



ANALYSIS OF MORPHOLOGY AND TENSILE STRENGTH OF BANANA KEPOK FIBRES USING A SCANNING ELECTRON MICROGRAPH (SEM) AND PULL TEST EQUIPMENT

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ABSTRACT

Banana plants are plants typical of tropical regions which can be easily found anywhere without knowing the season. Until now the use of banana plants in Indonesia has been merely the cultivation of fruit and there is very little use of other parts of this banana tree. The purpose of this study was to uncover behavioural engagement capability and Interfacial shear stress banana fibres cured epoxy matrix due to the soaking treatment of alcohol. Alcohol soaking treatment banana kapok fibre variation alcohol content of 0%, 70%, and 95%, and the soaking time of 8 hours. Banana fibre without and with soaking treatment was observed by SEM to determine the ability of the engagement fibre with epoxy matrix and also for banana fibre surface morphology. Tensile test was conducted to determine the interfacial shear strength by embedding a single fibre banana fibre into the epoxy matrix as deep as 1 mm. The test results showed that the soaking treatment causes the fibre surface becomes coarse, wrinkled, uneven forming grooves in a longitudinal direction and transverse impact on improving the ability of the engagement between banana fibre with epoxy matrix. Shear stress epoxy matrix interface with banana fibre without soaking treatment of alcohol obtained 2,358 kgf / mm², at 70% alcohol immersion shear stress 1.542 kgf / mm² and at the 70% alcohol immersion shear stress 1,254 kgf / mm².

Keywords: morphology, tensile strength, fibre, banana kepok, scanning electron micrograph (SEM), pull test equipment.

INTRODUCTION

Banana plants are plants typical of tropical regions which can be easily found anywhere without knowing the season. Until now the use of banana plants in Indonesia has been merely the cultivation of fruit and there is very little use of other parts of this banana tree. The addition of natural fibres into the composite is expected to improve the mechanical properties, namely tensile and flexural strength of the composites (Ibrahim *et al.*, 2010; Rozman *et al.*, 1998; Nair *et al.*, 1996).

Singh *et al.* (2012) conducted research on bananas and powdered silica fibre reinforced composite materials are developed, the results of this study were obtained scanning electron microscopy showed that the banana fibres are well dispersed in the matrix resin. The addition of banana fibres greatly reduces the yield strength and the addition of silica gives better results from banana fibre reinforced composites but still has a yield strength is greatly reduced. Natural rubber composite lamina reinforced with banana stem fibres by a mixture of NaOH and Na₂SO₃ has superior tensile strength (Sahari *et al.*, 2015). While the tensile strength, flexural strength, impact strength in woven banana pseudo stem Increased reinforced epoxy composites. Banana fibre composites showed a resilient performance with minimum plastic deformation (Maleque *et al.*, 2011; Pothan *et al.*, 2009; Magdaet *et al.*, 2010; Wuryanti, 2013). Giving coagulum in the polyester fibre banana can increase of the composite index, limiting oxygen from 18 to 21% with a reduction in smoke density (Budinsky *et al.*, 2003; Thiruchitrabalam *et al.*, 2009). Effect of fibre volume fraction pseudo stem of bananas (the form of woven cloth) on the properties of composite epoxy increases with increasing fibre volume fraction banana trunk in a matrix of epoxy (Radzi *et al.*,

2011; Maleque *et al.*, 2008; Mukhopadhyay *et al.*, 2008). Banana fibre in combination with an excellent glass to create a low cost composite materials (Pothan *et al.*, 2011).

Based on the brief description above, the research of natural fibres, especially cellulose fibre banana cured by soaking treatment by using a variable amount of alcohol. A series of tests to uncover the effect of submergence of alcohol on the fibre surface morphology and the ability of the engagement interface with fibre epoxy matrix and shear strength fibre with an epoxy matrix with the test method pull out.

MATERIALS AND METHODS

Materials

Materials used consist of:

- Banana kapok fibre with an average age of 10 months, with a leaf length of about one meter, then soaking for 2 weeks to rot. Furthermore, the fibre is separated from the skin leaves have decomposed, then cleaned with distilled water to clean dirt and then dried at room temperature 31 °C. Furthermore, alcohol soaking treatment is done with alcohol composition 70 and 95% of soaking for 10 hours.
- Composites, a composite material are used as a macroscopic mixture between the fibre and the matrix, a composite material made up of two element items, namely Resin as filler and binder fibre is called the matrix (Maudila, 2006). The matrix serves to protect the fibre from environmental effects and



damage due to collision impact. Generally the matrix material can include metals, polymers, ceramics, carbon (Reddy *et al.*, 2014). While the fibre material that is commonly used is carbon fibre, glass fibre, ceramics. However, lately the natural fibres are already Began ogled as an alternative eco-friendly fibre. Two important terms in the composite namely Lamina and Laminata. Based on the placement there are several types of fibre in composites, namely: (1) Continuous Fibre Composite; (2) Woven Fibre Composite (bi-directional); (3) discontinuous Fibre Composite and (4) Hybrid Fibre Composite. Discontinuous FibreComposite is the type of composites with short fibres. This type is distinguished into three, namely: Aligned discontinuous fibre, Off-axis aligned discontinuous fibre and Randomly oriented discontinuous fibre.

- Resin, generally resin is the material to be reinforced with fibres. Resin is a low viscosity liquid, which hardens after the polymerization process. Serves as a binder resin (bounding) between the fibres to one another so as to produce a strong bond formed solid composite material, which is a material that has the bond strength is high (Budinski, 2003). The resin is used in most Thermosetting, b). Phenolic, c).Epoxy and polyester. Plastic waste classified as polyester resin/thermoplastic that has the characteristics of resistance to strong acids except oxidizing acid, but weak against alkali (Monteiro *et al.*, 2008; Surdia, 1989; Smith, 1999 and Shackelford, 1996). Polyester resin is the most widely used as a matrix for fibre glass hull, automobile, water tanks and so forth (Naveen *et al.*, 2012).
- Catalyst, a catalyst is used to assist the drying process of resin and fibres in the composite. The time needed to transform into a plastic resin depends on the amount of catalyst is mixed (Chorkendorff *et al.*, 2007; Sheldon *et al.*, 2007). The addition of a good

catalyst 1% of the volume of resin. If there is a reaction will occur between 60-90°C heat. This heat is sufficient to react the resin in order to obtain the strength and form of plastic that maximum inaccordance with the desired shape of the mold (Deutschmann *et al.*, 2009; Schuit *et al.*, 1973)

Methods

- Testing Scanning Electron Micrograph (SEM)

SEM is a tool that can form the image of the specimen surface microscopically. The electron beam with a diameter of 5-10 NM is directed at the specimen. The interaction of the electron beam with the specimen produce some phenomena items, namely backscattering electron beam, x-rays, secondary electrons and electron absorption (Abed *et al.*, Stadlander, 2007). SEM technique is the investigation and analysis of surface.

- Pull Tests

The tensile test is used to determine the tensile strength of a specimen.

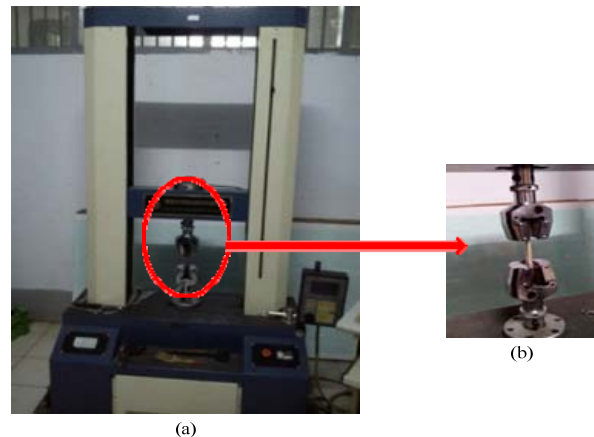


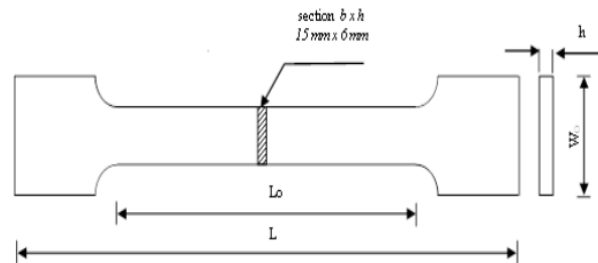
Figure-1. (a) Tensile test equipment; (b) fibre underpull test.

**Table-1.** Specifications tools.

Capacity	Kg	20,000
	kN	200
Units	Load	N,kN,g,kg,ton,ib
	Displacement	mm.cm.inch
Load Resolution		1/20000
Load Accuracy		±1% (0,5% optional)
Load Amplification		x1,x2,x5,x10 Auto range
Test width	(mm)	575
Crosshead Travel	(mm)	1440
Testing stroke		Crosshead travel minus upper/lower grips and gauge length
Range of test speed	(mm/min)	0.2-, 200
Max, load at full speed	(kgf)	2000
Max. speed at full load	(mm/min)	50
Speed Accuracy		±0.5% servo control
Displacement Resolution	(mm)	0,001
Driving Motor		AC Servo Motor
Power		3Ø22VAC,50/60Hz (380/415V optional)
Dimensions	(cm)	125x90x280

the standard used:

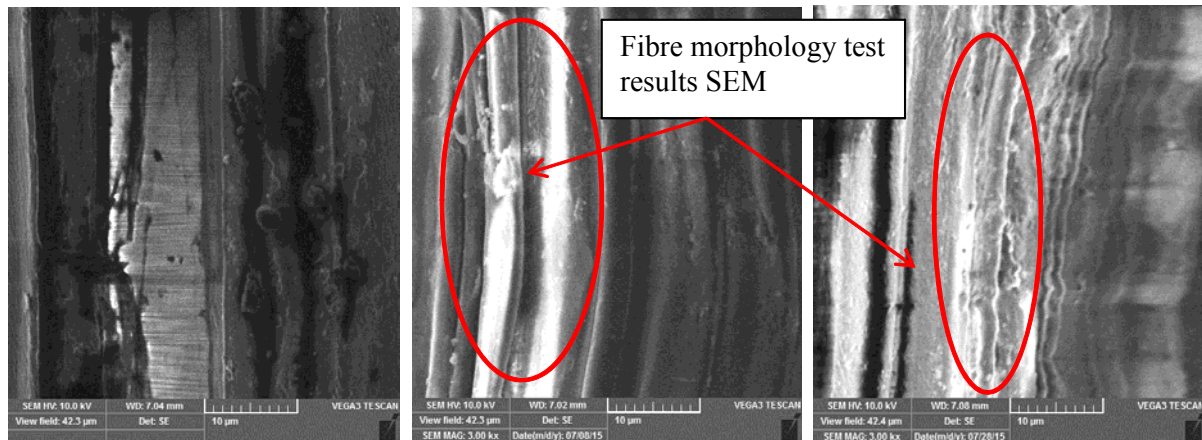
Tensile test carried out by using the standard American Society For Testing and Materials (ASTM). Wherein the dimensions of the specimen as shown in the figure below:

**Figure-2.** Tensile test specimens.

Where:

- W₀ = the notch width 25 mm;
- A = sectional area of 120 mm²;
- L = long specimen 150 mm;
- L₀ = long notch 80 mm;
- h = thick specimen 8 mm.

RESULTS AND DISCUSSIONS



(a) non alcohol

(b) alcohol 70% (c) alcohol 95 %

Figure-3. Banana Kepok fibres were soaked for 8 days.



Figure-4. Forms of fibre fracture Banana kapok.

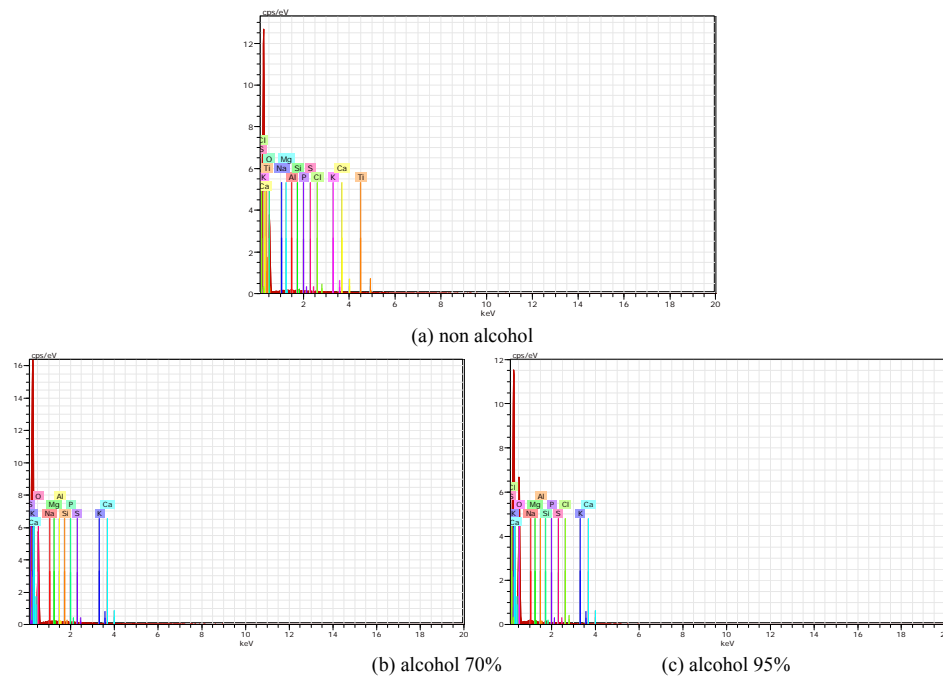


Figure-5. Banana kepok fibre composition test results the treated.

The longer the soaking fibre by using alcohol would result in the decrease in calcium, potassium in fibre. Reduction of calcium affects the fragility of these fibres. The function of potassium in plants is a catalyst that is highly active nutrients. Average tensile strength fibre composite with untreated slightly lower than the composite fibres treated with alcohol. This happens due to small differences in percentage and percentage of alcohol used in this study, so that almost no significant difference in tensile strength. Treatment of alcohol on the fibre causes partial loss of hemicellulose, lignin, wax and other impurities on the surface of the fibre. Surface topography becomes coarser fibres resulting mechanical interlocking. With the loss of lignin and various other impurities in the fibre surface, the field of chemical reactions and bonding between the fibres and the matrix increases the mechanical properties. Because in this study, the percentage used is too large, so much influence on the fibre surface conditions. This is shown in the fracture topography of the specimen is also quite similar (Figure-4).

Based on Table-2 shows that the tensile strength of the composite is soaked in alcohol is lower than without soaking alcohol. Topographic cross-section of the fault (Figure-4) it seems that the more alcohol without soaking the fibre pullout compared with alcohol immersion. This shows that with no alcohol soaking, the water more easily gets into polyester and eventually absorbed by the fibre so that the bonding surface with a matrix fibres (polyester) experienced depending and eventual release of the ligament fibre and polyester. The longer soaking the alcohol molecules are absorbed by the fibre resulted in fibre swell. Liberation bonding with polyester fibre surface and also the dissemination of fibre resulting in mechanical damage or damage to the mechanical strength of the composite, as shown in Figure-3 SEM cross section. the composition of the high alcohol content result in damage to the structure of the fibre. This damage affects the fragility of fibre.

Table-2. Results of pull testing composite fibre Banana kepok.

Alcohol levels	P	σ	ΔL	ϵ		E
	(kgf)	(kgf/mm ²)	(mm)	X100 %	%	(kgf/mm ²)
Non-alcohol	283	2.358	2,358	0.029	2.9	81.31
70 %	185	1.542	1,542	0.019	1.9	81.158
95 %	150,5	1.254	1,254	0.016	1.6	78.375

With the loss of learning and various other impurities in the fibre surface, the field of chemical reactions and bonding between the fibres and the matrix

increases that will improve mechanical properties. Because in this study, the percentage of alcohol used is too great so much influence on the fibre surface conditions



(Figure-4). From Table-2 shows that the tensile strength composite without soaking alcohol is higher than the soaked with alcohol.

CONCLUSIONS

From the test results can be concluded that banana fibres are not soaking alcohol has a higher tensile strength than the through immersion alcohol. The fibre is through immersion with the percentage of alcohol that are too large can result in fibers become brittle. The fragility of the fibre due to the release of fibres with polyester bonding surface and also delamination in fibre resulting in mechanical damage or deterioration of the mechanical strength of the composite.

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