A TECHNICAL REPORT

SUBMITTED BY

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TO

COUNCIL FOR THE REGULATION OF ENGINEERING IN NIGERIA (COREN)

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR COPERATE MEMBERSHIP REGISTRATION

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CHAPTER ONE

1.0 Introduction

This report is aimed at attempting to present a very brief but concise and practical record of some engineering activities I undertook from my pre-graduation work experience to my post graduation work experience as an Industrial Engineer from the Nnamdi Azikiwe University to date.

1.1 Pre-Graduation Work Experience (2008)

1.11 National Space Research and Development Agency Abuja (Industrial Training)

I was admitted into this agency as industrial attaché as a requirement for my students industrial work experience scheme (SIWES). National space research and development agency is a federal government agency dealing with satellite engineering design and communication. I was involved in the day to day systems design and development, data analysis and management and operation of supporting systems.

Knowledge Gained: It afforded me the opportunity of having hands-on knowledge on systems design, hierarchy development and engineering design for manufacture.

1.2 Post Graduate work Experience (June 2010 – Till date)

1.21 Dutse Municipal Council, Dutse, Jigawa State (National Youth Service Corps) (2010-2011)

After my graduation I did my National Youth Service Corps with the engineering and works department at Dutse municipal council, in Dutse Jigawa state.

Responsibilities

- Supervised of Vendors/Contractors to the municipality at several working sites
- Managed the lease agreement and renewal process.
- Managed relationships with contractors, vendors and manufacturers.

1.22 Maxprod EPCM Services, Belville, Western Cape South Africa. (2013)

As an Industrial Engineer and as part of the project engineering team for the construction of a coal-fired boiler house for Africa power house in Mozambique, the following were my responsibilities while I was employed by Maxprod on part-time basis:

- Preparing and developing a request for interest for the Construction of a Coal-fired Boiler House for the Africa Power Agency in Mozambique
- Preparing and developing the project charter for the project
- Preparing and developing the project management plan
- Convening bi-weekly stakeholders meeting
- Monitoring and controlling project work
- Performing integrated change control systems

Knowledge Gained: It afforded me the opportunity of having hands-on knowledge on project management and engineering software applications for cost and scheduling optimization.

1.23 Federal College of Education (Technical) Umunze, Anambra State (2012 – to date)

As a Lecturer in the Department of Mechanical and Automobile Technology Education, these are the courses that I taught the Undergraduate students in the department

TED 493 – Elements of Engineering Design,

TED 262 – Metal Works Technology

TED 218 – Auto Electrical Systems, Repairs and Computer

Other Key responsibilities:

- Lecturing courses, Conducting, marking, and recording of continuous assessment tests during the academic session.
- Setting question papers, conducting examination supervisions, marking of examination scripts, recording and submission of the Final semester Examinations results.
- Supervision of final year projects at the end of the academic session.

Challenges Encountered

The challenges encountered are as follows;

1. The non-challant attitudes of students to academics

2. Laziness on the part of the students to their lectures

3. Lateness of the students in attending classes.

1.24 Post Graduate Studies (2012 – to date)
The post graduate studies covered the following:

- Individual thesis project.
- Lectures and Presentation of seminars.

Updating my theoretical knowledge in Engineering has sharpened my philosophy and dexterity in the field of engineering.

1.25 Employment History

1. Assistant Lecturer, Department of Mechanical and Automobile Technology Education, Federal College of Education (Technical) Umunze, Anambra State (2012 – to date).
2. Industrial Engineer, Maxprod EPCM Services, Belville, Western Cape South Africa. (2013).
3. Engineer II, Duste Municipal Council, Jigawa State (National Youth Service Corps) (2010 – 2011).
4. Intern, National Space Research and Development Agency. (2008).

REFEREES

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CHAPTER TWO

2.0 Project Research

2.1 Fracture Characterization of Coir and Bamboo Fiber (Natural) Composites

Composites are engineering materials made from two or more constituent materials combined together to produce material properties that are different to the properties of those elements on their own. They are combined together in order to improve the properties of the material on which the reinforcement is added. In ancient history, the most primitive and known composite material were straw and mud which were combined together to form bricks for construction. In this modern era, the most visible application of composite material are asphalt (for road construction), aggregate reinforce cement and shower stalls (made of fibre glass), automobile seats (coir fibre) etc.

Natural fibre composites offer both economic and environmental advantage over traditional organic reinforcement and fillers. And in the automobile industries, because of its lightweight and low cost, it has been used in the design and production of door panels, seat backs, headliners, package trays, dashboard etc. In Nigeria, natural fibres are regarded as waste and have no economic value, as a result of this, it litters around the environment and contribute to pollution. Thus in order to preserve the environment, it is necessary to find economically feasible solution to the vast amount of natural fibre waste. Countries like ours with high abundance of these natural fibres continuously confront a problem of efficient disposal of waste fibres, which have a relatively high degrading time.

2.2 Objectives of this research

Since the application of natural fibres is of current interest around the world and a commercial potential market already exists, their utilization in the production of value added products is an important research and development goals. To this end, this research project has the following aim and objectives:

- To produce a composite using natural fibres.
- To characterize the tensile strengths of bamboo fibre and coconut (coir) fibre reinforced polyester composites in relationship to their aspect ratios

- To characterize the fracture behaviour of polyester resin based composites reinforced with coconut (coir) and bamboo stem fibres

2.3 Approach Employed

The basic raw materials include: fibers (coconut and bamboo), polyester resin, accelerator (cobalt), catalyst (methyl-ethyl ketone peroxide), binders (polyvinylacetate), release agents (polyvinylalchol) and wax (mirror glaze).

The catalyst is used to initiate the chemical reaction of the unsaturated polyester, while the accelerator is used to promote the catalyst at lower temperatures. The binder is used during fibre load formation to hold the fibres together for effective handling. The release agents are de-molding agent applied on the surface of the mould on which the laminate is formed. They also aid in the removal of the laminate after cure by constituting a barrier against adhesion to the mould surface.

2.31 Tools Used

Paint brush: for the application of resin and release agent.

A pair of scissors: for cutting of the fibre load to the required shape and size before the formation of the laminate.

Rubber hand gloves: To prevent the resin from being in contact with the human hands.

Rollers: to ensure proper consolidation, proper impregnation and removal of air from the laminate.

Electric cutting machine: Used to cut the laminates to the required sizes.

2.32 Methods

The coconut fruit fibres used for this research were sourced with the help of local coconut sellers. The husks were removed and soaked with water for 24 hours, for easy fermentation. Then the husks were washed very well to remove non fibre constituents and the fibres extracted manually by hand.

However, this manual extraction of coconut fibres was tedious and time consuming, consequently, this type of technique cannot be recommended for industrial application.

Fig 2: Extracted Coconut Coir Fibres

The bamboo fibres used for this research were harvested bamboo stem sourced from local farms and the stem of the fresh bamboo was cut down and smashed properly for easy separation of the fibre strand after which it was washed with water.

Figure 2.1 Extracted bamboo fibres

2.33 Fibre Treatment and Modification

This is the act of modifying the surface of fibres by using suitable chemicals in order to improve the mechanical properties of the various fibres.

Sodium hydroxide is the most commonly used chemical for the treatment of natural fibres. The fibres were soaked in 12.5 g/dm3 of sodium hydroxide for 24 hours and then washed very well in water to remove all the alkali and dried in open air.

2.34Fibre Matting and Load Formation

This is done in order to achieve dimensional stability and to make them more rigid for easy handling and serve as reinforcement materials.

The technique used for achieving this is outline below:

The fibres were initially chopped stranded into 5cm lengths and separated into single strands, distributed randomly and evenly on the Formica surface covered with PVA (poly vinyl acetate) binder. Water was sprinkled on the fibres and beaten to ensure adequate wet-out of the fibres with the PVA (poly vinyl acetate). This process is known as fibre impregnation and this was done to obtain a uniform thickness pressed with a roller to obtain better binding of the fibres. The fibre was then dried for 24 hours. One natural limitation for this technique is that when carried out during the wet season, there will be a delay in the whole drying process.

Figure 2.2 Matted Coconut Coir fibres

2.35 Mould Selection

Before selecting the type or material to use as a mould, one must consider the various properties, thickness, size and shape of the composite product. The best type of mould suitable for composite formation is one that is very rigid, which allows for the uniform distribution of the resin.

In this research, a flat rigid surface made of carbon steel was used to achieve this objective.

2.36 Mould Preparation

Though there are several techniques that have been developed for the preparation of a fibre reinforced polymer matrix composite the use of the hand lay-up technique remains to be the simplest technique till date. In this research a combination of hand lay-up and compression moulding technique (See Fig 2.4) was used for simplicity and also since the production volume is very low. The first step involved in composite fabrication is the mould preparation.

The outer shell of the mould, i.e. the base and the upper cover, are made of 3mm thick low carbon sheet. A frame that would serve as a mould is made out of 150 x 150 x 10.0 mm thick wide wooden bars. This frame is assembled on the base of the mould. Care is taken to keep the bars of the frame in place by applying using masking tape. The surfaces of moulds were coated on the inside with universal release wax and PVA (poly vinyl acetate) to avoid adhesion of the laminate to the mould and to allow easy removal of the composites.

REINFORCEMENT + RESIN

(Coconut& Bamboo) (Polyester resin)

↓

FABRICATION

TECHNIQUE

(Hand lay-up with compression method)

↓

CURE

(HEAT, PRESSURE, CATALYST, ACCELERATOR)

↓

USABLE FORM

Fig 2.4 Process Flow of a Combination of Hand Lay-up and Compression Moulding Technique

2.37 Fibre Volume Fraction Measurement

From Archimedes principle, which states that when a solid id fully immersed in a fluid, the volume of the volume displace equals the volume of the solid. This principle was applied to determine the volume fraction of the fibres.

$$\text{Solid volume fraction} = \frac{\text{Volume of solid}}{\text{Volume of fluid}} \qquad \text{............ (1)}$$

Therefore

$$\text{Fibre volume fraction} = \frac{\text{Volume of fibre}}{\text{Volume of composite}} \qquad \text{.......... (2)}$$

2.38 Tensile Testing

Having produced, machined and smoothened the various samples of bamboo-fibre and coconut-fibre reinforced polyester composites respectively, the whole samples were taken to Geolis Cables Onitsha Anambra state for the tensile testing and fracture characterization.

In a broad sense, tensile test is a measurement of the ability of a material to withstand forces that tend to pull it apart and to what extent the material stretches before breaking. The stiffness of a material which represented by tensile modulus can be determined from stress-strain diagram.

According to ASTM (D638), dumbbell shape (Type I) specimen is needed for reinforced composite testing. Detail dimension for this are shown in the Figure 2.5. and Table 2.0 The testing were done in standard laboratory atmosphere of 23°C ± 2°C (73.4°F ± 3.6°F) and 50 ± 5 percent relative humidity. This is in accordance with Procedure A of ASTM D618. Universal Testing Machine (Kao Tieh) was used at cross-head speed of 100 mm/minute. Figure 2.6 shows the Universal Testing Machine (KaoTieh) used for coconut/polyester and bamboo/polyester tensile testing.

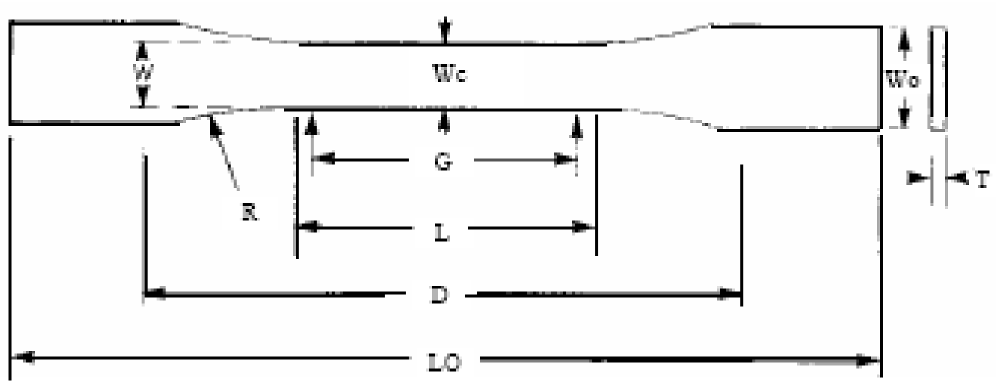

Fig 2.5 ASTM (D638), dumbbell shape (Type I) specimen

Table 2.0: Dumbbell Shaped Specimen Dimension for Type I in ASTM D638

Dimension Value,	**mm (in)**
Thickness <7mm (0.28in), T	1.00±0.4 (0.13± 0.02)
Width of narrow selection, W	13 (0.5)
Length of narrow selection, L	57 (2.25)
Width overall, WO	19 (0.75)
Length overall, LO	150 (6.2)
Gauge length, G	50 (2.00)
Distance between grips, D	110 (4.5)
Radius of fillet, R	76 (3.00)

Fig 2.6: Universal Testing Machine - UTM (Kao Tieh testing machine) for Tensile Testing

2.4 Results and Discussion

The results of the tensile strength test on the coconut coir fibre based composite are shown in Table 2.1:

Table 2.1: Tensile strength test on the coconut fibre results

S/N	Fibre Length(mm)	Fibre diameter(mm)	Aspect ratio ($x10^3$)	Max load (N)	Area (M^2) 10^{-4}	Tensile Strength $10^6 N/m^2$	Tensile strain
1	30	0.21	0.142	189.6	1.54	1.1	1.1

2	40	0.21	0.190	285.9	1.5	1.7	1.7
3	50	0.21	0.236	346.5	1.2	2.6	1.04
4	60	0.21	0.285	452.7	1.49	2.8	1.03
5	70	0.21	0.333	413.4	1.68	2.2	1.02
6	80	0.21	0.380	383.7	1.61	2.0	1.01

It can be seen that the tensile strength increased as aspect ratio increased up to a point from which the tensile strength decreased. This was attributed to the increased amount of fibre as corroborated by Prasad, S.V et.al (1980).

The results of the tensile strength test on the bamboo fibre based composite are shown in Table 2.2

Table 2.1: Tensile strength test on the Bamboo fibre results

S/N	Fiber Length(mm)	Fiber diameter(mm)	Aspect ratio ($x10^3$)	Max load (N)	Area (M^2) 10^{-4}	Tensile Strength $10^6 N/m^2$	Tensile strain
1	30	0.08	0.375	333.3	1.5	2.2	2.73
2	40	0.08	0..5	355.2	1.3	2.5	2.14
3	50	0.08	0.625	381.9	1.1	3.8	1.73
4	60	0.08	0.750	393.5	1.1	3.9	1.4

5	70	0.08	0.875	493.5	1.44	3.42	1.07
6	80	0.08	1.0	377.4	1.44	2.6	0.92

It can be seen that like coconut coir fibre reinforcement, tensile strength of bamboo fibre reinforced polyester matrix composite has been found to increase with increase in fibre aspect ratio in the experiment. From the table 2.2 it also is evident that at first tensile force increases with the increase in fibre aspect ratio but beyond 0.750 fibre aspect ratio a significant decrease in tensile strength was obtained.

From the results, one can conclude that:

• Tensile stress of composites increases as fibre aspect ratios increases on reinforcement within the fibres.

• The addition of the coir and bamboo fibre caused brittleness and the reduction of ductility of the polyester composite. Fracture takes place without any applicable deformation

• Random distributed coir and bamboo fibre polyester composites are low strength materials.

• Small aspect ratio fibre is typically less resistant to damage propagation.

• Coir fibres have a lower tensile strength as compared with bamboo fibres, which means that short coir fibres are not suitable for composite application.

Basically, a relative lower strength fibre composite does not have to be a negative aspect because there may be several non-structural applications where the strength properties could meet the technical and product requirements.

2.5 REFERENCE

ASTM D638 123-83a (1983). Annual book of ASTM Standards, section 7, vol 07:01, Textiles, Yarns, fabrics, general test methods.

Prasad, S.V.; Pavithran, C.; Rohatgi, P.K. (1980). Alkali treatment of coir fiber for coir fibers polyester composites. Research regional laboraty, India p 1443-1454.

2.6 Bill of Engineering Measurement and Evaluation

S/N	**Description of Materials**	**Quantity**	**Unit Price (Naira)**	**Total Price (Naira)**
1	Coconuts	6	300	1,800
2	Bamboo Stalks	2	150	300
3	polyester resin	1	2,500	2,500
4	Accelerator (cobalt)	1	6,300	6,300
5	Catalyst (methyl-ethyl ketone peroxide)	2	3,600	7,200
6	Binders (polyvinyl acetate)	1	6,900	6,900
7	Release agents (polyvinylalchol)	1	3,400	3,400
8	Wax (mirror glaze).	2	2,000	2,000
9	Paint Brush	1	350	350
10	Scissors	1	150	150
11	Rubber Hand Gloves	1	400	400
12	Rollers	2	500	1,000
Total		**21**	**26,550**	**32,300**