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Investigation of Leaf Spring using Basalt and Kevlar Fiber with Isopolymer

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Abstract :The composite material are replacing the traditional material, because of its superior properties such as high tensile strength, low thermal expansion, high strength to weight ratio. The development of new materials are on the anvil and are growing day by day. Natural fiber composites became more attractive due to their high specific strength, lightweight and biodegradability. In this project, natural fiber reinforced polymer composites is developed in two ways that is treated and non-treated and their mechanical properties such as tensile strength, flexural strength, impact strength and hardness test are evaluated. At last we are going to compare the both strength of treated and untreated natural fiber reinforced polymer and evaluate which one is the best and strengthen natural fiber reinforced polymer.In present year's natural fiber composite material locale a major role in industries like aerospace and automobile. The natural fiber is amplified by hook up with plastics. The ample availability of aramid and natural fibers such as basalt,kevlar, Palm fiber ramie, sisal, jute, banana, bagasse etc.Common matrix materials include epoxy, phenolic, polyester, polyurethane vinyl ester etc.The composites formed by fibres gained attention due to their low cost, light weight, renewability, low density, high specific strength, non abrasivity, non toxicity and biodegradability etc.In this paper discussed the Composite material Plate by using basalt and kevlar fiber with Epoxy composite and to evaluate the Mechanical properties of leaf spring (Tensile strength, Hardness, Toughness Examination).

Index words – Natural fiber, Caryota Urens, Polyster.

I. INTRODUCTION

Over the last thirty years composite materials, plastics and ceramics have been the dominant emergingmaterials. The volume and number of applications of composite materials have grown steadily, penetrating
And conquering new markets relentlessly.

Modern composite materials constitute a significant proportion ofthe engineered materials market ranging from everyday products to sophisticated niche applications. Whilecomposites have already proven their worth as weight-saving materials, the current challenge is to make themcost effective.

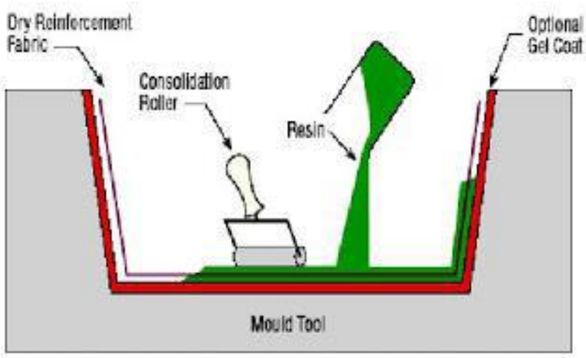

Fig. 1 Hand layup/ Wet layup process

The efforts to produce economically attractive composite components have resulted in severalinnovative manufacturing techniques currently being used in the composites industry. It is obvious, especiallyfor composites, that the improvement in manufacturing technology alone is not enough to overcome the costhurdle. It is essential that there be an integrated effort in design, material, process, tooling, quality assurance,manufacturing, and even program management for composites to become competitive with metals. Thecomposites industry has begun to recognize that the commercial applications of composites promise to offermuch larger business opportunities than the aerospace sector due to the sheer size of transportation industry.Thus the shift of composite applications from aircraft to other commercial uses has become prominent inrecent years. Increasingly enabled by the introduction of newer polymer resin matrix materials and highperformance reinforcement fibers of glass, carbon and aramid, the penetration of these advanced materials haswitnessed a steady expansion in uses and volume.The increased volume has resulted in an expected reductionin costs. High performance FRP can now be found in such diverse applications as composite armoringdesigned to resist explosive impacts, fuel cylinders for natural gas vehicles, windmill blades, industrial driveshafts, support beams of highway bridges and even papermaking rollers. For certain applications, the use ofcomposites rather than metals has in fact resulted in savings of both cost and weight. Some examples arecascades for engines, curved fairing and fillets, replacements for welded metallic parts, cylinders, tubes, ducts,blade containment bands etc. Further, the need of composite for lighter construction materials and moreseismic resistant structures has placed high emphasis on the use of new and advanced materials that not onlydecreases dead weight but also absorbs the shock & vibration through tailored microstructures. Compositesare now extensively being used for rehabilitation/ strengthening of pre-existing structures that have to be retrofitted to make them seismic resistant, or to repair damage caused by seismic activity. Unlike conventionalmaterials (e.g., steel), the properties of the composite material can be designed considering the structuralaspects. The design of a structural component using composites involves both material and structural design.

II.LITERATURE SURVEY

Now a day, Natural fibers are widely used as a composite material as a replacement for conventional & traditional fiber reinforced composite material such as carbon fibers, glass fibers, etc have excellent mechanical properties. But there are disadvantages in using these fibers such as non-eco friendly, toxic, etc. While comparing with natural fiber, the advantages of natural fiber are environmental friendly, fully biodegradable, cheap, light in weight, non toxic, no abrasion to machine & have low density. As like traditional fiber & conventional fiber the natural fiber also have good specific strength, high toughness, good thermal insulation & less respiratory irriation.

Amar Singh Singha& Vijay Kumar Thakur (2012) found that the natural fiber (grewiaoptiva) treated with silane has improving their properties such as swelling behavior, moisture absorbance, chemical resistance etc.

M.Thiruchitrambalam et.al (2010) compared the mechanical properties at banana / kenaf hybrid composite (natural fiber) subjected to alkali and sodium lauryl sulfate treatment and concluded that the SLS treatment has improved the mechanical properties than alkali treatment.

V.Manikandan et.al. (2010) developed an unsaturated polyester composites by basalt fiber using hand layup technique at room temperature both with & without acid & alkali treatments (NaOH& H2SO4). Then its mechanical properties & fracture are tested by using computer-assisted universal testing machine, Izod Impacttesting machine & SEM. They concluded that the basalt fiber reinforced composites treated with the acid is superior to the glass fiber in mechanical properties.

III. MATERIALS USED

The raw materials used in this work are

1. Kevlar fiber
2. Basalt fiber
3. Isopolymer

1. Kevlarfiber:

Kevlar is synthesized in solution from the monomers1,4-phenylene-diamine (*para*-henylenediamine) and terephthaloyl chloride ina condensation reaction yielding hydrochloric acid as a byproduct. The result has liquid-crystalline behavior, and mechanical drawing orients the polymer chains in thefiber's direction. Hexamethylphosphoramide (HMPA) was the solvent initially used for the polymerization, but for safety reasons, DuPont replaced it by a solution of *N*-methyl-pyrrolidone and calcium chloride. As this process had been patented by Akzo (see above) in the production of Twaron, a patent war ensued.

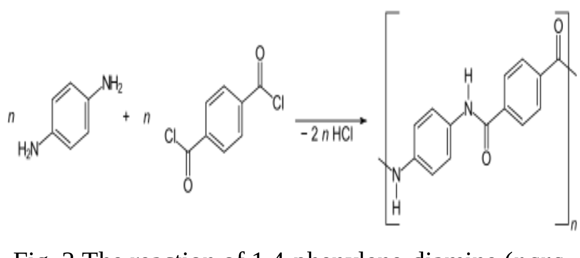

Fig. 2 The reaction of 1,4-phenylene-diamine (*para*-phenylenediamine) with terephthaloyl chloride yielding Kevlar

Kevlar (poly paraphenyleneterephthalamide) production is expensive because of the difficulties arising from using concentrated sulfuric acid, needed to keep the water-insoluble polymer in solution during its synthesis and spinning.

2. Basalt fiber:

Basalt fiber is a material made from extremely fine fibers of basalt, which is composed of the minerals plagioclase, pyroxene, and olivine. It is similar to fiberglass, having better physicomechanical properties than fiberglass, but being significantly cheaper than carbon fiber. It is used as a fireproof textile inthe aerospace andautomotive indus tries and can also be used as a composite to produce products such as camera tripods.

Fig. 3 Basalt fiber

Table. 1 Properties of basalt fiber

Property	Value
Tensile strength	2.8-3.1 GPa
Elastic modulus	85-87 GPa
Elongation at break	3.15%
Density	2.67 g/cm³

Basalt fiber is made from a single material, crushed basalt, from a carefully chosen quarry source.Basalt of high acidity (over 46% silica content) and low iron content is considered desirable for fiber production. Unlike with other composites, such as glass fiber, essentially no materials are added during its production. The basalt is simply washed and then melted.The manufacture of basalt fiber requires the melting of the crashed and washed basalt rock at about 1,500 °C (2,730 °F). The molten rock is then extruded through small nozzles to produce continuous filaments of basalt fiber.

IV. INGREDIENTS AND ADDITIVES USED IN MANUFACTURING OF RESINS

Manufacturers of all types of resins use various ingredients and additives, in different proportions, to give their resins differing properties and characteristics suited to particular applications. Some general classes of additives used are as follows:

1. Catalysts, Promoters, Inhibitors:

In polyesters, the most important additive is catalyst or initiator. Typically, organic peroxide such 3SMEKP (Methyl Ethyl Ketone Peroxide) is used for room temperature cured processes, or benzoyl peroxide is added to the resin for heat cured molding. When triggered by heat, or used in conjunction with a promoter (such as cobalt napthenate), peroxides convert to a reactive state (exhibiting free radicals), causing the unsaturated resin to react (cross-link) and become solid. Some additives such as TBC (Tertiary Butyl Catechol) are used to slow the rate of reaction and are called inhibitors.

2. Additives and Modifiers**:**

A wide variety of additives are used in composites to modify materials properties and tailor the laminates performance. Although these materials are generally used in relatively low quantity by weight compared to resins, reinforcements and fillers, they perform critical functions.

V. DESIGN PROCESS

A leaf spring is a simple form of spring commonly used for the ý in wheeled vehicles. Originally called a laminated or carriage spring, and sometimesreferred to as a semi-elliptical spring or cart spring.A leaf spring can either be attached directly to the frame at both ends or attached directly at one end,

usually the front, with the other end attached through a shackle, a short swinging arm. The shackle takes up the tendency of the leaf spring to elongate when compressed and thus makes for softer springiness. Some springs terminated in a concave end, called a *spoon end* (seldom used now), to carry a swivelling member.

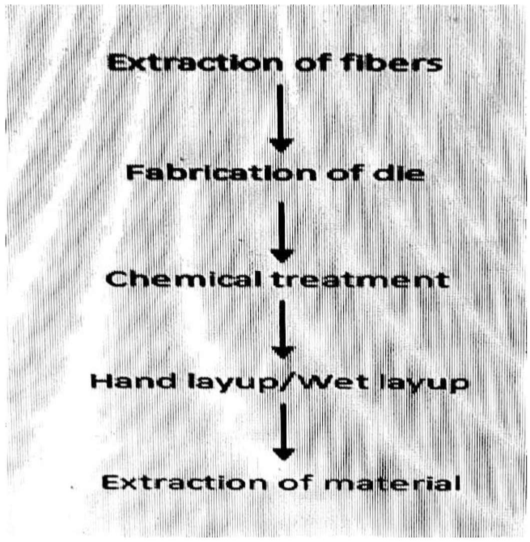

Fig. 4 Design procedure

Hand lay-up is the simplest process in the low end composite products, require low investment, higher operating skill, and versatile shapes of product that need single high quality surface finish. Hand lay-up is the process that starts with the application of gel coating onto a completely polished and waxed mould. (gel coating is an optional step. We will discuss about gel coating next time). A coat of laminating resin (resin that being mixed with catalyst / hardener, or else your part will not cure) is then being applied by brush or roller. Follow by the first layer of chopped strand mat (preferably 300 gs/m2 or less), or if desire a surface tissue. The laminating resin is then applied to the reinforcement (the fiber) so that all trap air can be force out using roller. Continue doing this for your next layer of fiber, until desired thickness is achieved.Once finished, allow the resin to cure. You can feel the reaction taken place when your product isproducing heat.Finally, remove your product from the mould (demould) and next step is trimming the fiber product.

VI. OPERATION

Initially the beating process is done to the caryota urens to extract the fiber. This beating process is done often until the fiber is extracted. After finishing the beating process a die should be designed for our required dimensions.The die should be fabricated for the required dimensions. The extracted fiber should be chemically treated to withstand the load after mixing it with the polyester resin. Hand lay-up is the simplest process in the low end composite products, require low investment, higheroperating skill, and versatile shapes of product that need single high quality surface finish.Hand lay-up is the process that starts with the application of gel coating onto a completely polished andwaxed mould. (gel coating is an optional step. We will discuss about gel coating next time). A coat of laminating resin (resin that being mixed with catalyst / hardener, or else your part will not cure) isthen being applied by brush or roller. Follow by the first layer of chopped strand mat (preferably 300 gs/m2 orless), or if desire a surface tissue.The laminating resin is then applied to the reinforcement (the fiber) so that all trap air can be force outusing roller. Continue doing this for your next layer of fiber, until desired thickness is achieved.Once finished, allow the resin to cure. You can feel the reaction taken place when your product isproducing heat.Finally, remove your product from the mould (demould) and next step is trimming the fiber product.

VII. TESTS MADE ON LEAF SPRING

1. Impact strength**:**

The static properties of materials and their attendant mechanical behavior are very much functions of factorssuch as the heat treatment the material may have received as well as design factors such as stress concentrations.

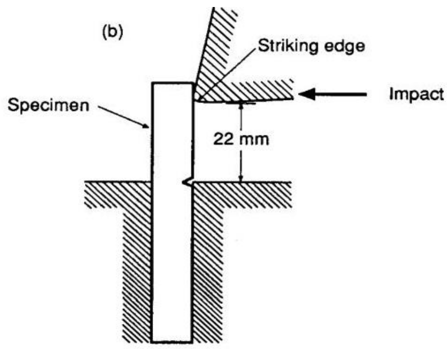

Fig. 5 Impact test specimen

In design applications, impact situations are frequently encountered, such as cylinder head bolts, in which it is necessary for the part to absorb a certain amount of energy without failure. In the static test, this energy absorption ability is called "toughness" and is indicated by the modulus of rupture. A similar "toughness" measurement is required for dynamic loadings; this measurement is made with astandard ASTM impact testknown as the Izod or Charpy test. When using one of these impact tests, a small notched specimen is broken in flexure by a single blow from as winging pendulum. With the Charpy test, the specimen is supported as a simple beam, while in the Izod it is held as a cantilever.

2. Tension test:

One of the most common mechanical stress–strain tests is performed in *tension.* As will be seen, the tension test can be used to ascertain several mechanical properties of materials that are important in design. A specimen is deformed, usually to fracture, with a gradually increasing tensile load that is applied uniaxiallyalong the long axis of a specimen. A standard tensilespecimen is shown in Figure. Normally, the cross sectionis circular, but rectangular specimens are also used.

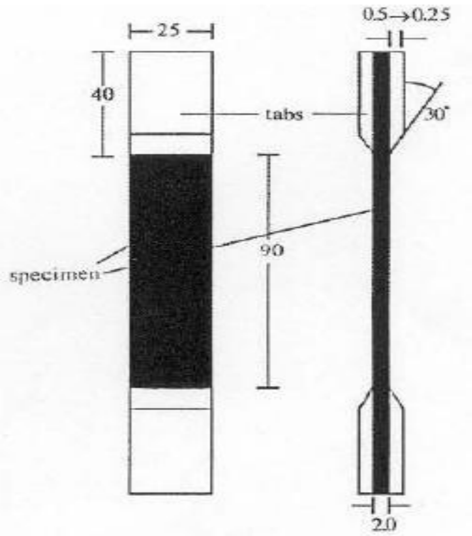

Fig. 6 Tensile composite test specimen

The output of such a tensile test is recorded on a strip chart (or by a computer)as load or force versus elongation. These load–deformation characteristics are dependent on the specimen size.

VIII. RESULT AND DISCUSSION

This chapter presents the physical and mechanical characterization of the class of polymer matrix composites developed for the present investigation. They are bidirectional caryota urens fiber reinforced polyester resin composites. Details of processing of these composites and the tests conducted on them have been described in the previous chapter. The results of various characterization tests are reported here. They include evaluation of tensile strength, flexural strength and impact strength has been studied and discussed.

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