Composite Multi Leaf Spring Manufacturing Technique and Testing on The Basis of Static Loading Conditions.

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Abstract—Composite material is one of best suited material for automotive vehicles. In automotive industry composite material can give better advances in weight, performance, load capability condition etc. In this paper composite material is used for the leaf spring and along with we are changing design. The static testing and analysis part is covered by using universal testing machine and ANSYS 12.1 software. While designing for light weight vehicles, we have considered maximum load near about 5000N in quarter car model. Existing leaf spring is made by steel material and its alloys but here we do replace it with Glass Fibre Reinforced Plastic material.

Keywords—GFRP, composite leaf, Resin, Kevlar, Hardener, weight reduction, PVA chemical

I. INTRODUCTION

For giving better life comfort and advances in emerging trends for automotive vehicles we do providing the best suspension system in light weight vehicles. Small trucks which have maximum load of 5000 N can be drive on the leaf spring suspension and for which if we provide leaf spring with low weight and of the same loading capacity it will becomes more advantageous for gross vehicle weight and its mileage. The overall performance of the suspensions like leaf spring is to stable the vehicle at its axle position. Also it will provide comfort in rolling, pitching, turning actions. This paper includes the manufacturing technique where fibre orientations and layers sequence can be changed. Composite material can shows the good riding comfort with lower weight and high stiffness capacity. Strain energy storing capacity of composite leaf is more.

II. COMPOSITE MATERIAL

Composite materials like CFRP, GFRP, KFRP etc fibres are available but as per low cost and higher strength capacity Glass Fibre Composite Materials are beneficial. Which have poisons ratio of 0.217 and mass density of 2.6 ×10−6 kg/mm². So as compare to steel spring it have low density and therefore the weight of leaf spring goes lower.

- GFRP material having low cost.
- It can have low weight
- High corrosion resistance.
- High weight to strength ratio.

The actual substitutes in GFRP composites are Glass fibre, Epoxy resin, hardener, pigments, Polyvinyl Alcohol (PVA) etc.

Epoxy resin is the basic need of composite leaf spring because it can provide inter laminar shear strength for the matrix. Fibre does not influence inter laminar shear strength. E Glass fibres are very high quality glass fibres. They can provide strength for the leaf spring. Fibres can be classified on their orientations of matrix as bidirectional, unidirectional and cross directional fibres. On the basis of their matrix it can be classified as Fine, super fine and coarse fibres as shown in fig. I, II, and III.
The design consideration for leaf spring is basically depends upon its loading conditions. As if we consider here 500 kg load on leaf spring. And this load is distributed along length wise on leaf. The design of leaf spring depends on the type of leaf being used, either monoleaf or assembly of leaves. We consider here assembly of leaves because the load will be distributed on each leaf. As excess load is applied second leaf can support first leaf.

IV. MANUFACTURING TECHNIQUE

Manufacturing technique used for composite material is hand layup process. This process is advantageous because it can provide manual handling and also cost efficient.

This process can be done by brush painting only. While manufacturing pattern and mold are necessary steps.

A. Pattern Making

While making pattern the particular sized wood piece have to take. Then by finishing with grinding wheel get the shape of the dimensions as shown in fig. IV. As for finding the shape, don’t directly cut the curvature, it may fail or generates cracks in it. Just finish it out and make smooth surface.

B. Mold Making

Mold can be generated as per shape and size of the pattern. Before applying resin layers and PVA chemical layers on pattern apply pigment on it. Pigment is the releasing agent which can release the pattern from mold. As the coarse E glass fibre is used for making mold. The layers of fibres and resins are applied on the pattern surface. Maximum 2mm layer is applied on it. As shown in fig. V and fig.VI. After soaking releases the pattern from mold and should conform the cavity of mold is fully prepared.

C. Product Manufacturing

The mixture of E glass epoxy resin is placed as layer wise in the mold. Before that the pigment layer is brushed up in mold. The reason to do so is to release the actual product easily and efficiently from the mold. While putting layer in mold after each layer of resin fibre mat layer is attached. For 2cm thickness 35 layers of all fibres and resin added. That means total thickness is of 70 layers combination.
V. Static Test

Assembly of leaf spring fixed in fixture and keep on the workbench of universal testing machine. After that turn on the universal testing machine and applied the load on the assembly of leaf spring. When load of universal testing machine increases gradually then deflection occur in the assembly of leaf spring. Static testing is done by using universal testing machine (UTM).

VII. Static Test Rig With Undeformed Spring

Total deflection of leaf spring is 3.6cm at camber while loading with 500kg load. That means at maximum loading of quarter car model can sustain the load with only 4 cm deflection as shown in fig. v.
Graph shows uniform increment in load as the deflection increases. But as the maximum loading condition reached it can start for cracking. Therefore as for 5.4kn it reaches maximum load and after that crack generates in it so system load directly goes to zero as shown in graph.

IX. STATIC TEST GRAPH

VI. RESULT AND CONCLUSIONS

As the static testing shows the result of loading conditions of leaf spring the deflection can be increased gradually.

<table>
<thead>
<tr>
<th>Load(Kg)</th>
<th>Deflection(mm)</th>
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<tbody>
<tr>
<td>50</td>
<td>5</td>
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<td>100</td>
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<td>64</td>
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<tr>
<td>500</td>
<td>74</td>
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As per the static load and deflection chart of the spring, at maximum load spring can deflect with maximum deflection .After that maximum camber distance will be achieved, and spring becomes flat. This will be the maximum deflection of spring in any condition of load .If deflection goes more than camber length spring definitely will fail.

The conclusion for the same project can shows the manufacturing technique because of which spring can give high strength and load carrying capacity. The combination of fine, superfine and coarse fibres and their orientations can give better performance and increase spring strength.

REFERENCES