FABRICATION AND MECHANICAL TESTING ON NATURAL FIBER COMPOSITE

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Abstract - *This project discusses the Natural Fiber Reinforced Composite Materials contribution as seats of aero planes. In the last decades, researchers have developed new materials to improve the quality of aircrafts. These plate materials have to be light weight, low stiffness, and be biocompatible with aircrafts. Drilling is the most frequently employed operation of machining for fiber-reinforced materials. An effort to utilize the natural fibers has been made through fabrication of Natural fiber composite material (Jute (corchorus), Hay and Coir) reinforced polymer composite plate material by using bio epoxy resin Grade 3554A and Hardener 3554B. Instead of using carbon fibre, this plate material can be used for making seats on aircrafts.*

Key Words*: *Natural Fibers, Hardness Test, Impact Test, Drilling & Composite

1. INTRODUCTION

Natural fibers occurring in the vegetable or animal kingdom are polymeric in terms of their chemical constitution, while natural fibers in the form of minerals are akin to crystalline ceramics. A distinctive feature of natural fibers is that they are generally a mixture (chemical or physical) of different compounds. One can further classify synthetic fibers as polymers, metals, and ceramics or glass. Here, one should also mention a very special and unique subclass of fibers, whiskers. Whiskers are mono crystalline, short fibers with extremely high strength. This high strength, approaching the theoretical strength, comes about because of the absence of crystalline imperfections such as dislocations. Being mono crystalline, there are no grain boundaries either. Whiskers are normally obtained by vapor phase growth. Typically, they have a diameter of a few micrometers and a length of a few millimeters. Thus, their aspect ratio (length/diameter) can vary from 50 to 10000. Perhaps the greatest drawback of whiskers is that they do not have uniform dimensions or properties. The use of natural fibres for technical composite applications has recently been the subject of intensive research in Europe. Many automotive components are already produced in natural composites, mainly based on polyester or PP and fibres like flax, hemp or sisal. The adoption of natural fibre composites in this industry is lead by motives of a) price b) weight reduction and c) marketing ('processing renewable resources') rather than technical demands. The range of products is restricted to interior and non-structural components like door upholstery or rear shelves.

The behavior of composite materials during machining has been widely observed experimentally. Drilling is the most frequently employed operation of secondary machining for fibre reinforced materials owing to the need for structure joining. The chisel edge of the drill point pushes aside the material at the center as it penetrates into the hole. A proper choice of cutting conditions is difficult due to the coexistence of hard abrasive fibres and a soft matrix. Based on the experimental observations, little plastic deformation of composite materials occurs during cutting, and the fracture resistance is 10–100 times lower than that of common steels. Amongst all machining operations, drilling using a twist drill is the most frequently applied in the aircraft industry for generating holes when riveting and fastening structural assemblies and are widely used in industry to produce holes rapidly and economically. Delamination has raised a lot of among researchers and has consequently been studied in a number of research projects by many numbers of organizations. The main reason of delamination is due to the thrust force applied in the material.

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, composites of polymers reinforced by natural fibers have received increased attention. Natural fibers such as Jute, Coir & Hay fibers possess good reinforcing capability when properly compounded with polymers. One of the unique aspects of designing parts with fiber reinforced composite materials is that the mechanical properties of the material can be tailored to fit a certain application. The major effort of natural composite material used in order to obtain high weight to strength ratio. The conventional drilling is most preferred and adopted techniques. Due to inherent quality such as anisotropy and brittleness when composite material subjected to drilling, exhibit damage phenomena such as delamination, spalling and crack formation. The quality of hole plays vital role in drilling. Holes dimensions, surface finish along length of holes, roundness are vital importance of part.

2. EXPERIMENTAL STUDY

The specimen used in this study is a plate of 200x85 mm made of natural fiber reinforced composite material. The composite is made of natural fibers. Commercially available natural fibers are taken. The materials used in this project are

1. Coir fibre reinforced composite
2. Jute fibre reinforced composite
3. Hay fibre reinforced composite
4. Jute & Hay (hybrid) fibre reinforced composite
5. Coir & Jute (hybrid) fibre reinforced composite
6. Coir & Hay (hybrid) fibre reinforced composite

A mold of 200-mm length and 85-mm width was created using GI sheet mold. An OHP Sheet was taken and a releasing agent was applied over it and fitted with the inner side of the mold and allowed to dry. A glass beaker and a glass rod or a stirrer were taken and cleaned well with running water and subsequently with warm water. Then, calculated quantity of bio epoxy resin Grade 3554A and Hardner 3554B Resin was added and the mixture was stirred for nearly 15 min. Stirring was done to create a homogeneous mixture of resin and accelerator molecules. Subsequently, calculated quantity of fibers was added and the stirring process was continued for the next 45 min. Then, the mixture was poured into the mold and rammed mildly for uniform settlement. The mold was allowed to solidify for nearly 24 hours.

Fig 2.1 Fabricated Materials

3. RESULTS AND DISCUSSION

Table 3.1 Calculation of Impact Strength

S.NO	NATURAL FIBRE REINFORCED COMPOSITE MATERIAL	IMPACT STRENGTH J/mm^2
01	Hay	0.203
02	Coir	0.205
03	Jute	0.229
04	Hay&Jute	0.28
05	Coir &jute	0.267
06	Coir&Hay	0.272

Table 3.2 Calculation of Water Absorption

S.NO	NATURAL FIBRE COMPOSITE MATERIAL	DRY WEIGHT Gm	WET WEIGHT Gm	PERCENTAGE OF WATER ABSORPTION
01	Hay	21.623	22.718	0.05
02	Coir	9.129	11.194	0.22
03	Jute	9.223	10.918	0.11
04	Hay&Jute	8.154	10.238	0.25
05	Coir &jute	22.485	23.87	0.14
06	Coir&Hay	16.543	17.786	0.17

Table 3.3 Calculation of Thrust and Torque

DATA ON THRUST AND TORQUE MEASUREMENT USING DRILL TOOL DYNAMOMETER															
Combination		Drill Size			Thrust (Kg)					Torque (Kg m)					
Natural fibre Composite Materials		Dia mm	SPEED (RPM)	Feed (m/ min)	ITERATION										
					1	2	3	4	5	1	2	3	4	5
Jute		5	440	0.10	5	6	8	9	7	0.06	0.04	0.04	0.03	0.03
Jute		6	440	0.10	7	8	7	7	8	0.07	0.08	0.09	0.08	0.07
Jute		8.5	440	0.10	15	12	14	13	13	0.08	0.08	0.09	0.08	0.07
Coir		5	440	0.10	6	6	5	4	6	0.03	0.003	0.04	0.04	0.07
Coir		6	440	0.10	6	7	6	6	5	0.07	0.008	0.08	0.10	0.04
Coir		8.5	440	0.10	11	12	10	12	11	0.08	0.07	0.09	0.09	0.09
Hay		5	440	0.10	4	5	6	5	6	0.15	0.12	0.16	0.15	0.12
Hay		6	440	0.10	6	6	7	7	6	0.09	0.10	0.09	0.10	0.09
Hay		8.5	440	0.10	8	10	8	9	9	0.03	0.03	0.03	0.04	0.04
Jute	Hay	5	440	0.10	9	9	9	6	9	0.06	0.05	0.04	0.06	0.07
Jute	Hay	6	44	0.10	7	8	8	8	7	0.09	0.11	0.08	0.08	0.09
Jute	Hay	8.5	440	0.10	11	10	11	12	12	0.05	0.06	0.07	0.07	0.09
Jute	Coir	5	440	0.10	8	9	7	7	8	0.08	0.08	0.07	0.06	0.07
Jute	Coir	6	440	0.10	8	7	7	7	7	0.08	0.10	0.09	0.09	0.10
Jute	Coir	8.5	440	0.10	11	11	8	8	11	0.04	0.04	0.03	0.05	0.04
Coir	Hay	5	440	0.10	6	7	7	7	8	0.05	0.05	0.08	0.09	0.10
Coir	Hay	6	440	0.10	7	7	6	7	6	0.09	0.09	0.09	0.08	0.07
Coir	Hay	8.5	440	0.10	9	8	9	7	8	0.05	0.05	0.04	0.03	0.05

Table 3.4 Calculation of Delamination Factor

S.NO	NATURAL FIBRE COMPOSITE MATERIAL	DELAMINATION FACTOR	
		Fda	Fd
1	HAY	1.084	1.99851
2	COIR	1.092	1.99432
3	JUTE	1.170	1.99199
4	HAY& JUTE	1.205	1.92321
5	COIR & JUTE	1.202	1.88717
6	COIR & HAY	1.213	1.90807

3. CONCLUSIONS

In the attempt to address the objectives stated for this project, a series of conclusions were found for the experimental and analytical methods:

1. The fabrication of natural fibre composite materials using hay, jute, coir & its combination was successfully prepared. The test specimen was established to check the mechanical properties.
2. A test matrix includes hardness test, impact test, water absorption test, and drilling, to get the value for Brinell hardness number (BHN), impact strength, percentage of water absorption, thrust, torque and Delamination factor.
3. The different matrix combinations were subjected to the above tests and the results were tabulated
4. From the results the best combination matrix of Hay and Jute is suggested for usage as an alternate to carbon fibre reinforced polymers for seats of aircrafts.

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