - 0.76 g / cm^3 and 0.05 - 0.18%, respectively. Comparing to SNI, only thickness development was meet the standard. The effects of NaOH immersion time on cement board composites have been observed. Shorter immersion time would cause lower the water content, higher the density and also increase the thickness development. The effects of material composition on the cement board composites were also observed. The composition of each material would be affecting homogeneity on the surface of the *purun tikus* cement board composite. When the composition of *purun tikus* fibers is smaller than the cement, the value of the water content is low, the density is high and the thickness development value is small. A good composite is a composite with a low water content and thick development, while its density is high. As for suggestions, further research needs to be done using other alkaline materials, for example $KMnO_4$, with varying immersion time variation.

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