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COMPARATIVE ANALYSIS OF MECHANICAL PROPERTIES OF NATURAL FIBER COMPOSITES BY USING UN-SATURATED POLYSTER RESIN

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Abstract: Natural fibers is having a major role in the emerging "green" technology based on energy efficiency, the use of renewable materials in polymer products, industrial processes that reduce carbon emissions and recyclable materials that minimize waste. Natural fibers are a kind of renewable resources, which have been renewed by nature and human ingenuity for thousands of years. These fibers are completely renewable, environmental friendly, high specific strength, non-abrasive, low cost, and bio-degradable, due to these characteristics, natural fibers have now attracting to researchers and scientists as an alternative material as fibers reinforced composites. This review paper summarized about the mechanical behavior of some of natural fibers composites and its applications.

Keywords: Natural Fiber, Green

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INTRODUCTION

In current scenario the sustainable material is gaining high popularity because of which researchers are trying to form low weight and high strength mate which can be utilized for multidisciplinary uses.

Natural fiber composites are attracting researchers for preparation of composite material because they are ecofriendly, renewable, light weight and mostly the major property they possess that is biodegradability. The natural fiber composite is playing a major role for green revolution in the field of material sciences & their applications. Natural fibers can be classified as plant, animal & mineral fibers. This paper deals with the study of comparative analysis of mechanical properties of composites prepared by some of the natural fibers with Unsaturated Polyester Resin (UPR) and also tried to compare with most popular E-Glass composites. In this paper collected the data from various research papers for silk, wool, hemp and jute fibers composites.

❖ CLASSIFICATION OF NATURAL FIBERS

Natural fibers can be classified according to their origin.
Animal fiber
Mineral fiber
Plant fiber

Animal Fiber
Animal fiber generally comprise proteins; examples mohair, wool, silk, alpaca, angora.

- **Animal hair (wool or hair)**: Fiber taken from animals or hairy mammals. E.g.: Sheep's wool, goat hair (cashmere, mohair), alpaca hair, horse hair, etc.
- **Silk fiber**: Fiber collected from dried saliva of bugs or insects during the preparation of cocoons. Examples include silk from silk worms.

Mineral fiber
Mineral fibers are naturally occurring fiber or slightly modified fiber procured from minerals. These can be categorized into the following categories:

- **Asbestos**: The only naturally occurring mineral fiber. Variations are serpentine and amphiboles, anthophyllite.
- **Ceramic fibers**: Glass fibers (Glass, wood and Quartz), aluminum oxide, silicon carbide and boron carbide.
- **Metal fibers**: Aluminum fibers.

Plant fiber
Plant fibers are generally comprised mainly of cellulose: examples include cotton, jute, flax, ramie, sisal and hemp. Cellulose fibers servers in the manufacture of paper and cloth. This fiber can be further categorizes into following.

- ***Seed fiber***: Fibers collected from the seed and seed case e.g. cotton and kapok.
- ***Leaf fiber***: Fibers collected from the leaves e.g. hemp, sisal and agave.
- ***Skin fiber***: Fibers are collected from the skin or bast surrounding the stem of their respective plant. These fibers have higher tensile strength than other fibers. Therefore, these fibers are used for durable yarn, fabric, packaging, and paper. Some examples are flax, jute, banana, hemp, and soybean.
- ***Fruit fiber***: Fibers are collected from the fruit of the plant, e.g. coconut (coir)

fiber.

- ***Stalk fiber***: Fibers are actually the stalks of the plant. E.g. straws of wheat, rice, barley, and other crops including bamboo and grass. Tree wood is also such a fiber.

❖ **CLASSIFICATION OF RESINS**

Resins can be classified as follows:

1. Polyester
2. Epoxy
3. Vinyl Ester
4. Phenolic
5. Polyurethane

In this paper we have studied about the composite manufacturing by using the Polyester Resin (Unsaturated Polyester Resins).

Unsaturated Polyester Resins (UPR) are the work-horse of the composites industry and represent approximately 75% of the total resins used. A range of raw materials and processing techniques are available to achieve the desired properties in the formulated or processed polyester resin. Polyesters are versatile because of their capacity to be modified or tailored during the building of the polymer chains. They have been found to have almost unlimited usefulness in all segments of the composites industry.

The principle advantage of these resins is a balance of properties (including mechanical, chemical, and electrical) dimensional stability, cost and ease of handling or processing. These resins can be formulated and chemically tailored to provide properties and process compatibility.

❖ **METHOD OF COMPOSITE PREPARATION**

The following methods are available for the composite preparation:

1. Hand Lay-Up Technique
2. Spray Up Technique
3. Vacuum Bagging Technique
4. Filament Winding
5. Pultrusion
6. Resin Transfer Molding
7. Compression Molding

In this paper we have studied about the composite manufacturing with the Hand Lay-Up Technique because the research papers which we have referred in this study have all used the Hand Lay-Up.

1. Hand Lay-Up Technique

This is probably the simplest method producing reinforced plastic articles. Hand Lay-Up method in which successive layers of resin and reinforcement are manually applied to an open mold to build the laminated FRP composite structure. It is labor-intensive. Finished molding must usually be trimmed with a power saw to size outside edges. Oldest Hand Lay-Up method for FRP laminates, dating to the 1940s when it was first used for boat hulls.

2. Spray Up Technique

Liquid resin and chopped fibers are sprayed onto an open mold to build successive FRP laminations. Attempt to mechanize application of resin-fiber layers and reduce lay-up time In Spray–up process, chopped fibers and resins are sprayed simultaneously into or onto the mold. Applications are lightly loaded structural panels, e.g. caravan bodies, truck fairings, bathtubs, small boats, etc.

3. Vacuum Bagging Technique

The vacuum–bag process was developed for making a variety of components, including relatively large parts with complex shapes. Applications are large cruising boats, racecar components, etc. Use atmospheric pressure to suck air from under vacuum bag, to compact composite layers down and make a high quality laminate. Layers from bottom include: mold, mold release, composite, peel-ply, breather cloth, vacuum bag, also need vacuum valve, sealing tape.

4. Filament Winding

Resin-impregnated continuous fibers are wrapped around a rotating mandrel that has the internal shape of the desired FRP product, the resin is then cured and the mandrel removed.

• The fiber rovings are pulled through a resin bath immediately before being wound in a helical pattern onto immediately before being wound in a helical pattern onto the mandrel.
• The operation is repeated to form additional layers, each having a criss-cross pattern with the previous, until the desired part thickness has been obtained.

5. Pultrusion

Similar to extrusion (hence the name similarity) but workpiece is pulled through die. Like extrusion, pultrusion produces continuous straight sections of constant cross section. It has been developed around 1950 for making fishing rods of glass, Fiber Reinforced Polymer (GFRP).

6. Resin Transfer Molding

Resin transfer molding or 'RTM' produces large, complex items such as bath and shower enclosures, cabinets, aircraft parts, and automotive components. In this process, a set of mold halves are loaded with reinforcement material then clamped together. Resin is then pumped or gravity fed into the mold infusing the reinforcement material. Once the mold is filled with resin, it is plugged and allowed to cure. After curing, the mold halves are separated and the part removed for final trimming and finishing.

7. Compression Molding

A charge is placed in lower mold section, and the sections are brought together under pressure, causing charge to take the shape of the cavity Mold halves are heated to cure polymer.

– When molding is sufficiently cured, the mold is opened and part is removed
  • Several shaping processes for PMCs based on compression molding.
– The differences are mostly in the form of the starting materials.

Technique Collected For Described Results For Preparation Of Composites

Hand Lay-Up Technique

In this technique resins with calculated amount of MEKP (hardening agent) & Cobalt Octate (accelerator) are impregnated by hand into wool fibers which are in the form randomly layered fiber sheet in predetermined sample size, the surface properties of fiber is improved by starch. This is usually accomplished by rollers or brushes, with

an increasing use of nip-roller type impregnators for forcing resin into the fibers by means of rotating rollers and a bath of resin. The required pressure is applied and excess solid resin trimmed & left to cure under standard atmospheric conditions.

PROCEDURE OF THE HANDLAY-UP TECHNIQUE

1. Right quantity of resin and the treated fibers in predetermine ratio was taken.
2. After taking the material in desire quantity first the mold is prepared and two operation need to be done that are cleaning of mold and applying the mold release agent.
3. Calculated amount of hardener and accelerator were added into the system. Care must be taken that the hardener & accelerator should not be added at the same time so that excess of exo-thermicity of the reaction can be controlled.
4. After preparing the resin with curing system in the pot the half quantity of resin is poured in to the mold in such way that it reach to the each corner of mold and sprier uniformly. The thickness and final properties are largely depends on the way of pouring. To achieve the uniformity the after pouring the material mold is move up and down from any two side. In this method the manual skill is most important.
5. As the fibers having very low density and available in random form it creates most of problems. It should be placed in such way that it gives the uniform thickness.
6. Remaining resin then poured on the fibers it is make sure that all fibers get wet and not come on the surface. The outer surface finish depends on this layer rollers can be used for better surface finish
7. Depending upon the resin and curing system used the curing time varies .The adequate pressure is applied & mold is kept on the flat surface until it get cured completely.
8. After it gets cured the marking is done on the sheet for the cutting. The marking should be as per the standards. Proper cutting of sheet is done, minimum stress should be developed while cutting the samples.

❖ RESULTS & DISCUSSION :

- The effect of Silk, Wool noil, Jute & Hemp fiber (Natural) as reinforcement material with unsaturated polyester resin composites was studied on primary basis.
- Incorporation of the waste in the composites enhanced considerably the mechanical properties such as tensile, flexural and impact strength.
- These results are evidence that the natural fibers are an efficient alternative and comparable with other fibers reinforced composites for their cycling.
- Further research can add more probabilities for replacement of these fibers with other popular fiber reinforcement

Mechanicals properties of Natural Fibers with E-Glass.

Properties	Natural Fibers				Synthetic Fiber
	Silk (15%)	Wool (15%)	Jute (25%)	Hemp (20%)	E-Glass
Tensile (Mpa)	29.84	30.10	47.4	37.82	2000
Flexural (Mpa)	279.39	40.9	16.23	25.8	203.8
Impact (kgcm/inch)	1.06	2.63	1.2	1.4	1.1

❖ CONCLUSION

The natural fiber composite manufactured by hand lay-up process provides an opportunity of replacing existing materials with a higher strength, low cost alternative that is environmentally friendly, with the utilization of such alternative materials , the extend and exploitation of natural resources in the form of conventional material can be reduced to high extend , making the manufacturing practice sustainable.

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