

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES MANUFACTURING AND ANALYSIS OF MONO LEAF SPRING USING COMPOSITE MATERIAL

Ganesh R. Chavhan*¹, Pawan V. Chilbule², Sudhir W. Burande³ & Masnaji R. Nukulwar⁴ *^{1,2,3} Assistant Professor Mechanical Engg. Deptt, Government college of Engineering, Chandrapur. ⁴Assistant Professor Mechanical Engg. Deptt, JSPMs, RSCOE, Pune

ABSTRACT

Now a day the fuel efficiency and emission gas regulation of automobiles are two most important issues. To fulfil this problem many automobile industries are trying to make new vehicle which can provide high efficiency with low cost. The best way to increase the fuel efficiency is to reduce the weight of the vehicle. By Introducing better material, design optimization and better manufacturing processes, the weight reduction can be achieved. A composite material leaf spring is a very good replacement for conventional steel spring by achieving weight reduction with adequate improvement of mechanical properties. The automobile vehicles have number of parts which can be able to replace by composite material, but due to the improvement of mechanical properties of composite material. It has more elastic strength and high strength to weight ratio has compared with the steel material. So, out of many components one of the components of vehicle, the leaf spring which use for carried out the whole weight of the vehicle is best option for replacement of steel material by composite material. For reduce the weight of leaf spring the analysis was carried out on the model of Mahindra Commander 650di leaf spring with same dimensional geometry. The material select for leaf spring are E-glass/epoxy which is more economical with similar mechanical and geometrical properties to the steel leaf spring. The analysis was carried out on ANSYS 15.0 with same loading condition for deflection and bending stress of steel as well as E-glass/epoxy composite material. Design and fabricated of mould by wood material and fabricate a mono leaf by using E-glass/Epoxy composite material. The analysis was carried out on ANSYS 15.0 with same loading condition for deflection and bending stress of steel as well as E-glass/epoxy composite material. The orientation optimization has been carried out by analysis of different stacking sequences of composite leaf spring. From the static analysis results it is found that there is a maximum displacement of 13.365 mm in the steel leaf spring and the corresponding displacements in Eglass/epoxy is 132.34 mm, also the vonmises stress in the steel leaf spring is found 144.75 MPa and in Eglass/epoxy composite is 196.71 MPa. Composite leaf springs have optimum displacements and stresses than that of existing steel leaf spring. A comparative study has been made for strength and weight between steel and composite leaf spring. Composite leaf spring reduces the weight by 73.65% for E-glass/epoxy over steel leaf spring

Keywords: Composite material, E-glass/epoxy, Spring material, Hand layup, Stacking Sequance

I. INTRODUCTION

In automobiles the fuel efficiency is one of the important issues, to reduce this problem automobile industries are trying to make vehicle which can be provide high efficiency with low cost. The vehicle is made up of heavy material. So the best way to increase the fuel efficiency is to reduce the weight of the vehicle. This reduction can be achieved by the replacement of heavy material. This can also achieved by the introduction of design optimization and better manufacturing process. For achieving the weight reduction with improvement of mechanical properties has made composite material a good perfect replacement for conventional steel material. A composite material made from two or more different constituent material having physical and different physical or chemical properties which do not merge in the finishing structure i.e. the individual constituent retain their properties. In automobile there is one component which carry 10 to 20% weight of vehicle, i.e. leaf spring .This leaf spring is one of the component which can be easily replaced.

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Materials contribute to the quality, performance of the vehicle and around 60 to 70% cost of the vehicle constitute by material. Even a small amount in weight reduction of the vehicle, may have a wider economic impact. Composite materials are prove as appropriate substitutes for steel in relation with weight reduction of the vehicle. Hence, the composite materials have been selected for leaf spring design.

II.A - COMOPOSITE MATERIAL

A composite material made from two or more different constituent material having physical and different physical or chemical properties which do not merge in the finishing structure i.e. the individual constituent retain their properties.

II.B - CLASSIFICATION OF COMPOSITE MATERAIL



Figure 1- Cuissification of composite mater

II.C - MECHANICAL PROPERTIES OF FRP COMPOSITE

Fiber reinforced polymer (FRP) composite are used in a wide variety of applications. A mechanical property of the products made by FRP has a unique benefits.FRP composite materials possess superior mechanical.

II.D - SAVING WEIGHT IN SUSPENSION SYSTEMS: COMPOSITE LEAF SPRING

Automobile industries are aware with performance of Composite material. By design, leaf spring absorbs vertical vibration caused by irregularities in the road. Variation in the springs deflection allow potential energy to be stored as strain energy and then released more gradually over time. Composites are well suitable for leaf spring purpose due to their high strength to weight ratio, fatigue resistance and natural frequency. Composite material leaf spring more durable than a steel spring. Mass reduction is the biggest benefit.

III. DIMENSIONS OF LEAF SPRING

Conventional design methods of leaf springs are largely based on the application of empirical and semi-empirical rules along with the use of available information in the existing literature. The functions of springs are absorbing energy and release this energy according to the desired functions to be performed. So leaf springs design depends on load carrying capacity and deflection. Hence the Mahindra \Model-Commander 650di" is consider for design of leaf spring.

III.A - MATERIAL OF LEAF SPRING E – Glass Fiber and Epoxy resin

III.B - BASIC DATA OF MAHINDRA PICKUP LEAF SPRING Total length of the spring (Eye to Eye) = 1120 mm No. of full length leaves (nf) = 1 Thickness of leaf (t) = 4 mm Width of the leaf spring (b) = 80 mm Total load = 500 N



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Figure 2: Terminology of leaf spring

IV. MANUFACTURING OF COMPOSITE MATERIAL LEAF SPRING

IV.A - CONSTRUCTION OF MOULD

The wooden mould is prepared for the fabrication process. The loose pattern type wooden roll is used to make the eye design.



Figure 3 - wooden mould

IV.B - MANUFACTURING OF LEAF

Material used

- 1. Resin LY556 and hardner HY951.
- 2. E-glass Fibre.
- 3. Releasing oil.

Method of Manufacturing

- 1. Cutting of natural fibre strips as per dimensions.
- 2. Appling the layer of releasing oil on base of mould.
- 3. Mixing of resin and hardner in the ratio 10:1.
- 4. Apply layer of mixture on the mould.
- 5. Put the strip of E-glass Fibre.
- 6. Alternately proceed with these steps up



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to 4mm thickness.

- 7. Leave this structure for drying.
- 8. Grinding process.



Figure 4 - Composite mono leaf

V. RESULT AND DISCUSSION

glass/

epoxy

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The result get after testing composite material leaf spring and steel leaf spring on UTM machine for the deflection over load are as follows:

| Table 7.1: Result for testing on UTM | | | | | | | | | | |
|--------------------------------------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| LOAD | 50 | 100 | 160 | 200 | 300 | 400 | 460 | 480 | 480 | 480 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| steel | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 3 | 3.5 |
| E- | | | | | | | | | | |
| glass/ | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 4 | 5 |
| epoxy | | | | | | | | | | |
| | | | | | | | | | | |
| LOAD | 48 | 480 | 480 | 480 | 480 | 560 | 560 | 640 | 640 | 640 |
| | 00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| steel | 4 | 4 | 4.5 | 5 | 5.5 | 6 | 9 | 26 | 27 | 41 |
| E- | | | | | | | | | | |

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Figure 5 - Comparison of steel leaf spring and composite leaf spring on UTM.

The result get after testing composite material leaf spring and steel leaf spring on Ansys with varying fiber orientation in composite material leaf spring.

| 2. comparison of sicci real spring and compo | sue ieug spin | is on m |
|---|--------------------|-------------------------|
| Stacking Sequance | Deflecti on(mm) | Stres s (Mp a) |
| steel spring | 13.365 | 145 |
| (0/0/0) s | 132.34 | 197 |
| (-45/90/0/90/45)s | 217.66 | 334 |
| (-90/90/0/90/-90)s | 234.47 | 350 |
| (03/45/(45/02)3/02/452/03)s | 154.79 | 249 |
| (03/-45/(-45/02)3/02/-452/03)s | 154.75 | 247 |
| (02/90/02/-45/90/03/-45/02/- 45/90/03/-45/90)s | 242.95 | 384 |
| (02/90/02/-45/90/03/-45/02/- 45/90/03/-45/90)s | 238.03 | 351 |

Table 7.2: comparison of steel leaf spring and composite leaf spring on Ansys

VI. CONCLUSION

The design and static structural analysis of steel leaf spring and composite leaf spring has been carried out. The orientation optimization has been carried out by analysis of different stacking sequences of composite leaf spring.

A Comparative study is carried out on composite leaf spring and steel leaf spring having same design and same load carrying capacity. The stress and displacements have been calculated using ANSYS 15.0 for steel leaf spring and composite leaf spring. From the static analysis results it is found that there is a maximum displacement of 13.365 mm in the steel leaf spring and the corresponding displacements in Eglass/epoxy is 132.34 mm. From the static analysis, it also seen that the von-mises stress in the steel leaf spring is 144.75 MPa and in E-glass/epoxy 196.71 MPa. The composite leaf springs have optimum displacements and stresses than that of existing steel leaf spring A Comparative study is carried out on composite leaf spring and steel leaf spring with respect to strength and weight. Composite leaf spring reduces the weight by 73.65%.

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