PAPER ID –D14

STRENGTH OF COCONUT FIBRE COMPOSITE

Ganesh Sirsat
Student, Department of Mechanical Engineering (sandwich)
ICEM, Parandwadi, Pune, India
Amit Narwade
Assistant Professor, Department of Mechanical Engineering (sandwich)
ICEM, Parandwadi, Pune, India

Abstract— This paper presents the versatility of coconut fibers and its applications in different branches of engineering. In present days, automobile industries are rapidly increased. All the automobile industries are in the process of supplying the vehicles at low cost. The major cost of the automobile components is its body parts. As per the any automobile industries concentrate with automotive components end life is very important factor in the design of the automotive. So, everybody is concentrating on new materials which will be strong enough, less weight, recyclable with reduced cost. Hence all the researchers are concentrated on the composite materials which have all the above properties. Hence the present work is concentrated on coconut coir fibre.

Coconut fibre is one of the natural fibres abundantly available in tropical regions, and is extracted from the husk of coconut fruit. Not only the physical, chemical and mechanical properties of coconut fibres are shown; but also, properties of composites in which coconut fibres are used as reinforcement, are discussed.

Keywords— Coconut Coir, Hybrid Composite, Tensile Properties, Flexural Properties, Water Absorption.

I. INTRODUCTION

The increase in environmental consciousness and community interest, the new environmental regulations and unsustain- able consumption of petroleum, led to thinking of the use of environmentally friendly materials. Natural fiber is considered one of the environmentally friendly materials which have good properties compared to synthetic fiber.

The availability of natural fibers is abundance and also, they are very inexpensive when compared to other advanced man-made fibers. These natural fibers are used as a suitable reinforcing material environmental concern and they are now emerging as a potential alternative for glass fibres in engineering composites. The natural fibers are used as reinforcements for composite materials due to its various advantages compared to conventional man-made fibers.

The primary advantages of natural fibers are low density, low cost, biodegradability, acceptable specific properties, less wear during processing and low energy consumption during extracting as well as manufacturing composites and wide varieties of natural fibers are locally available.

Coconut fibre is extracted from the outer shell of a coconut. The common name, scientific name and plant family of coconut fibre is Coir, Cocos nucifera and Aceraceae (Palm), respectively. There are two types of coconut fibres, brown fibre extracted from matured coconuts and white fibres extracted from immature coconuts. Brown fibres are thick, strong and have high abrasion resistance. White fibres are smoother and finer, but also weaker.

Coconut fibres are commercially available in three forms, namely bristle (long fibres), mattress (relatively short) and decorticated (mixed fibres). These different types of fibres have different uses depending upon the requirement. In engineering, brown fibres are mostly used.

One of the main concerns for the use of coconut fiber reinforced composite materials is their susceptibility to moisture absorption and the effect on physical andmechanical properties. Coir comes from the husk of coconut fruit fiber. Coir has more life compared to other natural fibers due to its high lignin content. Coir fiber reinforced with both thermoset and thermoplastic resins. The mechanical property of the composite depends on interfacial adhesion of fiber to the matrix material. The coconut husk is that part of the coconut found around the outer shell. Fibrous husks have a number of uses including fuel, as they can be used as a source of charcoal. Better still when burnt they are a good mosquito repellant as these unwanted insects don't like the smell of coconut husks burning and so the smoke effectively gets rid of them. Coir is a natural fiber that is made from coconut husks and is used to make all kinds of household items including rope, string, brushes, mats, and in some parts of the world, stuffing for mattresses. Coconut husks are also used to make contemporary flooring materials.

Coir fiber reinforced polymer composites developed for industrial and socio- economic applications such as automotive interior, paneling and roofing as building materials, storage tank, packing material, helmets and post boxes, mirror casing, paper weights, projector cover, voltage stabilizer cover. Coir fibers are more efficient and superior in reinforcement performance when compared to other reinforcement composite.

II. STRUCTURE OF COIR

Coir fibres are found between the hard, internal shell and the outer coat of a coconut. The individual fibre cells are narrow and hollow, with thick walls made of cellulose. They are pale when immature, but later become hardened and yellowed as a layer of lignin is deposited on their walls. Each cell is about 1 mm (0.04 in) long and 10 to 20 μm (0.0004 to 0.0008 in) in diameter. Fibres are typically 10 to 30 centimetres (4 to 12 in) long. The two varieties of coir are brown and white. Brown coir harvested from fully ripened coconuts is thick, strong and has high abrasion resistance. It is typically used in mats, brushes and sacking. Mature brown coir fibres contain more lignin and less cellulose than fibres such as flax and cotton, so are stronger but less flexible. White coir fibres harvested from coconuts before they are ripe are white or light brown in colour and are smoother and finer, but also weaker. They are generally spun to make yarn used in mats or rope. The coir fibre is relatively waterproof, and is one of the few natural fibres resistant to damage by saltwater. Fresh water is used to process brown coir, while seawater and fresh water are both used in the production of white coir.

1.Brown fibre

The fibrous husks are soaked in pits or in nets in a slow-moving body of water to swell and soften the fibres. The long bristle fibres are separated from the shorter mattress fibres underneath the skin of the nut, a process known as wet-milling. The mattress fibres are sifted to remove dirt and other rubbish, dried in the sun and packed into bales. Some mattress fibre is allowed to retain more moisture so it retains its elasticity for twisted fibre production. The coir fibre is elastic enough to twist without breaking and it holds a curl as though permanently waved. Twisting is done by simply making a rope of the hank of fibre and twisting it using a machine or by hand. The longer bristle fibre is washed in clean water and then dried before being tied into bundles or hanks. It may then be cleaned and'hackled' by steel combs to straighten the fibres and remove any shorter fibre pieces. Coir bristle fibre can also be bleached and dyed to obtain hanks of different colours.

2.White fibre

The immature husks are suspended in a river or water-filled pit for up to ten months.During this time, micro-organisms break down the plant tissues surrounding the fibres to loosen them — a process known as retting. The Segments of the husk are then beaten by hand to separate out the long fibres which are subsequently dried and cleaned. Cleaned fibre is ready for spinning into yarn using a simple one-handed system or a spinning wheel.

III. MATERIALS AND METHODS

A. Matrix

Epoxy is a thermosetting polymer that cures (polymerizes and cross links) when mixed with a hardener. Epoxy resin of the grade LM-556 with a density of 1.1–1.5 g/cm3 was used. The hardener used was HY-951. The matrix material was prepared with a mixture of epoxy and hardener HY-951 at a ratio of 10:1

B.Fibres

The fibers used for the fabrication of the composites are Coconut coir (short fibers) and Sisal fibers (long fibers)

1. Coconut Coir

Coir comes from the husk of coconut fruit fibres. Coir has more life compared to other natural fibers due to its high lignin content. Coir fiber reinforced with both thermosetting and thermoplastic resins. The mechanical property of the composite depends on interfacial adhesion of fiber to the matrix material. Coir fiber showed very high interfacial adhesion under dry conditions. Coir fiber is used in a wide variety of ways. Ropes, mats, brushes, furniture, car seat covers, mattresses, packaging, floor coverings, pots and basket liners.

Fig -1: Sisal fibres

1. Sisal fibres

Sisal is a natural fibre (Scientific name is Agave sisalana) of Agavaceae (Agave) family yields a stiff fibre traditionally used in making twine and rope. Sisal is fully biodegradable and highly renewable resource of energy. Sisal fibres is exceptionally durable and a low maintenance with minimal wear and tear. Sisal fibres is extracted by a process known as decortication, where leaves are crushed and beaten by a rotating wheel set with blunt knives, so that only fibres will remain.

Fiber	*Species*	*Density (gm/cm^2)*	*Tensile Strength (MPa)*	*Young's Modulus (GPa)*
Sisal	Agave Sisilana	1.5	468	22
Coir	Cocos Nucifera	1.2	175	5

Table-1: Mechanical Properties of Sisal fibre and Coconut Coir

Fig -2: Sisal fibres

C. Fabrication of Composites:

The molds are cleaned and dried before applying polyester. Then a coat of wax layer is applied throughout the board to facilitate easy removal of the laminate. The fibers were laid uniformly over the mold before applying any releasing agent or polyester. After arranging the fibers uniformly, they were compressed for a few minutes in the mold. Then the compressed form of fibers (coconut coir/chicken feather) is removed from the mold. This was followed by applying the releasing agent on the mold, after which a coat of polyester resin was applied. The compressed fiber was laid over the coat of polyester, ensuring uniform distribution of fibers. The polyester mixture is then poured over the fiber uniformly and compressed for a curing time of 2hour, with load of 5kg. After curing the composites are sized according to ASTM standards.

Composites are prepared by changing the weight fractions of both coconut coir and chicken feather-fiber.

IV. APPLICATIONS IN OTHER ENGINEERING TECHNOLOGIES

1. Bullet proof vest:

Bullet proof vest made of coconut fibre, which provides all the protection that can be found in a regular vest. It is not only economical but also lighter.

A normal bullet-proof vest costs about RM 16, 000/- and weighs 9 kg, but this vest is only 3 kg and cost RM 2, 000/-. The test proved that the vest was capable of stopping 9mm caliber bullets at a 5 m range.

2. Motorcycle helmet:

coconut fibres are also used in the manufacturing of motor cycle helmet. By using epoxy resins from thermo set polymer as the matrix materials and coconut fibres as the reinforcement. After the development of helmet shells fabrication method, mechanical testing (dynamic penetration) was performed on this composite material to determine its performance.

The result in the mechanical performance showed that coconut fibers performed well as a suitable reinforcement to the epoxy resin matrix.

3. Car parts

coconut fiber is also used asreplacement for synthetic polyester fibers in compression molded composites.

The aim is to use this coconut fibers to make trunk liners, floorboards and interior door covers on cars.

4.General use

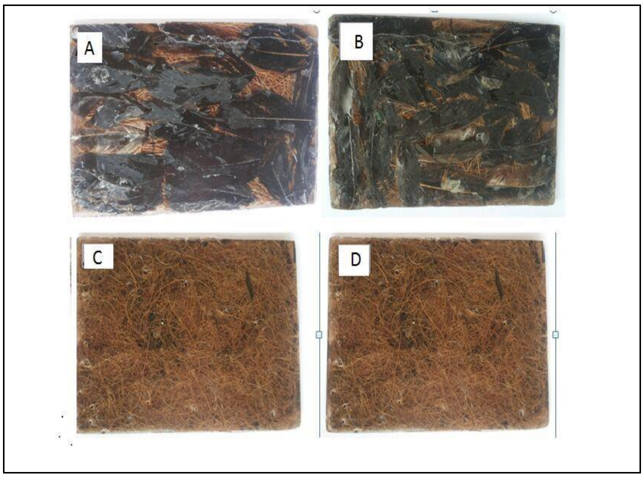
Apart from applications in engineering, coconut fibres are also used in yarn, ropes, mats, mattresses, brushes, sacking, caulking boats, rugs, geo-textiles, insulation panels and packaging.

V. CONCLUSION

Coconut fibres are reported as most ductile and energy absorbent material. It is concluded that coconut fibres have the potential to be used in composites for different purposes. The use of coconut fibres has given some marvellous products. From the present work it is concluded that the tensile strength and impact strength of composites depend on coconut coir fibre. This work shows that successful fabrication of a coconut coir fibre feather reinforced polyester hybrid composites with different weight fraction of fibre is possible by using simple hand lay-up technique. Coconut fibre composites have beneficial properties such as low density, less expensive, and reduced solidity when compared to synthetic composite products, thus providing advantages for utilization in commercial applications (automotive industry, buildings, and constructions).

VI. ACKNOWLEDGEMENT

"STENGTH OF COCONUT FIBRE COMPOSITES" has been a wonderful subject to research upon, which leadsone's mind to explore new heights in the field of Mechanical Engineering. I wish to express my senior thanks and deep sense of gratitude to respected guide Prof. AmitNarwade in department of Mechanical



Engineering of Indira College of Engineering and Management for the technical advice, encouragement and constructive criticism which motivated me to strive harder for excellence.

VII. REFERENCES

1..Girisha.C, Sanjeevamurthy, GuntiRanga Srinivas: 'Sisal/Coconut Coir Natural Fibers – EpoxyComposites'International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 3, September 2012.

2. Majid Ali: 'Coconut Fibre – A Versatile Material and its Applications in Engineering' SeniorEngineer, Structure Design Section, National Engineering Services Pakistan (NESPAK) Islamabad Office. June 30, 2010,

3. Alagarsamy.S.V1, Arockia Vincent Sagayaraj.S2, Vignesh.S.3 'Investigating the Mechanical Behaviour of Coconut Coir – Chicken Feather Reinforced Hybrid Composite' : 1Asst. Professor, Dept of Mechanical Engg, MahathAmma Institute of Engg& Tech, Pudukkottai,India, 2Asst. Professor, Dept of Automobile Engg, Shanmuganathan Engineering College, Pudukkottai, India, 3Lecturer, Dept of Mechanical Engg, MahathAmma Institute of Engg& Tech, Pudukkottai, India; December 2015

4. N. M. Ansari,1 Grace Pua,1 Mohammad Jawaid,2 and M. Saiful Islam: 'A Review on Natural Fiber Reinforced Polymer Composite and Its Applications':1 Centre for Advance Materials, Department of Mechanical Engineering, UniversitiTenagaNasional, 43000 Kajang, Selangor, Malaysia,2Laboratory of Biocomposite Technology, Institute of Tropical Forestry and Forest Products (INTROP), University Putra Malaysia (UPM), 43400 Serdang, Selangor, Malaysia,3Department of Chemistry, Faculty of Science, University Putra Malaysia (UPM), 43400 Serdang, Selangor, Malaysia. 30 August 2015