EVALUATION OF MECHANICAL PROPERTIES ON A DEVELOPED GREEN PACKAGING MATERIAL

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Abstract - *Papers, plastics and cardboard have gained major popularity in the field of packaging purposes. The production of paper is a major cause of air pollution, producing 70 percent more than the pro-duction of plastic bags. Paper used as packaging is less durable and more likely to get wet compared to plastic. In this work, the objective was to develop, investigate and analyse a green packaging material which is biodegradable, water repellent and sustainable, and acts as a substitute for all other conventional packaging materials. A quality analysis of the material is carried out and is compared with conventional materials.*

Key Words: Plastic, Paper bag, Bamboo, Composite.

1.INTRODUCTION

We use a lot of packaging materials, most of them are not biodegradable or water repellent . Cardboard, plastics are some of the examples. We know that cardboard boxes are the packaging products and also essential for protecting goods and products. But these boxes have certain disadvantages, such as they are not for packaging of certain heavy items. The corrugated cardboard boxes may get deformed under extreme pressure. Also they are not the best option for weatherproofing like water and other types of liquid.

Plastics are another form of packaging material. The dispos-able plastics used in packaging foodstuff meant for human consumption contain harmful compounds. These are generally non-biodegradable, hence, they may take decades to decay. Plastics generally have a short useful life compared to metals. This short life cycle results in pile-ups of unwanted garbage in the office, home or waste yards.

Paper has also gained popularity in the field of packaging. However even paper is doing more harm than good. The pro-duction of paper is a major cause of air pollution, producing 70 percent more than the production of plastic bags. Paper used as packaging is less durable and more likely to get wet compared to plastic which is sturdier and water proof.

1.1 LITERATURE REVIEW

In recent years, the interest of scientists and engineers has turned over on utilising plant fibres as effectively and eco-nomically as possible to produce good quality fibre-reinforced polymer composites for structural, building, and other needs. It is because of the high availability and has led to the devel-opment of alternative materials instead of conventional or man-made ones. Many types of natural fibres have been in-vestigated for their use in polymer such as wood fibre, sisal, pineapple, jute and bamboo. Water absorption showed an in-crease in water uptake with increase in fibre content. Maxi-mum tensile strength was observed at 30 mm fibre length while maximum impact strength was observed for 40 mm fibre length. Comparative analysis with other natural fibres shows bamboo fibre composite has superior mechanical prop-erties than other composites.

Influence of silica powder on tensile properties of bamboo fibre/epoxy composite. It showed that the addition of silica increases the modulus of elasticity and impact strength of composite.

2. EXPERIMENTAL SET UP

The fabrications of composite are carried out by conven-tional hand layup technique. The dimensions of length and breadth is of 30*30cm was used to prepare the specimen. The composite specimen consists of totally 3 layers of Bamboo Fibre for the preparation of one sample. A measured amount of epoxy is taken and mixed with the hardener in the ratio of 10:1.The material proportion of this composite is shown Ta-ble 1.

Table-1: Composite material proportion

MATERIAL	PROPORTION (%)
Bamboo	50
Epoxy Resin	50

2.1 HAND LAY UP PROCESS

Hand lay-up is the simplest and oldest open moulding method of the composite fabrication processes.The ex-perimental setup is shown in Fig-1.

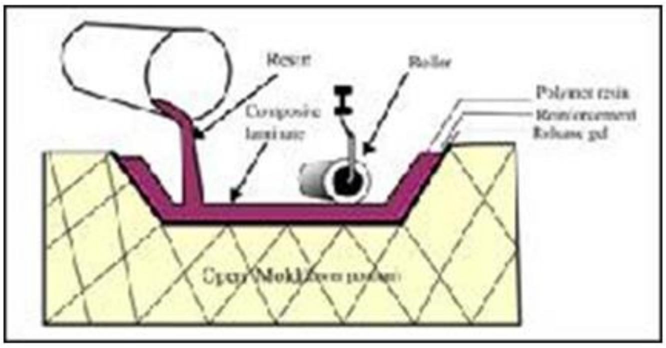

Fig-1: Hand layup process

The processing steps are quite simple. First of all, a release gel is sprayed on the mould surface to avoid the sticking of polymer to the surface. Thin plastic sheets are used at the top and bottom of the mould plate to get good surface finish of the product. The polymer is uni-formly spread with the help of brush. Second layer of bamboo is then placed on the polymer surface and a roller is moved with a mild pressure on the bamboo-polymer layer to remove any air trapped as well as the excess polymer present. The process is repeated for each layer of polymer and bamboo, till the required layers are stacked. After placing the plastic sheet, release gel is sprayed on the inner surface of the top mould plate which is then kept on the stacked layers and the pressure is applied. After curing at room temperature or at some specific temperature, mould is opened and the developed composite part is taken out and further processed. Curing time at room temperature is 24-48 hours.

2.2 MATERIAL USED

1. Bamboo Fibre
2. Epoxy Resin

2.2.1 BAMBOO FIBRE

Bamboo fibre is a cellulose fibre extracted or fabricated from natural bamboo, and is made from the pulp of bamboo plants. Manufacturers tout the fact that bamboo can be cultivated quickly, can be used as a cash crop to develop impoverished regions of the third world, and is a natural fibre whose cultivation results in a decrease in greenhouse gases. Around 75% of all polluting emis-sions coming from the bamboo viscose process occur in the form of air emissions. There may be environmental problems with the cultivation of land expressly for bam-boo plantations, and the use of harsh chemicals to turn bamboo into usable fibre for clothing.

Bidirectional bamboo fibre has been used as a reinforc-ing material in all composite. These are collected from local sources. Bamboo belongs to grass family Bambu-soideae. It is a natural Lignocellulosic composite, in which cellulose fibres are embedded in the lignin matrix. The average length of a bamboo fibre is about 2mm and average diameter is between 10-20μm. Bamboo is a naturally occurring composite material which grows abundantly in most of the tropical countries and has been used widely for household products and industrial applications due to advances in processing technology and increased market demand. In Asian countries, bam-boo has been used for household utilities such as con-tainers, chopsticks, woven mats, fishing poles, cricket boxes, handicrafts, chairs etc. It finds a variety of build-ing applications, such as flooring, ceiling, walls, win-dows, doors, fences, housing roofs, trusses etc. It is also used in construction as structural materials for bridges, water transportation facilities and skyscraper scaffold-ing. Bamboo grows with a very high speed in the first year and stops growing completely within five years.

2.2.2 EPOXY RESIN

Epoxy is a term used to denote both the basic compo-nents and the cured end products of epoxy resins, as well as a colloquial name for the epoxide functional group. Epoxy resins, also known as poly-epoxides, are a class of reactive prepolymers and polymers which con-tain epoxide groups. Epoxy resins may be reacted (cross-linked) either with themselves through catalytic homopolymerisation, or with a wide range of co-reac-tants including poly-functional amines, acids (and acid anhydrides), phenols, alcohols and thiols. These co-reac-tants are often referred to as hardeners or curatives, and the cross-linking reaction is commonly referred to as curing. Reaction of poly-epoxides with themselves or with poly-functional hardeners forms a thermosetting polymer, often with high mechanical properties, temper-ature and chemical resistance. Epoxy has a wide range of applications, including metal coatings, use in elec-tronics / electrical components, high tension electrical insulators, fibre-reinforced plastic materials and struc-tural adhesives.

3. PREPARATION OF COMPOSITE

The composite are fabricated by hand lay-up tech-nique, shown in figure 2. A group of sample is manufac-tured by 50% of volume fraction of fibre. Since it was found that 50% volume fraction of bamboo fibre rein-

forced in the composite gives optimum results. A calculated amount of epoxy resin and hardener (ratio of 10:1 by weight) was thoroughly mixed with gentle stir-ring to minimise air entrapment. For quick and easy re-moval gel and plastic sheet is applied on both glass plates. After applying that on glass plate the mixture of resin and hardener was poured. Then the required amount of fibres was distributed on the mixture. The remainder of the mixture was then poured into the mould. Care was taken to avoid formation of air bub-bles. Pressure was then applied from the top and the mould was allowed to cure at room temperature for 24 hrs. After 24 hrs the samples were taken out of the mould, cut into different sizes and kept in air tight con-tainer for further experimentation. Now the prepared composite were cut for testing conform to the dimen-sions of the specimen as per ASTM standards.

Fig-2: Fabricated composite

3.1 TENSILE TEST

Mechanical testing plays an important role in evaluat-ing fundamental properties of engineering materials as well as in developing new materials and in controlling the quality of materials for use in design and construc-tion. If a material is to be used as part of an engineering structure that will be subjected to a load, it is important to know that the material is strong enough and rigid enough to withstand the loads that it will experience in service.

The most common type of test used to measure the mechanical properties of a material is the Tension Test. Tension test is widely used to provide basic design in-formation on the strength of materials and is an accep-tance test for the specification of materials. The major parameters that describe the stress-strain curve obtained during the tension test are the tensile strength (UTS), yield strength Or yield point (σy), elastic modulus (E), percent elongation (L %). In this test, a specimen is prepared suitable for gripping into the jaws of the testing machine type that will be used.

Fig-3: Universal testing machine

3.2 HARDNESS TEST

Hardness is the property of a material that enables it to resist plastic deformation, usually by penetration. However, the term hardness may also refer to resistance to bending, scratching, abrasion or cutting.

3.2.1 SHORE HARDNESS TEST

Shore hardness is a measure of the resistance of a ma-terial to penetration of a spring loaded needle-like inden-ter. Hardness of Polymers is usually measured by Shore scales. Shore A scale is used for testing soft Elastomers and other soft polymers. Hardness of hard elastomers and most other polymer materials is measured by Shore D scale. Shore hardness is tested with an instrument called Durometer. Durometer utilises an indenter loaded by a calibrated spring. The measured hardness is deter-mined by the penetration depth of the indenter under the load. Two different indenter shapes and two different spring loads are used for two Shore scales (A and D).

Hardness qualifies the resistance to permanent indenta-tion of a material. Shore D Hardness is a standardised test consisting in measuring the depth of penetration of a specific indenter. The higher the value, the higher the hardness. The Shore D test is used when the material is too soft to be measured by a Rockwell test. For very soft materials such as rubber or TPEs, the Shore A test is recommended. The Shore Hardness is measured with an apparatus known as a Durometer and consequently is also known as “Durometer hardness”. The hardness val-ue is determined by the penetration of the Durometer indenter foot into the sample. Shore Hardness measures are dimensionless.

3.2.2 TEST PROCEDURE

The specimen is first placed on a hard flat surface. The indentor for the instrument is then pressed into the specimen making sure that it is parallel to the surface. The hardness is read within one second of firm contact with the specimen.

4. RESULT AND DISCUSSION

This chapter presents the mechanical properties of the bamboo fibre- epoxy resin composites prepared for this present investigation. The Details of processing of these composites and the tests conducted on them have been described in the before chapter. The results of vari-ous characterisation tests are reported here. These in-clude evaluation of tensile strength and hardness that has been studied and discussed.

4.1 TENSILE TEST

The test was conducted in Universal testing machine. According to ASTM standards specimen have gauge length, width and cross-section area of 50 mm, 10 mmand 153 mm^2

respectively. Representation of tensile properties are given below.

Load At Yield : 0.54 KN

Yield Stress : 3.158 N/mm**2**

Load at peak : 0.800 KN

Tensile strength : 5.212 N/mm**2**

Elongation : 1.12 %

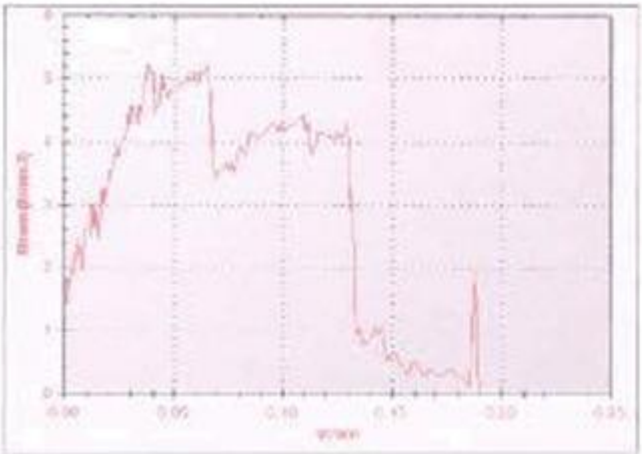

Fig-4: Stress vs strain plot

4.2 HARDNESS TEST

The hardness properties of composite represented in Table 2.

Table-2: Hardness test

Sl. No	Sample	Observed values, HRA			Average HRA
		1	2	3	
1	Bamboo with epoxy	75	74	75	75

5. CONCLUSION

This paper describes a newly developed green packag-ing material and evaluates its mechanical performance characteristics. This novel composite (bamboo fibre with epoxy resin) shows better yield characteristics under varying conditions as compared to conventional packag-ing materials like paper, plastics and card boards. The developed composite is purely biodegradable and water repellent and hence it is effective for packaging any per-ishable goods.

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