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# Tensile Strength of Coconut Coir Fiber Composite as an Alternative Material to Replace Fiberglass in Hard Socket

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**ABSTRACT** Physically disabled is someone who has a movement system disorder or has physical abnormalities such as amputation, withering, stiffness, and others. The self-confidence of someone who has an amputee can be improved by having a prosthesis made, because it can replace the anatomical and functional functions of the body. The socket on the prosthesis is the most important component, because the use of the socket on the prosthesis is directly related to the patient's stump. One of the materials for making socket prosthesis is fiberglass. However, the use of fiberglass has a negative effect, namely it produces gas and dust emissions that can irritate stumps, is not a local product, and is difficult to recycle. Alternative fiber materials are using fibers from nature, coco fiber is an option as an alternative to fiberglass. The tensile strength test is the most basic test. The tensile strength test was carried out to determine the stress, strain, and elastic modulus of the fibrous polymer composites. The purpose of this study was to analyze and compare the tensile strength between fiberglass and coconut coir fiber, so as to find out which fiber material is suitable as an alternative to fiberglass in the manufacture of socket prosthesis. Using experimental quantitative methods. The composite material uses coconut coir fiber which was previously treated with 5% NaOH for 1 hour and then dried for 2-3 days. In the fabrication process using the vacuum bag method. Standard specimen refers to ASTM D3039/3039M. Tensile testing showed that the average tensile strength value of the coco fiber composite was 16.2 MPa and the average tensile strength value of the fiberglass composite was 30.2 MPa. This means that the value of the tensile strength of coco fiber is still below fiberglass and cannot be used as a substitute for fiberglass. However, coconut coir fiber can be used as an alternative to fiberglass, judging from the average maximum force that the coco fiber composite can withstand, which is 2630 N or equivalent to a load of 263 kg, this value is sufficient for the average adult weight in Indonesia with an average weight of 60 kg body.

**INDEX TERMS** tensile strength, fiberglass, coconut fiber, socket prosthesis.

## I. INTRODUCTION

Every human being has advantages and disadvantages of each. Deficiencies in every human being are different, some have deficiencies in the form of physical limitations, some have deficiencies spiritually, and many more. Everyone who experiences physical and/or spiritual limitations is referred to as a person with a disability. Disability is a limitation on one's activities and restrictions on participation determined by interactions between structural disturbances in the body, bodily functions and other limitations [1].

Health workers who treat persons with disabilities must know the strategies for changing the behaviour of persons with disabilities, and be able to implement these strategies in order to help patients to be active. Health workers must be able to program strategies for increasing activity in the patient's daily activities so that they can have an increased quality of life [2]. Physical disability or commonly referred to as physically disabled is a person who has impaired body movement systems or has physical abnormalities such as amputation, wilting, stiffness, and others. A person who has a movement system disorder can affect his anatomical, physiological and psychological functions. A person's psychological self-image can be influenced by the person's physical condition. Self-image related to physical changes, poor physical assessment, depression after trauma. the cause of the many obstacles experienced by persons with disabilities lies in their decreased self-confidence due to their disability. the competent authorities are also unable to make policies that can support persons with disabilities to be more confident [3]. leg amputation has a negative impact on body image and the quality of life of patients who experience amputations, especially the lower limbs [4]. Increased self-confidence was seen in amputees who had used the prosthesis for one year as the activities that could be performed increased [5]. Prosthesis is a device that replaces a lost limb, a prosthesis can replace lost body functions and work together with the remaining limbs [6]. Prostheses with fiber materials have been widely used, including prostheses used for cycling sports activities. [7]. amputee patients have increased their daily activities by getting used to wearing a prosthesis [8]. By using a prosthesis, amputee patients can improve their dynamic balance while walking [9].

The prosthesis consists of several components, the socket on the prosthesis is the most important component, because the use of the socket on the prosthesis is directly related to the patient's stump. Prosthesis sockets are usually made using laminated materials, namely resin, catalyst, and stockinet with carbon fiber or fiberglass reinforcement [10]. Fiberglass is one of the synthetic fibers that is widely used in the manufacture of composites today, because it is a strong and sturdy material. However, the use of fiberglass has a negative effect, namely it produces gas and dust emissions that can irritate the stump, is not a local product, and is difficult to recycle. [10]. The hard socket prosthesis fabrication process uses the lamination method by stacking several layers of material, then resin is added to the material that has been prepared and assisted by a vacuum machine so that the resin can be evenly distributed, reducing voids, and the surface becomes flat [11].

The need for fiber replacement materials for reinforcement in making sockets for prostheses, namely using resin and fiber, fiber replacement is expected to come from plants which can be an alternative replacement needed [12]. The fiberglass-reinforced resin composite used in the manufacture of sockets aims to make the socket strong, durable and sturdy. Alternative materials that will be used as a substitute for fiberglass must have the same goal. Alternative fiber materials are using fibers from nature, fibers from nature that are used come from plants. The advantages of plant fiber are that it is sturdy, recyclable, cost effective, low waste, and is a renewable resource [10]. Mechanical and vibrational characteristics of laminated cotton fiber fabrics polyester hybrid composites have been studied with various fiber volumes glass. The manufacture of laminated composites is easy to do with low production costs [13]. Indonesia is rich in natural resources, especially plants. According to the Central Bureau of Statistics, Indonesia will produce 2.853 million tonnes of coconut in 2021. Indonesia is also the world's largest coconut producer. Many can be utilized from coconut, coconut coir fiber is one of them. the use of coir coconut fiber has been widely used in several products, the effect of coconut coir fiber has been known to have bio-composite mechanical properties. Natural fiber composites have mechanical properties that can be used as an alternative to glass fiber composites [14].

Composites reinforced with natural coconut coir fiber have shown higher fracture toughness and better mechanical properties when compared to pure polypropylene [15]. As a composite material for making prosthesis sockets, coconut coir fiber also does not cause irritation to the stump. Another advantage of coconut coir fiber is that it has pharmacological effects with low toxicity, not stiff, very flexible, most ductile, strong, light, heat resistant, salt water resistant, weather resistant, cheap and easy to obtain. [16]. The strength of a polymer composite can be determined by carrying out tests according to applicable testing standards. The tensile strength test is the most basic test. The tensile strength test was carried out to determine the stress, strain, and elastic modulus of the fibrous polymer composites [17].

Results of the analysis of tensile testing on coco fiber composites produced an average tensile strength of 9.73 MPa. These results cannot replace fiberglass as fiber in hard prosthesis. However, in this study there are still some shortcomings. In the manufacture of hard socket prostheses not only use fiber reinforcement but also stockinet layers, with fibers between the stockinet layers. When making composites the researcher uses the hand layup method, there is another method for making composites, namely the vacuum bag method with an excess matrix that can be more evenly distributed and can minimize trapped air during the lamination process. [18].

In the research entitled "Tensile Properties, Bending, and Impact of Coconut Coir Fiber-Polyester Composites with Volume Fraction Variations" [19]. The purpose of this study was to determine the effect of volume fraction of coconut coir fiber on the tensile properties, bending properties, and impact toughness of composites with a polyester matrix, MEKPO catalyst and NaOH. The tests carried out were tensile, bending and impact tests (D5941). Based on the research data, composite materials with a fiber volume fraction of 30% are able to obtain optimal strength. In this study, it was not stated what percentage of alkali was used and the soaking time, as well as the place where the research was conducted. The difference with the research that will be carried out by researchers lies in the fabrication technique of the test material and the laminate structure of the test material. It is using a press molding method fabrication technique on steel plates and there was no stockinet layer on the laminate structure [19]. Meanwhile, in this study using the vacuum bag method fabrication technique and using stockinet layers.

In research entitled "Sodium Hydroxide and Potassium Permanganate Treatment on Mechanical Properties of Coconut Fibers" [20]. The purpose of this study was to determine the tensile stress and interfacial shear stress of coco fiber treated with Sodium Hydroxide (NaOH) and Potassium Permanganate (KMnO4). The duration of the fiber treatment with NaOH was 3 hours, then the treatment with KMnO4 was continued for 3 hours, then the fiber was dried on the furnace at 90°C for 5 hours. The tests carried out are testing the tensile strength or tensile stress and shear stress. The difference with the research that will be carried out by the researcher is the method of testing the test material and the type of treatment that will be given to the coco fiber. Coco fiber were treated with NaOH and KMnO4 [20]. Meanwhile, in this study giving fiber treatment using only NaOH.

In the research entitled "The Effect of Alkalization of Coconut-Polyester Fiber Composites on Tensile Strength". The purpose of this study was to analyze the effect of alkaline treatment on the tensile strength and strain of coconut fiber composites with a polyester matrix with variations in NaOH concentrations of 0%, 2%, 5%, and 8%. The duration of treatment was 1 hour and then dried at room temperature for 8 hours. The test carried out is tensile strength. The difference with the research that will be carried out by researchers is the fabrication method of the test material and the structure of the laminated test material. It was using the wet hand lay up fabrication method and did not use stockinet as reinforcement in the composite structure. Meanwhile, in this study using the vacuum bag fabrication method and using a stockinet as a reinforcement in the composite structure.

The research entitled Effect of Different Fiber Reinforcements on Some Properties of Prosthetic Socket showing that the use of composite reinforcement with fiber reinforcement has an effect on composite properties (hardness, surface roughness, and density) with an increase in the volume fraction of the best material and composite. the specimens used were three layers of ramie with two layers of carbon fiber, hardness properties ranging from 86 MPa and density (1.276 gm./cm3)[21] .

Based on the background described above, the researcher is interested in conducting research on the use of coco fiber as an alternative material for fiberglass in composites in the manufacture of hard socket prosthesis in terms of the tensile strength of the composite. there are some differences in the procedure for making specimens compared to previous studies, those are: (a) The fabrication of specimen method is using the similar method in making prostheses socket. So that the expected test results on the specimen used are in accordance with the procedures performed when making a prosthetic socket so that the precision factor like the original socket can be obtained. (b) in this study we are giving fiber treatment using only NaOH. (c) in this study we are using the vacuum bag fabrication method and using a stockinet as a reinforcement in the composite structure.

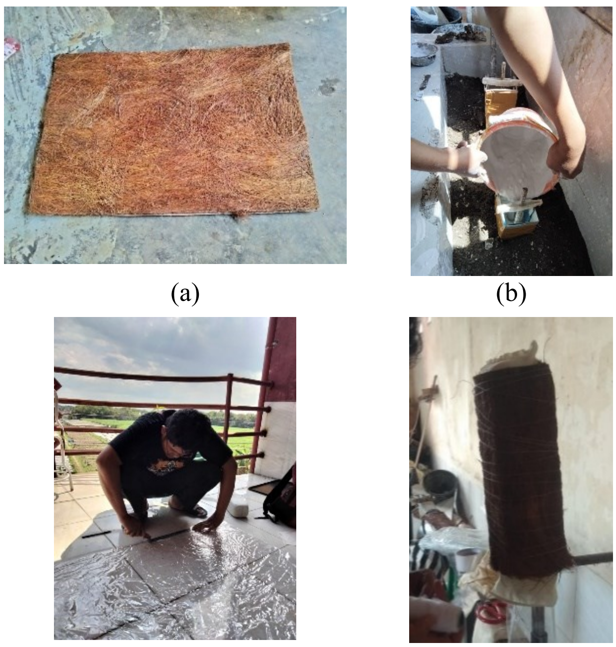
## II. MATERIALS AND METHODS

The type of research used in this research is experimental analysis using quantitative methods. The experiment was carried out in the form of making composites using coco fiber as reinforcement and composites using fiberglass as reinforcement, then tensile testing was carried out, the results of the tensile testing would be compared between the two. As the determination of a good reinforcement for the manufacture of hard socket prosthesis. The place for the fabrication of the test material is carried out at PT. Kuspito False Legs. Meanwhile, the tensile test for the test material was carried out at the Laboratory of Center for Excellence in Plastic Technology (PUT-P) ATMI Surakarta Polytechnic using the Universal Testing Machine (Zwick Z020 pre load 50 N, test speed 2 mm/min from Germany).

### *A. DATA COLLECTION*

#### 1. LITERATURE STUDY AND FIELD SURVEY

Literature studies are carried out with the aim of identifying and deepening the problems encountered, and can be used as a preparation of work plans to be carried out. Field surveys were carried out with the aim of determining places that could be used for research, as well as taking existing research data as a comparison with the results to be analyzed.



(a) (b) (c) (d)

**FIGURE 1. (a) Coconut Fiber Sheet, (b) Process of making positive models, (c) Coconut Fiber Sheet, and (d) Installation process of coconut fiber.**

#### 2. COCONUT FIBER PROCESSING

Coconut coir fiber is sorted and then cleaned. Then clean fiber soaked in 5% NaOH for 1 hour. After that the fiber is

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dried at room temperature for 8 hours. Then the fibers are woven to form sheets. Coconut fiber sheet looks like in FIGURE 1 a.

## 3. PREPARATION OF COMPOSITE SPECIMENS

The first process is to make a mold using gypsum powder which is printed in the form of blocks. the process of making positive models is shown in FIGURE 1 b.. After the mold is finished, 1 pair of bags is made for the inner layer and outer layer using PVC (Polyvinyl Cloride) plastic which is adjusted to the size of the mold. Mounting the mold on the vacuum machine. The process of making a PVC cone as shown in FIGURE 1 c.Then a bag of PVC plastic is attached to the mold for the inner layer of the bag. Then 2 stockinet are paired after the PVC coating. After giving 2 stockinet then giving a layer of coconut fiber and tying it with thread so that it doesn't come off easily during the after process. coconut fiber installation process looks like in FIGURE 1 d. After giving 2 stockinet then giving a layer of coconut fiber then 2 layers of stockinet are attached before being attached to a layer of PVC as the outer layer of the bag. When installing PVC as an outer layer bag, the shoot tip and base are exaggerated, the base is to be tied with a vacuum machine pipe so that the air inside can be sucked in by a vacuum machine while the shoot tip is exaggerated to add resin using a funnel.

After everything is installed the next step is mixing the resin and catalyst, the catalyst used is 2% of the amount of resin. After the resin and catalyst are mixed, then pour it through the top hole that is given a funnel. Even out the resin that has been poured, evenly distributed throughout the composite parts. Closing the hole as the entrance of the resin earlier, then turn on the vacuum machine while leveling the resin. When leveling the resin, care must be taken so that the bag is not damaged and minimizes the appearance of voids. If the resin is evenly distributed and starts setting, turn off the vacuum machine then wait for it to completely set. The next stage is to draw a specimen dimension pattern according to ASTM D3039, then cut the pattern to form a specimen as seen in FIGURE 2. In the figure 5 the specimen 250 mm long, 20 mm wide and 1.5 mm thick. The results of cutting the specimen look like in FIGURE 3 a.

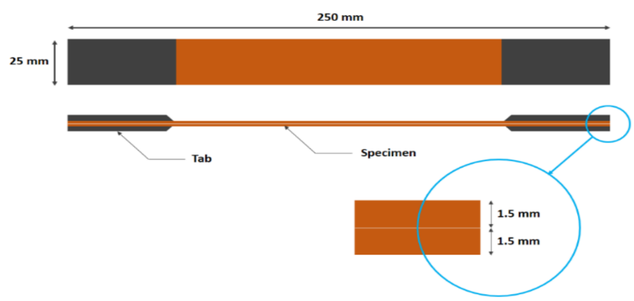
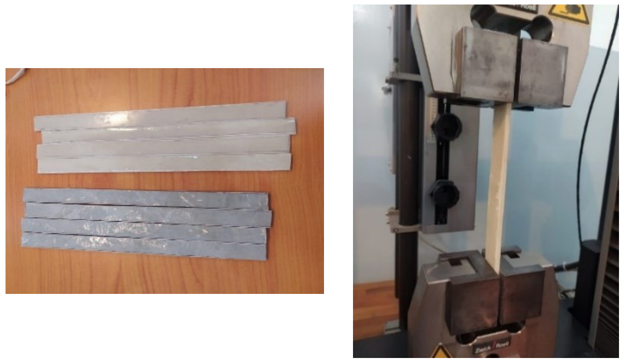



**FIGURE 2. Specimen Size by ASTM D3039 standard**

## 4. TENSILE TESTING

The tensile testing process was carried out using a Universal Testing Machine at the Laboratory of Center for Excellence in Plastic Technology (PUT-P) ATMI Surakarta Polytechnic with the process are measuring the specimen before the tensile test is carried out, testing the test material, and record the data results from testing the test material. The tensile testing process is shown in FIGURE 3 b.



(a) (b)

**FIGURE 3. (a) Specimen, (b) Testing the test material**

### *B. DATA ANALYSIS*

This study uses the ASTM (American Standard Testing and Materials) D3039 reference and simply uses the composite micromechanical formula, namely:

#### a. *TENSILE STRENGTH*

Tensile strength is obtained when the test material is subjected to a load or stress without causing damage to the test material, usually referred to as ultimate tensile strength. The tensile strength formula is σ=F/A. Where σ indicates tensile Stress (MPa). Then F is force (N). A is The initial cross-sectional area before being given a load or stress ($mm^2$).

#### b. *TENSILE STRAIN*

Strain is the difference between the final length of the test material and the initial length of the test material divided by the initial length of the test material and multiplied by the percentage [17]. The tensile strength formula is

$$\varepsilon = \frac{\Delta L}{L_0} \times 100\% \quad (1)$$

$$\varepsilon = \frac{\delta}{L_g} \quad (2)$$

$$\Delta L = L_1 - L_0 \quad (3)$$

where in equations ε indicates strain (%). ΔL is difference in final and initial length (mm). $L_0$ means initial length (mm). $L_1$ is final length(mm). δ shows extensometer displacement(mm) and $L_g$ is extensometer gage length (mm).

#### c. *MODULUS ELASTICITY*

The modulus of elasticity is used to measure the elastic resistance of the test material to deformation when it is given a force on the test material, by comparing the result or value of stress with strain. The modulus elasticity formula is $E=\sigma/\varepsilon$. Where E shows modulus elasticitys (MPa), $\sigma$ shows tensile strength or Tensile stress (MPa), $\varepsilon$ shows tensile strain (%). The experimental process is shown in the FIGURE 4 below.

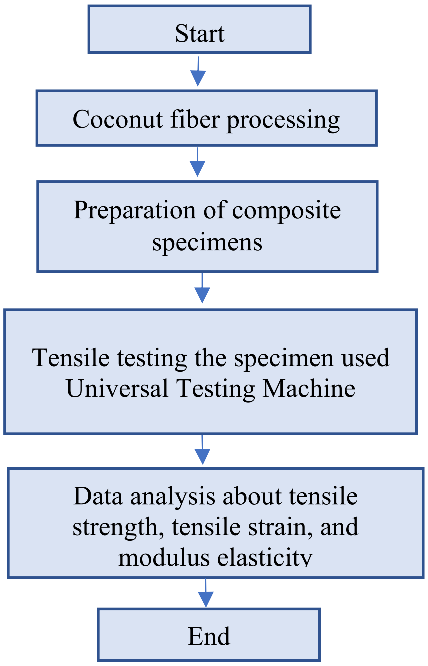



FIGURE 4. **Experimental process**

## III. RESULT

The tensile testing process was carried out using the Universal Testing Machine (Zwick Z020 pre load 50 N, test speed 2 mm/min from Germany) at the Laboratory of Center for Excellence in Plastic Technology (PUT-P) ATMI Surakarta Polytechnic.

### *A. RESULT OF TENSILE TEST*

1. COCONUT FIBER TENSILE TEST RESULT

*a. Tensile Stress Or Tensile Strength*

Tensile strength is obtained when the test material is subjected to a load or stress without causing damage to the test material, usually referred to as ultimate tensile strength.

TABLE 1
**Maximum tension of coco**

| No | Legend | Maximum Force (N) | Cross sectional Area ($mm^2$) | Maximum Stress (MPa) |
|---|---|---|---|---|
| 1 | | 2840 | 165,17 | 17,2 |
| 2 | | 2890 | 151,57 | 19,1 |
| 3 | | 2320 | 170,77 | 13,6 |
| 4 | | 2460 | 164,01 | 15,0 |

TABLE 1 shows that the greatest tensile stress of the coco fiber composite specimen is 19.1 MPa. Meanwhile, the lowest tensile stress is 13.6 MPa.

b. STRAIN

Strain is the difference between the final length of the test material and the initial length of the test material divided by the initial length of the test material and multiplied by the percentage[17].

TABEL 2
**Strain of coconut fiber**

| No | Legend | Difference in final and initial length (mm) | initial length (mm) | Strain (%) |
|---|---|---|---|---|
| 1 | | 1,65 | 27,62 | 6,0 |
| 2 | | 1,52 | 27,76 | 5,5 |
| 3 | | 1,21 | 27,02 | 4,5 |
| 4 | | 1,60 | 28,18 | 5,7 |

TABLE 2 shows that the largest strain of the coco fiber composite specimens is 6.0%. While the smallest strain is 4,5 %.

c. MODULUS ELASTICITY

Modulus is used to measure the elastic resistance of the test material to deform when it is given a force on the test material.

TABLE 3
**Modulus elasticity of coco fiber**

| No | Legend | Maximum Stress (MPa) | Strain (%) | Modulus Elasticity (MPa) |
|---|---|---|---|---|
| 1 | | 17,2 | 6,0 | 93,5 |
| 2 | | 19,1 | 5,5 | 80,6 |
| 3 | | 13,6 | 4,5 | 87,0 |
| 4 | | 15,0 | 5,7 | 78,3 |

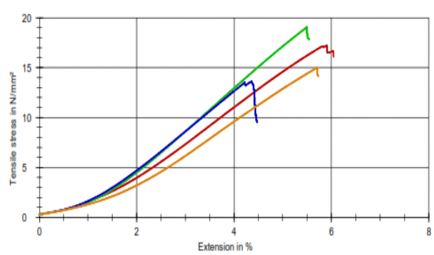



FIGURE 5. **Stress and Strain**

TABLE 3 shows that the largest value of the modulus of elasticity of the coco fiber composite specimens is 93.5 MPa. Meanwhile, the lowest elastic modulus is 78.3 MPa. The higher the value of the modulus of elasticity on the specimen, the less deformation that occurs when given a force. The higher the modulus value, the stiffer the object will be. FIGURE 5 shows a graph of stress and strain from the tensile strength test of four coco fiber composite specimens.

2. FIBERGLASS TENSILE TEST RESULTS

a. Tensile Stress or Tensile Strength

Tensile strength is obtained when the test material is subjected to a load or stress without causing damage to the test material, usually referred to as ultimate tensile strength.

TABLE 4

Maximum stress of fiberglass

| No | Legend | Maximum Force (N) | Cross sectional area (mm²) | Maximum stress (MPa) |
|---|---|---|---|---|
| 1 | | 3580 | 125,19 | 28,6 |
| 2 | | 4280 | 138,28 | 31,0 |
| 3 | | 3520 | 128,79 | 27,3 |
| 4 | | 4170 | 122,40 | 34,0 |

FIGURE 4. Coconut Coir Fiber Graphic

TABLE 4 shows that the greatest tensile stress of the fiberglass fiber composite specimen is 34.0 MPa. Meanwhile, the lowest tensile stress is 27.3 MPa.

b. Strain

Strain is the difference between the final length of the test material and the initial length of the test material divided by the initial length of the test material and multiplied by the percentage calister [17].

TABLE 5

Strain fiberglass

| No | Legend | Difference in final and initial length (mm) | Initial length (mm) | strain (%) |
|---|---|---|---|---|
| 1 | | 1,2 | 27,82 | 4,3 |
| 2 | | 1,3 | 27,88 | 4,6 |
| 3 | | 1,5 | 27,52 | 5,5 |
| 4 | | 1,4 | 26,96 | 5,2 |

TABLE 5 shows that the largest strain of the fiberglass fiber composite specimen is 5.5%. While the smallest strain is 4.3%.

c. Modulus Elasticity

The modulus of elasticity is used to measure the elastic resistance of the test material to deform when a force is applied to the test material

TABLE 6

Modulus of elasticity of fiberglass

| No | Legend | Maximum Stress (MPa) | Strain (%) | Modulus Elasticity (MPa) |
|---|---|---|---|---|
| 1 | | 28,6 | 4,3 | 233 |
| 2 | | 31,0 | 4,6 | 269 |
| 3 | | 27,3 | 5,5 | 137 |
| 4 | | 34,0 | 5,2 | 179 |

TABLE 6 shows that the largest modulus of elasticity of the fiberglass fiber composite specimens is 269 MPa. Meanwhile, the lowest elastic modulus is 137 MPa. The higher the value of the modulus of elasticity on the specimen, the less deformation that occurs when given a force. The higher the modulus value, the stiffer the object will be. FIGURE 6 shows a graph of stress and strain from the tensile strength test of 4 fiberglass fiber composite specimens.

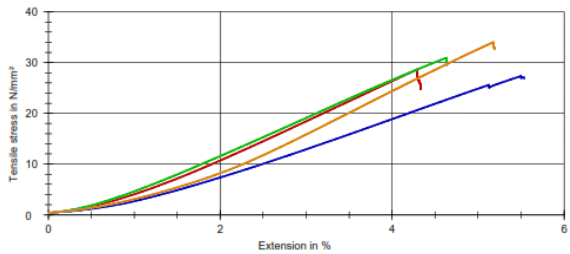



FIGURE 6. Stress and Strain

## B. DATA ANALYSIS

TABLE 7 shows that the average maximum force of the coco fiber composite specimens is 2630 N. The average maximum stress value is 16.2 MPa. The average strain value is 5.4%. The average value of the modulus of elasticity is 84.8 Mpa.

TABLE 7

Statistical data of coco fiber

| Series n = 4 | Force (N) | Strength (MPa) | Strain (%) | Modulus Elasticity (MPa) |
|---|---|---|---|---|
| x | 2630 | 16,2 | 5,4 | 84,8 |
| s | 280 | 2,41 | 0,7 | 6,86 |
| *v* [%] | 10,65 | 14,84 | 12,52 | 8,09 |

Where x indicates average, s shows standard deviation and *v* [%] indicates percentage deviation.

TABLE 8

Statistical data of fiberglass

| Series n = 4 | Force (N) | Strength (MPa) | Strain (%) | Modulus Elasticity (MPa) |
|---|---|---|---|---|
| x | 3890 | 30,2 | 4,9 | 205 |
| s | 392 | 2,94 | 0,5 | 58,2 |
| *v* [%] | 10,08 | 9,74 | 10,99 | 28,43 |

TABLE 8 shows that the average maximum force of the fiberglass fiber composite specimens is 3890 N. The average maximum stress value is 30.2 MPa. The average strain value is 4.9%. The average value of the elastic modulus is 205 Mpa.

## IV. DISCUSSION

Based on the results of the hypothesis test in this study by comparing the tensile strength value of the coco fiber composite with the fiberglass composite, the tensile strength of the coco fiber composite with an average value of 16.2 MPa could not exceed or match the tensile strength of fiberglass composites with an average value of average 30.2 MPa. This means that coconut coir fiber cannot be used as a substitute for fiberglass.

The hard socket on the prosthesis is an important part of a prosthesis because it is directly related to the patient's stump, so the selection of the material to be used when manufacturing needs to be considered. The use of fiberglass material in the hard socket prosthesis manufacturing process has several drawbacks because it can cause irritation and has stiff properties. The use of fiberglass which has deficiencies needs to be considered again by developing fibers that are used using substitute materials or alternatives such as natural fibers. One of the selected natural fibers is coco fiber because it has several advantages, namely pharmacological effects with low toxicity, not stiff, very flexible, most ductile, strong, light, heat resistant, saltwater resistant, weather resistant, cheap and easy to obtain **[16].**

The results obtained in this study cannot be used as a substitute for fiberglass, but coconut coir fiber can still be used as an alternative material in terms of the average maximum force that can be applied to coco fiber composite specimens, namely 2630 N, meaning that it can be given a load of 263 kg, this figure is large enough to support the average body weight of adults in Indonesia with an average weight of 60 kg. the body weight of Indonesian is 57.1 kg for male and 52.3 kg for female [22] and because coconut coir fiber has the characteristics of not being stiff, very flexible, the most ductile, and strong. However, it also has several drawbacks when it is made into a composite, namely the mass is heavier than fiberglass because it absorbs a lot of resin and the surface is not smooth because the fiber has a large diameter. In theory, it also says that the smaller the diameter of the fiber, the higher the strength value of the composite [17]. in line with other studies, which showed that the mechanical properties of CFR-HSC were better on 50 mm long coconut fiber and 1.5% fiber content and could be used in concrete structures [23].

The difference in tensile strength between coco fiber composites and fiberglass composites can be influenced by the type of fiber used, with the difference in fiber diameter which greatly affects the tensile strength of the composite. The smaller the fiber diameter, the smaller the voids in the fiber and the more intermolecular bonds, resulting in greater tensile strength. Grain size has a considerable impact on the acoustic properties of granular composite materials. Large grains have low absorption due to low flow resistivity, while small beads have increased absorption due to high flow resistivity and tortuosity . [24]

This research is in line with the research on Thermal stability and flammability of coconut fiber reinforced poly(lactic acid) composites which shows the tensile strength increases with increasing weight fraction. Plasma treatment has a positive impact on tensile strength compared to untreated composites [25].

This research has tried its best in the research process that has been carried out according to the procedure, but there are still deficiencies and limitations that hinder the research process. The limitations of this study are (1) in this study only tensile strength tests were carried out, not testing other mechanical properties such as compressive strength, bending strength, and impact strength, so that the values that can be compared are only tensile strength values. (2) This study only focuses on tensile strength and there is no measurement of the water content in the coco fiber used, (3) In this study only made a comparison of the fibers used and did not compare the matrix or resin used, (4) The research did not carry out fiber variations on fibers such as the direction of arrangement, fiber length, and fiber treatment.

## V. CONCLUSION

The aim for this study was to analyze and compare the tensile strength between fiberglass and coconut coir fiber, so as to find out which fiber material is suitable as an alternative to fiberglass in the manufacture of socket prosthesis. In the tensile test, the coco fiber specimens obtained an average yield of 16.2 MPa and the fiberglass specimens obtained an average yield of 30.2 MPa. From these results it can be concluded that the tensile strength of the coco fiber specimens is still below the tensile strength of the fiberglass specimens. So, coconut coir fiber cannot be used as a substitute for fiberglass in the manufacture of hard socket prosthesis. However, coconut coir fiber can be used as an alternative to fiberglass, in terms of the average maximum force that the coco fiber specimen can withstand with a value of 2630 N. This means that the coco fiber composite can be given a load of 263 kg, with this value it is large enough and exceeds the average weight of adults in Indonesia, namely 60 kg.

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