Tensile Loading on Composite Polymeric Foam Reinforced by Empty Fruit Bunch Waste (EFB)

Zainal Arif[1)], Taufan Arif Adlie [2)], Fazri[3)], Sulaiman Thalib[4)], Nurdin Ali[5)], Nazaruddin[6)], Mustafa[7)]
[1)2)3)6)7)] Mechanical Engineering of Samudra University
[4)5)] Mechanical Engineering of Syiah Kuala University
Correspondence e-mail: zainalarif@unsam.ac.id

Abstract - The utilization of Empty Fruit Bunch palm oil (EFB) waste into a material product that has high competitiveness is still limited in utilized. It is open the possibility of EFB fiber is processed into other materials or structures. So, the economic value of the waste material can be raised and at the same time can give solutions for handling waste products previously. Data obtained from the Aceh Forestry and Plantation Office in 2009, in Aceh there are 25 units of palm oil processing factory with a total operating capacity of 551.12 tons per hour. From the data, using the assumption of 20% Fresh Fruit Bunches (FFB) will produce solid waste in the form of EFB in a day of 110,224 tons. If this waste is not being utilized it will disrupt the environment. EFB waste has been mixed with Resin, polymeric foam agent and catalyst to produce new polymeric foam composite material reinforced by EFB fibers which are light and also strength. The tensile test was performed to determine the maximum strength of polymeric foam material composite reinforced by EFB fibers and the test specimens using the D-638 standard. The variations of composition were applied on the specimen test based on the weight of each composition, and mesh 80. From the test results obtained a loaded force and a maximum strength average of the materials composite are respectively 874,267 N and 8,921 MPa.

Keyword: *Tensile Loading, Composite Polymeric Foam, EFB*

1. Introduction

The advancement of science and technology in industry has driven the increasing demand for composite materials. (Hartono Yudo, 2008). Composite is engineered materials consisting of two or more materials in which the properties of each material differ from one another, both chemical and physical and remain separate in the final product (M. Budi Nur, 2011). The development of advanced composite technology led to the increasing need for composite materials in the industry, such as aviation, shipping, automotive, military equipment, sports equipment, medical equipment and household appliances (Zulfikar, 2012).

The main advantages of fiber reinforced composite materials over more conventional isotropic materials, however, are the very high specific strengths and specific stiffness which can be achieved. Moreover, with composites, the designer can vary the type of fiber, matrix and fiber orientation to produce composites with improved material properties. Besides the perspective of reduced weight, design flexibility and low fabrication costs (Robinson, A. G. M. M., etc, 1997), and easily produced in large quantities (East, U., & Anlas, G., 2011).

The fiber-reinforced polymer composite material is a commonly used engineering material because its elasticity and ease of shape are superior to those of metal fabrics. The advantages of using composite materials are: relatively light weight, corrosion resistance, water resistance, and good elasticity (Zulfikar, 2012).

In 2013, the global market of polymer foams was about 19.1 million tons according to the report "The future of polymer foams to 2019". This market represents around $87 billion, including those foams used in packaging, construction, automotive, and comfort applications. Furthermore, it is expected that this market continues growing reaching 25.1 million tons in 2019. Most of these polymer foams are used in construction applications, due to their good thermal and mechanical properties. For instance, rigid polyurethane (PU) foams are mainly used as thermal insulators in construction (Notario, B., 2015).

The use of fibers in composite materials is an innovation in materials engineering to produce composite materials that have better strength. The fiber used can be derived from synthetic materials and natural fibers. Natural fibers are organic fibers such as fibers derived from animals, plants, etc. The use of natural fibers in addition to easy to obtain, cheap, and easy to engineer, is also an effort to utilize waste is wasted. Waste material is one of the alternative materials that need to be studied in the development of replacement materials used as reinforcement materials in composite materials. One of its wastes is a waste of Empty Fruit Bunch (EFB) Palm Oil.

Data obtained from the Aceh Forestry and Plantation Office in 2009, in Aceh there are 25 units of Palm Oil Processing Plant (POPP), located in eight District with a total operating capacity of 551.12 tons per hour. From the data, using the assumption of 20% Fresh Fruit Bunches (FFB) will produce solid waste in the form of EFB in a day as much as 110,224 tons. If this waste is not utilized it will disrupt the environment.

EFB waste processes are now being investigated for its usefulness, so that the economic value of waste materials can be improved and at the same time can provide solutions for handling the waste of previously wasted products. For example, the utilization of EFB in the field of technology such as particle board manufacturing and paper raw materials, so it is still open the possibility of EFB fiber processed into materials/ other structures that have high economic value. To provide an environmentally friendly waste treatment solution, the researcher wishes to examine the utilization of this EFB waste in the construction of a composite traffic con structure made of fiber-reinforced of EFB, which has been widely used as fuel for boilers in each palm oil processing plant.

Surely this EFB waste is processed into a fiber which is then combined with other products (resins) to produce composite products that are strong and competitive, cheap and easy to produce.

The composition of this foamed polymer composite material is based on the weight fraction of the constituent material of each support material by variation of resin, blowing agent, EFB fibers and catalyst. The variation is to form of a polymeric foam material which has better strength and can decrease the final weight of the resulting product.

To know the strength or responsiveness of this product, of course need to be held further testing. A test method that will be done by Tensile Testing Machine.

2. Experimental Procedure

2.1. Test specimen's preparation

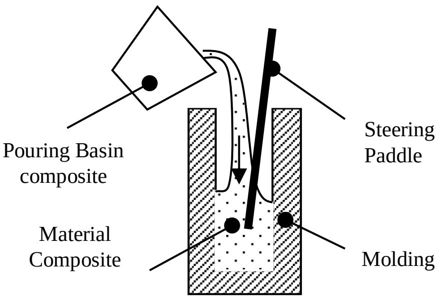

Figure 1. Pouring Molding Process

TABLE 1. MATERIALS RESEARCHES

No.	Material Name	Material type	Information
1.	Polyester Resin.	BQTN 157-EX	
2.	Waste EFB Fiber		fiber
3.	Blowing Agent	Polyurethane	
4.	Catalis	MEKPO	
5.	Fiber rinse	NaOH, 1M	1%
6.	lubricant	WAX	For Molding

EFB waste take from palm oil processing plants, with simple processes needed to make fibers. Firstly, the process of EFB waste was soaking in an aqueous solution mixed by chemical concentrate of NaOH with 1% concentration for 24 hours to eliminate the dirt and sugar cane in EFB waste. Then cleaned with fresh water and dried in the sunrise. The dried EFB then was processed into EFB fibers as shown in Figure 2. To produced composite materials product, the EFB fibers were mixed with thermoset resins and their constituents as shown in table 1.

The technique processed made of polymeric foam composite materials in this study used casting method and poured the composite mixture into the mold after being stirred evenly by using the stirrer in the mixing container. The casting process for more details can be seen in Figure 1. This casting process has resulted in a composite structure with random fiber directions and non-continuous fiber length.

Figure 2. EFB Wash Fibers Treatment Process

Figure 3. Composite Specimens EFB Fiber Reinforced Process.

EFB fibers that have been produced then mixed by resin and others constituent to produce the composite of the tensile test specimen as shown in Fig. 3. Specimens sampled in this study have 3 variations of the composition with 4 specimens for each composition, so the total specimen was 12 specimens. To obtain the best results required several test samples with different compositions with labels A, B, and C.

2.2. Tensile Test

The form of test specimens used in this study has used specimen tensile test specimen prepared in accordance with ASTM D-638 test standard.

The tensile test was performed to determine the strength stress and strain due to the tensile loading of the composite material polymeric foam reinforced by EFB fiber specimens. The universal testing machine is shown in fig. 6. And the process of set up the specimen on the testing machine can be seen in Fig. 7 (a) and the resulted test was shown in Figure 7 (b).

Figure 6. Universal Testing Machine

(a) (b)

Figure 7. set up specimen testing

The static universal testing machine has several procedure operations. The static test regression test step is: (1). Installation of Test Specimen on chuck test machine, (2). Set the test kit with 2 kN, (3) load. Start trial, (4). Record the test results.

3. Results and Discussions

The test specimen with the Lebel A composition has tested by tensile test machine can be seen in Fig. 8. The test results show that the maximum strength occurs in specimen A1 with a tensile strength has a value of 5.121 MPa and the strain generated by the tensile test is 0.025 mm/mm. meanwhile the minimum strength of the test specimen has occurred on the specimen A4 with tensile strength value of 4.787 MPa and a strain of 0.041 mm/mm

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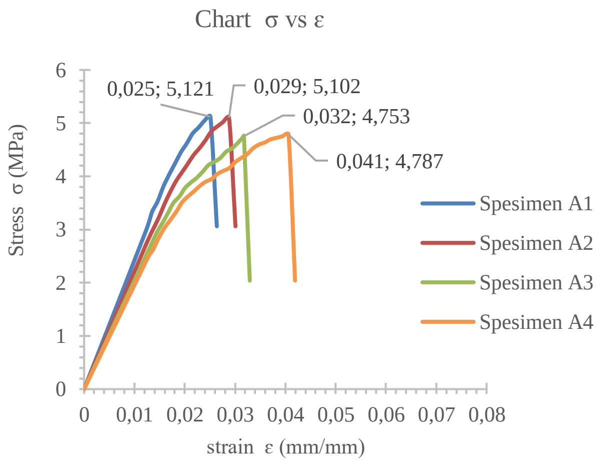

Figure 8. Tensile test on Specimen A composition

The loading conditions in the test conducted on the specimen with label B composition as shown in figure 9, obtained the maximum tensile strength figure occurs in label B4 with a value of 9,482 MPa and the strain formed of 0.019 mm/mm. meanwhile minimum tensile strength occurred in the specimen with B1 label has a value of 8.632, and the minimum strain of 0.032 mm/mm.

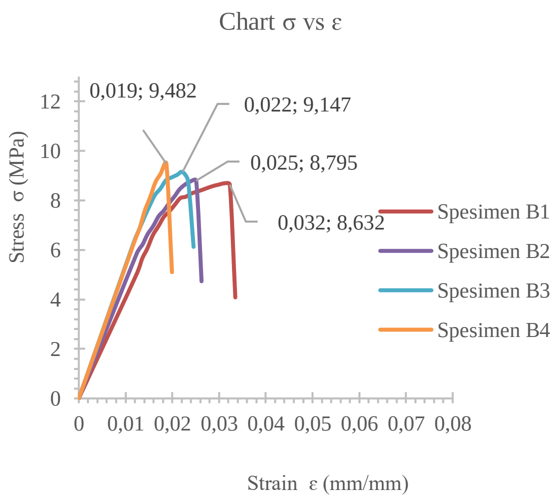

Figure 9. Tensile test on Specimen B composition

Tensile test conducted on specimen composition with label C as illustrated in figure 10. Where the maximum tensile strength value has occurred on specimen C3 label with the value of 2,615 MPa and strain value has occurred 0,024 mm/mm. Meanwhile the minimum stress strength has happened at specimen label C1 with a value of 1,846 MPa with strain has occurred at 0.019 mm/mm.

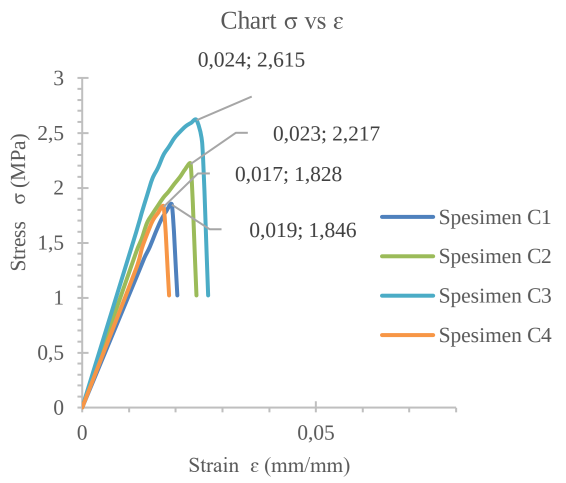

Figure 10. Tensile test on Specimen C composition

The test resulted by tensile testing machine on the specimen with the composition of labels A, B, and C can be concluded the average value of the test results as shown in table 3. In table 3 it is explained that the specimen with label A, the mean maximum voltage value is 4,944 MPa, with a strain value of 0.032 mm / mm. for specimens Composition of label B obtained the average maximum strength of 9,921 MPa with a strain of 0.025. While the Composition C contained a maximum value of 2.127 MPa, a strain formed of 0.021.

Table 3. Stress and strain average

No	Specimen	Average			
		ΔL (mm)	F (N)	ε (mm/mm)	σ (MPa)
1	A	2.684	484.522	0.032	4.944
2	B	2.115	874.267	0.025	8.921
3	C	1.792	208.399	0.021	2.127

4. Conclusion

Tensile test results have been performed on each specimen with a mixture of polymeric foam composite and empty palm oil bunches obtained the maximum average value at tensile load, strain strength and strain strength have respectively 874.267 N, 8,921 MPa, 0.025 mm / mm.

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