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Mechanical and Wear Studies of Epoxy/Carbonfiber Composites with Coconut Shell Ash and Ricehuskash Fillers

Ramesh Chandra bodupally[#1], R.Anand[#2],

Department of Aeronautical engineering

l,Assistant Professor, Department of Aeronautical Engineering ,

Dhanalakshmi Srinivasan College of Engineering and Technology, India

2, Assistant Professor, Department of Mechanical Engineering ,

Dhanalakshmi Srinivasan College of Engineering and Technology, India

rameshbodupally@gmail.com

anandr.mech@dscet.ac.in

ABSTRACT:

In the current scenario, the effect of Coconut shell Ash and Rice Husk Ash on the mechanical properties of carbon fiber reinforced epoxy composites are studied. Pure Epoxy polymer sheet specimens were prepared. Carbonisation method was used to prepare the Coconut Shell Ash and Rice Husk Ash by heat treating at a temperature of 600 degrees.

In light to the above statement, present investigation reveals that an attempt has been made to prepare composites using carbon fiber-reinforced polymer with natural fillers (CFRPNF). First, a composite is prepared using epoxy and fillers (Coconut Shell Ash, Rice Husk Ash) without fiber. Next, Coconut shell Ash (filler) at different contents (5%, 10%), Rice Husk Ash (filler) at different contents (5%, 10%) and various proportions of carbon fiber for both fillers (reinforcement) had been used to prepare the epoxy composites. Initially, Hardness, tensile, flexural and wear properties of the samples were evaluated.

Keywords: CFRPNF,Rice Husk Ash,Coconut shell Ash,tensile, flexural.

1 INTRODUCTION

It has been observed that in recent times composite materials with different categories has been found to play a significant role in most of the engineering applications due to their excellent

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mechanical properties. Researchers are fabricating composite materials using various filler materials to describe the wear performance of the composite, used as a machine component in industrial applications. The development of fibers such as glass, carbon, aramid and natural fiber replaces the high cost and corrosive materials in the manufacturing of the machine components in recent years.

Antaryami Mishra made an attempt to investigate the mechanical behaviour and water absorption capacity of coconut shell dust, Fly ash reinforced epoxy hybrid composites. Fly ash percentage has been kept constant and the coconut shell dust content is varied. The mechanical properties of the composite laminates so prepared have been investigated for micro structure, tensile strength, hardness, water absorption etc., as per standards. From the tensile test it is observed that as the percentage of coconut shell dust increases the tensile strength increases. Further with increase in shell dust particles the hardness of the composite increased. From the micro structure analysis it is clear that the shell dust is evenly distributed in the matrix. Fly ash presence is not significantly observable due to low magnification.

Navin Chand, Manoj K. Sharma in their work developed milled carbon fibre reinforced epoxy composites at different centrifugation speeds having 3wt% of milled carbon fibre. Composites were also prepared at different RPMs. There is a gradient formation at all the speeds which has been confirmed by determination of density at different zones. Highest rpm centrifuged sample gave best wear resistance as compared to two others, upto transition zone ie.,4.60 mm from the outermost side. After transition zone, wear resistance suddenly decreased. This is because maximum compaction of milled carbon fibers occurred at outer surface at 1100 rpm.

Vinod Kumar, Chandrasekaran, Santhanam in their research studied the effects of coconut shell powder on the mechanical properties of coconut fibre reinforced epoxy composites. Coconut shell powder (filler) at different contents and various proportions of coconut fiber (reinforcement) had been used to prepare the epoxy composites. Composite samples were prepared using hand lay-up method and the test specimens were cut as per ASTM standards. Initially, tensile, flexural and impact properties of the samples were evaluated.

The mechanical properties exhibited less significance towards the addition of filler on the tensile strength and Impact strength. Flexural strength exhibited reduction in value at higher fiber volume fractions. It was concluded from the experiments that the composite with 16 % volume fraction of coir fiber and 8% CSP filler gives better mechanical properties. Analysis of SEM

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images also revealed the less fiber-matrix interaction at higher fiber loading, which

leads to the reduction in strength. Wear tests have shown that the addition of CSP up to 16 v/v% resulted in reduction of the coefficient of friction between the contact surfaces. Addition of filler at a higher volume fraction resulted in an increase of coefficient of friction due to change of wear behavior caused by separation of filler particles from the matrix.

Sarki, Hassan, Aigbodion, Oghenevweta in their work evaluated the morphology and mechanical properties of coconut shell particles reinforced epoxy composites to assess the possibility of using it as a new material in engineering applications. Coconut shell filled composites were prepared from epoxy polymer matrix containing upto 30wt% coconut shell fillers. The effects of coconut shell particle content on the mechanical properties of the composites were investigated. Scanning electron microscopy (SEM) of the composite surfaces indicates that there is fairly good interfacial interaction between coconut shell particles and epoxy matrix. It was shown that the value of tensile modulus and tensile strength increases with the increase of coconut shell particles content, while the tensile strength slightly decreased compared to pure epoxy content. This work has shown that coconut shell particles can be used to improve the properties of epoxy polymer composite to be used in eco buildings.

G. Agarwal, A. Patnaik and R. Kumar Sharma in their article, evaluated the three-body abrasive wear behaviour of long and short carbon fibre reinforced epoxy composites at five different fibre loading (10, 20, 30, 40 and 50 wt%). Three body abrasive wear tests are conducted to notice the effect of loss in weight of the specimen. The loss in weight of the material during three body abrasion was tested using DUCOM Tr-50 Dry Abrasion Tester. The results revealed that the wear rate increases with the increase in the value of normal load for long as well as short carbon fibre reinforced epoxy composites whereas, with the increase in the value of sliding velocity the specific wear rate decreases in both cases. Wear characteristics and their significant factor settings are successfully analyzed using statistical methods, Taguchi experimental design and analysis of variance (ANOVA) respectively. Finally, the experimental wear rate results are compared with the theoretical one and the error lies within the acceptable limit i.e. for long carbon fibre composites the error values are within 8?11 and 5?56% for that of short carbon fibre composites. The SEM micrographs studies reveal the dynamics of three body abrasive wear and underlying micro-mechanisms that serve as determinant for wear performance of such

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composites.

Jin-Hua Han, Hui Zhang, Peng-Fei Chu, Abolhassan Imani, Zhong Zhang applied carbon nanotube buckypaper, a kind of non-woven nano-fiber film with excellent mechanical and electrical properties to enhance the tribological performance of epoxy resin. A relatively big BP film with a diameter up to 285 mm was obtained through a solution filtration method. The CNTs were surface-modified by ozone in order to improve their interfacial adhesion with the matrix. It was found that the CNTs were well impregnated by the epoxy resin and the interfacial adhesion was fairly good, especially for the modified ones. Depending on the conditions of the wear tests, the frictional coefficient can be reduced from 0.71 of the neat resin down to 0.32 of ozone-modified BP/epoxy composite and the wear resistance can be improved by more than 4 times. The BP/epoxy composites, even after subjected to harsh wear retained high electrical conductivity due to the robust CNTs network.

K. Kumaresan, G. Chandramohan in their research prepared Carbon fabric-reinforced epoxy composites with and without silicon carbide filler by hand lay-up technique followed by compression moulding. In this study, friction and dry sliding wear behaviour of silicon carbide (SiC)-filled carbon fabric-reinforced epoxy composites were investigated. The weight fraction of SiC filler was varied (0, 5 and 10 wt %) so as to obtain composite samples of three different compositions. Sliding wear experiments were conducted using a pin-on-disc wear tester. The tests were conducted at a fixed sliding distance by varying the applied load and sliding velocity. The results show that for increased load and sliding velocity, higher wear loss was recorded. Excellent wear characteristics were obtained with C-E containing SiC as filler. Especially, 10 wt% of SiC in C-E gave a low wear rate. Moreover, the results reveal that 5 and 10 wt% of SiC in C-E showed 21 and 35 percentage of increase, respectively, in the wear resistance as compared with unfilled C-E composite. The wear resistance of the C-E and SiC- filled C-E composites were found to be related to the stability of the transfer film on the counterface. Moreover, incorporation of SiC in C-E showed improved mechanical properties.

S. Nallusamy, A. Karthikeyan in their research work, an investigation was attempted in analyzing the wear behavior of glass fiber reinforced with epoxy resin using granite powder as a filler material in varying weight percentage ranging from 0-5%. Structural morphology of the prepared laminates was studied using SEM. Epoxy resin which was taken as matrix material was

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reinforced with a combination of chopped and woven roving mat glass fibers.

Pin on disc method was applied for completing the wear test at different constraints of load, sliding distance and velocity for the investigation. Influence of granite powder in the composite was synthesized by calculating the specific wear rate and weight loss occurring at varying speed and normal load were applied on it. On examining by SEM worn surface wear rate of the prepared laminate at 5 wt% of granite provided better wear resistance as compared to other compositions and characterizations of worn surfaces.

Shakuntala Ojha, G. Raghavendra, S.K. Acharya made an attempt to compare the mechanical and tribological properties of both biowaste wood apple and coconut shell particulate polymer matrix composite. The results show that maximum flexural strength is obtained 78.19 MPa for wood apple shell and 68.25 MPa for coconut shell at 15 wt% filler content. Density and void content of the wood apple shell particulates composites decrease with increasing of the filler content in to polymer. In case of coconut shell composites, the density increases as the filler content increases. The maximum tensile strength is found at 15 wt% filler loading in both composites. The maximum flexural strength is obtained 78.19 MPa for wood apple shell and 68.25 MPa for coconut shell particulates reinforcement composite. The peak erosion rate is found to be occurring at 45 to 60 impingement angles for all the composite samples under various experimental conditions irrespective of filler loading, which conforms the material, behaves semi ductile behavior. On the basis of the mechanical properties and tribological behavior of wood apple shell composite gives good results when compared with the coconut shell filler composites.

K.Srinivasa, M.S.Bhagyashekar presented a paper explaining the tribological behaviour of epoxy composites containing three different particulate fillers. The RT cured epoxy composites subjected to post cure cycle containing particulate Gr, SiC and Gr-SiC of length 25mm and diameter 10mm were the pin specimens and EN31 steel was the disc of the computerized pin on disc wear tester. The results show that the synergic effect of hybrid filler Gr-SiC is to improve the wear resistance when compared with that of Gr/SiC. The improvement in wear resistance for the composite containing 5%SiC 35%Graphite is 85% when compared with epoxy, 25% over composite containing 40%Gr and 36% over 40%SiC. The composites containing 5% Gr and 35% SiC exhibits highest wear resistance.

Nikil Gupta, Muralidharan Paramsothy in their work intended to capture the state of art in

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the research and practice of functional composites which includes the functionality of metal matric composites such as self-healing, self-lubricating and self-cleaning capabilities.

Vengatesh D, Chandra Mohan investigated the recent composite technology, performance and analyzed in it's mechanical properties and fabrication techniques.

Materials Options:

- Resins: Any, e.g. epoxy, polyester, vinyl ester, phenolic
- Fibers: Any, e.g. Glass fiber, Carbon fiber, Kevlar etc. although heavy aramid fabrics can be hard to wet-out by hand.
- Cores: Any.

METHODOLOGY

4.1 WEIGHTPERCENTAGE OFSAMPLE -PE

Epoxy103Grade	=65%	
HardnerHy 991	=35%	
VolumeofComposite	=	LxBxT
	=	16X16X0.3
	$=76.8cm^3$	
Density	$=1.3g/cm^3$	
Epoxy	=0.65x99.84	=64.896g
Hardener	=0.35x99.84	=34.944g

4.2 WEIGHTPERCENTAGE OFSAMPLE -CSA

Resin**:**Coconutshellash

90:10

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DensityofEpoxy	=	$1.2g/cm^3$		
DensityofCoconutshellashVolumeofEpoxy	=	$2.05g/cm^3$90/1.2		
	=		=$75cm^3$	
VolumeofCoconutshellash	=	10/2.05	=$4.87cm^3$	
TotalVolume	=	75+4.87		
	=	$79.87cm^3$		
VolumeFractionofEpoxy	=	75/79.87	=0.939%	
VolumeFractionofCoconutshell ash	=	4.87/79.87	=0.061%	
DensityofEpoxy inComposites	=	0.939X1.2	=1.127 g/cm^3	
DensityofEpoxyinCoconutshellashTotalDensityofComposites	=	0.061X2.05=$0.125g/cm^3$		
	=	$1.252g/cm^3$LxBxT		
Volumeof Composite	=			
	=	16X16X0.3	=	$76.8cm^3$
TotalMass ofComposite	=	**v**x$\boldsymbol{\rho}$		
	=	76.8X1.252	=	96.154 g
90%ofEpoxy	=	0.90X96.154	=	86.539 g
10%ofCoconutshellash	=	0.10X96.154	=	9.615g

4.3 WEIGHTPERCENTAGE OFSAMPLE- RHA

Resin:RiceHuskash

90:10

DensityofEpoxyDensityofRiceHuskash	=	$1.2g/cm^3$	
VolumeofEpoxy	=	$1.8g/cm^3$60/1.2	
			$50.00cm^3$

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Volumeof RiceHuskash	=	15/1.8	=	8.333cm^3
TotalVolume	=	50.00+15.625+8.333		
	=	73.958cm^3		
VolumeFractionofEpoxy	=	50.00/73.958=		0.670%
VolumeFractionofRiceHuskash	=	8.333/73.958=		0.113%
Densityof EpoxyinComposites	=	0.670X1.2	=	0.804g/cm^3
Densityof Epoxy inRiceHuskash	=	0.113X1.8	=	0.203g/cm^3
TotalDensityofComposites	=	1.34g/cm^3		
VolumeofComposite	=	LxBxT		
	=	16X16X0.3		
	=	76.8cm^3		
TotalMass ofComposite	=	**v**xρ		
	=	76.8X1.34	=	102.912g
90%ofEpoxy	=	0.90X102.912	=	61.75g
10%ofRiceHuskash	=	0.10X102.912	=	15.44g

4.4 WEIGHTPERCENTAGE OFSAMPLEC-1

Resin**:**Fiber**:**Coconut shellash

70:25:5

Densityof Epoxy =1.2g/cm^3

Densityof CarbonFiber =1.6g/cm^3

Densityof Coconutshellash =2.05g/cm^3

Volumeof Epoxy =70/1.2

=58.333cm^3

Volumeof Carbon Fiber =25/1.6

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=15.625cm^3

Volumeof Coconutshellash =5/2.05

=2.439cm^3

TotalVolume =58.333+15.625+2.439

=76.397cm^3

VolumeFractionofEpoxy = 58.333/76.397= 0.764

%VolumeFractionofCarbonFiber = 15.625/76.397= 0.205

%VolumeFractionofCoconutshell ash =2.439/76.397 = 0.032%Densityof Epoxy inComposites =0.764X1.2

=0.917g/cm^{3}Densityof Epoxy inCarbonFiber =0.205X1.6

=0.328g/cm^{3}Densityof Epoxy inCoconutshellash =0.032X2.05

=0.065g/cm^{3}TotalDensityofComposites

=1.31g/cm^3

VolumeofComposite =LxBxT

=16X16X0.3 =76.8cm^3

TotalMass ofComposite = **v**x***ρ***

=76.8X1.31 =100.6g

70%ofEpoxy =0.70X100.6 =70.42g

25%ofCarbonFiber =0.25X100.6 =25.15g

5%ofCoconutshellash =0.05X100.6 =5.03g

4.5 WEIGHTPERCENTAGE OFSAMPLEC-2

Resin**:**Fiber**:**Coconut shellash

65:25:10

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Density of EpoxyDensityofCarbonFiber	=	$1.2g/cm^3$		
Densityof Coconutshellash	=	$1.6g/cm^3$		
VolumeofEpoxy	=	$2.05g/cm^3$65/1.2		
	=		=	$54.166cm^3$
Volumeof CarbonFiber	=	25/1.6	=	$15.625cm^3$
VolumeofCoconutshellash	=	10/2.05	=	$4.878cm^3$
TotalVolume	=	54.166+15.625+4.878		
	=	$74.669cm^3$		

VolumeFractionofEpoxy	=	54.166/74.669	=0.685%
VolumeFractionofCarbonFiber=		15.625/74.669	=0.209%
VolumeFractionofCoconutshell ash=		4.878/74.669	=0.065%
Densityof EpoxyinComposites	=	0.685X1.2	$=0.822g/cm^3$
Densityof Epoxy inCarbonFiber=		0.209X1.6	$=0.334g/cm^3$

Densityof EpoxyinCoconutshellash	=	$0.065X2.05=0.133g/cm^3$	
TotalDensityofComposites	=	$1.28g/cm^3$	
VolumeofComposite	=	LxBxT	
	=	16X16X0.3	$=76.8cm^3$
TotalMass ofComposite	=	**v**x$\boldsymbol{\rho}$	
	=	76.8X1.28	
	=	98.304g	
65%ofEpoxy	=	0.65X98.304	
	=	63.89g	
25%ofCarbonFiber	=	0.25X98.304	
	=	24.57g	
10%ofCoconutshellash	=	0.10X98.304	

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= 9.83g

4.6 WEIGHTPERCENTAGE OFSAMPLER-1

Resin**:**Fiber**:**RiceHuskash

70:25:5

DensityofEpoxyDensity of Carbon FiberDensityofRiceHuskash	= = =	$1.2g/cm^3$ $1.6g/cm^3$ $1.8g/cm^3$		
VolumeofEpoxy	=	70/1.2	=	$58.333cm^3$
Volumeof CarbonFiber	=	25/1.6	=	$15.625cm^3$
Volumeof RiceHuskash	=	5/1.8	=	$2.777cm^3$
TotalVolume	=	58.333+15.625+2.777		
	=	$76.735cm^3$		
VolumeFractionofEpoxy	=	58.333/76.735=		0.760%
VolumeFractionofCarbonFiber	=	15.625/76.735=		0.204%
VolumeFractionofRiceHuskash	=	2.777/76.735	=	0.036%
Densityof EpoxyinComposites	=	0.760X1.2	=	$0.912g/cm^3$
Densityof EpoxyinCarbonFiber	=	0.204X1.6	=	$0.326g/cm^3$
Densityof Epoxy inRiceHusk ash	=	0.036X1.8	=	$0.065g/cm^3$
TotalDensityofComposites	=	$1.30g/cm^3$		
VolumeofComposite	=	LxBxT		
	=	16X16X0.3	=	$76.8cm^3$
TotalMass ofComposite	=	$\mathbf{v}x\boldsymbol{\rho}$		
	=	76.8X1.30		
	=	99.84g		

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70%ofEpoxy	=	0.70X99.84		
	=	69.88g		
25%ofCarbonFiber	=	0.25X99.84		
	=	24.96g		
5%ofRiceHuskash	=	0.05X99.84		
	=	4.99g		

4.7 WEIGHTPERCENTAGE OFSAMPLER-2

Resin:Fiber:Rice Huskash

65:25:10

DensityofEpoxyDensity of Carbon FiberDensityofRiceHuskash VolumeofEpoxy	=	1.2g/cm^3		
	=	1.6g/cm^3		
	=	1.8g/cm^{3}65/1.2		
	=		=	54.167cm^3
Volumeof Carbon Fiber	=	25/1.6	=	15.625cm^3
Volumeof RiceHuskash	=	10/1.8	=	5.556cm^3
TotalVolume	=	54.167+15.625+5.556		
	=	75.348cm^3		
VolumeFractionofEpoxy	=	54.167/75.348=		0.718%
VolumeFractionofCarbonFiber	=	15.625/75.348=		0.207%
VolumeFractionofRiceHuskash	=	5.556/75.348	=	0.073%
DensityofEpoxy inComposites	=	0.718X1.2		
	=	0.861g/cm^3		
Densityof Epoxy inCarbonFiber	=	0.207X1.6		
	=	0.331g/cm^3		

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Densityof Epoxy inRiceHuskash	=	0.073X2.05		
	=	$0.14 g/cm^3$		
TotalDensityofComposites	=	$1.33 g/cm^3$		
VolumeofComposite	=	LxBxT		
	=	16X16X0.3		
	=	$76.8 cm^3$		
TotalMass ofComposite	=	**v**xρ		
	=	76.8X1.33	=	102.144g
65%ofEpoxy	=	0.65X102.144	=	66.39g
25%ofCarbonFiber	=	0.25X102.144	=	25.53g
10%ofRiceHuskash	=	0.10X102.144	=	10.21g

5.1 MaterialsRequired

- WovenCarbonfiber
- EpoxyAY 103graderesin
- HY991Hardener
- Coconutshellash(NaturalFiller)
- RiceHusk Ash(NaturalFiller)

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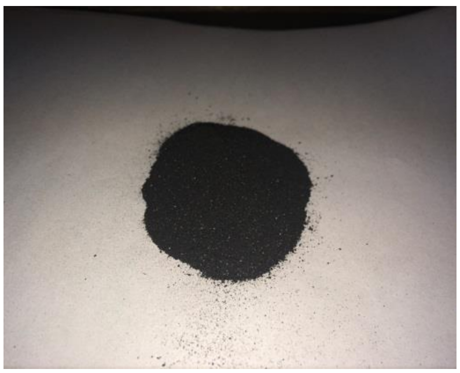
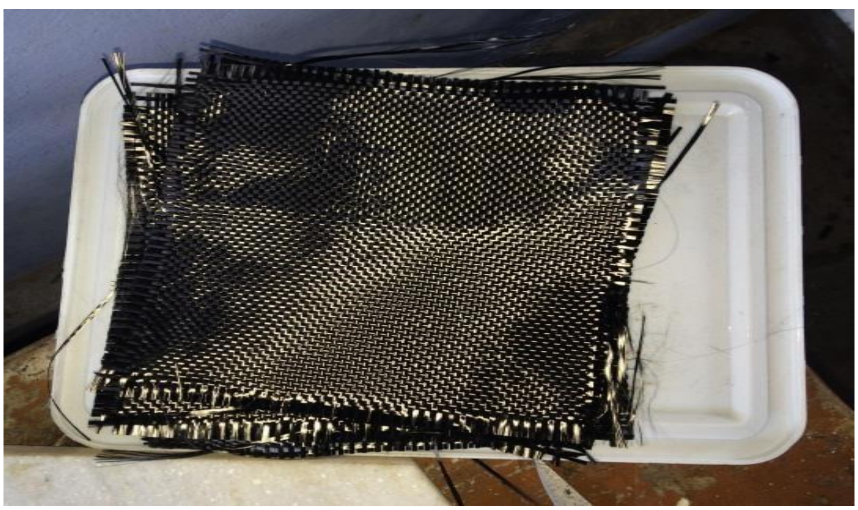
Fig–5.1(a)Epoxy AY103 Fig–5.1(b)HY991Hardener



Fig–5.1(c)CoconutShellAsh Fig–5.1(d)RiceHusk Ash



Fig–5.1(e)Carbonfiberfabric

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Matrix material selected for the present work is Epoxy AY 103 resin. Epoxy resinis a thermosetting polymer used as adhesives and have high performance and plotting andencapsulatingmaterials.Theseresinshaveexcellentmechanicalproperties,lowshrinkage,goodadhesionto metalsandresistancetomoisture,thermalandElectricshock.

Woven Carbon fiber fabric made of carbon fiber has been used as a reinforcementmaterialinallthecomposites.Themechanicalpropertiesofwovenfabriccomposites,such as strength and stiffness, are strongly determined by weave parameters, the laminateparameter, and the inherent material properties of fiber and matrix. HY 991 Hardener isusedforthepresentwork.Ithasgoodmechanicalstrengthandresistancetoatmosphericandchemicaldegradation.

5.2 FABRICATIONPROCESS

Thepresentworkdealswiththemanufactureofcompositeswithandwithoutfibers.Manufacturingprocesshassignificantinfluenceonthequality,productivityandcompetitivenessofpolymercompositestructures.Reinforcedcarbonfiberpolymercomposites are obtained ormanufactured using Hand lay-uptechnique.

Handlayuptechniqueisthesimplestmethodofcompositeprocessing.Theinfrastructuralrequirementforthismethodisalsominimal.Theprocessingstepsarequitesimple.First,areleasegel(PVA)isspreadonthe moldsurfacetoavoidstickingofpolymerto the surface. Thin OHP sheets are used at the top and bottom of the mold plate to getgoodsurfacefinishoftheproduct.ReinforcementintheformofwovenCarbonfibermatsarecut asperthe moldsize (160X160X3 mm).

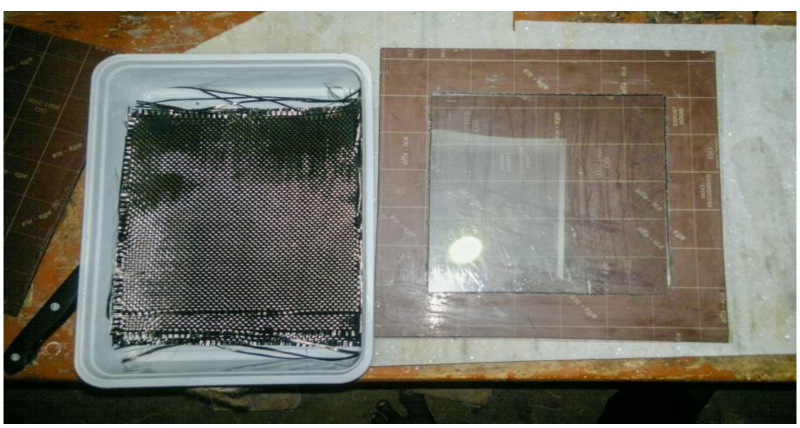

Fig5.2–Carbonfibermatsandmould

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Then with a prescribed hardener HY 991(curing agent), with Natural Fillers(Coconut shell ash or Rice Husk ash) are mixed more than 10 minutes for perfect mixingof resin and hardener and is poured onto the surface of the mat which is already placed inthemould.Thepolymerisuniformlyspreadwiththehelpofbrush.

Secondlayerofmatisthenplacedonthepolymersurfaceandarollerismovedwitha mild pressure on the mat-polymer layer to remove any air bubbles as well as the excesspolymerpresent.Theprocessisrepeatedforeachlayerofpolymerandmat,tilltherequired layers are stacked. After placing the OHP sheet, PVA gel is spread on the inner surface ofthetopmouldplatewhichisthenkeptonthestackedlayersandthepressureisapplied.

After curing either at room temperature or at some specific temperature, mold isopened and the developed composite part is taken out and further processed.The time ofcuring depends on type of polymer used for composite processing. For example, for anepoxy-based system, normal curing time at room temperature is 18-24 hours under apressure of 280 psi in UTM machine. This method is mainly suitable for thermosettingpolymer-based composites. Capital and infrastructural requirement is less as compared toother methods.Production rateis less and high-volume fractionof reinforcementis difficulttoachieve intheprocessedcomposites.

Thefollowingaretheprocedureformanufacturingcomposites,usinghandlay-upmethod:

- Thefibers mustbereadyasperthedimensions.
- Thediebasehorizontalshouldbestraighttopreventpolymerfromunevenspreading.
- Applythe PVA(releasingagent)ontheDiebase.
- PutoneOHPsheetontheDiebaseforgoodsurfacefinish
- Thenthemould(PVA applied)isplacedonthediebase.
- Thepolymermixispouredinthemouldasathinlayerandabrushisusedtospreadtheresintogetevenmouldsurface
- Thenthefirstcarbonfibermatlayerispositionedmanuallyinthe mould.

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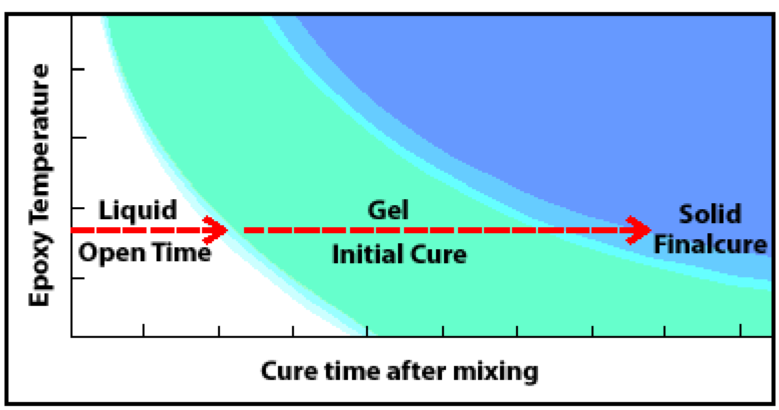
- Entrappedairisremovedmanuallywithsqueegeesorrollerstocompletethelaminatestructure .
- Applythe secondlayer,impregnatingitbyusingtheresin fromthepreviouslayer.
- Whenthereisnomore resininunderneath layer,newresinisapplied.
- Therestofthelayersareappliedas described above.
- Thisprocessiscontinuedtillthefinallayerofcarbonfibermatiscoatedwithresin.
- Thetopplateofmould isplacedon themiddle ofthecompleteassembly.
- Thenthemouldis compressedby giving weight
- Thecompressionmustensurethattheentrappedairbubblesarecompletelyremovedandtheexcess resinflowsout.
- Thismouldisleftfor18hoursto24hoursataroomtemperaturetocompletethecuringprocess.
- Underapressureof 280psiinUTMmachine
- Thesametechniquemustbeused tofabricatetheremaininglaminates.

Inordertoconvertepoxyresinintohard,infusible,andrigidmaterial,itisnecessaryto cure the resin with hardener, Curing initiated by the catalyst in the resin system.Speed curing is controlled by the amount of hardener in an epoxy resin. Epoxy resincure quickly and easily practically at any temperature from 5-150^{0}c depending on thechoiceof curing agent.



As it cures, mixed epxoy pass from a liquid state, through a gel state, to a solid state. (figure 1)

Figure5.2 (a)Epoxycuretime

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Somemajorconsiderationsinselectingthepropercurecycleforagivencompositematerialare:

- Thetemperatureinsidethematerialmustnotexceedapresetmaximumvalueatanytime during cure.
- Attheendofcure,alltheexcessresinissqueezedoutfromeveryplyofthecompositeand the resin distribution isuniform.
- Thematerialiscureduniformlyandcompletely.

Thecuredcompositehasthelowestpossiblevoidcontent.

6.1 ObjectiveofMechanicalTesting

Themechanicalpropertieshelptodeterminethevarious behavior ofthematerialandtounderstandhowmaterialsresistforcewhenforceisapplied on thematerial. Here,asetofFRPspecimensweremanufacturedwithvariousweightratioofepoxyresinand wovenCarbonfiber.

6.2 Flexure Test

Method for measuring the behaviour of materials subjected to simple beam loading. Itis also called a transverse beam test with some materials. Specimen is supported ontwo knife edges as a simple beam and load is applied at its midpoint. Maximum fiberstressand maximumstrainarecalculatedwithincrementinload.Resultsareplottedinastress-straindiagram,andmaximumfiberstressatfailureisflexuralstrength.

Flexural yield strength is reported for materials that do not crack. Standard testproceduresaregiveninASTMD-790(plastics)andASTMC-674(firedwhiteware).ASTMD-797(elastomers),ASTMA-438(castiron)andASTMD-86(glass).

A flexure test produces tensile stress in the convex side of the specimen andcompression stress in the concave side. This creates an area of shear stress along themidline. To ensure the primary failure comes from tensile or compression stress theshearstressmustbeminimized.Thisisdonebycontrollingthespantodepthratio;thelength of the outer span divided by the height (depth) of the specimen. For mostmaterials S/d=16 is acceptable. Some materials require S/d=32 to 64 to keep the shearstresslowenough.

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6.2.1 TypesofFlexureTests

Flexure testing is often done on relatively flexible materials such as polymers, woodand composites. There are two test types; 3-point flex and 4-point flex. In a 3-point testthe area of uniform stress is quite small and concentrated under the center loadingpoint.Ina4-pointtest, theareaofuniformstressexistsbetweentheinnerspanloading

points(typicallyhalftheouterspanlength).

The 3-point flexure test is the most common for polymers. Specimen deflection isusuallymeasuredbythecrossheadposition.Testresultsincludeflexuralstrengthandflexuralmodulus.

6.3 TensileTest

Tensile test is one of the most important mechanical property evaluation tests. Inthis test a cylindrical or a plate shaped specimen is deformed by applying uniaxial force.Oneendofthesampleisfixedinastaticgripwhiletheotherendofthespecimenispulledat a constant velocity. The load is continuously monitored during the test. It is usual toconductthis testuntil the sample fractures.

Fig6.3(a) Tensiletestingmachine

Fig6.3(b)SpecimenfixedinJaws

Thespecimenschartareshownbelowtable6.1.1

Samples	Weight%ofResin,fiberandfiller

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PE	65:35
CSA	90:10
RHA	90:10
C-1	70:25:5
C-2	65:25:10
R-1	70:25:5
R-2	65:25:10

6.4 HardnessTest

6.4.1 VickersHardnessTest

The **Vickers hardness test** was developed in 1921 by Robert L. Smith andGeorgeE.Sandlandat VickersLtdasan alternative to the Brinellmethod to measurethe hardnessof materials. The Vickers test is often easier to use than other hardness testssincetherequiredcalculationsareindependentofthesizeoftheindenter,andtheindentercan be used for all materials irrespective of hardness. The basic principle, as with allcommonmeasuresofhardness,istoobserveamaterial'sabilitytoresist plasticdeformationfrom a standard source. Vickers test can be used for all metalsand is one ofthe widest scales among hardness tests. The unit of hardness given by the test is known asthe **Vickers Pyramid Number** (**HV**) or Diamond Pyramid Hardness (DPH). Hardnessnumber can be converted into units of pascals, but should not be confused with pressure,whichusesthesameunits.Thehardnessnumberisdeterminedbytheloadoverthesurfaceareaoft heindentation andnotthe areanormaltotheforce, andis thereforenotpressure.

6.5 WEARTESTING

6.5.1 ObjectiveofWearTesting

Wear properties are used to determine various behavior of the material to understandhow a material resist wear when forces are applied, here a set of FRP specimens

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weremanufacturedwithvaryingweightratioofepoxyresinandwovenCarbonfiber.Tofindtheoptimized weightpercentageoffiberandresin fromtheweartestingofcomposites.

6.5.2 WEARTEST.

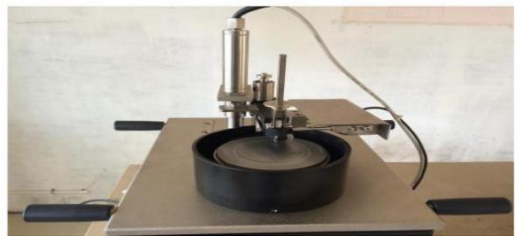

Fig6.5(a)PinonDiskweartestingmachine Fig6.5(b)SpecimenfixedinArm

A pin on disc tribometer consists of a stationary "pin" under the applied load in contactwitharotatingdisc.Thepincanhaveanyshapetosimulatespecificcontact,butsphericaltips are often used to simplify contact geometry. Coefficient of friction is determined bytheratiooffrictionalforcetothe loadingforceonthepin.

The pin on disc test has proved useful in providing a simple wear and friction test for lowfriction coatings such as diamond-like carbon coatings on valve train components ininternalcombustionengines.

For pin-on-disk wear test, two specimens are required. One, a pin with a radius tip, ispositioned perpendiculartotheother,

A flat circular disk and. A ball, rigidly held, is often used as the pin specimen. The testmachine causes either the disk specimen or the pin specimen to revolve about the diskcenter. In either case, the sliding path is a circle on the disk surface. The plane of the diskmaybeorientedeitherhorizontallyorvertically.

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6.7 FABRICATEDSPECIMENS

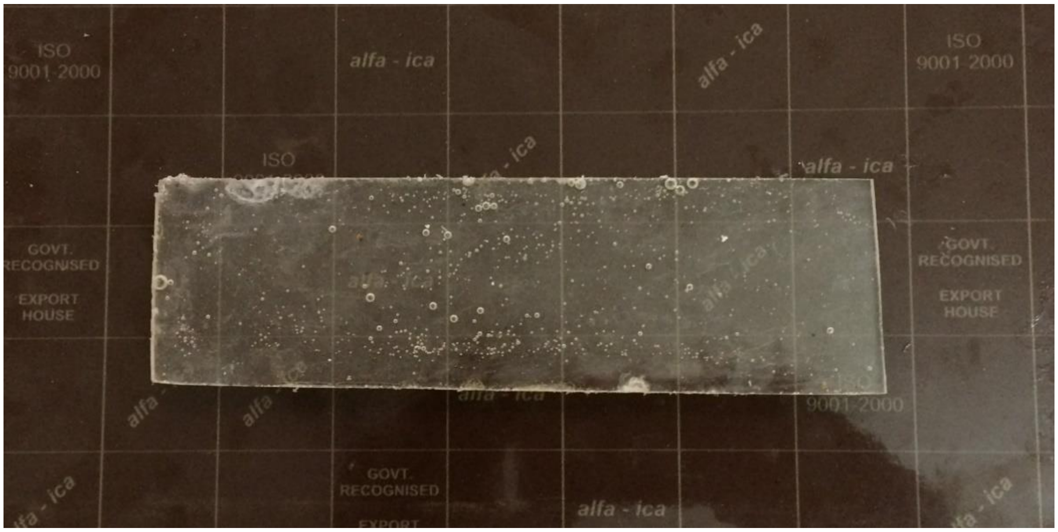

Fig6.8(a):Epoxysheet(withoutfiberandfiller)

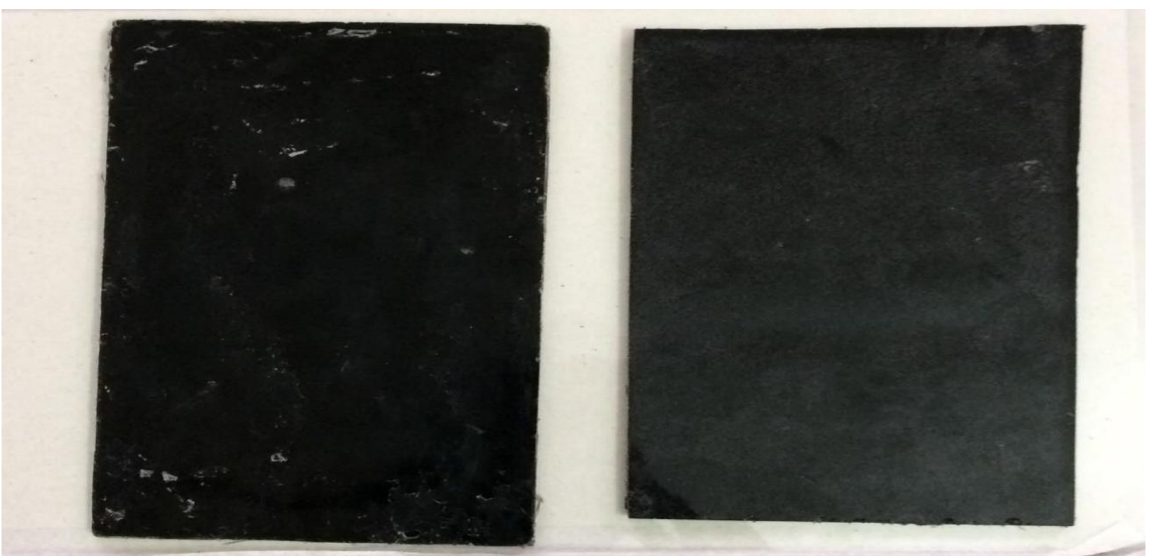

Fig6.8(b):Epoxy+CoconutShellAshcompositeandEpoxy+RiceHuskAshcomposite.

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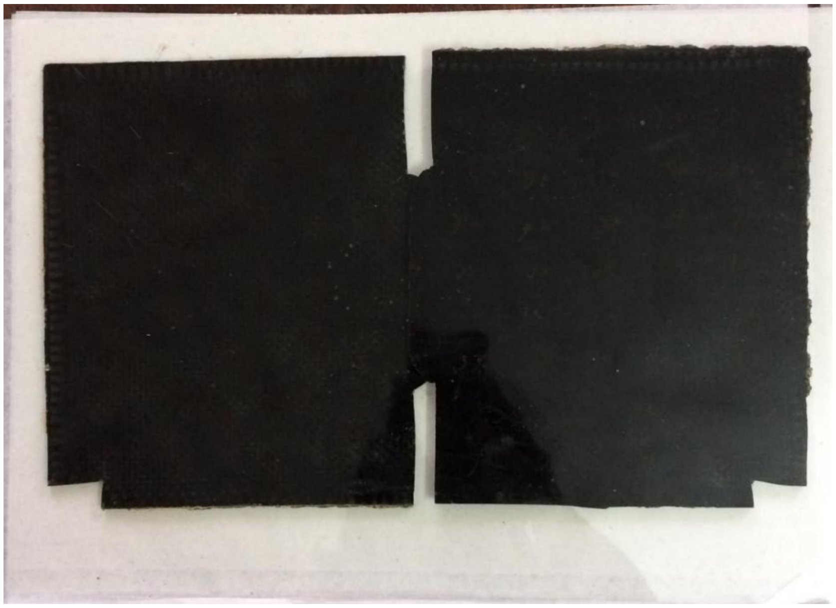

Fig6.8(c):Epoxy+Carbonfiber+CoconutShellAshcomposite(70:25:5),Epoxy+Carbonfiber+CoconutShellAshcomposite(65:25:10),

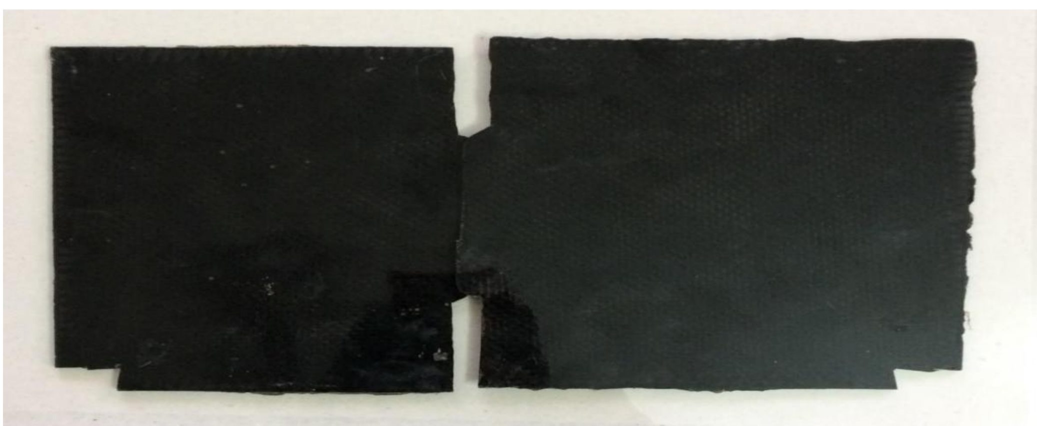

Fig 6.8(d): Epoxy +Carbonfiber+RiceHuskAsh composite(70:25:5),Epoxy+Carbonfiber+RiceHuskAshcomposite(65:25:10),

CHAPTER 7RESULTSANDDISCUSSIONS

7.1 Hardness:VickersHardness

Hardness of Carbon fibre reinforced composites with natural filler is determined using VickersHardnesstesting methods. Theobtained valuesareas below;

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SlNo	**SpecimensName**	**VickersHardness(Hv)**
1	PE	24
2	CSA	27
3	RHA	25
4	C-1	27
5	C-2	28
6	R-1	26
7	R-2	26

HardnessTestResultsTable7.1

7.2 TensileStrength

TensilestrengthofCarbonfibrereinforcedcompositeswithnaturalfiller wasdeterminedbyComputerisedUTM testing methods

SlNo	**Specimens**	**TensileStrength**
1	PE	1200mpa
2	CSA	2700mpa
3	RHA	2824mpa
4	C-1	3445mpa
5	C-2	4100mpa
6	R-1	3509mpa
7	R-2	3950mpa

TensileTestResults Table7.2

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7.3 Wear Test

The Wear analysis will be studied by Scanning Electron Microscope. The topographical surfaceand chemical composition variations and wear mechanisms are studied for both natural fillercarbonfiber composites.

SlNo	Specimens	Wear Rate(mm3/N.m)	Coefficientoffriction
1	PE	0.01534	3.14
2	CSA	0.00145	2.15
3	RHA	0.00389	2.74
4	C-1	0.000148	1.25
5	C-2	0.000125	1.22
6	R-1	0.000589	1.31
7	R-2	0.000789	1.4

WearTestResults Table7.3

CONCLUSION

EngineersandResearchersthinkthatnon-abrasives,environmental-friendlyandbiodegradablepropertiesinthematerialsaroundtheworldbecomesthesubstituteforfiberreinforced polymer compounds, due to it's high quality properties of fiber specific strength,low weight, low cost and high mechanical properties. From this point of view, there is abrief analysis of the use of large number of natural fibers (such as apple, banana, bamboo,cotton, sugar, jute, pineapple, chisel). This paper presents an analysis of the mechanicalproperties and frictional properties of Epoxy + Carbon fiber + Rice Husk Ash composite(70:25:5),Epoxy+Carbonfiber+RiceHuskAshcomposite(65:25:10), Epoxy+Carbonfiber+CoconutshellAshcomposite(70:25:5),Epoxy+Carbonfiber+Coconutshellashcomposite (65:25:10). The integration of intermittent bonds between fiber and polymermatrix is an important aspect of the optimal mechanical performance of fiber-reinforcedcompounds with general and elegance. The mechanical properties are compared betweenPE (Pure Epoxy sheet without fiber and filler), CSA (Epoxy + Coconut Shell Ashcomposite) and RHA (Epoxy + Rice Husk Ash composite), C-1: Epoxy + Carbon fiber +Coconut Shell Ash composite (70:25:5), C-2: Epoxy + Carbon fiber + Coconut Shell Ashcomposite (65:25:10), R-1: Epoxy + Carbon fiber +

Rice Husk Ash composite (70:25:5),R-2: Epoxy + Carbon fiber + Rice Husk Ash composite (65:25:10). The proportions are70:30 and 80:20. The quality of the fiber-matrix interface is important to strengthen theplastics to use carbon fibers and different natural fillers.

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