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Compressive Loading on Composite Polymeric Foam Material Reinforced by Sugar Cane Bagasse

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Abstract: ***Utilization of sugar cane bagasse into high-competing material product is still limited in its utilization. It is possible that the bagasse fiber can be processed into other materials or structures. Thus, the economic value of waste materials can be generated and at the same time can provide solutions for handling waste products. And if this garbage is not utilized it will disrupt the cleanliness of the environment. The sugar cane bagasse has been mixed with Resins, polymeric foam agents and catalysts to produce a new polymeric foam composite material reinforced by lightweight baggage fibers as well as strength. The compressive tests were performed to determine the force and compressive strength of composite polymeric foam materials reinforced by bagasse fibers and test specimens using the D-1021 standard. The variation of the composition was applied to the specimen test based on the weight of each composition, and mesh 40. From the test results obtained force and compressive average of the material composite respectively are 1140, 52N and 31, 58MPa.***

Keywords: composite polymeric foam, sugar cane baggase, force and compressive

1. Introduction

Advances in science and technology have led to an increase in demand for composite materials, functions and utilities [1], [2] .The use of composites as materials in structures because of composites has very specific stiffness and strength properties [3]. Composites are engineered materials composed of two or more materials [4], in which the properties of each material differ from one another both of chemical and physical properties [5], which are mixed macroscopically and produce new materials in which the original properties of matter remain real [6].The main advantages of fiber-reinforced composite materials are very high specific strength and specific rigidity attainable [7]. In addition, with composites, the designer can vary between fiber and matrix, as well as fiber orientation to produce composites with improved material properties. In addition to the perspective of reduced weight, design flexibility and low fabrication costs [8], and easily produced in large quantities [9]. The fiber-reinforced polymer composite material is a commonly used engineering material because its elasticity and ease of shape are superior to metal fabrics. The addition of blowing agent to the polymer composite is to produce polymeric foam composites. Polymeric foam composites are preferred because they are cheap, light and easy to produce in large quantities [10].Polymers are widely used in engineering component. It requires a detail knowledge of the way they respond to mechanical loading [11]. In 2013, the global market of polymer foams was about19.1 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. [7]. 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 [12]. Polymeric foam is also widely used in lightweight design and heat absorbing applications in the automotive and aircraft industries [10], [13], [14].Natural fiber composites are also claimed to offer environmental benefits such as reducing dependence on non-renewable sources of energy / energy sources, lower pollutant emissions, lower greenhouse gas emissions, enhanced energy recovery, and biodegradability end-components [15]. The use of fibers in composite materials is an innovation in materials engineering to produce composite materials that have better strength [7]. The application of polymeric foam composites is widely used in construction, due to its excellent heat resistance and mechanical properties [16].The fiber used can be derived from synthetic materials and natural fibers. Natural fibers are organic fibers such as fiber derived from animals, plants, etc. The use of natural fibers in addition to easy to obtain, cheap, and easy to do, is also an effort to exploit waste is wasted [7]. Sugarcane production throughout Indonesia based on statistical data in 2013 is 2, 517, 374 tons [17]. In the process of making sugar, harvested sugar cane is squeezed with a squeeze machine (press machine). From the process of making sugar cane will produce 5% sugar, 90% bagasse waste and the rest in the form of drops (molasses) and water. From this percentage, it will produce a lot of bagasse waste which is still widely used as organic fertilizer or just thrown away or burned. So, to increase the high economic value, waste bagasse is still open the possibility to be engineered to produce new material products. Surely this baggase 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.This study aimed to investigate the compressive force and stressstrength of composite polymeric foam material reinforced by sugar cane bagasse. A test method that will be done by Tensile Testing Machine.

2. Experimental Procedure

2.1. Test Specimen's preparation

The research methodology begins with preparation of tools and materials. The next step is the process of making fibers and the manufacture of test specimens. After the specimen is formed proceed with the test to obtain compressive strength. This is described in Figure 1

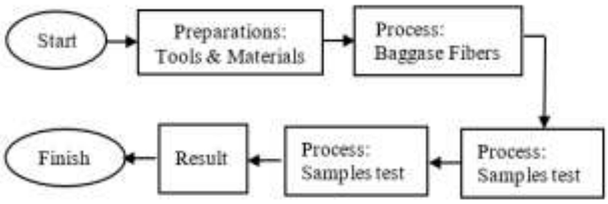

Figure 1: Scheme of Research Process

The composition of the polymeric foam composite material is taken based on the weight fraction of the constituent.Table 1 is the support material with variations for resin, sugar cane baggase, blowing agent, and catalyst. The variation is to form a polymeric foam composite material which has better compressive strength and can reduce the final weight of the resulting material product.

Table 1: Material specifications

No	*Material Name*	*Material Type*
1	Polyester Resin	BQTN 157-EX
2	Sugar Cane Baggase	fiber
3	Catalist	MEKPO
4	Blowing Agent	Polyurethane
5	Delignin	NaOH, 1M
6	Wax	Wax type

Technique of making polymeric foam composite materials in this studyusing the casting method into the mold after being stirred evenly using the stirrer in the mixing container. The casting process is carried out to produce a composite polimeric foam structure in the direction of random and non-continuous fibers as in Figure. 2. So it can not be done by hand lay up, where this method is used on long and continuous fibers.The fiber used is obtained from waste bagasse, which is very easy to obtain with a simple maintenance process. The measured variable is composition of the volume composition based on the specific gravity of the resin with fibers and other fixed material compositions. To get the best result then needed some sample test with three different compositions. Each composioon are lable with A, B, C. And the number of specimens to be tested for each the composition is 6 test specimens.

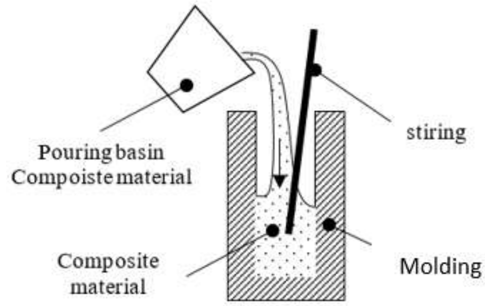

Figure 2: Composite Pouring Process

2.2. Testing

Responses of compressive strength of composite polymeric foam reinforced by sugar cane bagasse were tested under compressive-static loadings. Compressive-static test was conducted on universal testing machine (UTM) according to ASTM D-1021. The number of specimens tested were 6 each composition. The compressive test is performed to find out compressive strength and elongation of the composite polymeric foam material reinforced by sugar cane bagasse. The step of the test tensile test procedure is: (i). Installation of Test Specimens on test machine chucks, (ii). Set up the test equipment with load 2 kN, (iii). Start testing, (iv). Record test results.

3. Result

The test specimen with the Label A composition has tested by compressive testing machine can be seen in Figure3. The test results show that the maximum force occurs in sspecimen A2 with a compressivehas a value of 1006.36N and the stress generated by the compressive test is 11.981MPa. Meanwhile the minimum force of the test specimen has occurred on the specimen A4 with force value of 717.56N and a stress of 8, 542MPa.The compression force and stress value of the average variation for A label composition, respectively are 841.40N and 10.017MPa.

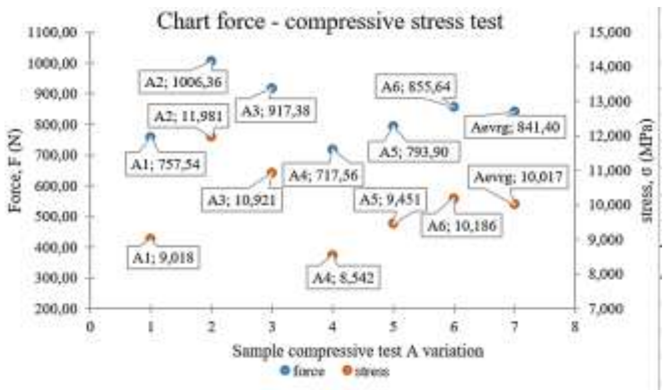

Figure 3: Compressive stress A Composition

The test specimen with the Label B composition has tested and it can be seen in Figure4. The test results show that the maximum force occurs in specimen B4 with a compressive has a value of 1340.64N and the stress generated by the compressive test is 15.96MPa. Meanwhile the minimum force of the test specimen has occurred on the specimen B3 with force value of 977.35N and a stress of 11, 64MPa. The compression force and stress value of the average variation for A label composition, respectively are 1140.52N and 13.73MPa.

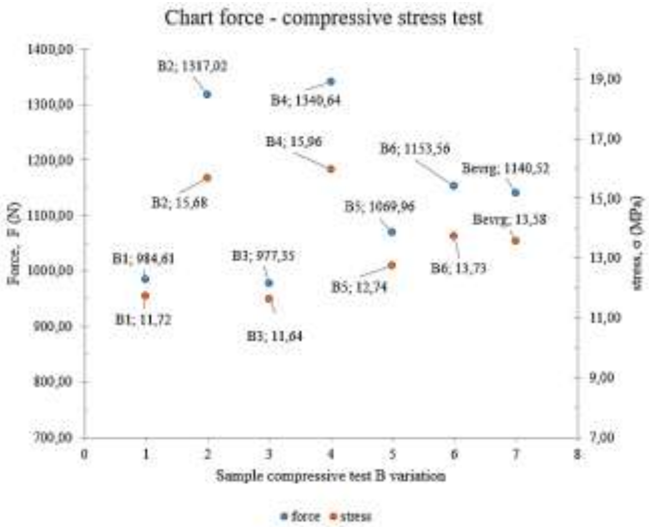

Figure 4: Compressive stress B Composition

The test specimen with the Label C composition has tested and it can be seen in Figure5. The test results show that the maximum force occurs in sspecimen C6 with a compressive has a value of 626.71N and the stress generated by the compressive test is 7.46MPa. Meanwhile the minimum force of the test specimen has occurred on the specimen C1 with force value of 477.75N and a stress of 5.69MPa. The compression force and stress value of the average variation for C label composition, respectively are 1140.52N and 13.73MPa.

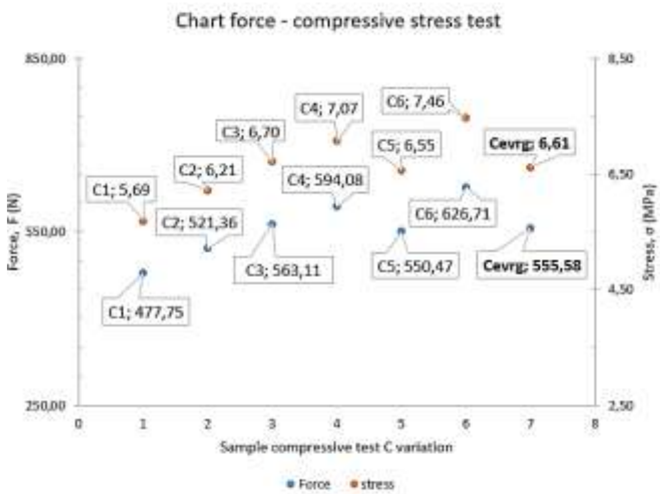

Figure 5: Compressive stress C Composition

From comparison of test result tap on test sample label A, label B, and label C can be seen in Figure 6.

The test results show that the maximum force occurs in specimen B with a compressive has a value of 1140.52N and the stress generated by the compressive test is 13.58MPa.

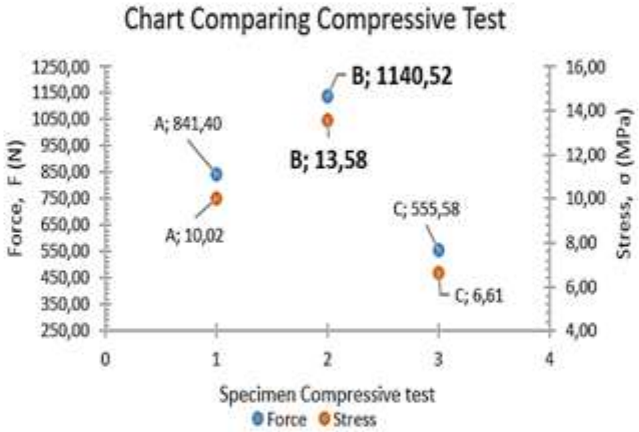

Figure 6: Comparing Compressive Test

4. Conclusion

Compressive test results have been performed on each specimen with a mixture of polymeric foam composite material reinforced by sugar cane bagasse obtained the maximum average value at compressive force and stress compressive strength have respectively 1140.52N and31, 58MPa.

References

[1] M. Rosso, "Ceramic and metal matrix composites: Routes and properties, " *J. Mater. Process. Technol.*, vol. 175, no. 1–3, pp. 364–375, Jun. 2006.

[2] H. Yudo and S. Jatmiko, "ANALISA TEKNIS KEKUATAN MEKANIS MATERIAL KOMPOSIT BERPENGUAT SERAT AMPAS TEBU (BAGGASE) DITINJAU DARI KEKUATAN TARIK DAN IMPAK, " *Kapal*, vol. 5, no. 2, pp. 95–101, 2008.

[3] R. A. Eshkoor, A. U. Ude, A. B. Sulong, R. Zulki, A. K. Arif, and C. H. Azhari, "Energy absorption and load carrying capability of woven natural silk epoxy e triggered composite tubes, " *Compos. Part B*, vol. 77, pp. 10–18, 2015.

[4] Y. Yang, M. C. Gupta, K. L. Dudley, and R. W. Lawrence, "Novel Carbon Nanotube−Polystyrene Foam Composites for Electromagnetic Interference Shielding, " *Nano Lett.*, vol. 5, no. 11, pp. 2131–2134, Nov. 2005.

[5] D. Van Krevelen and K. Te Nijenhuis, "Properties of polymers: their correlation with chemical structure; their numerical estimation and prediction from additive group contributions, " 2009.

[6] J. Lemaitre and J. Chaboche, "Mechanics of solid materials, " 1994.

[7] Z. Arif *et al.*, "Tensile Loading on Composite Polymeric Foam Reinforced by Empty Fruit Bunch Waste (EFB), " *Int. Conf. Sci. Technol. Mod. Soc.*, vol. 1, no. 1, pp. 168–171, 2017.

[8] A. G. M. M. Robinson, D. E. M. G. A. D. M. B. Ioannidis, and J. Carruthersb, "Review Crashworthy capability of composite material structures p, " *Compos. Struct.*, vol. 37, pp. 109–134, 1997.

[9] U. Esat and G. Anlas, "Hydrostatic compression of anisotropic low density polymeric foams under multiple loadings and unloadings, " *Polym. Test.*, vol. 30, pp. 737–742, 2011.

[10] S. Fu, Y. Wang, and Y. Wang, "Tension testing of

polycarbonate at high strain rates, ” *Polym. Test.*, vol. 28, no. 7, pp. 724–729, 2009.
[11] K. Kishimoto, “CRACK INITIATION BEHAVIOR OF ABS RESIN UNDER MODE I AND MIXED MODE LOADING ARTICLE in MATERIALS SCIENCE RESEARCH INTERNATIONAL · SEPTEMBER 1997 OF ABS RESIN I AND MIXED MODE LOADING, ” no. SEPTEMBER 1997, 2016.
[12] B. Notario and J. Pinto, “Towards a new generation of polymeric foams : PMMA nanocellular foams with enhanced physical properties, ” *Polymer (Guildf).*, vol. 63, pp. 116–126, 2015.
[13] E. Kabir, M. C. Saha, and S. Jeelani, “Tensile and fracture behavior of polymer foams, ” *Mater. Sci. Eng. A*, vol. 429, no. May, pp. 225–235, 2006.
[14] K. S. Yen, M. M. Ratnam, and H. M. Akil, “Measurement of flexural modulus of polymeric foam with improved ´ method accuracy using moire, ” *Polym. Test.*, vol. 29, pp. 358–368, 2010.
[15] S. V Joshi, L. T. Drzal, A. K. Mohanty, and S. Arora, “Are natural fiber composites environmentally superior to glass fiber reinforced composites ?, ” *Compos. Part A Appl. Sci. Manuf.*, vol. 35, pp. 371–376, 2004.
[16] F. Ramsteiner, N. Fell, and S. Forster, “Testing the deformation behaviour of polymer foams, ” *Polym. Test.*, vol. 20, pp. 661–670, 2001.
[17] E. D. Clareyna and L. J. Mawarani, “Pembuatan dan Karakteristik Komposit Polimer Berpenguat Bagasse, ” *J. Tek. ITS*, vol. 2, no. 2, pp. F208–F213, Aug. 2013.

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