

**BUSITEMA UNIVERSITY**



**FACULTY OF ENGINEERING**

**DEPARTMENT OF TEXTILE AND GINNING ENGINEERING**

**THE SUITABILITY OF UGANDAN BANANAS FIBRE FOR COMPOSITE  
APPLICATIONS**

**BY**

**OKELLO JOE**

**BU/UG/2009/82**

**A PROJECT REPORT SUBMITTED TO THE FACULTY OF ENGINEERING IN  
PARTIAL FULFILMENT OF THE AWARD OF BACHELOR OF SCIENCE IN  
TEXTILE AND GINNING ENGINEERING OF BUSITEMA UNIVERSITY**

**MAY 2013**

### DECLARATION

I, **OKELLO JOE**, do declare that this report entitled “the suitability of Ugandan bananas fibre for structural applications” is the result of my own research except the quotations and summaries that I have stated the sources clearly.

Signature: *Okello Joe*.....

Date: *28/05/2013*.....



## DEDICATION

I dedicate this project report to my dear parents, aunts, uncle and cousins for all the financial, moral and spiritual support they offered to me during my education carrier and make me fulfill my dream

May the Heavenly Father bless them abundantly!

## ACKNOWLEDGEMENT

Firstly, I would like to express my greatest gratitude to Mr. Rwawiire Samson and Madam Namuga Catherine for their invaluable guidance.

I would like to acknowledge my lovely parents, brothers and sisters whose wisdom and love shaped me as I grew up.

I would like to extend my great appreciations to all Textile and Ginning Engineering program lecturers and supporting staff in Busitema University.

Many thanks go to all my friends and colleagues in Busitema university main campus especially; Mutabazi Denis, Kashemri Damalie, Osinde Job, Habby geoffrey and Luggya George, for their support and help during my project.

Thus, I would like to thank everyone from the bottom of my heart and may almighty God bless you all!

### APPROVAL

This project report by **Okello Joe** has been prepared under my supervision and is now ready for presentation to the Department of Textile and Ginning Engineering of Busitema University with my approval.

Signature: .....

Date: .....

Mr. Rwawiire Samson

Signature.....

Date.....

Ms Namuga Catherine

## LIST OF TABLES

Table 1(a) Physical properties of different cellulosic fibre .....	6
Table 2 summarizes the basic properties of various natural fibres.....	8
Table 3 chemical composition of various types of natural fibers.....	9
Table 4 Moisture content of various fibres.....	23
Table 5 Fibre linear density of matooke, beer type of banana fibres and Glass fibres .....	24
Table 6(a) elongation and load as applied to single fibre of matooke type.....	25
Table 7 tensile strength of pure epoxy.....	26
Table 8 Tensile strength of the banana fibre composite.....	28
Table 9 the flexural strength and the load reading results from the dial reading .....	31
Table 10 flexural strength of a pure epoxy.....	32

## LIST OF FIGURES

Figure 1 shows different types of fibres base on their group.....	4
Figure 2(a) Musa plant .....	5
Figure 3 single fibre strength tester.....	17
Figure 4 preparation of a composite involving the different kind of weave.....	19
Figure 5 composite of both twill (left) and plain (right) weaves of the two species .....	20
Figure 6 Banana fibre composite under three point bending test using a multiplex loader.....	21
Figure 7 banana fibres before (left) and after treatment (right).....	22
Figure 8 a plot of stress against strain for pure epoxy sample.....	27
Figure 9 Sequence of micromechanics failure in composite.....	35

## ABSTRACT

Banana plant fibres which are abundantly available, banana fibre is light but high moisture content and less dense compared with other fibre. The fibre tensile properties are relatively low compare to the literature which may due to degradation problems. This study initially investigated the tensile behavior of single banana fibre and physical properties like, moisture content and fibre density. Then, the tensile behavior of banana fibre reinforced composites as a function of weave pattern (plain) and fibre surface modification. Lastly, comparing flexural strength and flexural modulus of reinforced composite with the weave pattern species of banana fibre composite was tested and was compared with epoxy resin property (control experiment). The stiffness of the composite is significantly improved when the fabric is increased. The failure pattern of the composite also study in the project and it show a matrix failure pattern. The alkali treatment increases of the tensile strength of the fibres. Banana fibre composite could be used as strengthening material in structural applications.



## TABLE OF CONTENTS

<b>DECLARATION</b> .....	<b>i</b>
<b>DEDICATION</b> .....	<b>ii</b>
<b>ACKNOWLEDGEMENT</b> .....	<b>iii</b>
<b>APPROVAL</b> .....	<b>iv</b>
<b>LIST OF TABLES</b> .....	<b>v</b>
<b>LIST OF FIGURES</b> .....	<b>vi</b>
<b>ABSTRACT</b> .....	<b>vii</b>
<b>INTRODUCTION</b> .....	<b>1</b>
1.1 Background .....	1
1.2 Problem Statement .....	2
1.3 Objectives .....	2
1.3.1 Main objective .....	2
1.3.2 Specific objectives .....	2
1.4 Justification .....	3
1.5 Scope .....	3
<b>LITERATURE REVIEW</b> .....	<b>4</b>
2.1 Banana plant .....	4
2.1.2 Structure and properties of banana fibers .....	4
2.1.3 Application of banana fibre .....	7
2.2 Mechanical properties of banana fibres .....	7
2.2.1 Research so far done on Banana reinforced composite .....	8
2.2.2 Chemical treatment of the banana fibres .....	8
2.2.3 Role of matrix materials in composites .....	10
2.3 Banana fiber reinforced with thermo set plastic composites .....	10
2.3.1 Banana fiber reinforced with thermoplastic composites .....	11
2.3.2 Banana fiber reinforced with biodegradable composites .....	12
2.3.3 Characteristic of biodegradable composites resin .....	12
<b>GENERAL METHODOLOGY</b> .....	<b>13</b>
3.1 Study design .....	13
3.2 Sampling design .....	14

---

3.3 Procedure used in the extraction of banana fibers.....	14
3.4 Chemical Treatment on banana Fibres .....	14
3.5 Measurement of the fibres properties .....	15
3.5.1 Fibre diameter.....	15
3.5.2 Tensile Properties of banana Fibre .....	15
3.5.3 Measurement of mass per unit length of the fibre (density of the fibre) .....	17
3.6 Material preparation for fabrication of banana fibre reinforced composite.....	18
3.6.1 Setting Time .....	18
3.6.2 Fabrication of Composite .....	18
3.6.3 Tensile Test.....	20
3.6.4 Flexural Test.....	20
3.7 Conclusions.....	21
4.1 General.....	22
4.2 Physical properties.....	22
4.2.1 Fibre Length .....	22
4.2.2 Moisture content in banana fibres.....	23
4.2.3 Fibre linear Density .....	24
4.2.4 Tensile strength of the two species of banana Fibre.....	25
4.3 Effect of chemical treatment to banana fibres .....	26
4.4 Tensile strength property of pure epoxy (Control Experiment) .....	26
4.4.1 Tensile strength of the banana fibre composite .....	27
4.4.2 Flexural strength of the composite .....	31
4.4.3 Flexural strength of the pure epoxy .....	32
4.5 Failure pattern.....	34
<b>CONCLUSIONS AND RECOMMENDATION.....</b>	<b>36</b>
Conclusion .....	36
Future recommendation .....	36
<b>REFERENCES .....</b>	<b>37</b>

## INTRODUCTION

### 1.1 Background

It is a well known fact that banana is one of the oldest cultivated plants in the world. The word 'banana' comes from the Arabic language and means 'finger'. It belongs to the Musaceae family. The main countries of origin of banana plants are India, Indonesia and Philippines. East Africa produces over 20 million tones of bananas annually which accounts for 25.58% of total world output. Uganda is among the world's leading countries in terms of banana production with an annual output of 9.84 million tones accounting for 11.18% of the world's total production. The area under banana production is 1.3 million hectares and this constitutes 75% of arable land (NARO, 2011) since each house hold has to grow it for food consumption and for generating income. The banana basts /pseudo stem are usually treated as residue product and cause environmental problems when disposing by burning them (Johnston, T. 2003).

Comparatively, man made fibers are created by humans from minerals like petroleum sources. Recently, due to uncertain conditions in the shortage, increased environmental consciousness, toxic, high energy consumption for production, high cost of petroleum, and its by products, there is a need to search for its alternate which is nothing but natural according to (Schemenauer et.al., 2000). In recent years the plant fibers proves itself as an alternative fiber to its synthetic counterpart due to that natural fibers are cheaper, bio-degradable and have no health hazard. Furthermore natural fiber reinforced fibers are seen to have good potential in the future as a substitute. It is interesting to note that natural fibers such as banana, sisal, etc., are abundantly available in countries like Uganda and some of the East African countries but are not optimally utilized. At present these banana fibers are used in a conventional manner for the production of yarns, ropes, mats, paper, cordage, tea bags, handbags, footwear and as well as in making articles like wall hangings, table mats, handbags, and purses and also used in making cloth.

The potential of banana fibres replacing synthetic fibres in composite is possible. In general, banana fibres offer high specific properties, low cost, light in weight, non abrasive, readily available and environmental friendly where no synthetic fibres can surpass these advantages according to (Matthiesen, M. L; Boteon, M. 2003 ). These advantages attract me to

## REFERENCES

1. Issac M. Daniel and Ori Ishai (1994), "Engineering Mechanics of Composite Materials", Oxford University Press,
2. [http://www.fibre-x.com/process\\_fibre.php](http://www.fibre-x.com/process_fibre.php)
3. C.A.S.Hill, H.P,S.Abdul Khalil (1999), "The Effect of Environmental Exposure Upon the Mechanical Properties of banana fibre Reinforced Composites",
4. [www.thebananagroup.uk.net/banana\\_group.html](http://www.thebananagroup.uk.net/banana_group.html)
5. Savastano, Jr, H., Warden, P. G. And Coutts, R. S. P. (2003). Potential of Alternative Fiber Cement as Building Material for Developing Areas, Journal of Cement Concrete and Composites, 25: 585 - 596.
6. Zhu, W. H., Tobias, B. C., Coutts, R. S. P. and Langfors, G. (1994). Air-cured Banana-fiber-reinforced Cement Composites, Journal of Cement and Concrete Composites, 16: 3 - 8.
7. Joseph, S., Sreekala, M. S., Oommen, Z. and Thomas, S. (2002). A Comparison of the Mechanical Properties of Phenol Formaldehyde Composites Reinforced with Banana Fibers and Glass Fibers, Journal of Composite Science and Technology, 62: 1857 -1868.
8. Maleque, M. A., Belal, E. Y. and Sapuan, S. A. (2006). Mechanical Properties of Study of Pseudo-stem Banana Fiber Reinforced Epoxy Composite, the Arabian Journal for Science and Engineering, 32: 359 - 363.
9. Kumar, R., Choudary, V., Mishra, S. and Varma, I. K. (2008). Banana Fiber Reinforced Biodegradable Soy Protein Composites, Frontiers of Chemistry in China, (3): 243 - 250.
10. Pothan, L. A., Oommen, Z. And Thomas, S. (2003). Dynamic Mechanical Analysis of Banana a Fiber Reinforced with Polyester Composites, Journal of Composite Science and Technology, 63: 283 293.
11. ASTM D368: Standard Test Method for Tensile Properties of Plastics.