ISSN : 2455-9679
Impact Factor : 3.340

IJRTSM
INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"OPTIMAL DESIGN OF A AUTOMOTIVE LEAF SPRING USING ANSYS"

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ABSTRACT

In the leaf spring the friction among the leaves of spring is one of the hassle the friction among the leaves reasons the carrying of the leaves and this ends in a breakdown of leaves. In this the evaluation of composite leaf spring on automobiles and their advantages has been discussed. Efforts had been made to lessen the load of composite leaf spring to that of metal leaf spring. The weight loss of the leaf spring with development of composite spring a totally beneficial substance for convectional metal. Materials have selected based at the value and energy factor. The layout approach is chosen on the idea of layout feasibility and requirement, as it's miles visible that the composite leaf spring is comparative much less weighted & has excessive energy than convectional leaf spring. The literature has indicated a developing hobby withinside the substitute of metal spring with composite leaf spring. The suspension device in a automobile notably impacts the behaviour of automobile, i.e. vibration traits along with experience comfort, balance etc. In this research work the contrast among EN45, E-glass/ epoxy, carbon/epoxy, and Kevlar epoxy.

Key Words: *Leaf spring , friction, composite leaf spring.*

I. INTRODUCTION

Obadiah Elliot was the first person to use leaf spring in horse drawn cart late it was introduced in primary design of automobile. The term weight reduction is crucial in current industry scenario to save money, material and energy. During lifecycle of any vehicle is subjected to masses that cause stresses, vibrations and noise within the totally different parts of its structure. This needs acceptable strength, stiffness and fatigue properties of the parts to be able to stand these masses. Above all, quality of a vehicle, as a system, that embodies economical energy consumption, safety and luxury to the user area unit extremely desired. All the higher than for the most part demand refined and sophisticated style and producing procedures concerned throughout theassembly stage.

This needs sensible understanding of the inner systems of the vehicle and therefore the characteristics of the various body structures in reaction to static and dynamic masses.Parabolic leaf spring and its evaluation the use of finite detail technique (the use of CAE tool) is a place on which distinctive researches were carried out.
Listed under are a number of the literatures surveyed which can be deemed to be giant to this studies this is performed on evaluation of parabolic leaf spring of the automobile. M.M.Shokrieh and D.Rezaei [1]supplied paintings on layout, evaluation and optimization of leaf spring. The purpose of this overview paper changed into metal leaf spring changed into changed with an optimized composite one. Main goal of this paper changed into to gain a spring with minimal weight this is able to wearing given static outside forces with out failure. Here the paintings is finished of a four-leaf metal spring which used withinside the rear suspension device of mild vehicles & heavy obligation vehicles. The four-

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leaf metal spring is analyzed with the aid of using the use of ANSYS V5.four software. The FEM consequences displaying strain and deflection established the present analytical and experimental answers. Using the end result of the metal leaf spring, a composite one crafted from fiberglass with epoxy resin is designed and optimize the use of ANSYS. Main attention is given to the optimizations of the spring geometry. n this look at strain and displacements had been used as layout constraint. The experimental consequences are established with the analytical facts and the finite detail answers for the equal dimensions. Result indicates that stresses withinside the composite leaf spring are lots decrease than that of the metal leaf spring. Compared to the metal leaf spring the optimized composite leaf spring with out eye unit weights almost approximately 80% much less than the metal spring. The herbal frequencies of composite leaf spring are better than that of the metal leaf spring and is a ways sufficient from the street frequency to keep away from the resonance. E. Mahdi a, O.M.S. Alkoles[2]and so forth supplied paintings on mild composite elliptic springs for automobile suspension. They labored on primarily based totally look at marries among the elliptical configuration and woven roving composites. In this paper, the affect of ellipticity ratios on overall performance of woven roving wrapped composites elliptical springs has been investigated each experimentally and numerically. A collection of test changed into carried out for composite elliptical springs with ellipticity ratios (a/b) starting from one to two. Here they had been additionally supplied records in their failure mechanism. Both spring charge (K) and most failure boom with growing wall thickness. In general, this gift research established that composite elliptical spring may be used for mild in addition to heavy vehicles and meet the requirement, collectively with sizable weight saving. The end result confirmed that the ellipticity ratio is extensively inspired the spring charge and failure loads. Composite elliptic spring with ellipticity ratio of a/b 2.zero displayed the very best spring charge. Y. N. V. Santhosh Kumar, M. Vimal Teja[3]and so forth supplied paintings on layout and evaluation of composite leaf spring . They additionally mentioned that the blessings of composite substances like better precise stiffness and power, better power to weight ratio. This paintings offers with substitute of traditional metal leaf spring with a Mono Composites leaf spring the use of E-Glass/Epoxy. For this they decided on layout parameters and evaluation of it. Main goal of this paintings is minimizing weight of the composite leaf springs compared to the metal leaf spring. For this they decided on the composite material changed into E-Glass/Epoxy. The leaf spring changed into designed in ProE and the evaluation changed into achieved the use of ANSYS Metaphysics. From consequences they located that the composite leaf spring weighed most effective 39.four% of the metal leaf springs for the analyzed stresses. So from end result they proved that weight loss received with the aid of using the use of composite leaf springs compared to metal changed into 60.48 %, and it changed into additionally proved that each one the stresses withinside the leaf springs had been nicely in the allowable limits and with right element of safety. It changed into discovered that the perpendicular orientation of fibers withinside the laminate provided right power to the leaf spring. Pankaj Saini, Ashish Goel, Dushyant Kumar[4]and so forth. studied on layout and evaluation of composite leaf spring for mild vehicles. Main goal of this paintings is to evaluate the stresses and weight saving of composite leaf spring with that of metal leaf spring. Here the 3 substances decided on which might be glass fiber bolstered polymer(E-glass/epoxy), carbon epoxy and graphite epoxy used in opposition to traditional metal. The layout parameters had been decided on and analyzed with the metal leaf spring From consequences, they located the substitute of metal with optimally designed composite leaf spring can offer 92% weight loss and additionally the composite leaf spring has decrease stresses as in comparison to metal spring. From the static evaluation end result it's miles discovered that there may be a most displacement of withinside the metal leaf spring. From the end result, a few of the 3 composite leaf springs, most effective graphite/epoxy composite leaf spring has better stresses than the metal leaf spring. From consequences its proved that composite mono leaf spring reduces the load with the aid of using 81.22% for E-Glass/Epoxy, 91.90% for Graphite/Epoxy, and 90.50 % for Carbon/Epoxy over metal leaf spring. Hence it's miles concluded that E-glass/epoxy composite leaf spring may be counseled as changing the metal leaf spring from strain and stiffness factor of view.

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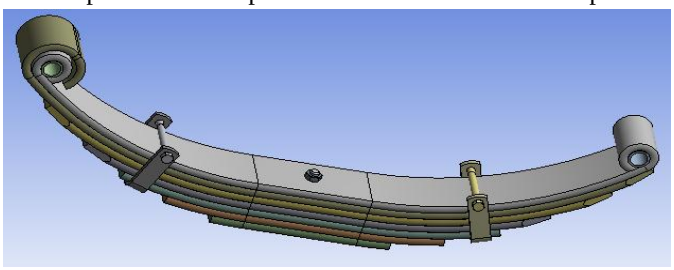
II. DESIGN SPECIFICATIONS

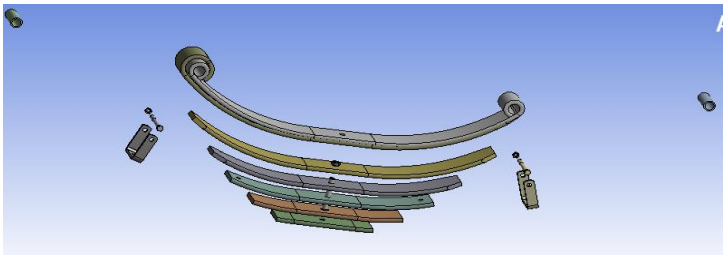
Here Weight and initial measurements of a Tata 1109 HEx2 Heavy commercial vehicle is taken-

III. MODELLING OF PARABOLIC LEAF SPRING

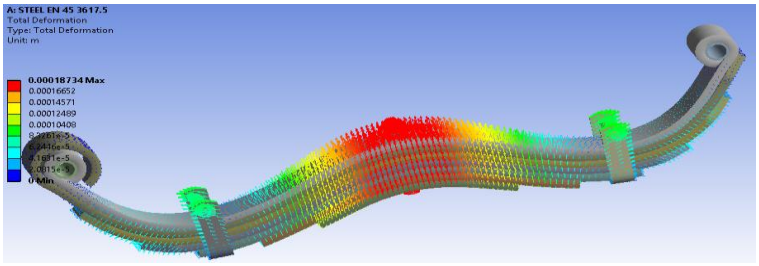
CREO is a feature-based, parametric stable modelling machine with many prolonged layout and production applications. Three dimensional version of parabolic leaf spring are organized through the use of three-D modelling software CREO 3.0 after layout and path of load implemented is offered in contour plot.



(a)



(b)



(C)

Fig-1 (a) CAD model of parabolic Leaf spring (b) Part Modelling of Leaf Spring (c) Vector Contour of Total Deformation

IV. SUMMARY

The modelling of parabolic leaf spring is achieved in CREO software program the usage of traditional modelling features. In order to layout a parabolic leaf spring of prolonged sturdiness it's far critical to behavior the layout procedure of the parabolic leaf spring as it's far given on this chapter, i.e. initially scratch to very last layout in a CAD system. Finally this version of parabolic leaf spring might be applied for mechanical evaluation the usage of FEM.

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Table no-1 Mechanical Properties of steel EN45

Material properties	**Value**
Density	7860 Kg/m^3
Young's modulus	210 GPa
Poisson's ratio	0.3
Shear modulus	7.6903E+10 Pa
Tensile yield strength	1500 Mpa
Tensile ultimate strength	1962 Mpa

V. MATERIAL PROPERTIES

There are 4 parabolic leaf springs on which the analyses are going to perform, one is traditional EN45 parabolic leaf spring and different 3 are composite parabolic leaf spring. The mechanical properties of the traditional metal material getting used on this evaluation are display in Table no-1 and the mechanical properties of composite material which may be taken as in line with ANSYS-16.1 wellknown material library are display in table no- .2, 3, 4.
Table no-2 shows the mechanical properties of composite (Carbon/Epoxy) material, which can be taken as per ANSYS-16.1 Standard material library.

Table no- 2 mechanical properties of carbon/epoxy

Material properties	**Value**
Tensile modulus along X-direction (E_x), Pa	2.09E+11
Tensile modulus along Y-direction (E_y), Pa	9.45E+09
Tensile modulus along Z-direction (E_z), Pa	9.45E+09
Shear modulus along XY-direction (G_{xy}), Pa	5.5E+09
Shear modulus along YZ-direction (G_{yz}), Pa	3.9E+09
Shear modulus along ZX-direction (G_{zx}), Pa	5.5E+09
Poisson ratio along XY-direction (NU_{xy})	0.27
Poisson ratio along YZ-direction (NU_{yz})	0.4
Poisson ratio along ZX-direction (NU_{zx})	0.27
Mass density of the material (ρ), kg/mm^3	1540

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Table no-3 Mechanical Properties of E-Glass/Epoxy

Material properties	Value
Tensile modulus along X-direction (E_x), Pa	4.5E+10
Tensile modulus along Y-direction (E_y), Pa	1E+10
Tensile modulus along Z-direction (E_z), Pa	1E+10
Shear modulus along XY-direction (G_{xy}), Pa	5E+09
Shear modulus along YZ-direction (G_{yz}), Pa	3.8462E+09
Shear modulus along ZX-direction (G_{zx}), Pa	5E+09
Poisson ratio along XY-direction (NU_{xy})	0.3
Poisson ratio along YZ-direction (NU_{yz})	0.4
Poisson ratio along ZX-direction (NU_{zx})	0.3
Mass density of the material (ρ), kg/mm3	2000

Table no-4 shows the mechanical properties of composite (Kevlar/Epoxy) material, which can be taken as per ANSYS-16.1 Standard material library.

Material properties	Value
Tensile modulus along X-direction (E_x), Pa	9.571E+10
Tensile modulus along Y-direction (E_y), Pa	1.045E+10
Tensile modulus along Z-direction (E_z), Pa	1.045E+10
Shear modulus along XY-direction (G_{xy}), Pa	2.508E+10
Shear modulus along YZ-direction (G_{yz}), Pa	2.508E+10
Shear modulus along ZX-direction (G_{zx}), Pa	2.508E+10
Poisson ratio along XY-direction (NU_{xy})	0.34
Poisson ratio along YZ-direction (NU_{yz})	0.37
Poisson ratio along ZX-direction (NU_{zx})	0.34
Mass density of the material (ρ), kg/mm3	1402

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VI. MESH CONVERGENCE TEST

By the use of mesh convergence test factor is examined at the assembly. This is executed so that you can simplify and justify the evaluation end result. In this system the von- misses pressure level is examined on assembly through taking specific size of detail for the duration of meshing. With the help of ANSYS-16.1 software, the respective mesh sizes with corresponding Total deformation are offered below. The load value is equal for every mesh length 15929 N. right here it's far found that during determine five.2 mess aren't so best the variety of node and detail are 37181 and 15655 respectively. So mess refining check are required to test whether or not the very last cost are impartial aren't as a result grid independence check had been achieved to get the very last end result of the parabolic leaf spring.

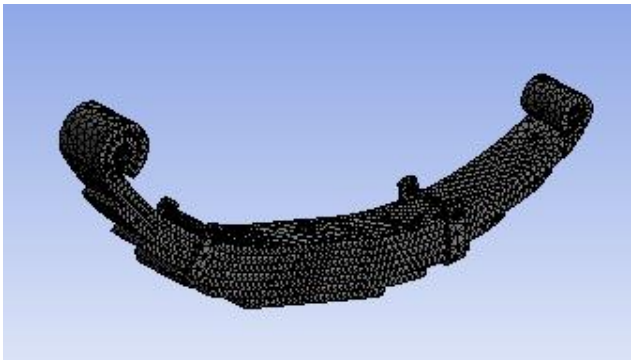
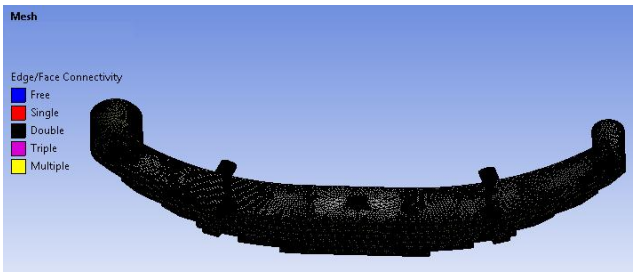


Fig -5.2 mesh element

Tetrahedral factors are used for all of the additives of parabolic leaf spring. Tetrahedral factors higher approximate the form with minimal mistakess in comparison to brick factors. According to the mesh convergence take a look at, the very last Size of the tetrahedral factors for all of the additives of parabolic leaf spring and a complete no. of 607575 nodes and 304886 factors are generated after the meshing which is nearly greater than 15 instances of preliminary generated mesh. Meshed parabolic leaf spring and mesh convergence take a look at or grid independence take a look at of the version is proven in below.



(a) Meshed parabolic leaf spring model

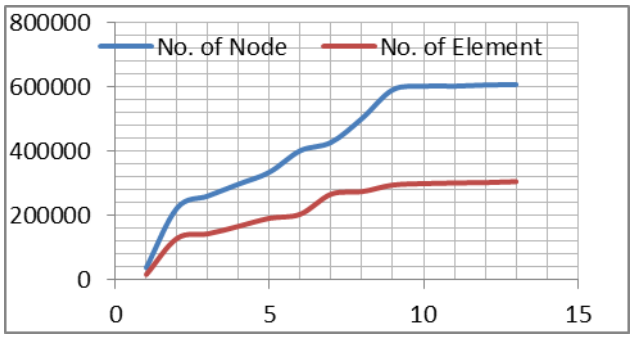


Fig.5.3 (a) Meshed parabolic leaf spring model (b) Grid Independence Test with respect to Total Deformation

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VII. MODELLING OF PARABOLIC LEAF SPRING

In this paper, a parabolic leaf spring is designed and examine for a positive automobile. The parabolic leaf spring is designed for the burden of 11150N. Theoretical calculations had been calculated for parabolic leaf spring dimensions at one-of-a-kind instances like various thickness, camber, span and no. of leaves through mathematical technique. In this thesis, evaluation has been carried out through taking substances Steel EN45, E-glass/epoxy, carbon/epoxy, and Kevlar/epoxy. Static and fatigue evaluation are performed on general meeting of parabolic leaf spring. The outcomes show: The stresses withinside the composite parabolic leaf spring of layout are a whole lot decrease than that of the allowable pressure

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