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EVALUATION OF MECHANICAL PROPERTIES OF HEMP AND WOOL NATURAL FIBERS

E LS MOHITHA[1], C. VENKAT SIVA MURALI[2]

[1]P.G Student (Machine Design) Department Of Mechanical Engineering, SRI PADMAVATHI MAHILA VISWAVIDYALAM, TIRUPATHI.
[2]Assistant Professor Department Of Mechanical Engineering, SRI PADMAVATHI MAHILA VISWAVIDYALAM, TIRUPATHI

ABSTRACT: In the present investigation natural fiber hemp and wool is reinforced with epoxy resin. These fiber reinforced composites were successfully prepared by simple and cost effective synthesis methods by hand lay process. The synthesized composites were subjected to different characterization techniques to test its suitability in different mechanical components. To test its suitability, mechanical properties such as tensile strength and hardness subjected to different composition of the hardener and resin percentage they are Epoxy resin 70%+ hardener 30%, Epoxy resin 75%+ hardener 25% and Epoxy resin 80%+ hardener 20%. The mechanical yield for different compositions of fiber and resins is discussed in detail.

In this project, we are also conducted static, modal and random vibration analysis in ANSYS Software.

Static, modal and random vibration analysis is for determining stress, deformation, strain frequency and shear stress.

Key words:Natural fiber,Hemp,wool,epoxy resin,hardner, hardness, impact and UTS.

INTRODUCTION

The artificial composites i.e. the conventional composites made from plastic based resins pollute the environment. There is increased demand to reduce the atmospheric pollution. The natural fibers are widely used in textiles from ancient times. The natural composites were also used from long time. The natural resins like starches can be used to make composites. The natural fibers from plants can be used to make composites. To reduce the pollution to some extent, the plastic based resins can used with natural fibers to make composites. These composites can be used as structural materials. The natural fibers can be obtained from plants, animals. But the plant fibers are widely used to make fabrics and the composites. The few examples for natural fibers from plants are flax, hemp, kenaf, jute, abaca, sisal, cotton, copal , flax, etc. The plant fibers can be obtained from various parts of plants like, roots, stem, leaves and fruits. Plant fibers have numerous advantages they are removable, they are low cost, they have low density, they are bio degradable etc. Plant fibers have many advantages compared to conventional reinforcements. These materials are renewable, have a low density compared to E-glass fibers, do not cause irritation when handled and are biodegradable under certain conditions.

Hemp

Advantage of hemp is that, it can be grown without chemicals, it gives long fibers. The scientific name of the hemp plant is cannabis sativa L

Fig: Hemp plant

Uses of hemp

Hempis used to make ropes, canvas,paper, fabrics, textiles, floor coverings. Jute fiber composites are widely used in automobiles, and civil engineering.

Wool

Wool is the textile fiber obtained from sheep and other animals, including cashmere and mohair from goats, quiet from muskoxen, from hide and fur clothing from bison, angora from rabbits, and other types of wool from camel lids; additionally, the Highland and the Mangalica breeds of cattle and swine, respectively, possess wooly coats. Wool consists of protein together with a few percent lipids.

In this regard it is chemically quite distinct from the more dominant textile, cotton, which is mainly cellulose.

Uses

•In addition to clothing, wool has been used for blankets, horse rugs, saddle cloths, carpeting, insulation and upholstery. Wool felt covers piano hammers, and it is used to absorb odors and noise in heavy machinery and stereo speakers. Ancient Greeks lined their helmets with felt, and Roman legionnaires used breastplates made of wool felt.

•Wool has also been traditionally used to cover cloth diapers. Wool fiber exteriors are hydrophobic (repel water) and the interior of the wool fiber is hygroscopic (attracts water); this makes a wool garment suitable cover for a wet diaper by inhibiting wicking, so outer garments remain dry. Wool felted and treated with lanolin is water resistant, air permeable, and slightly antibacterial, so it resists the buildup of odor. Some modern cloth diapers use felted wool fabric for covers, and there are several modern commercial knitting patterns for wool diaper covers.

PROPERTIES OF DIFFERENT NATURAL FIBERS

Table: 1.1. Properties of Different natural Fibers:

Properties	Hemp	Wool
Tensile Strength (Mpa)	250	120
Modulus (Gpa)	13.35	2.3 to 3.5
Elongation (%)	5.8 to 6.8	25 to 35
Density (g/cc)	0.86	1.54 to 1.56

LITERATURE SURVEY

Nicolas Martina, Nicolas Mouretc, Peter Daviesband ChristopheBaleya [1] found that the tensile strength of fibers increased with more retting of fibers. tensile strength aslo depends on aspect ratio of fibers, defects in fiber will reduce the tensile strength of fibers. R. Hemanth, M. Sekar , B. Suresha (2) note that Polyoxymethylene POM / polytetrafluroethylene PTEE resin based composites have better hardness, tensile and flextural properties when compared with Thermoplastic copolyester elastomer/ polytetrafluroethylene PTEE resin based composites. By adding more filler materials , the tensile strength is decreased further. G. Ramakrishna, T. Sundararajan and S. Kothandaraman (3) found that , interaction of resin (matrix) with other medium will influence the tensile properties of composites, so the use other mediums for any purpose should be evaluated properly. Generally the composites will be in NaOH medium for curing. SilvanaZhezhova, SanjaRisteski, Vineta Srebrenkoska1 (4) stated that for the textile fibers can be used to make the FRP composites, the advantage of the textile fibers is that they can be easily woven in 3Dimimentional array and can be woven in complex geometries. The fabrics have good physical, thermal, mechanical properties. They are good corrosion and wear resisting materials. With the good understanding of the behavior of fibers better FRP composites of textile can be fabricated. Textile fibers can be classified in four ways, fibers, yarns, two dimensional fabrics, and 3 Dimensional fabrics. There are new types of textile fibers like interlaced two dimensional fabrics, interlaced three dimensional fabrics, 2.5 D fabrics can be made by using different techniques of the wooing. Maria Cristina Santos Ribeiro et al (5) concluded that, there are no clearly defined methods for recycling the FRP composites. There are no better means of scrap of FRP composites, there no recycling units, no good marketing for FRP composites made from recycling. There is no FRP composites waste management. The landing by FRP composite waste creates environmental problems. Energy saving methods while producing the composites should encouraged a lot. The existing manufacturing methods should change with low energy input methods, this will decrease the cost of production and also environment pollution will be minimized. J.C. Chaplin (6) in his technical report on Effects of environmental factors on composite materials stated that, the study of the properties of the composites is complicated, because of their macroscopic anisotropy. The environment can influence the engineering response of the composite materials, the feasibility study can be

made by using conventional rate process theory. A correlation between strength of composite and environmental interaction. The elastic properties of materials can be divided into micro and macro mechanics. Micro deals with localized area on the composites, the macro deals with the quasi homogeneous media. The micro and macro are linked with unidirectional layer.

OBJECTIVE

The aim of the present project work is to fabricate various composite laminates with epoxy resin. The fibers used are, the hemp and wool fibers at different epoxy resin ratios (Epoxy resin 70%+ hardener 30%, Epoxy resin 75%+ hardener 25% and Epoxy resin 80%+ hardener 20%. The fabrication is done by hand lamination method. The tensile strength is found by ASTM D638.analysis done in ANSYS.

MATERIAL AND METHODS

Hemp

The scientific name f the hemp plant is cannabis sativa L. the hemp fibers long in length, they are used to make ropes, clothes, paper etc.

Fig: raw material of hemp

The glass fibers are relatively low cost than other conventional fibers. the defect is that , it breaks while bending and cuts the manufacturing tool material while fabrication. E -glass means the electrical glass, S-glass means Strength glass.

Wool

POLYMER: EPOXY RESIN:

Epoxy is the chemical name and Araldite is the marketing name by manufacturing company Hindustan international (India) private limited.

It has the following properties.

Good sticking, high strength, toughness, resistance to water, odorless, taste les and nontoxic.

Fig: hardener and resin

Epoxy consists of two liquids separately packed one is resin and other is hardener.

Resin is a glue, its binding agent, whereas hardener is a catalyst to accelerate binding action.

Tests Conducted

Tensile Test

Tensile testing, also known as tension testing is a fundamental materials science test in which a sample is subjected to a controlled tension until failure. The results from the test are commonly used to select a material for an application, for quality control, and to predict how a material will react under normal forces. Properties that are directly measured via a tensile test are ultimate tensile strength, maximum elongation and reduction in area. From these measurements the following properties can also be determined: Young's modulus, Poisson's ratio, yield strength, and strain-hardening characteristics.

Hardness Test

Shore Hardness is a measure of the resistance a material has to indentation. There are different Shore Hardness scales for measuring the hardness of different materials (soft rubbers, fibers, rigid plastics, and supersoft gels, for example). These scales were invented so that people can discuss these materials and have a common point of reference.

EXPERIMENTAL INVESTIGATION

Fabrication of natural Composites fiber

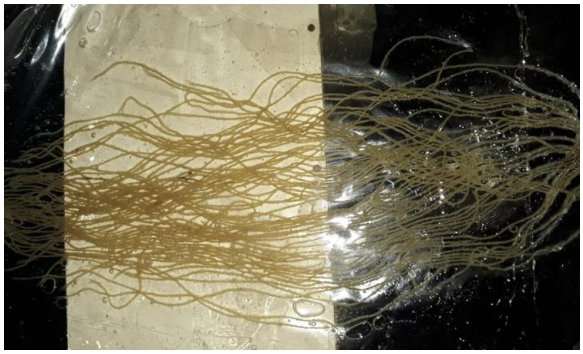
The composite laminate is made by hand fabrication method.

Hand layup Technique

Hand layup process is the easiest method of fabricating the FRP composites. The materials needed are least, a lay man can do the fabrication process. A long and wide plate taken as as a base. Not to stick the resin on this a wax is applied on it. If necessary a Teflon sheet can be placed.

A coating of resin is kept in uniform thickness on the entire area of the required size of laminate. Then a layer of evenly placed fiber kept over the resin, then a little amount of force is applied on it with roller. Then a coating of resin kept on it.

This processes repeated until required thickness is obtained. Then a coating of wax is kept to finish the product or a Teflon sheet is kept on it with a little weight.



INTRODUCTION TO CREO

Pro/ENGINEER, PTC's parametric, integrated **3D CAD/CAM/CAE solution**, is used by discrete manufacturers for mechanical engineering, design and manufacturing.Created by Dr. Samuel P. Geisberg in the mid-1980s, Pro/ENGINEER was the industry's first successful parametric, 3D CAD modeling system. The parametric modeling approach uses parameters, dimensions, features, and relationships to capture intended product behavior and create a recipe which enables design automation and the optimization of design and product development processes.

3D MODEL

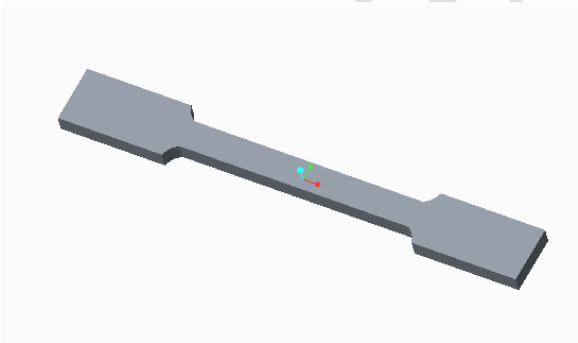


Fig:3d Model of Connecting Rod

2D MODEL OF CONNECTING ROD

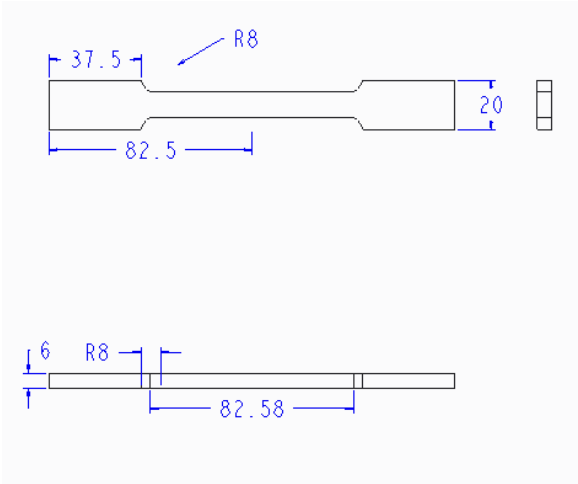


Fig: 2d Model of Connecting Rod

INTRODUCTION TO FEA

Finite element analysis is a method of solving, usually approximately, certain problems in engineering and science. It is used mainly for problems for which no exact solution, expressible in some mathematical form, is available. As such, it is a numerical rather than an analytical method. Methods of this type are needed because analytical methods cannot cope with the real, complicated problems that are met with in engineering. For example, engineering strength of materials or the mathematical theory of elasticity can be used to calculate analytically the stresses and strains in a bent beam, but neither will be very successful in finding out what is happening in part of a car suspension system during cornering.

Hemp Properties

	A	B	C	D
1	Property	Value	Unit	
2	Density	860	kg m^-3	
3	Isotropic Secant Coefficient of Thermal Expansion			
6	Isotropic Elasticity			
7	Derive from	Young's M...		
8	Young's Modulus	13350	MPa	

MATERIAL- HEMP

Deformation

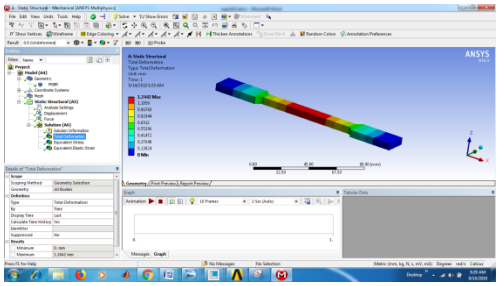


Fig: Deformation

Stress

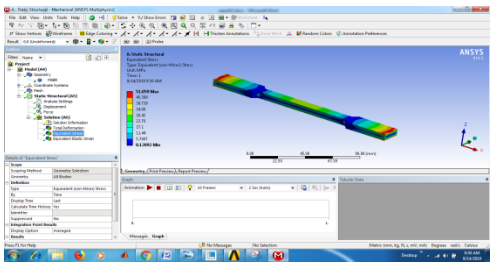
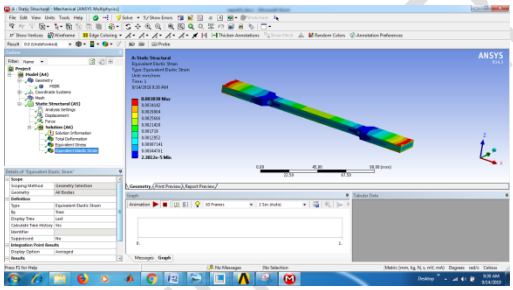


Fig: Stress

Strain



Results tables

Material	Deformation (mm)	Stress (N/mm²)	Strain
Hemp	1.242	51.059	0.003838
Wool	8.7518	61.882	0.026905

Modal analysis results

Material	Mode 1	Frequency	Mode 2	Frequency	Mode 3	Frequency
Hemp	7532.5	0	7760.5	2.2348e-03	6428	6.12e-3
Wool	4692	0	5788.8	0	5809.4	1.6741e-03

Random vibration analysis results

Material	Directional Deformation (mm)	Shear Stress (N/mm²)	Shear Strain
Hemp	3.59e-22	1.0905e-19	2.1238e-23
Wool	8.9022e-22	2.224e-20	2.478e-23

Machining Process for Tensile Test

Preparation of Specimens

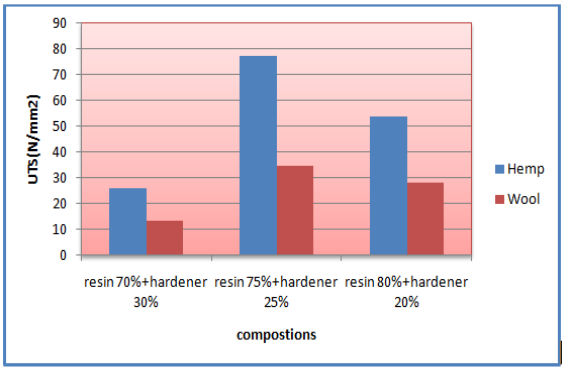
Specimens for the Tensile Test

Fig: cutting process for dumbbell shape,

Fig: dumbbell shape

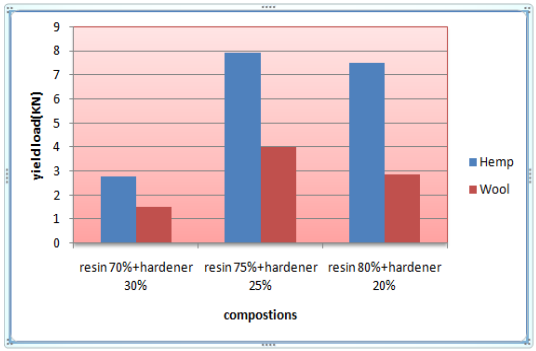
RESULTS AND DISCUSSIONS

Ultimate tensile stress



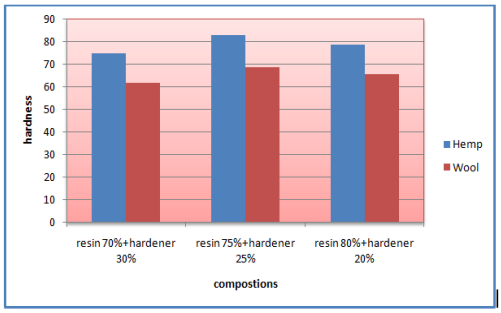
According to the above plot shows ultimate tensile strength, the maximum UTS at composition is resin 75%+hardener 25%with hemp fiber material compared to other compositions and material.

Yield load



According to the above plot shows yield load, the maximum yield load at composition is resin 75%+hardener 25%with hemp fiber material compared to other compositions and material.

Hardness



According to the above plot shows hardness, the maximum hardness at composition is resin 75%+hardener 25%with hemp fiber material compared to other compositions and material.

Conclusion

In this project, we are fabricated specimens at different composition of the hardener and resin percentage they are Epoxy resin 70%+ hardener 30%, Epoxy resin 75%+ hardener 25% and Epoxy resin 80%+ hardener 20%.

Natural fabricated by hand layup method effectively. The experimental study reveals the enhanced mechanical properties hardness and tensile strength.

The hardness improved by adding reinforcements to the base alloy. The addition of epoxy resin particles improved the hardness and the improved wear properties results by the addition of hardener and epoxy resin. Further the mechanical properties enriched by heat treatment. Hardness and tensile strength improved by Epoxy resin 75%+ hardener 25% with hemp natural fiber compared to wool fiber.

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