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Msc. In Mechanical (Manufacturing) Engineering

This Proposal on

Design and analysis of bending strength of hybrid composite (*Palm-Sisal Fiber* Hybrid-Epoxy composite)

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Abstract

A composite material system is composed of two or more physically distinct phases whose combination produces aggregate properties that are different from those of its constituents. Composites can be very important because of its strong and stiff, yet very light in weight, so ratios of strength to weight and stiffness to weight are several times stronger than steel or aluminum and also possible to achieve combinations of properties not attainable with metals, ceramics, or polymers alone. Hybrid composites made from natural fibers has better mechanical properties than single natural composites. Different weight ratio of natural fibers has effect on mechanical properties of hybrid composites. In this paper the bending strength of palm-sisal hybrid epoxy composite will be investigated using hydraulic universal testing machine and verification using FEA software will be done. Palm-sisal hybrid composite test specimens will be prepared at different sequence of fiber layers (palm-palm-sisal-sisal, palm-sisal-palm-sisal and sisal-palm-palm-sisal), Based orientation angle of fibers, based on concentration of fibers (weight ratio). Palm-sisal epoxy laminates will be done by compression molding process and laminate by hand lay-up method. In all method by using NaOH apply both treated and untreated palm and sisal composite, and will investigate the effect of bending strength of treated and untreated composites. After that specimens will be cut with dimensions according to ASTM standard and the test will be carried out using universal testing machine and see how their bending strength varies and in which specimen we will get largest bending strength. FEA analysis will be done using FEA software and comparison with experimental test will be done. The objectives of this paper is to present processing techniques of specimen preparation, conducting experiment to obtain bending strength of this composite structure. At the end of this paper I hope we will get better bending strength of palm-sisal fiber epoxy composite than synthetic or manmade fiber composites.

Key words: hybrid, palm, sisal, bending strength, matrix.

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Abbreviation

ASTM	American society of testing materials
CLT	classical laminated theory
FEA	Finite Element Analysis
HPSE	hybrid palm sisal epoxy
NFC	natural fiber composite
UOG	university of Gondar
PMC	polymer matrix composite

CHAPTER 1: INTRODUCTION

1.1. Back Ground of the Study

Natural fibers have attracting the interest to engineers, researchers, professionals and scientists all over the world as an alternative reinforcement for fiber reinforced polymer composites, because of its superior properties such as high specific strength, low weight, low cost, fairly good mechanical properties, non-abrasive, eco-friendly and bio-degradable characteristics [1].

Solid waste disposal has become a burning problem nowadays. Garbage wastes such as plastic grocery bags, food packaging materials, bottles, containers etc. are mainly responsible for causing environment pollution in urban areas due to non-biodegradable nature. At the same time, the emission of greenhouse gases during combustion is a serious global-scale problem. To keep our environment safe and green, it is compulsory to reduce the use of such pollution causing garbage. That is why, many countries banned plastic grocery bags responsible for so called ‘‘White Pollution’’. Alternative usage of biodegradable plastics and their natural fiber bio composites gained more popularity because they are degraded easily after landfill [2].

Natural fibers are potential replacement for synthetic fibers in automotive and aerospace engineering applications due to the low carbon footprint associated with them. Reducing the resonant amplitude of the vibration is an important issue in a machine component design process. Generally, damping associated with fiber reinforced composite structure is higher than conventional metal structures due to the viscos -elastic behavior, fiber-matrix interaction and the damping due to damage [3].

According to [4] review, Recently, growing environmental impact associated with production, disposal and recycling of synthetic fiber based polymer composites triggers the development of ecofriendly composite for various applications such as automotive, marine, chemical, Infrastructure, sporting goods etc. Among many natural fibers like kenaf, jute, oil palm, cotton, flax, banana and hemp, sisal are gaining attention as they are abundantly available, cheaper, eco-friendly and possess remarkable and satisfactory mechanical properties to hemp, banana and jute. Sisal fiber will play a key role to fabricate a varied range of structural and non-structural industrial products with different polymer matrix.

According to that of [5], Environmental awareness and sustainability concept attracts researchers and scientist towards utilization of natural fibers as reinforcement in polymer-based composites.

Natural fiber reinforced composites are attracting researchers due to their lower cost, light weight, high strength to weight ratio, renewability, lower density and lower energy requirements for processing. Natural fibers in the composite industry usually refers to wood fiber and agro based bast, leaf, seed and stem fibers. These fibers often contribute greatly to the structural performance of plant and when used in plastic composites can provide significant reinforcement. The stiffness and strength shortcomings of bio composites can be overcome by structural configurations and better arrangement in a sense of placing the fibers in specific locations for highest strength performance. Natural fiber composites can also be very cost effective material for application in building and construction areas (e.g. walls, ceiling, partition, window and door frames), storage devices (e.g. bio-gas container, post boxes, etc.), furniture (e.g. chair, table, tools, etc.), electronic devices (outer casting of mobile phones), automobile and railway coach interior parts (inner fenders and bumpers), toys and other miscellaneous applications (helmets, suitcases).Accordingly extensive studies on preparation and properties of polymer matrix composite (PMC) replacing the synthetic fiber with natural fiber like jute, sisal, pineapple, bamboo, kenaf and bagasse were carried out.

Generally, natural Composites fibers are multifunctional material. the following are the basic reasons why natural composites fibers are selected for certain applications rather than synthetic fiber:

- High strength to weight ratio
- High crawl or creep resistance
- Moisture absorbing ability
- High toughness
- Environmental eco-friendly
- Recyclability

This study will be focus on investigating of mechanical properties (bending strength) of palm-sisal hybrid fiber reinforced epoxy resin. By taking locally available palm-sisal fiber epoxy composite I will investigate the bending strength of the composite.



Figure 1. 1 types of palm species (photo)

Based on the above information, I use the following types of palm and sisal plant for my project that is available locally.



A) palm plant B) sisal plant

Figure 1. 2 palm and sisal plant (photo)

1.2. Statement of the problem

Ethiopia has a surplus amount of palm and sisal plant which has a great potential that can be used as a reinforcement material and has the ability to replace synthetic composites materials. For many years, researchers focused their attention on synthetic composites reinforced with glass, carbon and ceramics etc. There was less attention on natural fibers such as palm, sisal, bamboo, kenaf etc. the main reasons will make the natural fibers attractive than synthetic due to that their specific properties, their price, their biodegradability and their recyclability particularly, their low density and high specific properties are nice benefit than synthetic fiber. Beside this fact the

contribution of palm and sisal plants on agro-economic sector of the country is negligible as compared to other countries. Now on this paper, the first objective will be focusing on locally available palm and sisal fibers and study it's bending strength to reduce the cost of the materials during transportation and manufacturing comparing its property with that of synthetic (glass/carbon) fiber. However, problems will be encountered with the commonly used synthetic fiber composite materials like carbon and glass are rise in cost and non-renewable materials, based on the air pollution of the environment due to industrial process etc. this work will be deals with the fabrication and analysis of bending properties of sisal/palm fibers reinforced epoxy hybrid composites and tests as well as comparing with each sisal and palm fiber relating to the previous work. The primary purpose of matrix under this research will be to transfer the load or stress supplied to the composite reinforcement and to improve the mechanical properties (bending strength) of the composite material.

1.3. Objectives

1.3.1. General objective

The main objective of this study will be to producing and testing of the bending strength of hybrid palm-sisal fiber with epoxy resin in composite in order to improve the mechanical properties of a composite material with the effect of matrixes and fiber concentration.

1.3.2 Specific Objective

The specific objective includes:

- Theoretical analysis and determination of bending strength of hybrid composites using FEA Software.
- Designing a hybrid composite test specimen.
- Manufacturing of the specimen.
- Analyzing the Classical Lamination theory results with simulation results.
- Finally testing of the sample specimen
- Evaluating and comparing of the previous each sisal and palm fiber with that hybrid one.

1.4. Scope

Hybrid composition of polymer composites leads to an optimality in increasing the strength to weight ratio for a bending structure solely depends on the fiber strength effectiveness. Hybrid structure in composites model intrudes to more opportunity of better mechanical property

improvisation in the structure. This thesis mainly deals with the bending strength analysis of hybrid (palm-sisal hybrid epoxy composite) using Experimental and Analytical approach (FEA).

1.5. Significance of the research

Palm-Sisal-Epoxy resin composite has the following Significance

- It will reduce the cost of materials and increase the country economic.
- It replaces that of synthetic fiber.
- Renewable and easy to recycle.
- It is free from environmental pollution.
- Cheap in Cost.
- To develop agro economic activity of palm-sisal fiber in epoxy composite to the community.
- To use it in industrial applications like, internal Mercedes of an automobile, military helmet, valve covering

1.6. Expected output

At the end of this paper I hope we will get better bending strength of palm-sisal fiber epoxy composite than synthetic or manmade fiber composites. Since this research will focus on local palm-sisal natural fibers, the community will benefit by cultivating palm and sisal fibers easily and they will get money by selling this product and so on.

1.7. Beneficiaries

- The first beneficiaries are community farmers due to growing and selling of the plant
- Industry's by itself will benefit due to low transportation cost
- Customers also will benefit low cost than synthetic fibbers
- Totally the country will benefited economically and technologically

CHAPTER 2: LITERATURE REVIEW:

2.1. Previous work related to sisal fiber with matrix composite

According to [6], the word *composite* in the term *composite material* signifies that two or more materials are combined on a macroscopic scale to form a useful third material. The key is the macroscopic examination of a material wherein the components can be identified by the naked eye. The advantage of composite materials is that, if well designed, they usually exhibit the best qualities of their components or constituents and often some qualities that neither constituent possesses. Some of the properties that can be improved by forming a composite material are: strength, fatigue life, stiffness, temperature-dependent behavior, corrosion resistance, thermal insulation, wear resistance, thermal conductivity, attractiveness, acoustical insulation and light weights.

In the view of [7], Composite materials are light in weight but they have high strength. Because of higher specific strength stiffness and fatigue characteristics, natural fiber composites are good alternatives for the conventional plastic, metal and petroleum based materials.

In the discussion [8], Natural fibers such as banana, coir, sisal and jute have used to make composites which are used in consumer goods, low cost housing and other civil structures. Natural fibers have many advantages like low density, cheaper, acceptable specific properties and also they are renewable and biodegradable and its composites possess high strength and stiffness; good thermal; acoustic insulating properties and high resistance to fracture.

A studies defines [9], natural fibers have a hollow space (the lumen), as well as nodes at irregular distances that divide the fiber into individual cells. The surface of natural fibers is rough and uneven and provides good adhesion to the matrix in a composite structure. The low density, tensile strength and elongation at failure of natural fibers such as hemp, flax, ramie and synthetic fibers can compete with E-glass fibers properties and hence shows remarkable importance in composite technology. The specific modulus and elasticity are better in natural fibers than the synthetic fibers. A comparison of various parameters between natural and glass fibers are listed below.

Table 2. 1 comparison between glass fiber and natural fiber [9].

Properties	Natural fiber	E-Glass fiber
Density	Low	Double
Cost	Low	High
Renewability	Yes	No
Recyclability	Yes	No
Energy Consumption	Low	High
Distribution	Wide	Wide
CO_2 Neutral	Yes	No
Abrasion To The Machine	No	Yes
Health Risk When Inhaled	No	Yes
Disposal	Biodegradable	Non Bio Degradable

In the description of [10], Composite materials were used in automobile, aeronautical, marine and construction field and Hybrid composite is one of the important in composite field. Hence natural, synthetic fibers have to intersperse in a common matrix form called as hybrid composites. It is the one of the important in the composite materials field. It shows better moisture observation behavior; hence it was suggested by many researchers for various applications.

According to that of [11], the fabrication of The simple hand lay-up technique followed by compression molding process was adopted to prepare the composite with various fiber volume fractions (Vf). The number of layers (lamina – woven mat) varied for each volume fractions of fiber as shown in Figure below. Commercially available polyester resin was used as a matrix.

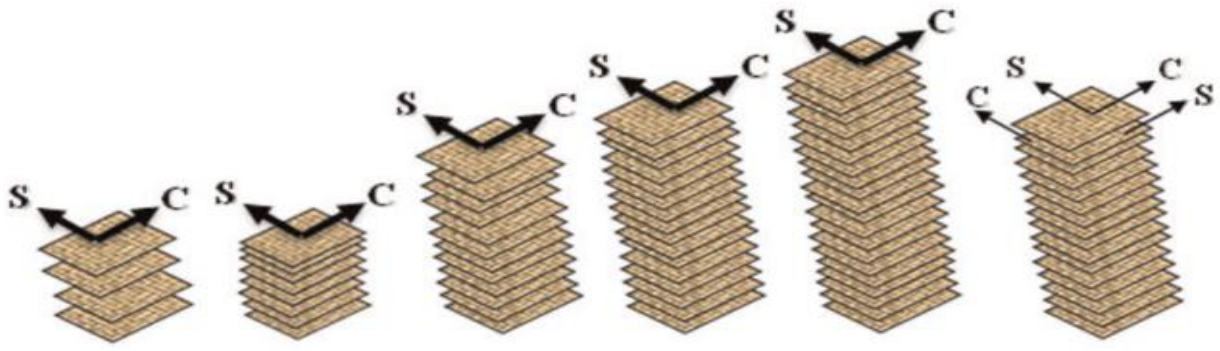


Figure 2. 1 hybrid sisal –cotton fiber woven composite [11]

Generally [1], polymer can be classified into two classes, thermoplastics and thermosetting. Thermoplastic materials currently dominate, as matrices for bio-fibers; the most commonly used thermoplastics for this purpose are polypropylene (PP), polyethylene, and poly vinyl chloride (PVC); while phenolic, epoxy and polyester resins are the most commonly used thermosetting matrices. Plant fibers are classified into Bast, Leaf, Seed, Fruit, Wood and grasses. Figure.2.2 shows commonly used natural fibers and matrices for polymer composites

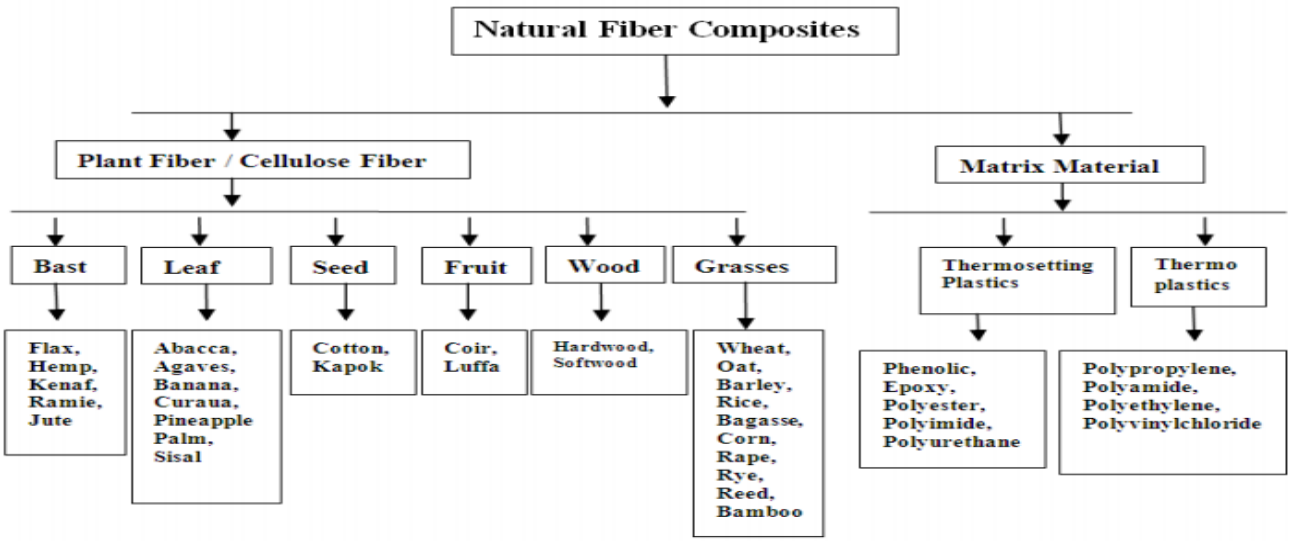


Figure 2. 2 commonly use type of natural fiber and matrices of polymer composite **[12]**

As defines **[13]**, Hybrid fabrics are used to achieve optimal ratio between the performances and the costs of the fabric. Various chemical compositions, different weights, and mechanical properties can be applied within the same fabrics. Therefore, a fabric can be designed in the required specification with low cost. For example, a mixture of carbon fibers and aramid in the weft and warp arrangement is possible, resulting in a composite with diverse elastic properties in the main directions of stress.

Based on **[14]**, describe the moduli and expansion coefficients of the lamina from properties of the fiber and matrix, the microstructure of the composite, and the volume fractions of the constituents.

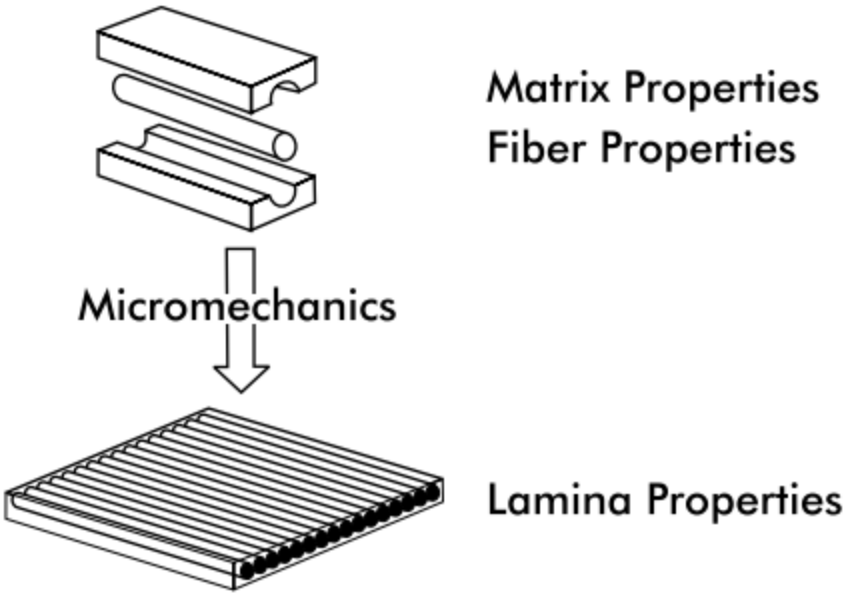


Figure 2. 3 fiber and matrix in lamina reinforced composite [14]

As discus [15], the interest in natural fiber-reinforced polymer composite materials is rapidly growing both in terms of their industrial applications and fundamental research. They are renewable, cheap, completely or partially recyclable, and biodegradable. Plants, such as flax, cotton, hemp, jute, sisal, kenaf, pineapple, ramie, bamboo, banana, etc., as well as wood, used from time immemorial as a source of lingo cellulosic fibers, are more and more often applied as the reinforcement of composites. Their availability, renewability, low density, and price as well as satisfactory mechanical properties make them an attractive ecological alternative to glass, carbon and man-made fibers used for the manufacturing of composites.

Alaa Abdulzahra Deli [16] , studies the reinforcement of the resin materials was made with two types of powder and short fiber to produce an isotropic hyper composite material presented. So it is composed of three materials, polyester resin material and two reinforcements: short glass fiber and powder in the form of glass or date palm nuts. The composite structure was studied to estimate the mechanical properties (modulus of elasticity E, yield stress y) experimentally and analytically, whereas the natural frequencies were estimated theoretically, experimentally and numerically. The results show that, when using the date palm nuts powder, the yield stresses and the fundamental natural frequency are increased. This encourage using this type of hyper composite plate safely in the engineering applications where high loads are encountered in a wide range of operating frequencies. The main purpose of this research studding the effect of natural fiber palm on mechanical properties and dynamic properties (natural frequency) of composite plate with various volume fraction of reinforcement fiber and different boundary conditions of plate. [16]The experimental part included the experimental test of the spacemen, with tensile and vibration test, which is manufactured in the laboratory. Where the tensile test can be done to calculate the tensile strength of the spacemen’s and to find the young's modulus

of elasticity which gives an indication to the toughness of the composite material with in various fiber volume fraction of date palms reinforcement fiber. The experimental test of the spacemen included the test of many spacemen to compare the toughness of the composite material with various properties which can be changed to get the most appropriate values of the fiber and matrix fraction. Where this study take into account the following property.



Figure 2. 4 palm fiber sample specimen [16]

Researchers studies [9], Properties of Date Palm Fiber palm fiber such as density, fiber's length, diameter, thermal conductivity, aspect ratio (length/diameter), cost, and availability of the natural fibers are important to determine their compatibility for different natural fiber polymer composites industrial applications. Date palm fiber is the most readily usable natural fibers having highest cellulosic content nearly 50 % as compared with other natural fibers. Shows the density property comparison of date palm fibers and other natural types. Because of lower density of date palm fiber when compare to other natural fibers it is evident that it is accepted and reliable in the field of natural fiber composites.

Table 2. 2 comparison of date palm fiber physical properties with other natural fiber [9].

Properties	Fibers			
	Coir	Date palm	Hemp	Sisal
Density (g/cm^3)	1.15–1.46	0.9–1.2	1.4–1.5	1.33–1.5
Length (mm)	20–150	20–250	5–55	900
Diameter (μm)	10–460	100–1,000	25–500	8–200
Annual world Production	100	4,200	214	378
Cost Per Weight (USD/Kg)	0.3	0.02	1.2	1
Thermal Conductivity (W/mK)	0.047	0.083	0.115	0.07

Table 2. 3 mechanical properties of various natural fiber [9].

Properties	Diameter (μm)	Tensile Strength (MPa)	Young's Modulus (GPa)	Elongation at break (%)
Jute	25–200	393–773	13–26.5	1.16–1.5
Flax	10–40	600–2,000	12–85	1–4
Sisal	50–200	468–640	9.4–22.0	3–7
Coir	100–450	131–175	4–6	15–40
Raw-date palm fiber	100–1,000	58–203	2–7.5	5–10

CHAPTER 3: MATERIALS AND METHODS

3.1 Materials

This chapter describes the details of processing of the composites and the experimental procedures followed for their mechanical characterization. The raw materials used in this work are listed below:

Materials used are;

- Epoxy resin and hardener
- Natural fiber(sisal, palm)
- NaOH for treating of the sample.

1. **Feature of Epoxy resin**
   - Light weight
   - Resists most alkalis and acids
   - Resists stress cracking
   - Retains stiffness and flexibility
   - Low moisture absorption
   - Non-staining
   - Easily fabricated

   Applications of Epoxy
   - Structural applications
   - Industrial tooling and composites
   - Electrical system and electronic
2. **Hardener(HY-95):**
   Hardener is a curing agent for epoxy or fiberglass. Epoxy resin requires a hardener to initiate curing; it is also called as catalyst, the substance that hardens the adhesive when mixed with resin. It is the specific selection and combination of the epoxy and hardener components that determines the final characteristics and suitability of the epoxy coating for given environment.
3. **Natural fiber:**
   Fiber-reinforced polymer composites have played a dominant role for a long time in a variety of applications for their high specific strength and modulus. The manufacture, use and removal of traditional fiber–reinforced plastic, usually made of glass, carbon or aramid fibers–reinforced thermoplastic and thermoset resins are considered critically because of environmental problems. By natural fiber composites we mean a composite material that is reinforced with fibers, particles or platelets from natural or renewable resources, in contrast to for example carbon or aramid fibers that have to be synthesized

   Advantage and properties of palm and sisal fiber:

Comparing to conventional reinforcing fibers like glass, carbon and Kevlar, natural fibers have the following advantages:

- Environmentally friendly
- Fully biodegradable
- Nontoxic
- Easy to handle
- Nonabrasive during processing and use
- Low density/light weight
- Source of income for rural/agricultural community

-
- Renewable, abundant and continuous supply of raw materials
- Low cost
- Free from health hazard (cause no skin irritations)
- High toughness
- Good thermal properties

3. a Properties of sisal fiber:

3. b Properties of palm fiber:

Composite: Composite is a material which is composed of two or more material at a microscopic scale and has chemically distinct phases.

Fiber: Fiber is a reinforcing material of the composite. Its role is to increase the mechanical properties of the composite. Fiber is stronger and harder as compared to matrix material. Fibers are discontinuous unlike matrix.

Matrix: Matrix is a material which holds the fibers together. It protects the fibers from environment and abrasion with each other. Matrix distributes the loads evenly between the fibers. It helps to maintain the distribution of fibers and provides better finish to final product. In the experiment epoxy resin is used as a matrix material. Modulus of elasticity of epoxy resin is 3700 MPa [7].

3.2 Methodology

Sample preparation and experimental test methods

1. Preparation of composite specimen

After revising the related literatures, sample of palm–sisal hybrid epoxy composite will be prepared at different sequence of fiber layers, orientation angle and with different concentration of fibers (weight ratio).

The fabrication of the composite material is carried out through the hand lay-up technique. The mold used for preparing composites is made from two rectangular mild steel sheets having dimension with ASTM standards.

2. Preparation of Epoxy and Hardener

The matrix used to fabricate the fiber specimen will epoxy of density 1.13 g/cm3 at 25°C mixed with hardener of density 0.97 to 0.99 g/cm3. The weight ratio of mixing epoxy and hardener will be as per the supplier norms.

3. Fiber Extraction

Extracted palm and sisal fibers are not easily available in Ethiopia so I will use a mechanical extraction method to extract sisal fiber from raw palm and sisal manually using serrated knives. In the mechanical process, the fiber is extracted by rasping the leaves with a blunted knife. put the raw sisals on the table rasp it until the resinous material are remove and fiber strands are obtained. A bunch of fibers are mounted or clamped on a stick to facilitate segregation. In this method almost the entire extraneous matter is removed leaving only the fiber strand. Decorticated fibers are washed before drying in the sun or by hot air. Proper drying is important as fiber quality depends largely on moisture content.

Sample Preparation

The materials used for the experiment is prepared by hand layup process. Extracted sisal and palm fibers are used specimen preparation.

Initially the fibers are dried under sunlight for 3 to 5 hours.

Step 1 — first applying the releasing agent on the mold;

Step 2 — Implementation of the first layer of resin with a brush over the releasing agent;

Step 3—positioning the first palm fiber blanket on the resin;

Step 4—Application of resin on palm fiber blanket, using a brush;

Step 5 — Elimination of air bubbles using the roller across the surface of the mold;

Step 6 —positioning the second layer palm fiber on the resin;

Step 7 — Application of resin on palm fiber blanket, using a brush;

Step 8 — positioning the first sisal fiber blanket on the resin;

Step 9—Application of resin on sisal fiber blanket, using a brush;

Step 10 — Elimination of air bubbles using the roller across the surface of the mold;

Step 11 —positioning the second layer sisal fiber on the resin;

Step 12—Application of resin on sisal fiber blanket, using a brush;

Step 13 — Elimination of air bubbles using the roller across the surface of the mold;

Finally, to remove air excess resin it will be sucked by vacuum pump to keep homogeneity in the specimen. The thickness of the lamina is limited to 5mm and the size is 30x30 cm. After dried,

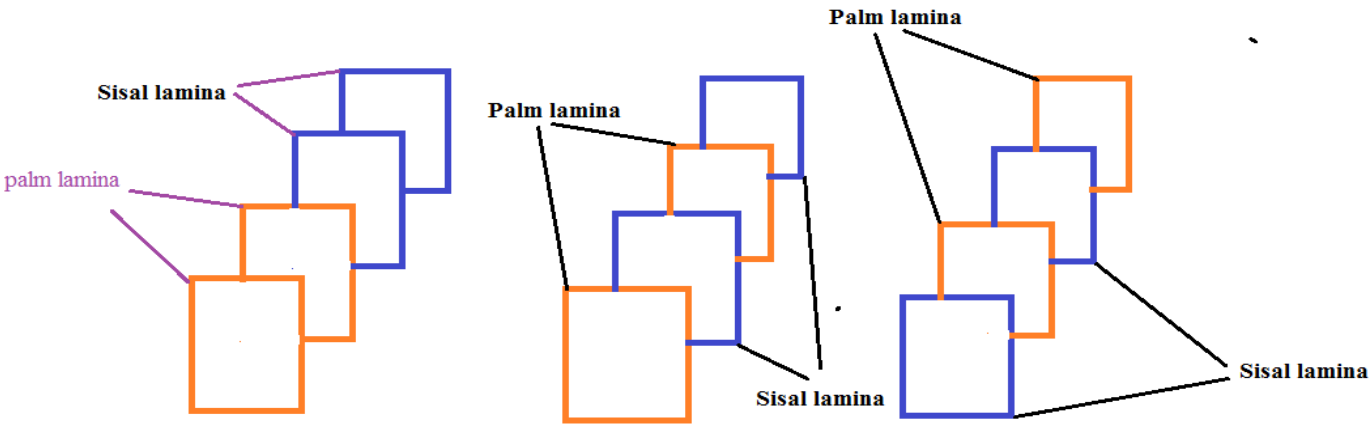
the edges of the specimen are neatly cut by using saw as per the required dimensions. And test samples were cut to the required sizes prescribed in the ASTM standards and make ready for test. The specimens are prepared based on three different types.

A) Based on sequence of fiber layers.

The lamina consisting of two layers of jute fibers and two layers of sisal fibers. Three specimens will be prepared with different sequence of fiber layers.

Table 3. 1 sequence of fiber layer arrangement

Specimen Number	Number Of Layers	Layer Details	Sample size	Total no. of specimen
S1	4	palm- palm-sisal-sisal	3	9
S2	4	palm- sisal-palm-sisal	3	
S3	4	Sisal-palm-palm-sisal	3	



a) palm- palm-sisal-sisal b) palm- sisal-palm-sisal c) Sisal-palm-palm-sisal

Figure 3. 1 sequence layer arrangement

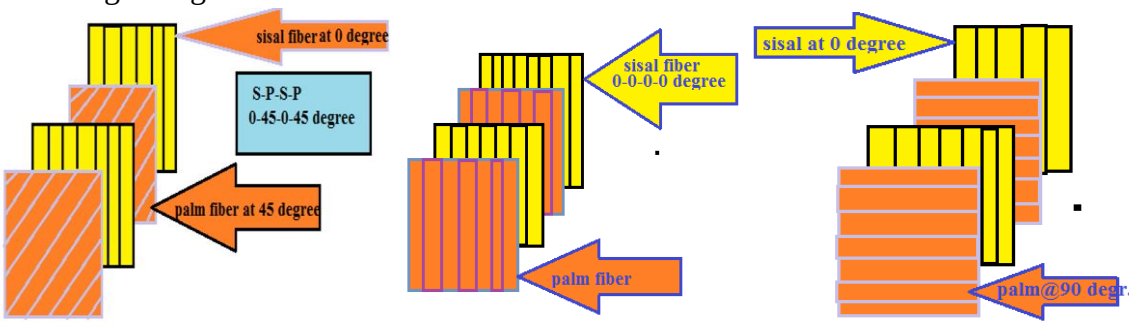
The final average value will be taken by the following relations.

$$S1, S2, S3 \rightarrow \frac{S1+S2+S3}{3} = \text{aver.}$$

Where S1, S2 and S3 are sample number.

B) Based orientation angle of fibers

The direction of the palm-sisal fibre (PSF) to the load applied has also an effect on the result of bending strength so I will examine with different angle arrangement of PSF fibre that gives better bending strength**.**



a. **b.** **c.**

Angle of S-P-S-P @ a. 0^0-45^0-0^0-45^0 b. 0^0-0^0-0^0-0^0 c. 0^0-90^0-0^0-90^0

Figure 3. 2 fiber layer with angle orientation

Table 3. 2 sample size in angle arrangement

	Fiber	Angle	Sample size	Total no. of sample size
S1.	S-P-S-P	0-45-0-45	3	**9**
S2.	S-P-S-P	0-0-0-0	3	
S3.	S-P-S-P	0-90-0-90	3	

C) Based on concentration of fibers (weight ratio)

Since the fibre concentration has an effect on the property of the composite, so I will examine the different fibre concentration and their mechanical strength:

- 10% palm fibre, 10% sisal, 80% Epoxy **(10P-10S-80E)**
- 5% palm fibre, 20% sisal, 75%Epoxy **(5P-20S-75E)**
- 20% palm fibre 40%sisal, 40% Epoxy**(20P-40S-40E)**

Table 3. 3 concentration of fiber based on weight ratio

	Palm (%)	**Sisal (%)**	**Epoxy (%)**	**100%**	Sample size	**Total number of size**
S1.	10	10	80	100	3	**9**
S2.	5	20	75	100	3	
S3.	20	40	40	100	3	

D) Before and after chemical treatments (NaOH).

Sodium Hydroxide (NaOH) is an alkaline solution used to enhance the surface morphology of natural fibers. Mostly recommended treating by 6% and 10% in previous work.

Table 3. 4 No. of sample size in case of chemical treatment (NaOH)

	Sample type	treating by 10%	Treating by 6%	Variation	No. of sample
S1.	Weight ratio	3	3		**18**
S2.	Angle arrangement	3	3		
S3.	Layering	3	3		

CHAPTER 4: WORK PLAN AND COST ESTIMATION ANALYSIS

4.1 work plan

Table 4. 1 work plan schedule

Task	November 2018			December 2018				January 2019				Februar y 2019				Match 2019				April 2019				May 2019				June 2019			
	Week			Week				Week				Week				week				Week				Week				Week			
	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Literature Review																															
Preparing proposal																															
Comprehensive assessment of thesis																															
analysis of palm-sisal-epoxy matrix composite model using ANSYS																															
Preparation of sample material for the test																															
Testing and Validation of results																															
Documentation																															
Preparing final Paper submission																															
Final report Presentation																															

4.2 estimated cost analysis

Table 4. 2 estimated material cost

NO.	Item	Unit	Quantity	Unit Cost	Total (Birr)
1.	Sisal	No.	30	15	750
2.	Jell releaser	No.	7	50	350
3.	Palm leaf	No.	30	10	300
4.	Perforated nylon	Size	3m*3m	200	200
5.	Breather	Size	1m*3m	100	100
6.	Vacuum nylon	Size	3m*3m	200	200
7.	Mastic sealant	No.	2	75	150
8.	Release fabric	Size	3m*3m	100	100
9.	Epoxy-resin	No.	8	500	4000
10.	Hardener	No.	6	70	420
11.	Mold plate	No.	6	150	800
Total (Birr)					7370

Table 4. 3 estimated stationary cost

No	Item	Unit	Quantity	Unit Price	Total (Birr)
1.	Photocopy paper	Rim	3	1*2*100	600
2.	pen	Pcs	12	5	60
3.	Stapler pin	Packet	2	15	30
4.	Notebook	No.	2	30	60
5.	Fixer	Pcs	1	26	26
6.	A4 paper	Pcs	2	130	260
7.	Print	Pages	100*3	2	600
8.	Binding	No.	3	50	150
Total (Birr)					1786

Table 4. 4 Miscellanea expense cost

No.	Description	Quantity	Purpose	Unit cost	Total cost in birr
1	Transportation cost From (Gondar – debre tabor and bahir dar)	For 2 weeks- debre tabor including machine depression	Testing of The sample	-	8000
		For 3 weeks – bahir dar	For preparing of specimen		6000
2	Taxi transport	-		-	1200
3	Telephone	-		-	1500
Total in birr					16700

Table 4. 5 Final summarized estimated cost

No.	Item	Total (birr)
1	estimated cost	7370
2	Stationary cost	1786
3	Miscellaneous expenses	16700
Grand total (Birr)		25,856

5. REFERENCE

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