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Bending Strength Of Sandwich Composite Material With Polyester Reinforced Stem Banana Fiber Skin AndParaserianthes Falcataria Core

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Abstract:*This study aims to determine the bending strength of a sandwich composite material with a polyester skin reinforced with fiberglass and banana stem fiber with the coreParaserianthes falcataria wood. The skin was made by hand lay up method, with a volume fraction of 10% glass fiber and a banana stem fiber volume fraction of 10%, 20% and 30%. The sandwich composite was made by gluing skin and sengon marine wood core composites. The test carried out is the bending strength test with ASTM C393 standards.The test results showed that the highest average bending strength of 53.81 MPa was obtained in sandwich composites with polyester skin with a volume fraction of 10% glass fiber and 30% banana stem fiber, while the lowest average bending strength of 41.43 MPa was obtained at 10% glass fiber sandwich composite and 10% addition of banana stem fiber. So it can be concluded that the addition of volume fraction of banana stem fiber has an effect on the bending strength of the sandwich composite material***.**

Keywords:*Compocite sandwich material, bending strength, polyester, banana stem fiber, Paraserianthes falcataria, core*

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I. INTRODUCTION

Sandwich composite material is one type of structural composite consisting of two layers of composite skin and a core in the middle. Skin is a fiber-reinforced composite matrix resin. The cores that are usually used are polyurethane (PU), polyvinyl cell (PVC), and honeycomb. Sandwich composites can be applied as structural and nonstructural internal and external parts on trains, buses, trucks, and other types of vehicles.(Zheng al., 2012).The abundant availability of Paraserianthes falcatariais a natural resource that can be engineered into national flagship technology products as sandwich composite cores. Core engineering can be done from whole wood or wood waste. The core engineering concept is a stage of technology transfer inspired by the entry of core imports of balsa wood from Australia. The physical properties of sea sengon wood are almost the same as balsa wood.Banana is a plant that has a high enough fiber content in the stem, so the fiber from the banana stem has the potential to be an ingredient in the development of composites. In this study, banana stem fiber was used as a reinforcing fiber for polyester fiber glass composite, skin in sandwich composites.As a structured and non-structured material, the sandwich composite material must have good bending strength, so that there is no deflection if there are external forces or loads. Studies on the characteristics of the bending strength of sandwich composite materials have been carried out, among others: Tests for bending 3-layer glass fiber composite in the form of a chopped strand mat with a density of 300 grams / m2 and 450 grams / m2 obtained bending strength of 208.58 MPa and 157.06 MPa. Composites with a smaller density mat produce a thin composite thickness, so that their flexural properties are higher. The composite has a higher bending strength, but the ability to withstand loads is still lower (Guo et al.,2003; Zhang et., 2018).Based on the description above, research on glass fiber sandwich composites with the addition of the volume fraction of banana stem fiber and marine sengon wood cores is a very interesting study for further research.

The The recent years, the bending strength, flexure properties of the material sandwich composite has been diligently studied. In the research carried out by (Yousefpou etal., 2017; Huang et., 2017; Li et al., 2019), about the bending behavior of these sandwich composites with two types of carbon fiber reinforced polymer face sheets. Under bending deformation, sandwich composites with truss core materials provide highest flexural stiffness and strength that are desirable in structural components. The sandwich composites with re-entrant honeycomb core exhibit a sequential snap-through instability which significantly enhances the energy absorption abilities. The results indicate that architected core structures can be utilized to tailor the bending properties as well as failure mechanisms. These findings offer new insights into the study of nonlinear mechanical response of sandwich structures, which can benefit a wide range of industries and applications.

In order to improve the overall performance of sandwich structures. In this study(Yazdani Sarvestani et al.,2018; Selver et al, 2019), they implement semi-analytical and finite element approaches and conduct experimental impact tests to evaluate the performance of 3D printed lightweight sandwich panels with architected cellular cores of programmable six-sided cells. Changing the geometrical parameters of the cells leads to cores of hexagonal, rectangular and auxetic topologies. A semi-analytical methodology is developed for conducting structural and low-velocity impact analyses based on a modified higher-order shear deformation theory. The standard mechanics homogenization is implemented through finite element modelling to accurately predict the effective mechanical properties of architected cellular cores. The large deformation finite element simulation using ANSYS to analyze the elasto-plastic behavior of architected sandwich panels under a low-velocity impact. To experimentally corroborate the developed theoretical and computational models and to evaluate the manufacturability of the sandwich panels, we use the fused deposition modeling to 3D print samples of polylactic acid biopolymers. Uniaxial tensile test is first used to characterize the biopolymer. They conduct low-velocity impact tests to investigate the energy absorption capability of architected sandwich panels. X-ray micro-tomography is finally employed to study the microstructural features of panels before and after the impact. The results show that the auxetic sandwich panel is potentially an appropriate candidate for energy absorption applications due to its high-energy absorption capability and a minimum response force transferred from the 3D printed panel.

The researched obout investigates the effect of face materials, Z-pin types and distribution densities on drop-weight impact properties of foam core sandwich composites have done (Yolacan et al 2019; Balıkoğlu et al., 2018). The novelty of this study is to eliminate damage of face part by only reinforcing the core part of sandwich structures. Impact test was performed at different energy levels (20–50 J). The addition of Z-pins into the sandwich composites decreased the elasticity and ductility while it increased the stiffness of sandwich composites. The Z-pin reinforcement increased the peak forces, but decreased the peak deformations of the sandwich composites. However, higher energy absorption was only observed at the higher Z-pin distribution density. The results showed that Z-pin distribution density, bonding between the face sheets/pins, and the face sheet material have a great influence on the impact behaviour of the Z-pin-reinforced sandwich composites besides the Z-pin types.Mechanical performance of marine sandwich panels comprising E-glass/vinyl ester face sheets and perforated poly-vinyl chloride foam core was evaluated and compared with conventional foam core sandwich panels. Circular holes through the foam core thickness were drilled with 12 different arrangements in square patterns and the holes were filled with the resin during the infusion process which created the through-the-thickness solid resin pins. The effect of each pattern on the flatwise compression and core shear properties of the sandwich panels were experimentally investigated. The three-point bending maximum failure load of perforated foam core sandwich panels was increased over 133.8% by increasing the diameter of the resin pins at the expense of increased panel weight up to 67%. The flatwise compression stress to induce core crushing was significantly increased by reinforcing the resin pins (Balıkoğlu et al., 2018).

Novel lightweight sandwich panels with hybrid core made of honeycomb, foam and through-thickness pin was developed (Jayaram & Michael Raj et al., 2017; Yalkin et al., 2015). Reinforcing polyester pins between faces and core is an effectual way to strengthen the core and enhance the interfacial strength between the face/core to improve the structural performance of sandwich panels. To provide feasibility for pin reinforcement, honeycomb core was pre-filled with foam. Mechanical properties enhancement due to polyester pinning were investigated experimentally under flatwise compression, edgewise compression and flexural test. The experimental investigations were carried out for both "foam filled honeycomb sandwich panels" (FHS) and "polyester pin-reinforced foam filled honeycomb sandwich panels" (PFHS). The results show that polyester pin reinforcement in foam filled honeycomb sandwich panel enhanced the flatwise, edgewise compression and flexural properties considerably. Moreover, increasing the pin diameter has a larger effect on the flexural rigidity of PFHS panels. PFHS panels have inconsequential increase in weight but appreciably improved their structural performance.

Natural fibres offer good acoustic properties due to their structures; hence natural fibre reinforced composites have been widely used as sound absorber materials for structural applications in recent years. This study aims to explore the relationship between sound absorption properties and stacking sequence of natural fibre and hybrid composites. Hybrid laminates consisted of glass/flax and glass/jute fabrics with various stacking sequences were produced using vacuum infusion method. Sound absorption coefficient and sound transmission loss (STL) of composites were measured through a medium type impedance tube with four microphones at frequencies from 100 to 3500 Hz. Results showed that composite laminates made from hybrid fabrics showed higher sound absorption coefficient than glass and natural (jute and flax) fibre composites. Stacking sequence played a critical role whilst using natural fibres at the face region offered higher sound absorption coefficient than using them at cores. It was observed that natural fibre and hybrid composites had higher transmission losses compared to glass composites, and less amount of sound weretransmitted through when natural fibres were used at the outer region (Selver&Erdem., 2019).

In order to optimize the physico-chemical properties of a drug, certain functional groups can be derived by means of a biorreversible process with small organic molecules, masking some undesirable characteristics without permanently changing the bioactive properties of the molecule. Such a strategy has been successfully applied to functional groups such as alcohols which, converted to esters, can be regenerated in vivo either chemically or enzymatically. This process is termed drug latency (Chin et al., 1999; Djurendić et al., 2014; Pang et al., 2017; Sun et al., 2016).

In this sense, ibuprofen is a drug that has aroused significant interest in the scientific community, since in addition to its recognized anti-inflammatory effect linked to its low cost and sale without prescription, it consecrates it as one of the most commercialized anti-inflammatory in Brazil and worldwide. This compound is therefore biologically active, and has been the precursor of derivatives with promising pharmacological properties, such as antimicrobials, gastroprotectors, enzyme inhibitors, among others(Abdulla, 2014; Gandomkar et al., 2015; Gundogdu-hizliates et al., 2014; Habibi et al., 2013; Kansara et al., 2009; Kong et al., 2014; Lolli et al., 2001; Pérez et al., 2017; Rashidi et al., 2008; Shu, 1998; Wang et al., 2014).

In view of the promising and recognized volume fraction of banana stem fiberand the coreParaserianthes falcataria wood effects. This study aims to determine the bending strength of a sandwich composite material with a polyester skin reinforced with fiberglass and banana stem fiber with the coreParaserianthes falcataria wood.

II. EXPERIMENTAL PROCEDURE

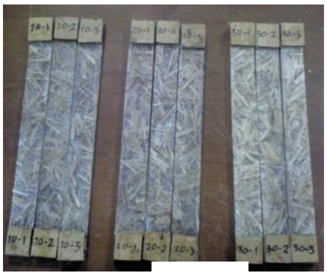
2.1 The material

The the material composite sandwich used in this study consisted of skins and cores,shown in Figure 1. Skin in the form of polyster which is reinforced with fiber glass and banana stem fiber , core are Paraserianthes falcataria wood. The volume fraction offiber glassare 10 %, and the volume fraction ofbanana stem fiber are 15 %, 20 % and 30 %. The process of taking fiber is done by soaking the banana stems for 2 days then dredging, drying at room temperature or aerating. The fibers were immersed in 4% NaOH solution by volume for 2 hours.The length of the fiber is 20 mm with random oriented. The skin mold is made using plate iron with a thickness of 12.7 mm with a printing area of 80 mm x 80 mm. The core composite sandwich is made using Paraserianthes falcataria wood which is cut into 280 mm length, 100 mm width and 30 mm thickness, then dried in the sun for 15 days. Making a composite sandwich by gluing the skin and core using polyester resin.

Figure 1. The material used in this study

Banan stem fiber

Banan stem fiber



Skin

Compocite sandwich

2.2 The research method

.The size of specimens in this study is the length of 280 mm, a width of 100 mm and a thickness of 40 mm, according to standard ASTM C – 393, are shawn at Figure 2 . This sandwich composite bending test usesUFTM (*Universal Flexure Testing Machine*). the bending test for skin uses CBR Tester T104 with the three point bending method, shown in Figure 3.

Figure 2. The bending test specimen standard ASTM C – 393

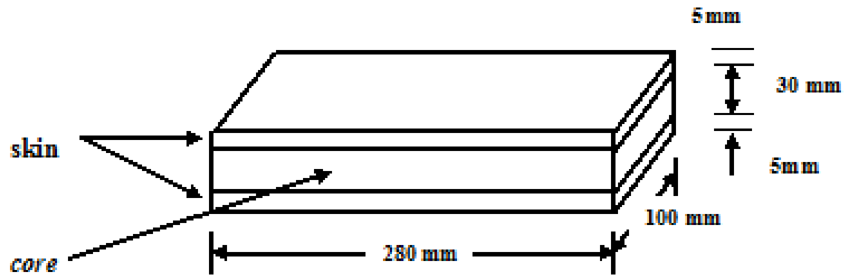
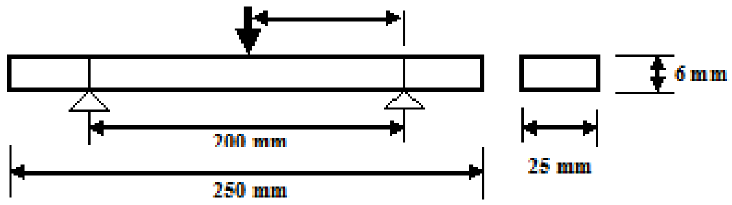


Figure 3. The methode of three point bending

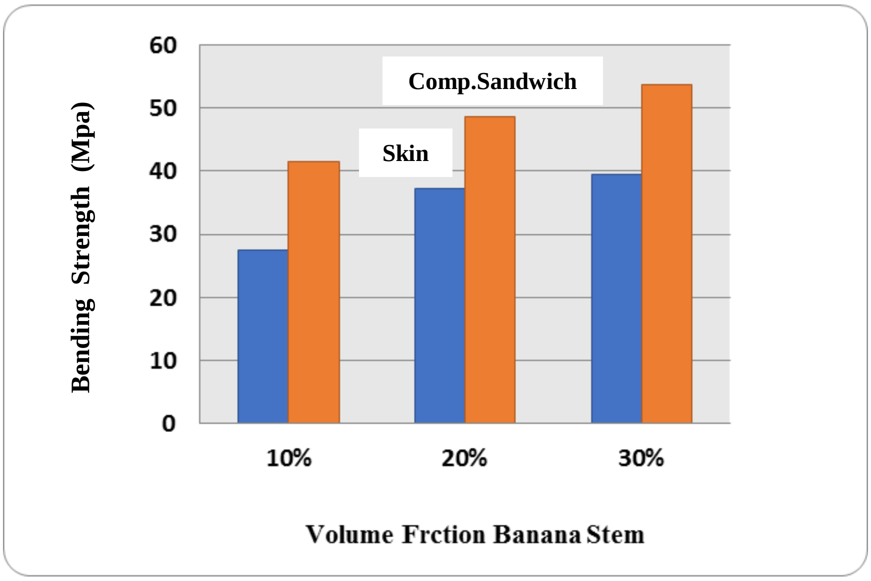


III. RESULTS AND DISCUSSIONS(11 BOLD)

3.1. The bending test of skin and material copmpcite sandwich

Figure 4is shown that the addition of the volume of banana stem fiber by 30% in the sandwich composition material produces the highest bending strength compared to the addition of volume of 10% and 20%.

Figure 4. Bending strength of skin and sandwich composites



This is due to the increasing number of fibers that will contribute very well in bearing the load, so that the load given to the composite will be held by the fiber to the maximum load limit which causes the composite to experience fractures or crack. In addition, with the sandwich composite structure added with sengon laut wood as the core, it will make the composite stronger against the given load. So that with the addition of the volume of banana stem fiber in the sandwich composite with the cores of sengon laut wood, it will make the sandwich composite to have greater strength than the skin composite.

In the graph above, it can be seen that the bending strength of glass fiber sandwich composites is 10% with variations in the addition of banana stem fibers is higher than the bending strength of the skin composites before making the composite sandwich. This can be seen from the comparison of the bending strength in the graph above, where for the addition of 10% volume of banana stem fiber, the bending strength for the skin composite was 27.55 MPa, while for the sandwich composite the bending strength was 41.43 MPa. Likewise, the addition of the banana stem fiber volume fraction of 20% and 30% obtained the bending strength of the sandwich composite was greater than the bending strength of the skin composite. The difference in bending strength is due to the bending strength of the skin composite which is then added to the bending strength of the core to produce a bending strength greater than the bending strength of the skin composite alone.

In the increase in the bending strength between the skin composite and the sandwich composite above, there is a change in the strength value that is not too large as shown in the graph, the bending strength of the sandwich composite has an increase of 13.88 MPa from the bending strength of the skin composite before the sandwich composite is made. This is due to the reduced bond between the skin and the composite sandwich core due to the long curing time. Sengon Laut wood as a core which has a small absorption capacity of resin results in the skin being detached from the core easily, so that the load-bearing ability will not be perfect due to the delamination. In the sandwich composite bending test, the first part that experienced a failure was the lower skin which experienced tensile stress due to loading, followed by the failure experienced by the sengon laut wood core due to its brittle nature and finally the upper skin failure which experienced compressive stress. Due to the failure experienced by each component of the sandwich composite, it causes the ability to withstand loads to be smaller and causes the sandwich composite to quickly experience fractures or cracks. Therefore, the sandwich composite has a bending strength that is not too large an increase from the bending strength of the skin composite before making the sandwich composite.

3.2 Failure observation of skin and composites candwich

Figure 5. shows the failure of the skin after bending testing. Specimens fracture or break after receiving the maximum load. Figure 6. shows the failure of the 10% glass fiber sandwich composite with the addition of volume variations of banana stem fiber after bending testing with the Three Point Bending method. The sandwich composite specimens tested for bending will experience a different magnitude of stress at each point. The weakness of the sandwich composites at the time of loading lies in the skin composite layer of glass fiber and banana stem fibers at the bottom of the specimen. At the bottom of this sandwich composite has the maximum tensile stress and experiences the earliest failure because the tensile stress cannot be resisted, causing cracks.

Figure 5. The failure of skin

10% banan stem fiber

20% banan stem fiber

30% banan stem fiber

The failure experienced by the lower sandwich composite skin became the initial crack in the sandwich composite. Due to this failure, the strength of the specimen decreased. Subsequent failure was experienced by the core composite sandwich. The strength of the specimen decreased, followed by failure of the core due to delamination between the core and the skin. The upper composite skin also failed after failure of the core and lower skin, indicated by buckling or failure to press on the upper skin. In the composite material bending test, the specimen does not break like the metal material test, because the composite structure consisting of fibers and matrices is not homogeneous. So that when the bending test, the load given to the specimen will increase, but the increase in load that occurs is getting smaller until the specimen breaks or cracks, and when the specimen is broken the load will decrease, which means that the maximum load has been obtained.

Figure 6. The failure of the material sandwich composites

10% banan stem fiber

20% banan stem fiber

30% banan stem fiber

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IV. CONCLUSION

From data analysis and discussion that has been done, the conclusion are the addition of the volume fraction of banana stem fiber by 10%, 20% and 30% affected the bending strength of the sandwich composite material with glass fiber reinforced polyester skin and sengon laut wood core. The greater the volume fraction of banana stem fiber added, the higher the bending strength. The highest bending strength was 53.81 MPa at the addition of a banana stem fiber volume fraction of 30% and the lowest bending strength of 41.43 MPa, at the addition of a banana stem fiber volume fraction of 10%..

Conflict of interest

There is no conflict to disclose.

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