DESIGN AND ANALYSIS OF HEAVY VECHICLE LEAF SPRING
Energy storage and stress analysis

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Abstract:

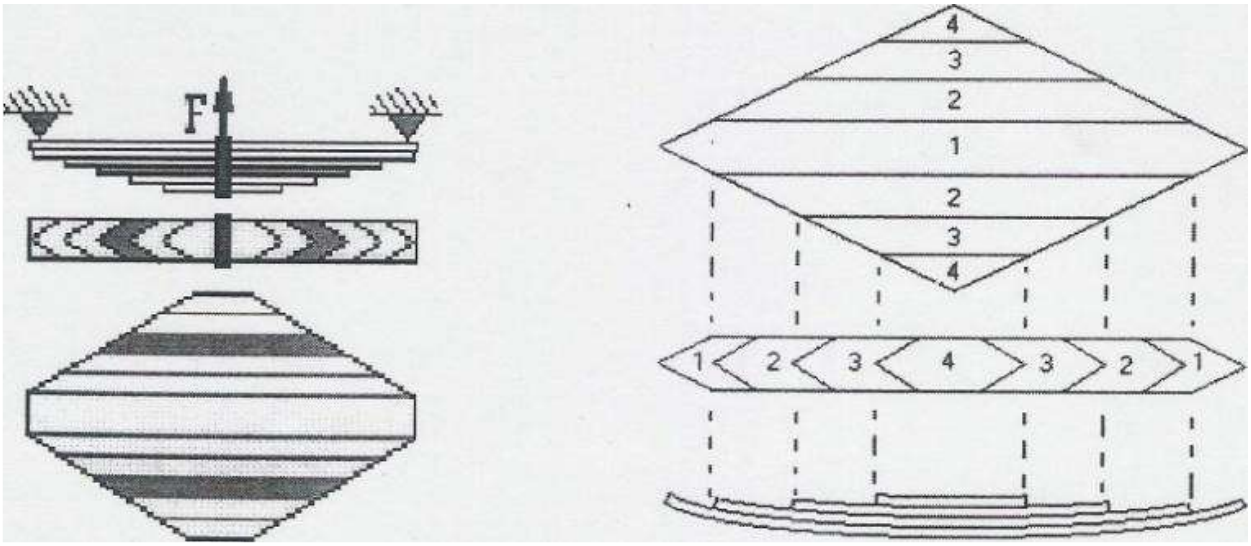
The automobile industry has shown increased interested in the replacement of steel spring with e glass epoxy leaf spring due to high strength to weight ratio the aim of this project is to present low cost fabrication of e glass epoxy leaf spring with end joints and also general study on the design by using CATIA V5R19 123 and ANSYS12.0 A single leaf with variable thickness and width of constant cross sectional area Epoxy glass leaf spring with similar mechanical and Geometrical properties of Multi leaf spring Compared to the steel spring, the Composite spring ha stresses that are Much lower, the natural frequency is higher and The spring weight is nearly 85 % lower with bonded end joint and with complete eye Bonded end joint

Index terms: leaf spring, stress, ANSYS, deformation ,energy.

1 .INTRODUCTION:

A spring is defined as an elastic body, whose function is to distort when the load is removed its original shape when the load is removed. Springs are unlike other structure components in that they undergo significant deformation when loaded their compliance enables them to store readily recoverable mechanical energy. In a vehicle suspension, when the wheel meets an obstacle, the springing allows movement of wheel over the obstacle and thereafter returns the wheel to its normal position. The simplest spring is the tension bar. This is an efficient energy store since all its elements are stressed identically, but its deformation is small if it is made of metal. Unlike the constant cross-section beam the leaf spring is stressed almost constantly along its length because the linear increase of bending movement either simple support is matched by the beam's widening.

Semi-elliptical leaf springs are almost universally used for suspension. The laminated spring consists of number of leaves called blades. The blades are varying in length curvature so that they will tend to straighten under the load. The leaf spring is design is based upon the theory of beams of uniforms strength. Leaf springs are essential elements in the suspension systems of vehicles. Accurate modeling of leaf springs is necessary in evaluating ride comfort, braking performance, vibration characteristics and stability. Through simple in appearance, a leaf spring suspension causes many problems in modeling. For dynamic simulation the vehicles are usually modeled by multi-body-systems (MBS).For realistic ride and handling, simulations of the leaf springs must be taken into account. The objective of this study has been to find an efficient FE method for the analysis of springs, which lows for fast analyses and easy implementation.



brief description :

The suspension leaf spring is one of the potential items for weight reduction in automobile as it accounts for ten to twenty percent of the un-sprung weight [9]. The introduction of composites helps in designing a better suspension system with better ride quality if it can be achieved without much increase in cost and decrease in quality and reliability [7]. The relationship of the specific strain energy can be expressed as it is well known that springs, are designed to absorb and store energy and then release it slowly. Ability to store and absorb more amount of strain energy ensures the comfortable suspension system. Hence, the strain energy of the material becomes a major factor in designing the springs. The relationship of the specific strain energy can be expressed.

Methodology :

- **S**election of the material.
- Making samples from the material.
- Design of leaf spring.
- Analysis of leaf spring using ANSYS software.
- Comparison of normal and modified leaf spring.
- V1alidation of results.

II. SOFTWARE:

The software will start (by default) with all toolbars docked to the edges of the main window. The toolbars contain buttons, which when clicked, open the various information windows or operate features in the software. The toolbars and windows can be freely moved around inside the main program window, to create your own screen layout.

A.INRODUCTION TO CATIA

CATIA started as an in-house development in 1977 by French aircraft manufacturer Avion Marce l Dassault, at that time customer of the CADAM software to develop Dassault's Mirage fighter jet. It was later adopted by aerospace,automotive, shipbuilding, and other industries. Commonly referred to as a software suite, CATIA supports multiple stages of product development (CAx) including conceptualization, design (CAD), engineering (CAE) and manufacturing (CAM). CATIA facilitates collaborative engineering across disciplines around its 3DEXPERIENCE platform, including surfacing & shape design, electrical, fluid and electronic systems design, mechanical engineering and systems engineering .CATIA facilitates the design of electronic, electrical, and distributed systems such as fluid and HVAC systems, all the way to the production of documentation for manufacturing.

B. INTRODUCTION TO ANSYS WORKBENCH

ANSYS can carry out advanced engineering analyses quickly, safely and practically by its variety of contact algorithms, time based loading features and nonlinear material models. ANSYS Workbench is aplatform which integrate simulation technologies and parametric CAD systems with unique automation and performance. The power of ANSYS Workbench comes from ANSYS solver algorithms with years of experience. Furthermore, the object of ANSYS Workbench is verification and improving of the product in virtual environment. ANSYS Workbench, which is written for high level compatibility with especially PC, is more than an interface and anybody In the planetary dual mass flywheel, the planetary gear and the torsional damper are incorporated into the flywheel. For this purpose, the flywheel is divided into a primary and a secondary mass, hence the name exists planetary "dual mass flywheel". Rattle and booming noise are now a thing of the past which is rectified by DMF. Again By reducing the mass and keeping the Inertia factor same we will be able to optimize the Dual mass flywheel giving the better results than that of conventional flywheel.

who has an ANSYS license can work with ANSYS Workbench. As same as ANSYS interface, capacities of ANSYS Workbench are limited due to possessed license.

ANSYS mechanical is a finite element analysis tool for structural analysis including linear, non linear and dynamic studies. This computer simulation product provides finite elements to model behavior and supports material models and equation solvers for a wide range of mechanical design problems. ANSYS mechanical also includes thermal HYPER LINK and coupled analysis capabilities acoustics, piezoelectric, thermal –structural and thermo electric analysis.

En 8 carbon steel:

EN8 steel stockholders and suppliers, delivering to the whole of the UK. EN8 is an unalloyed medium carbon steel grade with reasonable tensile strength. It is normally supplied in the cold drawn or as rolled condition. Tensile properties can vary but are usually between 500-800 N/mm². EN8 is widely used for applications which require better properties than mild steel but does not justify the costs of an alloy steel. EN8 can be flame or induction hardened to produce a good surface hardness with moderate wear resistance. EN8 is available from stock in bar and can be cut to your requirements. We also offer flame cut plates cut to you required sizes and normalized . EN8 plates can be supplied surface ground or precision ground.

Applications:
EN8 is widely used for many general engineering applications. Typical applications include shafts, studs, bolts, connecting rods, screws, rollers.

a**nalysis** :

Carbon	0.35-0.45%	Phosphorous	0.06% max		
Manganese	0.60-1.00%	Sulphur	0.06% max	Silicon	0.05-0.35%

En 9 carbon steel:
EN9 steel stockholders and suppliers, delivering to the whole of the UK. EN9 is a medium carbon steel grade commonly supplied in the as rolled condition. It can be flame or induction hardened to produce a high surface hardness with excellent wear resistance for a carbon steel grade. EN9 bar is available in full lengths or can be cut to your requirements. EN9 flame cut steel plates can be supplied cut to your required sizes and normalized. Flame cut plates can be supplied Lumsden ground or precision ground.

Applications:

EN9 is used commonly for many general engineering applications. Typical applications include, shafts, axes,

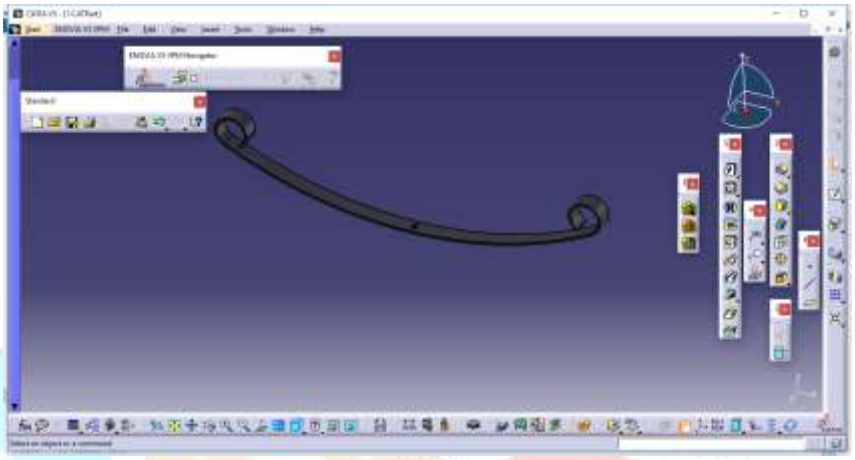
knives, bushes, crankshafts, screws, sickles, wood working drills and hammers.
Anaylsis:

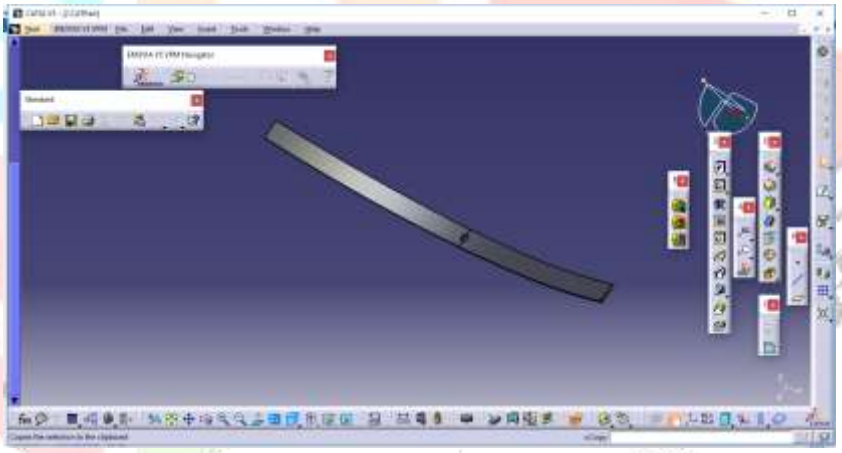
Carbon	0.50-0.60%	Phosphorous	0.06% max
Manganese	0.50-0.80%	Sulphur	0.06% max
Silicon	0.05-0.35%		

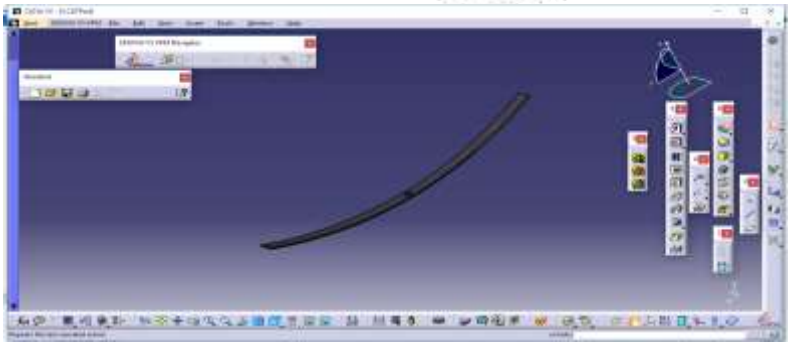
EN19:

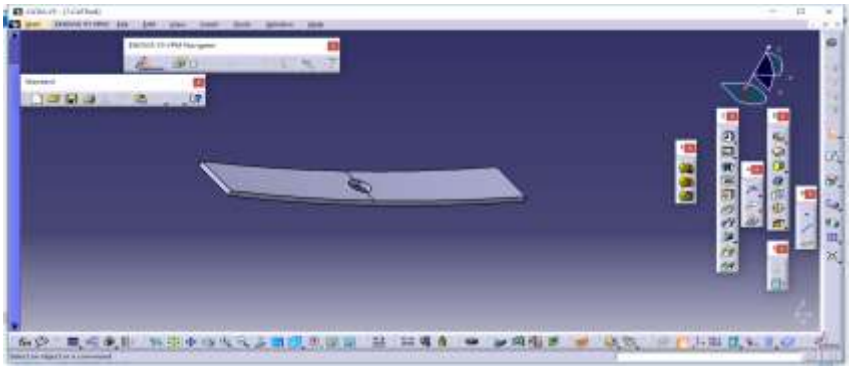
EN19 is a high quality alloy steel with tensile strength. With a combination of good ductility and shock resistance, EN19 is suitable for applications with very high loading such as engine gear boxes. Popular in the automotive sector it is possible to machine the material extremely accurately, in recent years EN19 has become an established material in the Oil & Gas sector. The material lends itself well to any application where strength
Primary consideration.

Part design:

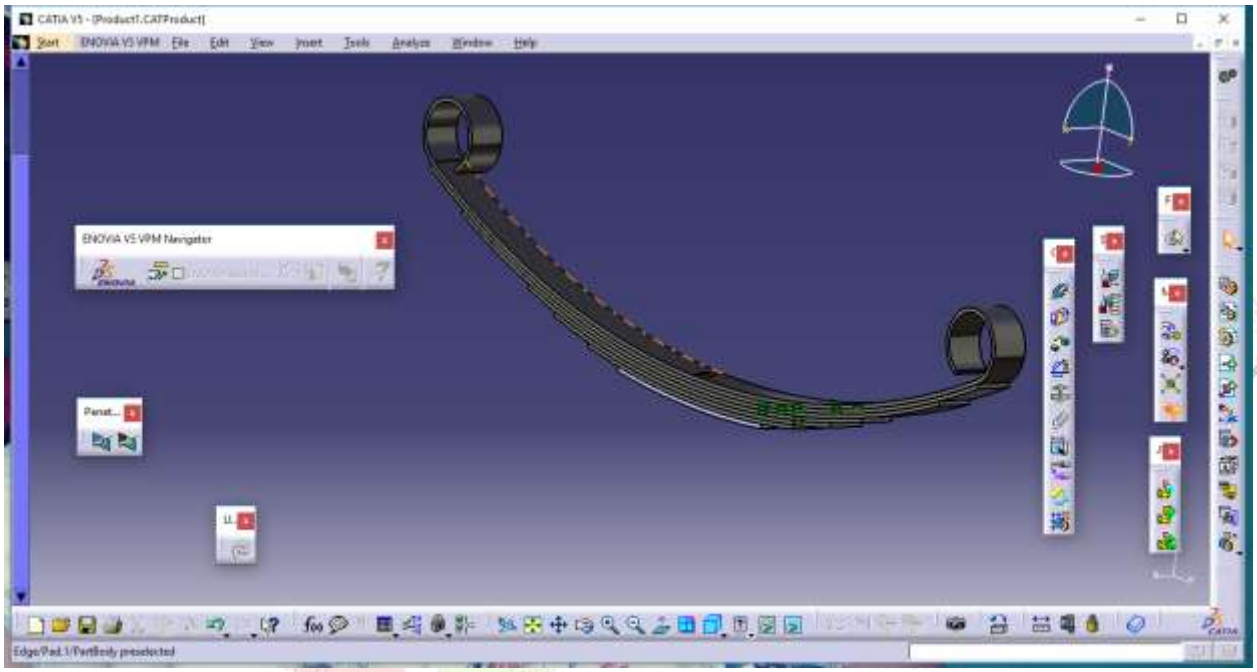






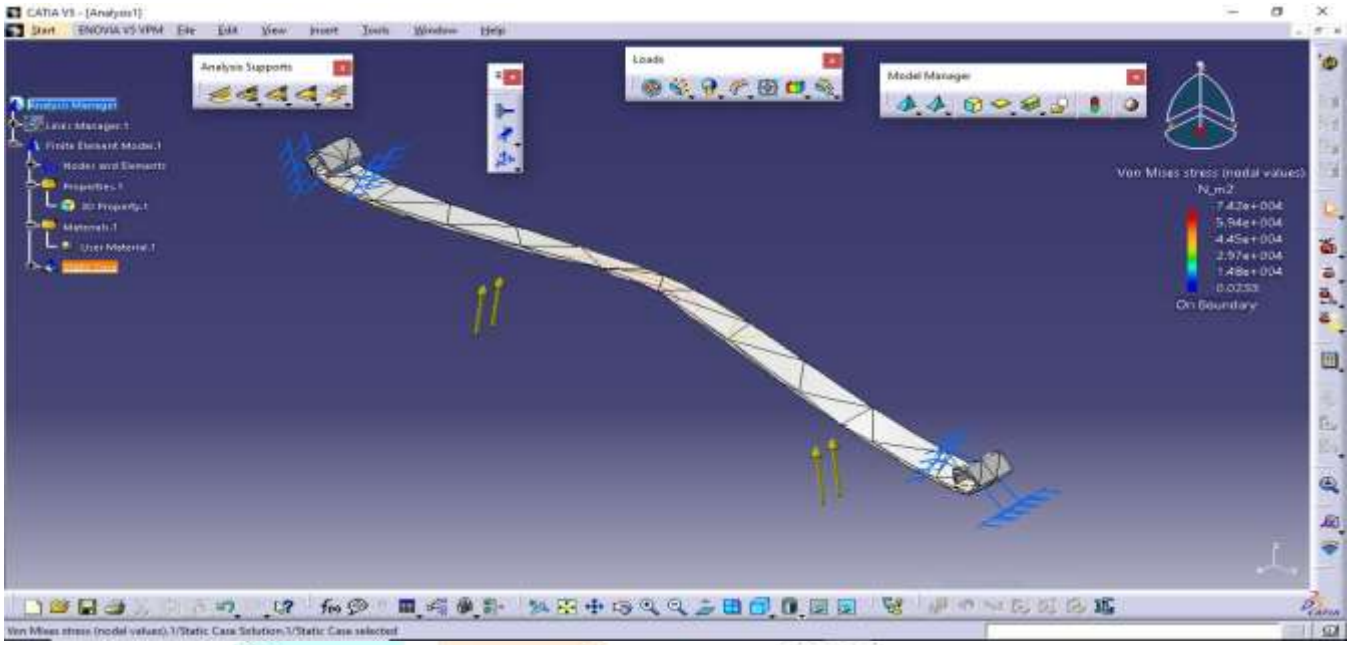


Product design

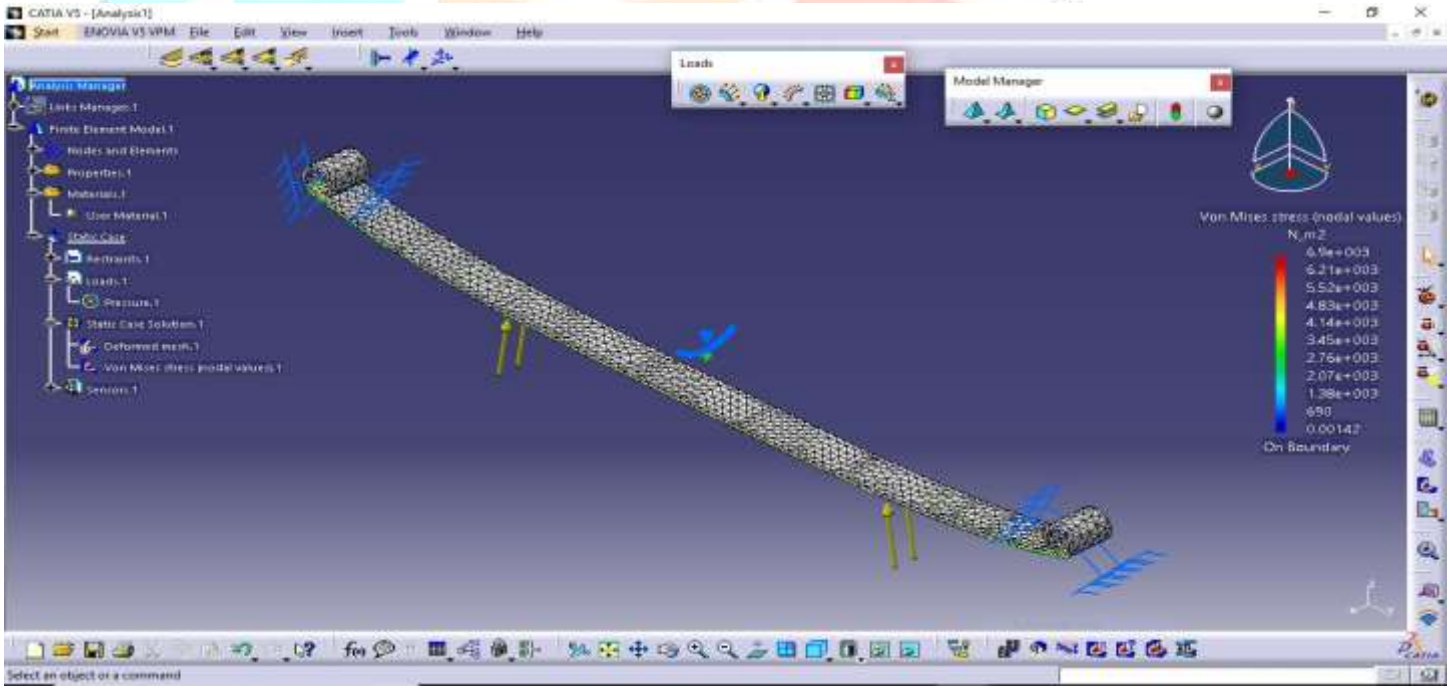


Analysis result of leaf spring

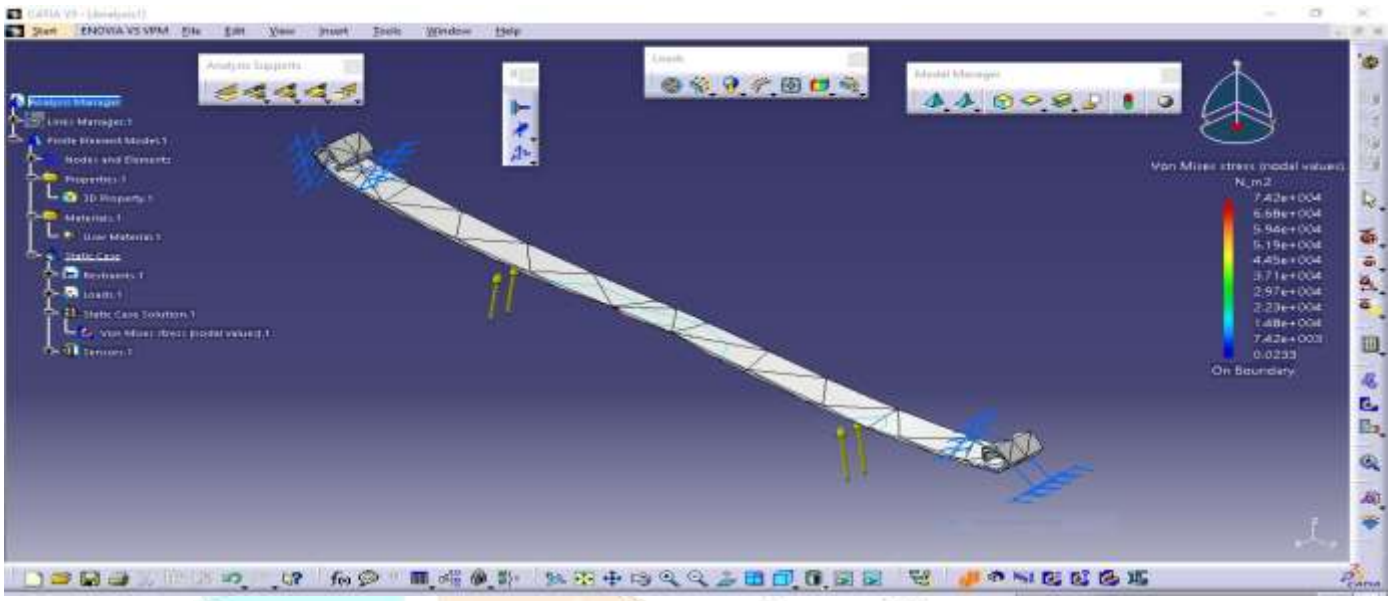
Total deformation:



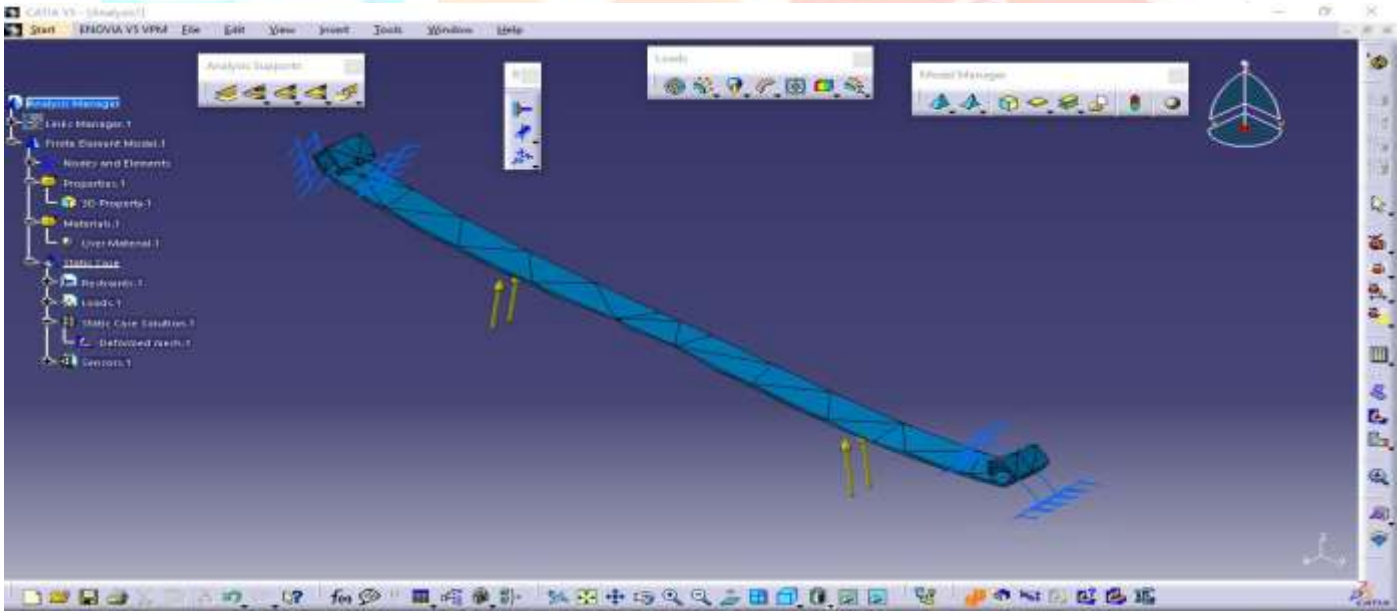
Deformation stress:



Equivalent stress:



Maximum bending stress:



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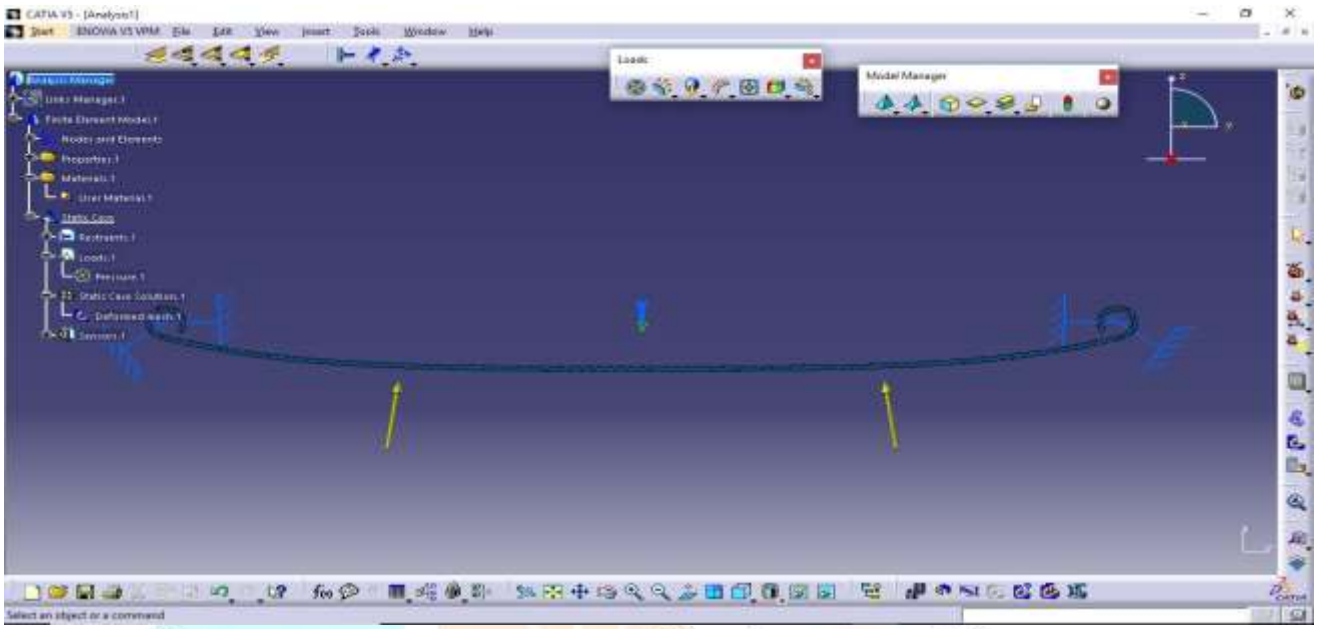
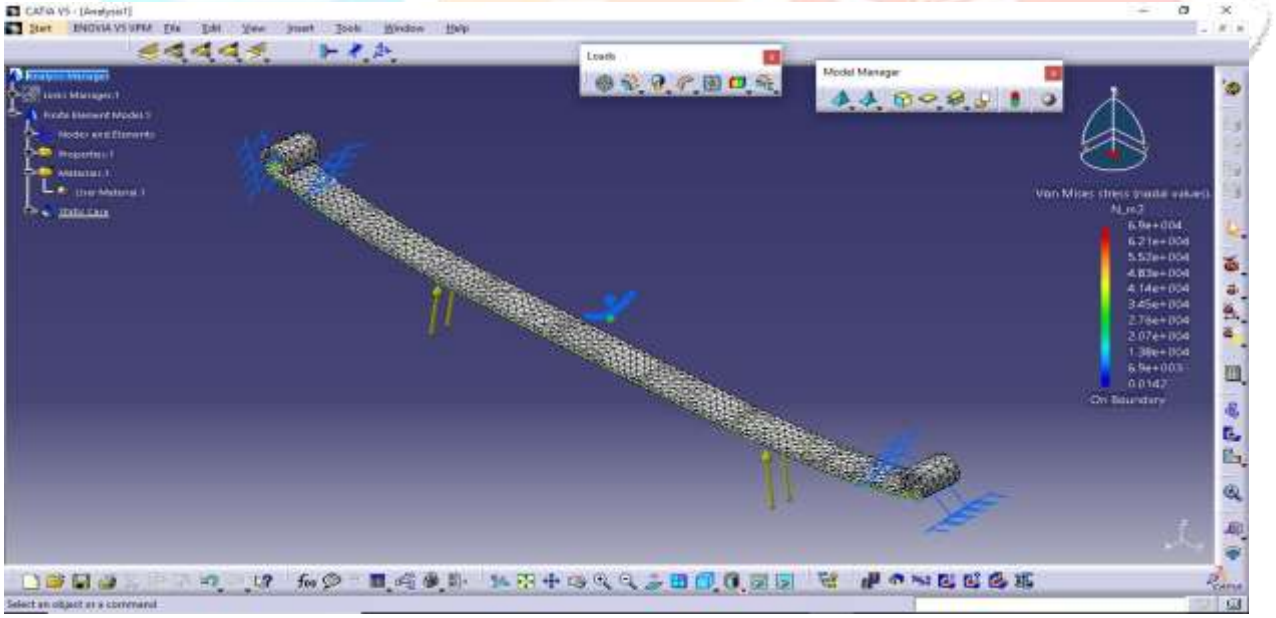


Equivalent stress:



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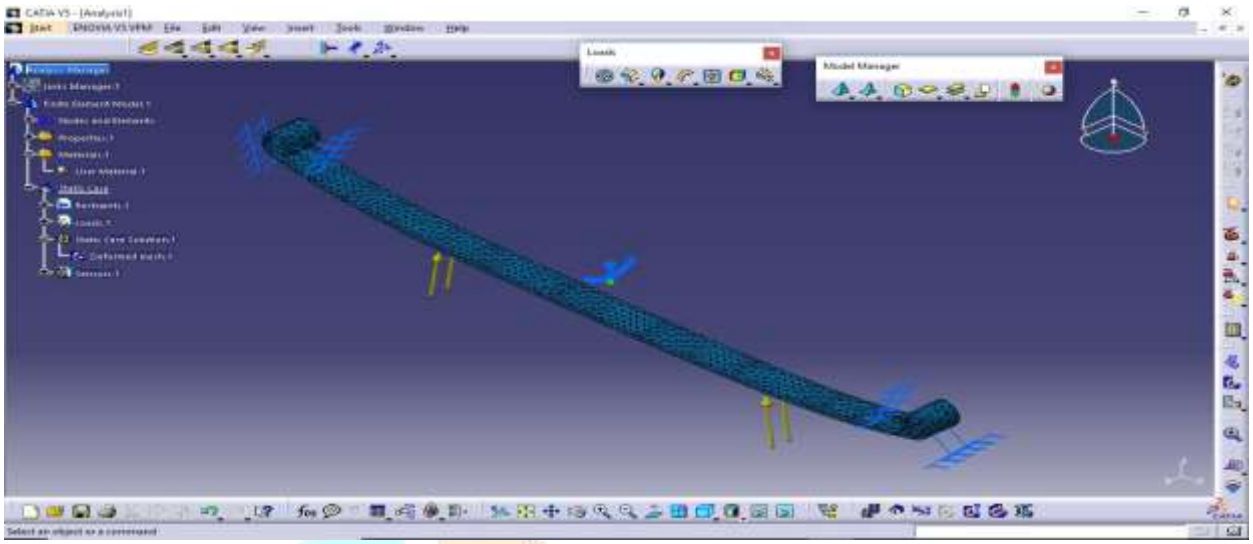
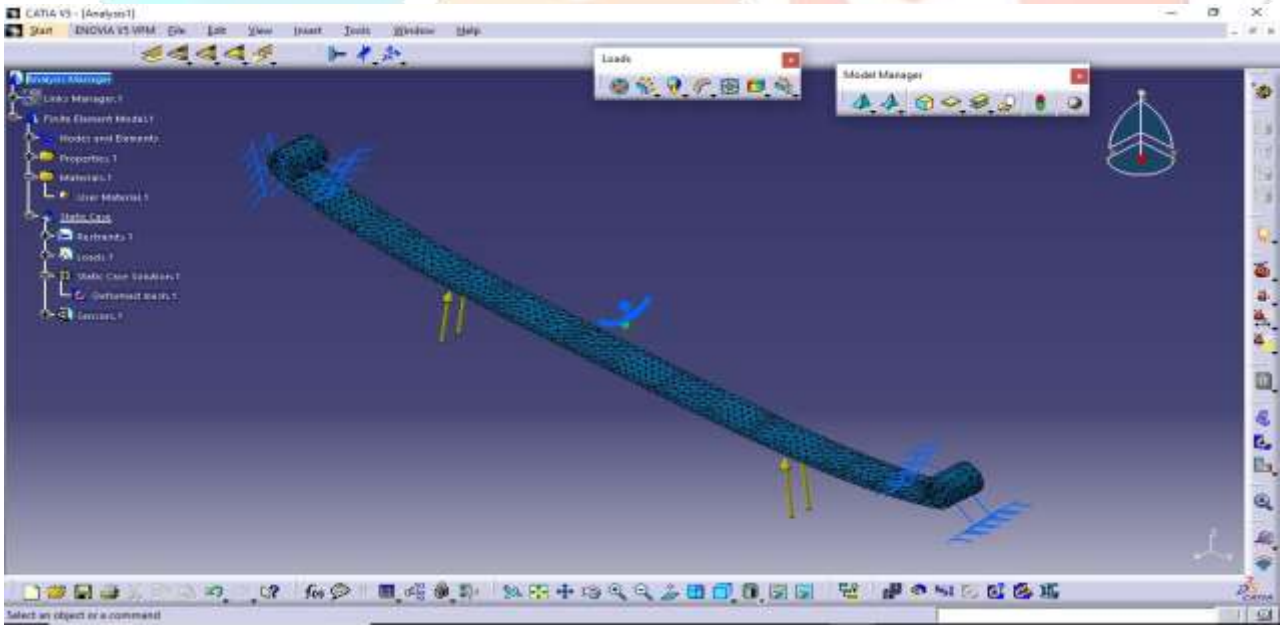


Deformation stress:



COMPARISON OF RESULT BEFORE AND AFTER OPTIMIZATION

Materials Before optimization After optimization

Material	Before optimiziation			After optimization		
	Stress(mpa)	Displacement (mm)	Weight(kg)	Stress(mpa)	Displacement(mm)	Weight(kg)
EN8	237.49	51.62	4.57	332.53	80.52	3.91
EN9	229.83	17.18	3.65	324.93	26.58	3.13
EN19	229.15	17.79	3.63	314.47	27.30	3.11

CONCLUSION:

The design and static structural analysis of steel leaf spring and composite leaf spring has been carried out. Comparison has been made between composite leaf spring with steel having same design and same load carrying capacity. The stress and displacement shave been calculated using analytically as well as using ANSYS for steel leaf spring and composite leaf spring. From the static analysis results it is found that there is a maximum displacement of 175.22 mm in the steel leaf spring and the corresponding displacements in En8, En9 and En19 are 51.62 mm, 17.18 mm and 17.79 mm. From the static analysis results, it also seen that the von- in the steel leaf spring is 739.08 MPa and in En8 ,En9, En19 are 237.49 MPa,229.83 MPa and 229.15 M Pa respectively. All the three composite leaf springs have lower displacements and stresses than that of existing steel leaf spring. A comparative study has been made between steel and composite leaf spring with respect to strength and weight. Composite leaf spring reduces the weight by74.54% for En8 79.66% for EN9 and 79.77% for EN19 over steel leaf spring. The size optimization has been carried further mass reduction of composite leaf spring. By reduction of 1 mm width of composite leaf spring reduce weight of leaf spring by 78.21% for EN8 82.56% for EN9 and 82.67% for EN19 compared to steel leaf spring.

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