ANALYSIS OF THE ALKALI TREATMENT AND FIBER DIRECTION EFFECT ON COMPOSITE MATERIAL MECHANICS OF PINEAPPLE LEAF FIBER

FINAL PROJECT

submitted in partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering Vocational Education

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SUPERVISOR APPROVAL PAGE

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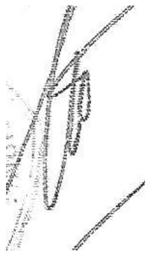

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DECLARATION

I hereby confirm that:

1. My final project, title “Analysis of The Alkali Treatment and Fiber Direction Effect on Composite Material Mechanics of Pineapple Leaf Fiber” is my own;

2. This final project is my original work from aspects of idea, formulation, and research without other guidance, except from supervisor;

3. In this final project, no others works’ except for quotations and summaries which have been duly acknowledge;

4. I made this statement in truth and if there is a deviation in this statement, I am willing to accept academic punishment in the form of revocation of the academic title that have been obtained, as well as other punishment in accordance with the norms and legal provisions in force.

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ABSTRACT

M. Febriyan Baruna Putra. 2020. " Analysis of The Alkali Treatment and Fiber Direction Effect on Composite Material Mechanics of Pineapple Leaf Fiber". Final Project. Padang: Mechanical Engineering Vocational Education, Department of Mechanical Engineering, Faculty of Engineering Universitas Negeri Padang.

Coconut coir and fibers can be alternative raw materials as a composite reinforcement for synthetic fibers. This study aims to determine the mechanical properties of the effect of alkalization and fiber direction on the composite reinforced with pineapple leaf fiber.

The matrix used in this study was polyester resin BQTN 157 with NaOH of 10% and 20% variation of immersion time of 1 hour, 2 hours and 3 hours, with a fiber direction of 0^0, 30^0 and 60^0. Tests were carried out using the Monsanto Tensometer Education Kit tensile testing machine.

The results of the tensile test research showed that the alkaline treatment (NaOH) on pineapple leaf fiber decreased the tensile stress of the pineapple leaf fiber, the decrease in eating properties was caused by the alkaline solution (NaOH) which has properties that can change the surface of the fiber to become coarse, due to the fiber being coarse it will causes the tensile strength of the fiber to decrease after exceeding its saturation limit. For the fiber direction 00 has the best tensile stress because the direction of the fiber is directly proportional to the static load applied to the tensile testing machine.

FOREWORD

Praise to Allah Subhanahuwata'alla, because of His grace and grace, the author was able to complete the thesis with the title "Analysis of the Alkaline Treatment and Fiber Direction Effect on the Composite Material Mehanics of Pineapple Leaf Fiber". which is one of the requirements for completing the Bachelor of Mechanical Engineering Vocational Education program at Universitas Negeri Padang.

For the preparation and writing of this thesis, the author expresses his gratitude for all the support and assistance, especially to:

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7. Fellow of Mechanical Engineering Department, Faculty of Engineering, Universitas Negeri Padang.

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May Allah Subhanahu wa Ta'ala give a reward in kind to all who have helped the author in completing this thesis. The author realizes that this thesis is far from perfect. The author expects constructive criticism and suggestions in completing this thesis.

Lastly, the author hopes that this thesis can provide many benefits for us all. Aamiin ya Rabbal 'Alamin.

Padang, October 2020

M. Febriyan Baruna Putra

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CHAPTER I

INTRODUCTION

A. Background

The last few years the development in the field of industrial technology has grown very rapidly. It is also possible in the field of material technology. Natural fiber reinforced composite materials are a major concern and continue to be developed because besides being environmentally friendly they also have their own advantages over other alternative materials. Composite material itself is the result of engineering which is composed of a mixture of two or more of a material, where each of the properties of the material is different from one another, both chemical and physical properties, to produce a new material that has different properties from the material. constituent material (Oliver-Borrachero et al., 2018 : 9-16).

The 2009 International Year of Natural Fiber declaration is in accordance with the FAO (Food and Agriculture Organization) recommendation, that the use of natural fibers as a material for making composites is the right action in the industry, because it is more environmentally friendly and easily degraded (Xander, 2012). This natural fiber reinforced composite fiber material also has the main advantages of low density, easy to decompose by nature, produces high stiffness, does not break easily, has various types and is energy efficient and inexpensive (Rowell et al., 1997).

Currently, the use of natural fibrous composite materials as an alternative material is widely used in the automotive industry, starting from Audi, BMW, Mercedes, Ford, Peugeot, Volkswagen, to Volvo (Mohanty, 2005). The composite material itself can be arranged in such a way that it can efficiently meet the requirements for strength, stiffness and other desired parameters. The process of making natural fiber reinforced composites is easy and often used, namely by hand (hand lay up) assisted by a few simple tools.

So far, the natural fibers that are often used as composite reinforcing materials are coconut coir, hemp, water hyacinth, sugarcane fiber, areca fiber, pineapple leaf fiber and so on. Indonesia as a country that has a wide variety of biodiversity has great potential in the use of natural fiber as a reinforcement for composite materials, one of which is pineapple leaves. Reporting from the Worldatlas website, Indonesia is ranked 9th in the world with a production of 1.39 million tons / year.

Seeing the large number of pineapple plant production per year, of course pineapple leaves will have great potential to become waste. Pineapple leaf waste is classified as wet organic waste, which if not treated properly it will cause disease and unpleasant odors because the process of decomposing wet organic waste is relatively fast. The amount of pineapple leaf waste that is produced per year and the use of wet organic waste which is still not done optimally so in this study researchers will use extracted pineapple leaves to get the fiber, these fibers will later be used as reinforcement material in composite materials.

Natural fibers have weaknesses when compared to synthetic fibers, these weaknesses are easy to absorb water (hydrophils) so that they can affect the mechanical properties of natural fibers (Layth et al., 2015 : 1-15). One of the efforts that can be made to improve these weaknesses is by providing chemical treatment (Diharjo, 2006 : 8 - 13). In this study researchers used alkaline chemical treatment (NaOH) by providing immersion treatment in pineapple leaf fiber. Composites that are not given alkaline immersion treatment will later affect the mechanical properties of the fibers, because they are blocked by a waxy coating on the surface of the fiber. The wax coating on plants has a function to slow the leaves from drying out, therefore treatment is given.

In the manufacture of natural fiber composite materials, in addition to alkaline immersion (NaOH), another factor that also affects the mechanical properties of the composites is the direction of fiber orientation (Hendriwan Fahmi et al., 2011 : 46 - 52). Several studies have shown that composites with a certain direction of fiber orientation will produce the greatest tensile strength. Such as research conducted by Michael Cordin et al. (2018), with the title *Effect of fi bre orientation on the mechanical properties of polypropylene – lyocell composites* shows that the maximum tensile strength of fiber orientation 00 values obtained are 147 MPa and the lowest is 10 MPa at 900 fiber orientation.

Research conducted by Teguh Sulistyo et al. (2016), in his article entitled Technical Analysis of the Use of Pineapple Leaf Fiber as an Alternative to

Composite Materials for Boat Shell Making in terms of Tensile Strength, Bending and Impact concluded that testing of pineapple leaf fiber reinforced composites with an average 45 ° orientation. - The average tensile strength is 34.8 Mpa and the average modulus of elasticity is 6088.16 Mpa.

The characteristics of pineapple leaf fiber reinforced composites are still not widely known. Observations on the effect of alkaline treatment and fiber direction on their mechanical properties are still being carried out. In this study, researchers investigated the effect of variations in alkaline treatment, immersion time and variations in fiber orientation on tensile stress, strain, and modulus of elasticity of pineapple leaf fiber reinforced composite materials.

B. Identification of Problems

In this study, the analysis was carried out on the pineapple leaf fiber reinforced composite material, the authors identified the problems in this study as follows:

1. The high production of pineapples in Indonesia makes pineapple leaves have great potential to become organic waste. So that it can be used as a material for making composite materials.
2. Natural fibers have a weakness, namely that they easily absorb water (hydrophils) so that they can affect their mechanical properties. Giving alkaline immersion to natural fibers is used to overcome these drawbacks.
3. It is not known how much the percentage of alkaline, the duration of soaking, and the influence of the proper / optimal fiber orientation to obtain the best mechanical properties of pineapple leaf fibers.

C. Scope of Problems

In order for this research to be more focused and directed, this research is limited to the size and shape of the test object used. In this study, the standard used was ASTMD638-03for tensile testing with the process of making the test object by hand (hand lay up). The material for the test object that the researchers used was a pineapple leaf fiber reinforced composite soaked with 10% and 20% NaOH solution with each variation of immersion time of 1 hour, 2 hours, and 3 hours with the orientation of the fiber directions 00, 300, and 600. The mechanical properties observed were tensile stress (σ), strain (ε), and modulus of elasticity (E). The type of resin usedYukalac 157 BQTN-EX Series, the volume fraction of fiber used is 70% matrix and 30% pineapple leaf fiber.

D. Research Questions

Based on the background description of the problem above, the problems examined in this study are:

1. How is the effect of giving 10% and 20% NaOH solution with each variation of immersion time of 1 hour, 2 hours, and 3 hours on mechanical properties?
2. How does the orientation of the fiber affect the mechanical properties?

E. Research Objectives

The research objectives are:

1. To detemine the effect of giving alkaline percentage and soaking time of pineapple leaf fiber on tensile stress, strain, and modulus of elasticity.

2. To detemine the effect of tensile stress, strain, and modulus of elasticity of the composite material of pineapple leaf fiber on variations in the orientation of the fiber direction.

F. Significant of Study

For the author, this study is useful to add to the writer's insight about the composite, especially pineapple leaf fiber reinforcement. For academics, this study is expected to become a reference for further research with the aim of developing composites, especially those using pineapple leaf fiber with more varied fiber treatment, orientation, and volume fraction, especially in the Mechanical Engineering Department, UNP. Providing information to the public and the industrial world about the use of pineapple leaf fiber as a composite material.

CHAPTER II

LITERATURE REVIEW

A. Composite

1. Definition

Polymer composite materials can be defined as a combination of two or more macroscopically different materials and each of which has the desired properties, but cannot be obtained from the original constituent materials when working independently (Gibson, 2016 : 35). Composite is a material consisting of two or more constituent elements. Composites are a number of multiphase systems of combined properties, namely a combination of a matrix or binder with reinforcing elements or what is called reinforcement (Setyawan, 2013 : 2). Reinforcement or reinforcement functions as a strength enhancer in the composite material.This fiber determines the characteristics of the composite material, such as: stiffness, strength and mechanical properties obtained. While the matrix is in charge of protecting and binding the fibers so that they can work properly.

Composite is formed from two different types of materials, namely:

1. Reinforcement, which is a filler used in the manufacture of composites, has less ductile properties but is more rigid and stronger.
2. The matrix generally functions to bind the fibers into a composite structure, has more ductile properties but has lower strength and rigidity.

One of the advantages of composite materials when compared to other materials is the superior combination of elements from their respective constituent elements. The material properties resulting from this combination are expected to complement the weaknesses that exist in each constituent material.

2. Composite Classification

Composite materials can be classified into several types, depending on the goemetry of the fiber type. This is understandable, because fiber is the main element in composite materials. The mechanical properties of composite materials, such as strength, stiffness, plasticity and resistance depend on the geometry and properties of the fiber. Composites are broadly classified into three types, namely:

a. Fibrous Composites

It is a type of composite consisting of only one lamina or one layer using a fiber filler. The need for fiber placement and different fiber directions make fiber-reinforced composites differentiated into several parts including:

1) Continous fiber composite (composite reinforced with continuous fiber).

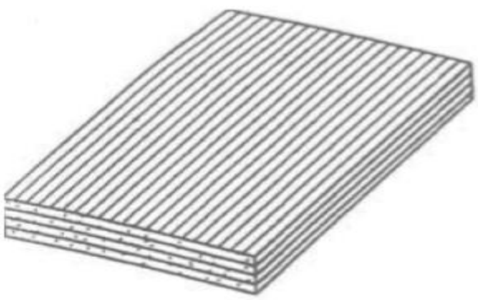


Figure 1. Continous Fiber Composite (Gibson, 2016: 5)

2) *Woven fiber composite* (composite reinforced with woven fibers)

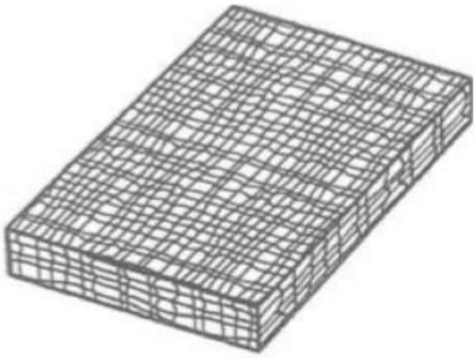


Figure 2. Woven Fiber Composite (Gibson, 2016 : 5)

3) *Chopped fiber composite* (short / random fiber reinforced composite)

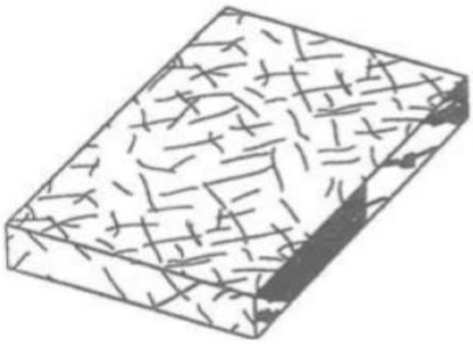


Figure 3. Chopped Fiber Composite (Gibson, 2016 : 5)

4) *Hybrid composite* (continuous fiber reinforced composite and random fiber)

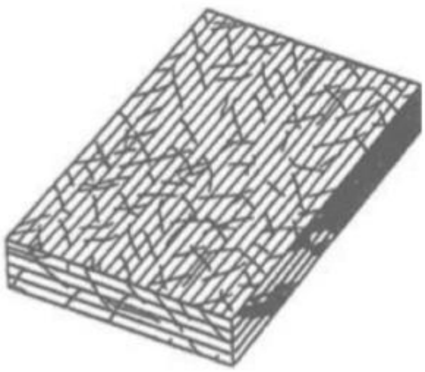


Figure 4. Hybrid Composite (Gibson, 2016 : 5)

b. Particulate Composites

The properties of the composites with particle fillers are uniform (isotropic) in any direction due to the distribution of particles in a random and even matrix.

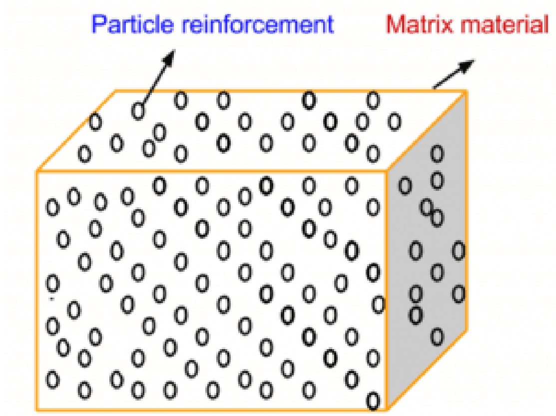


Figure 5. Particulate Composite (*www.google.com*)

c. Laminates Composites

Composite laminates is a type of composite consisting of two or more layers combined into one and each layer has its own characteristic.

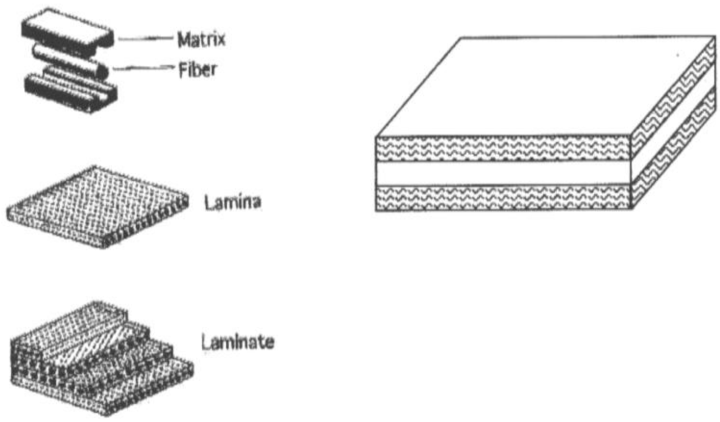


Figure 6. Laminated Composites (*www.kemahasiswaan.its.ac.id*)

Lamina composites consist of various layers of material in one matrix. The real form of the lamina composite is:

1. Bimetallic
2. Metal plating
3. Coated glass
4. Fiber-coated composites

3. Fiber direction

Fiber direction or also known as fiber direction orientation has a different strength effect according to the location in the composite manufacturing process. Fibers that are designed with a specific fiber direction can improve the mechanical properties along the fiber direction that support the load during the test process (Michhael et al., 2018). Carbon fiber or glass fiber if you look carefully, the direction of these fibers is pointing in a different direction specifically.

Natural fiber reinforced composite materials with the location and direction of certain fibers can also affect the performance of the composite. Composites with the orientation of the arranged fiber directions can achieve the optimal rate of strength against a given load according to the expected parameters (Hossain et al., 2013). The fiber can be oriented in any direction between 0^0 and 180^0 although the orientation of the fiber above 90^0 is usually referred to as a negative angle value, for example a fiber with a direction of 135^0 is equal to -45^0. In this research, the researchers will vary the direction of the pineapple leaf fibers with the orientation of the fibers of 0^0, 30^0 and 60^0.

4. Main Elements Forming Fiber Reinforced Composites

a. Fiber

The fiber or fiber in the composite material acts as the main part that holds the load, so the size of the strength of the composite material depends on the strength of the fibers that form it. Fiber is a matrix filler that is used to improve the properties and structure of the matrix it does not have, and is also expected to be able to reinforce the matrix in the composite to withstand the forces that occur. The main functions of fiber are:

1. As a load bearer. In a composite structure 70% - 90% of the load is carried by the fiber.
2. Provides stiffness, heat stability and other properties in composites.
3. Provides electrical insulin (conductivity) in composites, but this depends on the fiber used.

b. Matrix

The matrix in the composite structure is a material that can be derived from polymers, metals, or ceramics. The matrix generally functions to bind the fibers into one composite structure (Gibson, 2016).

The matrix has the following functions:

1. Binds fibers into a single structure.
2. Protects fiber from damage due to environmental conditions.
3. Transfer and distribute load to fiber.
4. Contributes several properties such as, stiffness, toughness and electrical resistance.

The polymer materials most often used as matrix materials in composites are thermosets and thermoplastics. Unsaturated Polyester Resin (UPR) is a type of thermoset resin or better known as polyester. UPR is a liquid resin with a relatively low viscosity which solidifies at room temperature with the use of a catalyst without generating gas during dilution like many other thermoset resins.

B. Alkali Treatment (NaOH) Fiber

NaOH solution is a solution that is easily soluble in water and is a strong base. These solutions react with various acids. In addition to neutralizing the acidic properties of pineapples, this solution greatly affects the strength of the fiber. Cellulose fibers soaked with NaOH will expand. This expanded fiber does not experience degradation, but only increases absorption and better strength than its original state (Hendrodiyantopo, 1998 : 5). With this treatment on the fiber, the bond between the fiber and matrix becomes stronger, so that the density and strength of the fiber is higher.

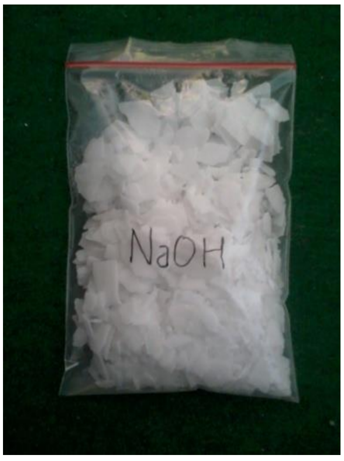


Figure 7. NaOH

NaOH (Figure 7) is available as a white solid, flakes and in pellet form. NaOH solution is hygroscopic and easily absorbs water from the air, so it must be stored in an airtight place as shown in Figure 7. NaOH is also used as a cleaning agent which is often referred to as caustic, used to clean storage tanks, pipelines and others. Sodium hydroside solution will cause chemical burns, if contact with the eyes will cause blindness.

$$Na_2O + H_2O \longrightarrow 2NaOH$$

$$NaOH \longrightarrow Na^+ + OH^-$$

The sodium hydroxide dissolves to give hydroxide ions and sodium ions which are free when dissolved in water. In the presence of hydroxide ions, the alkaline properties of an alkaline solution can be demonstrated. Then alkalis can be interpreted as a chemical that produces hydroxide ions in water. The purpose of giving the alkaline immersion treatment is so that the strength of the fiber which is blocked by the waxy coating can be optimally utilized so that the fibers are not easily brittle and break easily.

C. Fiber

1. Glass Fiber

Glass fiber or commonly referred to as fiberglass is a fiber commonly used for Composite reinforcement. This fiber is very common when compared to fiber other reinforcement because it is produced in a modern way, the price is relatively cheaper and is commonly used for polymer matrix composites (Polymer Matrix

Composite) and is the main production of composite reinforcement in the industrial world.

Table 1. Mechanical Properties of Some Fibers

Material	**Tensile stregth 103 psi (Mpa)**	**Tensile modulus 104 psi (Mpa)**	**Density lb / in3 *(g / cm3)***
E-glass fibers	500.0 (3448)	10.5 (72)	0.009 (2.54)
S-glass fiber	650.0 (4482)	12.5 (86)	0.090 (2.49)
Carbon fiber (PAN) precusor			
AS-4 (Hercules)	580.0 (4000)	33.0 (228)	0.065 (1.80)
IM-7 (Hercules)	785.0 (5413)	40.0 (276)	0.064 (1.77)
T-300 (Amoco)	530.0 (3654)	33.5 (231)	0.064 (1.77)
T-650 (Amoco)	730.0 (5033)	42.0 (290)	0.064 (1.77)
Carbon fiber (pitch precusor)			
P-55 (Hercules)	250.0 (1724)	55.0 (379)	0.072 (1.99)
P-75 (Hercules)	300.0 (2068)	75.0 (517)	0.072 (1.99)
P-100 (Amoco)	325.0 (2241)	100.0 (690)	0.078 (2.16)
Aramid fibers			
Kevlar ® 29 (Dupont)	550.0 (3792)	9.0 (62)	0.052 (1.44)
Kevlar ® 49 (Dupont)	550.0 (3792)	19.0 (131)	0.053 (1.47)
Bororn fibers			
0.004 "diameter (Textron)	510.0 (3516)	58.0 (400)	0.093 (2.57)
0.0056 "diameter (Textron)	510.0 (3516)	58.0 (400)	0.090 (2.49)
Silocon carbide fibers			
0.0056 "diameter (Textron)	500.0 (3448)	62.0 (427)	0.110 (3.04)

(Gibson, 2016 : 8)

Table 2. Mechanical Properties of CSM Type E-Glass Fiber

Mechanical Properties	**Unit**	**Score**
Diameter	μm	12
Density	Kg.m-3	2350-2600
Modulus of Elasticity (E)	GPa	7.3
Tensile strength	MPa	350
Elongation	%	4.8

(Justus Kimia Raya, 2001)

2. Natural Fiber

Natural fibers are types of fibers as raw materials for the textile industry or others, which are obtained directly from nature. Based on their origin, natural fibers can be classified into several groups, namely fibers derived from animals, minerals and plants (Kirby, 1963 : 7).In industry, most of the natural fibers used today, some of which are used and designed, come from plants considering that they are easy to obtain and have a long lasting durability. In Table 3 some natural fibers are used and their mechanical properties.

Table 3. Mechanical Properties of Some Fibers

Fiber	**Rang Diameter (mm)**	**Density (g / cm3)**	**Elongation at Break (%)**	**Tensile Stregth (MPa)**	**Young's Modulus (GPa)**
Cotton	12-38	1.5	7.0-8.0	287-597	5.5-12.6
Jute	10-25	1.3	1.5-1.8	393-773	26.5
Flax	5-38	1.5	2.7-3.2	345-1035	27.6
Hemp	10-51	1.4	1.6	690	35
Sisal	8-41	1.5	2.0-2.5	511-635	9.4-22.0
Bamboo		0.8	-	391-1000	48-89
Soft wood		1.5	-	1000	
Ramie	11-80	1.5	3.6-3.8	400-938	61.4-128.0
E-glass	10	2.5	2.5	2000-3500	70
S-glass	10	2.5	2.8	4570	86
Aramid (Normal)	12	1.4	3.3-3.7	3000-3150	63-67
Carbon (Standard)	7-10	1.4	1.4-1.8	4000	230-240

(Mohanty, 2005 : 9)

D. Pineapple Leaves

Pineapple or a plant with the Latin name Ananas Comosus is a plant from the Bromeliaceae family. This plant is generally known as a source of food in the form of pineapples. However, pineapples can also be used as an alternative to plants that produce fiber from their leaves.

Figure 8. Pineapple Plant

Pineapple fruit after harvesting pineapple leaves are cut from the fruit to facilitate the harvest and distribution process. The pineapple leaves that have been cut are then sorted in order to select quality pineapple leaves that have the potential to have a lot of fiber, for the results of the fiber that have been extracted from pineapple leaves can be seen in Figure 8.

Figure 9. Pineapple leaf fiber

Pineapple leaf fiber contains content consisting of 69.5 - 71.5% cellulose, 17.0 - 17.8% pentosan, 4.4 - 4.7 lignin, 3.0 - 3.3% fat and wax, 0 , 71 - 0.87% ash and other substances (protein, organic acids, etc.) 4.5 - 5.3% (Pratikno, 2008 : 31 - 35). Pineapple leaf fibers have a smooth surface and have been widely used in the textile industry. Following are the mechanical properties of pineapple leaf fibers, can be seen in Table 4.

Table 4. Mechanical Properties of Pineapple Leaf Fiber

Mechanical properties	**Unit**	**Score**
Tensile Strength	MPa	17.14
Young's Modulus	GPa	1.44
Elongation at Break	%	30
Denisty	(g / cm3)	0.8-1.6

(Omar et al., 2018)

E. Composite Manufacturing Process

Making Composites in producing various component products are carried out by various methods. However, the strength of the components of the resulting composite material will be different. Some of the methods used in making composites, namelySpray Lay-up, Hand Lay-Up, Vacuum Bagging, Pultrusion, and Resin Transfer Molding.The method used in the process of making composites which is possible and very simple to do is the hand lay-up method.

Process making composites with the hand lay up method are pouring resinby hand to a sheet of woven fiber, mat or cloth, with a matrix (resin) ratio of 70% and reinforcement (pineapple leaf fiber) of 30% and a catalyst of 1% by weight of resin, then apply pressure as well as level it using a roller or brush. This process is repeated until the desired thickness is reached and allows it to harden at room temperature conditions. This extremely simple execution process is one reason the method is widely used*hand lay up*in the manufacture of components from composite materials. In this pineapple leaf fiber reinforced composite material using the fiber arrangement method, namely Continous fiber composite (composite reinforced with continuous fibers) with variations in the orientation of the fiber.

F. Unsaturated Polyester Resin

Unsaturated polyester resin is a type of thermoset polymer which has a long carbon chain structure. This type of matrix has the property of being able to harden at room temperature with the addition of a catalyst without applying pressure during the forming process. The resulting material structure is in the form of a crosslink with the advantage of better resistance to static and impact loading types. This is because the molecules possessed by this material are in the form of giant molecular chains of carbon atoms that are interconnected with one another (Falma Irawati et al., 2013).

Figure 10. Yukalac 157 BQTN-EX Series UPR Resin

This resin contains a lot of styrene monomer, therefore it is resistant to heat from about 110-1400C, and is resistant to UV rays and is resistant to weather when left outside. The cold resistance of this resin is relatively good and is able to conduct electricity well compared to other thermoset resins (Tata Surdia, 1999: 257). In this study using UPR Yukalac 157 BQTN-EX Series resin. Following are the mechanical properties of the polymer matrix material can be seen in Table 5.

Table 5. Mechanical properties of polymer matrix materials

Polymer	E (Gpa)	σ (Mpa)	Use Temp (0C)
PC	2345	62	120
Polyester	2415	76	125
Phenolic	3100	62	160
Epoxy	2480	83	145

(Hartono et al., 1992)

G. Tensile Testing

Tensile test is one of the tests carried out to determine the mechanical properties of a material. The working principle of the tensile test is to apply static loading gradually until the specimen breaks. Several mechanical properties that can be obtained from the results of the tensile test are tensile stress (σ), strain (ε), and modulus of elasticity (E). Figure 9 shows a graphical illustration of the results of the tensile test.

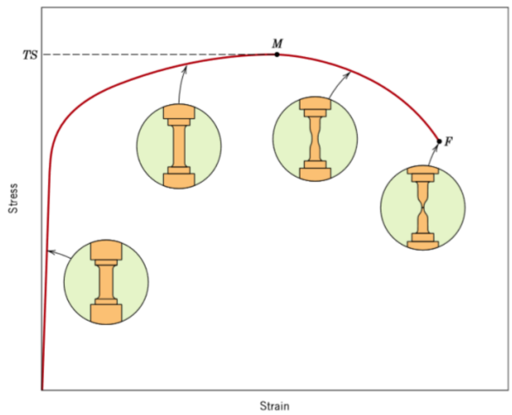


Figure 11. Graph of Tensile Test and Phenomena that Occur in Specimens
(Callister, 2009 : 164)

In the test, the tensile load (P) of the specimen test that is carried out will produce stress that is evenly distributed across the cross-section of the specimen, so the resultant obtained is equal to the tensile stress intensity (σ) times the cross-sectional area (A) of the specimen. From this equilibrium, it is found that this resultant is equal to the load imposed but in the opposite direction, so that (Gere and Timoshenko, 2001) :

$$\sigma = \frac{P}{A} \qquad (1)$$

Where:

σ = Tensile stress (MPa)

P = Style (N)

A = The cross-sectional area of the specimen (mm^2)

The axially loaded rod will later experience a change in length, where it becomes longer when subjected to tension and shorter when subjected to compression. The total change in length is symbolized by (ΔL). Elongation that occurs is the cumulative result of the pulling of the material over the entire length L of the stem. The concept of the ratio of elongation to unit length is called the strain (Gere and Timoshenko, 2001) :

$$\varepsilon = \frac{\Delta L}{L} = \frac{l_i - l_o}{L} \qquad (2)$$

. Where:

ε = Strain (%)

L = Length of Specimen (mm)

ΔL = Increase in length due to tensile load (mm)

l_o = Initial length (mm)

l_i = Length after tensile test (mm)

The results of the tensile test can be described in the stress-strain curve. The parameters used to describe the stress-strain curve of the test specimens are tensile strength, yield strength, percentage elongation and reduction in cross-sectional area. The measurement of specimen tensile stress is based on Hooke's Law (Hooke Law). This law states that a material behaves elastically and shows a linear relationship between stress and strain which is called linear elasticity. The linear relationship between the stress-strain for a rod subjected to tension or compression is stated (Gere and Timoshenko, 2001 : 8).

(3)

$$\sigma = E \, . \, \varepsilon$$

Where :

E = Modulus of Elasticity (GPa)

σ = Tensile stress (MPa)

ε = Strain (%)

Composite material that is commonly used is a mixture of resin as a matrix and glass fibers as reinforcement. One of the simplest relationships between the matrix and the amplifier to obtain the theoretical composite characteristics is calculated using the equation (Hwerakovich, 1998):

$$\rho_c = \rho_m . V_m + \rho_f . \rho_f \qquad (5)$$

Where: ρc = Composite Density

ρm = Density matrix

Vm = Volume fraction matrix

ρf = Density matrix

Vf = volume fraction matrix

In determining the thickness by the ratio of the volume fraction of resin and fiber contained by the composite, which indicates the total fraction by weight. This is obtained by the equation (Hwerakovich, 1998):

$$W = \frac{V_m \, . \, \rho_m}{V_m \, . \rho_m + V_f \, . \, \rho_f} \qquad (6)$$

Where:

W = Total mass of Composite (kg)

V_m = volume fraction matrix (m3)

ρ_m = Density matrix (kg / m3)

V_f = Volume of fiber (m3)

ρf = Density of fiber (kg / m3)

H. Relevant Research

The research carried out has several relevant studies, namely as follows:

1. Research conducted by Kuncoro Diharjo (2008), in his article entitled "Effect of Alkali Treatment on Tensile Properties of Hemp-Polyester Composite Materials" concluded that hemp fiber was immersed in an alkaline solution (5% NaOH) for 0, 2, 4, and 6 hours, indicating that the composite tensile strength and strain have the optimum value for the 2 hour fiber treatment, namely 190.27 MPa and 0.44%. Meanwhile, the fiber-reinforced composites subjected to 6 hours of treatment had the lowest strength, 147099 Mpa.

2. Research conducted by Teguh Sulistyo et al. (2016). In his article entitled "Technical Analysis of the Use of Pineapple Leaf Fiber as an Alternative to Composite Materials for Shipshells" in terms of tensile strength, bending and impact, it is concluded that the test of pineapple leaf fiber reinforced composites compares the direction of fiber angles 0 °, 11.25 °, 22.50 ° and 45 ° woven pattern fibers, volume fraction 70% polyester matrix and 30% pineapple leaf fibers, with

the hand lay up method, the test results obtained that the highest tensile strength value is owned by the composite with an angle of 45 ° with an average tensile strength of 34.8 MPa and an average modulus elasticity 6088.16 Mpa

3. Research conducted by Erik Fernandes (2010), in his thesis entitled "The Effect of Alkali Treatment on Cane Dregs Fiber Reinforced Polymer Composites on Tensile Strength" for treatment duration of 2, 4, and 6 hours with a fiber volume fraction of 40% and 60% with BQTN polyester matrix. 157 concluded that the highest average tensile strength was owned by bagasse fiber composite with 2 hours alkaline treatment, which was 28.29 MPa with an elastic modulus of 0.64 GPa, the lowest tensile strength value was obtained in 6 hours alkaline treatment which was 18.86 Mpa with a modulus of elasticity of 0.29 Gpa and the price of tensile stress without treatment, 21.38 MPa.

4. Research conducted by Dita Novi Susanti (2018), in her article entitled "Effect of Length of Pineapple Fiber on Tensile Strength and Impact of Polyester Composites - Pineapple Fiber" concluded that testing of pineapple fiber reinforced composites had the optimum tensile stress value occurring in alkaline NaOH 30% for 2 hours which is 25.17 MPa with a fiber length of 2cm and the lowest is 18.29 MPa with a fiber length of 0.5cm.

5. Research conducted by Yusuf Umardani and Catur Pramono (2009), in their article entitled "The Effect of Alkali and Ethanol Solutions on the Tensile Strength of Water Hyacinth Fiber and Water Hyacinth Fiber Compatibility in the Unsaturated Polyester Yukalac Matrix Type 157 Bqtn-Ex" with 5% alkaline, 10% and 15% concluded that the tensile strength of the water hyacinth fiber decreased

in the alkaline percentage of 10%, namely 13.25 MPa from the untreated 27.39 MPa.

CHAPTER III

RESEARCH METHODS

A. Research Design

The method used in this research is the experimental research method. Experimental research itself is a quantitative research design that is carried out to determine whether a treatment affects the results of the study (Creswell, 2016). In this research, the effect of alkaline treatment on pineapple leaf fibers was carried out, then the pineapple leaf fibers that had been treated with alkaline were woven with variations in angular orientation and then tested their mechanical properties on tensile strength.

B. Time and place

The timing of the research was carried out in the range of July - December 2019 to January - June 2020 semesters starting from submitting titles, making proceedings, guidance on proposal writing, proposal seminars, specimen making processes, testing, data analysis to reporting. The place where the research was carried out was in the Material and Metrology Laboratory of the Mechanical Engineering Department, UNP, Padang.

C. Research Object

The object of research to be studied is the immersed fiber of pineapple leaves in an alkaline solution (10%, and 20% NaOH) with immersion time variations of 1 hour, 2 hours, and 3 hours with the orientation of the fibers 0, 300, and 600.

Furthermore, the fibers are neutralized from the effect of NaOH by drying them to dry with light rock sun. The matrix material used was 157 BQTN unsaturated polyester (UPRs).

D. Types and Sources of Data

This research is a type of primary data research that is obtained directly. The test results were obtained through direct experimentation on the specimen. Based on the main issues discussed in the previous chapter, the data were obtained through the results of tensile test research followed by observation and analysis of the data obtained from tensile testing in the laboratory.

E. Tools and Materials

1. Tool

The tool used in this study was the Monsanto Tensometer Education Kit tensile testing machine (Figure 13).

Figure 13. Monsanto Tensometer Education Kit Tensile Testing Machine

2. Material

In this research, a polymer composite material was made. As the matrix, unsaturated polyester resin BQTN 157-EX (unsaturated polyester resin) and pineapple leaf fiber as reinforcement. The manufacturing process is done by using the hand lay up method. The building blocks of polymer composites (GFRP) are:

a. The matrix material is Unsaturated Polyester Resin BQTN 157-EX with mechanical properties as shown in table 6.

Table 6. Mechanical Properties of Unsaturated Polyester Resin BQTN 157-EX

Mechanical properties	**Unit**	**Score**
Density	Kg m-3	1215
Modulus of Elasticity (E)	Gpa	0.03
Static tensile strength	Mpa	55
Elongation	%	1.6

(Justus Kimia Raya, 2001)

b. The reinforcing material is pineapple leaf fiber which is used from the home industry that manages pineapple leaf waste into fiber, ALFIBER which is in the subang, West Java (Figure 14), with its mechanical properties (Table 3).

Figure 14. Pineapple Leaves and Fiber Extraction Process

Figure 15. Pineapple Leaf Fiber

F. Research Implementation Procedure

The procedure for making pineapple leaf fiber reinforced composites with a polyester matrix using the hand lay-up method is as follows:

1. Prepare pineapple leaf fibers.
2. The prepared fibers were then treated by soaking in an alkaline solution, namely 10% and 20% NaOH for 1, 2, and 3 hours, then drying them under the sun.

3. After soaking it according to the immersion time, clean it with clean running water until it is completely clean, so that the remaining alkaline solution does not stick to the fibers.
4. Making a glass mold with a thickness of 4 mm and a length of 200 mm x width of 200 mm.
5. After the mold is finished, grease with mirror wax glaze on the glass mold base, this is useful for making it easier to pick up the material when it dries.
6. The fibers are then weighed in an amount according to their volume fraction against the mold and their density (Attachment 1).
7. The resin is also weighed according to the number of volume fractions against the die and the density (Attachment 1).
8. After the fibers have dried and weighed beforehand, the pineapple leaf fibers are arranged on the mold in the fiber direction 0^0, 30^0, 60^0 (Figure 16).

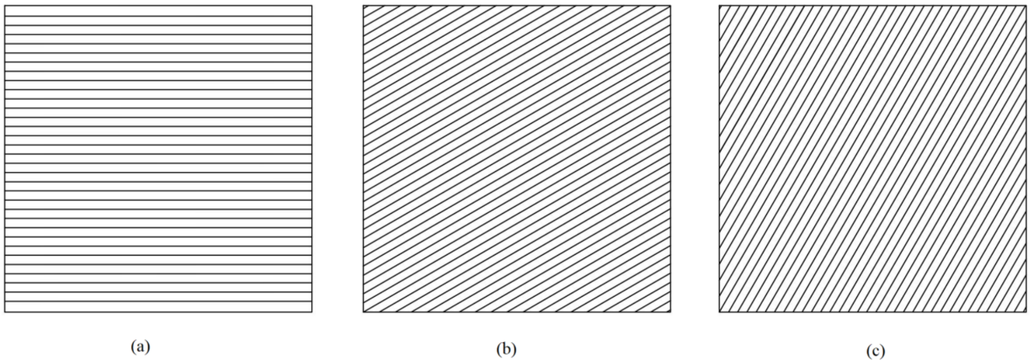


Figure 16. Sketch of the fiber direction (a) 0^0, (b) 30^0, (c) 60^0.

1. After that, apply the catalyst to the resin as much as 1% of the amount of resin used and then stir until the resin color turns lighter.

2. After the matrix is ready, then it is poured into a mold that previously had pineapple leaf fibers arranged according to the direction of the fibers, and leveled with a brush.
3. Cover the matrixed composite with glass again. Closing by using glass aims to minimize the amount of voids which are then pressed using loading.
4. The drying process is carried out until it is completely dry, which is 5 - 10 hours and if it is still not completely dry then the drying process can be carried out longer.
5. The process of taking the composite from the mold is using a cutter or steel ruler.

After the printing process is complete, cutting is carried out according to the specimen size by manual processing using a saw, the shape and size of the specimen are in accordance (Figure 17) ASTM D638-03 standard (Gibson, 2016).

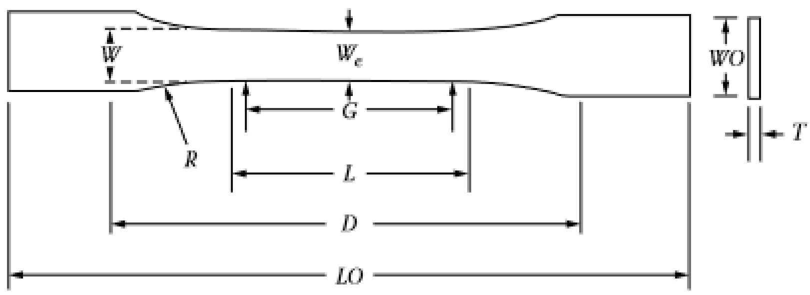


Figure 17. ASTM D638-03 Testing Standard (Gibson, 2016)

Table 7. Size of tensile test specimens ASTM D638-03

Dimension of Tensile Test Specimen (mm)								
W	L	WO	T	LO	G.	D	R	WC
13	57	19	4	165	50	115	76	+ 0.00-0.10 /: W.

(Gibson, 2016)

G. Setup of Equipment and Measurement

Setup of test equipment on static tensile testing that is tailored to the specimen holder. The tensile loading is given parallel to the axial axis and is assumed to be uniform at each test point. The tensile test specimen holder is adjusted to the test instrument holder for use as a plate-shaped specimen holder (Figure 18).

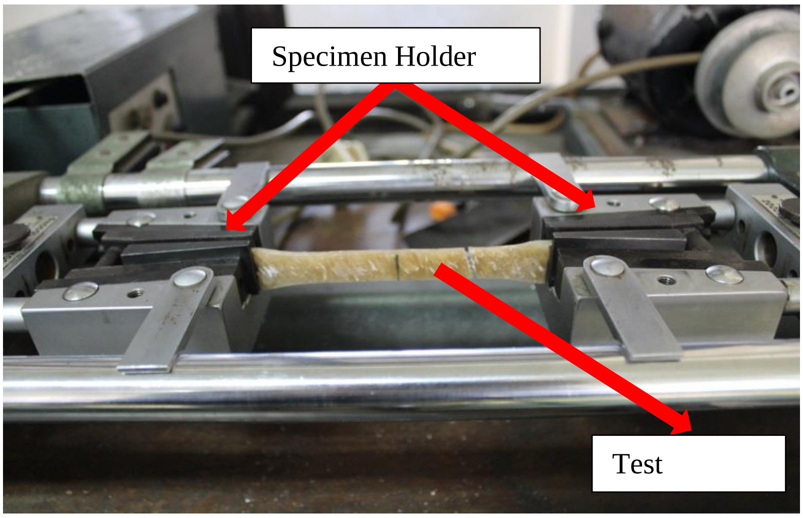


Figure 18. Tensile Test Specimen Holder

The steps for the tensile test of pineapple leaf fiber reinforced composites are as follows:

1. Prepare the Monsanto Tensometer Education Kit tensile testing machine and equipment.
2. Measure the initial width and thickness of the specimen (specimen) with a caliper before testing, record the measurement results.
3. Attach the specimen to the prepared specimen holder.

4. Install the specimen holder that has been attached to the specimen on the tensile testing machine holder.
5. Measure the distance between the inside side of the fixed cross head and the inside of the moving cross head on the tensile testing machine, the long value of this distance is recorded as the initial length of the specimen before testing.
6. Place graph paper on the test machine.
7. Set force scale reading at zero position (force scale calibration)
8. Pulling starts from zero load by turning the crank on the engine slowly and constantly so that no shock load occurs.
9. Perform continuous rotation accompanied by notes on graph paper, until the test specimen breaks.
10. Re-measure the distance between the inner side of the fixed cross head and the inner side of the movable cross head on the tensile testing machine, the long value of this distance is recorded as the final length of the specimen after being tested.
11. perform these steps on the other test specimen.

The measurement of specimen tensile stress is based on Hooke's Law (Hooke Law). This law states that a material behaves elastically and shows a linear relationship between stress and strain which is called linear elasticity. A linear relationship is obtained between the stress strain for a rod subjected to tension.

H. Data Analysis

The test data processing method is carried out by mathematical calculations that apply several equations. From the theoretical mathematical calculations, various properties can be obtainedcomposite specimen material. The calculation result is clarified by comparing it with the specimen test results.

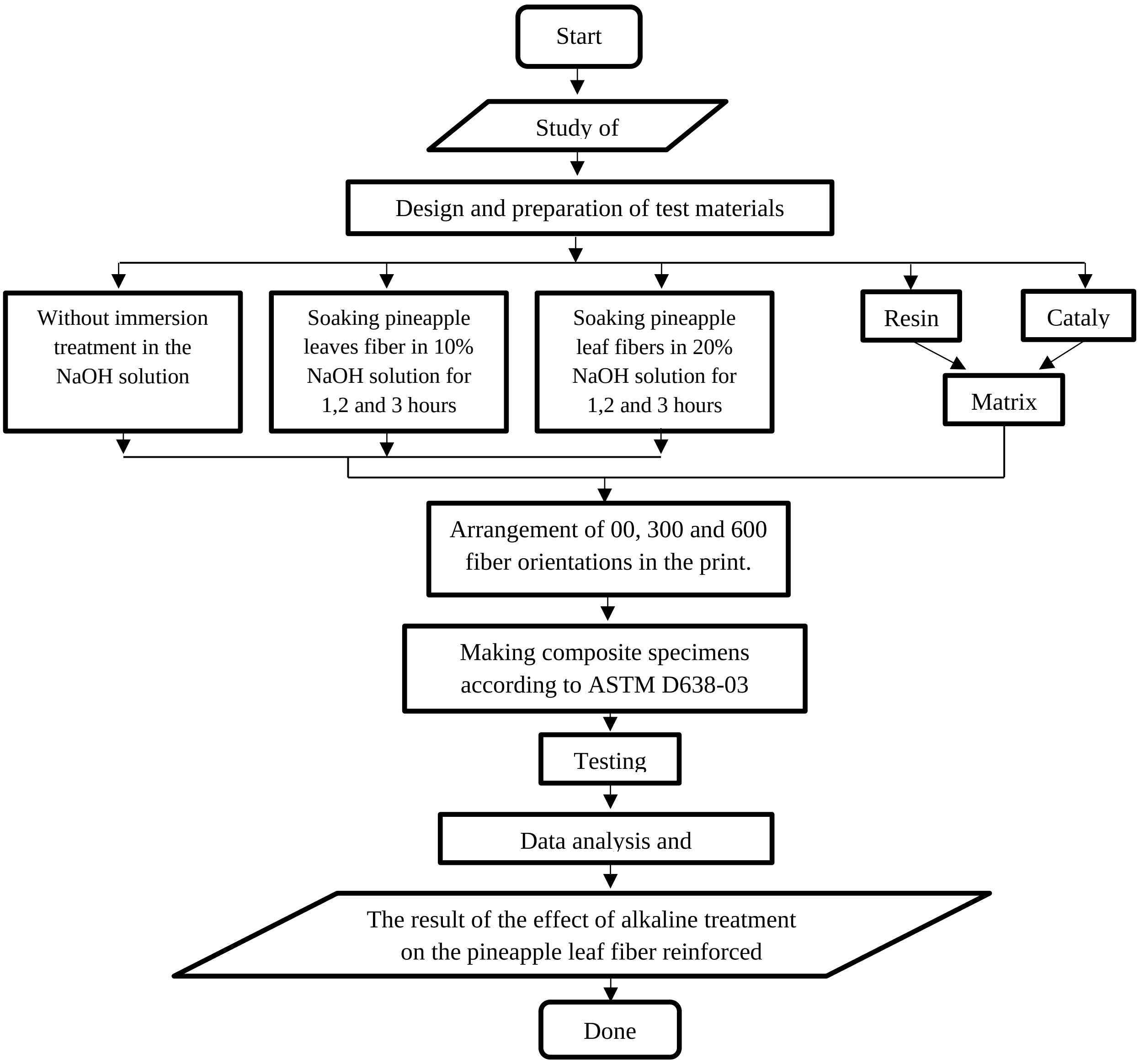
Table 8. Data Tabulation of Tensile Testing Results Composites Treated with 10% NaOH Alkali

ALKALI TREATMENT (10% NaOH) (HOUR)	**FIBER ORIENTATION**	**Stretch (%)**	**Voltage (MPa)**	**Modulus of Elasticity (Gpa)**	**Toughness (toughness)**
1	00				
	300				
	600				
2	00				
	300				
	600				
3	00				
	300				
	600				

Table 9. Data Tabulation of Tensile Testing Results Composites Treated with 20% NaOH Alkali

ALKALI TREATMENT (20% NaOH) (HOUR)	FIBER ORIENTATION	Stretch (%)	Voltage (MPa)	Modulus of Elasticity (Gpa)	Toughness (toughness)
1	00				
	300				
	600				
2	00				
	300				
	600				
3	00				
	300				
	600				

I. Research Flow Chart



CHAPTER IV

RESEARCH RESULTS AND DISCUSSION

A. Test Result Data

Table 10. Results of Tensile Stress, Strain and Modulus of Elasticity of Untreated Pineapple Leaf Fiber

NaOH 10%						
COMPOSITE		**Corner**	**Specimens**	**Tensile Stress**	**Stretch**	**Modulus of Elasticity (E)**
Resin 70%	**Fiber 30%**			(MPa)	**(%)**	(GPa)
Without Treatment		00	1	50.7	1.52	3.33
			2	50	1.71	2.91
			3	48.1	1.59	3.42
			Average	**49.6**	**1.61**	**3.22**
		300	1	40.1	1.15	3.48
			2	35.3	0.82	4.30
			3	38.9	0.85	4.58
			Average	**38.1**	**0.94**	**4.12**
		600	1	24.6	0.09	2.71
			2	22.8	0.98	2.63
			3	37.6	0.91	4.13
			Average	**28.3**	**0.66**	**3.15**

Table 11. Results of Tensile Stress, Strain and Elastic Modulus of Fiber From Pineapple Leaves with Alkaline Treatment 10%

NaOH 10%						
COMPOSITE		**Corner**	**Specimens**	**Tensile Stress**	**Stretch**	**Modulus of Elasticity (E)**
Resin 70%	**Fiber 30%**			(MPa)	**(%)**	(GPa)
1 hour		00	A1 - 1	42.9	0.88	4.89
			A1 - 2	22.8	0.45	5.02

		A1 - 3	25.6	0.51	4.97
		Average	**30.4**	**0.62**	**4.96**
	300	B1 - 1	9.9	0.58	1.71
		B1 - 2	12.7	0.73	1.74
		B1 - 3	16.0	0.70	2.30
		Average	**12.9**	**0.67**	**1.92**
	600	C1 - 1	13.2	0.52	2.56
		C1 - 2	17.0	0.48	3.50
		C1 - 3	20.8	0.48	4.28
		Average	**17.0**	**0.50**	**3.44**
2 hours	00	A2 - 1	36.8	0.70	5.28
		A2 - 2	21.6	0.33	6.37
		A2 - 3	21.7	0.36	5.96
		Average	**26.7**	**0.46**	**5.87**
	300	B2 - 1	25.5	0.73	3.50
		B2 - 2	17.9	0.55	3.28
		B2 - 3	20.0	0.76	2.63
		Average	**21.1**	**0.68**	**3.14**
	600	C2 - 1	10.4	0.21	4.89
		C2 - 2	13.0	0.30	4.27
		C2 - 3	13.8	0.55	2.52
		Average	**12.4**	**0.35**	**3.89**
3 hours	00	A3 - 1	23.9	0.48	4.93
		A3 - 2	29.2	0.73	4.02
		A3 - 3	34.0	0.67	5,10
		Average	**29.0**	**0.63**	**4.68**
	300	B3 - 1	14.4	0.79	1.82
		B3 - 2	13.2	0.55	2.42
		B3 - 3	22.8	0.61	3.76
		Average	**16.8**	**0.65**	**2.67**
	600	C3 - 1	13.0	0.30	4.29
		C3 - 2	11.3	0.24	4.67
		C3 - 3	9.7	0.33	2.92
		Average	**11.4**	**0.29**	**2.97**

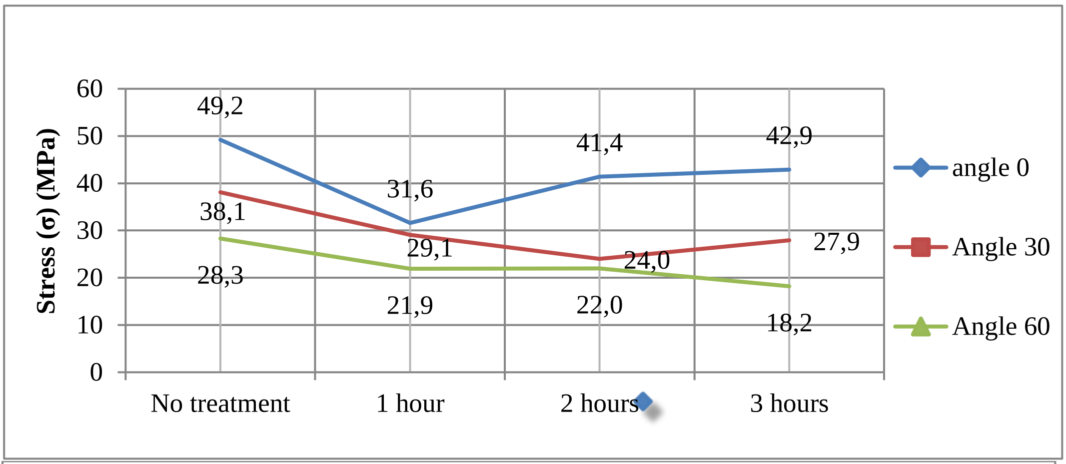
Table 12. The Results of Tensile Stress, Strain and Elastic Modulus of Pineapple Leaves Fiber with Alkaline Treatment 20%

20% NaOH						
COMPOSITE		**Corner**	**Specimens**	**Tensile Stress**	**Stretch**	**Modulus of Elasticity (E)**
Resin 70%	**Fiber 30%**			(MPa)	**(%)**	(GPa)
1 hour		00	A'1 - 1	20.8	0.55	3.81
			A'1 - 2	39.6	0.61	6.54

		A'1 - 3	34.2	0.61	5.65
		Average	**31.6**	**0.59**	**5.33**
	300	B'1 - 1	31.4	0.64	4.88
		B'1 - 2	29.7	0.55	5.37
		B'1 - 3	26.3	0.61	4.34
		Average	**29.1**	**0.60**	**4.86**
	600	C'1 - 1	22.5	0.55	4.12
		C'1 - 2	22.5	0.48	4.28
		C'1 - 3	20.8	0.39	5.26
		Average	**21.9**	**0.47**	**4.55**
2 hours	00	A'2 - 1	47.3	0.70	6.79
		A'2 - 2	44.7	0.61	7.36
		A'2 - 3	32.3	0.73	4.44
		Average	**41.4**	**0.51**	**6.20**
	300	B'2 - 1	23.9	0.67	3.59
		B'2 - 2	18.9	0.67	2.83
		B'2 - 3	29.2	0.67	4.38
		Average	**24.0**	**0.67**	**3.60**
	600	C'2 - 1	18.7	0.48	3.86
		C'2 - 2	24.2	0.48	4.98
		C'2 - 3	23.2	0.48	4.78
		Average	**22.0**	**0.48**	**4.54**
3 hours	00	A'3 - 1	41.5	1.09	3.80
		A'3 - 2	36.4	0.67	5.46
		A'3 - 3	50.7	0.76	6.70
		Average	**42.9**	**0.84**	**5.32**
	300	B'3 - 1	24.2	0.73	3.31
		B'3 - 2	27.9	0.85	3.28
		B'3 - 3	31.8	0.82	3.88
		Average	**27.9**	**0.80**	**3.49**
	600	C'3 - 1	20.6	0.48	4.24
		C'3 - 2	18.9	0.42	4.44
		C'3 - 3	15.3	0.42	3.60
		Average	**18.2**	**0.44**	**4.09**

B. Discussion

This study used a tensile test which aims to determine the mechanical properties of pineapple leaf fibers to the effect of alkaline treatment using tensile testing. The following graph of the test results on the mechanical properties of the pineapple leaf fiber compositing material can be seen in the following figure.



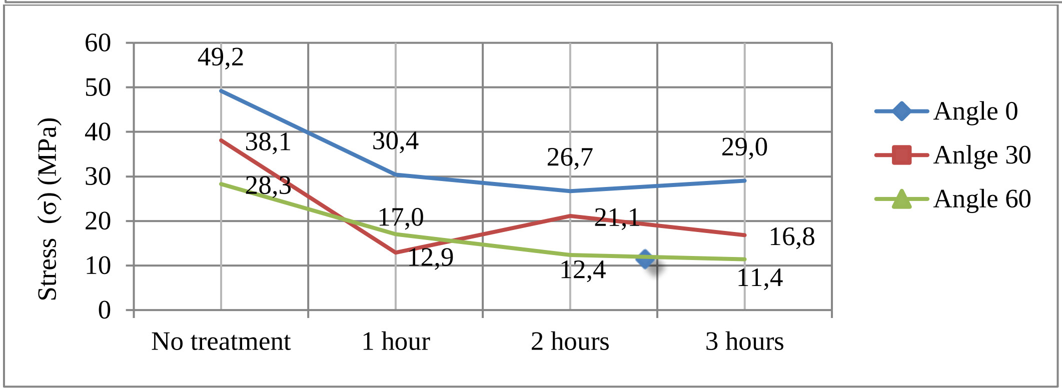


Figure 19. Graph of the Relationship between Stress and Length of Time Soaking 10% Alkaline Pineapple Leaves Fiber Composite

Figure 20. Graph of the Relationship between Stress and the Length of Soaking Time for Alkaline 20% of Pineapple Leaf Fiber Composite

The results of the stress data from the tensile test in the figure show that the resulting average tensile stress shows the influence of variations in the treatment of alkaline (NaOH), immersion time, and direction of orientation of the fibers to pineapple leaf fibers. The highest tensile strength was obtained in the untreated specimens in the direction of fiber orientation 00 with an average value of 49.2 MPa. The high tensile stress obtained by the orientation of the fiber orientation is 00 because the direction of the fiber is directly proportional to the given static load.

When compared with untreated specimens, it shows that the average yield tensile tensile stress of the fibers is influenced by variations in alkaline application, orientation direction, and immersion time. The results of the tensile stress data from the variation of 10% to 20% alkaline application, the better average specimen tensile stress obtained in the 20% alkaline treatment was 42.9 MPa, angle 00 with 3 hours immersion time.While the lowest average tensile stress results obtained in pineapple leaf fiber composites in the direction of 600 fiber orientation with 10% alkaline NaOH treatment were 11.4 Mpa immersion time 3 hours. This corresponds to (Hendriwan Fahmi et al., 2011 : 46 - 52), which states that one of the other factors that also affects the mechanical properties of composites is the direction of fiber orientation.

The decrease in the tensile strength of pineapple leaf fibers after being given treatment compared to without treatment is caused by giving a high percentage of alkaline solution (NaOH), because the basic principle of alkaline solution (NaOH) has properties that can change the surface of the fiber to become rough, due to giving a high percentage of alkali to the surface. coarser it will cause the tensile strength of the fibers to decrease after exceeding the saturation limit (Hana Wardani et al., 2019). Tensile testing is carried out on the material, there will be a fracture from the load given to the material, the process of the fracture begins with the crack that continues to propagate the crack (Hendri &

Mulianti, 2011 : 46-52). From this basic principle, giving an alkaline solution (NaOH) to pineapple leaf fibers can reduce its tensile stress.

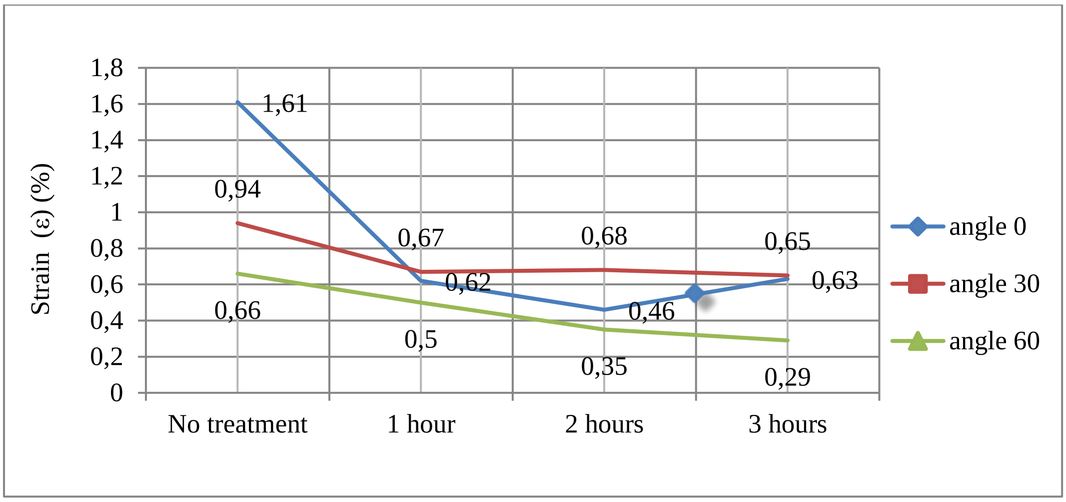


Figure 21. Graph of the Strain Relationship to the Length of Soaking Time in Alkaline 10% Pineapple Leaf Fiber Composite

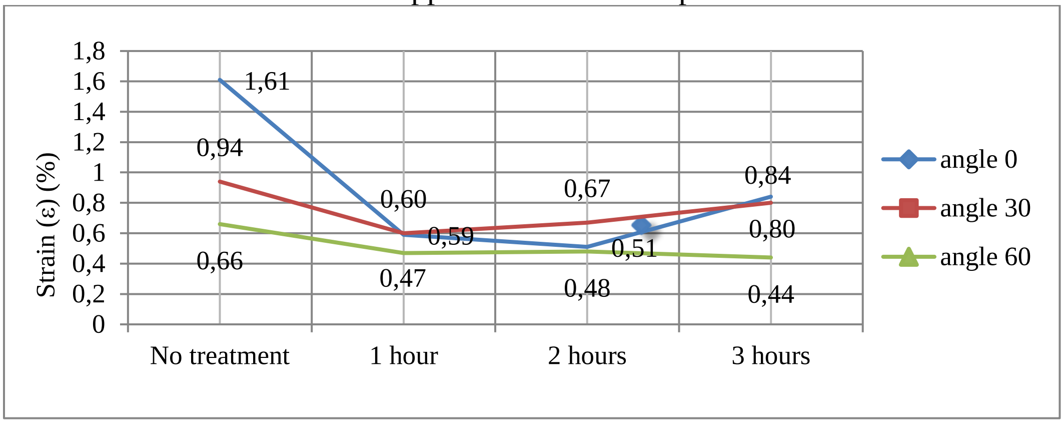


Figure 22. Graph of the Strain Relationship to the Length of Soaking Time Alkaline 20% Pineapple Leaf Fiber Composite

The results of the resulting strain value data can be seen that the strain of the untreated specimen is higher than that of the alkaline treated specimen. This reduction in strain occurs due to the effect of chemical treatment (NaOH), so that the lack of a composite ratio reaction at the received tensile load causes strain at the atomic level of the compositing particles of the composite (Mohammad

Irkham et al., 2019). Judging by the average value of strain on the composite material of pineapple leaf fiber, it shows that the alkaline treatment affects the strain on the fiber and the fracture results become increasingly brittle.

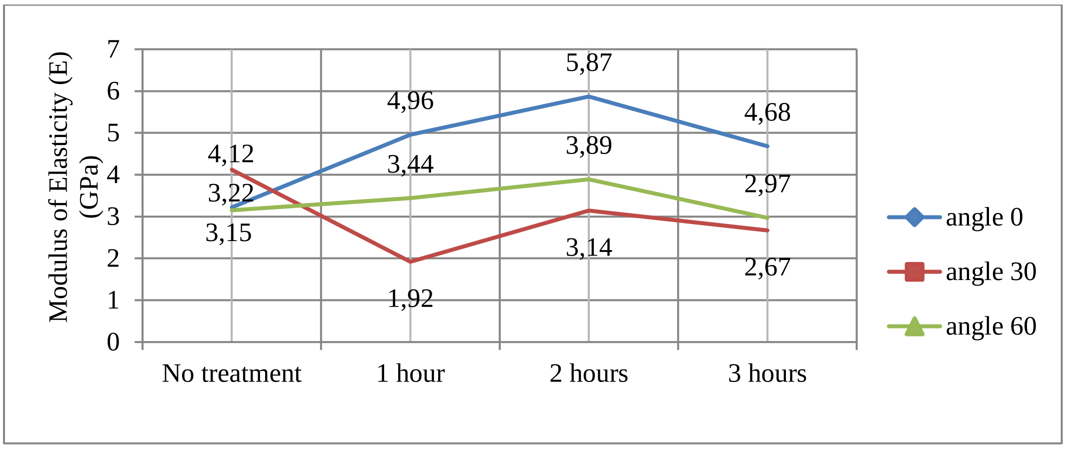


Figure 23. Graph of the Relationship of Modulus of Elasticity to the Length of Soaking Time in Alkali 10% of Pineapple Leaf Fiber Composite

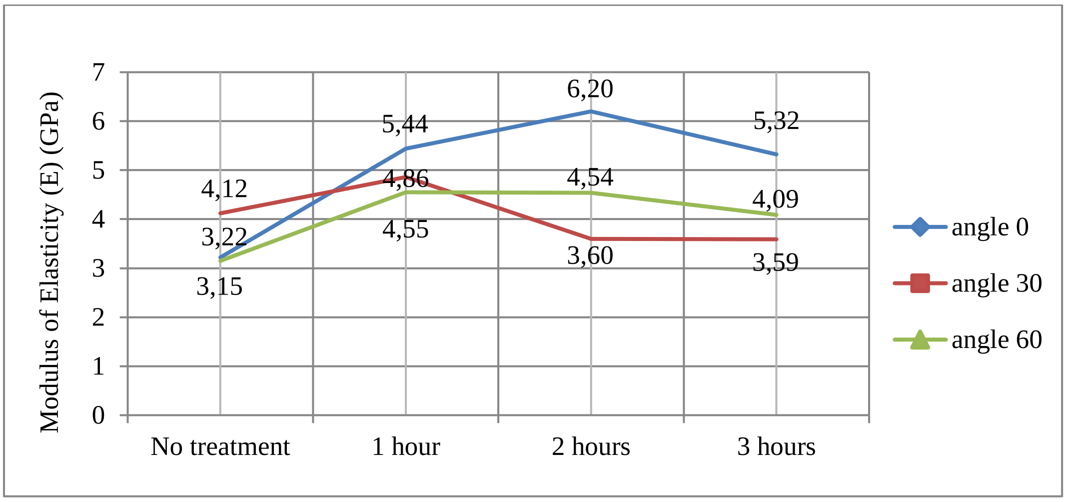


Figure 24. Graph of the Relationship between Modulus of Elasticity and Immersion Time for Alkaline 20% of Pineapple Leaf Fiber Composite

The results of the data for the modulus of elasticity, it can be seen that the modulus of elasticity of the specimens given alkaline at a certain immersion time tends to increase compared to untreated specimens. This is consistent with the researchwhich is conducted Diharjo (2006), stated that the alkaline immersion time given to the fiber will increase in its elastic modulus. This increase indicates that it is increasingly difficult for an object to increase in length or withstand changes in shape (Kiswadi, 2017). From the results of the test data, it is found that the pineapple leaf fiber after being given alkaline treatment has a slight increase in length, this of course affects the tensile stress on the fiber because the elastic modulus value increases, so the smaller the strain value obtained.

C. Tensile Test Calculation

1. Tensile Stress

The loading applied to the composite specimen tensile test is the application of axial forces to the ends of the specimen. These axial forces will cause a uniform pull on the specimen so that it experiences tension. One of the calculated calculations is without treatment of specimen 1 with a matrix of 70% and 30% fiber. By assuming that the stress is evenly distributed over the entire cross-section of the specimen rod, where the load P is divided by the cross-sectional area A of the specimen rod, so we get (Gere & Timoshenko, 2001):

$$\sigma = \frac{P}{A}$$

Where :

σ = Voltage (Mpa)

P = Load (2599.7 N)

A = Cross-sectional Area (5.12)$\times 10^{-5}\ m^2$

Then:

$$\sigma = \frac{P}{A}$$

$$\sigma = \frac{2599.7\ N}{5.12 \times 10^{-5}\ m^2}$$

$$\sigma = 50.8\ \times 10^6\ {}^{N}/{}_{m^2} = 50.8\ Mpa$$

Detailed calculation calculations and the overall calculation of test specimens for each treatment can be seen in list of attachment 2 to 11.

2. Strain Calculation

The axially loaded rod will experience a change in length, where the stem will become short when under pressure and will become long when subjected to tension. The change in the length of the rod that experiences tension is symbolized (ΔL). Elongation that occurs is the cumulative result of the pulling of the material over the entire length L of the stem. One of the calculated calculations is the untreated specimen 1 with a matrix of 60% and 40% fiber. The concept of lengthening to unit length ratio is called strain (Gere & Timoshenko, 2001):

$$\varepsilon = \frac{\Delta L}{L} = \frac{l_i - l_0}{L}$$

Where :

ε = strain (%)

ΔL = Increase long (0.0025 m)

lo = long initial (0.1641 m)

li = final length (0.1666 m)

With: $\Delta L = L_1 - L_0$

$= 0{,}1666\ m - 0{,}1641\ m$

$= 0{,}0025\ m$

Then:

$$\varepsilon = \frac{\Delta L}{L} = \frac{0{,}0025\ m}{0{,}1641\ m} = 0{,}0152\ m$$

Percentage of Strain:

$$\varepsilon = \frac{L_1 - L_0}{L_0} \times 100\ \%$$

$$\varepsilon = \frac{0{,}1666\ m - 0{,}1641\ m}{0{,}1666\ m} \times 100\ \%$$

$$\varepsilon = 1.52\ \%$$

Detailed calculation calculations and the overall calculation of test specimens for each treatment can be seen in attachment 2 to 11.

3. Calculation of the Modulus of Elasticity

The data obtained in the form of stress and strain are calculated in a calculated manner to obtain the Modulus of Elasticity of each composite material. One of the calculations calculated is on composites that are not given alkaline treatment (specimen 1). With the application of Hooke's Law theory, a linear relationship in stress-strain graph is obtained (Gere & Timoshenko, 2001):

$$\sigma = E\ .\ \varepsilon \qquad \text{or} \qquad E = \frac{\sigma}{\varepsilon}$$

Where:

σ = Voltage

E = Modulus of elasticity

ε = Stretch

Then:

$$E = \frac{\sigma}{\varepsilon}$$

$$E = \frac{50.8 \times 10^{6} \ ^{N}/_{m^2}}{0{,}0152 \ ^{m}/_{m}}$$

$$E = 3{,}33 \times 10^{9} \, ^{N}/_{m^2} = 3{,}33 \ Gpa$$

Detailed calculation calculations and the overall calculation of test specimens for each treatment can be seen in attachment 2 to 11.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

A. Conclusion

The results of this study can be concluded as follows:

1. From the tensile test result data, it shows that the pineapple leaf fiber given alkaline treatment produces a lower tensile stress than the alkaline treatment. The low tensile stress value obtained is because NaOH has propertieswhich is able to change the surface of the fiber to become rough, due to the fiber being coarse, it will cause the tensile strength of the fiber to decrease after exceeding its saturation limit. This is indicated by the low strain of the test results.
2. The results showed that the orientation of the fiber orientation 0^0 had a better tensile stress than the 30^0 and 60^0 fiber orientation directions, this was due to the orientation of the 0^0 fibers is directly proportional to the static load applied to the tensile testing machine.

B. Recomendations

1. Before making a composite, equipment should be prepared supporters so as to facilitate the process of making composites
2. In mixing the resin with the catalyst it must be even, because the resin will not harden if it is not combined with the catalyst.

3. In making composites using the hand lay-up method is not spared with the voids and cracks, to minimize it do manufacture composites correctly and thoroughly.
4. In making specimens, tools should be used work safety. Because the specimen material comes from chemicals.

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ATTACHMENTS

Attachment 1: Composite Percentage Calculation

Calculation of the mechanical properties of composites for the percentage of resin 70% and fiber 30%

1. Calculation of the Volume Percentage

   Determining the Volume of the Mold:

   Given:

   P = 200 mm

   L = 200 mm

   T = 4 mm

   V_{cetak} = p x l x t

   = (200 x 200 x 4) mm^3

   = 160.000 mm^3

   = 0,00016 m^3

   1. Volume of Resin 70 %

      V_r = V_{cetak} x 60 %

      = 0,00016 m^3 x 0,7

      = 0,000112 m^3

   2. Volume of Catalyst

      V_k = V_{cetak} x 1 %

      = 0,00016 m^3 x 0,01

$= 0{,}0000016 \text{ m}^3$

3. Volume of Matrix

$V_m = V_r + V_k$

$= 0{,}000112 \text{ m}^3 + 0{,}0000016 \text{ m}^3$

$= 0{,}0001136 \text{ m}^3$

4. Volume of Peneapple Leaf Fiber 30 %

$V_f = V_{cetak} \times 30\ \%$

$= 0{,}00016 \text{ m}^3 \times 0{,}3$

$= 0{,}000048 \text{ m}^3$

Resin	fiber	V_{cetak}	V_r	V_k	V_m	V_f
%		m^3				
70	30	0,00016	0,000112	0,0000016	0,0001136	0,000048

5. Composite Density = density of matrix x volume of matrix + Fiber density x volume of fiber

$= (1215 \times 0{,}7) + (0{,}016 \times 0{,}3)$

$= 850{,}5 + 0{,}0048$

$= 850{,}6 \text{ kg/m}^3$

6. Total mass $= V_{cetak} \times$ density

$= 0{,}00016 \text{ m}^3 \times 850{,}6 \text{ kg/m}^3$

$= 0.136096 \text{ kg}$

7. Mass of resin = Total mass x volume of resin

= 0.136096 x 0.7

= 0.0952 kg

= 95.2 gr

8. Mass of fiber = total mass x volume of fiber

= 0.136096 x 0.3

= 0.0408 kg

= 40.8 g

Attachment 2: Result of Tensile Test for Pineapple Leaf Fiber Composite Without Alkali Treatment Angle 0^0

Table 1. Tabulation of Composite Tensile Test Data for Pineapple Leaf Fiber without Alkali Treatment Angle 0^0 Specimen I

Lo = 0.164 m
Li = 0.1661 m

Width = 0.0128 m
Thickness = 0.004m

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPa)
50	490,5	5,12E-05	9,6E+6	0,30%	3,144E+09
100	981	5,12E-05	19,2E+6	0,61%	3,144E+09
150	1471,5	5,12E-05	28,7E+6	0,85%	3,369E+09
200	1962	5,12E-05	38,3E+6	1,16%	3,310E+09
250	2452,5	5,12E-05	47,9E+6	1,43%	3,345E+09
265	2599,7	5,12E-05	50,8E+6	1,52%	3,333E+09

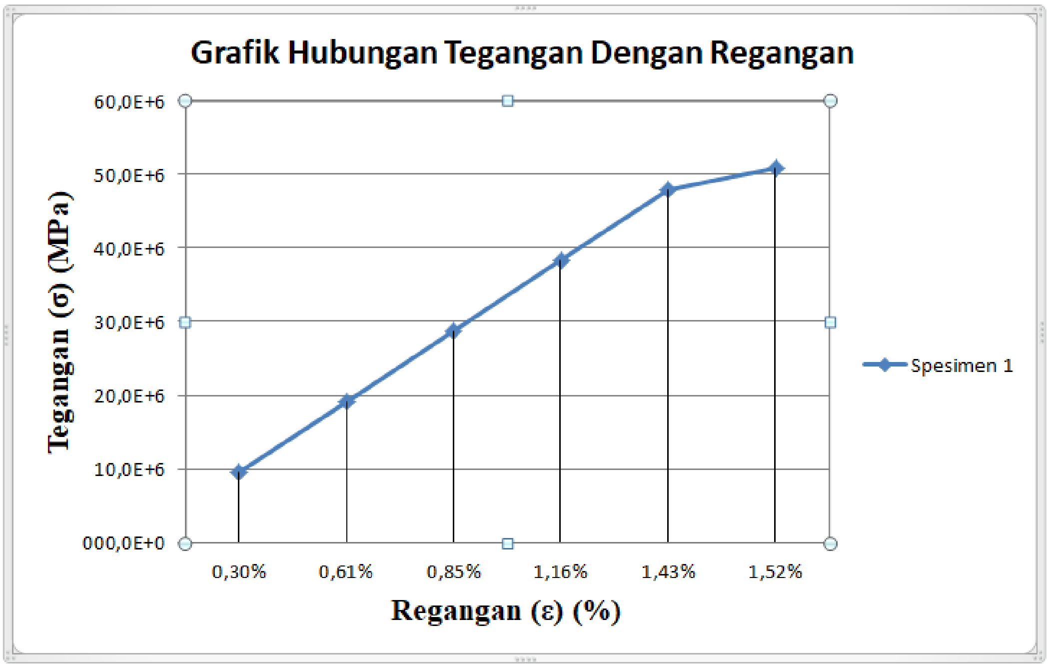


Figure 1. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber without Alkali Treatment Angle 0^0 Specimen I

Table 2. Tabulation of Composite Tensile Test Data for Pineapple Leaf Fiber without Alkali Treatment Angle 00 Specimen II

Lo = 0.165 m
Li = 0.166 m

Width = 0.1275 m
Thickness = 0.004m

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
50	490,5	0,000051	9,6E+6	0,31%	3,14E+09
100	981	0,000051	19,2E+6	0,61%	3,14E+09
150	1471,5	0,000051	28,9E+6	0,92%	3,14E+09
200	1962	0,000051	38,5E+6	1,29%	2,99E+09
250	2452,5	0,000051	48,1E+6	1,59%	3,02E+09
260	2550,6	0,000051	50,0E+6	1,71%	2,92E+09

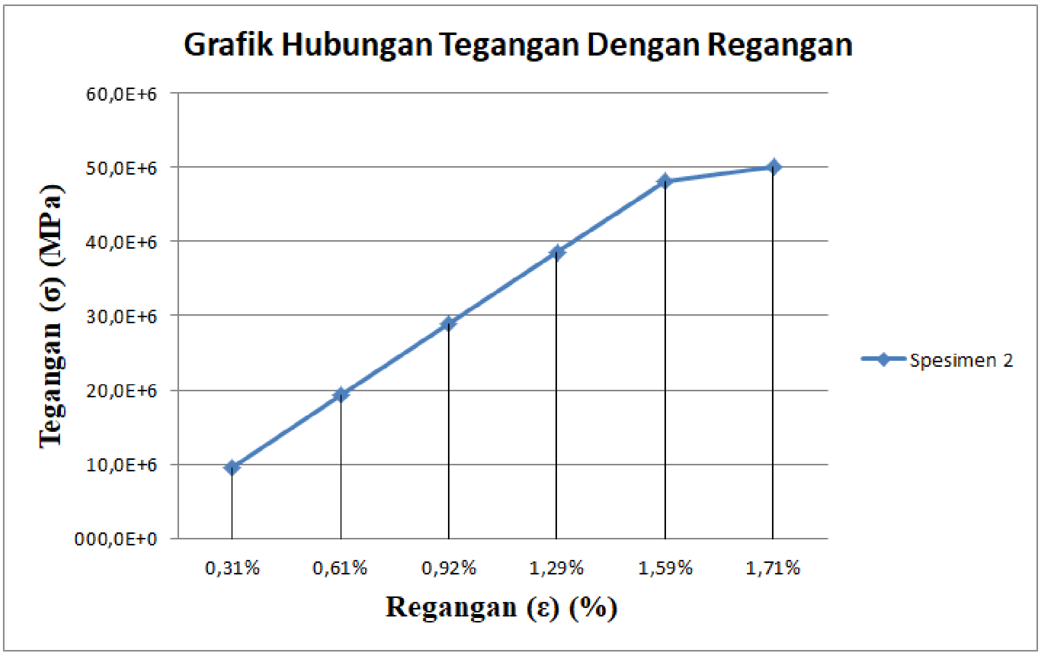


Figure 2. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber without Alkali Treatment Angle 0^0 Specimen II

Table 3. Tabulation of Composite Tensile Test Data for Pineapple Leaf Fiber without Alkali Treatment Angle 0^0 Specimen III

Lo = 0.16505 m
Li = 0.16615 m

Width = 0.0128 m
Thickness = 0.0039m

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
50	490,5	4,99E-05	9,8E+06	0,18%	5,358E+09
100	981	4,99E-05	19,7E+6	0,55%	3,572E+09
150	1471,5	4,99E-05	29,5E+6	0,79%	3,710E+09
200	1962	4,99E-05	39,3E+6	1,10%	3,572E+09
245	2403,5	4,99E-05	48,1E+6	1,41%	3,425E+09

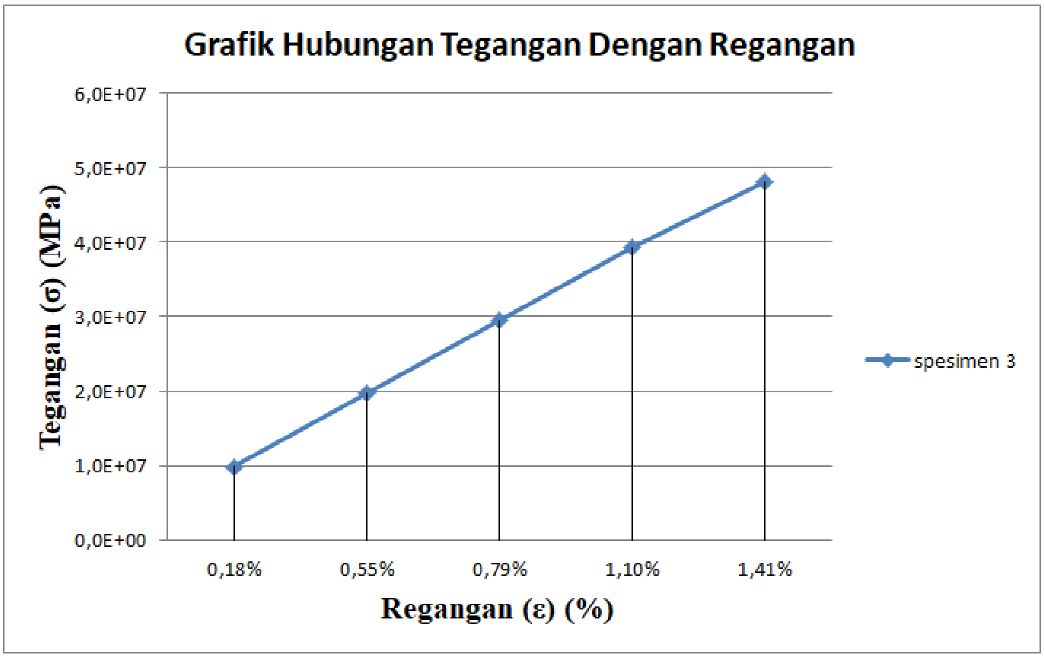


Figure 3. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber without Alkali Treatment Angle 0^0 Specimen III

Attachment 3: Results of Tensile Test for Pineapple Leaf Fiber Composite Without Alkali Treatment Angle 30⁰

Table 4. Tabulation of Composite Tensile Test Data for Pineapple Leaf Fiber without Alkali Treatment Angle of 30^0 Specimens I

Lo = 0.165 m
Li = 0.1656 m

Width = 0.0131 m
Thickness = 0.0039m

spesimen 30-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,11E-05	3,8E+06	0,18%	2,112E+09
40	392,4	5,11E-05	7,7E+6	0,30%	2,535E+09
60	588,6	5,11E-05	11,5E+6	0,48%	2,376E+09
80	784,8	5,11E-05	15,4E+6	0,55%	2,816E+09
100	981	5,11E-05	19,2E+6	0,67%	2,880E+09
120	1177,2	5,11E-05	23,0E+6	0,79%	2,925E+09
140	1373,4	5,11E-05	26,9E+6	0,91%	2,957E+09
160	1373,4	5,11E-05	30,7E+6	0,97%	2,957E+09
180	1765,8	5,11E-05	34,6E+6	1,09%	1,091E-02
200	1962	5,11E-05	38,4E+6	1,12%	3,425E+09
209	2050,29	5,11E-05	40,1E+6	1,15%	3,485E+09

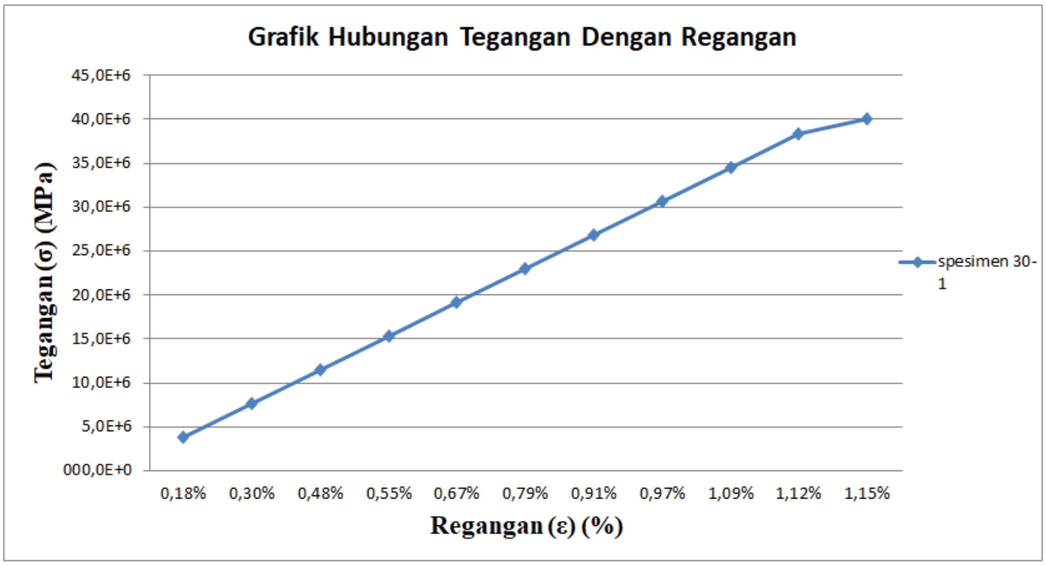


Figure 4. Graph of K Tensile Test Results for Fiber Composite Pineapple Leaves Without Alkali Treatment Angle of 30^0 Specimen I

Table 5. Tabulation of Composite Tensile Test Data for Pineapple Leaf Fiber without Alkali Treatment Angle 30^0 Specimens II

Lo = 0.165 m
Li = 0.1661 m

Width = 0.0132 m
Thickness = 0.0039m

spesimen 30-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,17E-05	3,8E+6	0,09%	4,171E+09
40	392,4	5,17E-05	7,6E+6	0,15%	5,005E+09
60	588,6	5,17E-05	11,4E+6	0,27%	4,171E+09
80	784,8	5,17E-05	15,2E+6	0,30%	5,005E+09
100	981	5,17E-05	19,0E+6	0,33%	5,688E+09
120	1177,2	5,17E-05	22,8E+6	0,48%	4,692E+09
140	1373,4	5,17E-05	26,5E+6	0,58%	4,610E+09
160	1569,6	5,17E-05	30,3E+6	0,61%	5,005E+09
180	1765,8	5,17E-05	34,1E+6	0,70%	4,896E+09
200	1962	5,17E-05	37,9E+6	0,82%	4,634E+09
205	2011,05	5,17E-05	38,9E+6	0,85%	4,580E+09

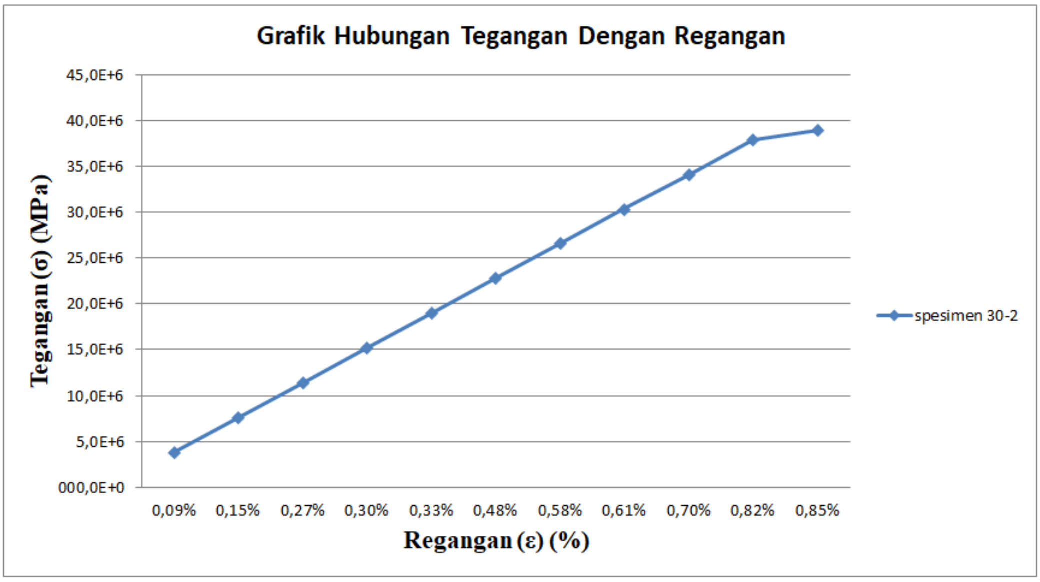


Figure 5. Graph of K Tensile Test Results for Fiber Composite Pineapple Leaves Without Alkali Treatment Angle 30^0 Specimens II

Table 6. Tabulation of Composite Tensile Test Data for Pineapple Leaf Fiber without Alkali Treatment Angle 30^0 Specimen III

Lo = 0.165 m
Li = 0.16585 m

Width = 0.0131 m
Thickness = 0.00395 m

spesimen 30-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,15E-05	3,8E+6	0,09%	4,192E+09
40	392,4	5,15E-05	7,6E+6	0,27%	2,795E+09
60	588,6	5,15E-05	11,4E+6	0,30%	3,773E+09
80	784,8	5,15E-05	15,2E+6	0,36%	4,192E+09
100	981	5,15E-05	19,1E+6	0,45%	4,192E+09
120	1177,2	5,15E-05	23,0E+6	0,55%	4,192E+09
140	1373,4	5,15E-05	26,7E+6	0,61%	4,402E+09
160	1569,6	5,15E-05	30,5E+6	0,73%	4,192E+09
180	1765,8	5,15E-05	34,3E+6	0,79%	4,354E+09
185	1765,8	5,15E-05	35,3E+6	0,82%	4,309E+09

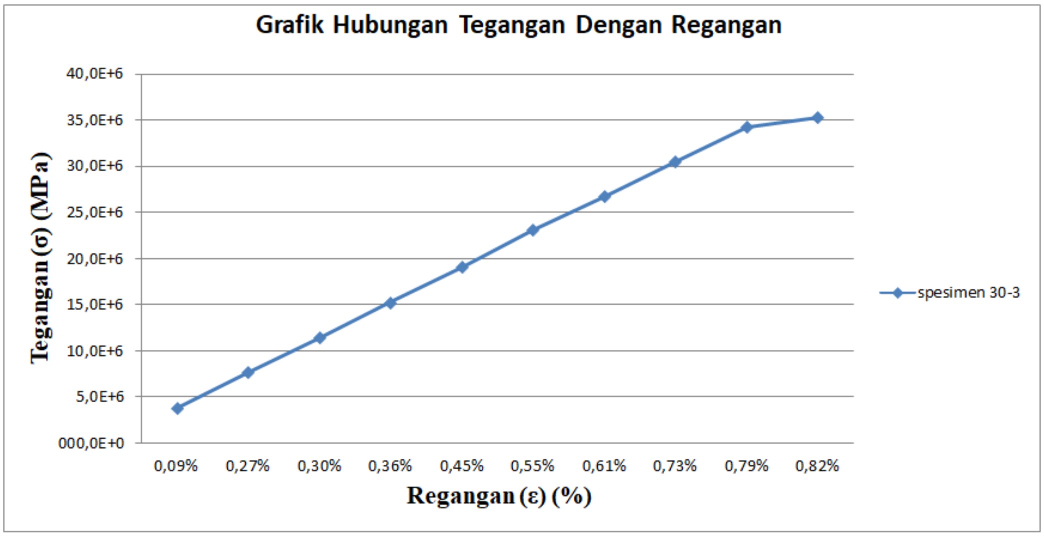


Figure 6. Graph of K Tensile Test Results for Fiber Composite Pineapple Leaves Without Alkali Treatment Angle of 30^0 Specimens III

Attachment 4: Tensile Test Results for Pineapple Leaf Fiber Composite Without Alkali Treatment Angle 60^0

Table 7. Tabulation of Composite Tensile Test Data for Pineapple Leaf Fiber without Alkali Treatment Angle of 600 Specimens I

Lo = 0.165 m
Li = 0.16515 m

Width = 0.0131 m
Thickness = 0.00395 m

spesimen 60-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,17E-05	3,8E+06	0,03%	1,244E+10
40	392,4	5,17E-05	7,6E+6	0,12%	6,222E+09
60	588,6	5,17E-05	11,4E+6	0,27%	4,148E+09
80	784,8	5,17E-05	15,2E+6	0,43%	3,556E+09
100	981	5,17E-05	19,0E+6	0,49%	3,889E+09
120	1177,2	5,17E-05	22,8E+6	0,61%	3,733E+09
130	1275,3	5,17E-05	24,6E+6	0,09%	2,711E+10

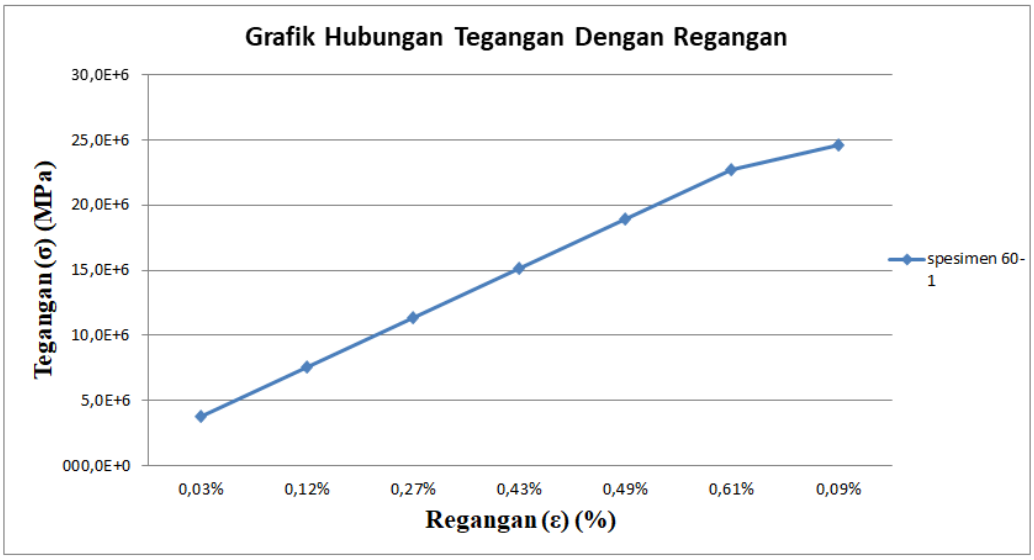


Figure 7. Graph of K Tensile Test Results for Fiber Composite Pineapple Leaves Without Alkali Treatment Angle of 600 Specimen I

Table 8. Tabulation of Composite Tensile Test Data for Pineapple Leaf Fiber without Alkali Treatment Angle of 60^0 Specimens II

Lo = 0.165 m
Li = 0.1658 m

Width = 0.0131 m
Thickness = 0.00395 m

spesimen 60-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	4,59E-05	4,3E+6	0,12%	3,509E+09
40	392,4	4,59E-05	8,6E+6	0,30%	2,807E+09
60	588,6	4,59E-05	12,8E+6	0,49%	2,632E+09
80	784,8	4,59E-05	17,1E+6	0,67%	2,552E+09
100	981	4,59E-05	21,4E+6	0,85%	2,506E+09
120	1177,2	4,59E-05	22,8E+6	0,98%	2,632E+09

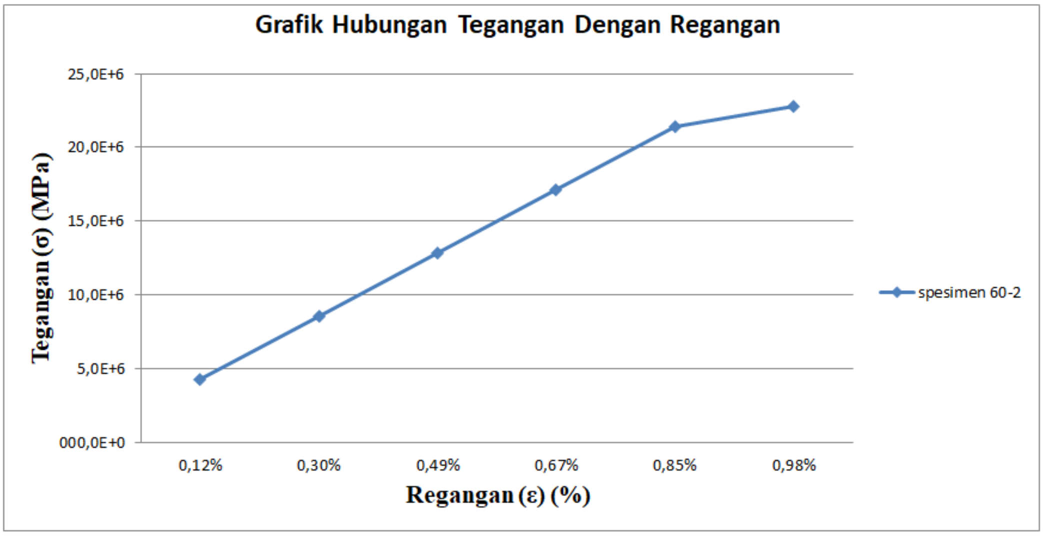


Figure 8. Graph of K Tensile Test Results for Composite Fiber of Pineapple Leaves Without Alkali Treatment Angle of 60^0 Specimens II

Table 9. Tabulation of Composite Tensile Test Data for Pineapple Leaf Fiber without Alkali Treatment Angle of 60^0 Specimen III

Lo = 0.165 m
Li = 0.1653 m

Width = 0.0132 m
Thickness = 0.00395 m

spesimen 60-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,21E-05	3,8E+6	0,09%	4,132E+09
40	392,4	5,21E-05	7,5E+6	0,18%	4,132E+09
60	588,6	5,21E-05	11,3E+6	0,30%	3,719E+09
80	784,8	5,21E-05	15,1E+6	0,43%	3,541E+09
100	981	5,21E-05	18,8E+6	0,49%	3,873E+09
120	1177,2	5,21E-05	22,6E+6	0,61%	3,719E+09
140	1373,4	5,21E-05	26,3E+6	0,67%	3,944E+09
160	1569,6	5,21E-05	30,1E+6	0,76%	3,966E+09
180	1765,8	5,21E-05	33,9E+6	0,85%	3,984E+09
200	1962	5,21E-05	37,6E+6	0,91%	4,132E+09

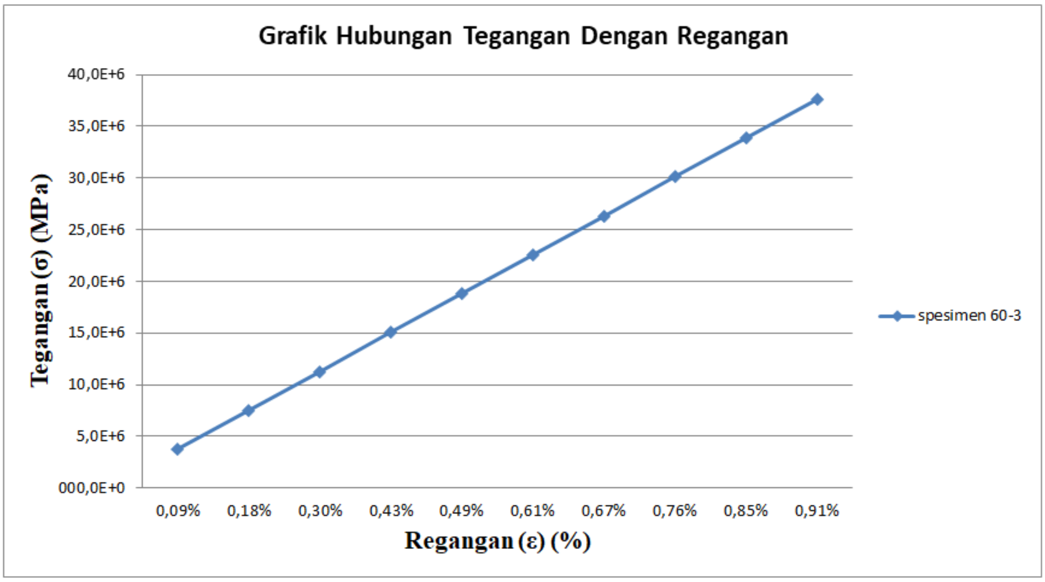


Figure 9. Graph of K Tensile Test Results for Fiber Composite Pineapple Leaves Without Alkali Treatment Angle of 60^0 Specimens III

Attachment 5: Result of Tensile Test for Alkali Pineapple Leaf Fiber Composite 10% Angle 0^0

Table 10. Tabulation of Tensile Test Data for Alkali Pineapple Leaf Fiber Composite 10%, 1 hour, Angle 0^0 Specimen I

Lo = 0.1652 m
Li = 0.16665 m

Width = 0.131 m
Thickness = 0.0041m

spesimen A1-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,37E-05	3,7E+06	0,06%	6,035E+09
40	392,4	5,37E-05	7,3E+6	0,09%	8,046E+09
60	588,6	5,37E-05	11,0E+6	0,18%	6,035E+09
80	784,8	5,37E-05	14,6E+6	0,27%	5,364E+09
100	981	5,37E-05	18,3E+6	0,36%	5,029E+09
120	1177,2	5,37E-05	21,9E+6	0,42%	5,173E+09
140	1373,4	5,37E-05	25,6E+6	0,51%	4,970E+09
160	1373,4	5,37E-05	29,2E+6	0,61%	4,970E+09
180	1765,8	5,37E-05	32,9E+6	0,67%	6,659E-03
200	1962	5,37E-05	36,5E+6	0,73%	5,029E+09
220	2158,2	5,37E-05	40,2E+6	0,82%	4,917E+09
235	**2305,35**	**5,37E-05**	**42,9E+6**	**0,88%**	**4,890E+09**

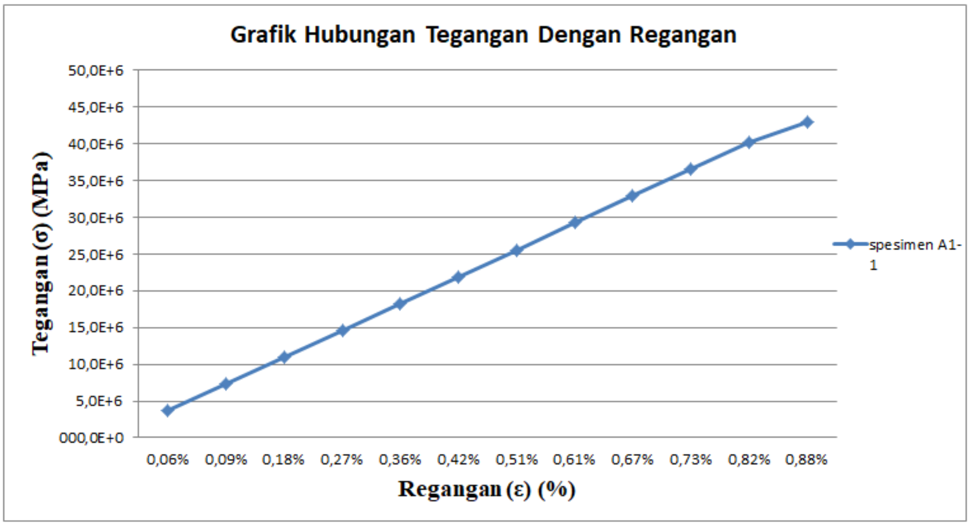


Figure 10. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 1 hour, Angle 0^0 Specimen I

Table 11. Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 1 hour, Angle 0^0 Specimen II

Lo = 0.165 m
Li = 0.16545 m

Width = 0.13 m
Thickness = 0.004 m

spesimen A1-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+6	0,03%	1,245E+10
40	392,4	5,20E-05	7,5E+6	0,12%	6,226E+09
60	588,6	5,20E-05	11,3E+6	0,18%	6,226E+09
80	784,8	5,20E-05	15,1E+6	0,27%	5,534E+09
100	981	5,20E-05	18,9E+6	0,33%	5,660E+09
120	1177,2	5,20E-05	21,9E+6	0,42%	5,336E+09
121	**1187,01**	**5,20E-05**	**22,8E+6**	**0,45%**	**5,022E+09**

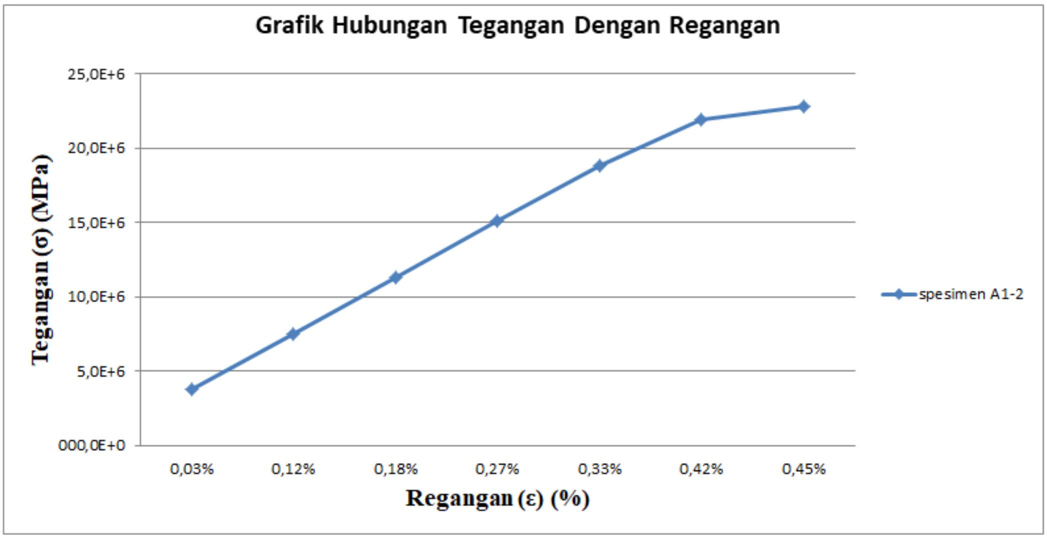


Figure 11. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 1 hour, Angle 0^0 Specimen II

Table 12. Tabulation of Tensile Test Data for Alkali Pineapple Leaf Fiber Composite 10%, 1 hour, Angle 0^0 Specimen III

Lo = 0.16505 m
Li = 0.1655 m

Width = 0.131 m
Thickness = 0.00395 m

spesimen A1-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,17E-05	3,8E+6	0,06%	6,258E+09
40	392,4	5,17E-05	7,6E+6	0,12%	6,258E+09
60	588,6	5,17E-05	11,4E+6	0,21%	5,364E+09
80	784,8	5,17E-05	15,2E+6	0,27%	5,563E+09
100	981	5,17E-05	19,0E+6	0,39%	4,814E+09
120	1177,2	5,17E-05	22,8E+6	0,48%	4,694E+09
135	**1324,35**	**5,17E-05**	**25,6E+6**	**0,51%**	**4,970E+09**

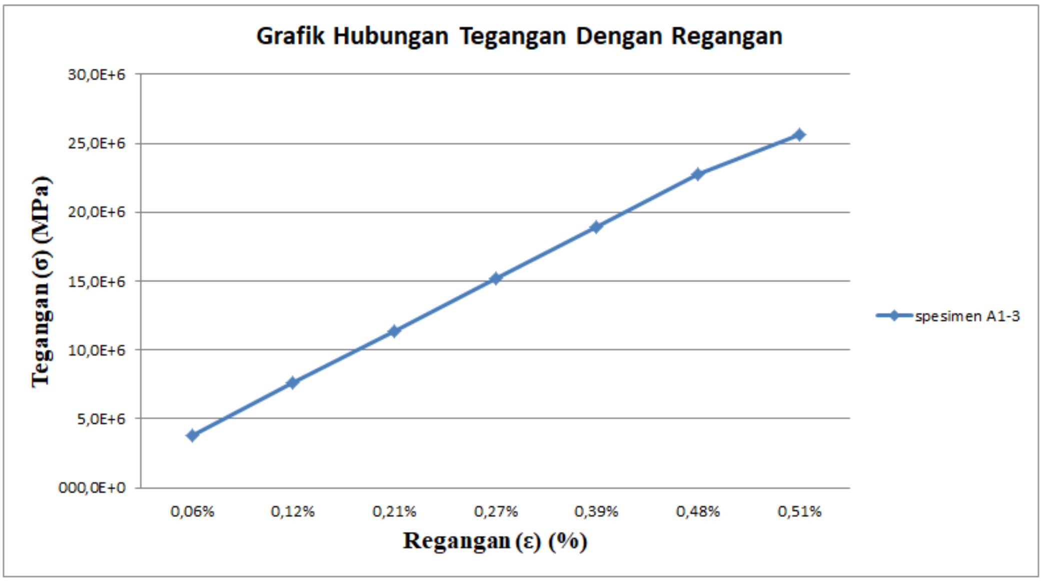


Figure 12. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 1 hour, Angle 0^0 Specimen III

Table 13. Tabulation of Tensile Test Data for Alkali Pineapple Leaf Fiber Composite 10%, 2 hours, Angle 0^0 Specimen I

Lo = 0.1651 m
Li = 0.1665 m

Width = 0.13 m
Thickness = 0.0042 m

spesimen A2-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,46E-05	3,6E+06	0,06%	5,933E+09
40	392,4	5,46E-05	7,2E+6	0,12%	5,933E+09
60	588,6	5,46E-05	10,8E+6	0,18%	5,933E+09
80	784,8	5,46E-05	14,4E+6	0,24%	5,933E+09
100	981	5,46E-05	18,0E+6	0,33%	5,393E+09
120	1177,2	5,46E-05	21,6E+6	0,36%	5,933E+09
140	1373,4	5,46E-05	25,2E+6	0,45%	5,537E+09
160	1373,4	5,46E-05	28,7E+6	0,51%	5,537E+09
180	1765,8	5,46E-05	32,3E+6	0,58%	5,754E-03
200	1962	5,46E-05	35,9E+6	0,67%	5,393E+09
205	**2011,05**	**5,46E-05**	**36,8E+6**	**0,70%**	**5,288E+09**

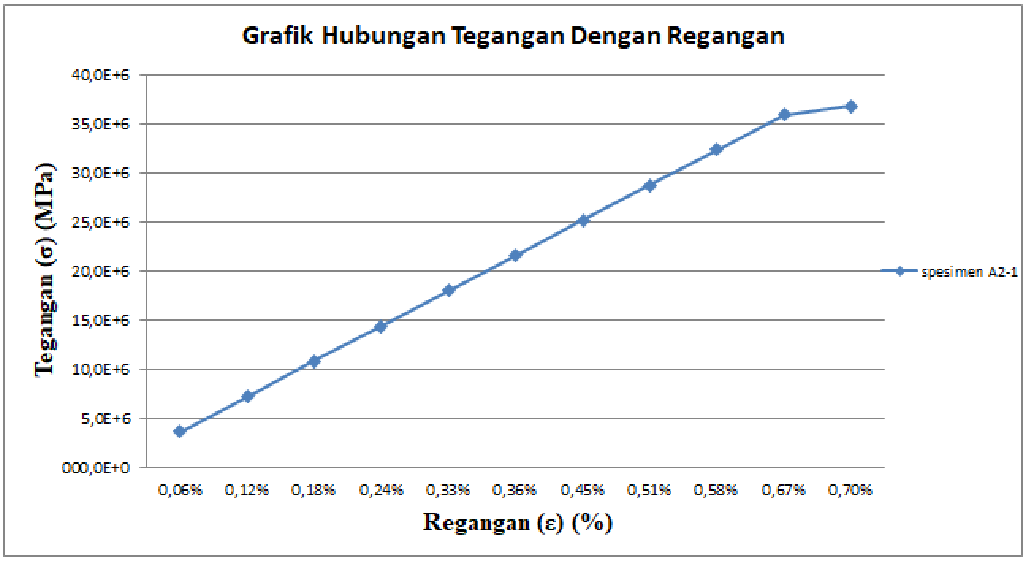


Figure 13. Graph of Composite Tensile Test Result for Pineapple Leaf Fiber with Alkali Treatment 10%, 2 hours, Angle of 0^0 Specimen I

Table 14 Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 2 hours, Angle 0^0 Specimen II

Lo = 0.16495 m
Li = 0.16565 m

Width = 0.129 m
Thickness = 0.0039m

spesimen A2-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,03E-05	3,9E+6	0,06%	6,433E+09
40	392,4	5,03E-05	7,8E+6	0,15%	5,146E+09
60	588,6	5,03E-05	11,7E+6	0,18%	6,433E+09
80	784,8	5,03E-05	15,6E+6	0,24%	6,433E+09
100	981	5,03E-05	19,5E+6	0,30%	6,433E+09
109	**1069,29**	**5,03E-05**	**21,6E+6**	**0,33%**	**6,374E+09**

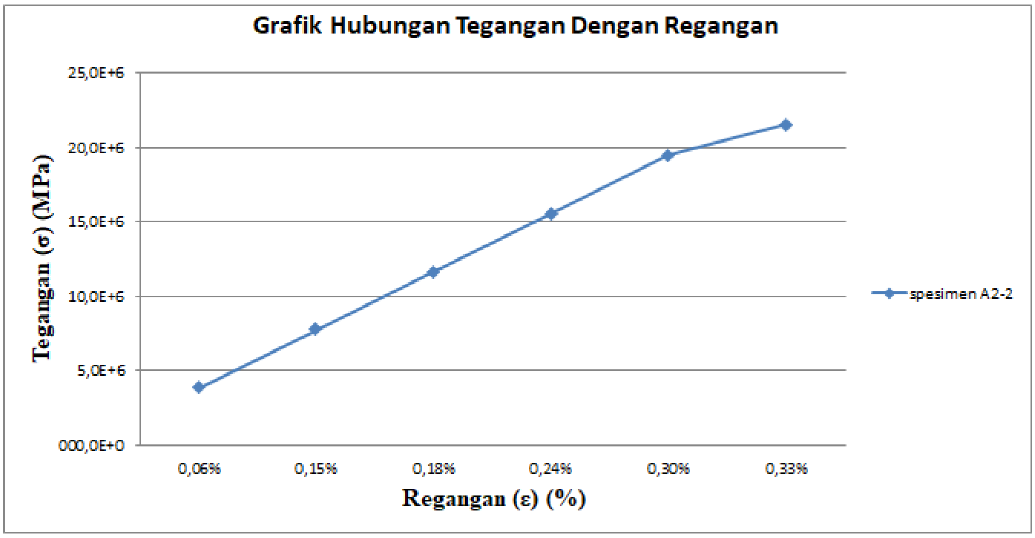


Figure 14. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 2 hours, Angle 0^0 Specimen II

Table 15. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 10%, 2 hours, Angle 0^0 Specimen III

Lo = 0.165 m Width = 0.13 m
Li = 0.1659 m Thickness = 0.004 m

spesimen A2-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+6	0,06%	6,226E+09
40	392,4	5,20E-05	7,5E+6	0,09%	8,301E+09
60	588,6	5,20E-05	11,3E+6	0,18%	6,226E+09
80	784,8	5,20E-05	15,1E+6	0,24%	6,226E+09
100	981	5,20E-05	18,9E+6	0,30%	6,226E+09
115	**1128,15**	**5,20E-05**	**21,7E+6**	**0,36%**	**5,966E+09**

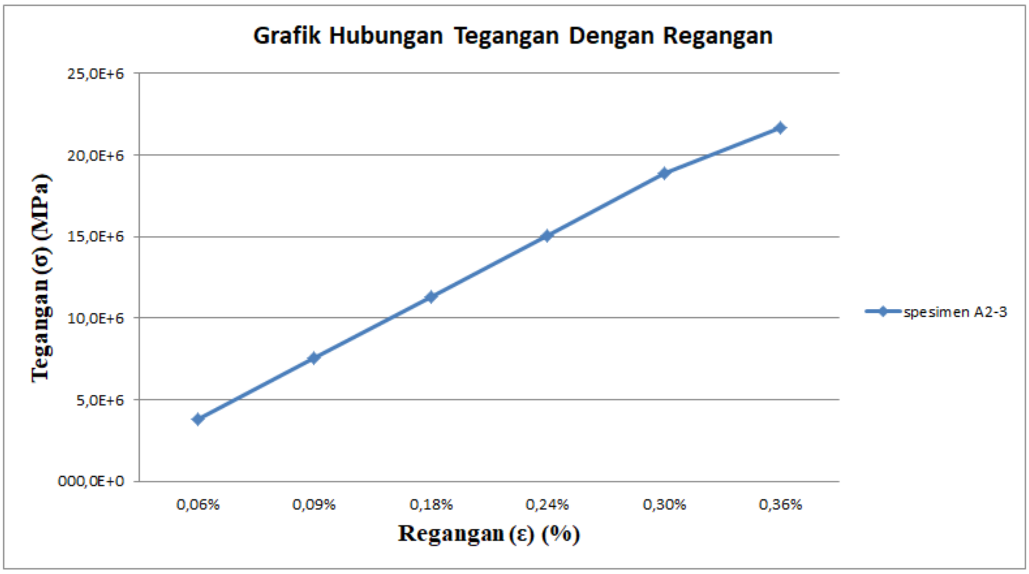


Figure 15. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 2 hours, Angle 0^0 Specimen III

Table 16. Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 3 hours, Angle 0^0 Specimen I

Lo = 0.165 m
Li = 0.1655 m

Width = 0.129 m
Thickness = 0.0041 m

spesimen A3-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,29E-05	3,7E+06	0,06%	6,121E+09
40	392,4	5,29E-05	7,5E+6	0,12%	6,226E+09
60	588,6	5,29E-05	11,1E+6	0,21%	5,246E+09
80	784,8	5,29E-05	14,8E+6	0,30%	4,897E+09
100	981	5,29E-05	18,5E+6	0,36%	5,101E+09
120	1177,2	5,29E-05	22,3E+6	0,42%	5,246E+09
129	**1265,49**	**5,29E-05**	**23,9E+6**	**0,48%**	**4,935E+09**

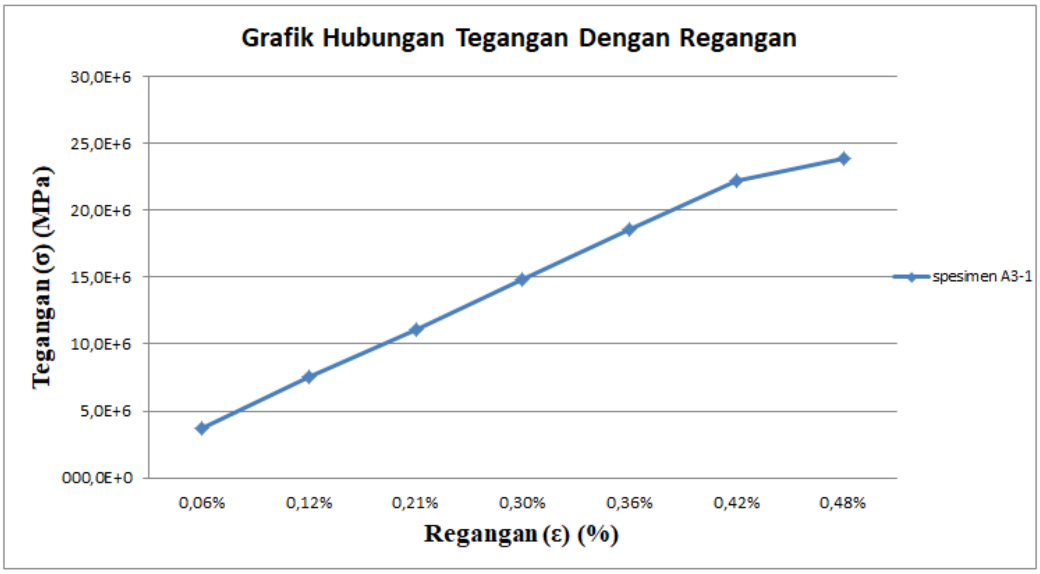


Figure 16. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 3 hours, Angle 0^0 Specimen I

Table 17. Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 3 hours, Angle 0^0 Specimen II

Lo = 0.1652 m
Li = 0.1657 m

Width = 0.129 m
Thickness = 0.0039 m

spesimen A3-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,03E-05	3,9E+6	0,06%	6,443E+09
40	392,4	5,03E-05	7,8E+6	0,18%	4,295E+09
60	588,6	5,03E-05	11,7E+6	0,27%	4,295E+09
80	784,8	5,03E-05	15,6E+6	0,36%	4,295E+09
100	981	5,03E-05	19,5E+6	0,45%	4,295E+09
120	1177,2	5,03E-05	22,3E+6	0,58%	4,069E+09
140	1373,4	5,03E-05	23,9E+6	0,67%	4,100E+09
150	**1471,5**	**5,03E-05**	**29,2E+6**	**0,73%**	**4,027E+09**

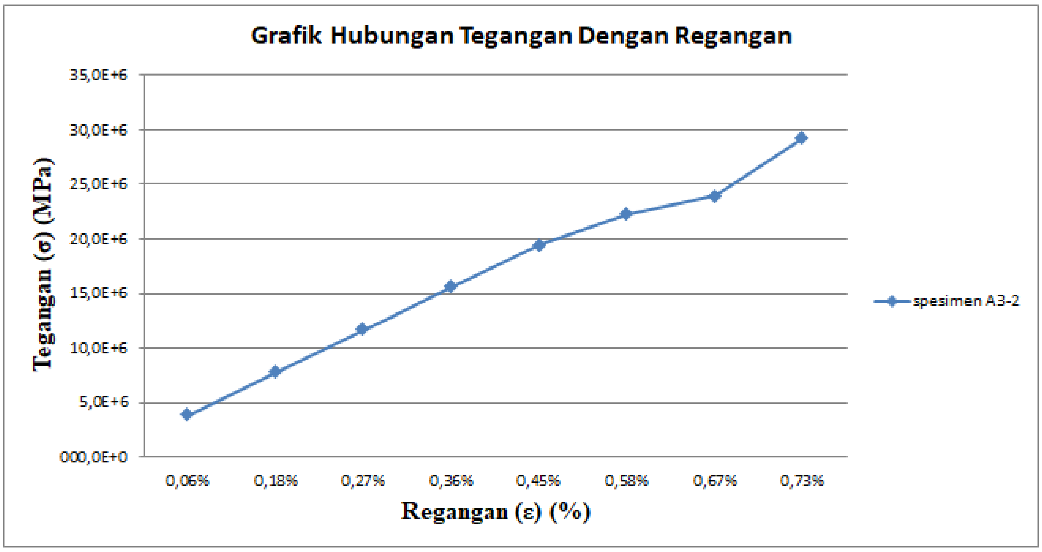


Figure 17. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 3 hours, Angle 0^0 Specimen II

Table 18. Tabulation of Tensile Test Data for Alkali Pineapple Leaf Fiber Composite 10%, 3 hours, Angle 0^0 Specimen III

Lo = 0.1653 m
Li = 0.1669 m

Width = 0.13 m
Thickness = 0.004 m

spesimen A3-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+6	0,06%	6,237E+09
40	392,4	5,20E-05	7,5E+6	0,73%	1,039E+09
60	588,6	5,20E-05	11,3E+6	0,21%	5,346E+09
80	784,8	5,20E-05	15,1E+6	0,27%	5,544E+09
100	981	5,20E-05	18,9E+6	0,36%	5,197E+09
120	1177,2	5,20E-05	22,6E+6	0,42%	5,346E+09
140	1373,4	5,20E-05	26,4E+6	0,48%	5,457E+09
160	1569,6	5,20E-05	30,2E+6	0,57%	5,252E+09
180	**1765,8**	**5,20E-05**	**34,0E+6**	**0,67%**	**5,103E+09**

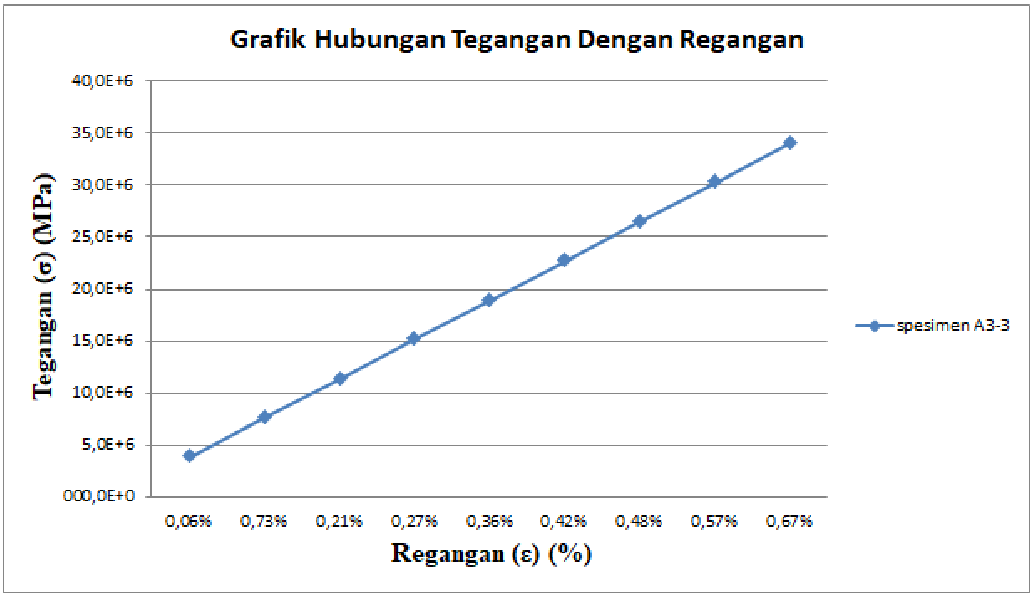


Figure 18. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 3 hours, Angle 00 Specimen III

Attachment 6: Tensile Test Results for Alkali Pineapple Leaf Fiber Composite 10% Angle 30^0

Table 19. Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 1 hour, Angle 30^0 Specimen I

Lo = 0.16495 m
Li = 0.1655 m

Width = 0.13 m
Thickness = 0.0042m

spesimen B1-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,46E-05	3,6E+06	0,21%	1,694E+09
40	392,4	5,46E-05	7,2E+6	0,39%	1,824E+09
55	**539,55**	**5,46E-05**	**9,9E+6**	**0,58%**	**1,716E+09**

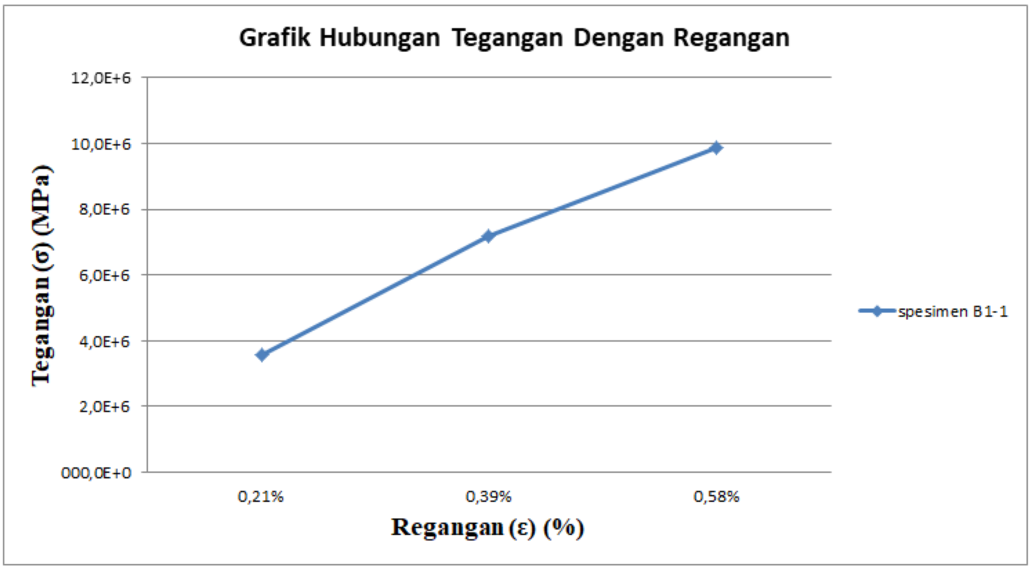


Figure 19. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 1 hour, Angle 30^0 Specimen I

Table 20. Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 1 hour, Angle 30^0 Specimen II

Lo = 0.165 m
Li = 0.1657 m

Width = 0.132 m
Thickness = 0.0041 m

spesimen B1-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,41E-05	3,6E+6	0,27%	1,329E+09
40	392,4	5,41E-05	7,3E+6	0,48%	1,495E+09
60	588,6	5,41E-05	10,9E+6	0,61%	1,795E+09
70	**686,7**	**5,41E-05**	**12,7E+6**	**0,73%**	**1,745E+09**

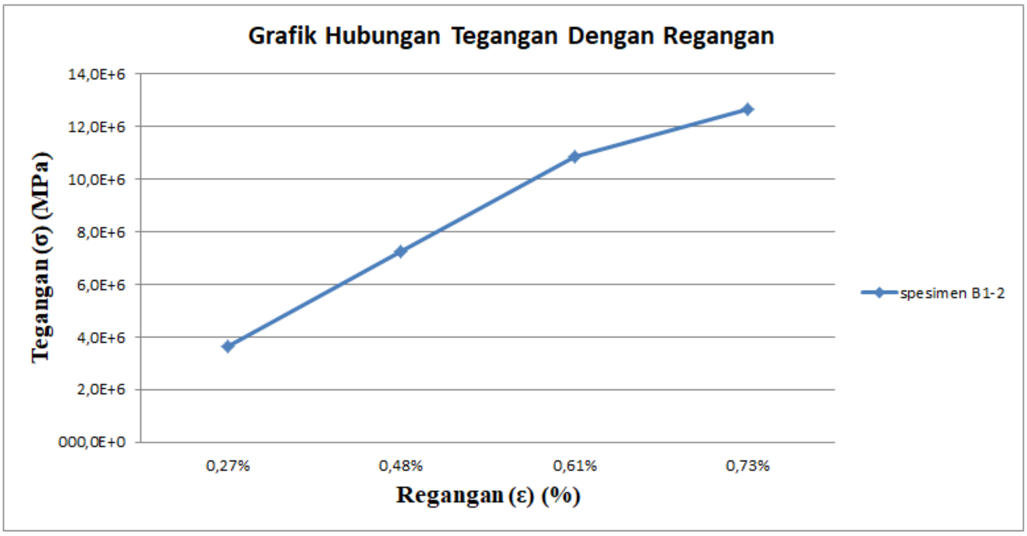


Figure 20. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 1 hour, Angle 30^0 Specimen II

Table 21. Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 1 hour, Angle 30^0 Specimen III

Lo = 0.165 m
Li = 0.16615 m

Width = 0.131 m
Thickness = 0.0042 m

spesimen B1-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,50E-05	3,6E+6	0,12%	2,942E+09
40	392,4	5,50E-05	7,1E+6	0,30%	2,354E+09
60	588,6	5,50E-05	10,7E+6	0,48%	2,206E+09
80	784,8	5,50E-05	14,3E+6	0,61%	2,354E+09
90	**882,9**	**5,50E-05**	**16,0E+6**	**0,70%**	**2,302E+09**

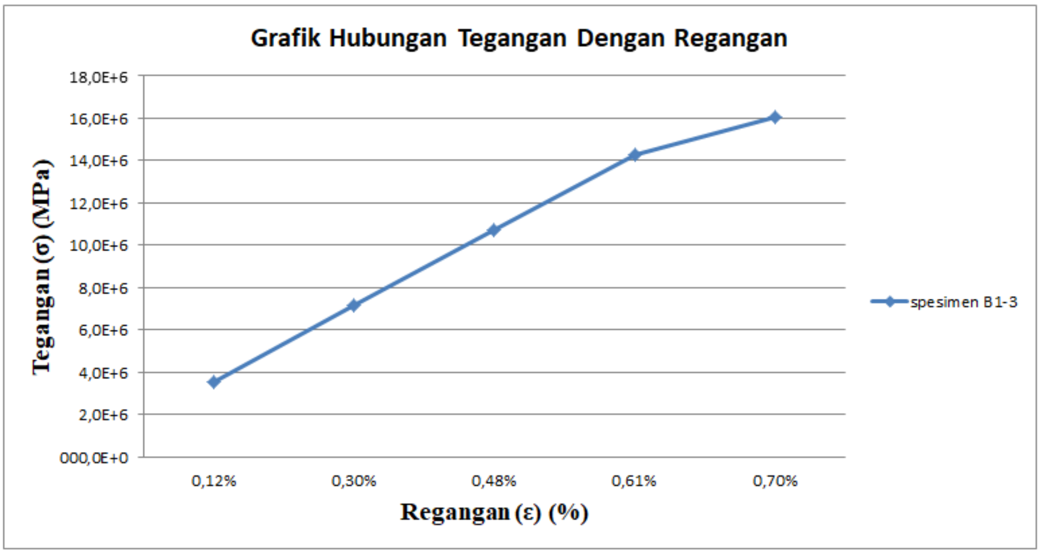


Figure 21. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 1 hour, Angle 30^0 Specimen III

Table 22. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 10%, 2 hours, Angle 30^0 Specimen I

Lo = 0.165 m
Li = 0.1667 m

Width = 0.13 m
Thickness = 0.004 m

spesimen B2-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+06	0,06%	6,226E+09
40	392,4	5,20E-05	7,5E+6	0,18%	4,150E+09
60	588,6	5,20E-05	11,3E+6	0,27%	4,150E+09
80	784,8	5,20E-05	15,1E+6	0,42%	3,557E+09
100	981	5,20E-05	18,9E+6	0,55%	3,459E+09
120	1177,2	5,20E-05	22,6E+6	0,64%	3,557E+09
135	**1324,35**	**5,20E-05**	**25,5E+6**	**0,73%**	**3,502E+09**

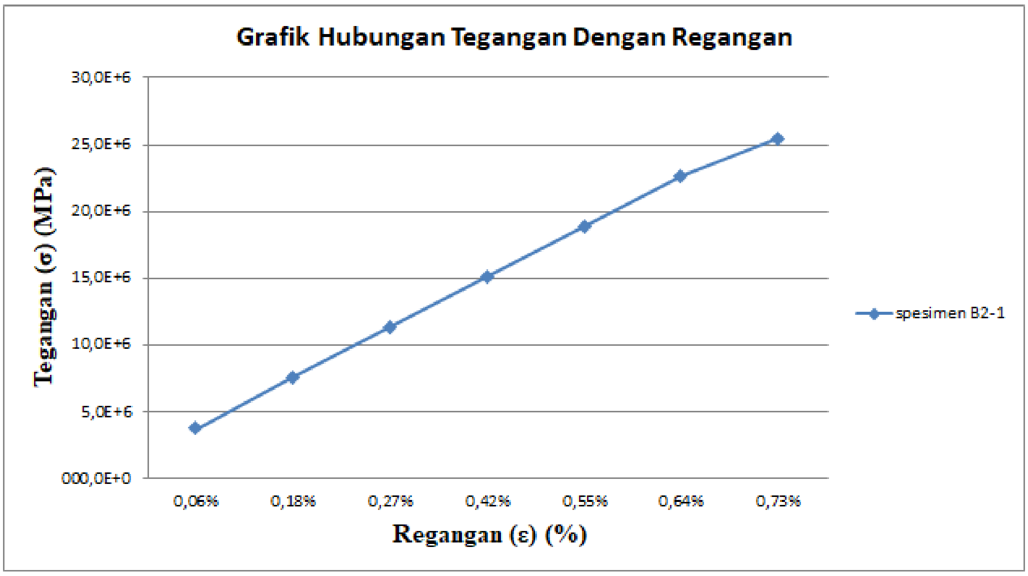


Figure 22. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 2 hours, Angle 30^0 Specimen I

Table 23. Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 2 hours, Angle 30^0 Specimen II

Lo = 0.1649 m
Li = 0.16671m

Width = 0.13 m
Thickness = 0.004 m

spesimen B2-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+6	0,18%	2,074E+09
40	392,4	5,20E-05	7,5E+6	0,27%	2,765E+09
60	588,6	5,20E-05	11,3E+6	0,36%	3,111E+09
80	784,8	5,20E-05	15,1E+6	0,49%	3,111E+09
95	**931,95**	**5,20E-05**	**17,9E+6**	**0,55%**	**3,284E+09**

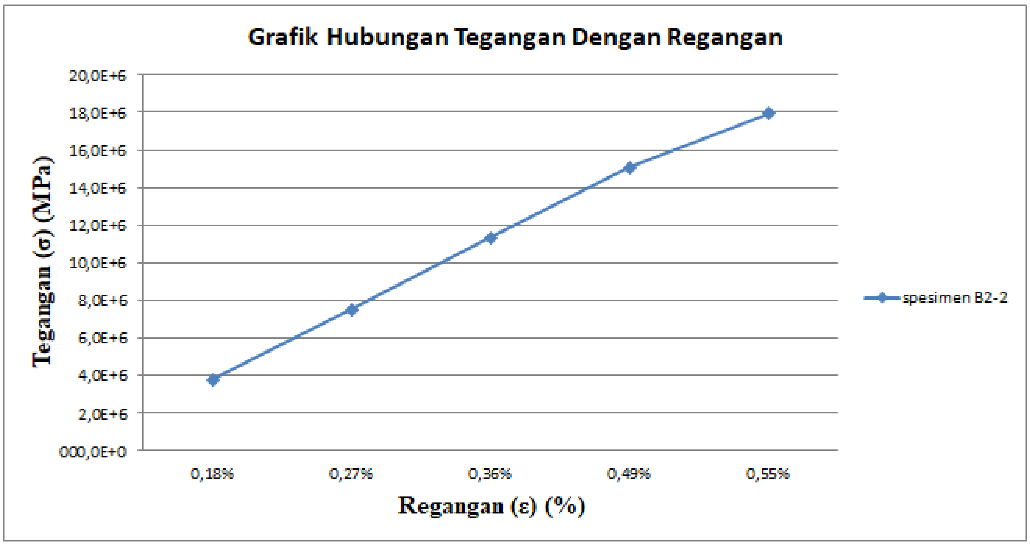


Figure 23. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 2 hours, Angle 30^0 Specimen II

Table 24. Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 2 hours, Angle 30^0 Specimen III

Lo = 0.16495 m
Li = 0.16615m

Width = 0.129 m
Thickness = 0.004 m

spesimen B2-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,16E-05	3,8E+6	0,12%	3,136E+09
40	392,4	5,16E-05	7,6E+6	0,30%	2,509E+09
60	588,6	5,16E-05	11,4E+6	0,45%	2,509E+09
80	784,8	5,16E-05	15,2E+6	0,61%	2,509E+09
100	981	5,16E-05	19,0E+6	0,73%	2,613E+09
105	**1030,05**	**5,16E-05**	**20,0E+6**	**0,76%**	**2,634E+09**

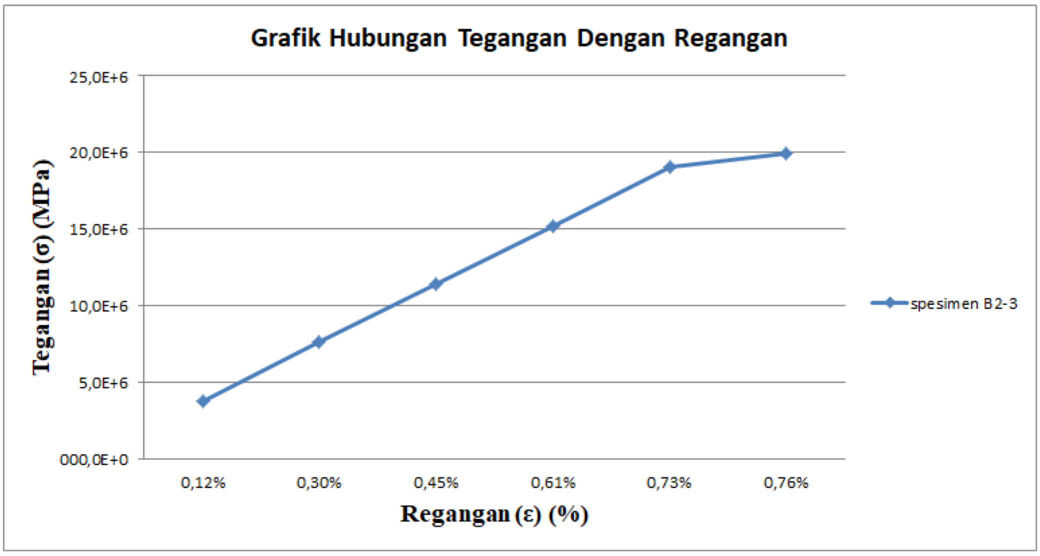


Figure 24. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 2 hours, Angle 30^0 Specimen III

Table 25. Tabulation of Tensile Test Data for Alkali Pineapple Leaf Fiber Composite 10%, 3 hours, Angle 30^0 Specimen I

Lo = 0.16505 m   Width = 0.13 m
Li = 0.16555m   Thickness = 0.0042 m

spesimen B3-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,46E-05	3,6E+06	0,24%	1,483E+09
40	392,4	5,46E-05	7,2E+6	0,42%	1,695E+09
60	588,6	5,46E-05	10,8E+6	0,64%	1,695E+09
80	**784,8**	**5,46E-05**	**14,4E+6**	**0,79%**	**1,825E+09**

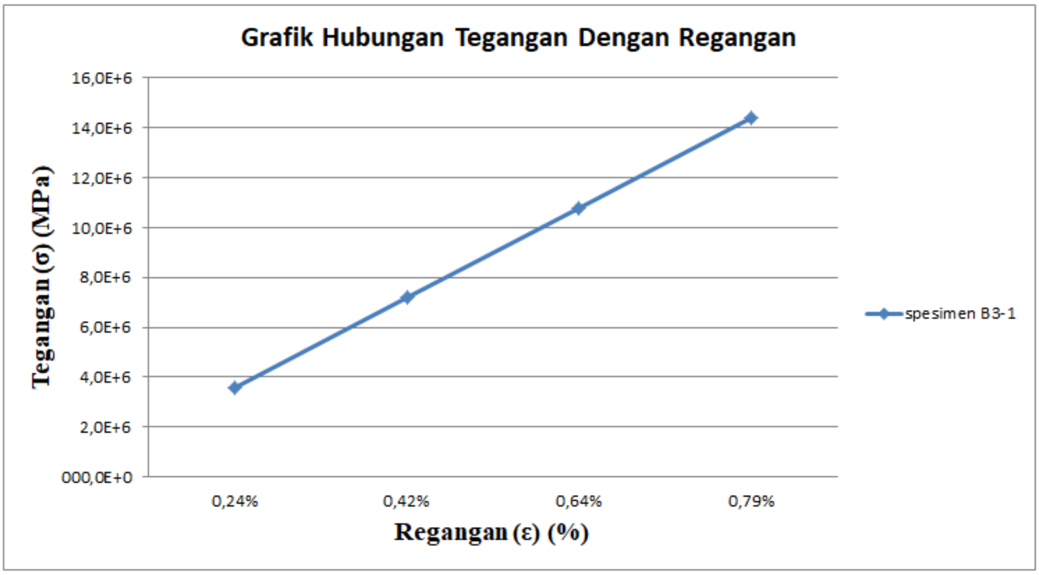


Figure 25. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 3 hours, Angle 30^0 Specimen I

Table 26. Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 3 hours, Angle 30^0 Specimen II

Lo = 0.165 m
Li = 0.1659m

Width = 0.13 m
Thickness = 0.004 m

spesimen B3-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+6	0,18%	2,075E+09
40	392,4	5,20E-05	7,5E+6	0,30%	2,490E+09
60	588,6	5,20E-05	11,3E+6	0,42%	2,668E+09
70	**686,7**	**5,20E-05**	**13,2E+6**	**0,55%**	**2,421E+09**

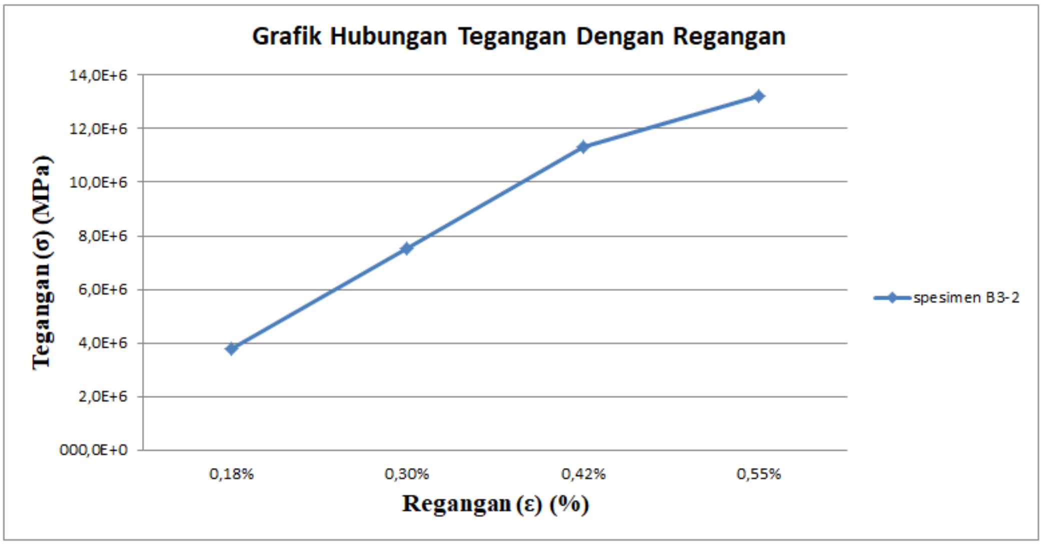


Figure 26. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 3 hours, Angle 30^0 Specimen II

Table 27. Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 3 hours, Angle 30^0 Specimen III

Lo = 0.16515 m
Li = 0.166m

Width = 0.129 m
Thickness = 0.004 m

spesimen B3-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,16E-05	3,8E+6	0,06%	6,280E+09
40	392,4	5,16E-05	7,6E+6	0,18%	4,186E+09
60	588,6	5,16E-05	11,4E+6	0,27%	4,186E+09
80	784,8	5,16E-05	15,2E+6	0,39%	3,864E+09
100	981	5,16E-05	19,0E+6	0,48%	3,925E+09
120	**1177,2**	**5,16E-05**	**22,8E+6**	**0,61%**	**3,768E+09**

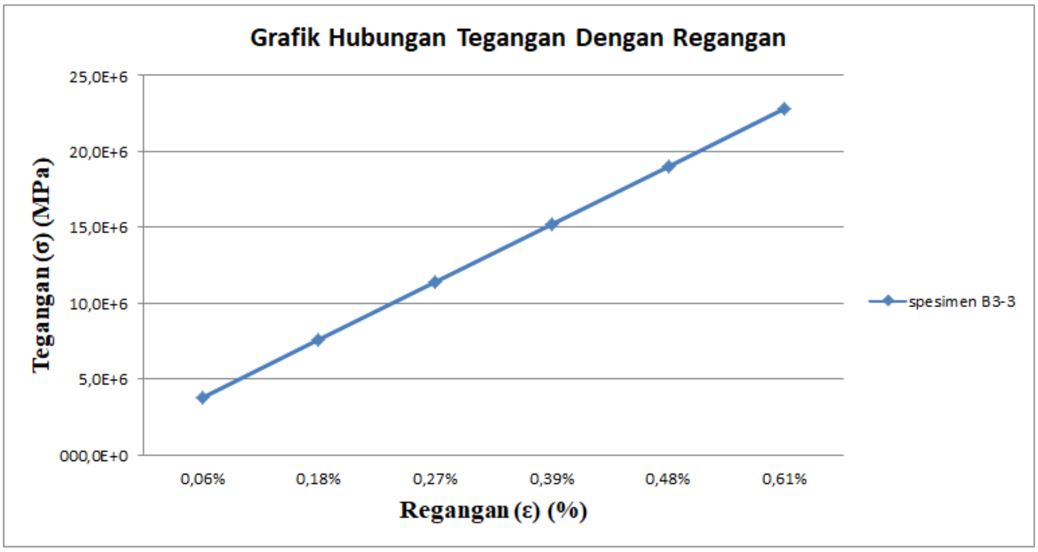


Figure 27. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 3 hours, Angle 30^0 Specimen III

Attachment 7: Tensile Test Results for Alkali Pineapple Leaf Fiber Composite 10% Angle 60^0

Table 28. Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 1 hour, Angle of 60^0 Specimen I

Lo = 0.16495 m
Li = 0.1653m

Width = 0.13 m
Thickness = 0.004 m

spesimen C1-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+06	0,12%	3,112E+09
40	392,4	5,20E-05	7,5E+6	0,30%	2,489E+09
60	588,6	5,20E-05	11,3E+6	0,42%	2,667E+09
70	**686,7**	**5,20E-05**	**13,2E+6**	**0,52%**	**2,563E+09**

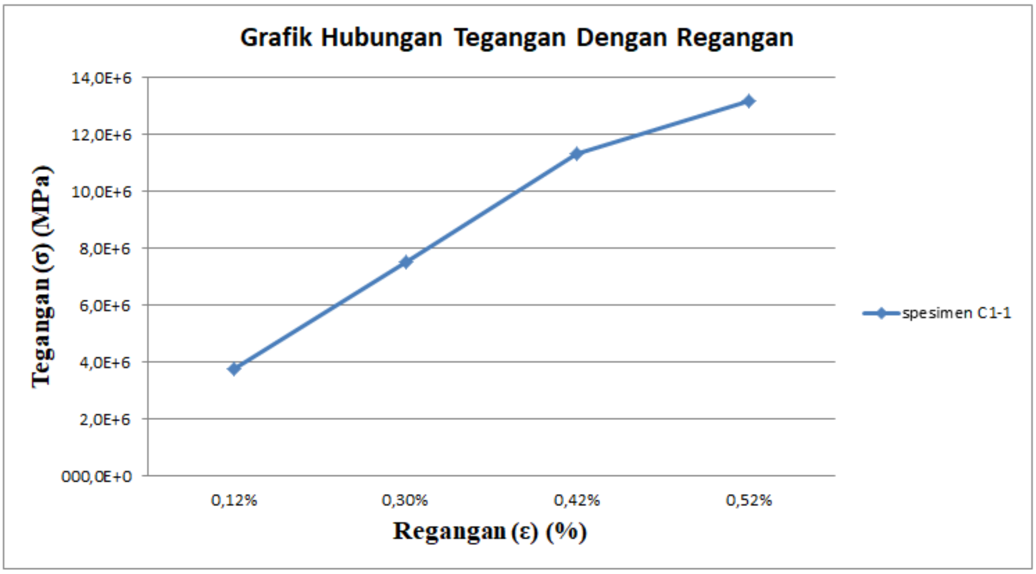


Figure 28. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 1 hour, Angle of 60^0 Specimen I

Table 29. Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 1 hour, Angle 60^0 Specimen II

Lo = 0.165 m
Li = 0.16545m

Width = 0.13 m
Thickness = 0.004 m

spesimen C1-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+6	0,09%	4,150E+09
40	392,4	5,20E-05	7,5E+6	0,21%	3,557E+09
60	588,6	5,20E-05	11,3E+6	0,33%	3,396E+09
80	784,8	5,20E-05	15,1E+6	0,45%	3,320E+09
90	**882,9**	**5,20E-05**	**17,0E+6**	**0,48%**	**3,502E+09**

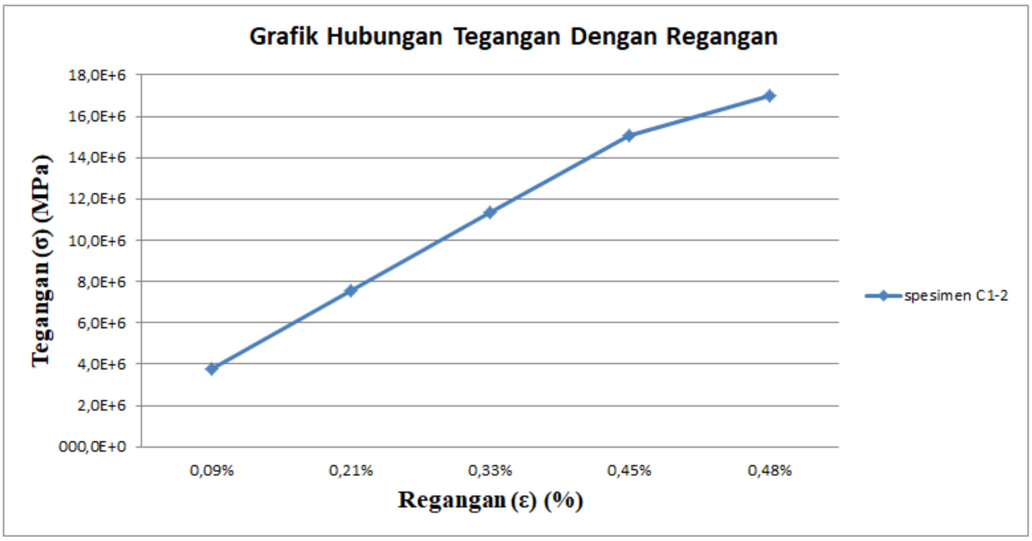


Figure 29. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 1 hour, Angle 60^0 Specimen II

Table 30. Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 1 hour, Angle of 60^0 Specimen III

Lo = 0.1655 m
Li = 0.1655m

Width = 0.13 m
Thickness = 0.004 m

spesimen C1-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+6	0,06%	6,226E+09
40	392,4	5,20E-05	7,5E+6	0,15%	4,980E+09
60	588,6	5,20E-05	11,3E+6	0,24%	4,669E+09
80	784,8	5,20E-05	15,1E+6	0,33%	4,528E+09
100	981	5,20E-05	18,9E+6	0,42%	4,447E+09
110	**1079,1**	**5,20E-05**	**20,8E+6**	**0,48%**	**4,280E+09**

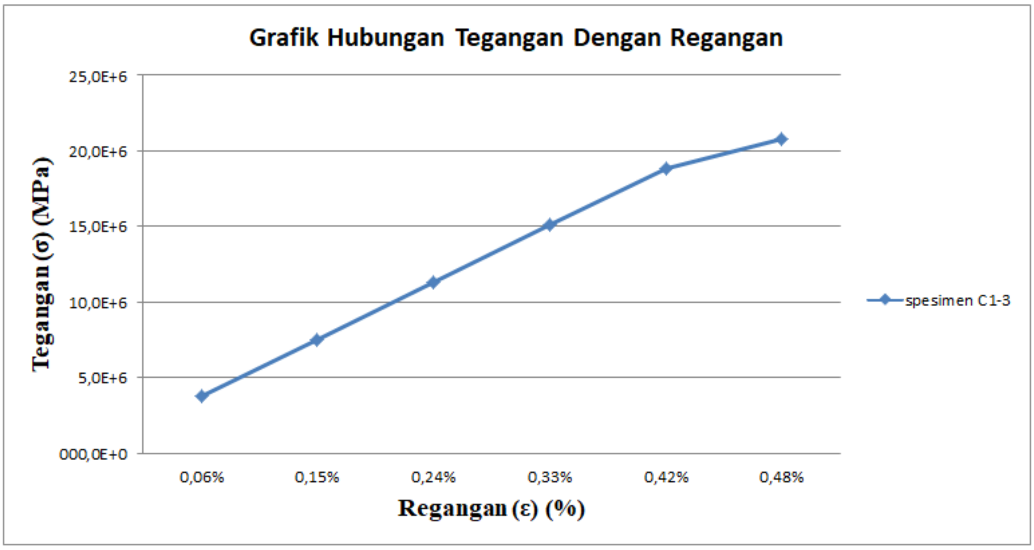


Figure 31. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 1 hour, Angle of 60^0 Specimen III

Table 31. Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 2 hours, Angle of 60^0 Specimen I

Lo = 0.16495 m
Li = 0.16565m

Width = 0.13 m
Thickness = 0.004 m

spesimen C2-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+06	0,09%	4,149E+09
40	392,4	5,20E-05	7,5E+6	0,15%	4,979E+09
55	**539,55**	**5,20E-05**	**10,4E+6**	**0,21%**	**4,890E+09**

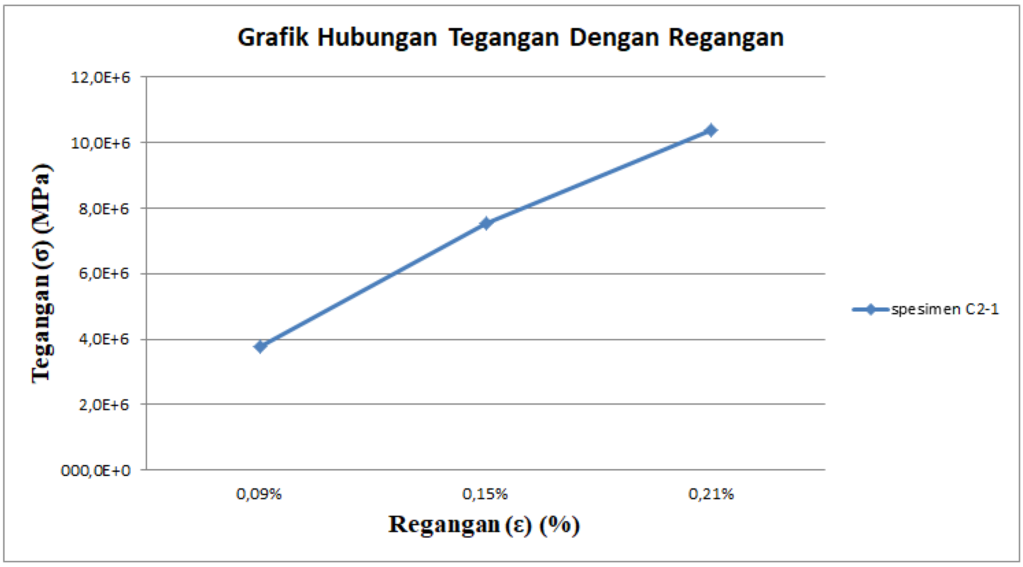


Figure 31. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 2 hours, Angle of 60^0 Specimen I

Table 32. Tabulation of Tensile Test Data for Alkali Pineapple Leaf Fiber Composite 10%, 2 hours, Angle 60^0 Specimen II

Lo = 0.165 m
Li = 0.1662 m

Width = 0.132 m
Thickness = 0.0043 m

spesimen C2-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,68E-05	3,5E+6	0,06%	5,703E+09
40	392,4	5,68E-05	6,9E+6	0,15%	4,563E+09
60	588,6	5,68E-05	10,4E+6	0,24%	4,278E+09
75	**735,75**	**5,68E-05**	**13,0E+6**	**0,30%**	**4,278E+09**

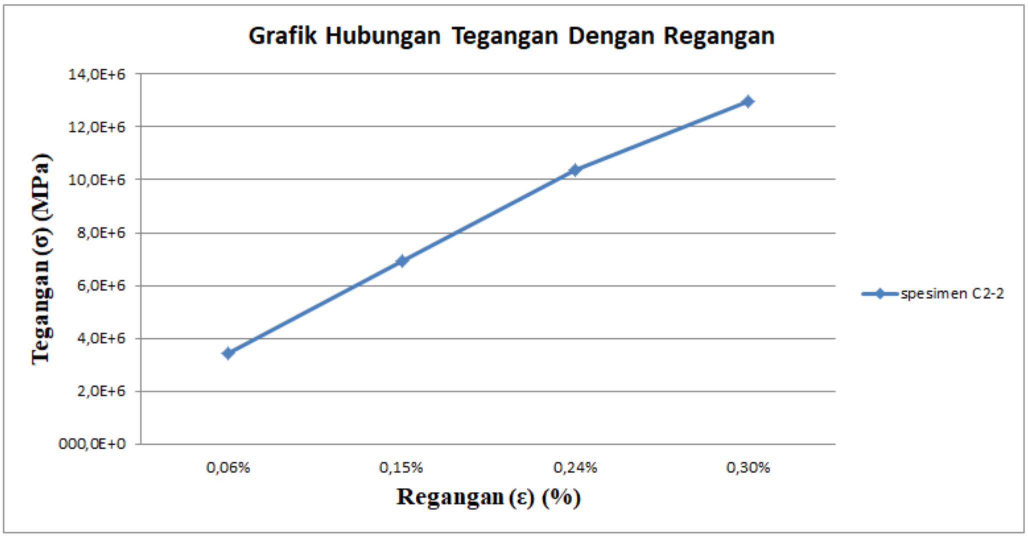


Figure 32. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 2 hours, Angle of 60^0 Specimen II

Table 33 Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 2 hours, Angle of 60^0 Specimen III

Lo = 0.165 m
Li = 0.1658 m

Width = 0.1321 m
Thickness = 0.0038 m

spesimen C2-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	4,98E-05	3,9E+6	0,12%	3,252E+09
40	392,4	4,98E-05	7,9E+6	0,30%	2,601E+09
60	588,6	4,98E-05	11,8E+6	0,48%	2,439E+09
70	**686,7**	**4,98E-05**	**13,8E+6**	**0,55%**	**2,529E+09**

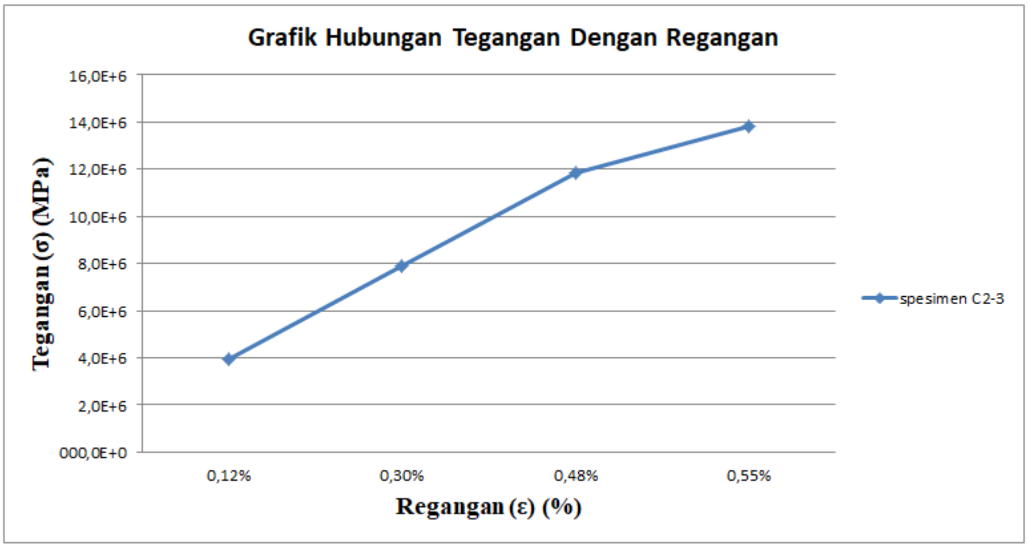


Figure 33. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 2 hours, Angle of 600 Specimen III

Table 34. Tabulation of Tensile Test Data for Alkali Pineapple Leaf Fiber Composite 10%, 3 hours, Angle of 60^0 Specimen I

Lo = 0.16505 m
Li = 0.1654 m

Width = 0.13 m
Thickness = 0.004 m

spesimen C3-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+06	0,12%	3,114E+09
40	392,4	5,20E-05	7,5E+6	0,15%	4,982E+09
60	588,6	5,20E-05	11,3E+6	0,24%	4,671E+09
69	**676,89**	**5,20E-05**	**13,0E+6**	**0,30%**	**4,297E+09**

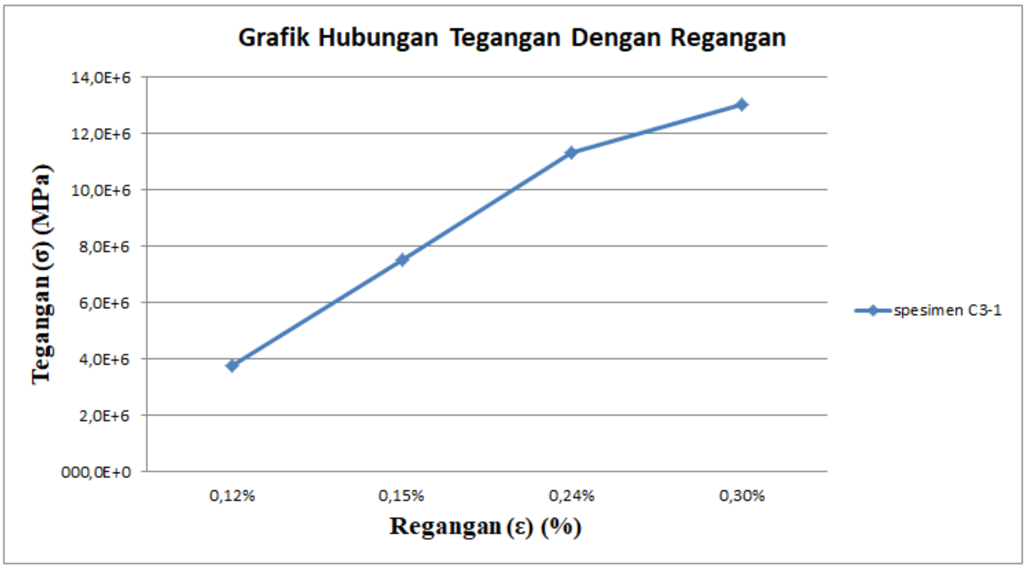


Figure 34. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 3 hours, Angle of 60^0 Specimen I

Table 35. Tabulation of Tensile Test Data for Alkali Pineapple Leaf Fiber Composite 10%, 3 hours, Angle 60^0 Specimen II

Lo = 0.1651 m
Li = 0.16545 m

Width = 0.13 m
Thickness = 0.004 m

spesimen C3-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+6	0,12%	3,115E+09
40	392,4	5,20E-05	7,5E+6	0,18%	4,153E+09
60	**588,6**	**5,20E-05**	**11,3E+6**	**0,24%**	**4,672E+09**

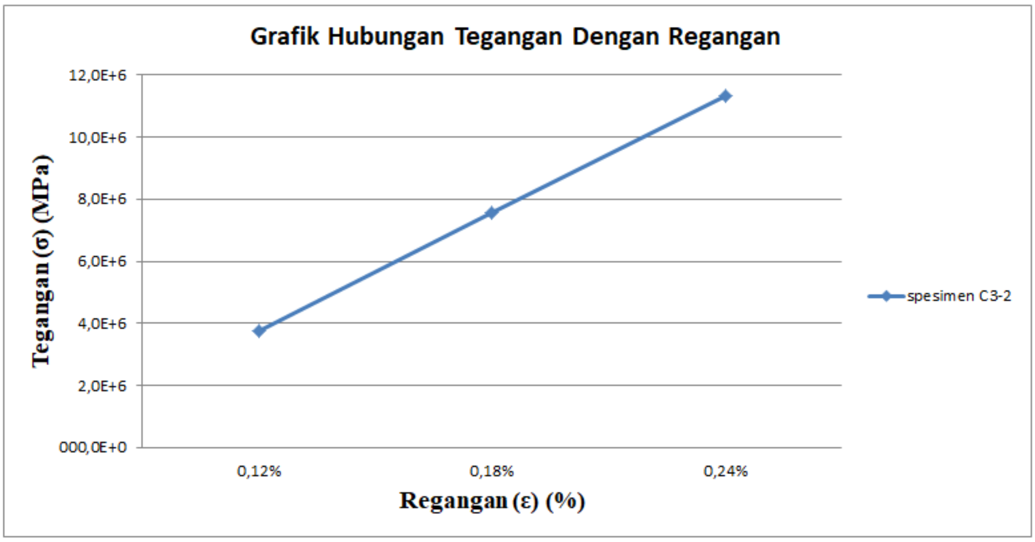


Figure 35. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 3 hours, Angle of 60^0 Specimen II

Table 36. Tabulation of 10% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 3 hours, Angle 60^0 Specimen III

Lo = 0.165 m
Li = 0.16525 m

Width = 0.129 m
Thickness = 0.0039 m

spesimen C3-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,03E-05	3,9E+6	0,18%	2,145E+09
40	392,4	5,03E-05	7,8E+6	0,27%	2,860E+09
50	**490,5**	**5,03E-05**	**9,7E+6**	**0,33%**	**2,925E+09**

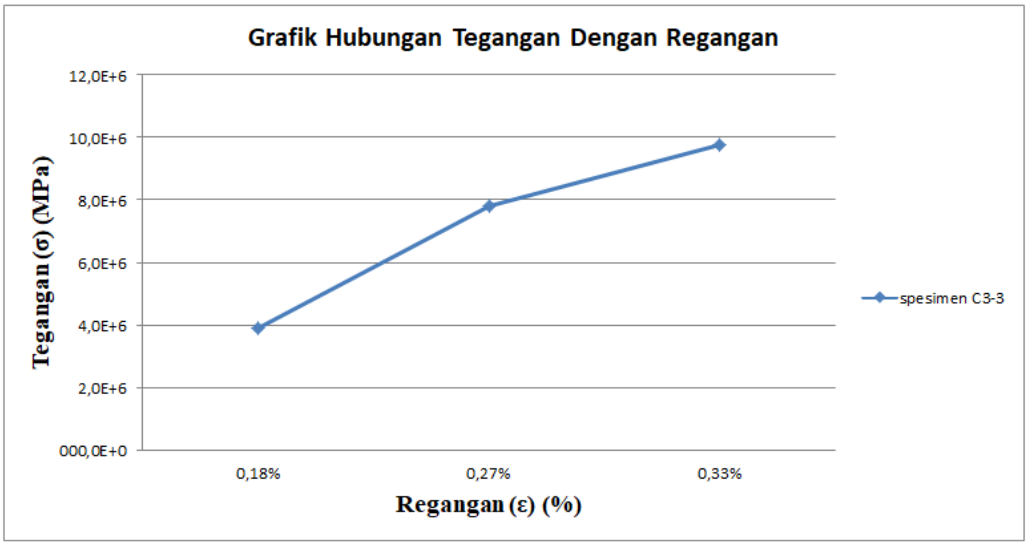


Figure 36. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 10%, 3 hours, Angle of 60^0 Specimen III

Attachment 8: Result of Tensile Test for Alkali Pineapple Leaf Fiber Composite 20% Angle 0^0

Table 37. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 1 hour, Angle 0^0 Specimen I

Lo = 0.1649 m
Li = 0.16505 m

Width = 0.1295 m
Thickness = 0.004 m

spesimen A'1-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,18E-05	3,8E+06	0,03%	1,249E+10
40	392,4	5,18E-05	7,6E+6	0,09%	8,328E+09
60	588,6	5,18E-05	11,4E+6	0,15%	7,495E+09
80	784,8	5,18E-05	15,2E+6	0,27%	5,552E+09
100	981	5,18E-05	18,9E+6	0,42%	4,461E+09
110	**1079,1**	**0,00E+00**	**20,8E+6**	**0,55%**	**3,817E+09**

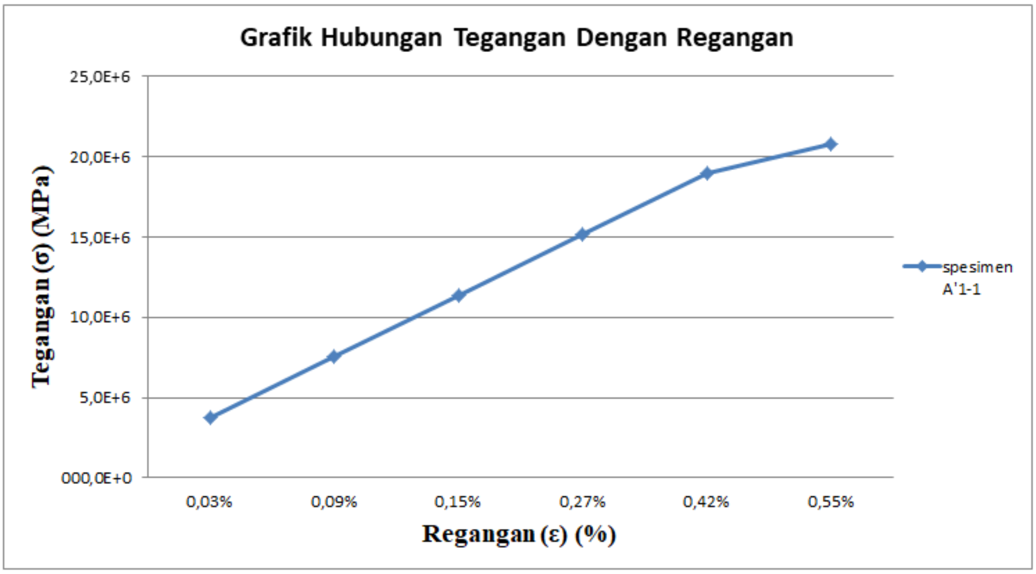


Figure 37. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 1 hour, Angle 0^0 Specimen I

Table 38. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 1 hour, Angle 0^0 Specimen II

Lo = 0.1652 m
Li = 0.1661 m

Width = 0.13 m
Thickness = 0.004 m

spesimen A'1-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+6	0,03%	1,247E+10
40	392,4	5,20E-05	7,5E+6	0,09%	8,311E+09
60	588,6	5,20E-05	11,3E+6	0,15%	7,480E+09
80	784,8	5,20E-05	15,1E+6	0,21%	7,124E+09
100	981	5,20E-05	18,9E+6	0,27%	6,926E+09
120	1177,2	5,20E-05	22,6E+6	0,33%	6,800E+09
140	1373,4	5,20E-05	26,4E+6	0,39%	6,713E+09
160	1569,6	5,20E-05	30,2E+6	0,42%	7,124E+09
180	1765,8	5,20E-05	34,0E+6	0,48%	7,012E+09
200	1962	5,20E-05	37,7E+6	0,54%	6,926E+09
210	**2060,1**	**5,20E-05**	**39,6E+6**	**0,61%**	**6,545E+09**

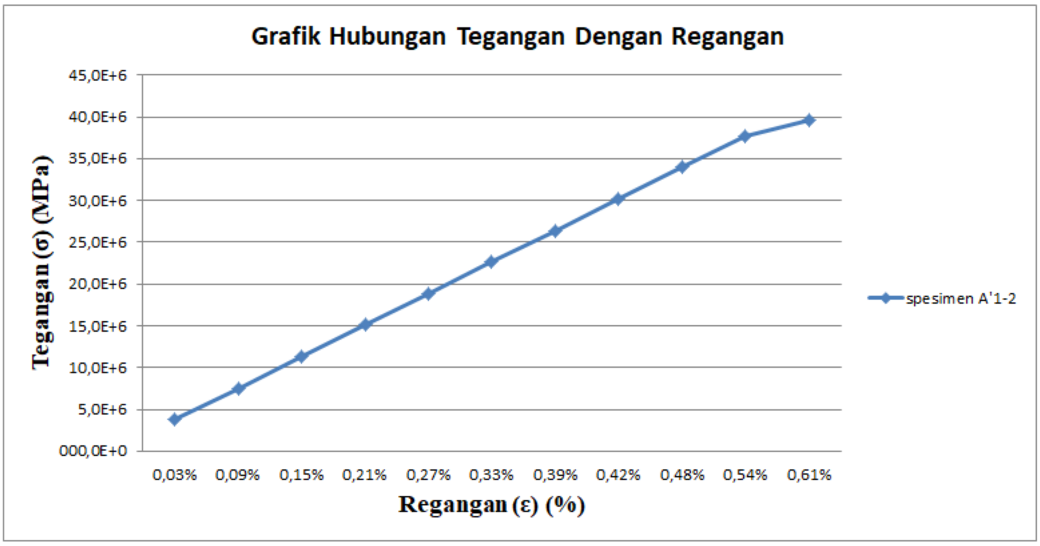


Figure 38. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 1 hour, Angle 0^0 Specimen II

Table 39. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 1 hour, Angle 0^0 Specimen III

Lo = 0.1651 m
Li = 0.1662 m

Width = 0.129 m
Thickness = 0.004 m

spesimen A'1-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,16E-05	3,8E+6	0,03%	1,256E+10
40	392,4	5,16E-05	7,6E+6	0,09%	8,370E+09
60	588,6	5,16E-05	11,4E+6	0,18%	6,278E+09
80	784,8	5,16E-05	15,2E+6	0,24%	6,278E+09
100	981	5,16E-05	19,0E+6	0,97%	1,962E+09
120	1177,2	5,16E-05	22,8E+6	0,42%	5,381E+09
140	1373,4	5,16E-05	26,6E+6	0,48%	5,493E+09
160	1569,6	5,16E-05	30,4E+6	0,55%	5,580E+09
180	**1765,8**	**5,16E-05**	**34,2E+6**	**0,61%**	**5,650E+09**

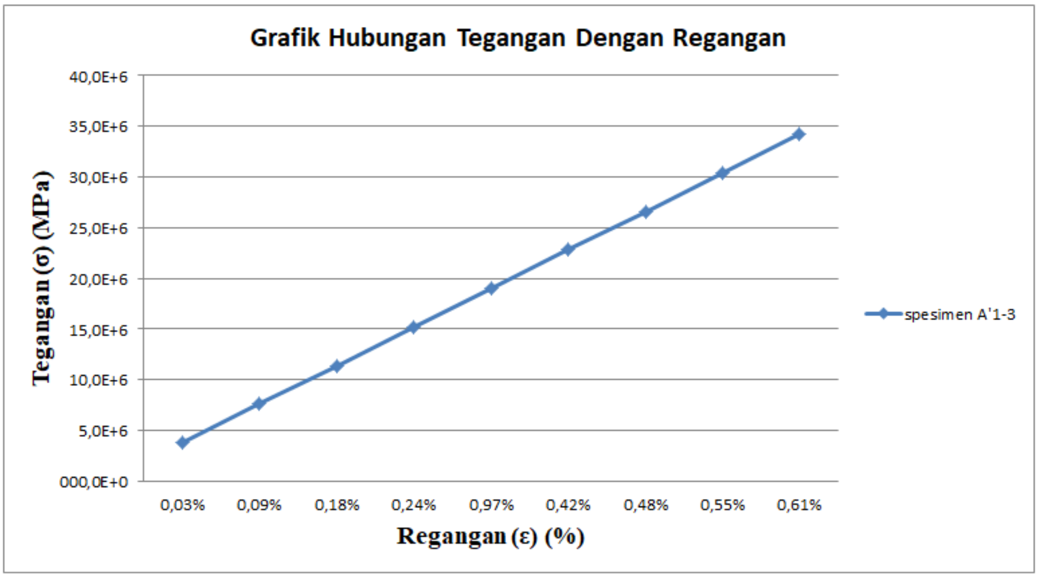


Figure 39. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 1 hour, Angle 0^0 Specimen III

Table 40. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 2 hours, Angle 0^0 Specimen I

Lo = 0.165 m
Li = 0.1656 m
Width = 0.1295 m
Thickness = 0.004 m

spesimen A'2-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,18E-05	3,8E+06	0,06%	6,250E+09
40	392,4	5,18E-05	7,5E+6	0,09%	8,301E+09
60	588,6	5,18E-05	11,4E+6	0,12%	9,374E+09
80	784,8	5,18E-05	15,2E+6	0,18%	8,333E+09
100	981	5,18E-05	18,9E+6	0,24%	7,812E+09
120	1177,2	5,18E-05	22,7E+6	0,30%	7,500E+09
140	1373,4	5,18E-05	26,5E+6	0,36%	7,291E+09
160	1569,6	5,18E-05	30,3E+6	0,42%	7,142E+09
180	1765,8	5,18E-05	34,1E+6	0,48%	7,031E+09
200	1962	5,18E-05	37,9E+6	0,55%	6,944E+09
220	2158,2	5,18E-05	41,7E+6	0,61%	6,875E+09
240	2354,4	5,18E-05	45,5E+6	0,67%	6,818E+09
250	**2452,5**	**5,18E-05**	**47,3E+6**	**0,70%**	**6,793E+09**

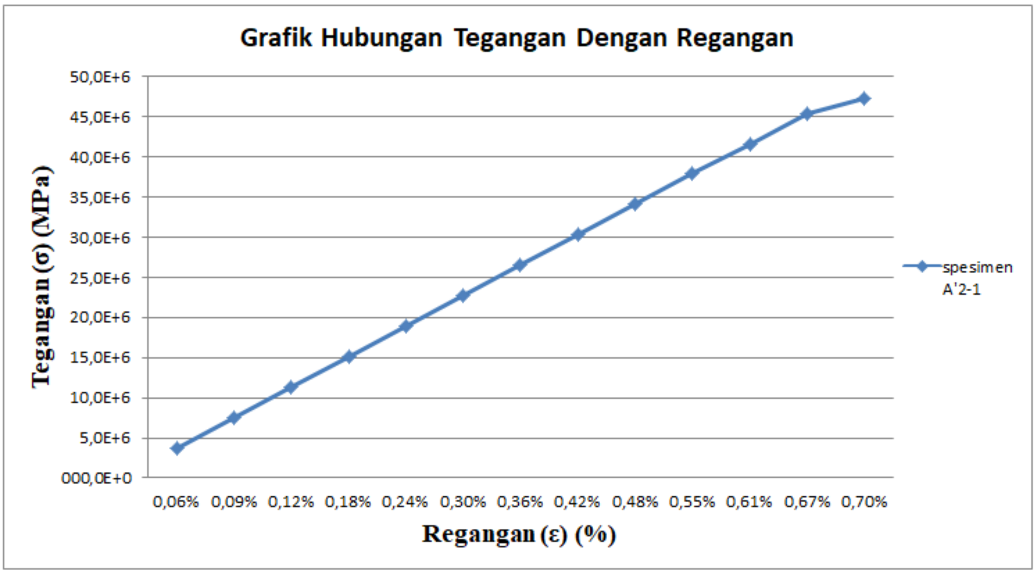


Figure 40. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 2 hours, Angle 0^0 Specimen I

Table 41. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 2 hours, Angle 0^0 Specimen II

Lo = 0.16495 m
Li = 0.16585 m

Width = 0.129 m
Thickness = 0.0039 m

spesimen A'2-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,03E-05	3,9E+6	0,06%	6,433E+09
40	392,4	5,03E-05	7,8E+6	0,09%	8,577E+09
60	588,6	5,03E-05	11,7E+6	0,15%	7,719E+09
80	784,8	5,03E-05	15,6E+6	0,18%	8,577E+09
100	981	5,03E-05	19,5E+6	0,24%	8,041E+09
120	1177,2	5,03E-05	22,7E+6	0,30%	7,719E+09
140	1373,4	5,03E-05	26,5E+6	0,36%	7,505E+09
160	1569,6	5,03E-05	31,2E+6	0,42%	7,352E+09
180	1765,8	5,03E-05	35,1E+6	0,48%	7,237E+09
200	1962	5,03E-05	39,0E+6	0,55%	7,148E+09
220	2158,2	5,03E-05	42,9E+6	0,58%	7,448E+09
229	**2246,49**	**5,03E-05**	**44,7E+6**	**0,61%**	**7,366E+09**

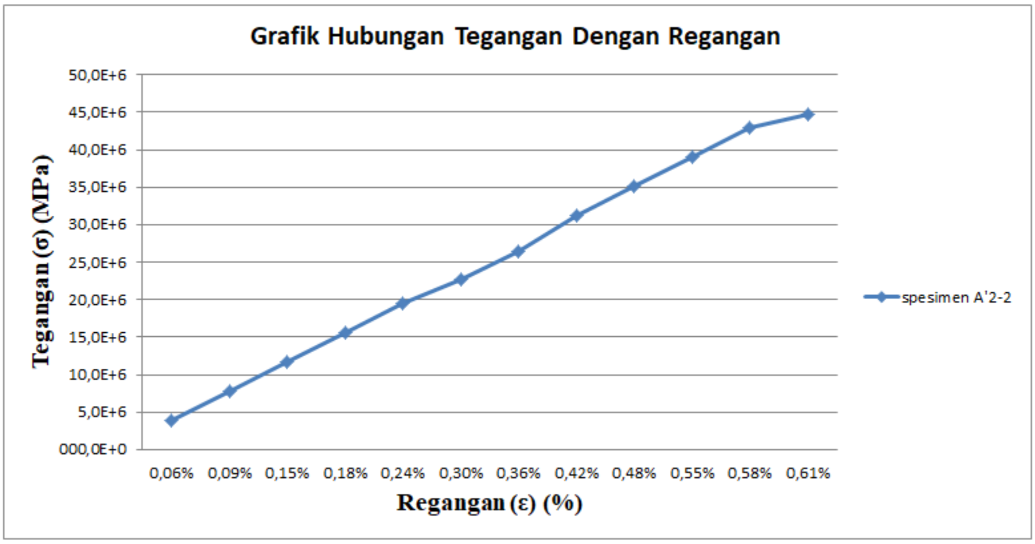


Figure 41. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 2 hours, Angle 0^0 Specimen II

Table 42. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 2 hours, Angle 0^0 Specimen III

Lo = 0.1649 m
Li = 0.1656 m

Width = 0.129 m
Thickness = 0.004 m

spesimen A'2-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,16E-05	3,8E+6	0,06%	6,270E+09
40	392,4	5,16E-05	7,6E+6	0,12%	6,270E+09
60	588,6	5,16E-05	11,4E+6	0,18%	6,270E+09
80	784,8	5,16E-05	15,2E+6	0,30%	5,016E+09
100	981	5,16E-05	19,0E+6	0,42%	4,479E+09
120	1177,2	5,16E-05	22,8E+6	0,52%	4,426E+09
140	1373,4	5,16E-05	26,6E+6	0,58%	4,620E+09
160	1569,6	5,16E-05	30,4E+6	0,67%	4,560E+09
170	**1667,7**	**5,16E-05**	**32,3E+6**	**0,73%**	**4,441E+09**

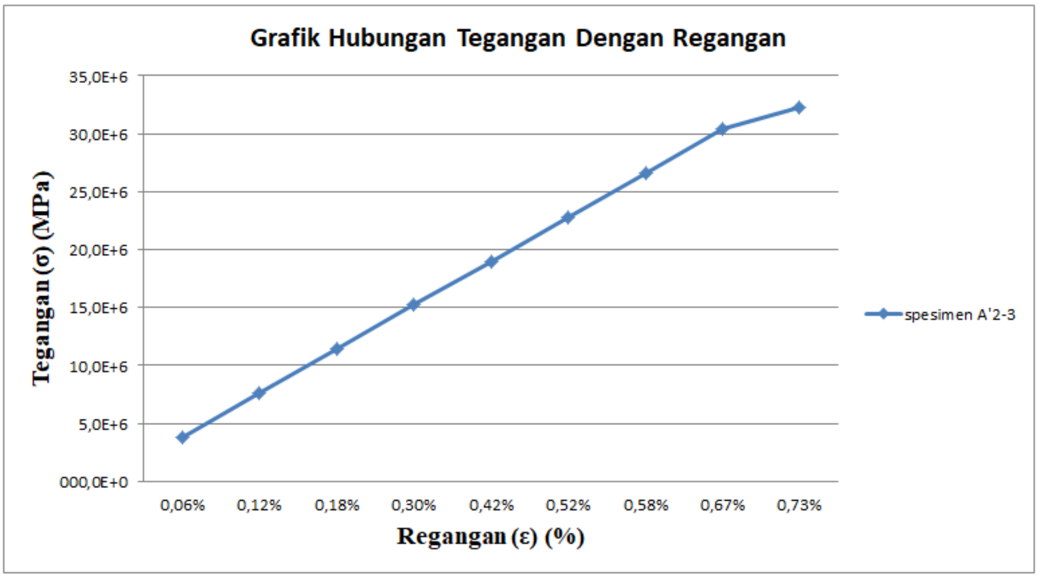


Figure 42. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 2 hours, Angle 0^0 Specimen III

Table 43. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 3 hours, Angle 0^0 Specimen I

Lo = 0.165 m
Li = 0.1659 m

Width = 0.13 m
Thickness = 0.004 m

spesimen A'3-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+06	0,06%	6,226E+09
40	392,4	5,20E-05	7,5E+6	0,09%	8,301E+09
60	588,6	5,20E-05	11,3E+6	0,12%	9,338E+09
80	784,8	5,20E-05	15,1E+6	0,18%	8,301E+09
100	981	5,20E-05	18,9E+6	0,24%	7,782E+09
120	1177,2	5,20E-05	22,6E+6	0,30%	7,471E+09
140	1373,4	5,20E-05	26,4E+6	0,36%	7,263E+09
160	1569,6	5,20E-05	30,2E+6	0,42%	7,115E+09
180	1765,8	5,20E-05	34,0E+6	0,52%	6,592E+09
200	1962	5,20E-05	37,7E+6	0,58%	6,553E+09
220	**2158,2**	**5,20E-05**	**41,5E+6**	**1,09%**	**3,805E+09**

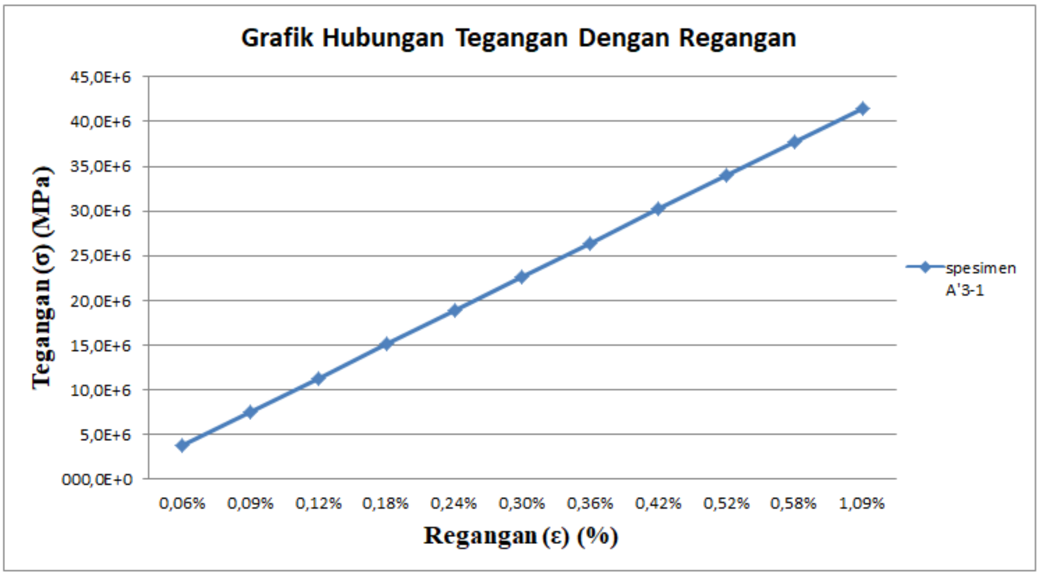


Figure 43. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 3 hours, Angle 0^0 Specimen I

Table 44. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 3 hours, Angle 0^0 Specimen II

Lo = 0.1649 m
Li = 0.16565 m

Width = 0.1295 m
Thickness = 0.00395 m

spesimen A'3-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,12E-05	3,8E+6	0,06%	6,325E+09
40	392,4	5,12E-05	7,7E+6	0,15%	5,060E+09
60	588,6	5,12E-05	11,5E+6	0,24%	4,744E+09
80	784,8	5,12E-05	15,3E+6	0,30%	5,060E+09
100	981	5,12E-05	19,2E+6	0,39%	4,865E+09
120	1177,2	5,12E-05	22,6E+6	0,45%	5,060E+09
140	1373,4	5,12E-05	26,4E+6	0,55%	4,919E+09
160	1569,6	5,12E-05	30,7E+6	0,58%	5,326E+09
180	1765,8	5,12E-05	34,5E+6	0,61%	5,692E+09
190	**1863,9**	**5,12E-05**	**36,4E+6**	**0,67%**	**5,462E+09**

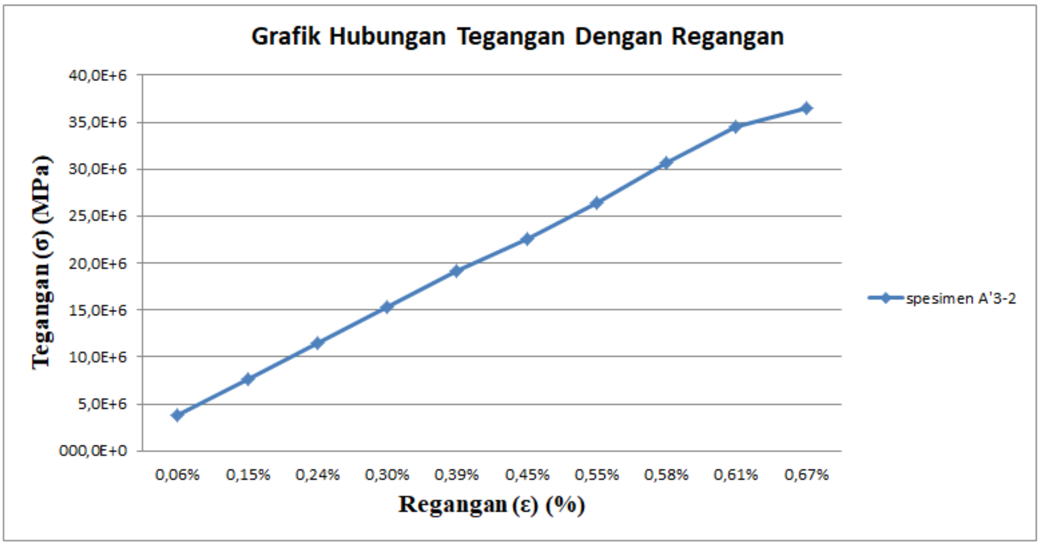


Figure 44. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 3 hours, Angle 0^0 Specimen II

Table 45. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 3 hours, Angle 0^0 Specimen III

Lo = 0.1652 m
Width = 0.129 m
Li = 0.1663 m
Thickness = 0.0039 m

spesimen A'3-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,03E-05	3,9E+6	0,06%	6,443E+09
40	392,4	5,03E-05	7,8E+6	0,12%	6,443E+09
60	588,6	5,03E-05	11,7E+6	0,15%	7,731E+09
80	784,8	5,03E-05	15,6E+6	0,21%	7,363E+09
100	981	5,03E-05	19,5E+6	0,27%	7,158E+09
120	1177,2	5,03E-05	23,4E+6	0,33%	7,028E+09
140	1373,4	5,03E-05	27,3E+6	0,39%	6,938E+09
160	1569,6	5,03E-05	31,2E+6	0,45%	6,872E+09
180	1765,8	5,03E-05	35,1E+6	0,51%	6,821E+09
200	1962	5,03E-05	39,0E+6	0,58%	6,782E+09
220	2158,2	5,03E-05	42,9E+6	0,64%	6,749E+09
240	2354,4	5,03E-05	46,8E+6	0,70%	6,723E+09
260	**2550,6**	**5,03E-05**	**50,7E+6**	**0,76%**	**6,700E+09**

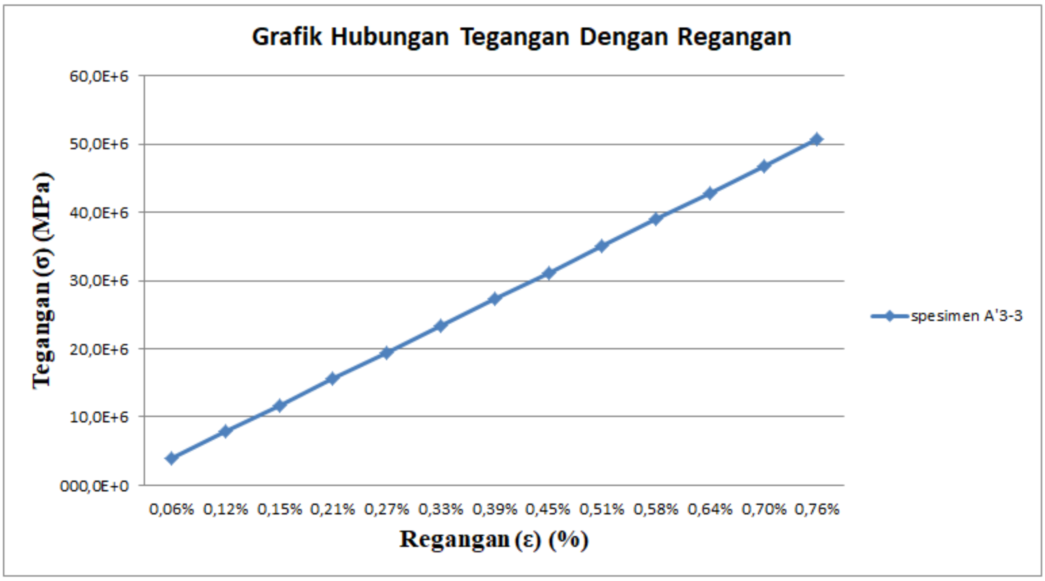


Figure 45. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 3 hours, Angle 0^0 Specimen III

Attachment 9: Tensile Test Results for Alkali Pineapple Leaf Fiber Composite 20% Angle 30^0

Table 46. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 1 hour, Angle 30^0 Specimen I

Lo = 0.1653 m
Li = 0.1655 m

Width = 0.132 m
Thickness = 0.004 m

spesimen B'1-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,28E-05	3,7E+06	0,06%	6,072E+09
40	392,4	5,28E-05	7,4E+6	0,12%	6,072E+09
60	588,6	5,28E-05	11,1E+6	0,18%	6,072E+09
80	784,8	5,28E-05	14,9E+6	0,24%	6,072E+09
100	981	5,28E-05	18,6E+6	0,34%	5,520E+09
120	1177,2	5,28E-05	22,3E+6	0,43%	5,204E+09
140	1373,4	5,28E-05	26,0E+6	0,58%	4,474E+09
160	1569,6	5,28E-05	29,7E+6	0,61%	4,857E+09
169	**1657,89**	**5,28E-05**	**31,4E+6**	**0,64%**	**4,886E+09**

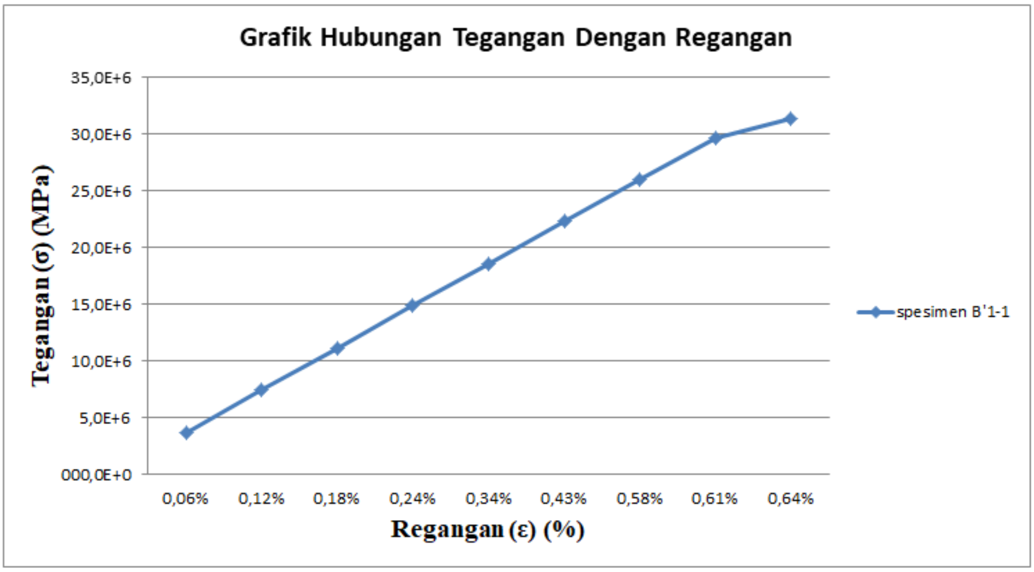


Figure 46. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 1 hour, Angle 30^0 Specimen I

Table 47. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 1 hour, Angle 30^0 Specimen II

Lo = 0.165 m
Li = 0.1652 m

Width = 0.132 m
Thickness = 0.004 m

spesimen B'1-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,28E-05	3,7E+6	0,06%	6,046E+09
40	392,4	5,28E-05	7,4E+6	0,12%	6,046E+09
60	588,6	5,28E-05	11,1E+6	0,17%	6,478E+09
80	784,8	5,28E-05	14,9E+6	0,25%	6,046E+09
100	981	5,28E-05	18,6E+6	0,37%	5,038E+09
120	1177,2	5,28E-05	22,3E+6	0,40%	5,581E+09
140	1373,4	5,28E-05	26,0E+6	0,46%	5,643E+09
160	**1569,6**	**5,28E-05**	**29,7E+6**	**0,55%**	**5,374E+09**

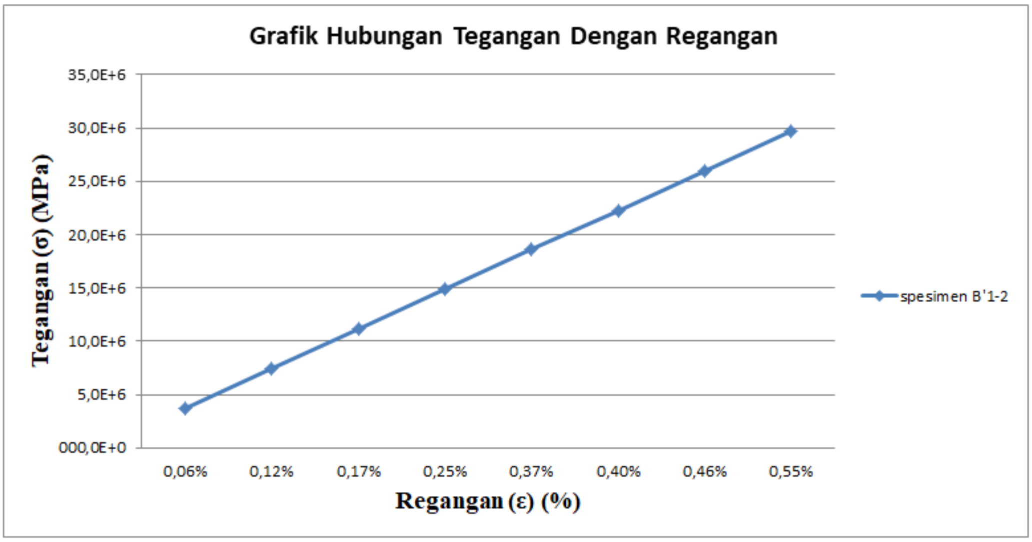


Figure 47. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 1 hour, Angle 30^0 Specimen II

Table 48. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 1 hour, Angle 30^0 Specimen III

Lo = 0.165 m
Li = 0.16575 m
Width = 0.1305 m
Thickness = 0.004 m

spesimen B'1-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,22E-05	3,8E+6	0,09%	4,134E+09
40	392,4	5,22E-05	7,5E+6	0,18%	4,134E+09
60	588,6	5,22E-05	11,3E+6	0,24%	4,651E+09
80	784,8	5,22E-05	15,0E+6	0,36%	4,134E+09
100	981	5,22E-05	18,8E+6	0,42%	4,430E+09
120	1177,2	5,22E-05	22,6E+6	0,52%	4,378E+09
140	**1373,4**	**5,22E-05**	**26,3E+6**	**0,61%**	**4,341E+09**

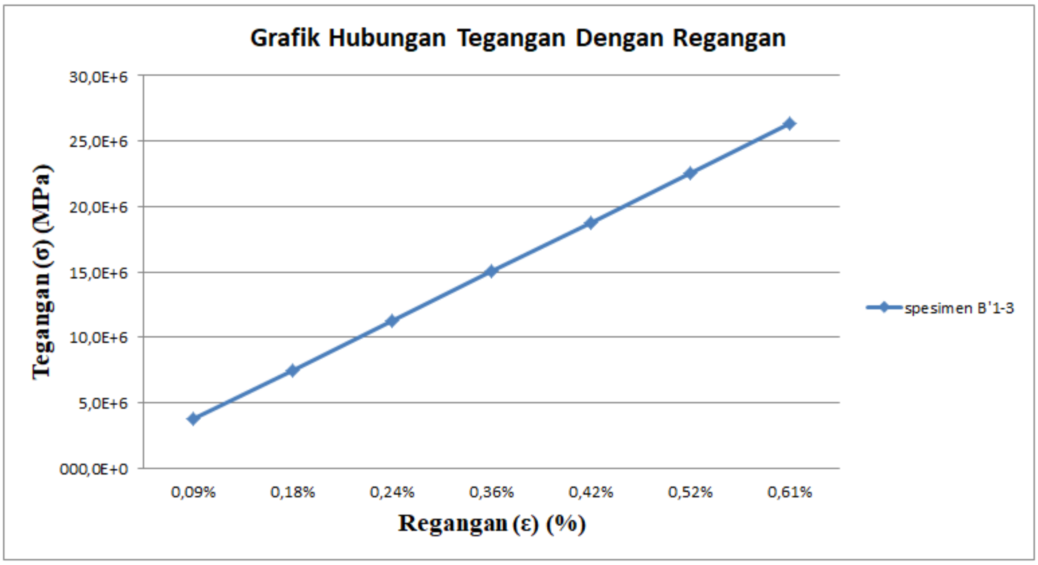


Figure 48. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 1 hour, Angle 30^0 Specimen III

Table 49. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 2 hours, Angle 30^0 Specimen I

Lo = 0.1651 m
Li = 0.1655 m

Width = 0.13 m
Thickness = 0.0041 m

spesimen B'2-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,33E-05	3,7E+06	0,12%	3,039E+09
40	392,4	5,33E-05	7,4E+6	0,18%	4,052E+09
60	588,6	5,33E-05	11,0E+6	0,30%	3,646E+09
80	784,8	5,33E-05	14,7E+6	0,42%	3,473E+09
100	981	5,33E-05	18,4E+6	0,55%	3,376E+09
120	1177,2	5,33E-05	22,1E+6	0,61%	3,646E+09
130	**1275,3**	**5,33E-05**	**23,9E+6**	**0,67%**	**3,591E+09**

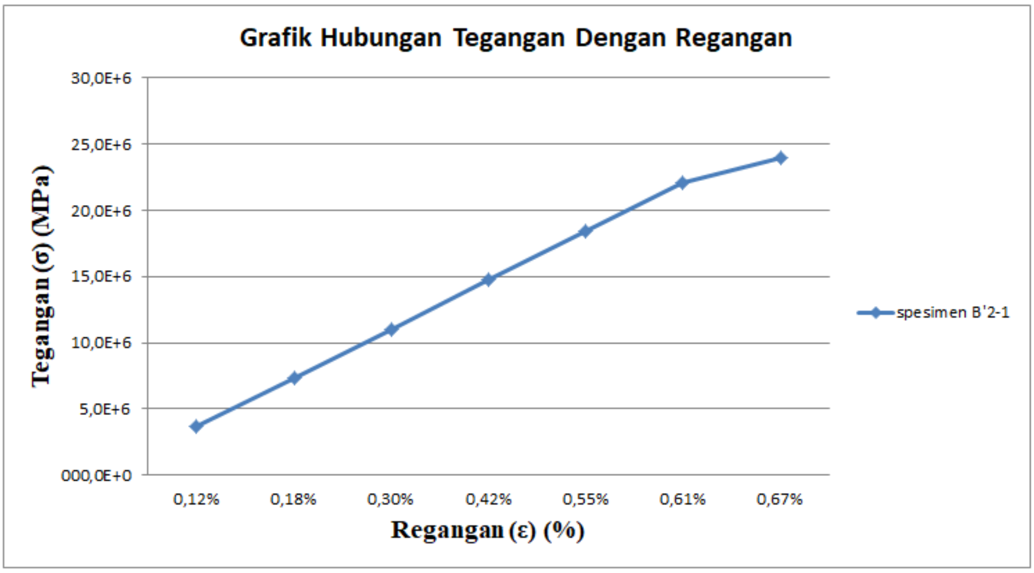


Figure 49. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 2 hours, Angle 30^0 Specimen I

Table 50. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 2 hours, Angle 30^0 Specimen II

Lo = 0.165 m
Li = 0.1654 m

Width = 0.13 m
Thickness = 0.0041 m

spesimen B'2-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+6	0,15%	2,490E+09
40	392,4	5,20E-05	7,5E+6	0,27%	2,767E+09
60	588,6	5,20E-05	11,3E+6	0,42%	2,668E+09
80	784,8	5,20E-05	15,1E+6	0,55%	2,767E+09
100	**981**	**5,20E-05**	**18,9E+6**	**0,67%**	**2,830E+09**

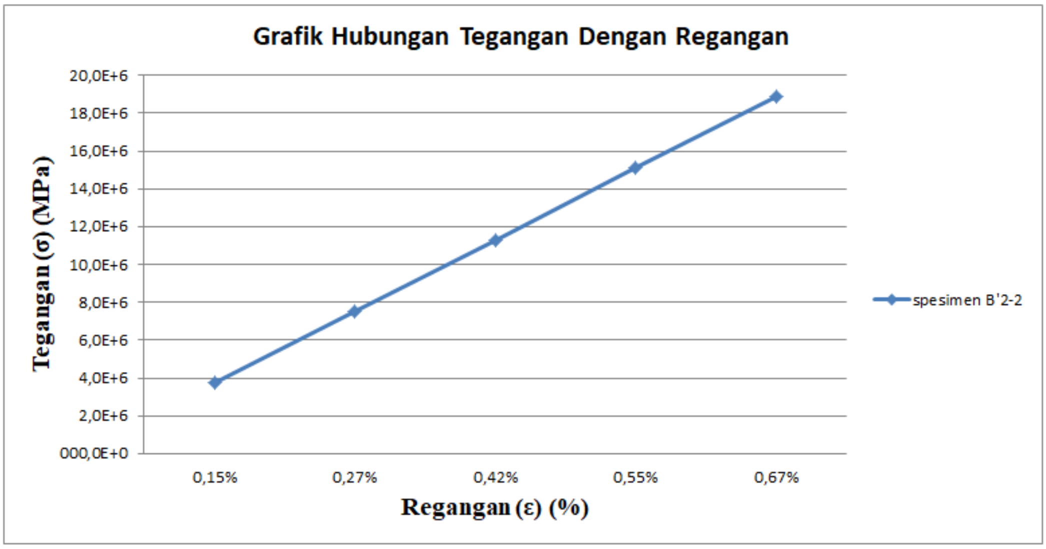


Figure 50. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 2 hours, Angle 30^0 Specimen II

Table 51. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 2 hours, Angle 30^0 Specimen III

Lo = 0.1653 m
Li = 0.1659 m

Width = 0.132 m
Thickness = 0.0042 m

spesimen B'2-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,22E-05	3,8E+6	0,06%	6,213E+09
40	392,4	5,54E-05	7,1E+6	0,12%	5,850E+09
60	588,6	5,54E-05	10,6E+6	0,21%	5,014E+09
80	784,8	5,54E-05	14,2E+6	0,30%	4,680E+09
100	981	5,54E-05	17,7E+6	0,42%	4,179E+09
120	1177,2	5,54E-05	21,2E+6	0,48%	4,387E+09
140	1373,4	5,54E-05	24,8E+6	0,57%	4,310E+09
165	**1618,65**	**5,54E-05**	**29,2E+6**	**0,67%**	**4,387E+09**

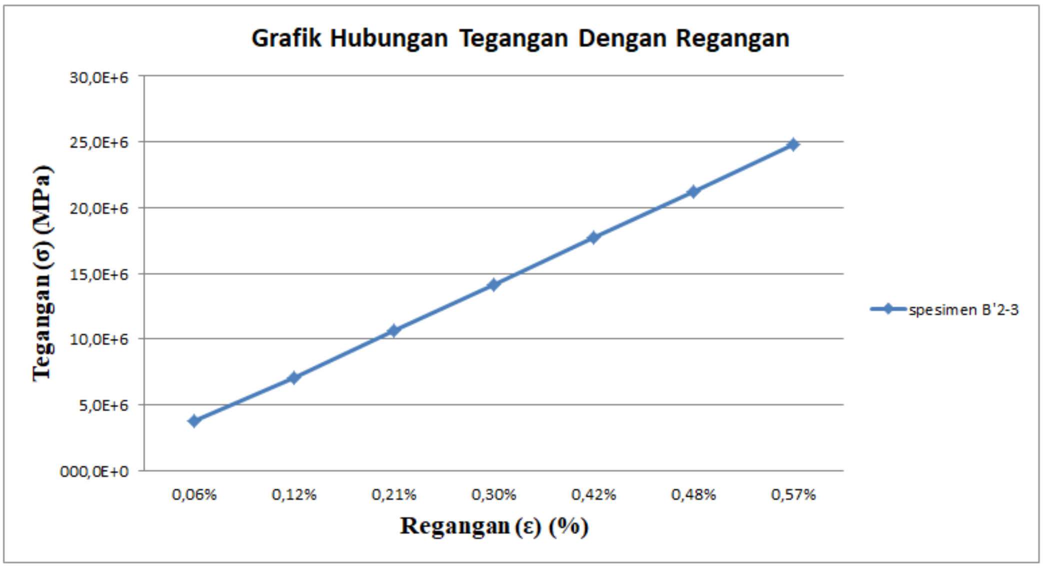


Figure 51. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 2 hours, Angle 30^0 Specimen III

Table 52. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 3 hours, Angle 30^0 Specimen I

Lo = 0.1649 m
Li = 0.1655 m

Width = 0.132 m
Thickness = 0.004 m

spesimen B'3-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,28E-05	3,7E+06	0,12%	3,064E+09
40	392,4	5,28E-05	7,4E+6	0,18%	4,085E+09
60	588,6	5,28E-05	11,1E+6	0,27%	4,085E+09
80	784,8	5,28E-05	14,9E+6	0,42%	3,501E+09
100	981	5,28E-05	18,6E+6	0,61%	3,064E+09
120	1177,2	5,28E-05	22,3E+6	0,67%	3,342E+09
130	**1275,3**	**5,28E-05**	**24,2E+6**	**0,73%**	**3,319E+09**

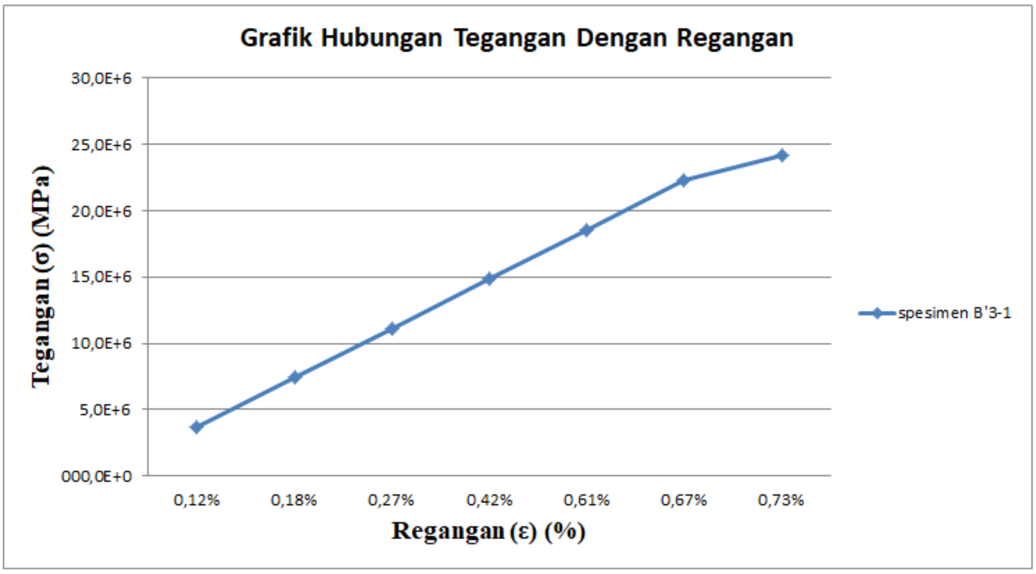


Figure 52. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 3 hours, Angle 30^0 Specimen I

Table 53. Tabulation of 20% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 3 hours, Angle 30^0 Specimen II

Lo = 0.1651 m
Width = 0.132 m
Li = 0.16535 m
Thickness = 0.004 m

spesimen B'3-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,28E-05	3,7E+6	0,12%	3,067E+09
40	392,4	5,28E-05	7,4E+6	0,18%	4,090E+09
60	588,6	5,28E-05	11,1E+6	0,30%	3,681E+09
80	784,8	5,28E-05	14,9E+6	2,06%	7,218E+08
100	981	5,28E-05	18,6E+6	0,58%	3,229E+09
120	1177,2	5,28E-05	22,3E+6	0,73%	3,067E+09
140	1373,4	5,28E-05	26,0E+6	0,79%	3,303E+09
150	**1569,6**	**5,28E-05**	**27,9E+6**	**0,85%**	**3,287E+09**

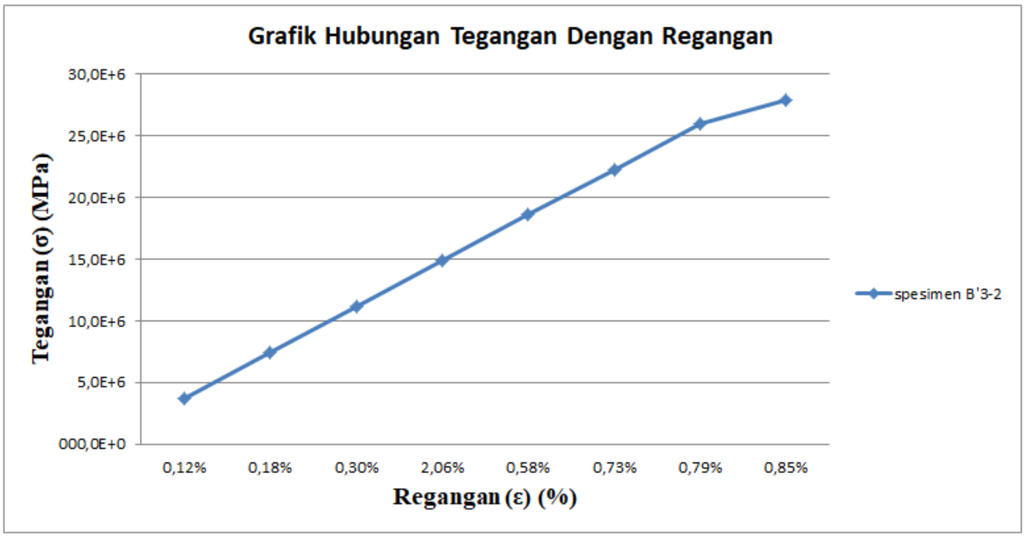


Figure 53. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 3 hours, Angle 30^0 Specimen II

Table 54. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 3 hours, Angle 30^0 Specimen III

Lo = 0.16525 m
Li = 0.16565 m

Width = 0.1305 m
Thickness = 0.004 m

spesimen B'3-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,22E-05	3,8E+6	0,09%	4,141E+09
40	392,4	5,22E-05	7,5E+6	0,15%	4,969E+09
60	588,6	5,22E-05	11,3E+6	0,36%	3,106E+09
80	784,8	5,22E-05	15,0E+6	0,45%	3,313E+09
100	981	5,22E-05	18,8E+6	0,61%	3,106E+09
120	1177,2	5,22E-05	22,6E+6	0,70%	3,241E+09
140	1373,4	5,22E-05	26,3E+6	0,79%	3,344E+09
160	1569,6	5,22E-05	30,1E+6	0,91%	3,313E+09
169	**1657,89**	**5,22E-05**	**31,8E+6**	**0,82%**	**3,888E+09**

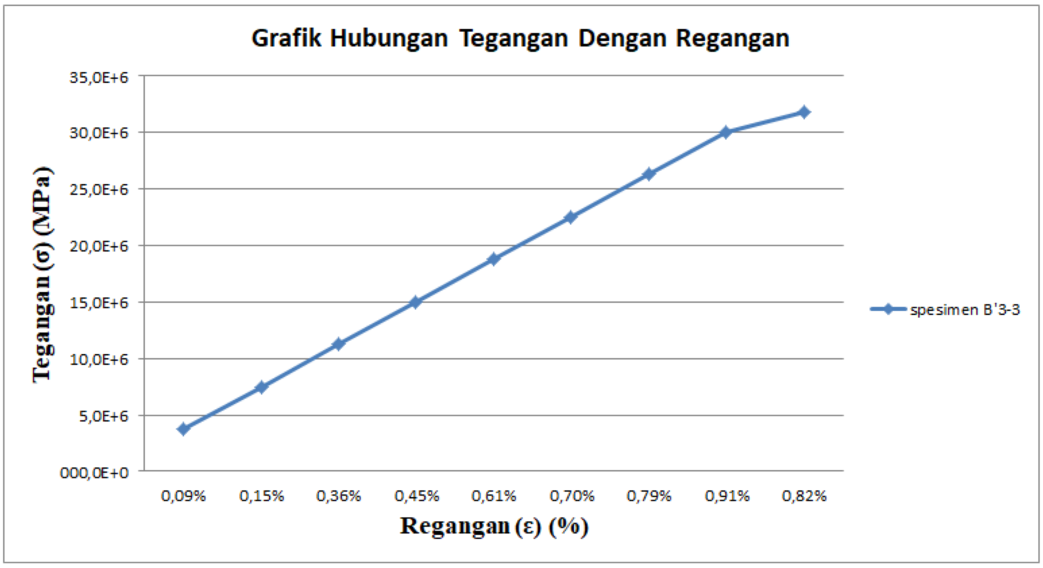


Figure 54. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 3 hours, Angle 30^0 Specimen III

Attachment 10: Tensile Test Results for Alkali Pineapple Leaf Fiber Composite 20% Angle 60^0

Table 55. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 1 hour, Angle of 60^0 Specimen I

Lo = 0.1651 m
Li = 0.1654 m

Width = 0.131 m
Thickness = 0.004 m

spesimen C'1-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,24E-05	3,7E+06	0,12%	3,091E+09
40	392,4	5,24E-05	7,5E+6	0,18%	4,121E+09
60	588,6	5,24E-05	11,2E+6	0,24%	4,636E+09
80	784,8	5,24E-05	15,0E+6	0,33%	4,496E+09
100	981	5,24E-05	18,7E+6	0,45%	4,121E+09
120	**1177,2**	**0,00E+00**	**22,5E+6**	**0,55%**	**4,121E+09**

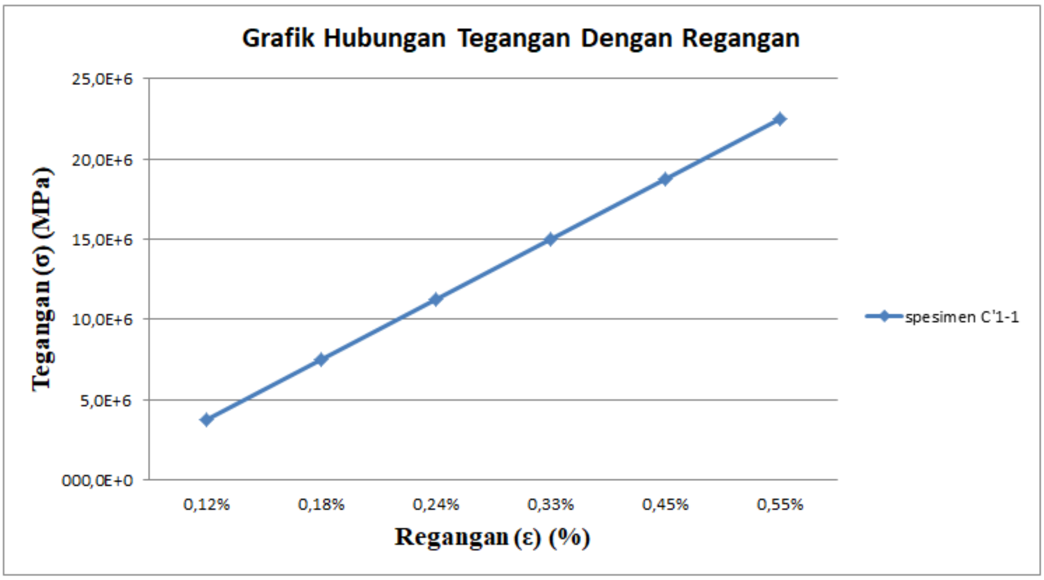


Figure 55. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 1 hour, Angle of 60^0 Specimen I

Table 56. Tabulation of 20% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 1 hour, Angle 60^0 Specimen II

Lo = 0.165 m
Li = 0.1653 m

Width = 0.13 m
Thickness = 0.004 m

spesimen C'1-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+6	0,12%	3,113E+09
40	392,4	5,20E-05	7,5E+6	0,18%	4,150E+09
60	588,6	5,20E-05	11,3E+6	0,27%	4,150E+09
80	784,8	5,20E-05	15,1E+6	0,36%	4,150E+09
100	981	5,20E-05	18,9E+6	0,45%	4,150E+09
110	**1079,1**	**5,20E-05**	**22,5E+6**	**0,48%**	**4,280E+09**

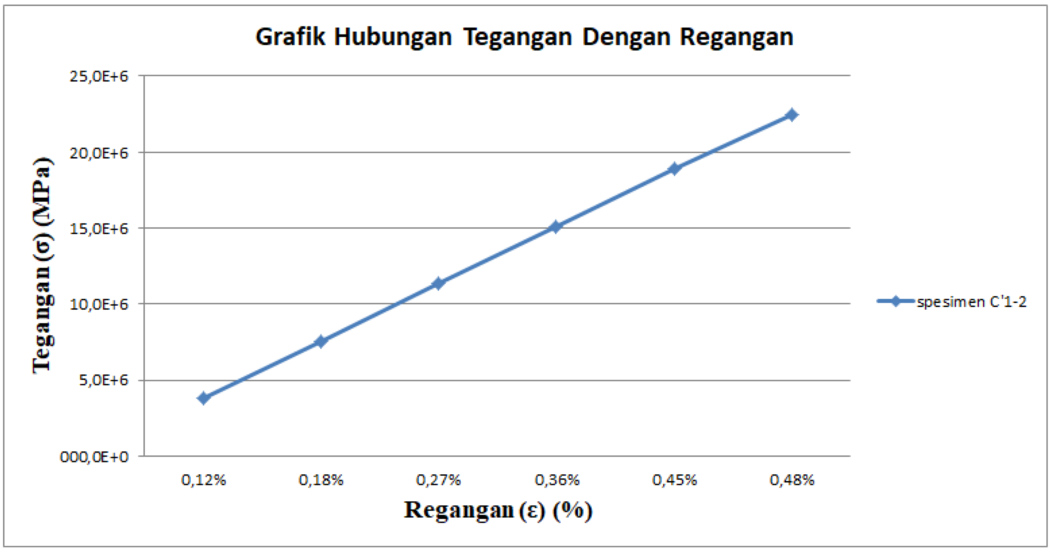


Figure 56. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 1 hour, Angle 60^0 Specimen II

Table 57. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 1 hour, Angle of 60^0 Specimen III

Lo = 0.165 m
Li = 0.1653 m

Width = 0.13 m
Thickness = 0.004 m

spesimen C'1-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+6	0,09%	4,150E+09
40	392,4	5,20E-05	7,5E+6	0,15%	4,980E+09
60	588,6	5,20E-05	11,3E+6	0,21%	5,336E+09
80	784,8	5,20E-05	15,1E+6	0,24%	6,226E+09
100	981	5,20E-05	18,9E+6	0,33%	5,660E+09
110	**1079,1**	**5,20E-05**	**20,8E+6**	**0,39%**	**5,268E+09**

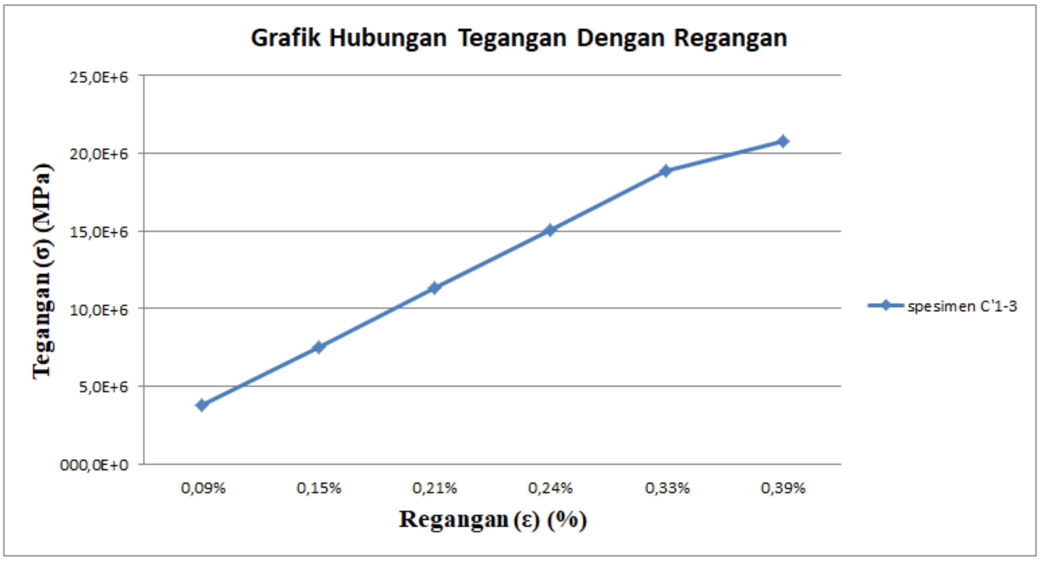


Figure 57. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 1 hour, Angle of 60^0 Specimen III

Table 58. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 2 hours, Angle of 60^0 Specimen I

Lo = 0.165 m
Li = 0.16525 m

Width = 0.13 m
Thickness = 0.004 m

spesimen C'2-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,24E-05	3,7E+06	0,12%	3,089E+09
40	392,4	5,24E-05	7,5E+6	0,18%	4,119E+09
60	588,6	5,24E-05	11,2E+6	0,30%	3,707E+09
80	784,8	5,24E-05	15,0E+6	0,39%	3,802E+09
100	**981**	**5,24E-05**	**18,7E+6**	**0,48%**	**3,861E+09**

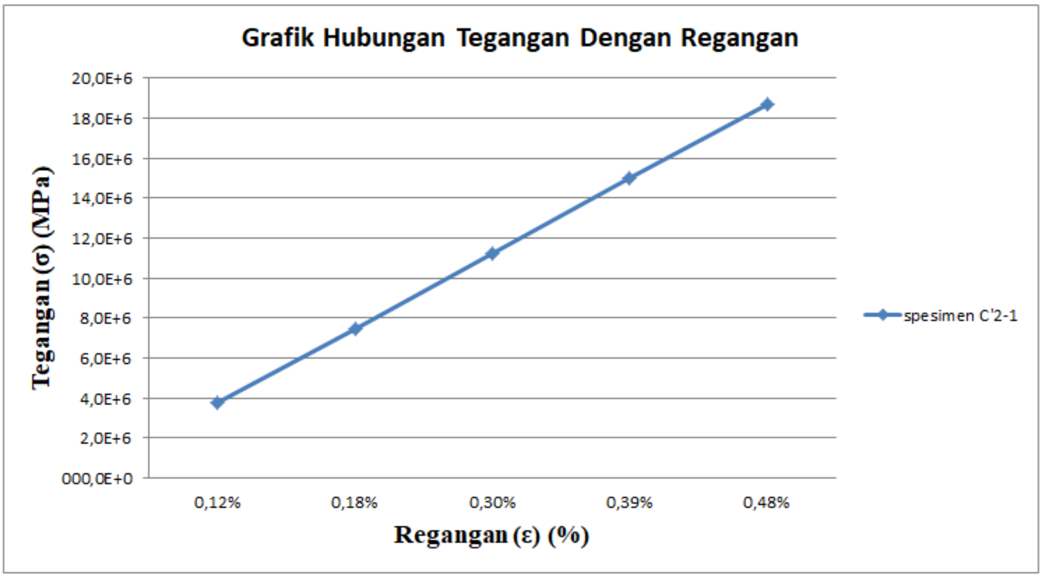


Figure 58. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 2 hours, Angle of 60^0 Specimen I

Table 59. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 2 hours, Angle of 60^0 Specimen II

Lo = 0.165 m
Li = 0.16525 m

Width = 0.132 m
Thickness = 0.004 m

spesimen C'2-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,28E-05	3,7E+6	0,06%	6,137E+09
40	392,4	5,28E-05	7,4E+6	0,12%	6,137E+09
60	588,6	5,28E-05	11,1E+6	0,24%	4,603E+09
80	784,8	5,28E-05	14,9E+6	0,30%	4,909E+09
100	981	5,28E-05	18,6E+6	0,39%	4,721E+09
120	1177,2	5,28E-05	22,3E+6	0,45%	4,909E+09
130	**1275,3**	**5,28E-05**	**24,2E+6**	**0,48%**	**4,986E+09**

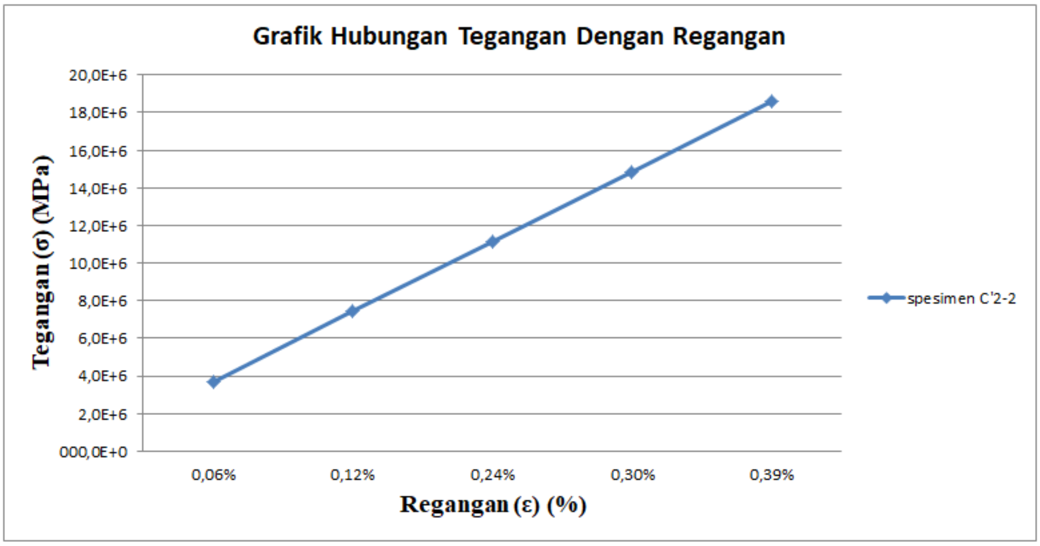


Figure 59. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 2 hours, Angle 60^0 Specimen II

Table 60 Tabulation of Alkali Pineapple Leaf Fiber Composite Tensile Test Data 20%, 2 hours, Angle 60^0 Specimen III

Lo = 0.165 m
Li = 0.1654 m

Width = 0.13 m
Thickness = 0.0039 m

spesimen C'2-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,07E-05	3,9E+6	0,18%	2,128E+09
40	392,4	5,07E-05	7,7E+6	0,24%	3,193E+09
60	588,6	5,07E-05	11,6E+6	0,30%	3,831E+09
80	784,8	5,07E-05	15,5E+6	0,36%	4,257E+09
100	981	5,07E-05	19,3E+6	0,42%	4,561E+09
120	**1177,2**	**5,07E-05**	**23,2E+6**	**0,48%**	**4,789E+09**

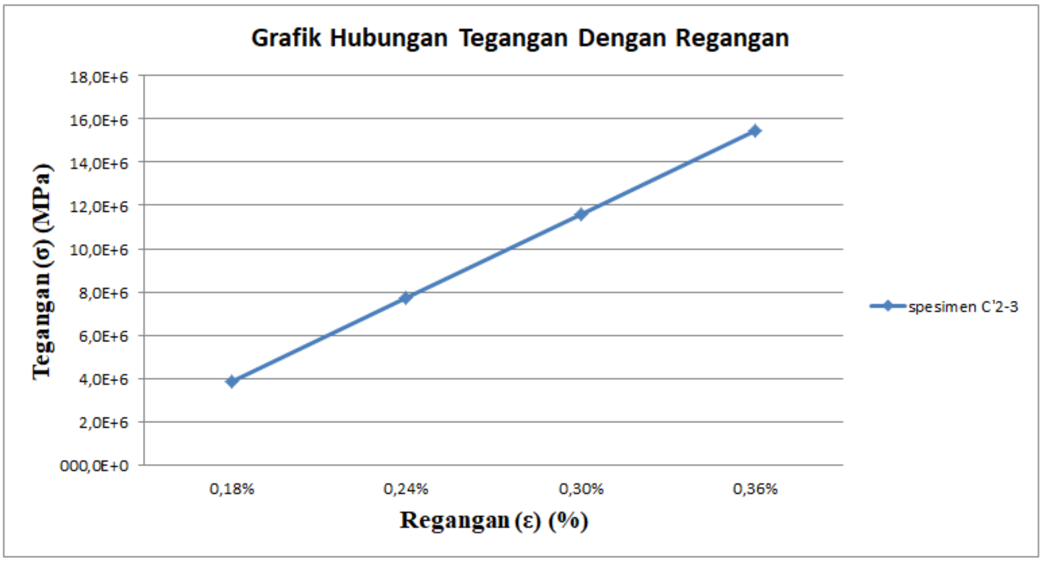


Figure 60. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 2 hours, Angle of 60^0 Specimen III

Table 61. Tabulation of Composite Tensile Test Data for Alkali Pineapple Leaf Fiber 20%, 3 hours, Angle of 60^0 Specimen I

Lo = 0.165 m
Li = 0.16535 m

Width = 0.131 m
Thickness = 0.004 m

spesimen C'3-1

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,24E-05	3,7E+06	0,12%	3,089E+09
40	392,4	5,24E-05	7,5E+6	0,18%	4,119E+09
60	588,6	5,24E-05	11,2E+6	0,27%	4,119E+09
80	784,8	5,24E-05	15,0E+6	0,36%	4,119E+09
100	981	5,24E-05	18,7E+6	0,42%	4,413E+09
110	**1079,1**	**0,00E+00**	**20,6E+6**	**0,48%**	**4,247E+09**

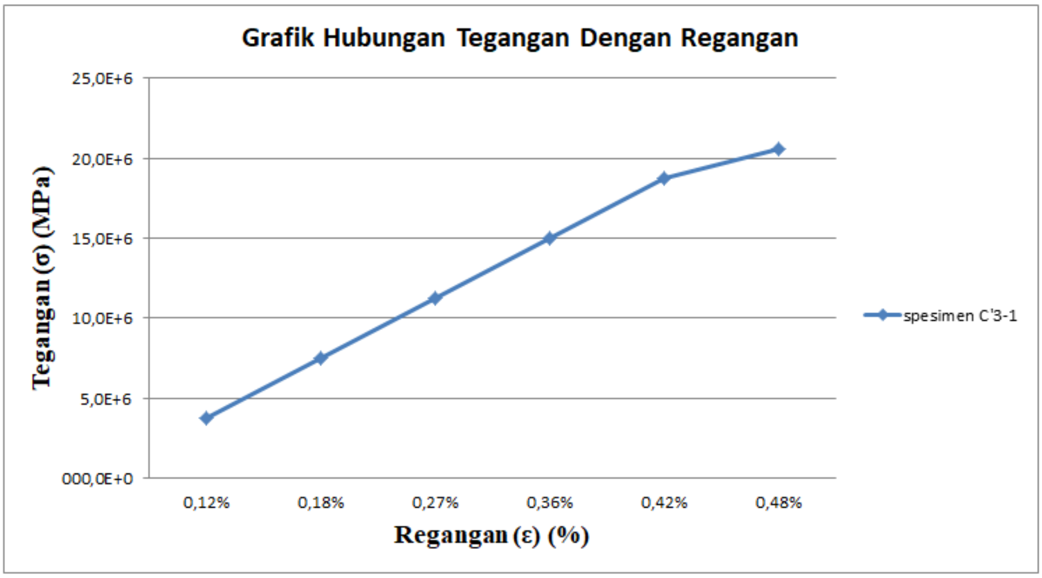


Figure 61. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 3 hours, Angle of 60^0 Specimen I

Table 62 Tabulation of 20% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 3 hours, Angle of 60^0 Specimen II

Lo = 0.165 m
Li = 0.1653 m

Width = 0.13 m
Thickness = 0.004 m

spesimen C'3-2

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,20E-05	3,8E+6	0,12%	3,113E+09
40	392,4	5,20E-05	7,5E+6	0,18%	4,150E+09
60	588,6	5,20E-05	11,3E+6	0,24%	4,669E+09
80	784,8	5,20E-05	15,1E+6	0,33%	4,528E+09
100	**981**	**5,20E-05**	**18,9E+6**	**0,42%**	**4,447E+09**

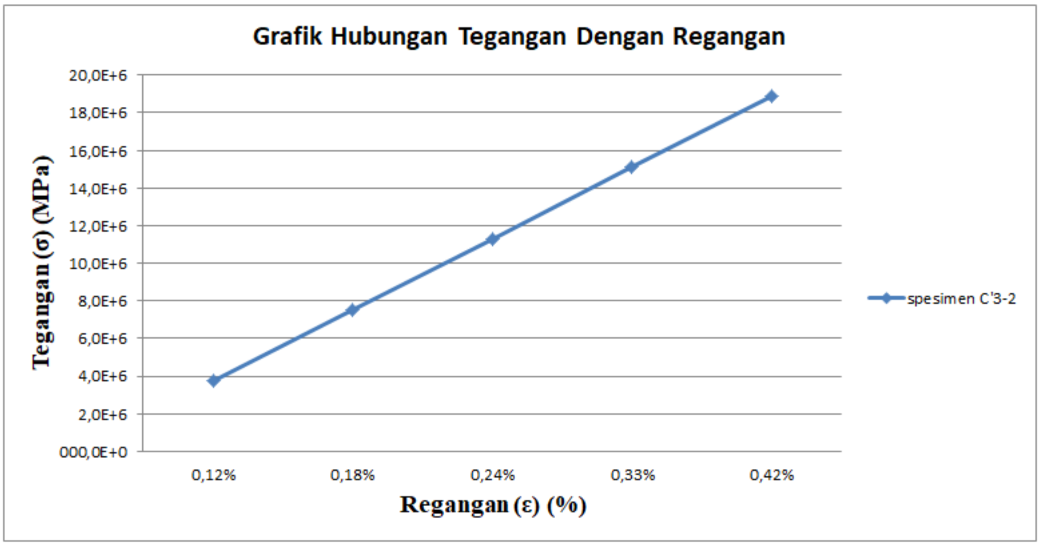


Figure 62. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 3 hours, Angle 60^0 Specimen II

Table 63 Tabulation of 20% Alkali Pineapple Leaf Fiber Composite Tensile Test Data, 3 hours, Angle of 60^0 Specimen II

Lo = 0.1649 m
Li = 0.16505 m

Width = 0.13 m
Thickness = 0.0039 m

spesimen C'3-3

Massa (Kg)	Gaya (N)	Penampang (A) (m^2)	Tegangan (σ) (MPa)	Regangan (ε) (%)	Elastisitas (E) (GPA)
20	196,2	5,07E-05	3,9E+6	0,18%	2,127E+09
40	392,4	5,07E-05	7,7E+6	0,24%	3,191E+09
60	588,6	5,07E-05	11,6E+6	0,36%	3,191E+09
79	**774,99**	**5,07E-05**	**15,3E+6**	**0,42%**	**3,601E+09**

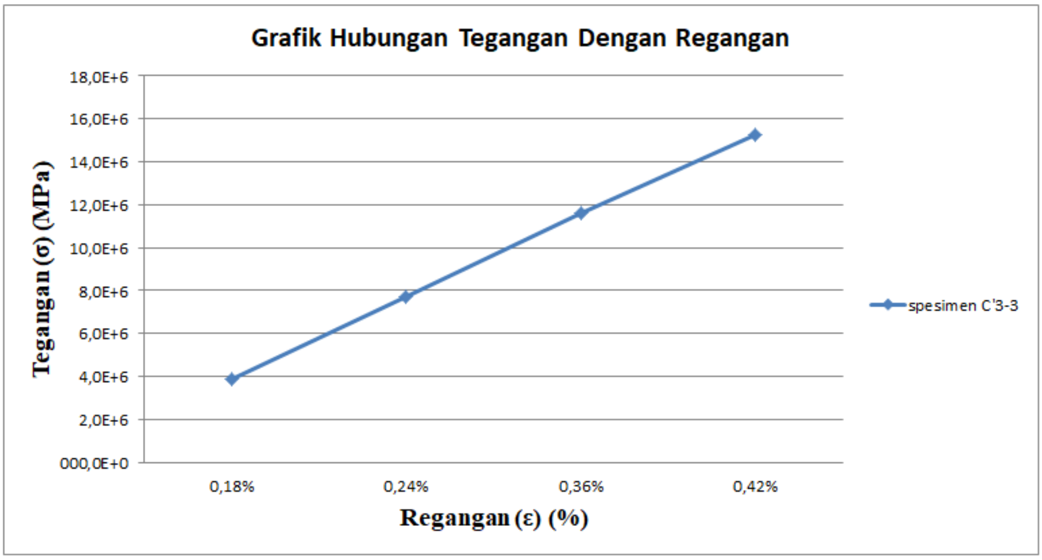


Figure 63. Graph of Composite Tensile Test Results for Pineapple Leaf Fiber with Alkali Treatment 20%, 3 hours, Angle of 60^0 Specimen III

Attachment 11: Curves of Specimen Tensile Test Results Using the Monsanto MachineTensometer Education Kit

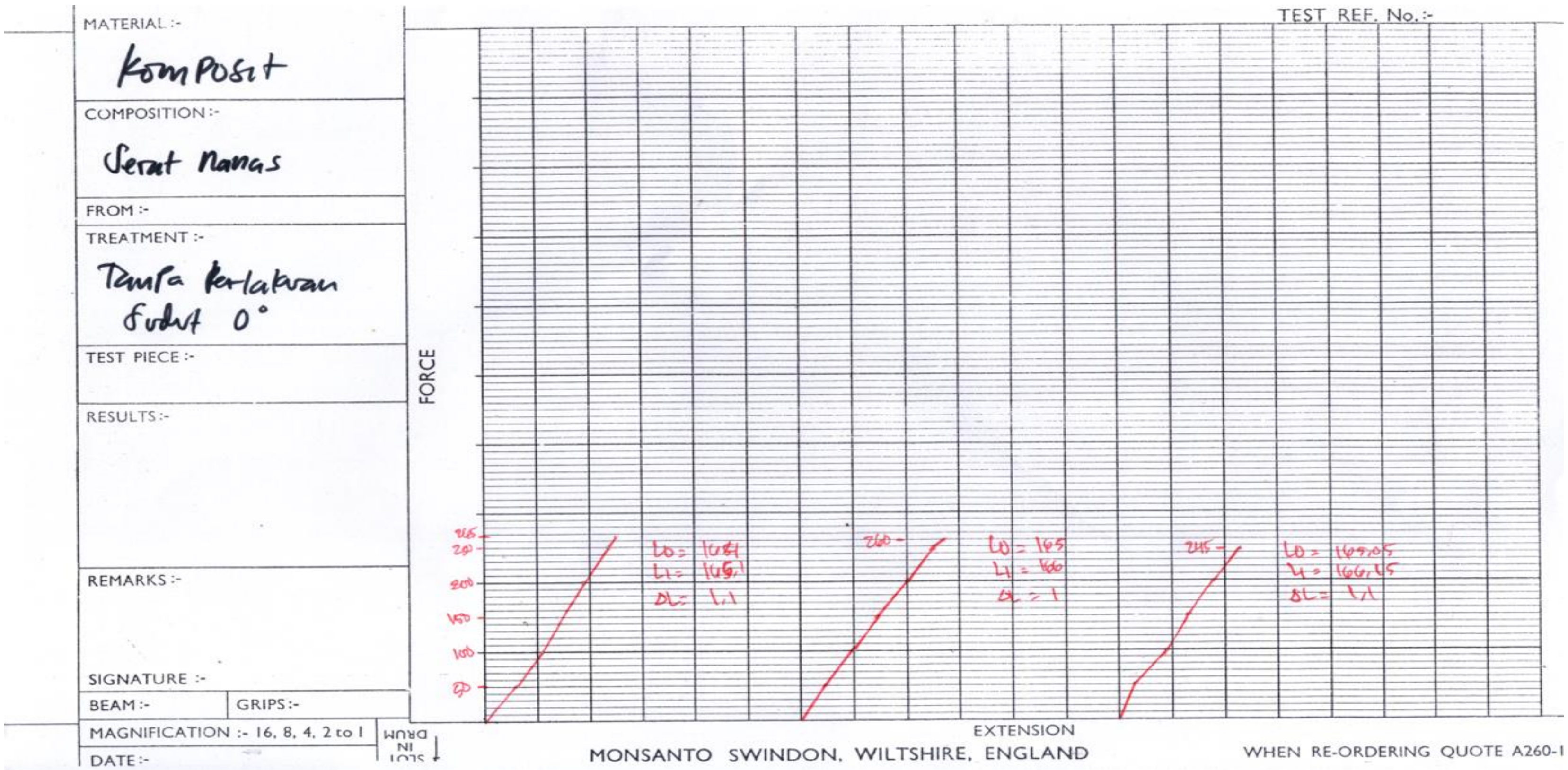


Figure 64. Tensile Test Curve of Pineapple Leaf Fiber Composite Specimen Without Alkali Treatment Angle 0^0

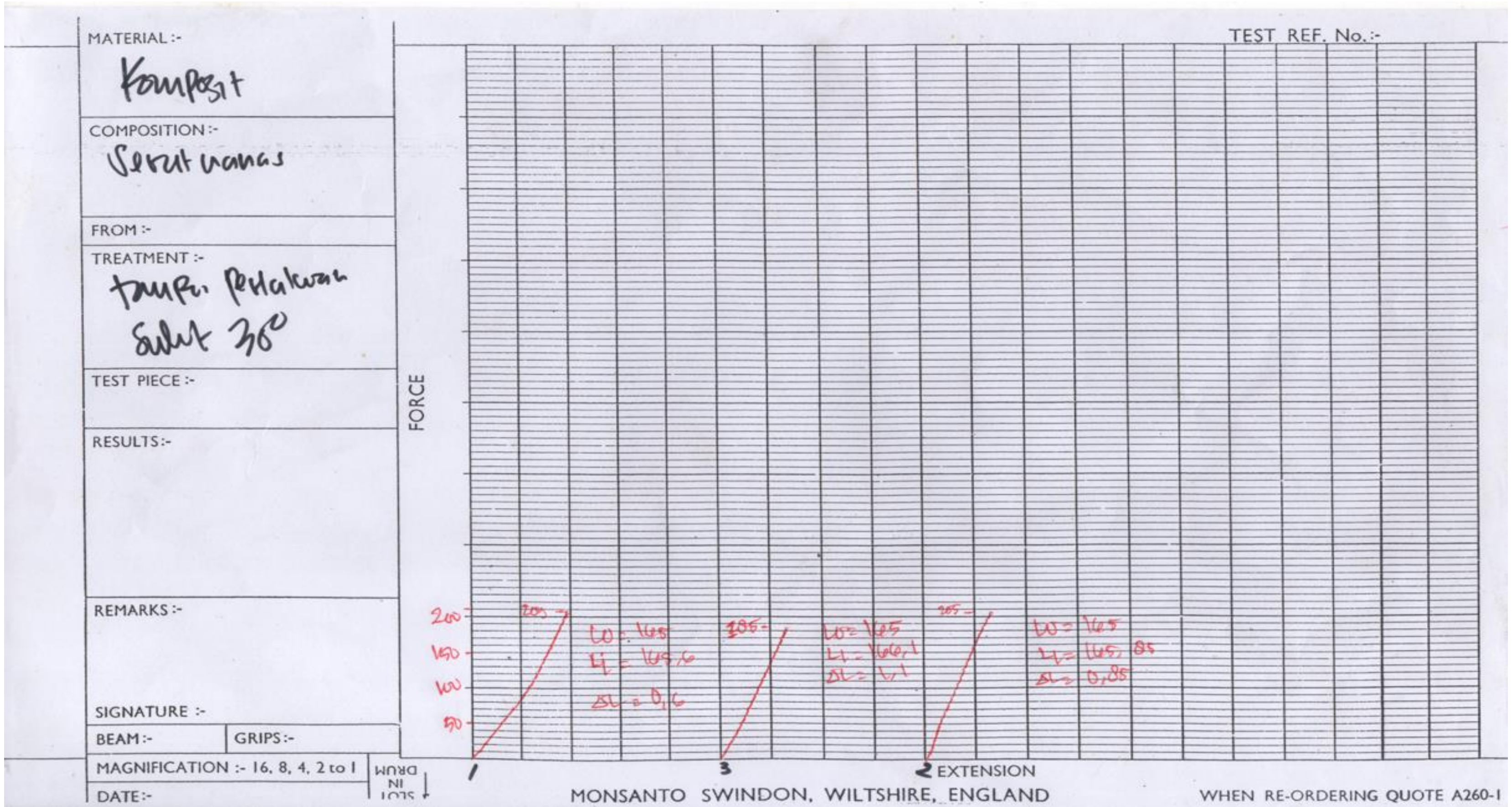


Figure 65. Tensile Test Curve of Pineapple Leaf Fiber Composite Specimen Without Alkali Treatment Angle 30^0

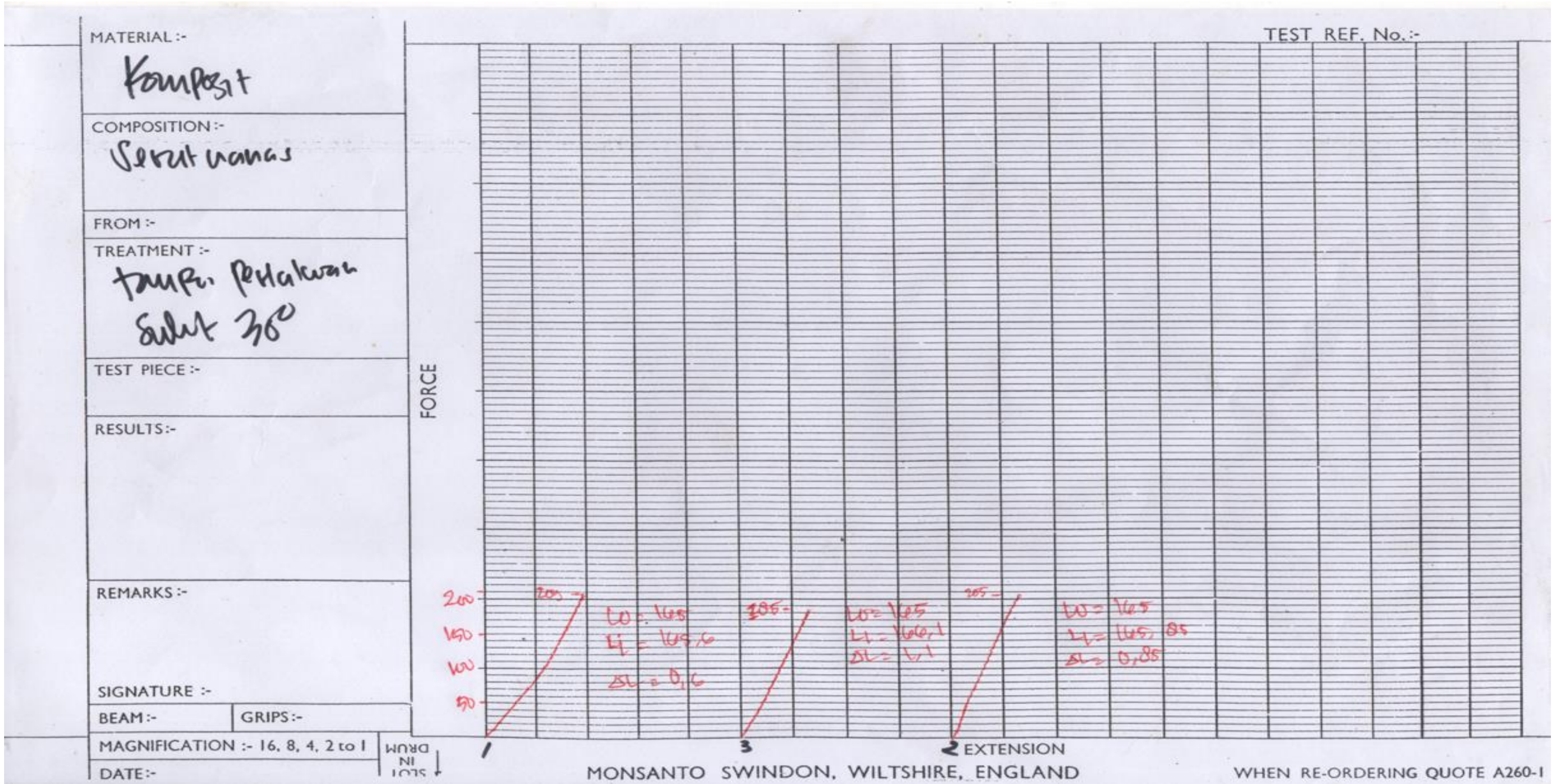


Figure 66. Tensile Test Curve of Pineapple Leaf Fiber Composite Specimen Without Alkali Treatment Angle 60^0

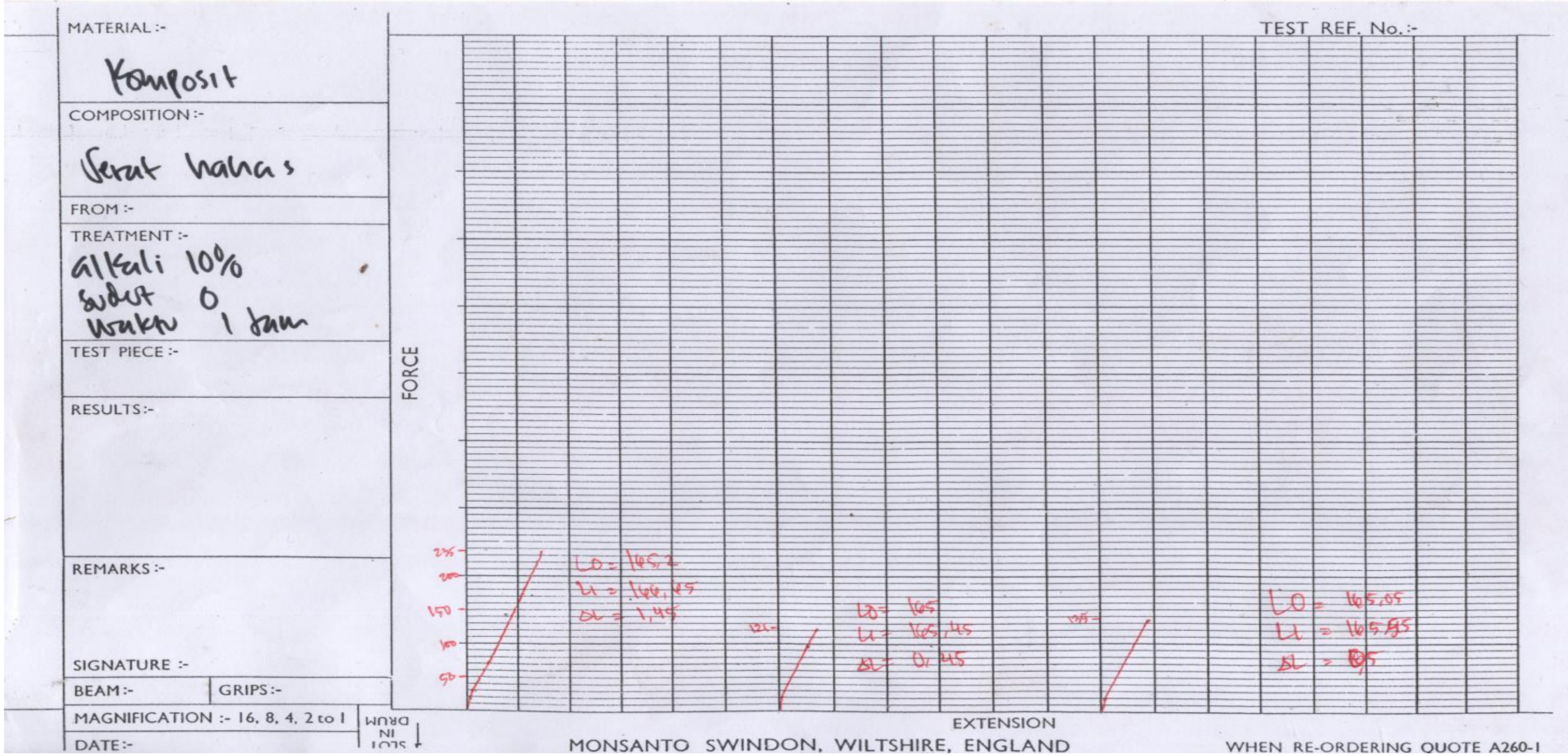


Figure 67. Tensile Test Curve of 10% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 0^0 Time 1 hour

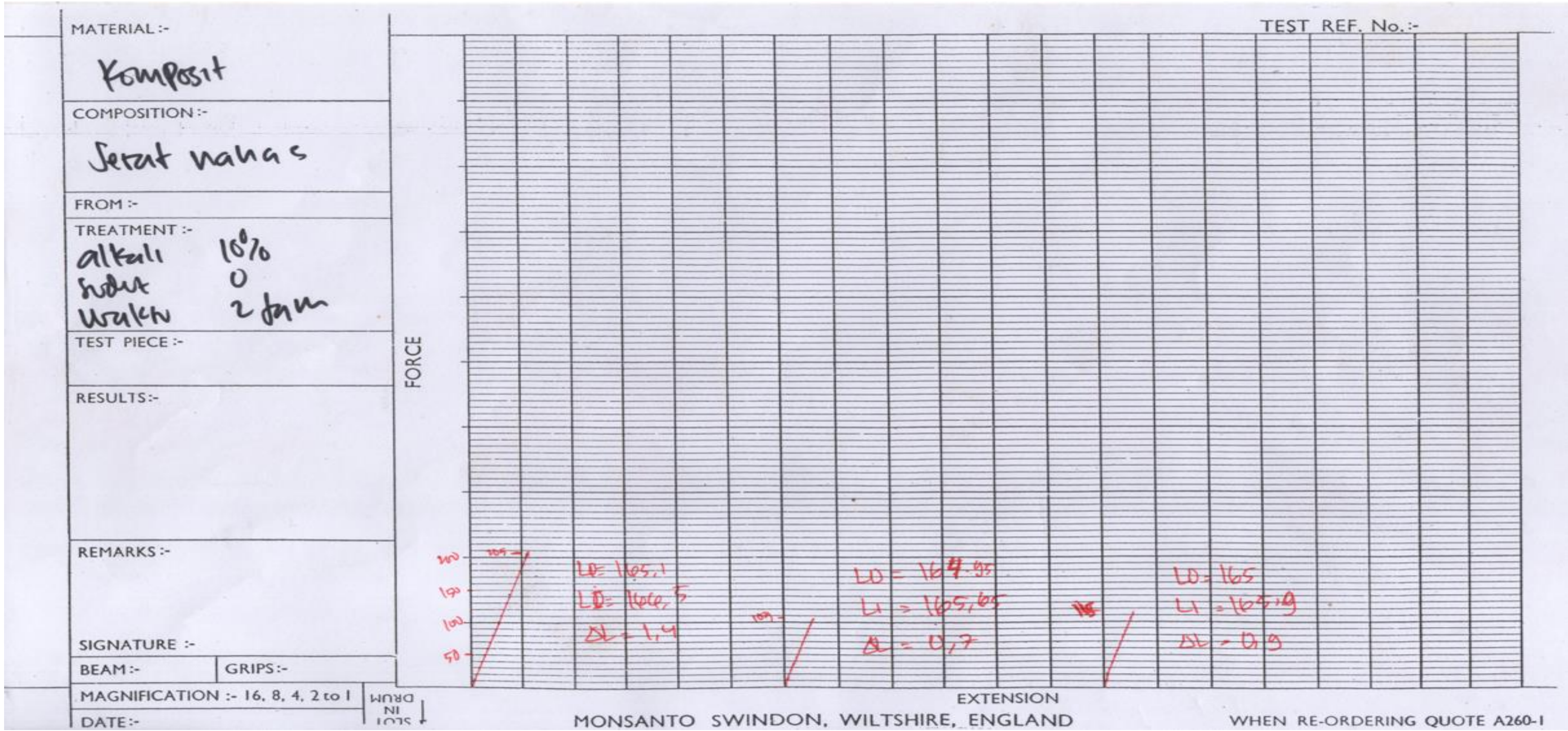


Figure 68. Tensile Test Curve of 10% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 0^0 Time 2 hours

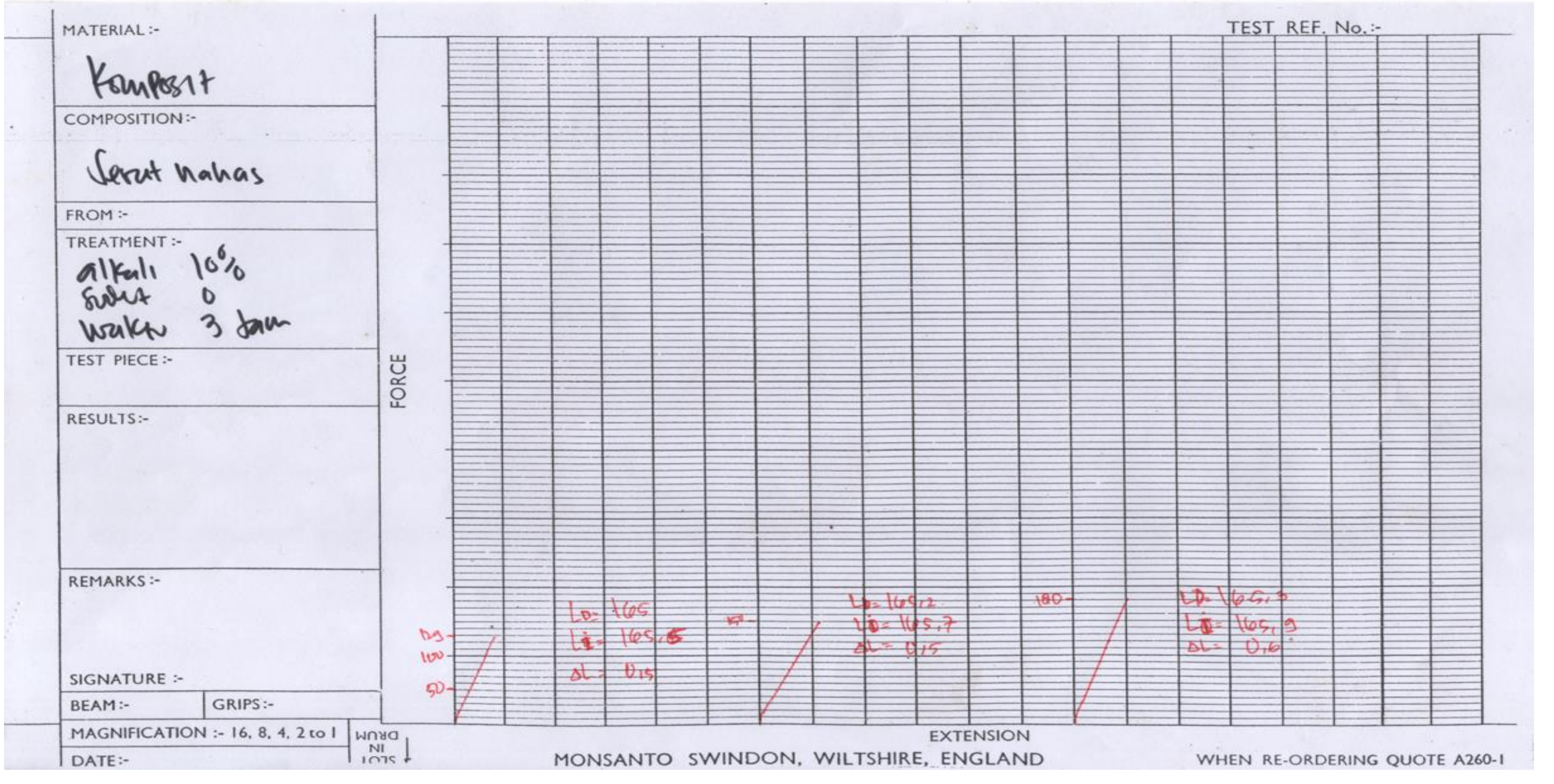


Figure 69. Tensile Test Curve of 10% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 0^0 Time 3 hours

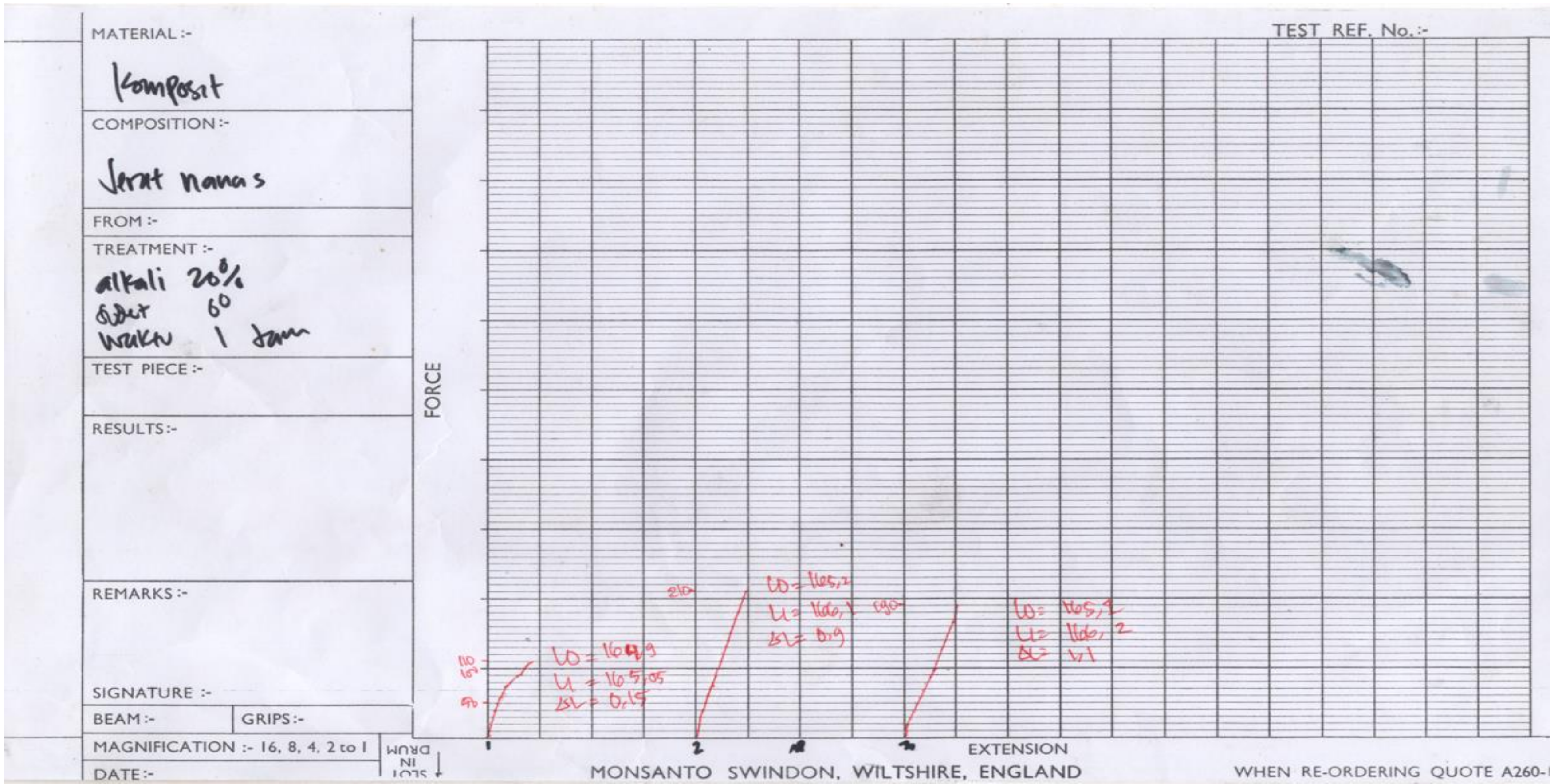


Figure 70. Tensile Test Curve of 20% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 0^0 Time 1 hour

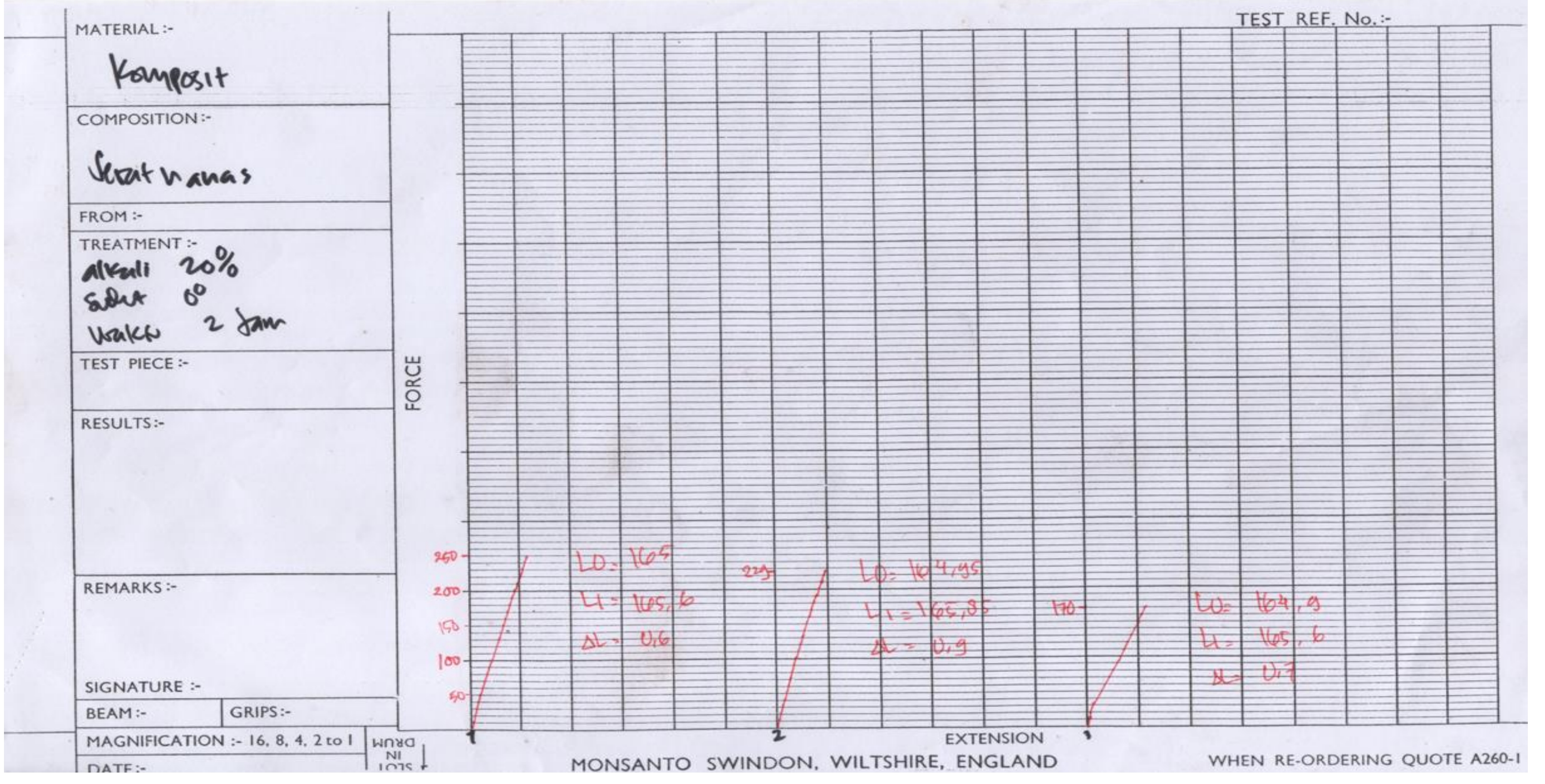


Figure 71. Tensile Test Curve of 20% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 0^0 Time 2 hours

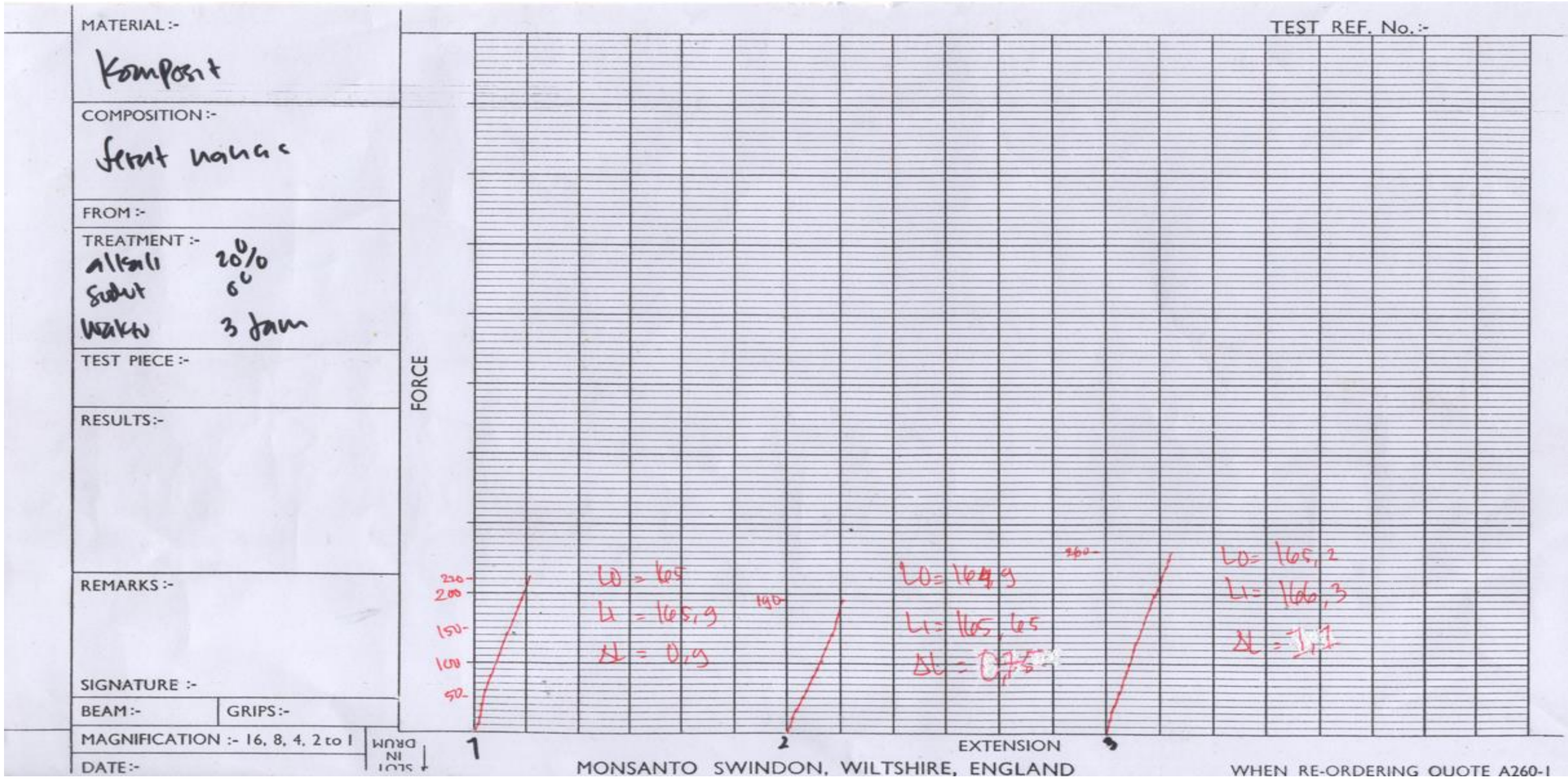


Figure 72. Tensile Test Curve for Alkali Pineapple Leaf Fiber Composite Specimen 20%, Angle 0^0 Time 3 hours

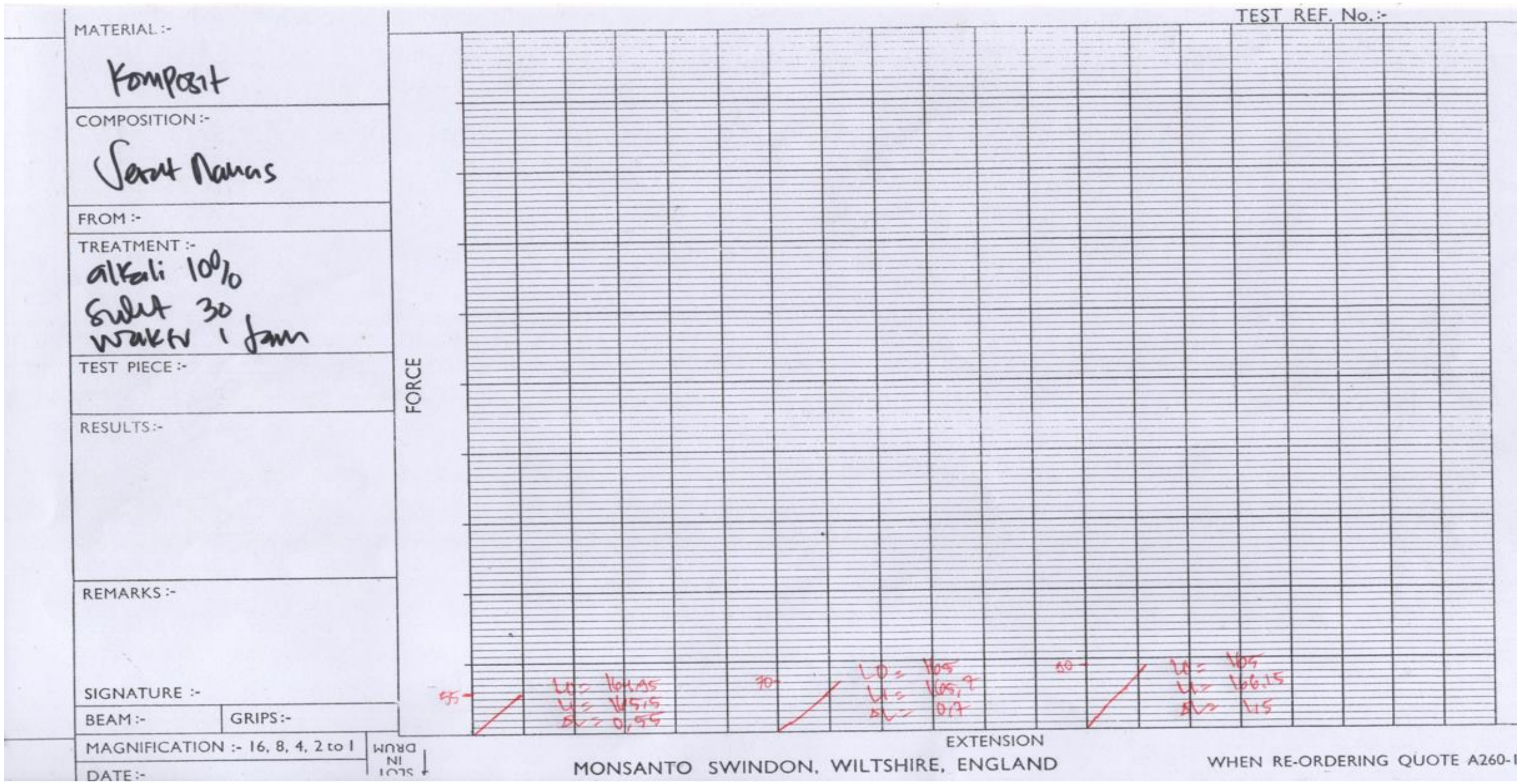


Figure 73. Tensile Test Curve of 10% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 30^0 Time 1 hour

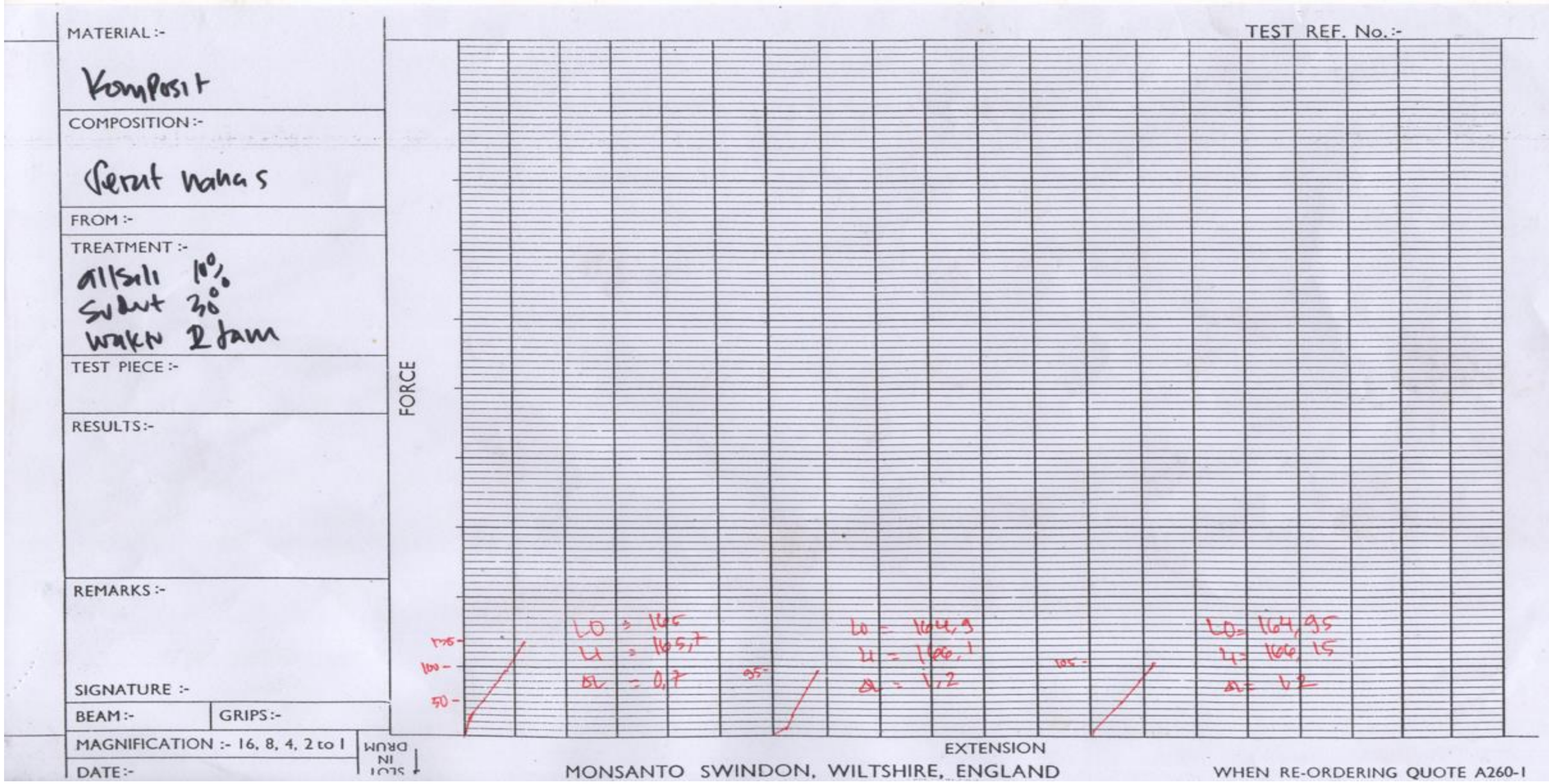


Figure 74. Tensile Test Curve of 10% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 30^0 Time 2 hours

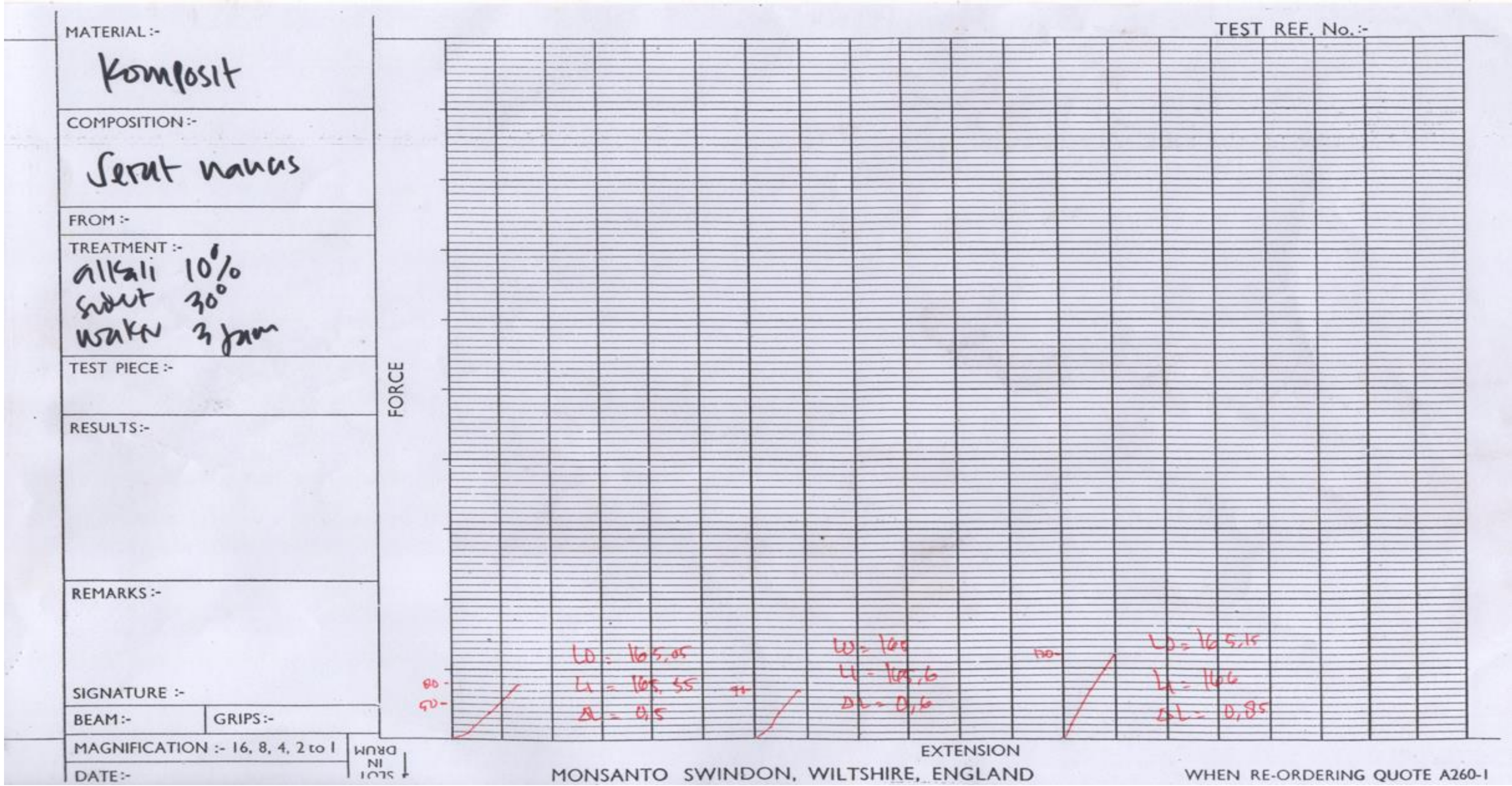


Figure 75. Tensile Test Curve of 10% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 30^0 Time 3 hours

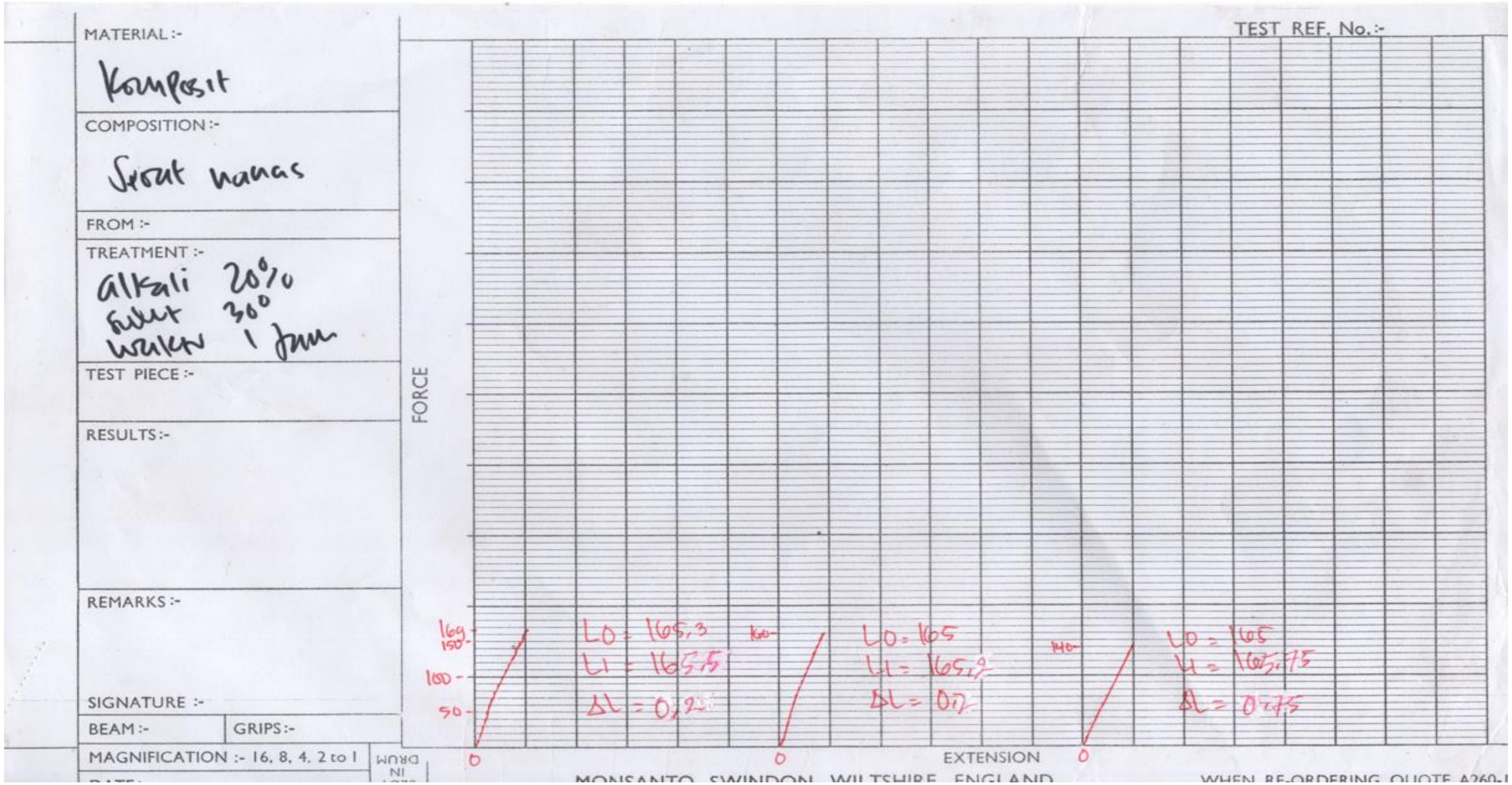


Figure 76. Tensile Test Curve of 20% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 30^0 Time 1 hour

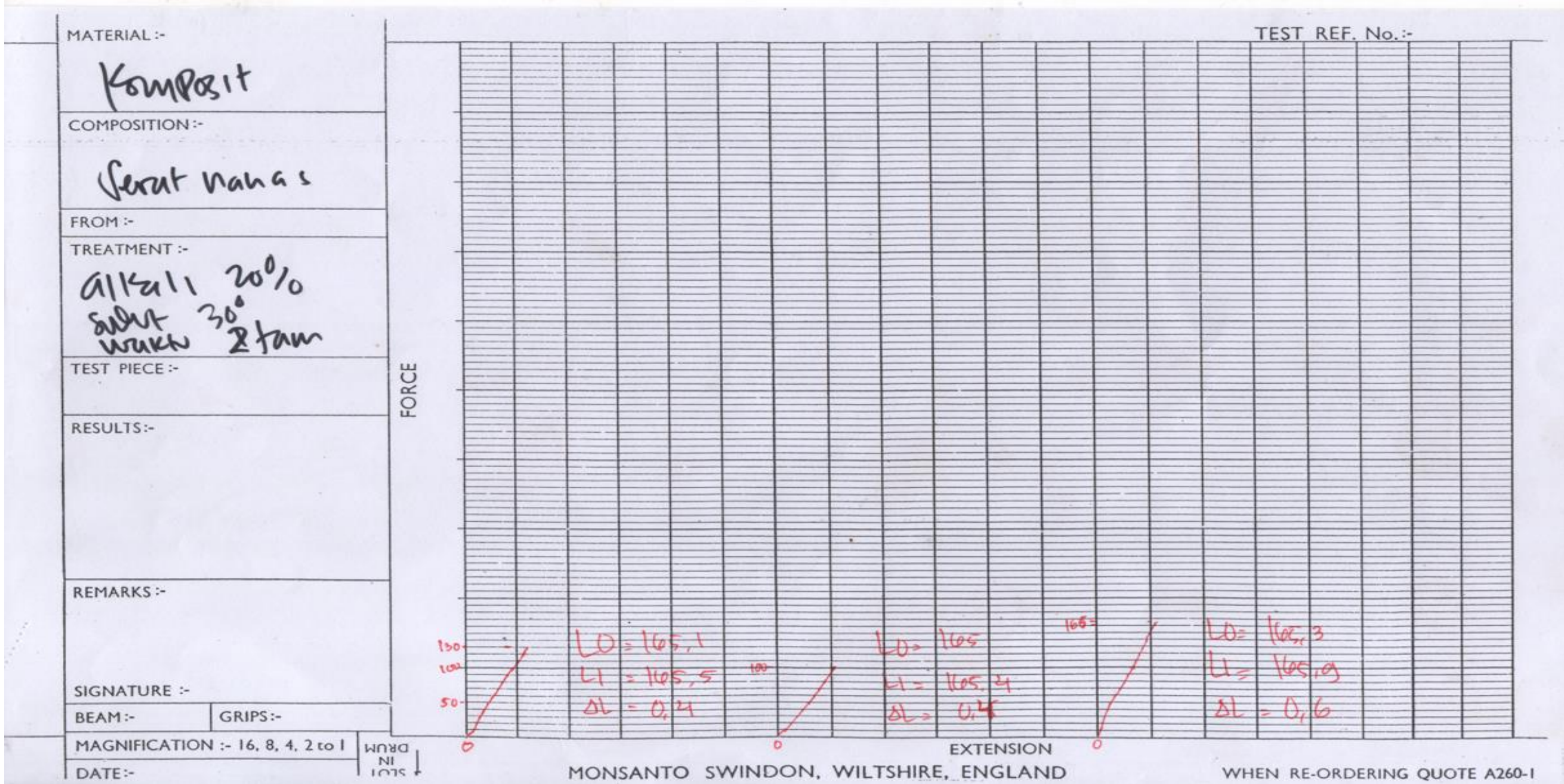


Figure 77. Tensile Test Curve of 20% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 30^0 Time 2 hours

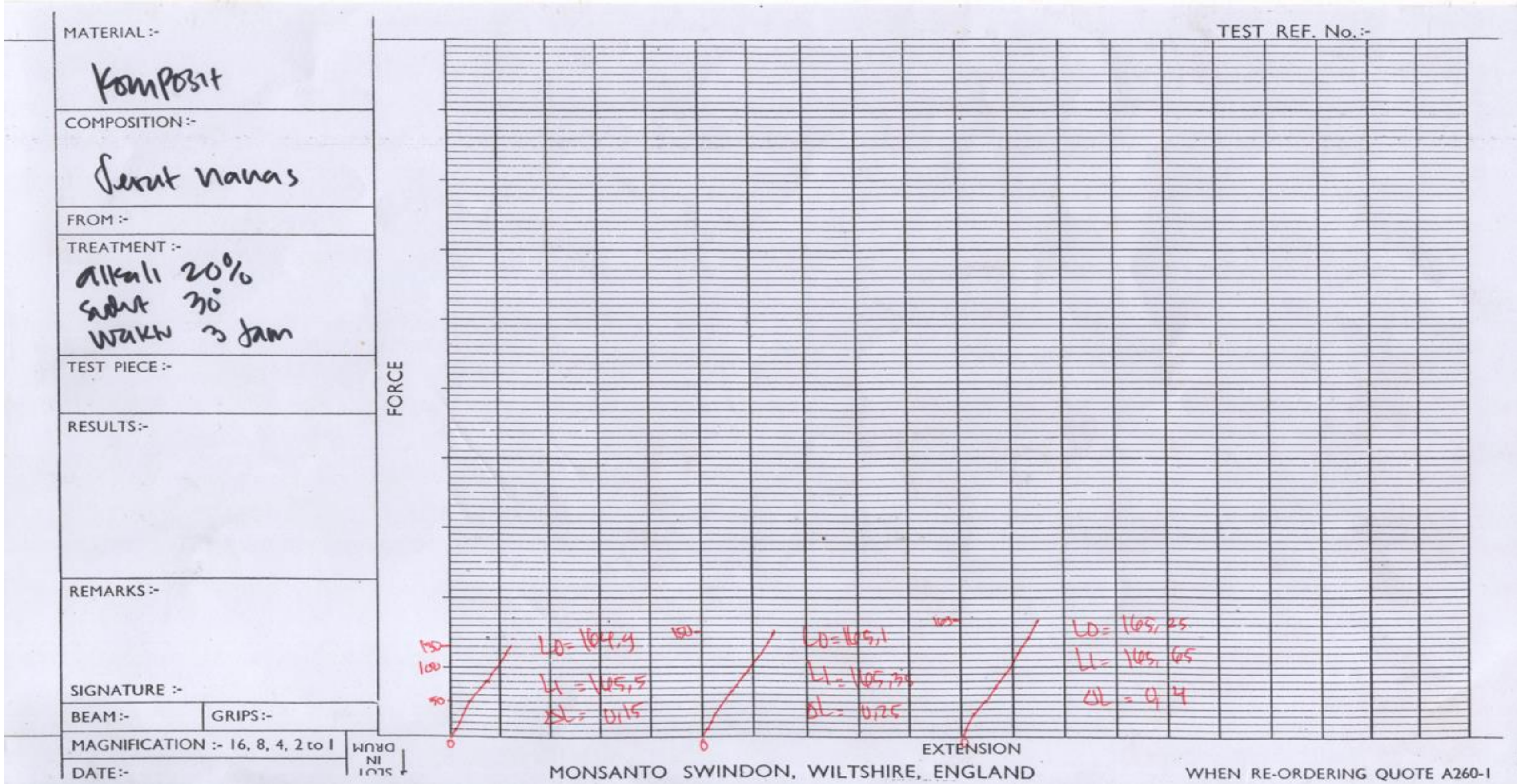


Figure 78. Tensile Test Curve of 20% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 30^0 Time 3 hours

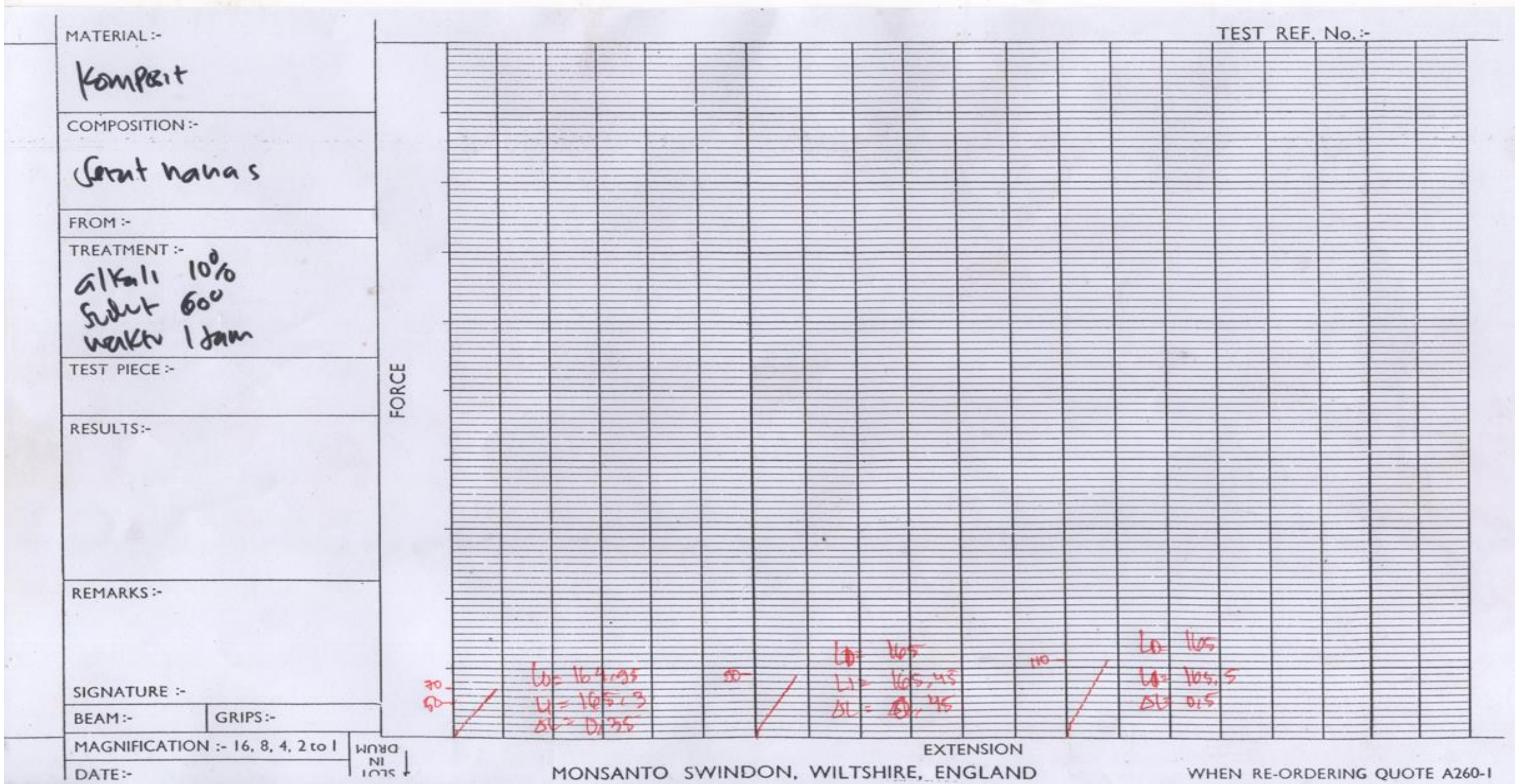


Figure 79. Tensile Test Curve of 10% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 60^0 Time 1 hour

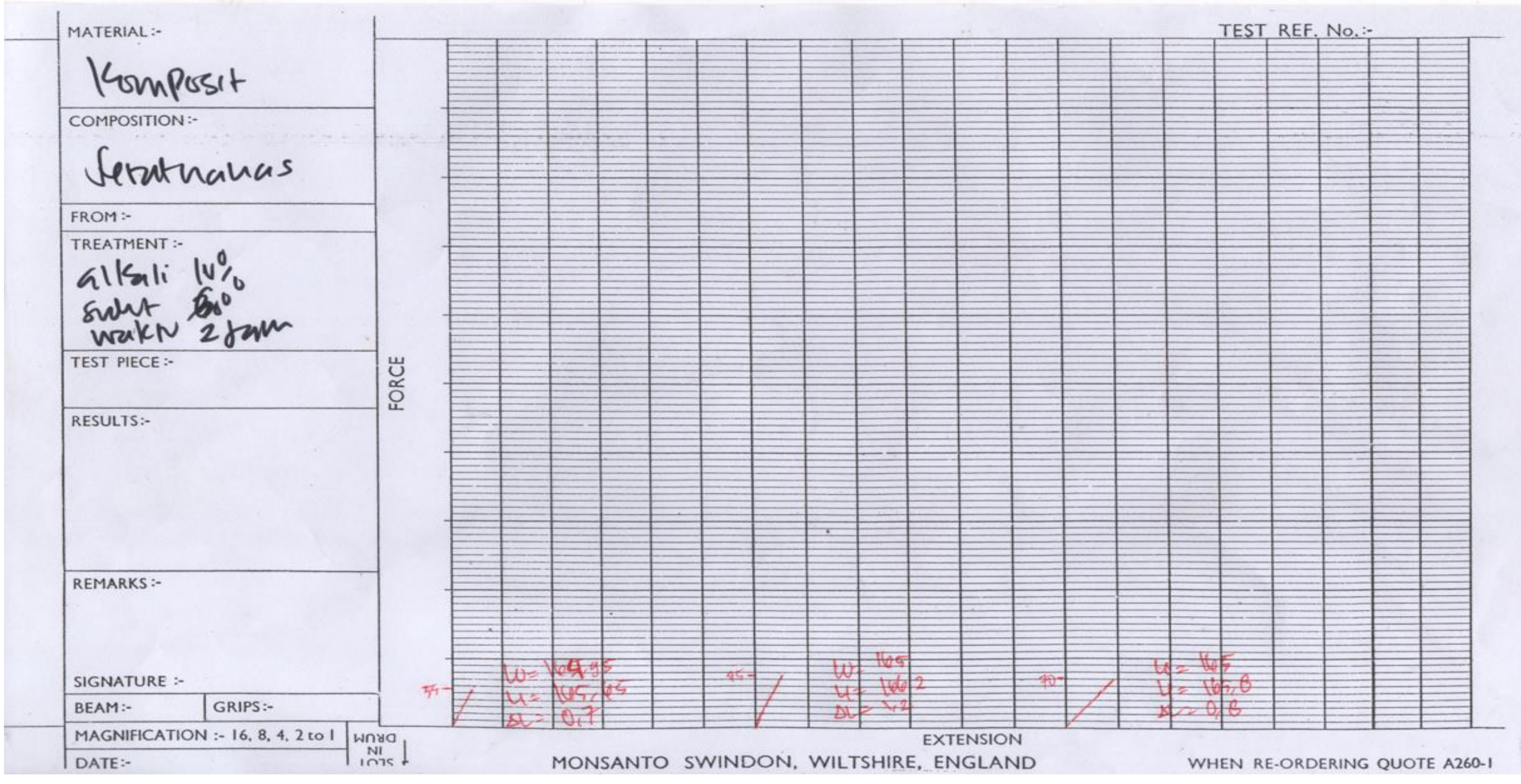


Figure 80. Tensile Test Curve of 10% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 60^0 Time 2 hours

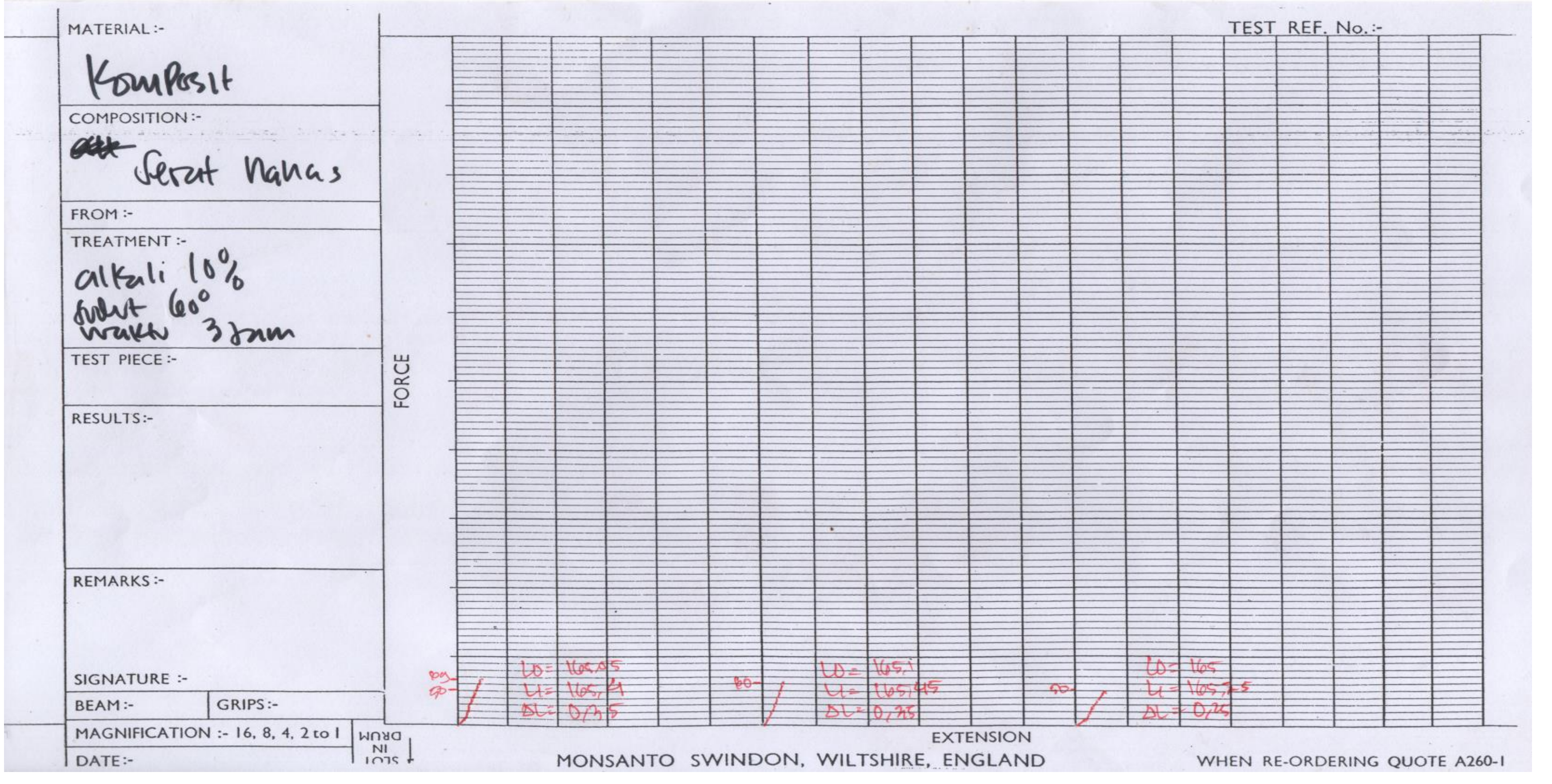


Figure 81. Tensile Test Curve of 10% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 60^0 Time 3 hours

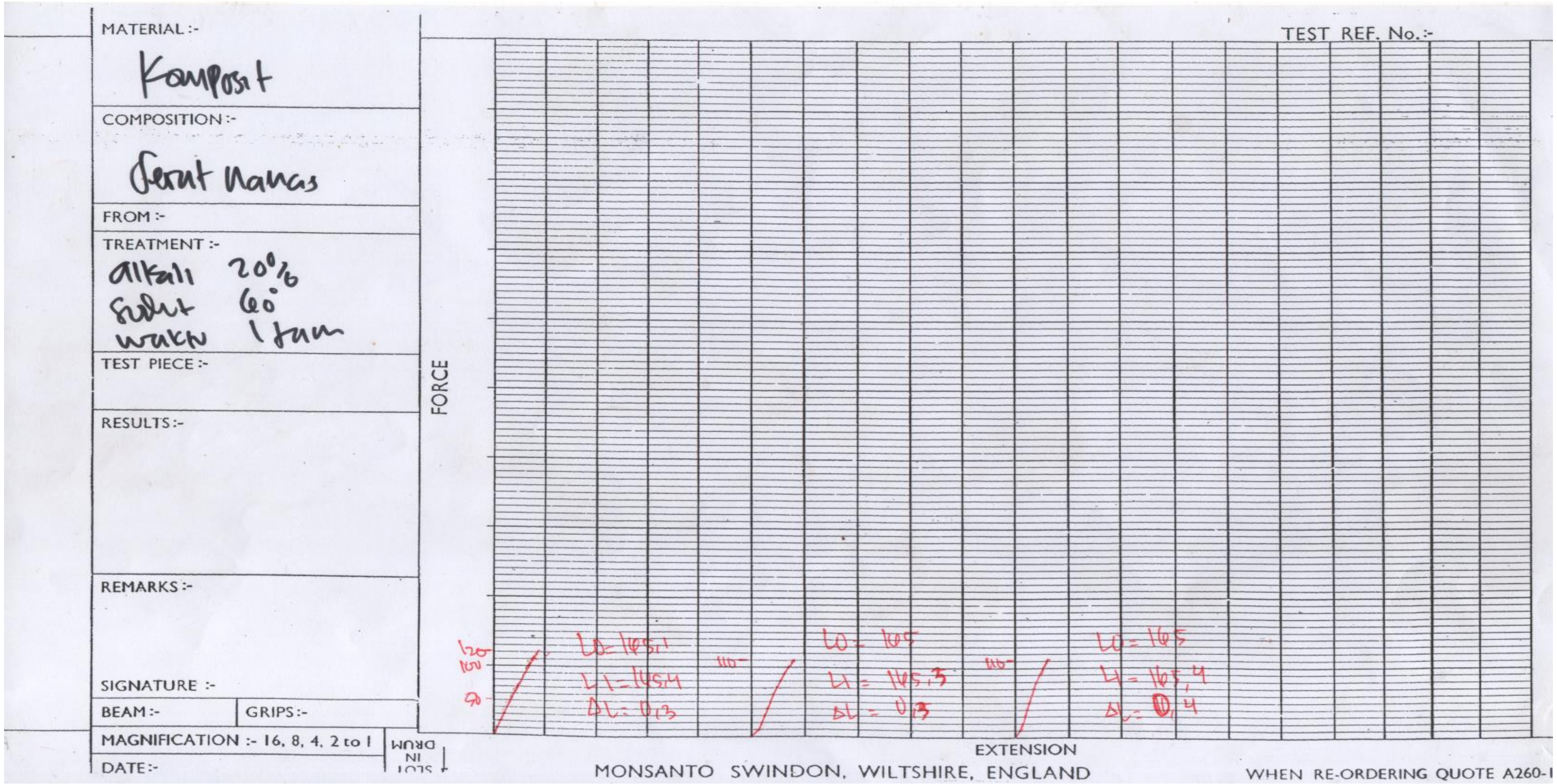


Figure 82. Tensile Test Curve of 20% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 60^0 Time 1 hour

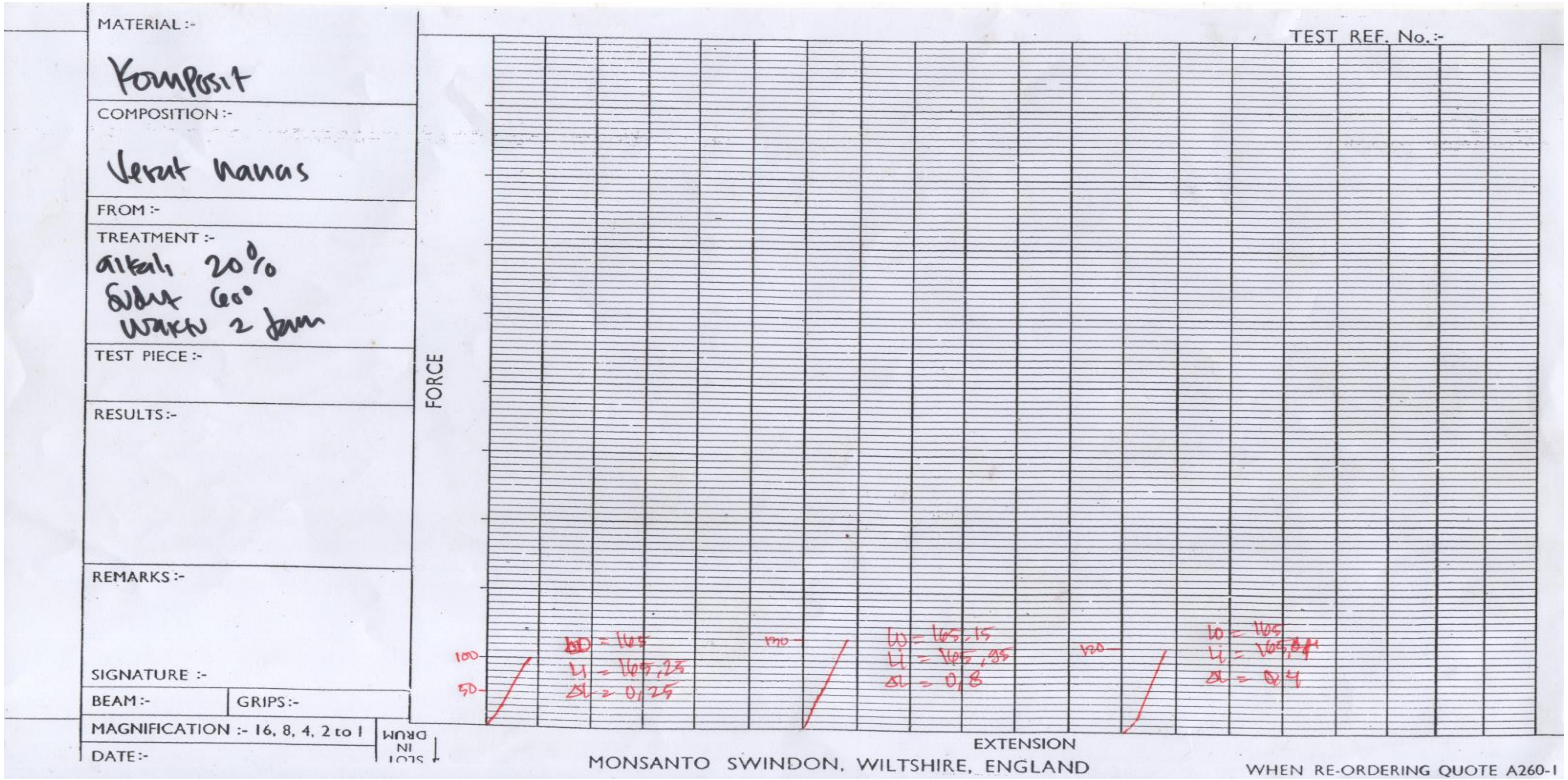


Figure 83. Tensile Test Curve of 20% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 60^0 Time 2 hours

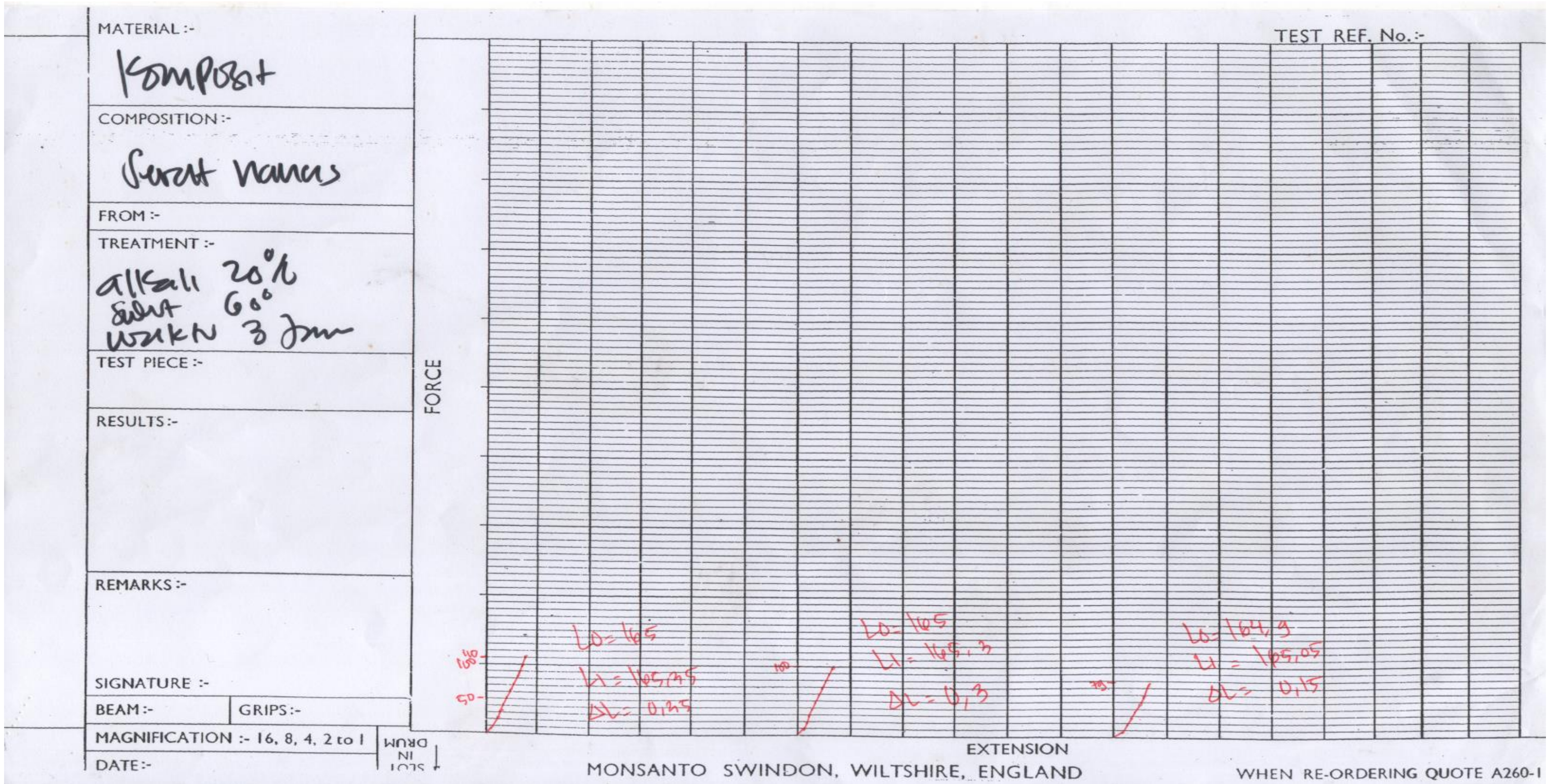
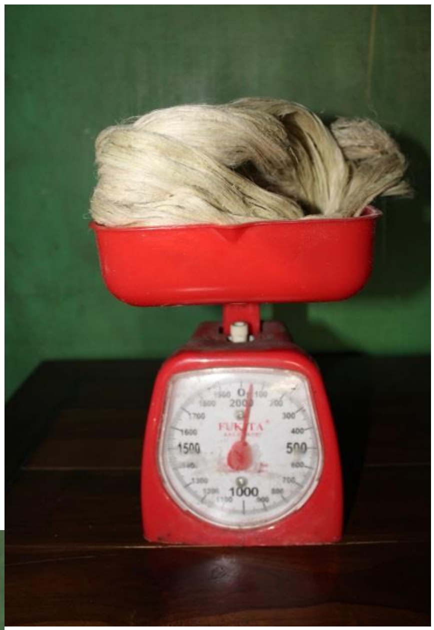
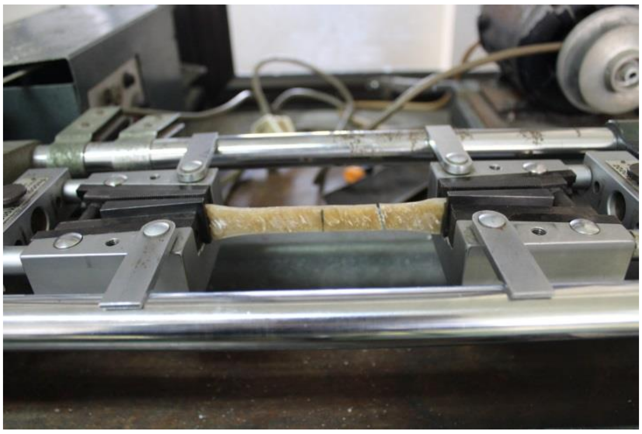


Figure 84. Tensile Test Curve of 20% Alkali Pineapple Leaf Fiber Composite Specimen, Angle 60^0 Time 3 hours

Attachment 12: Documentation of the Pineapple Leaf Fiber Reinforced Composites Process and Testing




MIRROR GLAZE



Attachment 13: Thesis Approval Sheet

HALAMAN PERSETUJUAN SKRIPSI

Pengaruh Perlakuan Alkali terhadap Sifat Mekanik Material Komposit Serat Daun Nanas

Nama	**: M. Febriyan Baruna Putra**
NIM/BP	**: 16067091/2016**
Jurusan	**: Teknik Mesin**
Program Studi	**: (S1) Pendidikan Teknik Mesin**
Fakultas	**: Teknik**

Padang, September 2020

Disetujui oleh:
Dosen Pembimbing

Acc u/sidang
21 September 2020

Delima Yanti Sari, S.T., M.T., Ph.D.
NIP. 19780114 200312 2 003

Mengetahui,

Ketua Jurusan Teknik Mesin

Drs. Purwantono, M.Pd
NIP. 19630804 198603 1 002

ii

Attachment 14: Application Letter for Labor and Equipment

Hal : ***Permohonan Pemakaian Labor dan ALat***

Kepada Yth.
Kepala Laboratorium Material dan Metrologi
Bapak Budi Syahri, S.Pd., M.Pd.T
di
Tempat

Dengan hormat,

Sehubungan dengan penelitian kami mahasiswa Program Studi Pendidikan Teknik Mesin FT-UNP dengan nama tersebut dibawah ini:

Nama	: M. Febriyan Baruna Putra 16067091 / 2016
Jurusan/Prodi	: Pendidikan Teknik Mesin / S1
No. Hp	: 0821 7642 2630
Judul Skripsi	: **"*Pengaruh Perlakuan Alkali terhadap Sifat Mekanik Material Komposit Serat Daun Nanas*"**

Dengan ini bermaksud untuk meminta izin kepada bapak agar dapat kiranya menggunakan fasilitas Laboratorium Material dan Metrologi di Jurusan Teknik Mesin FT-UNP.

Demikianlah surat ini disampaikan, atas perhatian dan bantuan Bapak kami ucapkan terima kasih.

Mengetahui
Pembimbing Skripsi,

Delima Yanti Sari, S.T., M.T., Ph.D
NIP. 19780114 200312 2 003

Padang, 29 Juni 2020
Mahasiswa ybs,

M. Febriyan Baruna Putra
NIM/BP. 16067091/2016

3/Juli/20
Budi Syahri
Pak Rismal tolong di bantu
Mahasiswa tsb. untuk
Penelitian dan terapkan
protokol covid-19

Attachment 15 : Consultation Sheets

KEMENTERIAN RISET, TEKNOLOGI DAN PENDIDIKAN TINGGI
UNIVERSITAS NEGERI PADANG
FAKULTAS TEKNIK
JURUSAN TEKNIK MESIN
Alamat: Jl. Prof. Dr. Hamka, Kampus UNP Air Tawar, Padang 25131
Telp. (0751) 7055644, 445118 Fax (0751) 7055644, 7055628
website: www.ft.unp.ac.id e-mail: info@ft.unp.ac.id

LEMBARAN KONSULTASI
SKRIPSI/~~PROYEK AKHIR*~~)

Nama : M. Ferryan Baruna Putra
NIM/TM : 16067091 / 2016
Prog. Studi : Pendidikan Teknik Mesin
Pembimbing : 1. Delima Yanti Sari, S.T., M.T., Ph.D.
2. ....
Judul : Pengaruh Perlakuan Alkali terhadap Sifat Mekanik Material Komposit Serat Daun Nanas.

No	Hari, Tanggal	Uraian Konsultasi	T. Tangan Pembimbing
1.	Senin, 2 Desember 2019	Cari jurnal, buku tentang material komposit. Buat rancangan pelaksanaan kegiatan	
2.	Kamis, 5 Desember 2019	Latar belakang tambah penjelasan dan referensi. Identifikasi masalah, batasan masalah, dan variasi variabel harus berkaitan dengan latar belakang. Perubahan kalimat pada judul.	
3.	Selasa, 10 Desember 2019	Bab I revisi kalimat pada latar belakang. Bab II tambah referensi pada alkali. Bab III flow chart, tabel dan jadwal penelitian diperbaiki	

No	Hari, Tanggal	Uraian Konsultasi	T. Tangan Pembimbing
4.	Kamis, 12 Desember 2019	Tambahkan Teori ketangguhan dan tabel area harus dibawah kurva Uji tarik regangan tegangan.	
5.	Selasa, 17 Desember 2019	Perbaiki gambar Variasi orientasi arah serat dan kalimat yang tidak sesuai pada setiap paragraf	
6.	Kamis, 19 Desember 2019	Tambah sub bab materi serat alam dan sifat mekanik. Pemberian kesimpulan pada penelitian yang relevan dan perbaikan kalimat.	
		Perbaikan setelah seminar:	
7.	Jumat, 8-5-2020	Perbaiki daftar penulisan pustaka sesuai dengan abjad. Perbaiki Bab I, Bab II, Bab III	
8.	Senin, 29-6-2020	Perbaiki serta tambahkan bukti rujukan pada proposal sesuai dengan penelitian yang relevan.	

No	Hari, Tanggal	Uraian Konsultasi	T. Tangan Pembimbing
9.	Rabu, 15-7-2020	Perbaiki kalimat pada bab IV dan tambahkan referensinya	
10.	Senin, 24-8-2020	Tambahkan teori-teori pendukung terhadap hasil penelitian	
11.	Selasa, 1-9 2020	Gambar grafik diperbaiki disesuaikan dengan hasil penelitian. Ubah bentuk grafik yang lebih mudah dibaca	
12.	Kamis, 3-9-2020	Perbaiki kalimat setelah gambar grafik, serta tambahkan teori pendukung lainnya.	
13.	Jumat, 4-9-2020	Perbaiki kesimpulan pada bab V	

No	Hari, Tanggal	Uraian Konsultasi	T. Tangan Pembimbing
14.	Senin, 7-09-2020	Perbaiki Lampiran serta halaman	
15.	Senin, 14-09-2020	Tambahkan kembali teori pendukung serta perbaiki tata tulis kalimat	
16.	Senin, 28-9-2020	Tambahkan saran dan perbaiki kalimat pada bab IV dan bab V. ACC kompre.	