Study of Hybrid Composite Leaf Spring of Light Weight Vehicle

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Abstract:- The focus of the automobile industry now a days is on the light weight vehicles suspension system. The replacement of steel leaf spring by the polymer matrix composite leaf spring is needed. This is because polymer matrix composite leaf spring weights are reducing without decreasing the load carrying capacity. The basic aim of automobile industries was to reduce the overall fuel consumption of the vehicles. The polymer matrix material was used to fabricate composite leaf spring. This is because of more elastic strain energy storage capacity and more strength to weight ratio as compared to steel. It may be noted that the costs of polymer matrix materials are lesser than steel. So the aim of this paper is to propose a low cost fabrication of mono graduated polymer matrix composite leaf spring. The composite leaf spring is fabricated using the hybrid composite material. Composite materials such as glass fiber, resin and natural fiber are used to do this. The objective of the paper is to carry out different tests such as impact test, flexural test, tensile test.

Keywords: E-glass, Epoxy, Vinyl ester, Jute

1. INTRODUCTION

Leaf springs was absorbs the vehicles vibration, shock and bump load by mean of spring deflections, so that the potential energy are stored in the leaf spring and then relieved slowly. Ability to stores and absorbs more amount of elastic strain energy ensure the comfortable suspension system. Nowadays the main issues of automobile industries are weight reduction.

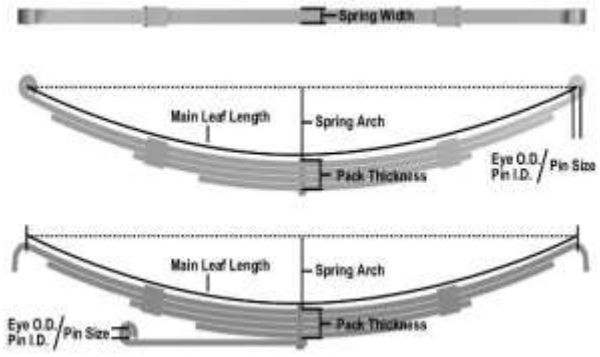

Fig 1. Graduated and master leaf spring

Fabricate the graduatedpolymer matrix composite leaf spring. The master leaf spring length is higher than graduated leaves. Hybrids composite materials are using to fabricate graduated leave. Composite material such as natural fiber, glass fiber, resin.

2. PROBLEM IDENTIFICATION

After reviewing the literatures, we identify some of the problem which generally occurs in case of composite leaf spring. The usual steel leaf spring has various problems identified which are listed as below:

- High weight.
- High cost
- Less compressive strength.

3. DESIGN PARAMETER OF POLYMER MATRIX COMPOSITE MONO GRADUATED LEAF SPRING

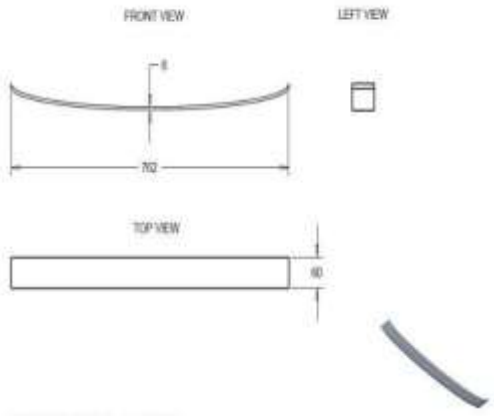

Fig 2. Leaf spring design parameter

Mono Graduated leaf spring design parameter:

Total length of graduated leaf spring = 762mm
Width of leaf spring = 60mm

Thickness of leaf spring = 6mm

4. DESIGNS OF HYBRID COMPOSITE LEAF SPRING

Consider several types of vehicles leaf spring and different load acting on them, various types of composite leaf spring have developed. The below different method used to fabricate the hybrid composite leaf spring.

- Constant thickness, Constant widthdesign.
- Constant thicknessVarying widthdesign.
- Varying width, varying thickness design.

5. CONSTANT WIDTH, CONSTANT THICKNESS DESIGN

I chose constant thickness; constant width design method to fabricate the mono graduated hybrid composite leaf spring. Polymer matrix with natural fiber materials was used to fabricate the composite leaf spring. Single mold was used to fabricate the constant width: constant thickness design method. Mold cost is less compare to other methods. Two different resin were used to fabricate the monograduated composite leaf spring (epoxy and vinyl ester). I compare to both experimental results after chose best one.

6. MOLD DESIGN

The mold design parameter given below:

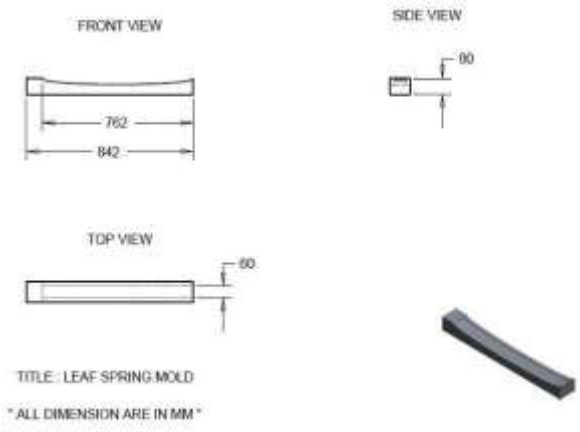

Fig3. Wood mold design parameter

Fig4. Leaf spring testing specimen

Manufacturingmold

Fig5.Composite leaf spring manufacturing wooden mold.

7. MATERIALS ARE USED TO FABRICATE THE HYBRID COMPOSITE LEAF SPRING

- PVA- mold release agent
- Biaxial direction jute
- E-glass chopped strand mat
- Biaxial direction E-glass
- Resin (vinyl ester, epoxy).

8. MANUFACTURING PROCESS TYPES

- Hand Lay-up Technique.
- Prepreg lay-up.
- Resin Transfer Molding.
- Vacuum assisted resin transfer molding.
- Pultrusion.
- Filament Winding
- Bag Molding Processes.
- Autoclave processing.
- Compression molding.

8.1 Selection of manufacturing process

- Chosen easy process.
- The process has choosing to easy manufacture.
- To choose less cost of mold and manufacturing method.

Hand Lay-up process mentioned above fulfills the requirement. Therefore it can be chosen in manufacturing process.

8.2 Hand lay-up-technique used to fabricate the composite leaf spring

The hand lay-up technique also called wet lay-up. In this method simplest and most widely used manufacturing process. The wet composite rolled using hand roller to facilitate uniform resin distribution and removal air pocket. This process repeating until the desired thickness reached. The layered structure is cured after.

The hand layup process divided into four basic steps:

- Mold preparation
- Gel coating
- Lay-up
- Curing

The mold preparations one of the most critical step in hand layup process. The mold may be male or female type, depend on which surface need to be smooth. A coating of PVAmold release agent is applied to the mold to facilitate the removal of the finishing part.

Fig6 Lay-up

Fig 7.Final curing stage

9. RESULT COMPARISONS

9.1 Tensile test

Tensile testing, also known as tension testing, is a fundamental materials science test in which a sample is subjecting to a controlled tension until failure.

The results from the test commonly used to select a material for an application, for quality controls, and to predict how a material will be react under other types of forces. Properties that are measuring directly via a tensile test are ultimate tensile strength, maximum elongation and reduction in area. Tensile load, tensile strength, elongation results was compared to two different type of hydride composite materials.

Table 1. Comparison of tensile testing results ofvinyl esterand epoxy type leaf spring.

Leaf Springtype	Tensile Load[kg]	TensileStrength[Mpa]	Elongation[mm]
E-glass/Epoxy/jute	415	78.5	5.6
E-glass/Vinyl ester/jute	467	88.45	6.2

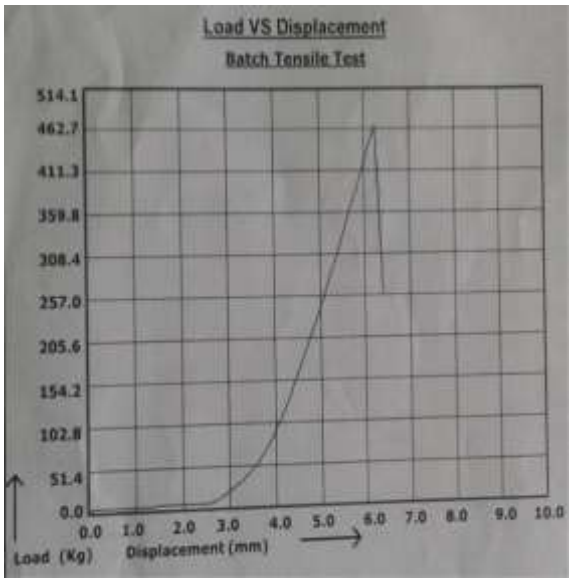

Fig 8.Load vs displacement of polymer matrix leaf spring (E-glass/Vinyl ester/jute).

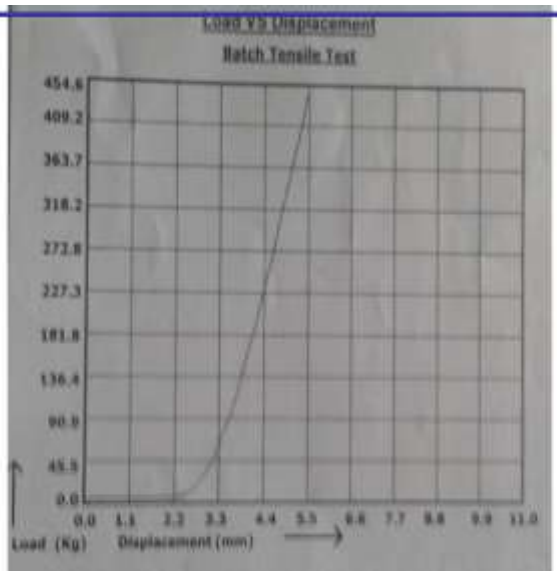

Fig 9.Load vs displacement of polymer matrix leaf spring (E-glass/Epoxy/jute).

9.2 Impact test

A test specimen, usually of square crossed section was notched and held between a pair of jaws, to be broken by a swinging weight. When the pendulum of the Izod testing machine released it swings with a downward movement and when it reached the vertical the hammer make contacts with the specimen which is broking by the force of the blow. The hammer continues its upward motion but the energy absorb in breaking the test piece reduces its momentum. A graduated scale enables a reading to taken of the energy using to fracture the test piece. To obtain a representative result the average of three tests was used.

S.no	Izod Impact Value [J]	
1.	E-glass/Epoxy/jute	E-glass/Vinyl Ester/jute
	3.30	5.11

Table 3.Izod impact test result compare to Epoxy and Vinyl ester leaf spring.

9.3 Weight comparisons

We have compared the two different combination of hybrid Composite Leaf Spring. We have chosen the less weight of leaf spring because of reducing the weight in automobile and increase the fuel efficiency.

Leaf Spring Type	Epoxy	Vinyl Ester
Weight (g)	451	369

Table 4. Weight Comparisons

CONCLUSIONS

The experimental investigation was conducted on two different hybrids composites leaf spring lead to the following conclusions.

- Both composite leaf spring [E-glass/Epoxy/Jute and E-glass/Vinyl ester/Jute] experimental results compared such as tensile strength, impact strength and weight.
- To choose the best one result. Vinyl ester composite leaf spring experimental test result are good than Epoxy composite leaf spring.
- These types of leaf spring are using for light weight commercial vehicles. Composite and steel leaf spring load carrying capacities are same for medium vehicles.
- In this type of composite leaf spring are less cost and weight compare to steel leaf spring. To increase the fuel efficiency of vehicle.

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