CHARACTERIZATION OF JUTE AND GLASS FIBER REINFORCED HYBRID COMPOSITE PIPES

R.Muthuraja[a*], Dr.R.Sarala[b], C.IlaiyaPerumal[c], R.Senthilraja[d], R.Ramkumar[e]

a*- Research Scholar, Alagappa Chettiar Government College of Engineering and Technology, Karaikudi, Sivaganga-630003.
b -Assistant Professor, Alagappa Chettiar Government College of Engineering and Technology, Karaikudi Sivaganga-630003.
c, d,e- Research Scholar, Alagappa Chettiar Government College of Engineering and Technology, Sivaganga-630003.

ABSTRACT

Theaimof the presentworkwas to investigatethe hybridization ofglassfiberswith naturalfibers forapplications in theaerospace and navalindustry.Mechanicalpropertiessuch as tensile, impactand flexural testofhybridglass/jutefiberreinforcedepoxy composite pipeintheformsoflaminaand laminates weredetermined. Thelaminapreparedwithnaturalfibermatshowed lowermechanicalproperties comparedtolaminaswith glassmat.Forthisreasonweproposedtouseahybriddesignforthevarious applicationswhichmakesuseofglasswovenfabricsandjutefibermats. The adoptionofthisdesign allowedforacostreductionof20%andaweightsaving of23%comparedto thecurrentcommercial solution.Laminates were fabricated by hand lay-up technique in a mold and cured under light pressure for 1h, followed by curing at room temperature for 48 h. All the laminates were made with a total of 10 plies, by varying the number and position of glass layers so as to obtain six different stacking sequences. One group of all jute laminate was also fabricated for comparison purpose. Total fiber weight fraction was maintained at 42%. Specimen preparation and testing was carried out as per ASTM standards.

Keywords: Hybrid composite pipe, Mechanical properties, hand lay-up.

INTRODUCTION

Natural fibers exhibit many advantageous properties as reinforcement for composites. They are low-density materials, yielding relatively light weight composite with high specificproperties (Dweib et al., 2004; Rana et al., 2003). Natural fibers also offer significant cost advantages and benefits associated with processing, as compared to synthetic fibers such as glass, nylon, carbon, etc. However, mechanical properties of natural fiber composites are much lower than those of synthetic fiber composites.

MATERIALSAND METHODS

FIBERPREPARATION

The trend in studies of glass fiber composites in recent years has been towards developing materials with high physical and mechanical characteristics. Attention has also been concentrated on the creation of heat- resistant composites. Aluminized glass fiber composites present potential advantages, namely the improvement of thermal and electrical conduction, and impact and fatigue properties. Until now this innovative material has only been used inmilitaryapplications. Therefore, its advantages must be experimentally confirmed by mechanical and physical properties characterization in order to make possible comparisons with the more common glass fiber composites and to explore possible civil applications. Glass fibers currently used in composites production have relatively high-strength and high modulus. Some types of glass fibers have high heat resistance or particular dielectric characteristics. Epoxy resin are widely used in the production of glass fiber composites due to their wetting power and adhesion to glass fiber, low setting shrinkage, considerable cohesion strength and adequate dielectric characteristics[1].

PROPERTIES OFGLASSFIBERS

Table1 PropertyofGlass Fibers

Property	GlassFiber
Density(gms./cc)	2.55
Elongation atbreak(%)	4.8
Tensilestrength (Mpa)	2000
Young's modulus (Gpa)	80

SELECTION OFJUTEFIBER:

Jute fiber is obtained from two herbaceous annual plants, white Corchoruscapsularis (white jute) originating from Asia and Corchorusolitorius (Tossa jute) originating from Africa. Next to cotton, it is the second most common natural fibre, cultivated in the world and extensively grown in Bangladesh, China, India, Indonesia, Brazil. The cell wall of a fibre is made up of a number of layers: the so-called primary wall (the first layer deposited during cell development) and the secondary wall (S), which again is made up of the three layers (S1, S2 and S3). As in all lingo cellulosic fibers, these layers mainly contain cellulose, hemi cellulose and lignin in varying amounts. The individual fibers are bonded together by a lignin-rich region known as the middle lamella. Cellulose attains highest concentration in the S2 layer (about 50%) and lignin is most concentrated in the middle lamella (about 90%) which, in principle, is free of cellulose. The S2 layer is usually by far the thickest layer and dominates the properties of the fibers. Cellulose, a primary component of the fibre, is a linear condensation polymer consisting of Danhydro - glucopyranose units joined together by ß-1, 4-glucosidic bonds.

Table2ChemicalComposition

Substances	WeightPercent (%)
Cellulose	61-71.5
Hemicellulose	13.6-20.4
Pectin	0.2
Lignin	12-13
Moisture content	12.6
Wax	0.5

SELECTION OFRESIN AND HARDENER:

Epoxy orpoly-epoxideis athermosetting polymerformedfrom reactionofanepoxide “resin”withpolyamine“hardener”.Epoxy hasa widerangeofapplications,including fiber-reinforcedplasticmaterials andgeneralpurpose adhesives.

PROPERTIES OFRESIN

Thechoiceofaresinsystem foruseinany componentdependson anumberofits characteristics, with the following probably being themost important formostcomposite structures:

1. Adhesive Properties
2. MechanicalProperties
3. Micro-Crackingresistance
4. Fatigue Resistance

FUNCTIONS OF EPOXY RESINS

The curing process is a chemical reaction in which the epoxide groups in epoxy resin reacts with a curing agent (hardener) to form a highly crosslinked, three-dimensional network. In order to convert epoxy resins into a hard, infusible, and rigid material, it is necessary to cure the resin with hardener. Epoxy resins cure quickly and easily at practically any temperature from 5-150oC depending on the choice of curing agent.

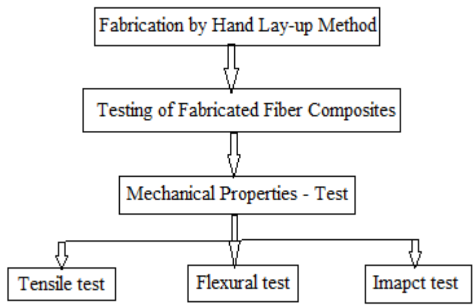
EPOXY AND HARDENER

A wide variety of curing agent for epoxy resins is available depending on the process and properties required. The commonly used curing agents for epoxies include amines, polyamides, phenolic resins, anhydrides, isocyanates and polymercaptans. The cure kinetics and the Tg of cured systemare dependent on the molecular structure of the hardener. The choice of resin and hardeners depends on the application, the process selected, and the properties desired. The stoichiometry of the epoxy-hardener system also affects the properties of the cured material. Employing different types and amounts of hardener which, tend to control cross-link density vary the structure.

Table3 Typicalcomposition ofjutefiber

Property	Epoxy Resin
Appearance	Pale yellowcolour
Viscosity(cps)at25˚C	10000
Density(gms/cc)	1.15-1.20
Elongation atbreak(%)	0.8
Tensilestrength(Mpa)	85
Young’s modulus(Mpa)	968

METHODOLOGY



Methodology

FABRICATION OFCOMPOSITE MATERIALS

Thischapterdealswith thefabrication stagescarriedout to obtain the composite material. Thematerialsusedinour fabrication processare

1.Fiberreinforcementmaterial(sayglassfiber

600 g.s-m)

2.Matrix(EpoxyLY556andHardenerHY

951)

3. OHBsheet

4. Wax

5. Acetone

6. Roller

7. Gloves

COMPOSITIONS OF FIBER REINFORCED POLYMER COMPOSITE

Fabrications of polymer composites arecompositions with various fiber lengths. The compositions of polymer composites are given in the Table 4.

Table4 Designation ofComposites

COMPOSI T ES	FIBER DIAMET E R	COMPOSITIONS			
		Fiberwt(%)			Resi n wt(
		Glas	Jut	Choppe	
C1	0.5cm	10	10	10	70
C2	1cm	10	10	10	70
C3	2cm	10	10	10	70
C4	3cm	10	10	10	70

STAGES IN HAND-LAY-UP METHOD

1. First, cut the fiber mats into 300 x 300 x 3 mm size.
2. Then, prepare the matrix by mixing of Epoxy LY556 and Hardener in the ratio of 1:10.
3. Then, three OHB sheets be placed in the floor and apply the wax in the sheets.
4. Then, apply the mixed matrix on the OHB sheets.
5. Then keep the fibre mat as a first layer and roller be rolled properly on the mat.
6. Again apply the mixed matrix on the first layer of fiber and rolled properly.
7. Then second layer of fiber mats kept above the first layer and apply mixed matrix and again rolled properly.
8. Similarly the consecutive layer can be formed up to required thickness.
9. Then the laminates are allowed for curing in atmospheric condition for 2 days.

TENSILE TEST

Tensile test was carried out by applying tensile load. Tensile test was carried out by using Universal Testing Machine. The figure 4.4 shows the tensile test specimen. TheUniversal Testing Machine (UTM-100). This machine can be used to apply a maximum load of 40KN and this machine is interfaced with a computer and results are obtained in graphs. The specimen size is 24cm X3cm X 0.3cm.

FLEXURE TEST

Flexuretestisdoneby applying apointload atcentreofcomposite material.Itis alsocarried out byusingUniversalTestingMachine.The specimensizeis24cm X3cm X0.3cm.Flexure testwascarriedoutusing UTMforaspecimen havingdimensionof24cmlength,3cmwidth,0.3cm thicknessandthe various parameters determined asfollows:

Table5 Comparison ofFlexuralTest Results

Composites	Experimental Parameters					
	Peak loadin KN	Disp at Fmax in	Breaking loadin KN	Max Disp in mm	Area in sq.mm	Ultimate stressin GPa(Flexural
C1	14.550	13.40	14.45	24.60	90	0.162
C2	14.700	14.50	14.50	29.10	90	0.163
C3	14.900	21.40	14.55	23.20	90	0.166
C4	15.20	22.50	14.60	21.50	90	0.168

IMPACT TEST

Thespecimen size forCharpyimpact test bed is 9cmX1.5cm.

Table7Comparison of ImpactStrength

Composite Designation	C1	C2	C3	C4
Impact Strength in J/sq.cm	25.1	32	41.46	56.28

CONCLUSION

The investigation of jute and glass fiber hybrid composite leads to the following conclusions:Successful fabrication of Glass, Jute fiber and chopped fiber reinforced polyester composites with different fiber lengths is possible by simple hand lay-up technique.The mechanical properties of the composites such as tensile strength, flexural strength and impact strengthof the composites are also greatly influenced by the fiber lengths.

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