Thermal Cyclic Resistance Polyester Resin Composites Reinforce Fiber Nut Shell

Hendriwan Fahmi
Institut Teknologi Padang, Padang, 25146, Indonesia
Telp/fax : +62751443317
Email : hendriwan.basyaruddin@gmail.com

Abstract: The purpose of study is to determine the effect of fiber length and thermal cyclic of the bending strength of polyester resin composite reinforced by fibers nut shell. The materials used in this study is a nut shell fibers with fiber length of 1 cm, 2 cm and 3 cm and polyester resin with composition 70-30%wt. Fiber nut shell treated soaking in NaOH 30% for 30 minutes, then rinse with clean water so that the fiber free of alkali and then dried. Furthermore, the composite is heated in an oven to a temperature of 100^0C for 1 hour and then cooled in the open with a variety of thermal cyclic 30, 40, and 50 times. Bending properties of composites known through the testing process using a three-point bending test equipment universal testing machine. The test results show that the bending strength bending highest in fiber length of 3 cm with 30 treatment cycles of thermal to the value of 53.325 MPa, while the lowest occurred in bending strength fiber length of 1 cm with no cycles of thermal treatment to the value of 30.675 MPa.

Keywords: Composites, fiber nut shell, Long Fiber, Thermal Cyclic, BendingTest

1. Introduction

The prospect of developing natural fiber-based composite in Indonesia is very good, since the majority of natural fiber-producing plants can be cultivated in the country, such as cotton, kapok, flax, jute, hemp, sisal, coconut, palm, banana,. The development of natural fiber-fiber composite technology is also in line with government policy to explore local potential genius. This will certainly increase the empowerment of renewable local natural resources (Boimau, 2015). Technological developments turned out to cause the emergence of new problems, namely environmental problems that can interfere with human life. One of the environmental problems that began to feel today is the destruction of the environment caused by the amount of material that can not be destroyed by nature, therefore more environmentally friendly replacement materials are needed. Natural fiber materials include environmentally friendly materials, these materials can be broken down by nature, the fiber has a tendency to suck water, the fiber can be decomposed by nature under certain conditions by bacteria / fungi. In addition to environmentally friendly natural fiber materials have various advantages of cheap price. A study of HDPE waste composites with natural fibers has been done Thimothy and Baillie (2007), the effect of agave fiber extract method and HDPE waste as roof ceilings indicates that fibers with previous heat treatment will increase their strength compared to non-treated fibers previously.

Research on long-term heat cycles between fiberglass and epoxy with a temperature cycle of 27 ° C and a peak temperature of 50 ° C, with repetitions of 6, 12, 24, 36, and 48 retained within 5 minutes indicates that the length of time at high temperatures Will result in damage to the interfacial bond between the amplifier and the matrix resulting in a decrease in composite strength (Papanicolaou and Xepapadaki 2009). The mechanical strength of the HDPE matrix with volume fractions of 5, 10, 20, 30, and 40% of clay particles and rubber tires pressed at 10 MPa at 190ºC for 10 min indicates a decrease in mechanical strength (Avila and Fajula 2009).

Fiber nut shell is one of alternative natural fiber materials in the manufacture of composites scientifically utilization was continuously developed. This areca nut begins by the user because in addition to easy to obtain, cheap, can reduce environmental pollution (biodegradability) so that this composite can overcome environmental problems, and do not endanger health. The development of fiber nut shell as a composite material is very understandable given the availability of natural fiber raw materials, Indonesia has abundant raw materials. K.Boimau and T.D. Cunha (2015), conducted research on the influence of fiber length of gewang leaves to composite properties showed that composite with 70-30% v composition with 3 cm fiber length has bending strength of 45.35 MPa, length 2 cm 39,7 Mpa and length 1 Cm of 35.1 Mpa. This result shows that the longer the fiber the higher the bending power. This study aims to determine the effect of fiber length and the effect of thermal cyclic produced on bending strength with random fiber orientation.
A composite is a material formed from a combination of two or more materials, in which the mechanical properties of the constituent material vary. Due to different forming characteristics, it will produce new material that is composite which has mechanical properties and the combined characteristics of the material forming. The matrix in the composite functions as a fiber binding material into a unit of structure. Protect from external damage, forward or move external load on the sliding plane between fiber and matrix, so that matrix and fiber are interconnected (Schwartz, 1992). The fabrication of fiber composites requires a strong surface bond between the fiber and the matrix. In addition, the matrix must also have chemical compatibility so that unwanted reactions do not occur on the contact surface between the two. To select the matrix should be considered its properties, among others, resistance to heat, poor weather resistance, and resistance to shocks that are usually a consideration in the selection of matrix materials. Polymer materials that are widely used as a matrix material in composites are two kinds: thermoplastic and thermoset (Schwartz, 1992).

According to Gibson R.F (1994), matrices in composite structures can be derived from polymer, metal and ceramic materials. In general, the matrix has the following functions:

- Bind fibers into one unified structure.
- Protects fibers from damage due to environmental conditions.
- Transfer and distribute foil loads.
- Contribute several traits such as stiffness, strength, and
- physical resistance.
- Below are the conditions that must be met as matrix materials for printing of composite materials (Surdia, 1985):
- The resin used should have a low viscosity, in accordance with the reinforcing and permeable materials.
- Can be measured at room temperature in optimal time.
- Has a small shrinkage in preservation.
- It has good adhesiveness with reinforcing materials.
- It has good properties of the preserved material.

In general the matrix is divided into two groups namely (Feldman and Hartomo, 1995):

- Thermosets are materials that can not melt or soft when heated because the molecules are cross-linked so that the material can not be recycled back. For example epoxyesin, polyester, urea formaldehyde.
  Phonolformaldehyde, melamine formaldehyde and others.

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- hermoplastic is a material that can become soft again when heated and hardened when cooled so that the formation can be done repeatedly because it has a linear structure. Examples of thermoplastics: PVC (poly vinyl cloride), FE (Polyethylene), PP (polypropylene) nylon 66, polyamide poiasetal and others.

Composite amplifiers generally have less ductile properties but are more rigid and stronger. The main function of the amplifier is to support the strength of the composite, so that the high strength of the composite depends greatly on the amplifier used, since the voltage applied to the composite is initially received by the matrix to the amplifier, so that the amplifier will hold the load to the maximum load. Therefore the amplifier must have higher tensile stress and modulus of elasticity than the composite matrix. The polyester resin is a matrix of composites. These resins are also included in thermoset resins. In the polyester thermoset the liquid resin is converted into a hard and brittle solid formed by the chemical crosslinking which forms a very strong polymer chain. According to Mubarak (2006) thermoset resins do not melt due to heating. At the time of printing, this resin does not need to be applied pressure, because when it is liquid it has a relatively low viscosity, hardened at room temperature with the use of a catalyst without producing gas (unlike other thermoset resins).

In general, the polyester resin is strong to the acid except the oxidizing acid, but has a low resistance to the base. If the resin is inserted into boiling water for 300 hours it will break and crack. Widely polyester is used in the form of composite materials.

The mechanical properties of the epoxy proposed by F.smith (1993) can be explained based on Table 1:

Table 1. Mechanical properties of epoxy resin

Properties	
Tensile Strength	40-90 MPa
Modulus of elasticity	2,0-4,4 GPa
Bending Strength	60-160 MPa
Impact	10,6-21,2 J m
Density	1,10-1,46 gr/cm^3

Many betel nut utilization is still limited. Nuts that are still often used so far are the leaves, stems and seeds. Meanwhile, the coir part of the nut is wasted with no use or used further. Given the very limited use of fiber nut shell, there needs to be innovation for the use of fibers nut shell such as the manufacture of natural composites. Fiber nut is one of the alternative fiber materials in the manufacture of scientific composites, the utilization is still developed because nut shell nutrients in addition to easy to obtain, cheap, can reduce environmental pollution so that the composite is able to overcome environmental problems, and not harm the health.
Development of betel fiber as a composite material is very understandable given the availability of raw materials of natural fiber Indonesia which has abundant raw materials. The composites with natural fiber reinforcement have advantages such as specific strength and high modulus, low density, low price, abundant in many countries, lower pollution emissions.
The content in betel nut fiber is:
a. Cellulose content 70,2%
b. Water 10,92%
c. Ash 6.02%

Figure 1. Fiber nut shell

2. Methodology

Fiber Preparation

Betel nut fibers are taken only fine, the skin and fiber are rough. The selected betel nut is dry fiber. After the betel nut fibers are sufficient for the manufacture of specimens, a specimen will be made using polyester resin, the position of the areca nut is made randomly or randomly. Preparation stage of betel nut fiber is:

2.1 Preparation of betel nut

The areca fruit is an old and ripe fruit, to indicate the areca nut that has been able to take this usually from the discoloration of the skin (from green to reddish yellow), There is also a fruit that has been old or ripe this will fall from itself Stem nut.

2.2 Separation of the skin and the contents of areca nut

After the fruit is taken, it will be separated between the contents and the skin. There are two ways of separating the skin and the contents of areca nut. The first ripe fruit is directly split and separated with aids, for example: a screwdriver or a knife. Both nuts are dried in the sun until the skin is dry, just separated.

2.3 Drying of betel nut skin

For betel nut fiber that is used is, fiber that comes from the skin of fruit that has been dried. Ripe areca nut will be dried first.

2.4 Separation of betel nut fiber

The dry skin consists of 3 parts:

- Outer skin, black or gray. Being on the outside.
- Fine fiber, yellow. Is a constituent after the outer skin of betel nut, located between the outer shell and coarse nut shell fiber.
- The coarse nutrient shell, yellow, is shaped like a coarse grain and larger than fine fibers of areca nut. Coarse fibers directly blend with the shell of betel nut

Separation between these fine fibers in a simple and manual way. The outer shell and coarse shell fiber are removed, leaving only fine fibers, the results obtained in the form of a cotton-like yarn.

2.5 The formation of dimension (length) fiber of betel nut

Cutting will be done after the fine fibers are separated on the skin of betel nut fibers, the lengths made in this case are 1 cm, 2 cm and 3 cm.

2.6 Soaking with NaOH solution
After the formation of the length dimensions of betel nut fiber, it will be immersed in NaOH solution, the areca nut is treated by immersion in 30% NaOH solution for 30 minutes. The soaked betel nut is then cleaned with water and dried.

Specimen manufacture
After immersion in the NaOH solution and resin preparation is complete, the next step is to perform the specimen, the fiber orientation in this case is random, the composite panel making begins by preparing a square mold with dimensions of 300 mm x 170 mm x 5 mm (for bending test) That have been waxed throughout the surface. Then the fiber nut is positioned randomly / randomly in the mold. After that the polyester resin and hardener mixed with a ratio of 30 : 1 until evenly distributed, then poured on molds that have been filled with areca nut. After that the mold is left to harden and dry in room temperature for ± 24 hours. All these composite manufacturing processes are carried out by the same method for each fiber length. The bending test specimen complies with ASTM-D790.

Figure 2. Dimensional specimen bending test

Figure 3. Specimen

Thermal cyclic
After the specimen is ready to be formed, the thermal cycle test is 30, 40 and 50 times at 100^0C and held for 60 min. Further testing is done bending.

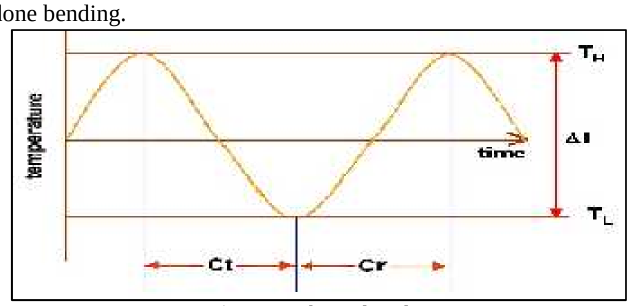

Figure 4. Thermal cyclic

3. Results and Discussion

The tested composite was a polyester resin composite with a betel nut fiber reinforcement, with a composition of 70: 30 wt. The fiber length used in this study was 1 cm, 2 cm and 3 cm and used thermal cyclic variations of 30, 40 and 50 cycles at 100 ° C and held for 60 minutes. Furthermore, the bending test with the method of Three Point Bending.

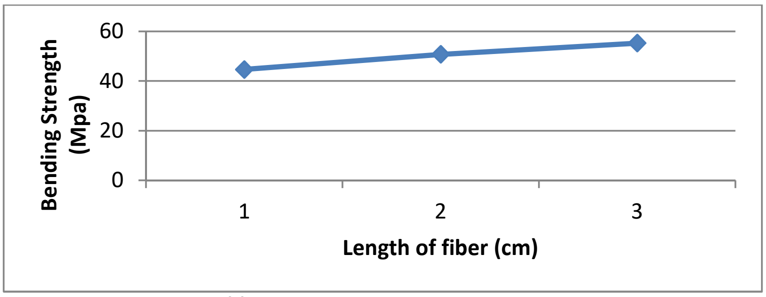

Figure 5. Graph of fiber length relation with composite bending strength.

From the picture above got the highest strength value is 55.2 MPa at 3cm fiber length and the lowest value obtained at 1 cm fiber length is 44,63 MPa. In general, the manufacture of composites is aimed at combining properties possessed by the resin as a matrix and fiber as a reinforcement, therefore the incorporation of these two things will result in the composite material being formed to be stronger. This fiber will eventually retain most of the forces acting on the composite, when the test is carried out the initial voltage will be received by the matrix (resin) and forwarded to the fiber so as to withstand the maximum load.

Thermal cyclic

From the thermal cycling test the results obtained as in table 2

Table 2. Thermal Cyclic testing data

Thermal Cyclic	Length of fiber (cm)		
	1	2	3
0	44,63	50,7	55,2
30	35,93	49,05	53,3
40	30,9	43,5	53,13
50	30,68	37,65	48

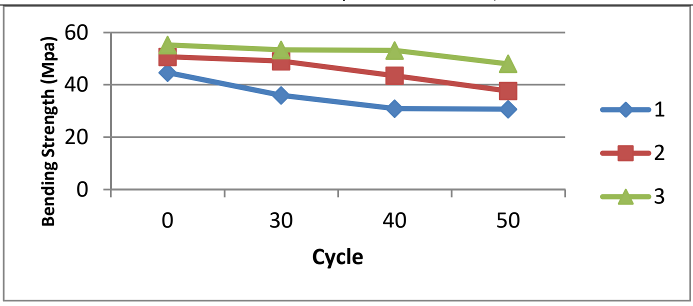

Figure 6. Graph of thermal cyclic relation to bending strength.

From the picture above, the bending strength decreases with the increase of thermal cycle. Thermal cycling treatment results in lower tensile strength as the larger cycle is given to the composite properties. This is because during the process of thermal cycling, there is a shift of the interface between the matrix and the amplifier, so that will cause a gap in this composite is the beginning of the formation of cracks. The time cycle shifts occur because of the expansion coefficient between different matrices and fibers (Avila and Fajula 2009), so that over time the fibers will be detached from the matrix causing the tensile strength of the reduced composites. The decrease in bending strength occurs due to the occurrence of a gap caused by the release of the bond between the matrix and the areca nut which causes the area of the specimen to accept the smaller the force. The influence of thermal cyclic treatment on composites using epoxy matrices, debonding failure of the matrix due to the influence of thermal fatigue, research (Surdia 2010) of time and high temperatures can be the cause of decreasing polymer strength, polymers in a short time at higher temperatures Give effect damage.

4. Conclusion

The highest bending strength in epoxy resin matrix composite reinforced with betel leather fiber with a fiber length of 3 cm is 55.2 MPa and the lowest value at 1 cm fiber length is 44.63 MPa. In testing the thermal cycle in getting the value of bending strength decreases with increasing number of heating cycles due to the occurrence of a gap caused by the release of the bond between the matrix and pinang fiber which causes the area of the specimen to accept the smaller the force.

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