ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering
IJARMATE IJARMATE) Vol. IV, Issue V, May 2018

Study and characterization of NFRPC using human Bone Grafting Substitutes

P.Venkatesan[1] S.Sugumar[1] Samuel.M[1]

1Assistant Professor,Department of Mechanical Engineering,Indra Ganesan College of Engineering,Trichy 620 012,India

Abstract- Bones are living tissues, consists of minerals like calcium and phosphorus. They grow rapidly during one's early years and renew themselves. The bone is considered as a linear-elastic, isotropic and homogeneous material. Bones are the essential part of the human skeleton. It helps to support the softer parts of the body. Trauma is a major cause of death and disability in both developed and developing countries. The World Health Organization (WHO) predicts that by the year 2020, trauma will be the leading cause of years of life lost for both developed and developing nations. In the last decades, researchers have developed new materials to improve the quality of human life. Owing to the frequent occurrence of bone fractures, it is important to develop plate materials for the fixation of fractured bones. These plate materials have to be lightweight, compatible with human tissues and ought to allow stiffness. Natural fibers have the advantage that they are renewable resources and have marketing appeal. The Asian markets have been supplying natural fibers for many years, e.g., sisal, banana and Roselle are common reinforcement in India. The aim of this project is to fabricate Roselle (Hibiscus sabdariffa), with bio epoxy resin Grade 3554A and Hardener 3554B, using molding method and characterizing its mechanical behavior as bone grafting instead of Orthopedic alloy plates. The objective of this research was to utilize the advantages offered by renewable resources for the development of bio composite materials based on biopolymers and natural fibers.

Key words-Bone, Roselle, Natural fiber, bio epoxy, modeling,characterization.

1.Introduction: Natural fibers present important advantages such as low density, appropriate stiffness and mechanical properties and high disposability and renewability. Moreover, they are recyclable and biodegradable. Over the last decade, the composites of polymers reinforced with natural fibers have received in- creased attention. Natural fibers such as sisal, flax, jute and wood-fibers possess good reinforcing capability when properly compounded with polymers. One of the unique aspects of designing the parts with fiber-reinforced composite materials is that the mechanical properties of the material can be tailored to fit a certain application. By changing the orientation or placement of the fibers the material can be de- signed to exhibit properties that are isotropic or highly anisotropic, depending on the desired end results. In the last decades, researchers have developed new materials to improve the quality of human life. Owing to the frequent occurrence of bone fractures, it is important to develop plate materials for the fixation of fractured bones. Orthopaedic surgeons have

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering
IJARMATE) Vol. IV, Issue V, May 2018

been using metallic bone plates for the fixation of humerus bone fractures. Apparently, metallic prostheses, which are generally made of stainless steel and titanium alloys, cause problems like metal incompatibility, corrosion, magnetism effect, anode-cathode reactions, including a decrease in bone mass (osteopenia), increase in bone porosity (osteoporosis), and delay in fracture healing. Due to insufficient bone growth, refractures after the removal of the prostheses are also widely reported. It was also found that the difference in the elasticity of a metallic implant and bone may cause loosening of the implant [4]. Also, in composite plates, the screw at the area of maximum bending moment was found to back out of the bone while it is rare in metal plates Thus, research on alternative implant materials has been undertaken in the past decade. Natural fiber reinforced polymer composite materials which are less rigid than metals may be good alternatives because of properties closer to bone mechanical properties. It was found that they help to avoid stress shielding and increase bone remodeling. A tubular composite bone cast for improving the efficiency and quality of bone fracture treatment is investigated. Finite element analysis was used to evaluate stress concentration in fracture sites supported which plate and tubular casts. The stress in a plated bone is 76.8 % of that in a whole bone at the same location, while it is only 47 % in a bone with a tubular cast. Three unbroken synthetic humeri were mechanically tested using an in-vitro long bone testing procedure developed in- house to find their stiffness at 20 degree and 60 degree abduction. This novel method of bone casting is promising if other clinical challenges can be minimized.

2. Materials and Methods

2.1 Roselle Fiber : The roselle (Hibiscus sabdariffa) is a species of hibiscus native to the old world tropics. It is an annual or perennial herb or woody-based subshrub, growing to 2–2.5 m tall. The leaves are deeply three- to five- lobed, 8–15 cm long, arranged alternately on the stems. The flowers are 8–10 cm in diameter, white to pale yellow with a dark red spot at the base of each petal, and have a stout fleshy calyx at the base, 1.5–2 cm wide, enlarging to 3–3.5 cm, fleshy and bright red as the fruit matures. It is an annual plant, and takes about six months to mature.

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

IJARMATE
International Journal of Advanced Research in Management, Architecture, Technology and Engineering
IJARMATE) Vol. IV, Issue V, May 2018

Fig 1 Roselle Fiber

Fig 2 Fabrication Bio composite

Roselle is native to the areas from India to Malaysia, where it is commonly cultivated, and must have been carried at an early date to Africa. It has been widely distributed in the tropics and subtropics of both hemispheres, and in many areas of the West Indies and Central America has become naturalized.

Fiber	Density (g/cm^3)	Elongation (%)	Tensile strength (MPa)	Elastic Modulus (GPa)
Roselle	1.45	1.6	930	53

Table 1 Comparison of properties of Roselle fiber

2.2 Bio Epoxy Resin: Epoxy resins are low molecular weight pre-polymers or higher molecular weight polymers which normally contain at least two epoxide groups. The epoxide group is also sometimes referred to as a glycidyl or oxirane group.Epoxy resins, also known as polyepoxides are a class of reactive prepolymers and polymers which contain epoxide groups. Epoxy resins may be reacted (cross-linked) either with themselves through catalytic homopolymerisation, or with a wide range of co-reactants including polyfunctional amines, acids (and acid anhydrides), phenols, alcohols, and thiols. These co-reactants are often referred to as hardeners or curatives, and the cross-linking reaction is commonly referred to as curing. Reaction of polyepoxides with themselves or with polyfunctional hardeners forms a thermosetting polymer, often with strong mechanical properties as well as high temperature and chemical resistance.

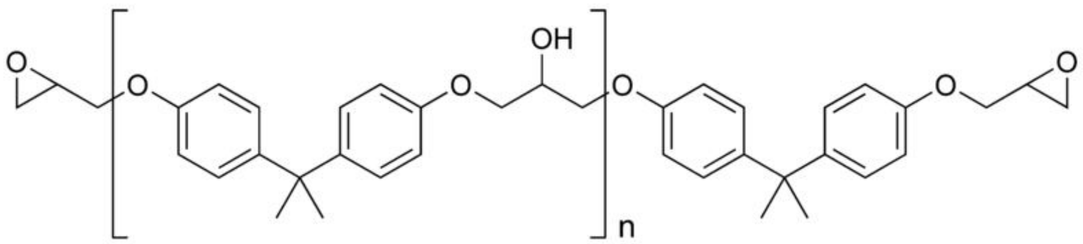

Fig 3 Chemical structure of bio epoxy resin 3354A

2.3 Curing agents (Hardener 3354B): Curing agents play an important role in the curing process of epoxy resin because they relate to the curing kinetics, reaction rate, gel time, degree of cure, viscosity, curing cycle, and the final properties of the cured products. The selection of curing agents is a critical parameter. There are numerous types of chemical reagents that can react with epoxy resins. Besides affecting viscosity and reactivity of the formulation, curing agents determine both the types of chemical bonds formed and the functionality of the cross-link junctions that are formed. Thermal

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering IJARMATE) Vol. IV, Issue V, May 2018

stability is affected by the structure of the hardener.

3. Modeling and Testing Analysis

3.1 Flexural rigidity (ASTM D790)

Volume of the Mold = 13 X 1.3 X 0.8 = 13.52 cm^3

Density of the Roselle fiber = 1.45 g/cm^3

Mass = 1.45 x 13.52 = 19.604 g

Specimen	% of fiber	% of matrix	Mass of the fiber (g)	Mass of the matrix (g)	Total mass of the composite (g)
00001	35	65	6.8614	12.7426	19.604

Table 2Volume fraction of fiber for the flexural specimen.

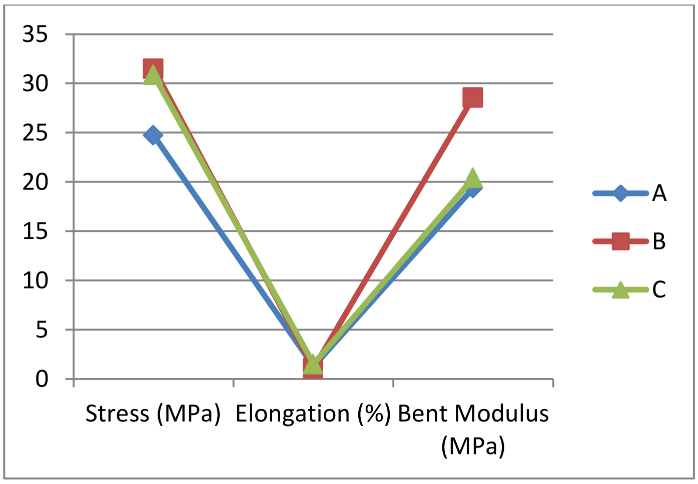

Fig 4 Flexural tested specimen Fig 5 Flexural Rigidity of values of specimen

3.2Tensile test (ASTM D7205) [10]

Volume of the mold = 20 X 3 X 0.5 = 30cm^3

Density of the Roselle fiber = 1.45 g/cm^3

Mass = 1.45 x 30 = 43.5 g

Specimen	% of fiber	% of matrix	Mass of the fiber (g)	Mass of the matrix (g)	Total mass of the composite (g)
00001	35	65	15.225	28.275	43.5

Table 3 Volume fraction of fiber for the tensile specimen.

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com
International Journal of Advanced Research in Management, Architecture, Technology and Engineering
IJARMATE) Vol. IV, Issue V, May 2018

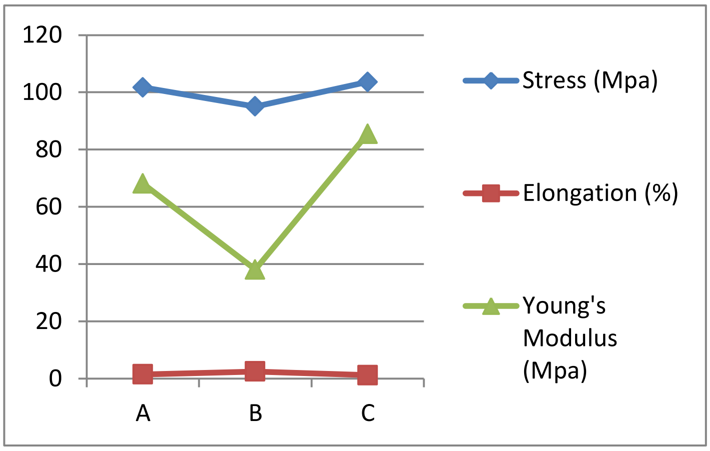

Fig 6 Tensile test specimenFig 7 Tensile values of specimen

3.3Impact Test

Charpy - Impact Test (ASTM A370)

Volume of the mold = 5.5 x 1 x 1 = 5.5cm^3

Density of the Roselle fiber = 1.45 g/cm^3

Mass = 1.45 x 5.5 = 7.975 g

Specimen	% of fiber	% of matrix	Mass of the fiber (g)	Mass of the matrix (g)	Total mass of the composite (g)
00001	35	65	2.79125	5.18375	7.975

Table 4 Volume fraction of fiber for the izod impact specimen.

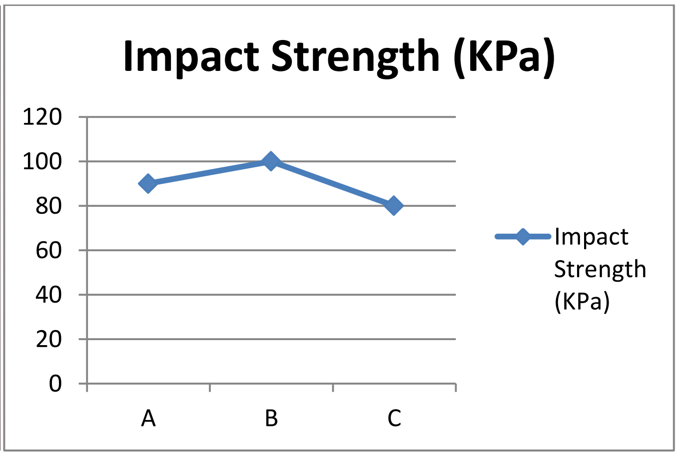

Fig 8 Bio composite specimen Fig 9 Impact test values of specimen

4. Conclusion:

➢ After determining the material properties of natural fiber-reinforced epoxy composite using Roselle fiber reinforced polymer matrix composite materials and geometries subjected to Tensile test, Impact test, flexural test, Shore D Hardness.

- The composites showed comparatively better performance.
- The materials used in this experimental work is roselle fiber reinforced composites will be coated with calcium phosphate and hydroxyapatite (hybrid) composite.
- This plate material can be used for both inside and external fixation of human fractured bone.

5.References

[1] Chandramohan D, Marimuthu K. European Journal of Scientific Research 2011, 54:384-406.
[2] Chandramohan D, Marimuthu K. Acta of Bioengineering and Biomechanics 2011, 13:77-84.
[3] Chandramohan D, Marimuthu K. International Journal of Advanced Medical Sciences and Applied Research 2011, 1:9-12.
[4] Chandramohan D, Marimuthu K. International Journal of Advanced Engineering Technology 2011,2:435-448.
[5] Chandramohan D, Marimuthu K. International Journal of Current Research 2011, 3:331-337.
[6] Chandramohan D, Marimuthu K. International Journal of Engineering Research and Applications 2011,1:1256-1261.
[7] Chandramohan D, Marimuthu K. International Journal of Advanced Engineering Sciences and Technologies 2011, 6:97-104.
[8] Chandramohan D, Marimuthu K. International Journal of Materials Science 2010, 3:445-463.
[9] Chandramohan D, Marimuthu K, Rajesh S, Ravikumar MM. International Journal of Applied Engineering.Research 2010, 5:1653-1666.
[10] R. Manikandan, T.R. Manimaran, V. Roopesh Babu, M. SAMUEL M.Tech., Fabrication Of Bamboo Fibre Reinforced Polymer Matrix Composites. **Advances in Natural and Applied Sciences.** 10(4);