Enhancement of Mechanical Properties of Hybrid Composite Materials

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Abstract: A hybrid composite materialsare one of the types to provide good suspension in wheeled vehicles application.By reducing weight of suspension systems, lowers total fuel exhaustion and costs.One of the most common approaches is to replace steel components with composite materials.To improve safety, comfort, and durability, composite have been introduced. Composite materials are corrosion resistant, have a good strength-to-weight ratio, and can store a lot of elastic strain. The aim of this study is to look into the structural properties of a hybrid compositematerials made of 95 percent Epoxy, 5% rubber, 5% glass fiber, and 5% hybrid composite of rubber and glass fiber. Since it has advantages over other approaches, hand layup was used in the fabrication. The mechanical experiments were used to determine the efficacy of the proposed composite leaf spring. We performed tensile, impact, hardness tests. When reinforcing fibers were used, the experimental results showed an improvement in hardness, impact, tensile strength. after the reinforcing fibers have been added, the best mechanical test results were obtained when hybrid reinforcement was used.

Keywords: rubber, glass fiber, composite material, mechanical properties

BACKGROUND INFORMATION

In 1804, Obadiah Elliot used leaf springs to suspend his drawn wagon.It was used in the design automobiles.The spring is an elastic element that deflects in response to external loads and returns to its original shape depending on the severity of the loads applied.The key application of springs is as a shock and vibration absorber, as well as storing potential energy by deflection during load application.Leaf springs were used to withstand shock and vibration in trucks and vehicles.A suspension strength of a leaf spring can be improved to withstand heavy loads.The ride is more pleasant with a strong suspension system, but the failure of the leaf springs is disastrous.As opposed to helical springs, leaf springs have the advantage of having their ends directed along a definite path and functioning as a structural member [1].Depending on the vehicle, leaf springs can be mounted in two different ways.The first kind is a simply supported leaf spring with two ends attached to the vehicle's chassis.The second type is a cantilever leaf spring with one end displaced freely and the other end attached to the vehicle frame.Steel is a popular material for making leaf springs with a slender arc-shaped cross section and a rectangular cross section.The axle's location is determined by the arc's base.Both ends of the chassis are linked by a loop.As a coupling, the leaf spring keeps the axle in place, making it an essential feature.The key functions of multi leaf springs are to carry lateral load, breaking torque, driving torque, and shock absorption.A set of semi-elliptic flat plates or leaves are held together by a center clip and U-shaped bolts.There are two styles of leaves in a multi-leaf spring.These leaves have a graduated length, with shorter leaves at the top and longer leaves at the bottom.A master leaf is the tallest leaf at the top, bent at both ends to form spring eyes.The second type of leaves that sustain the transverse shear force (inserted between the master leaf and the graduated leaves) is full-length leaves.Rebound clips are used to hold leaves in place and prevent them from moving laterally .The springs are supported by the vehicle axle since the front end of the springs is connected to the frame by a simple pin joint.A versatile link connects the back end of the vehicle to the frame. (known as a shackle) [2].One of the important using is a semi-elliptical leaf spring [3].Leaf springs made of hybrid composite materialswords. In the longitudinal direction, The best material for producing leaf springs is one that has a high strength and low modulus of elasticity.Conventional leaf spring failure is caused by an accident, which can be minimized by using progressively failed composite leaf springs [4].Weight reduction can be accomplished mainly by incorporating improved material design optimization and better manufacturing processes.Suspension leaf springs are one of the possible products for weight reduction in vehicles, with ten to twenty percent less weight than un-sprung.As a result, the standard of riding has improved [5].The key feature of spring design is to absorb and store energy before releasing it.The material's strain energy is a significant concern when designing springs.The basic strain energy can be measured using the formula [6].According to the equation above, materials with a lower density and a lower young modulus have a higher specific strain energy.The weight of the leaf spring can be decreased without losing load carrying capacity or stiffness by using composite materials.

Steel has a lower strength-to-weight ratio and less elastic strain energy storage than composite materials.Von and the bendingThe architecture constraints are misses, pressures, and deflections.The leaf spring is responsible for absorbing vertical movements and impacts caused by road irregularities.Vibrations in the spring deflection cause potential energy to be stored as strain energy in the spring, which is then slowly released [7-8].
Advanced composite materials are ideal for suspension (leaf spring) applications.Adjusting their elasticity to increase strength and reduce stresses caused during application [9].The study of composite material leaf springs has become essential to display comparative results with steel springs.There have been several studies performed.Anjish M George (2017) used E-glass/Epoxy, E-glass/banana/Epoxy, and flax, E-glass/Epoxy to create a leaf spring.The fibers used were chosen to save weight and money.As steel was replaced with an E-glass/flax/Epoxy hybrid composite leaf spring, the weight was reduced by 88.49% [10].Leaf springs were made from three different materials by S.Seralathan.Congenital steel, glass/Epoxy, and hybrid composite (combination of both steel and glass Epoxy) leaf springs were analyzed using ANSYS finite element software.Using the new composite materials results in a 34% reduction in mass and a 60% reduction in gross theory stresses [11].The fabrication of a leaf spring made up of three separate composite materials was considered by 291 K.Umanath (2020).The springs were made using the open molding process.The composite's first layer was carbon fiber, with the second layer being Epoxy and the third layer being pineapple fiber.The result showed high strength, stiffness, and light weight due to the composite material's smart corrosion resistance and high strength to weight ratio.[12]Changes from traditional steel leaf springs to carbon reinforced polymer composites were investigated by T.G. Loganathan (2019).Having a lot of power combined with a lot of weight reduction improves the vehicle's efficiency and reduces fuel consumption.The use of finite element analysis yielded better results in terms of fatigue life and flexural activity of composite leaf springs.Since the weight of carbon fiber reinforced polymer is less than steel and the deformation is less than steel, the stiffness of the composite material is higher and the fatigue life is longer [13].Patil, R. M. (2014)Metallic leaf springs add a large amount of static weight to cars, reducing fuel efficiency.Due to properties such as corrosion resistance and a high strength-to-weight ratio, composite materials have been described as possible materials for replacing these typical metallic leaf springs.After that, the experimental experiments are carried out on the composite leaf spring.The materials used were glass/epoxy, which resulted in a weight reduction of 57.23% as compared to metallic leaf springs, as well as a stiffness reduction of 18% when compared to steel leaf springs [14].To compare stiffness, deflection, and stress, Manjunath H.N used a variety E-Glass/Epoxy, Graphite/Epoxy, Boron/Aluminum, Carbon/Epoxy, Kevlar/Epoxy) are examples of composite materials. and steel.As compared to traditional steel springs with identical design parameters.As compared to traditional steel springs with identical design requirements, the composite leaf spring is found to have good performance characteristics.Boron/Aluminum has a low deflection and tension, as well as a high stiffness relative to other composites [15].The light weight vehicle design and study of composite leaf spring was studied by D.LydiaMahanthi.The use of Kevlar with spring materials contributes to a large amount of vehicle spring weight reduction and must be solid enough.As compared to other fabrics, Kevlar is the lightest and can handle heavy loads with less deformation.The best leaf spring is KEVLAR, according to static study of steel and composite leaf springs like EN47, KEVLAR, S- Glass Epoxy, and E-Glass [16].

SUMMARY OF MATERIALS AND METHODS

The composite material's matrix is Epoxy (Cleaver) reinforced with glass, rubber, and hybrid fibers, with the properties described in Tables 1 and 2.The composite was prepared using hand lay-up molding.To ensure that the bonding sequence is correct and that the final composite layer is the correct thickness.The reinforcing fibers are applied in the proper order, layer by layer.In a 3:1 ratio, epoxy resin isblended with hardener.Epoxy was applied to the fiber layers with a brush.The first layer was Epoxy, followed by a layer of glass, or a rubber of both fibers, put according to the desired weight percent (Table.3).To ensure full Epoxy cure, the composite sheets were left at 27 temperature for 24 hours.The sheets were then put in a drying oven for 1 hour at 60 degrees Celsius to eliminate the stresses and air bubbles that had formed during the layering process.For the mechanical checks, 292 were cut from the sheet according to ASTM,

Table 1 properties of Epoxy

Properties of epoxy	Value
Tensile strength	60-80 Mpa
Modulus of elasticity	2.9-3.2 Mpa
Deformation	4-7%
Impact energy	35-50 J

Table 2 properties of fiber glass

Properties of fiber glass	Value
Tensile strength	3400 Mpa
Tensile elongation	2.6%
Modulus of elasticity	76 Mpa

Density	2.65 gr/l

Table 3 composite sample used

Samples	Weight ratio
A1	Epoxy
A2	Epoxy + 4 layer of fiber glass
A3	Epoxy + 4 layer of rubber
A4	Epoxy + 2 layer of rubber + 2 layer of fiber glass

RESULTS AND DISCUSSION

Tensile strength test

Addition the glass fibers , rubber to Epoxy increases the tensile values to 134, 42, and 145 Mpa for samples A4, A3, and A2, respectively, as shown in Figure 3.When hybrid fiber reinforcement is added, the most substantial increase occurs (combining the excellent properties of the two fibers).Since epoxy resin is a porous material with low tensile strength, it gains tensile strength when reinforced with fibers.glass fibers has high ultimate tensile strength and ductility, giving the Epoxy matrices strength and durability.

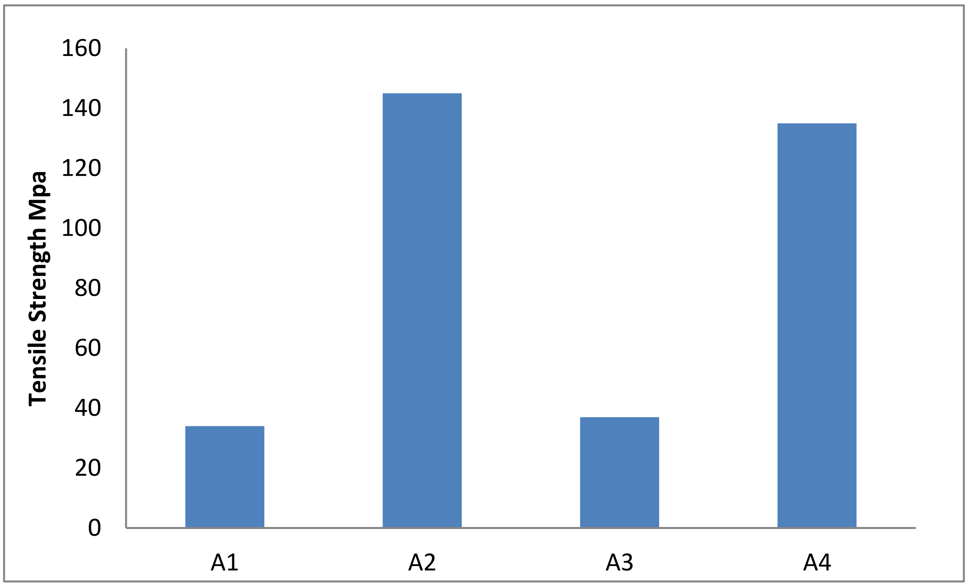


Figure 3: Composite sample tensile strength

Test of Hardness

Figure 4 indicates the effects of Shore D hardness studies.There was an improvement in composite hardness, as can be shown.As glass fibers are used, the maximum increase is achieved.The reasons for A2 and A3 having higher hardness values than A1 are their high strength and ability to withstand external loads .AsRubber and glass fibers were gathered in sample A4, the maximum value was obtained.

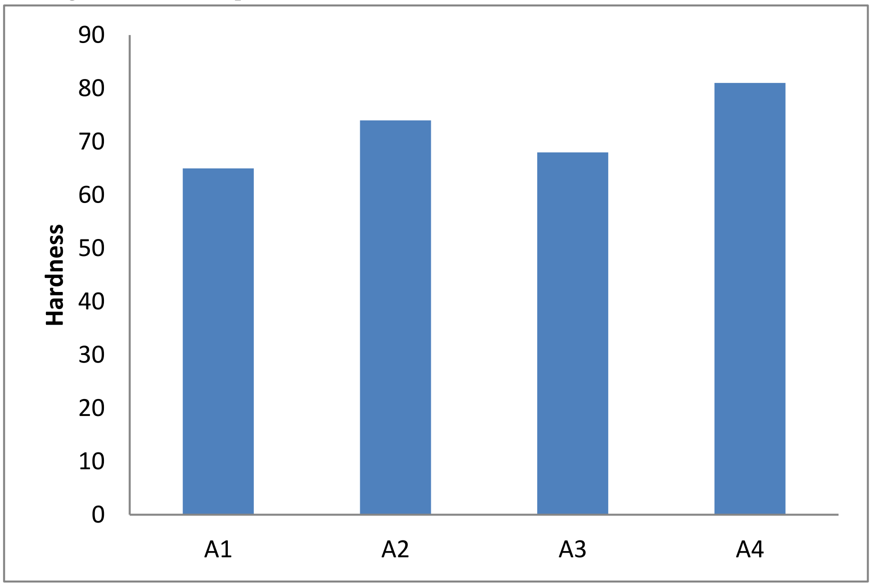
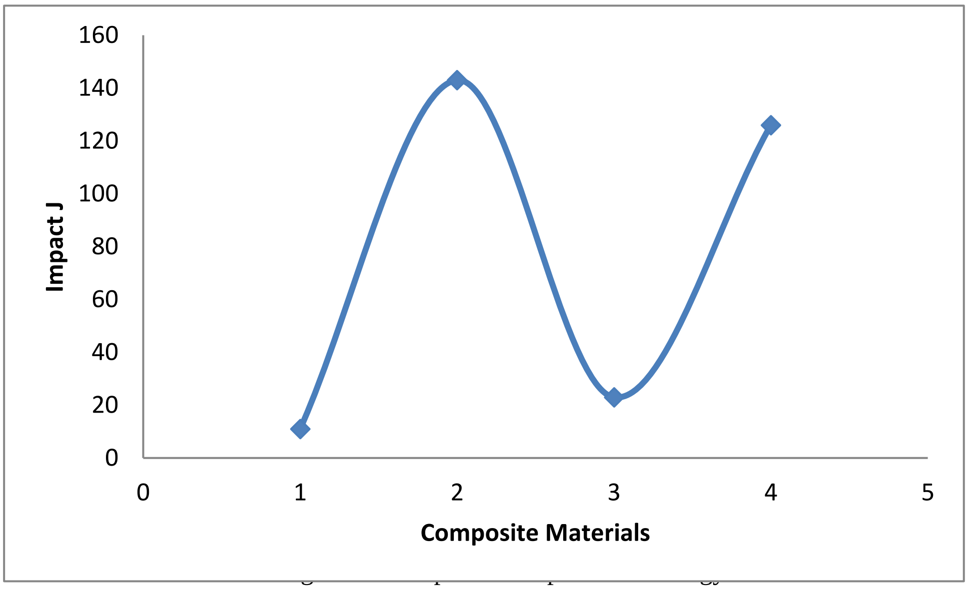


Figure 4: Composite sample hardnessstrength

Impact Test

Hardness of composite material were determined using the Charpy impact test.The ability of a material to absorb energy during fracturing is measured by its toughness.The impact strength of Epoxy is 13 kJ/m 2, while the impact strength values of A2, A3, A4 are 139,26,132 kJ/m 2 respectively, according to the results shown in Figure (5).Because of its brittleness, the Epoxy has a poor impact tolerance.Impact resistance is increased by reinforcing it with fibers because fibers carry the majority of the impact energy.



Conclusions

1-When matric was reinforced with rubber and glass fibers, the tensile, impact of the material increased.Because of its high strength and ductility

2-Glass fiber had the strongest mechanical properties for impact tests.

3-The proposed hybrid composite benefits from the high tensile strength of glass and rubber.

4-Because the three components of the composite have low densities relative to steel, using epoxy/glass and rubber reduces the composite weight substantially.

5- Researching the mechanical properties of the hybrid composite improves the case for using it to produce any thing.

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