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DEVELOPMENT OF COMPOSITES AND ASSESSING THE DURABILITY AND ACCEPTABILITY OF THE COMPOSITES IN SALINE WATER

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ABSTRACT

Composites began to be used more and more in every day commodities like bath tubs, railings, electrical goods, sports equipment, aerospace and ship industry. Now their applications have enhanced says Tang *et al.* (1997). The greatest advantage of composite materials is their strength and stiffness combined with lightness. By choosing an appropriate combination of reinforcement and matrix material, manufactures can produce properties that exactly fit the requirements for a particular structure and for a particular purpose. Due to the relatively high cost of synthetic fibres such as glass, plastic, carbon and Kevlar used in fibre reinforced composites and the health hazards of asbestos fibre, it becomes necessary to explore natural fibres says Hovroelas (2000). From above information the investigator felt the need to replace glass fibre and selected jute, coir and banana which are locally available, low cost and ease of manufacture. The materials selected for the development of composites were nonwovens made of jute, coir and banana (first, second and third samples), jute coir, coir banana and jute banana (fourth, fifth and sixth samples) and the combination of jute, coir, banana (seventh sample). The selected resins were epoxy resin, accelerator and catalyst (100: 20: 10) for preparing the matrix material. Since jute, coir and banana fibres are very stiff in nature, eco-friendly and less cost, they were selected and converted into nonwoven with the help of needle punching process and was used by the investigator to prepare a composites following the Hand lay-up techniques and assessed the durability and acceptability of composites in saline water.

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INTRODUCTION

The properties of the fiber reinforcement – resin matrix combination in a homogeneous composition have proved to be superior to those of traditional materials in many ways. The technology of composites making is very new and has very high potential in the natural fibres. In this technology, either the woven materials or the nonwoven materials are used as base for producing composites using suitable resin bonding materials. The above technology produces sheets of different thickness which replaces in many cases the use of wood and glass. Technology has been developed to produce automobile body parts out of such blended materials says Mathews (1999). A composite may be defined as a bi-phase or multi-phase material which is made by combing two or more materials differing in composition or which remain bonded together but retain their identity and properties. A composite can be classified based on the type of reinforcement and the type of matrix (thermoplastic or thermoset composites) used, said Gupta (2001). Reinforced plastics based on a variety of reinforcing agents and resins gradually entered civilian life as a material used in the manufacture of boats, cars, appliance housings, trays, storage containers, and other items. Although the basic elements of RP (Reinforced plastic) as composite materials were understood, the need for their higher structural capabilities generated by World War II that provided the impetus for the ultimate development of RP as composite materials. The reinforcements used in FRP (Fibre reinforced plastic) are inherently fire resistant, with the exception of the organic fibers. Dependent on the matrix, coupled with the reinforcement, the fiber can have either a negative or a positive effect on the flammability of the composite. Fiber – reinforced composites can also be employed in the absence of a lightning

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like protection scheme when the design involves a deliberate attempt to prevent strikes. In general, FRP materials are less susceptible to attracting a strike when compared to metals. Today with the increasing consumer markets, new products have been introduced in order to replace materials such as glass, metals, carbon, cement that are heavy, costly, corrosive and less environmental friendly. One such material is fibre composites. Nowadays fibre reinforced composites are increasingly used in a very wide range of applications such as automobile construction, aircraft construction, construction of doors, boats etc., The natural fibre composites offer specific properties compared to those of conventional fibre composite points out Richardson (1998). However, in development of these composites, the incompatibility of these fibre and poor resistance to moisture often reduce the potential of natural fibre. The developments in composite material after meeting the challenges of aerospace sector have cascaded down for catering to domestic and industrial applications. Composites, the wonder material with light - weight, high strength – to – weight ratio and stiffness properties, have come a long way in replacing the conventional materials like metal, woods etc. The material scientists all over the world focused their attention on natural composites reinforced with jute, sisal, coir, pineapple, banana etc. primarily to cut down the cost of raw materials.

Although the development of technical and industrial applications for textiles can be traced back many years, a number of more recent milestones have marked the emergence of technical textiles. The potential adoption of high volume glass-reinforced composite manufacturing techniques by the automotive industry as a replacement for metal body parts and components, as well as by manufacturing industry in general for all sorts of industrial and domestic equipment, promises major new marks. Composites are used to produce a variety of economical, efficient, and sophisticated items, ranging from toys and tennis rackets to reentry insulation shields and miniature printed circuits for spacecraft. Textile materials are used in various marine products for function and fashion purpose including mooring covers, boat tops, shading, sail covers, etc. Industrial textiles made their way into the sail boat industry a long time age. The requirements for these textiles include low stretch, high strength along with good resistance to weather, ageing chemicals and of course, the material must be waterproof as well. Greater demands for increased efficiency on a cost-to-performance basis will continue to grow as composite products inevitably move into larger – volume markets, which emphasize durability under different environment conditions. The primary reinforcing agents used in the production of composites at the present time are glass, paper (cellulosic fiber), cotton, polyamide and other natural fibers, asbestos, sisal, and jute.

MATERIALS AND METHODS

Production of Composite Sheets with Resin

In the design of the composite, the selection of materials and the construction techniques must be matched with product performance, productivity and cost requirements. Apart from the type of nonwoven prepared by web formation with the help of Dilo needle punching machine, the matrix also plays an important role in deciding the properties of the composites. The main function of the resin system is to provide rigidity and hold the textiles reinforcement materials in a prescribed suspension. Resin is responsible for structural integrity of textile materials. The textile perform may be a chopped fibre mat. The selected resin must be able to penetrate in all the selected nonwoven and wet the exposed fibre surface.

Fabrication method

A separate mould was prepared to place the nonwoven. The mould was given preliminary treatment before placing the nonwoven mat. The mould was made of wood which was in the form of a table. On the top of the table paint coating was given. Wax was applied evenly to the mould to leave shining effect and also to release the nonwoven mat from the mould. PVA which was a releasing agent was applied on the top of the table to release the mat. PVA was allowed to dry. It took 20 minutes to dry the chemicals. The time taken for drying depends upon the climate. Hot climate was favorable to prepare the mould and composite.

Preparation process

A flat table was used as a mould which was made of wood and finished with lamination. The mould was cleaned with acetone prior to composite preparation. Mould release agents such as wax and PVA were applied uniformly on the surface cleaned moulds to release the composite. The selected nonwoven such as jute, coir and banana (1^{st}, 2^{nd} and 3^{rd} samples), jute coir, coir banana, jute banana (4^{th}, 5^{th} and 6^{th} samples) and the mixture of jute, coir and banana (7^{th} sample) were precut in 100 x 70 cm sizes. The layers of the prepared nonwoven were placed one by one separately on the mould. The mould was kept at room temperature. A separate container was taken to mix the liquid reactant. The required amount of epoxy resin, accelerator and catalyst were poured in the container as per the instruction given by the manufacturer of the boat company (100 : 20 : 10) one liter of Epoxy resin was mixed with 20 ml of accelerator and 10 ml of catalysts. This resin mixture was applied to the nonwoven with the help of the brush. Care was taken to spread the resin mixer evenly. As the resin enters nonwoven, it got impregnated with the product. After gelation of resin the application was stopped and the panel was cured at 120^0C for 2 hours. The composite was removed from the mould and subjected to post curing at 120^0C for 3 hours to complete the reactors.

The weight, length and width of the selected nonwoven mats were taken before they were subjected to resin treatment and the measurement for all the samples are given in Table - I. The investigator selected the banana and coir nonwoven as the first sample and placed them on the mould. 4.5 kilo of resin was taken and it was mixed with 90 ml of accelerator. The mixture was kept for 20 minutes to settle. Then 35 ml of catalyst was added to the above mixture. It was observed that the selected nonwoven took few seconds to absorb and dry the chemicals which was not needed for glass fibre because glass fibres do not have air holes and it was observed that the chemical immediately dried whereas the selected nonwoven took few seconds to absorb the resin. A small roller was used to have uniform spreading of the resin on the nonwoven mat. The coir banana nonwoven sample taken was, one meter length and 70 cm width and the weight of the sample was 450 gram. The time taken for resin to settle on the nonwoven was 20 minutes. During hot climate, the time taken for curing was less than cold climate and the intake of resin by the nonwoven was slow in cold climate when compared to hot climate. The final weight of the sample was taken. It weighted about 4,660.

About 200 gram weight was less, this was due to exothermic reaction stated by the employee. The same procedure was followed for all the selected samples and the amount of resin used for each samples, their weight, size, length are before and after are given in Table I.

Preparation of Composite

Resin transfer moulding is a modern technology which was adopted to produce fibre reinforced composites using unsaturated polyester, vinyl ester etc. Earlier to construct a country boat the fibre mainly used were glass, wood and kevlar. As the natural fibres such as jute, coir and banana fibres are very stiff in nature, eco-friendly and less cost, they were selected and converted into nonwoven with the help of needle punching process and was used by the investigator to prepare a composites following the Hand lay-up techniques. The durability and acceptability of the composites in saline water are discussed in result and discussion.

RESULT AND DISCUSSION

Assessing the effect of saline water on the selected composites: The composites made of resin were cut in small sizes. A size of 25 / 17.5 cm was taken from all the samples, and the weight was taken before treating them with sea water. The cut samples such as jute (J), coir (C), banana (B), jute coir (JC), (50:50), coir banana (CB) (50:50), jute banana (JB) (50:50) and jute coir banana (JCB) (33:33:33) were subjected to sea water treatment at the room temperature. The water was replaced every 8 hours. At the completion of eight hours, the readings were taken to find out the weight gain of the composite as well as the color change. The saline water treatment was carried out to see the rot resistance property. The weight of the composite treated with saline water revealed that composite made of coir had absorbed more water and jute had absorbed less when compared to other composites. From the table to it was understood that the weight has increased in composite after treatment with saline water. The composite made of coir had absorbed more water due to the space found in between the composite than the other composite. Jute has absorbed found in between the compared to other nonwoven. Hence it could be concluded that composites made of coir and their combination absorbed more water and increased in the weight. Jute had absorbed less water when compared with coir. From the Table III It is clearly understood that the general appearance of composite was good and fair stated by 63 and 37 percent. 80 and 20 percent stated that the lustre of the jute was high and medium respectively. The color of the jute was light stated by 89 percent and dull stated by 11 percent. 44 percent stated that the texture of the jute was fine and 66 percent stated that the texture of the jute was fine and 66 percent stated that the texture of the jute was smooth. 53 percent stated that the feel of the jute was good, 41 percent stated that the feel of the jute was poor and 10 percent stated that the feel of the jute was poor. The general appearance of coir composite was fair and poor stated by 29 and 71 percent. The lustre of the coir was medium and low stated by 20 and 80 percent.

Table 1. Weight, Length and Width of the selected nonwoven to prepare composite

Sl. No	Name of the Sample	Size of the Sample		Weight of the nonwoven (gms)	Amount of chemical impregnated (kg)
		Length (m)	Width (cm)		
1.	Jute	1	70	234	2.270
2.	Coir	1	70	750	6.800
3.	Banana	1	70	244	3.100
4.	Jute Coir (50:50)	1	70	400	3.970
5.	Coir Banana (50:50)	1	70	304	4.500
6.	Jute Banana (50:50)	1	70	450	3.050
7.	Jute Coir Banana (33:33:33)	1	70	268	3.740

Table 2. Weight of the Composite Treated with Saline Water

Sl. No	Name of the Sample	Size of the Sample		Weight Before Treatment (gms)	Weight after Treatment (gms)	Percentage Increase (%)
		Length (cm)	Width (cm)			
1.	Jute	25	17.5	199.4	200.6	0.60
2.	Coir	25	17.5	241.0	248.9	3.28
3.	Banana	25	17.5	207.5	210.3	1.35
4.	Coir Banana (50:50)	25	17.5	343.0	351.5	2.48
5.	Banana Jute (50:50)	25	17.5	206.3	208.4	1.02
6.	Jute Coir (50:50)	25	17.5	199.4	205.7	3.16
7.	Coir Banana and Jute (33:33:33)	25	17.5	234.0	236.6	1.11

Table 3. Evaluation of the Composites Treated with Saline Water

Name of the Selected Samples	General Appearance			Lustre			Colour			Texture			Feel		
	Good	Fair	Poor	High	Medium	Low	Dark	Light	Dull	Fine	Rough	Smooth	Poor	Fair	Good
Jute	63	37	-	80	20	-	-	89	11	44	-	66	7	40	53
Coir	-	29	7	-	20	80	78		22	33	67	-	76	24	-
Banana	58	38	9	88	12	-	-	92	8	43	-	57	49	41	10
Jute Coir	10	64	26	-	28	72	64	-	36	5	81	14	12	68	20
Coir Banana	19	69	12	12	62	26	56	28	16	11	67	22	23	56	21
Jute Banana	55	35	10	79	21	-	-	61	39	51	16	33	38	52	10
Jute Coir Banana	63	37	-	39	48	13	31	41	28	30	26	44	29	46	25

The color of the coir composite was dark and dull stated by 78 and 22 percent. The texture of the coir was fine and rough stated by 33 and 67 percent respectively. The feel of the coir was fair and good stated by 24 and 76 percent. The general appearance of the banana was good stated by 58 percent, fair stated by 38 percent and poor stated by 9 percent. The lustre of the banana was high and medium stated by 88 and 12 percent. The color was light stated by 92 percent and dull stated by 8 percent. The texture was fine stated by 43 percent and smooth stated by 57 percent. The feel was poor, fair and good stated by 49, and 10 percent. The general appearance of the jute coir was good stated by 10 percent, fair stated by 64 percent and poor stated by 26 percent. The lustre of the jute coir was medium and low stated by 28 and 72 percent. The color of the jute coir was dark stated by 64 percent and dull stated by 36 percent. The texture of the jute was fine stated by 5 percent, rough stated by 81 percent and smooth stated by 14 percent. The feel of the jute coir was poor, fair and good stated by 12, 68 and 20 percent. The general appearance of the coir banana was good stated by 19 percent, fair stated by 69 percent and poor stated by 12 percent. The lustre of the coir banana was high, medium and low stated by 12, 62 and 26 percent. The color of the coir banana was dark stated by 56 percent, light stated by 28 percent and dull stated by 16 percent. The texture of the coir banana was fine stated by 11 percent, rough stated by 67 percent and smooth stated by 22 percent. The feel of the coir banana was poor, fair and good stated by 23, 56 and 21 percent.

The general appearance of the jute banana was good stated by 55 percent, fair stated by 35 percent and poor stated by 10 percent. The lustre of the jute banana was high and medium stated by 79 and 21 percent. The color of the jute banana was light stated by 61 percent and dull stated by 39 percent. The texture of the jute banana was fine stated by 51 percent, rough stated by 16 percent and smooth stated by 33 percent. The feel of the jute banana was poor, fair and good stated by 38, 52 and 10 percent. The general appearance of the jute, coir banana was good stated by 63 percent and fair stated by 37 percent. The lustre of the jute, coir banana was high, medium and low stated by 39, 48 and 13 percent. The color of the jute, coir banana was light stated by 31 percent, light stated by 41 percent and dull stated by 28 percent. The texture of the jute, coir banana was fine stated by 30 percent, rough stated by 26 percent and smooth stated by 44 percent. The feel of the jute, coir banana was poor, fair and good stated by 29, 46 and 25 percent. Hence it was concluded that the general appearance of the jute banana coir was good, coir banana was fair and coir had poor appearance. Banana had highest lustre whereas coir had lowest lustre. The color of the coir was dark, banana had a light color and jute banana had dull color. The texture of the jute banana was fine whereas jute coir had rough texture and jute had smooth texture. The feel of the jute was good, jute coir was fair and coir had poor feel.

Conclusion

The study revealed that the nonwovens and composites showed a slight increase in the weight especially in coir and their combination. Other materials such as jute had taken less moisture. Thus it was concluded that the presence of coir in all the nonwovens and composites had absorbed the moisture when treated with saline water. The study also revealed that the general appearance of the jute, banana coir was good and banana had highest lustre when compared to coir. The texture of the jute banana was fine, jute had smooth texture and the feel of the jute was good.

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