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Characteristics of polyester composite reinforced hybrid *Hibiscus tiliaceust* bark and palm fibers as harrow comb (leveler) material

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Abstract

In the present research preparation and characterization of polyester composite reinforced hybrid fiber *Hibiscus tiliaceust* bark fiber (HTBF) and palm fibers (PF). PF is obtained from palm plantation in Kekait village. HTBF has gained from the beach Krandangan, West Lombok, Indonesia. The fibers were treated with alkali by soaking it in 5% NaOH solution for 2 days Composites were made using the vacuum infusion method. The matrix used is polyester resin BTQN 157. The volume fractions between palm fibers (PF) and *Hibiscus tiliaceust* bark fiber (HTBF) are, 5% : 25%, 10% : 20%, 15% : 15%, and 20% : 10 %. Specimens for tensile testing using the ASTM D638-03 Type I standard and impact testing using the Izod method, specimens using the ASTM D256-03 standard, and further Observation of the specimen fracture was carried out using Canon EOS 700D Kit (EF S18-55 IS STM) camera. The results of this study indicate the addition of the volume fraction of palm fiber (PF), affects the tensile strength, modulus of elasticity, impact toughness and the extent of the fracture shape of the specimen. As the volume fraction of PF increases, the tensile strength, modulus of elasticity, fracture area increases, but the impact toughness of the specimen decreases. The specimen is suitable to be used as a leveler, mainly crushing and destroying paddy fields

Keywords: Polyester composite; Hybrid fiber; *Hibiscus tiliaceust* bark fiber; Palm fibers

1. Introduction

The comb harrow is one of the soil processing tools in the form of a rake with toothed nails as shawn Figure 1. Its main function is for secondary tillage (soil smoothing). Comb harrows are usually used when the agricultural land is in a wet condition after it has been processed with a plow machine. In the conventional or old method, the comb rake will be moved by dragging a cow or buffalo. But in more modern agriculture, the harrow is driven by a diesel engine mounted on a hand tractor. The use of diesel causes the performance of the harrow to decrease. Such as blunting, cracking and stress corrosion cracking occur. Because it is made of low carbon steel metal. Several studies to improve the performance of comb harrows that have been carried out are as follows:

Powered disc harrow, dedicated to crop residue management in developed fields [2]. It was further evaluated on the farm for its performance at different forward speeds compared to unpowered disc harrows under the same operating conditions. The results of the field evaluation confirm that the developed powered disc harrow is beneficial for conservation tillage practices in terms of excellent penetration, smooth tillage operations, reduced draft requirements, increased cutting and mixing of weeds and residues, increased soil reversal, and better energy utilization. good. However, based on observations in the field, the disc harrow is easily blunted/low hardness. As a result, the energy used is greater, the result is rough land.

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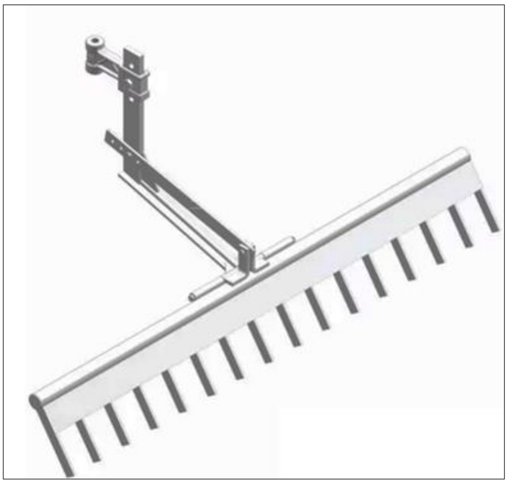

Figure 1 The harrow comb (leveler) [1]

The traditional one way disc harrow is as the basic structure for developing powerful disc rake. The works [3] have revealed that the different patterns of the cutting edge of tillage discs have a significant effect on the applied force and result in the cutting action of the soil. Moreover, they also reported that spiral grooved discs exhibit lower ground reaction values than standard and notched discs, and offer shear cutting action eliminating shock loads, thereby providing a smooth ground cutting operation.

The timing of post emergence weed harrowing was evaluated for two years in spring barley with crop-weed selectivity and crop recovery as the key parameters measured. Selectivity describes the relationship between weed control and crop soil cover immediately after harrowing, with crop soil cover as the percentage of the crop that has been covered by soil due to harrowing [4] .

Selectivity describing the relationship between weed control and ground cover cropping immediately after raking, with plant cover as the percentage of plants covered by soil due to raking, was evaluated [5]. Crop recovery described the relationship between crop yield loss and crop soil cover in the absence of weeds, after harrowing with a harrow comb/leveler. Neither selectivity nor plant recovery was affected by time in the two-week period at the early growth stage of the rainy season. Crop recovery is affected by time, with an average yield loss of 3.5% caused by 25% of crop soil cover. A detailed study of plant growth and weed density in the post harrowing period, showed that crop and weed recovery processes were affected by raking time, but this had no impact on crop yields [1].

The timing of post-emergence weed harrowing was evaluated for two years in spring barley with crop-weed selectivity and crop recovery as the key parameters measured [4]. Selectivity describes the relationship between weed control and crop soil cover immediately after harrowing, with crop soil cover as the percentage of the crop that has been covered by soil due to harrowing. Crop recovery describes the relationship between crop yield loss and crop soil cover in the absence of weeds. Neither selectivity nor crop recovery was affected by timing within a period of two weeks in the early growth stages of spring barley. Selectivity was unaffected by year and 80% weed control was associated with crop soil cover in the range of 23–33%, for all combinations of year and growth stage. Crop recovery was affected by year, with an average crop yield loss of 3.5% caused by 25% crop soil cover in 2007 and complete recovery in 2008. A detailed study of crop growth and weed density in the period just after harrowing, showed that the recovery processes of crop and weeds were influenced by timing of harrowing, but this had no impacts on crop yield. In conclusion, timing of post-emergence.

In this study [6], three vertical tillage discs with different shapes, namely notch, plain, and rippled were tested at two different working depths, namely shallow (63.5 mm) and deep (127 mm). Corn residue is spread over the ground as surface residue. shear strength of soil, soil displacement, and admixture of residue with soil, and shearing of residue were measured. The results showed that working depth had a stronger effect on disc performance compared to disc type. No difference in residual cutting was found between treatments. The deep working depth resulted in 5.1% higher residual mixing, 53.4% greater soil cutting force, and 34.9% greater soil displacement, compared to shallow depth. Corrugated discs produce the greatest ground displacement with the greatest demand in ground cutting forces. Overall, the bumpy disc is the most aggressive of the three discs in terms of the performance indicators measured.

The leveler's performance, crushing and softening the soil before planting is not only influenced by the amount of power from the hand tractor (power tiller), but also by the material of the leveler. In general, the decreasing performance of the leveler is due to the decrease in the hardness number, the occurrence of corrosion so that the leveler blunts, as a result it requires more power to destroy the soil/agricultural land. Research [7] was carried out to develop a leveling tool, for the convenience of farming operations to improve timeliness to minimize, energy and soil compaction by performing tillage and leveling in one pass. Two individual field tests were carried out for dry and wet land

The method used to improve leveler performance in the results of the research above is only on design. Research to determine the natural fiber-reinforced polyester composite material has not been carried out. Therefore, in this study characterization of the physical and mechanical properties of polyester composite reinforced hybrid Hibiscus tiliaceus bark fiber (HTBF) and palm fibers (PF) was carried out. To simplify the process of making specimens, the method used is vacuum infusion. Testing of physical and mechanical properties includes testing of hardness and impact toughness. Furthermore, it will be studied and analyzed the tendency of physical and mechanical properties of the specimens produced as leveler/harrow comb materials.

Thus, it should be noted that there are no data found in the literature that would explain the possible use of hybrid natural fiber-reinforced polyester composites as leveling materials for power tiller tillage purposes.

2. Material and methods

2.1. Materials

The main material of this research is Palm Fiber (PF) is taken from the palm tree (Arenga Pinata) from Kekait Village and *Hibiscus Tiliaceust* bark fiber (HTBF) is derived from the bark of *Hibiscus Tiliaceust* stems from Krandangan Beach, West Lombok, as shown in Figure 2. Palm Fiber (PF) is taken from the palm tree (Arenga Pinata). *Hibiscus Tiliaceust* bark fiber (HTBF) is derived from the bark of hibiscus stems. Fiber extraction begins with cutting the bark of the hibiscus tree followed by soaking the bark of the hibiscus bark for 14 days, so that the epidermis peels off, so that the fiber can easily be taken. Then dried in the sun to dry. Palm Fiber (PF) and *Hibiscus Tiliaceust* bark fiber (HTBF) were soaked in 5% $KMnO4$ solution for 2 hours. Then proceed with the oven process until the water content is 10 PPM.

Figure 2 The palm and *Hibiscus Tiliaceust* bark fiber

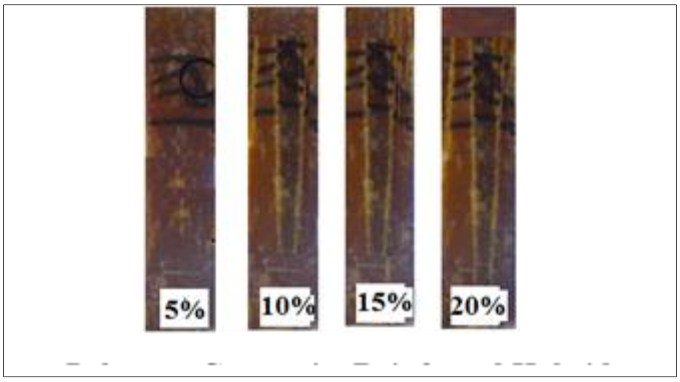

Figure 3 Polyester composite reinforced hybrid fiber HTBF – PF

2.2. Methods

Composites were made using the vacuum infusion method. The matrix used is polyester resin BTQN 157. The volume fractions between palm fibers (PF) and *Hibiscus Tiliaceust* bark fiber (HTBF) are, 5% : 25%, 10% : 20%, 15% : 15%, and 20% : 10 %, shown in Figure 3. Specimens for tensile testing using the ASTM D638-03 Type I standard and impact testing using the Izod method, specimens using the ASTM D256-03 standard, and further observation of the morphology of the specimen by scanning electron microscopy (SEM).

3. Results and discussion

3.1. The tensile properties of polyester composite reinforced hybrid *Hibiscus Tiliaceust* bark and palm fibers.

Based on the results of the tensile test of the polyester composite reinforced hybrid fiber HTBF-PF with variations in the volume fraction of PF, the stress-strain graph is shown in Figure 3. Based on the graph of the tensile test results, it can be seen that the highest stress value is found in the specimen with a volume fraction of 20% PF, while the specimen produces the lowest stress value in the volume fraction of 5% PF. Based on Figure 4. the increase in the volume fraction of PF, increases the tensile strength of the specimen. The tensile strengths were 315, 332, 335 and 347 MPa, respectively, for the volume fractions of 5%, 10%, 15% and 20% PF, respectively. Tensile strain occurs has decreased. The magnitude of the tensile strain is 0.034; 0.032; 0.029; and 0.025, for the volume fraction 5%, 10%, 15% and 20% PF, respectively. Composite specimen with the highest maximum strain occurs at composite specimen with a volume fraction of 5% PF, the lowest maximum strain of the specimen occurred at composite specimens with a volume fraction of 20% PF. The tensile strength of the polyester composite with HTBF strengthened as a result of research [8] was 306,76 MPa with a maximum strain of 0, 0271, and modulus elasticity about 19.233, 20 MPa.

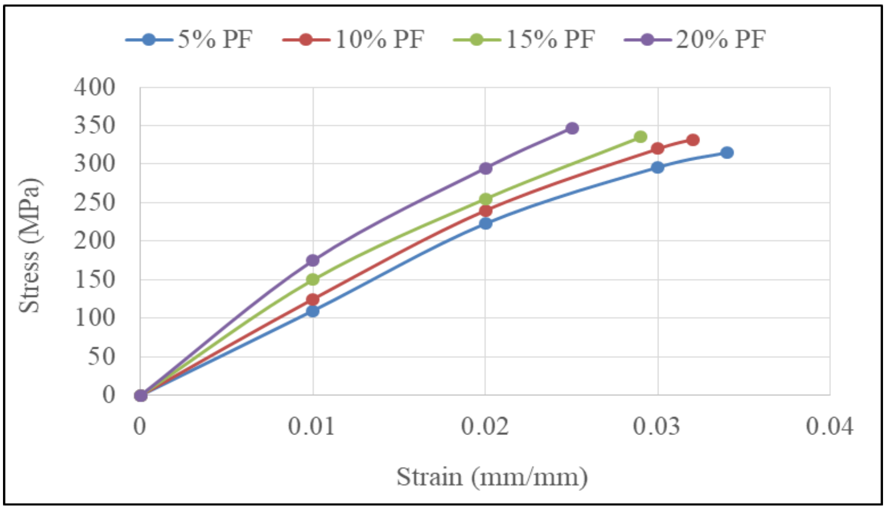

Figure 4 The results of the tensile test of polyester composites reinforced hybrid fibers HTBF-PF

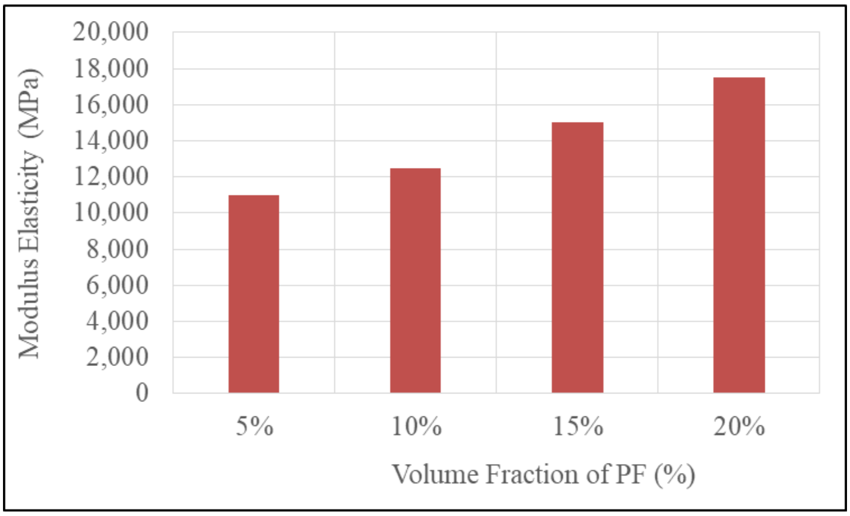

Figure 5 Modulus Elasticiy of polyester composites reinforced hybrid fibers HTBF-PF

The modulus of elasticity of the specimen is shown in Figure 5. The addition of the volume fraction of PF affects the modulus of elasticity of the specimen. The modulus of elasticity of the composite specimen about 11.000, 12.500, 15.000 and 17.500 MPa for the volume fraction 5%, 10%, 15% and 20% PF, respectively. The larger the volume fraction of the PF, the greater the modulus of elasticity of the specimen.

3.2. The impact toughness of polyester composite reinforced hybrid *Hibiscus Tiliaceust* bark and palm fiber

Impact testing using the Izod method of impact testing. Specimen refers to ASTM D256-03 standard. The purpose of the test is to determine the impact toughness, which is the impact energy (energy absorbed) of the specimen per unit area of the test object.

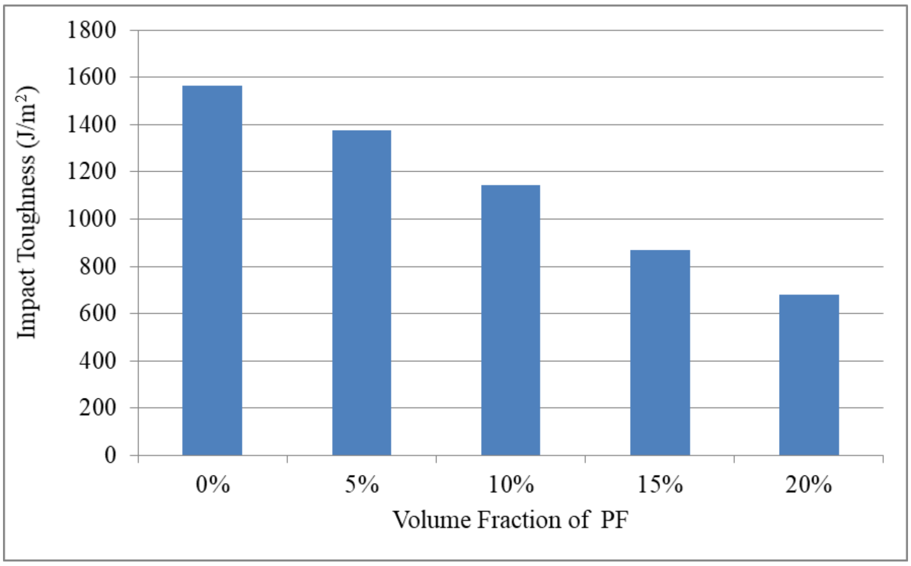

Figure 6 Toughness impact of specimens

Based on the Figure 6. the addition of the volume fraction of PF to the specimen reduces the energy absorbed so that the impact toughness decreases. Sequentially the impact toughness of the specimen: 1.376, 1.143, 869, and 682 J/m^2 for each volume fraction 5%, 10%, 15% and 20% PF. The impact toughness of the polyester composite with HTBF strengthened volume fraction of 5% are 0.0292 J/cm^2 , based on the results of research [9] , 15% volume fraction HTBF of 0.1235 J/cm^2

The use of palm fiber causes the ductility of the polyester composite material to decrease. But the tensile strength, its modulus of elasticity increase. In general, the increase in the strength of a material is proportional to the increase in its hardness value. So that the HTBF-PF hybrid fiber reinforced composite polyester material has the opportunity to be used for levelers. The mechanical properties required for the leveler are high surface hardness, high tensile strength and modulus of elasticity. Another advantage of making levelers is that it is much easier, cheaper to do with hand lay up, compared to making levelers from carbon steel.

3.3. The fault analysis of polyester composite reinforced hybrid ***Hibiscus Tiliaceust*** bark and palm fiber

Observation of the specimen fracture was carried out using the Fault Macro using a Canon EOS 700D Kit (EF S18-55 IS STM) camera with a Canon EF Macro 100mm F2.8L IS USM lens. Observations were made after being carried out after the tensile test of the specimen, the specimen broke after reaching the maximum tensile stress. Fault observation results are shown in Figure 7

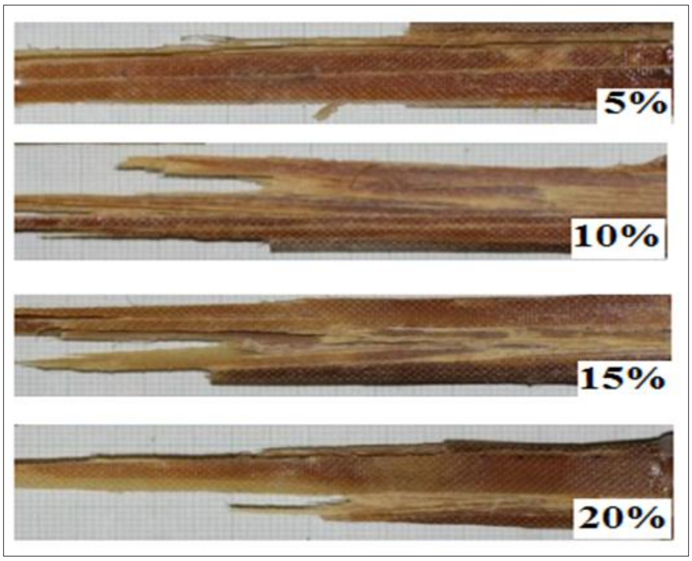

Figure 7 The results of specimen fractures observations with variations in the volume fraction of palm fiber (PF)

In Figure 7. it is shown that the faults that occur in all specimens do not occur at a single point or the fault position cannot be predicted. The fracture in the specimen with a volume fraction of 5% PF has a smaller fracture area, a volume fraction of 10%, 15% and 20% PF. It is assumed that the larger the volume fraction of PF, the polyester matrix composite can distribute the load given to the fiber evenly and the tolerance value to the strength of the fiber is higher. The larger the volume fraction PF, the higher the tensile strength and modulus of elasticity. So that it can be recommended for leveler materials from HTBF-PF hybrid fiber-reinforced polyester composites. Because the shape of the fracture is sharp, indicating it can be used to flatten and destroy rice fields.

4. Conclusion

The addition of the volume fraction of palm fiber (PF), affects the tensile strength, modulus of elasticity, impact toughness and the extent of the fracture shape of the specimen (hybrid polyester composite reinforced HTBF - PF. As the volume fraction of PF increases, the tensile strength, modulus of elasticity, fracture area increases, but the impact toughness of the specimen decreases.HTBF - PF hybrid fiber reinforced composite polyester material, is suitable to be used as a leveler, mainly crushing and destroying paddy fields.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest.

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