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Material Optimization of Leaf Spring of Tractor Trolley by FEA

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Abstract: *Leaf Spring (LS) is an indispensable machine element of the automobile sector. In this particular work we are analyzed a LS with the help of Finite Element Method when subjected to static loads and appropriate boundary conditions. The LS taken into consideration is that of a Tractor Trolley having a Gross Vehicle Weight of 20 ton. According to the existing dimension of simple leaf spring it has modeled in solid works 2013.after that cad model has used to discretized in to small no of element and nodes to perform the required finite element analysis. Initially analysis has done for three different materials and taken the most economic and suitable material for leaf spring in the optimization stages. Comparision of material was perform on the basis of result obtained from the analysis of leaf spring like von mises stress, strain and deflection.*

Keywords: *leaf spring (LS), Finite Element Analysis (FEA), Camber, Leaf Span, Static loading, Computer Aided Engineering (CAE)*

I. Introduction

Leaf sprigs are crucial suspension elements used on light passenger vehicle, mini loader and truck necessary to minimize the vertical vibrations impacts and bumps due to road irregularities and to create a comfortable ride. Leaf springs are widely used for automobile and rail road suspensions. The leaf spring should absorb the vertical vibrations and impacts due to road irregularities by means of variations in the spring deflection so that the potential energy is stored in spring as strain energy and then released slowly so increasing the energy storage capabilities of a leaf spring and ensures a more compliant suspension system. Three dimensional finite element analysis of the leaf spring consists of a computer model or design that is stressed and analyzed for specific results.

The leaf spring is analyzed for static strength and deflection using 3D finite element analysis. The general purpose finite element analysis software ANSYS is used for present study. The variation of bending stress and displacement values are predicted. With the Indian market becoming global and advent of multinationals in the market, a cut throat competition has a rise between the Indian companies and the Multinational company .thus to remain in the contest it has become necessary for the Indian industries to improve and innovate their product.

II. Material

The existing material of tractor trolley leaf spring is 50Cr1V23 and we had applied three different materials for analysis of leaf spring like 55Si2Mn90, 38Si6 and 50Cr1. The material used for the experimental work is 55Si2Mn90.

Tab.1 Parameters of the steel leaf spring

Material options	**Material**	**Input Properties**	
	Spring Steel	Tensile Yield Strength (MPa)	Ultimate Tensile Strength (M6Pa)
Existing	50Cr1V23	1800	2050
Option 1	50Cr1	1650	1950
Option 2	38Si6	1050	1300
Option 3	55Si2Mn90	1800	1950

III. Three Dimensional Solid Model

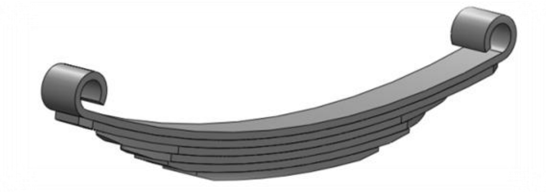


Fig. 1: Three Dimensional CAD Model

IV. Finite Element Analysis

Analysis of leaf spring is done by Finite Element Method in software ANSYS Workbench. Finite element method (FEM) is a numerical method for solving a differential or integral equation. It has been applied to a number of physical problems, where the governing differential equations are available. The method essentially consists of assuming the piecewise continuous function for the solution and obtaining the parameters of the functions in a manner that reduces the error in the solution. In this article, a brief introduction to finite element method is provided. The method is illustrated with the help of the plane stress and plane strain formulation

The first phase for applying the method of Finite Elements is Meshing or Discretization. Meshing is basically the process of breaking the CAD model into very small elements. It is also known as piecewise approximation. Meshing are of different types, it may be comprising of 1D, 2D or 3D elements. In present case selected is shown in Table-2

Mesh			Element type	
S.N.	Entity	Size		
1	Nodes	9201	Connectivity	Statistics
2	Elements	4185	TE10	4185 (100%)

V. Results from FEA

The following result we obtained by applying FEA on the leaf spring assembly.

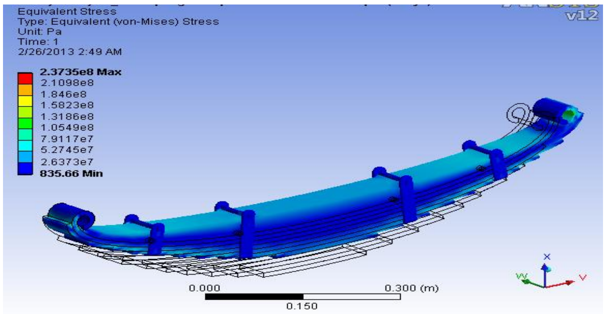


Fig. 2 Stress Analysis (Material-50Cr1V23)

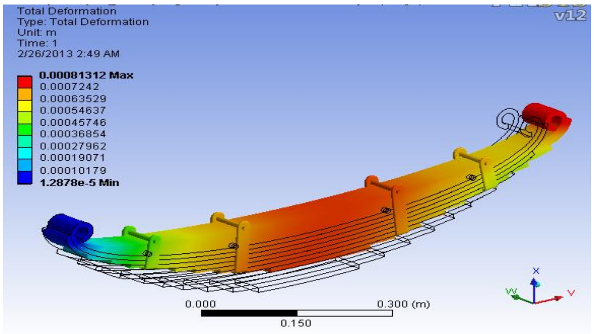


Fig 3 Deflection Analysis (Material-50Cr1V23)

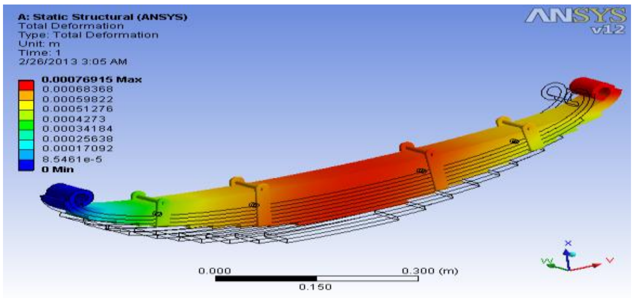


Fig 4 Deflection Analysis (Material-38Si6)

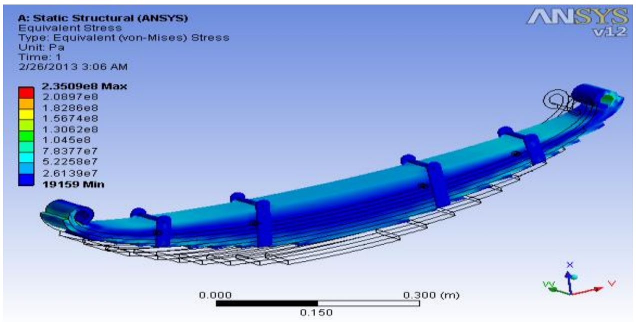


Fig 5 Stress Analysis (Material-38Si6)

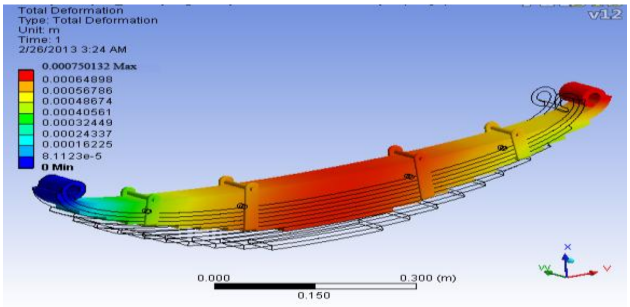


Fig 6 Deflection Analysis (Material-50Cr1)

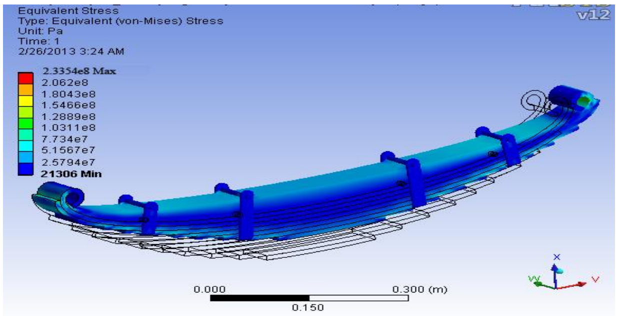


Fig 7 Stress Analysis (Material-50Cr1)

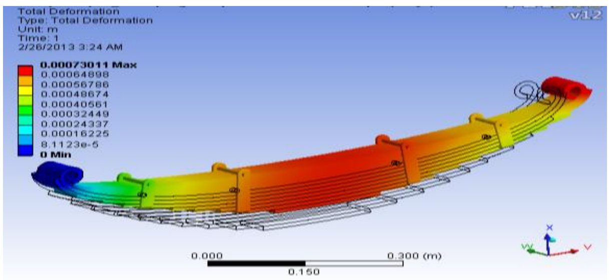


Fig 8 Deflection Analysis (Material-55Si2Mn90)

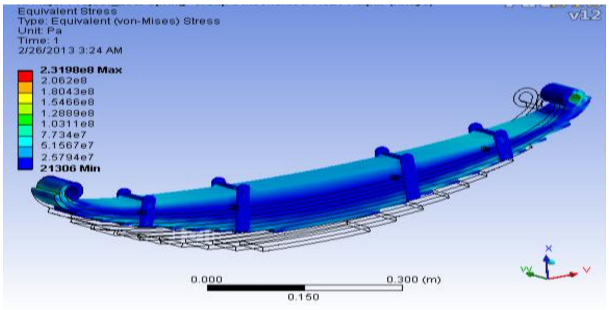


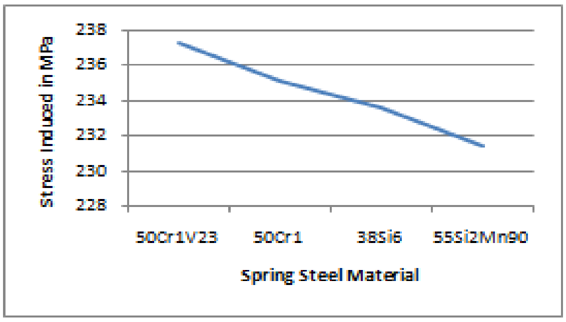
Fig 9 Stress Analysis (Material-55Si2Mn90)

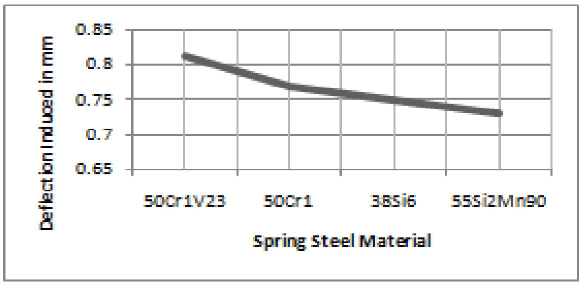
After the analysis of leaf spring gives the above result for different materials.

Materiel options	Material	Input Properties		Analysis Result	
	Spring Steel	TYS (MPa)	UTS (MPa)	Stress (MPa)	Deflection mm
Existing	50Cr1V23	1800	2050	237.30	0.81312
option 1	50Cr1	1650	1950	235.09	0.76915
option 2	38Si6	1050	1300	233.54	0.75010
option 3	55Si2Mn90	1800	1950	231.38	0.73011

VI. Conclusion

As per the result obtained from Finite Element Analysis in ANSYS we found that leaf spring provides good performance when it is made up of Spring Steel 55Si2Mn90 the results are-





In this work the main focus was to create a method wherein the load carrying capacity of leaf spring can be computed, and in this context FEA turned out to be very effective. The work elucidated is completely devoted to the conglomeration of Mechanical Engineering Design & Computer Aided Engineering.

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