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Analyzing the Efficiency of Leaf Spring by Hybrid Composite Material Converter

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ABSTRACT

The development in rivalry and development in car area will adjust the current items or supplant old and obsolete items by recently improved and propelled material items. A suspension arrangement of any vehicle is additionally a zone where these kinds of developments are completed reliable. To expanding the solace of client, the loads of endeavors are taken. Essentially leaf springs are for the most part utilized as a suspension framework in car vehicles. The leaf spring structure enhancement will be performed occasionally by changing from regular steel to composite material. Vehicle world has an expanded enthusiasm for decrease of weight by the substitution of steel by characteristic fiber fortified composites. Also, the composite materials have progressively versatile strain vitality stockpiling limit and high quality limit and high solidarity to weight proportion contrasted with steel. Characteristic filaments are rising as minimal effort, lightweight and evidently ecologically better choices than glass strands in composites. But this proposed is focused on natural fiber instead of composite leaf spring. The point of present work is to compare the combination of Glass-Fiber-Reinforced with a Natural-Fiber-Reinforced Composite/Jute-Fiber leaf spring and to think about the Glass-Fiber-Reinforced with a Natural-Fiber-Reinforced Composite/Banana-Fiber. Manufacture is conveyed by hand lay-up system and tried. The outcome demonstrates that the blend of glass and jute fiber is more powerful than glass and banana fiber.

Keywords: Composite, Natural Fiber, Glass, Banana, Jute, Leaf spring.

1. INTRODUCTION

By the various methods in the spring redirection and due to the street abnormalities the leaf spring ought to ingest the vertical vibrations and effects, with the goal that the potential energy is put away in spring as strain vitality and discharged gradually. In this way, expanding the vitality stockpiling ability of a leaf spring guarantees an increasingly agreeable suspension framework. As indicated by the investigations a material is made with greatest quality and least modulus of versatility and the longitudinal way is the most reasonable material for a leaf spring. Luckily, composites have these qualities [6]. Exhaustion disappointment is the overwhelming method of in-administration disappointment of many car segments. This is because of the way that the car segments are exposed to assortment of exhaustion loads like stuns caused because of street inconsistencies followed by the street wheels, the unexpected loads because of the wheel going over the knocks and so forth [7].

The leaf springs are increasingly influenced because of load weariness, as they are a piece of the unstrung mass of the vehicle. The exhaustion conduct of Glass Fiber Reinforced Plastic (GFRP) epoxy composite materials has been contemplated previously [3]. Hypothetical condition for foreseeing fatigue life is defined utilizing weariness modulus and its corrupting rate. This connection is streamlined by strain disappointment paradigm for down to earth application. A forecast strategy for the weariness quality of composite structures at a discretionary mix of recurrence, stress proportion and temperature has been displayed. These investigations were performed to mono-leaf springs.

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In the present situation, to upgrade the use of vitality, the reduction of weight ended up one of the primary focal points of car makers. Weight decrease can be accomplished by the presentation of better material. Leaf springs are for the most part utilized in suspension frameworks to ingest stun stacks in autos like light engine vehicles, hard core trucks and in rail frameworks. They convey horizontal burdens, brake torque, driving torque notwithstanding stun retainity. Leaf springs are having preference that the closures of the spring might be guided along a clear way as it avoids. The utilization of composite materials for suspension leaf spring decreases the heaviness of regular multi leaf steel leaf spring by almost 75%. This accomplishes the vehicle with more eco-friendliness and improved riding characteristics. For progressively agreeable suspension framework (for example vitality stockpiling capacity), the leaf spring ought to retain the vertical vibrations and effects because of street inconsistencies by methods for varieties in the spring diversion with the goal that the potential Energy is put away in spring as strain vitality and after that discharged gradually [8]. A material with greatest quality and least modulus of versatility the longitudinal way is the most appropriate material for a leaf spring. The presentation of composite materials was made it conceivable to diminish the heaviness of leaf spring with no decrease on burden conveying limit and solidness. The composite materials have progressively versatile strain vitality stockpiling limit, superb consumption opposition, high solidarity to weight proportion as contrasted and those of steel. Traditional Multi-leaf steel springs are being supplanted by mono-leaf composite springs [5].

Fatigue failure is the prevalent method of in-administration breakdown of many vehicle segments. This is because of the way that the vehicle segments are exposed to assortment of weariness loads like stuns caused because of street inconsistencies followed by the street wheels, the unexpected loads because of the wheel going over the knocks and so forth. The leaf springs are increasingly influenced because of weakness loads, as they are a piece of the unstrung mass of the car. The exhaustion conduct of Jute Glass Fiber Reinforced natural fiber materials has been examined. The weariness quality at a subjective mix of recurrence, stress proportion and temperature has been introduced. In the present work, a multi-leaf steel spring utilized in traveler vehicles is supplanted with a composite single leaf spring made of Eglass and banana fiber and Eglass/epoxy and Jute-Glass natural fiber. The essential goal is to think about their heap conveying limit, firmness and weight funds of natural fiber leaf spring.

2. RELATED WORK

It has been grouped into three distinct zones, for example, composite material for leaf spring, structure and advancement of composite leaf spring and in conclusion examination of composite leaf spring.

By utilizing composite material for leaf spring, there are such a significant number of attributes which are

- **Good weakness quality.**
- **High solidarity to weight proportion.**
- **High normal recurrence.**
- **Good consumption obstruction.**

At that point the utilization of composite material for leaf spring is to lessen the heaviness of leaf spring without diminishing the firmness and burden conveying limit in the suspension framework. For the leaf spring, the structure

imperatives are stresses and avoidances. Senthilkumar M. and Vijayarangan S, 2007 [1] has performed the limited component investigation with full knock load on 3-D model of composite multi leaf spring is finished utilizing ANSYS 7.1 and the diagnostic outcomes are contrasted and test results. Exhaustion life of steel leaf spring and composite leaf is likewise anticipated. Contrasted with steel spring, the composite leaf spring is found to have 67.35 % lesser pressure, 64.95 % higher firmness and 126.98% higher characteristic recurrence than that of existing steel leaf spring. A weight decrease of 68.15 % is additionally accomplished by utilizing composite leaf spring. It is additionally presumed that weariness life of composite is more than that of traditional steel leaf spring.

Ganesan K, Kailasanathan C, et al. 2015 [2] performed the investigation of Composite Leaf Spring enhanced with Nanoparticles. Weight decrease is presently the primary issue in car ventures. In this work due to weight reduction of steel spring with composite leaf spring the high quality proportion has to improve. The fundamental point is to contrast with the heap conveying limit, firmness and weight reserve funds of composite leaf spring with that of steel leaf spring at evaluated load and over-load condition. The investigation has been done for the leaf spring made up of steel and Composite materials. Composite examples are created with two distinctive staking successions like the (gum with dirt and upgraded with Nanoparticles).

3. DESIGN OF COMPOSITE LEAF SPRING

The hand layup is one of the most established and most regularly utilized techniques for assembling of the natural fiber parts. Layers of unidirectional or woven composite are joined to result in a material displaying attractive properties in at least one bearing. Every layer is situated to accomplish the greatest usage of its properties [4]. Layers of various materials (distinctive fiber in various headings) can be joined to additionally improve the general execution of the covered natural fiber material. Tars are impregnated by hand into filaments, which are as woven, sewed, sewed or fortified textures. This is normally practiced by rollers or brushes, with an expansion utilization of nip– roller type impregnators for compelling tar into textures by methods for turning rollers and a shower of gum. Covers are left to fix under standard environmental conditions. Multi leaf structure makes issues, for example, delivering squeaking sound, worrying consumption and also diminishing the fatigue life. The goal of the present work is to structure and investigate natural fiber leaf spring. For this reason, Glass Fiber/Epoxy and Natural fiber Jute leaf springs were remanufactured utilizing hand-layup strategy. At that point they are tentatively tried for static burden conditions and the outcomes are contrasted and FEA results.

The fundamental necessities of natural fiber leaf spring is that the chosen evaluation of and it must have adequate solidify capacity for the size required to guarantee a full martensitic structure all through the whole leaf segment. By and large terms higher compound substance is compulsory to guarantee satisfactory solidify capacity when the thick leaf areas are utilized.

4. TENSILE LOAD TEST AND FLEXURE (3 POINT BEND) TEST

In tensile load test, the example is fixed between the jaws of the testing machine before stacking. The example utilized is uniform over the test length inside where the lengthening estimations are finished. Pliable test examples are created by the ASTM guidelines. The cross area of the example is rectangular fit as a fiddle. The adjustment in

check length of the example is estimated from an extensometer or by the stroke or by and large change long and it is appeared in figure 1.

Figure No: 1 Tensile Load Test **Figure No: 2** Bending load test

The three points twisting bending test gives esteems to the bowing modulus, flexural quality, flexural strain and the flexural (bowing) stress-strain reaction of the material. The simplicity of the specimen preparation and testing is principle preferred standpoint of a three-point flexural test. The consequences of the testing strategy are touchy to example and stacking geometry alongside strain rate which are sure detriments of this technique.

5. FABRICATION PROCESS

A compressed wood form was set up with required components of leaf spring. Wax clean (Manson) was connected with the assistance of material on form for better surface completion and for simple evacuation of leaf spring subsequent to restoring. Number of layers of E-glass, Jute and epoxy are covered at the same time for required thickness of leaf spring. Similarly it is accomplished for E-glass and Banana fiber. At that point it is restored for 24 hours before expulsion. The prepared glass and Banana Fiber and glass and Jute fiber are shown in figure 2.

Figure No: 3 Glass/Banana Fiber and Glass/Jute Fiber

6. RESULTS AND DISCUSSION

After the fabrication process, leaf springs are experimentally tested. The results of E Glass and Banana fiber are shown in table 1.

S.No	Parameters	Output Data
1	Load at Yield	1.462 KN
2	Elongation at Yield	7.508 mm
3	Yield Stress	10.202 N/ mm^2
4	Load at Peak	1.831 KN
5	Elongation at Peak	8.951 mm
6	Tensile Strength	12.779 N/ mm^2
7	Load at Break	0.015 KN
8	Elongation at Break	9.543 mm
9	% Elongation	0.72%

Table No: 1 Glass and Banana Fiber

The stress and strain ratio is analyzed and the result is given in figure 4.

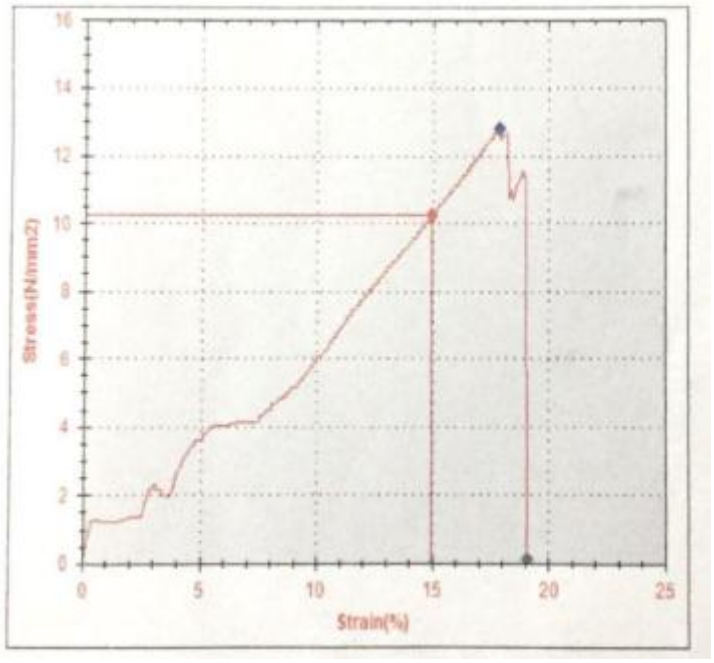

Figure No: 4 Stress and Strain Ratio of Glass and Banana Fiber

In the same way E Glass and Jute fiber are shown in table 2.

S.No	Parameters	Output Data
1	Load at Yield	3.773 KN

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2	Elongation at Yield	14.903 mm
3	Yield Stress	29.406 N/ mm^2
4	Load at Peak	4.649 KN
5	Elongation at Peak	16.370 mm
6	Tensile Strength	36.232 N/ mm^2
7	Load at Break	0.034 KN
8	Elongation at Break	16.879 mm
9	% Elongation	0.32%

Table No: 2 Glass and Jute Fiber

The stress and strain ratio is analyzed and the results are shown in figure 4.

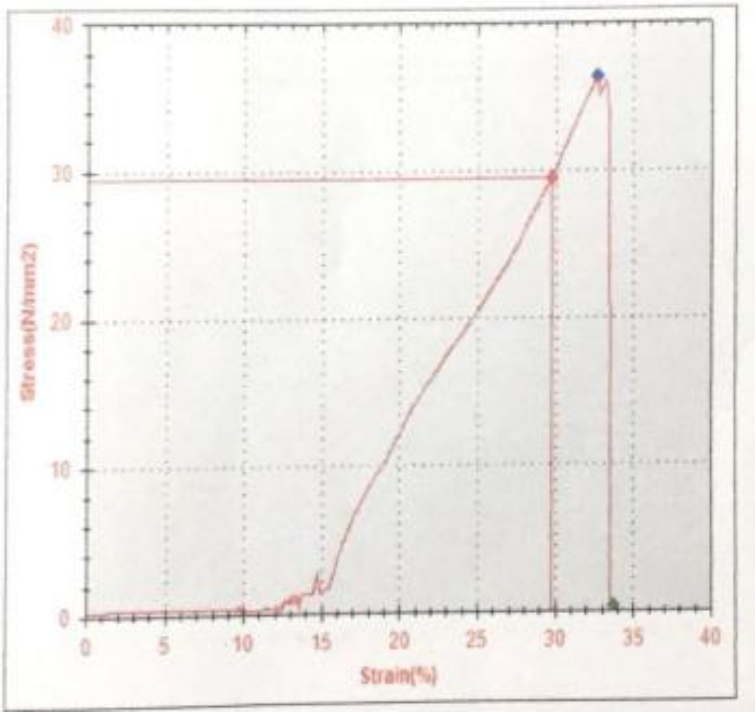

Figure No: 5 Stress and Strain Ratio of Glass and Jute Fiber

Similarly, the bending test is performed and the compression ratio of E-Glass/Banana fiber is given in table 3.

S.No	Parameters	Output Data
1	Load at Peak	0.580 KN
2	C.H Trevel at Peak	26.390 mm
3	Shear Strength	1.136 N/ mm^2

Table No: 3 Compression Test Report of E-Glass/Banana Fiber Report

The bending test report regarding load and time is given in figure 6.

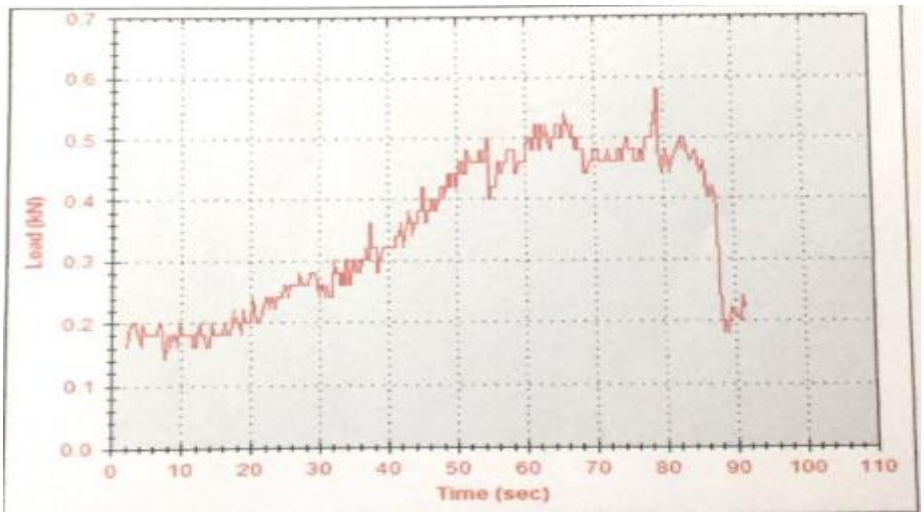

Figure No: 6 Load and Time Analysis of E-Glass/Banana Fiber Report

In the same way, the compression ratio of E-Glass/Jute fiber is given in table 4.

S.No	Parameters	Output Data
1	Load at Peak	0.800 KN
2	C.H Trevel at Peak	7.710 mm
3	Shear Strength	2.279 N/ mm^2

Table No: 4 Compression Test Report of E-Glass/Jute Fiber Report

The bending test report regarding load and time is given in figure 7.

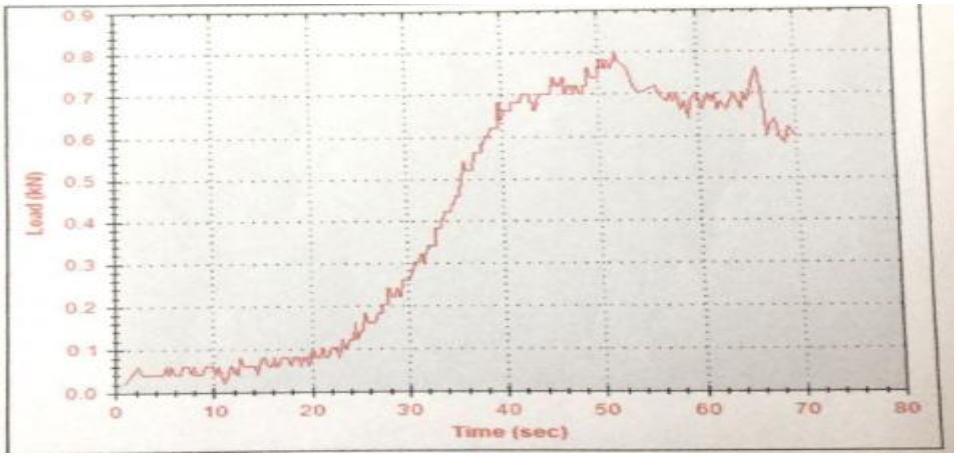

Figure No: 7 Load and Time Analysis of E-Glass/Jute Fiber Report

The weight reduction strategy is compared, i.e. steel spring is compared with the weight of the jute fiber. The computation is performed below:

- **Total length of the spring (Eye to Eye) = 1150mm**
- **No. of full length leaves (n_f) = 1**
- **No. of graduated leaves (n_g) = 4**

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- **Thickness of leaf (t) = 8 mm**
- **Width of the leaf spring (b) = 65 mm**
- **Young's modulus (E) = 2x105 N/mm²**
- **Central band 80 mm wide (Ineffective length)**
- **Tensile strength (σ_t) = 1962N/mm²**
- **Yield strength (σ_y) = 1470 N/mm²**
- **Total load = 2200Kg**

Bending stress is given by,

$$\sigma_b = \frac{6 \times w \times L}{n \times b \times t^2}$$

$$\sigma_b = \frac{6 \times 3657 \times 535}{5 \times 65 \times 8^2}$$

$$= 564 \text{ N/mm}^2$$

Deflection generation is given by,

$$y = \frac{6 \times w \times L^3}{n \times E \times b \times t^3}$$

$$y = \frac{6 \times 3657 \times 535^3}{5 \times 210000 \times 65 \times 8^3}$$

$$y = 100.06\text{mm}$$

Now the weight is analysis is executed and compared.

a) Steel

Weight of the smallest leaf (leaf 1) = density × volume ×acceleration due to gravity

$$= 290 \times 8 \times 65 \times 0.00000786 \times 9.81$$

$$= 11.62 \text{ N}$$

Weight of the smallest leaf (leaf 2) = density × volume ×acceleration due to gravity

$$= 504 \times 8 \times 65 \times 0.00000786 \times 9.81$$

$$= 20.20 \text{ N}$$

Weight of the smallest leaf (leaf 3) = density × volume ×acceleration due to gravity

$$= 717 \times 8 \times 65 \times 0.00000786 \times 9.81$$

$$= 28.74 \text{ N}$$

Weight of the smallest leaf (leaf 4) = density × volume ×acceleration due to gravity

$= 932 \times 8 \times 65 \times 0.00000786 \times 9.81$

$= 37.36$ N

Weight of the smallest leaf (leaf 5) = density × volume ×acceleration due to gravity

$= 1150 \times 8 \times 65 \times 0.00000786 \times 9.81$

$= 46.10$ N

Total weight of the steel spring is = 144.0 N

b) E-Glass/Jute Fiber

Weight of the mono leaf spring = $1150 \times 14 \times 65 \times 0.000016 \times 9.81$

$= 16.42$ N

Weight Saved = 144.0 – 16.42

$= 127.6$

Percentage of weight reduction = $(127.6 \div 144.0) \times 100$

$= 88.61\%$

Thus the weight reduction of 88.61% is attained using E-Glass/Jute natural fiber combination.

The outcomes demonstrated that the most extreme pressure and removals are inside the farthest point for both natural fiber materials. Contrasted with the heaviness of steel leaf spring and weight decrease is workable for E-glass epoxy and natural fiber separately without influencing the heap conveying limit. Natural fiber is having level with qualities as e-glass epoxy with further weight reduction. The normal recurrence of natural fiber is higher than enough from the street recurrence to maintain a strategic distance from the reverberation. The outcome demonstrates that the combination of Glass and Jute fiber is successful than the combination of Glass and Banana Fiber.

7. CONCLUSION

This work gives the data about the work did on the natural fiber leaf spring. First the material determination is the imperative parameter after planning; examination and advancement on car natural fiber leaf spring were talked about. Likewise in this work the traditional steel leaf spring will be contrasted with the natural fiber leaf spring for vehicles. This examination work gives near investigation between E-Glass/Banana and E-Glass/Jute natural fiber. The results demonstrate that the Jute fiber is more effectual than banana fiber. Weight decrease diminishes the fuel utilization of the vehicle.

8. REFERENCES

[1] Senthilkumar and Vijayarangan, “Analytical and Experimental studies on Fatigue life Prediction of steel leaf spring and composite leaf multi leaf spring for Light passanger vehicles using life data analysis” ISSN: 1392-1320, material science ,Vol. 13 No.2 (2007).

[2] K. Ganesan , C. Kailasanathan , Y. Kumarasamy, "Analysis of Composite Leaf Spring Enhanced With Nanoparticles", Carbon – Science and Technology, ISSN 0974 – 0546,December 2015.

[3] Syambabu Nutalapati, "Design and analysis of leaf spring by using composite material for light vehicles" International Journal of Mechanical Engineering and Technology (IJMET) Volume 6, Issue 12, 2015.

[4] Saira Taj, Munawar Ali, hafiullah Khan "Natural fiber reinforced polymer composite" Proc. Pakistan acad. Sci. 44(2); 129-144:2007.

[5] Jadhavk.k. and Dr.Dalu R.S, "Design and analysis of composite leaf spring",IJRMET,Vol.4,October (2014).

[6] Keshavamurthy Y. C, Chetan H. S, Dhanush C.&NithishPrabhu T, "Design and finite element analysis of hybrid composites mono leaf spring, International Journal of Mechanical and Production Engineering Research and Development", (IJMPERD), ISSN 2249- 6890 Vol. 3, Issue 3, August(2013), pp. 77-82.

[7] Z. Triveni, B. Amara Babu, "Finite element analysis on leaf spring made of composite material", IJARSE,Vol-5,Issue No-4, April 2016.

[8] Mahmood M.Shokreih, Davood Rezaei "Analysis and optimization of a composite leaf spring" Composite Structures 60 (2003) pp 317- 325.