JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

DESIGN AND ANALYSIS OF LEAF SPRING USING COMPOSITE MATERIALS

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ABSTRACT

Today in automobile sector wear and tear is based on the mass balance and suspension arrangement in heavy truck. The essential part of truck is interrelated to the spring design in quadrilateral cross-section with semi-elliptical shape. The suspension system is mostly coupled with shackle bracket and leaf spring assembly in the vehicle which restrains the entire vehicle vibration etc. It is plays vital role in the vehicle reduction of loss in body and tyre of the vehicle. In this thesis proposed applications is based on the concentration of vehicle suspension and their components. The design is creating with existing dimension as per standard design consideration. The 3d model is created by using SOLIDWORKS software and import to FEA software (ANAYS) where structural parameters are analyses with respect to different composite material with help of Ansys software.

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1. INTRODUCTION

Leaf springs are used in automobile as a suspension system to isolate shocks & vibrations transmitted due to the undulation in road conditions to the vehicle in service. Due to the superior performance of specific strains energy, damping & corrosion resistance of composite material or metal matrix composite over Mild Steel, composite leaf springs are being widely used in lightweight vehicles, passenger cars, and heavy tank trailer suspension systems & in vibrating machinery.

The spring suspension in automobiles is a very important components in deciding vehicles drive comfort & the stability of the chassis. As the tire rotates, the suspension is in a state of dynamic balance, nonstop compensating for & adjusting to varying driving conditions.

The mechanisms of the suspension perform basic functions such as maintaining the right vehicle drive height, falling the outcome of the shock forces, supporting the vehicle weight, carrying the driving torque, etc.

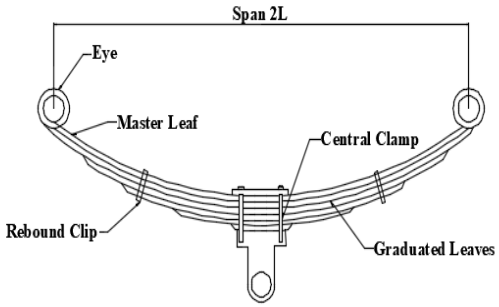
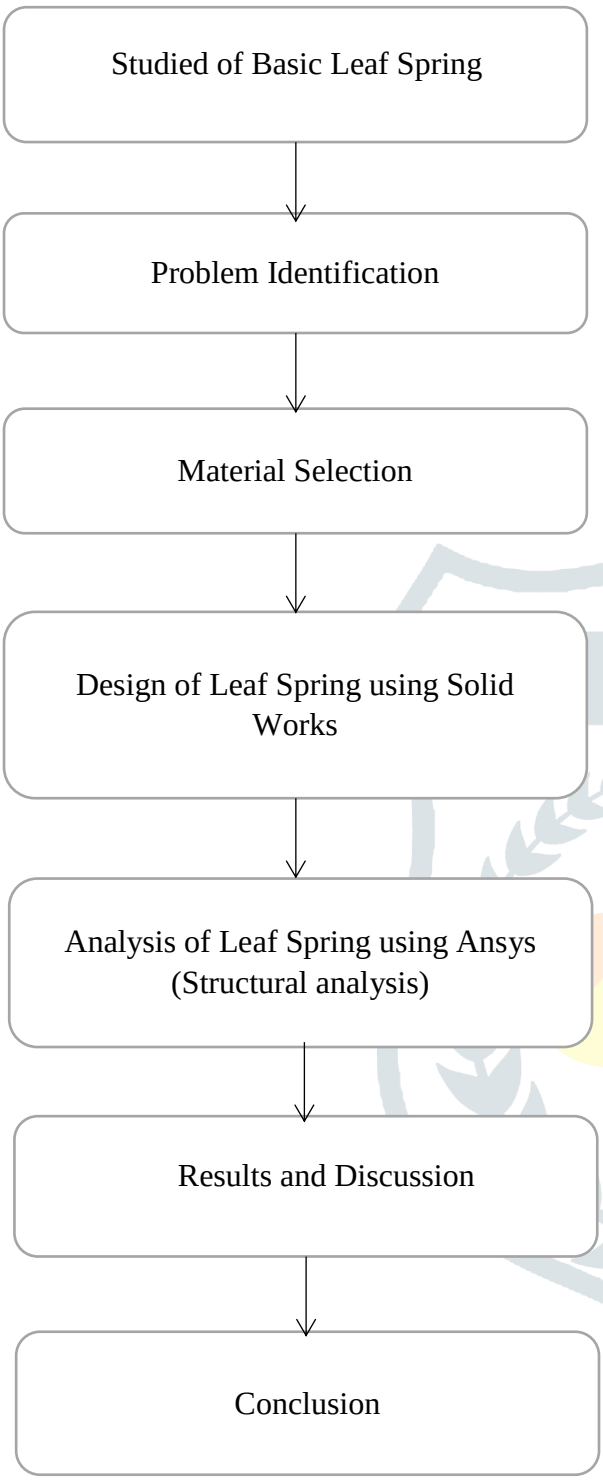


Fig. 1.1 Leaf Spring

2. METHODOLOGY



LITERATURE REVIEW

J.P. Hou et al (2007), Three eye-end designs of a double GRP leaf suspension have been evaluated by finite element analysis and fatigue testing. The first two designs consisted of integral eye ends where the skin tape layers went around the eye and along the leaf body. These layers were then maintained in place via a transverse wrap using woven GRP tape. The third design consisted of open-eye ends. FEA and static test results show that the stress concentration at the tip of the fibers coming back along the leaf body for the first two designs led to local delamination. However, this did not have any effect on the static proof loading of the suspension nor on its fatigue life. The third eye-end design (open eye) showed that this option led to a reduction of shear stresses in the critical area and prevented the local delamination encountered with the first two designs. The open eye design survived the static proof loading and showed very good fatigue resistance and has been selected as the final design.

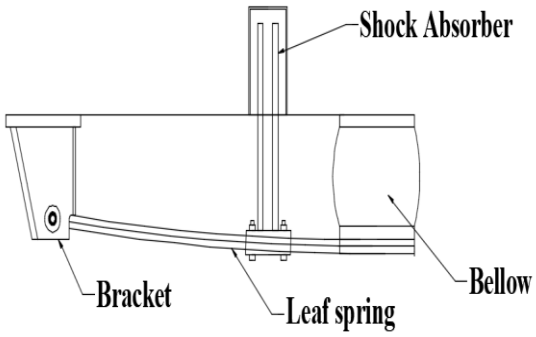
Y.S Kong et al **(2016)**, This paper presented a transient dynamic multi body simulation of a truck leaf spring front suspension module. Torsional and tensional forces along the leaf spring eye design were extracted from the simulation under braking, cornering, and pothole striking load cases. The extracted forces were used as the load input to the finite element simulation model to obtain the principal surface stress of the spring eye designs. Based on the analysis of the material yield strength, the stress level of the spring eye design with a thickness of 17 mm surpassed all three harsh loading conditions. The results also show that the designs with a thickness below 16 mm failed under those extreme load cases, whereas the design with a thickness of 16 mm only slightly passed the requirement.

C.K. Clarke and G.E. Borowski (2005), The determination of the point of failure during an accident sequence of a rear leaf spring in a sport utility vehicle is presented in terms of fracture surface analysis and residual-strength estimates. Marks at the scene of the accident pointed to two possibilities for the point of failure: marks in the roadway at the start of the accident sequence and a rock strike near the end of the sequence.

A.V. Guimaraes et al The Formula SAE is a competition among students worldwide, where they are challenged to design, build and test a small formula-type racing car, following rules and specifications defined by the society of Automotive Engineers(SAE). In the present analysis, a premature failure of a half-shaft of the transmission system of a racing car occurred after circa 100 km of use. The results show that the alloy Mild Steel bar used for the half-shaft did not follow specifications, with a consequent lower strength and resulting in a material with insufficient loading capacity and fatigue resistance.

PROBLEM IDENTIFICATION

The schematic diagram of the Air suspension is shown within the figure 3.2. It consists of four different components are attached within the chase except spring. A part of the bellow, shock absorber & shackle bracket are attached on the chases of the vehicles. One end of spring is attached below the bellow & alternative end id mounted with bracket. A similar method repeated once the vehicle is moving in the road because of road irregularity. Due to the bracket under goes fatigue load. So, it results in bend within the bracket & crack formation.



Schematic diagram of leaf spring assembly

OJECTIVE

The leaf spring is proposed material based on composite combination of glass and banana fibre. It's comparatively stress value in analysis software using ANSYS with similar boundary condition & predicts the deformation, equipment von-mises stress, equivalent elastic strain & shear stress. To comparatively better strength material chooses with help of Ansys software.

MATERAIL SELECTION

MILD STEEL

Mild steel contains approximately 0.05-0.25% carbon making it malleable and ductile. Mild steel has a relatively low tensile strength, but it is cheap and easy to form; surface hardness can be increased through carburizing.

Material properties of mild steel:

- Density -7800kg/m^3
- Young's Modulus -200GPa
- Poisson ratio -0.3
- Yield strength -275MPa
- Tensile strength -475MPa

CARBON STEEL

Carbon steel is the most important group of engineering alloys and a large portion of the steel produced today is plain carbon steel. They account for the vast majority of steel applications depending on the processes and needs. Civilization and modern urbanization are greatly dependent on steel without a doubt. A wide range of application as well as its abundance in nature has given it a dominance over other materials. Today it is used every sector of our lives and been subjected to constant modification for able to be used in advanced applications in near future.

Material properties of medium carbon steel:

- Density -7850kg/m^3
- Young's Modulus -212.4GPa
- Poisson ratio -0.29
- Yield strength - 293.MPa

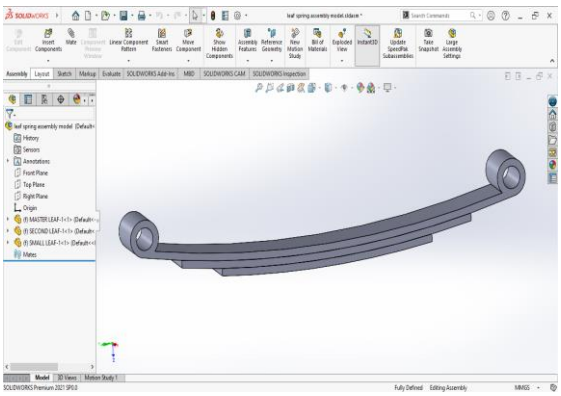
Material properties of lows carbon steel:

- Density -7850kg/m3
- Young's Modulus -212.5GPa
- Poisson ratio - 0.29
- Yield strength -652.2MPa

DESIGN OF LEAF SPRING

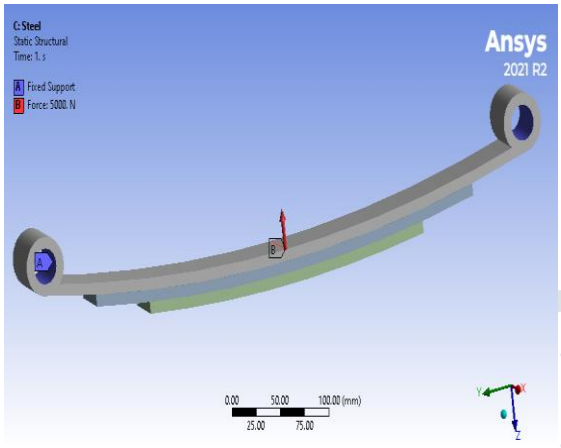
INTRODUCTION TO SOLID WORKS

Solid works is a modelling computer aided design (CAD) and computer aided engineering (CAE) computer program that runs primarily on Microsoft windows. While it is possible to run solid works on MacOS, that is not supported by. Solid works is published by Dassault system. According to the publisher, over two million engineers and designers at more than 165,000 companies were using solid works as of 2013.

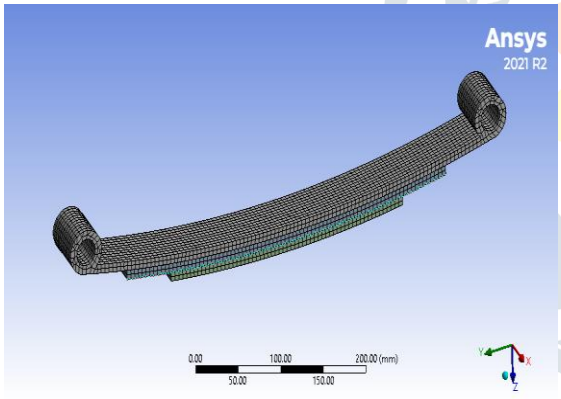


ANALYSIS OF LEAF SPRING

An existing machine tool spindle model has been taken for this analysis work. In this work, boundary conditions and meshing is done on pre-processing. Pressure is applied on outer surface and the inner surface should be kept in fixed constraint. Initially, the model is structurally analyzed with pressure load and then the model analysis is taken and for frequency analysis.



Boundary Condition of Leaf Spring

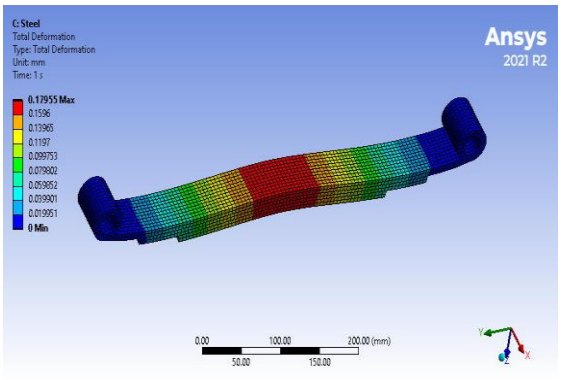


Mesh Geometry of Leaf Spring

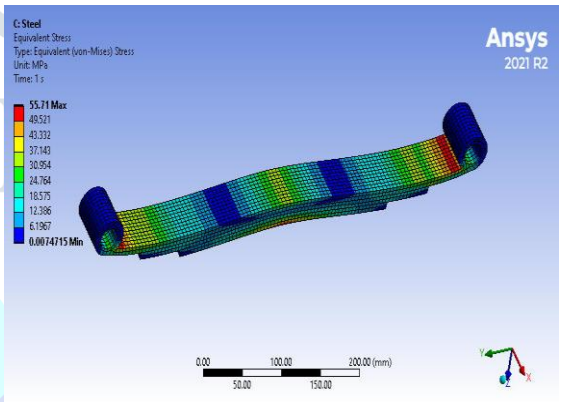
RESULTS AND DISCUSSION

Structural Analysis of Leaf Spring

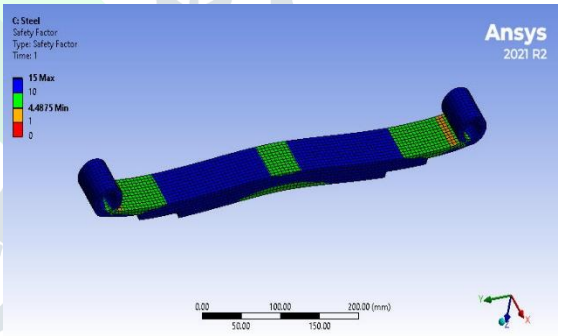
Mild Steel



Deformation results of Mild Steel Leaf Spring

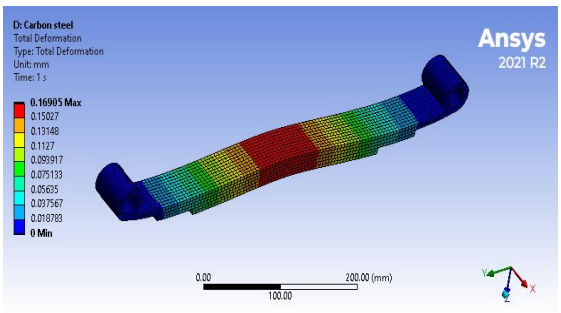


Stress results of Mild Steel Leaf Spring

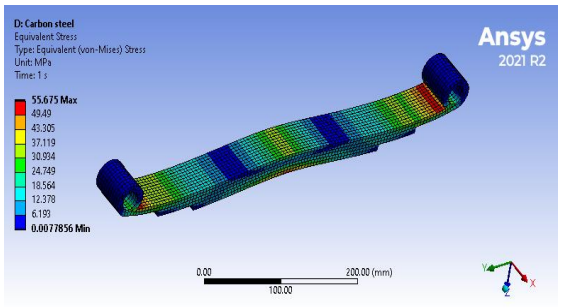


Safety Factor of Mild Steel Leaf Spring

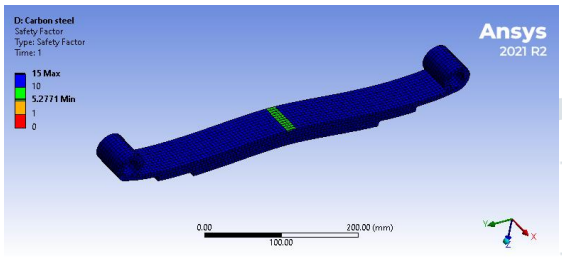
MEDIUM CARBON STEEL



Deformation Results of Medium Carbon Steel Leaf Spring

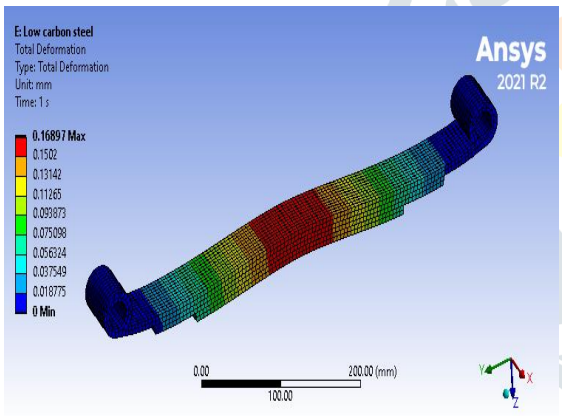


Stress Results of Medium Carbon Steel Leaf Spring



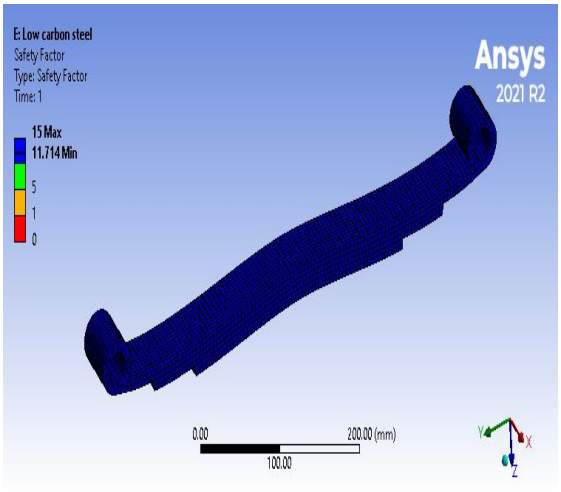
Safety Factor of Medium Carbon Steel Leaf Spring

LOW CARBON STEEL



Deformation results of Low Carbon Steel Leaf Spring

Stress Results of Low Carbon Steel Leaf Spring



Safety Factor of Low Carbon Steel Leaf Spring

Structural analysis results of leaf spring with Mild Steel, medium carbon steel, and low carbon steel are given in the above figures. From the results, the deformation of leaf spring with low carbon steel is better than the medium carbon steel and mild steel. And stress results indicate that mild steel has maximum stress and low carbon steel has minimum stress. With the safety factor results, the low carbon steel has the maximum performance (11.714) and minimum performance (4.4875).

OVERALL RESULTS OF LEAF SPRING WITH MILD STEEL, MEDIUM CARBON STEEL, AND LOW CARBON STEEL

	Deformation	Stress	Safety factor
Steel	0.17955	55.71	4.4875
Medium Carbon Steel	0.16905	55.675	5.2771
Low Carbon Steel	0.16897	55.675	11.714

CONCLUSION

In this study, the Leaf Spring model has been thoroughly studied and designed, and structural analysis has been taken on leaf spring existing mild steel material and proposed material (medium carbon steel and low carbon steel) and evaluated this result. Based on these analyses, deformation was identified and stress and safety factor were found. Overall results show the structural analysis results of steel, medium carbon steel, and low carbon steel leaf spring. From these results, low carbon steel is superior to steel when considering the factor of safety factor of safety, stress, and deformation results.

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