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FEA ANALYSIS OF MASTER LEAF SPRING

ZOMAN DIGAMBAR B, JADHAV MAHESH V, R R KHARDE & Y R KHARDE

Pravara Rural Engineering College, Loni, India

ABSTRACT

Leaf springs are one of the oldest suspension components they are still frequently used, especially in commercial vehicles. The past literature survey shows that leaf springs are designed as generalized force elements where the position, velocity and orientation of the axle mounting gives the reaction forces in the chassis attachment Positions. Modeling is done using CATIA V5R17 and Analysis is carried out by using ANSYS 14.0 software for better understanding. This paper describes static analysis of two conventional steel leaf springs made of SUP 10 & EN 45. Analytical calculated results are compared with FEA result. These springs are comparing for maximum stress, deflection and stiffness. SUP 10 springs has lower value of maximum stress, deflection and stiffness in compare to 55 Si 2 Mn 90 spring. Although, market price is much lower than Sup 10 spring.

KEYWORDS: Ansys 14.0, CATIA V5R17, Steel Leaf Spring, SUP 10

INTRODUCTION

Increasing competition and innovations in automobile sector tends to modify the existing products by new and advanced material products. A suspension system of vehicle is also an area where these innovations are carried out regularly. More efforts are taken in order to increase the comfort of user. Appropriate balance of comfort riding qualities and economy in manufacturing of leaf spring becomes an obvious necessity. To improve the suspension system many modification have taken place over the time. Inventions of parabolic leaf spring, use of SUP 10 materials for these springs are some of these latest modifications in suspension systems. This paper is mainly focused on the implementation of SUP 10 materials by replacing steel in conventional leaf springs of a suspension system. Therefore analysis of SUP 10 material leaf springs has become essential in showing the comparative results with conventional leaf springs. In order to conserve natural resources and economic, energy, strength has been the main focus of automobile manufactures. In the present scenario Strength can be achieved primarily by the introduction on better material. Design specialization and better manufacturing process.[1]

Leaf spring should absorb vertical vibration and impacts due to load irregularities by means of variation in the spring deflection show that potential energy is stored in spring as strain energy and then release slowly so, increasing energy stored capability of a leaf spring insure a more complaint suspension system.[2]

The large vehicle needs a good suspension system that can be delivered a good ride and handling. At the same time that component need to be light weight and had an excellent of fatigue life.[3, 4]

Most of researches focused on improving fatigue resistance by shoot penning process, making the nucleation and propagation of fatigue cracks difficult. Few publication, which are listed in references attempted predictions of fatigue life from stress approach model.[5] The fatigue durability testing of the mechanical structure is performed extensively in all industries as one of the part in design process. In the real application, the fatigue loading services such as stresses on a car wheel, bending moment on stub axle of a car, stresses on rear axle passenger car etc. [6]

MATERIALS

The materials SUP 10 steel behavior characteristics related to spring performance are first determined. The effect of component processing on these characteristics is then documented followed by a demonstration of the application of these concepts to component fatigue life. Of particulars concern in fatigue problems is the tendency for material properties to change as a result of cyclic deformation. These circumstances require the determinations cyclic stress –strain relation for fatigue analysis.[7] Many industries are manufactured steel leaf spring by 55 Si 2 Mn 90 material; these materials are widely used for production of parabolic leaf spring and conventional multi leaf spring. Leaf spring absorbed the vertical vibrations, shocks and bumps loads (induced due to road irregularities) by means of spring deflection, so that the potential energy stored in the leaf spring and then relieved slowly[8]. Ability to store and absorb more amount of strain energy insures the comfortable suspension system.

Table 1: The Material Properties of SUP 10 Steel Properties

1	Ultimate Tensile Strength Sut (Mpa)	1158
2	Yield tensile strength Syt (Mpa)	1034
3	Modulus of elasticity E (Gpa)	190

Table 2: The Material Properties of 55 Si 2 Mn 90 Steel Properties

1	Ultimate tensile strength Su (Mpa)	1962
2	Yield tensile strength Su (Mpa)	1470
3	Modulus of elasticity E (Gpa)	210

CHEMICAL COMPOSITION (11)

Table 3: Composition of SUP 10 Materials

Mtl	C	Si	Mn	S&P	Cr	V
%	0.47/ 0.55	0.15/ 0.35	0.65/ 0.95	0.03	0.8/ 1.1	0.15/ 0.25

Table 4: Composition of 55 Si 2 Mn 90 Materials

Mtl.	C	Si	Mn
%	0.55	0.20	0.90

DESIGN PARAMETER OF STEEL LEAF SPRING

Parameters of the Steel leaf Spring used in this Work is Given Below:- Material selected –Steel= 55SiMn90, Tensile strength=1962 N/mm2, Yield strength = 1470 N/mm2, Young's modulus *E*=2.1-1.05 N/mm2, Design Stress=653 N/mm2, Total length= 1010mm, The arc length between the axle seat and the front eye = 120mm, Spring rate= 31.98 N/mm, Normal static loading = 2943 N, Available space for spring width = 45mm, Spring weight = 13.6 Kg.

Let,

δ max =120 mm, σ max =2000 N/mm2, Factor of safety =2.5,Weight (W) = 2943 N, Length L=505 mm,

E= 11.9 GPa , K req. =25 N/mm

$$I = \left(\frac{bt^3}{12}\right)$$

Lets find the safe value of b, t that would satisfy three condition as $\sigma a \geq \sigma$, δ max $\geq \delta$, $K \geq K$ req.

Let, b = 45 mm , t = 20 mm

Step-1

$$\sigma_a = \left(\frac{\sigma_{max}}{\text{factor of safety}}\right)$$

σa= 800 N/mm^2

Step-2

$$\sigma = \left(\frac{6WL}{bt^2}\right)$$

σ = 495.405 N/mm^2

$\sigma a \geq \sigma$. **Thus, value for b, t satisfied 1st condition**.

Step- 3

$$I = \left(\frac{bt^3}{12}\right)$$

I = 30000 mm^4

$$\delta = \left(\frac{WL^3}{3EI}\right)$$

= 20.05mm

Thus, value for b, t fails it does not satisfied 2nd condition.

Finally It was found that b = 45mm, t = 30mm and L = 505 mm, were safe value for composite leaf springthat would satis fy all three condition. So, we took these dimensions for fabricating composite leaf spring.

Two leaf steel spring use in this work includes : total length (eye to eye), 1010 mm; arc height of axle seat (camber) 125mm; width of leaves 45 mm (SUP10 material) & 45 mm (55 Si 2 Mn 90 material); thickness of leaves 30 mm, full bump loading 2943 N even though the leaf spring is simply supported at the end.

The Procedure for a Static Analysis Consists of These Tasks

1. Build the Model

2. Define Parameters

The parameters for building the composite leaf spring are as follows-

Young's modulus is 11.9 GPa (EXX) value is 11900 MPa, Poison ratio is 0.217 XY (PRXY) value is 0.217

Length of cantilever beam =505mm, Width of cantilever beam.= 45mm, Height of cantilever beam. = 30mm

3. Stacking Sequence of Layers

The stacking sequence of layer are shown fig having unidirectional fibre with stacking angle of zero.

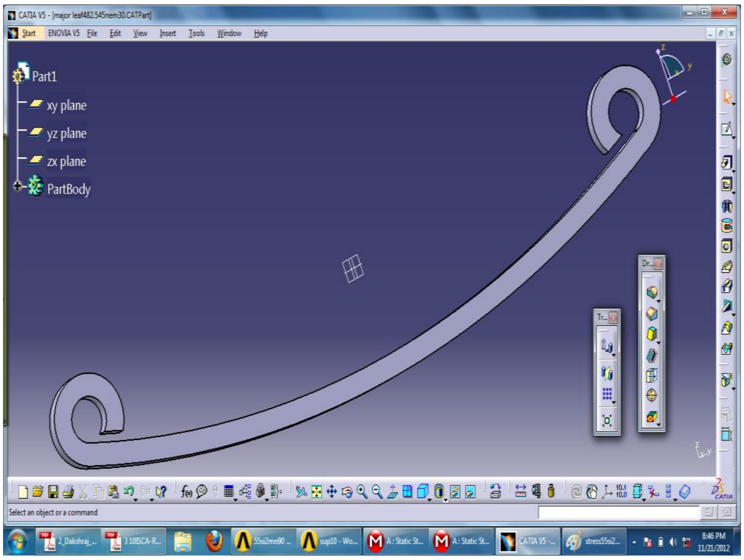

Figure 1: Design in CATIA

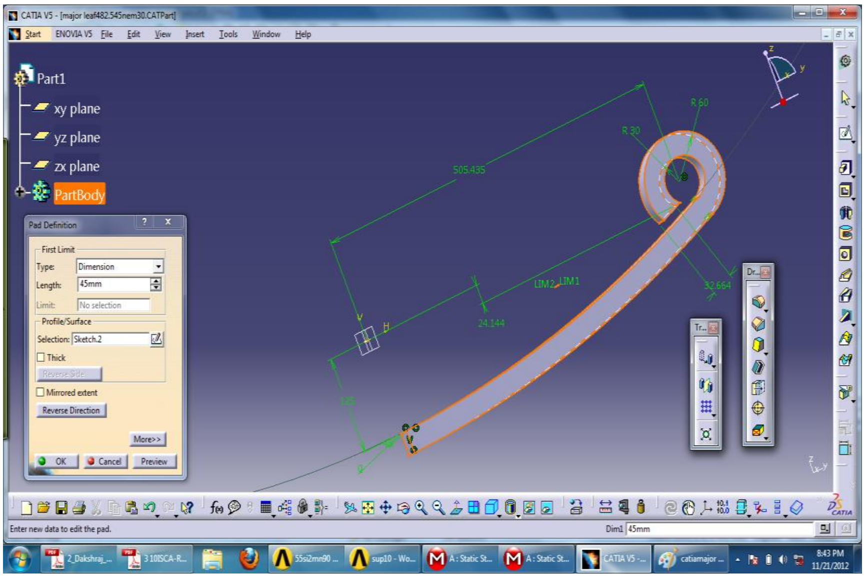

Figure 2: Design in CATIA for Analysis

BOUNDARY CONDITION

Model of parabolic spring was partition into small region for easier mashing process method is used patch conforming method the boundary condition was set according to rear static load which is the front eye was allowing on a rotational at y axis and rear eye was constrained in y and z translation and x and z rotations alloying free x translation and y rotation. Contact from main to helper leaf also been defined helper leaf was constant 2nd degree of freedom to represent the clip that holds that to spring together. Finally vertical load was applied at the center of the leaf spring.

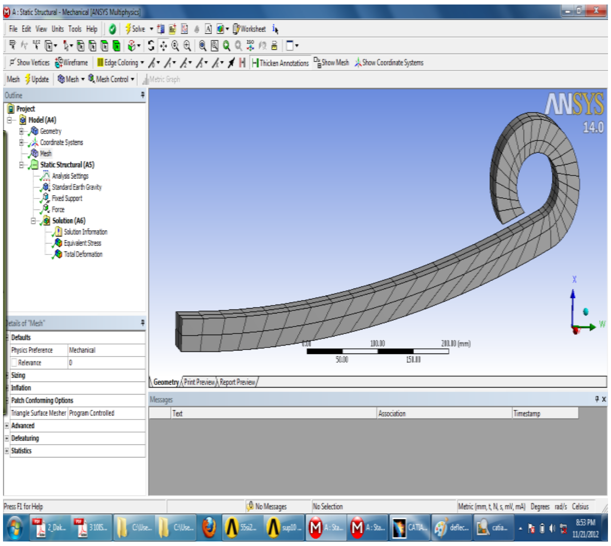

Figure 3: Meshing of Model

ANALYSIS USING ANSYS 14.0

The model of leaf spring now imported into ANSYS 14 the boundary conditions and material properties are specified as for the standards used in the practical application. The material used for the leaf spring for analysis is structure steel, which have approximately similar isotropic behavior and properties as compared to SUP 10 and 55 Si 2 Mn 90.

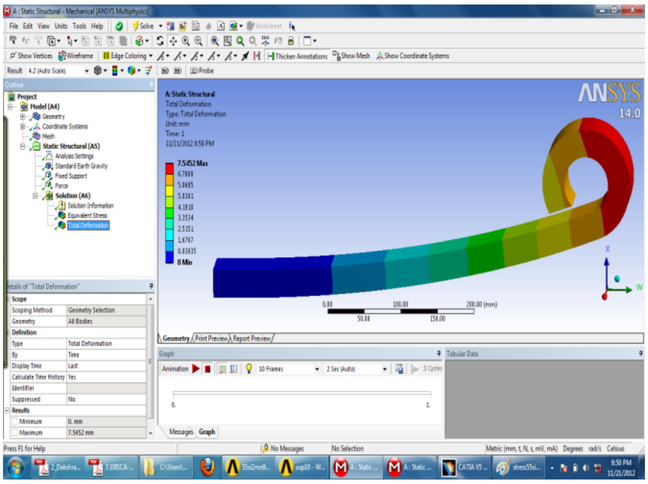

Figure 4: Deflection Analysis of 55Si2Mn90 Leaf Spring at 300kg

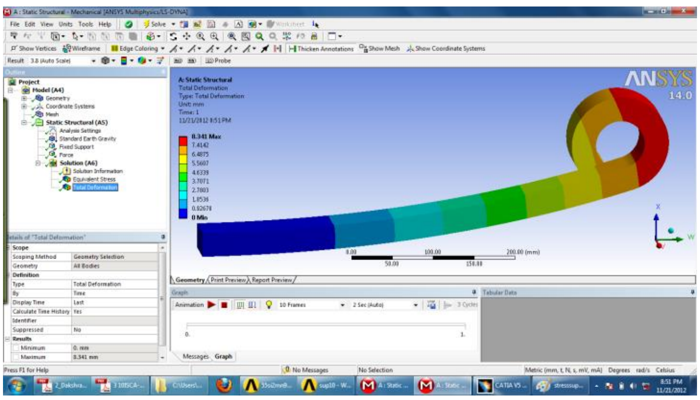

Figure 5: Deflection Analysis of SUP 10 Leaf Spring at 300 Kg

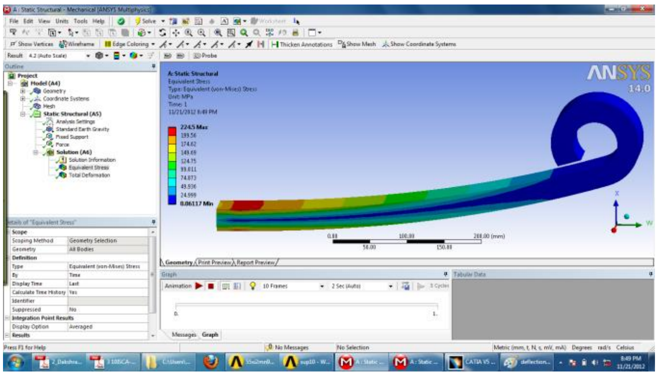

Figure 6: Von Mises Stress Analysis of 55Si2Mn90 Leaf Spring

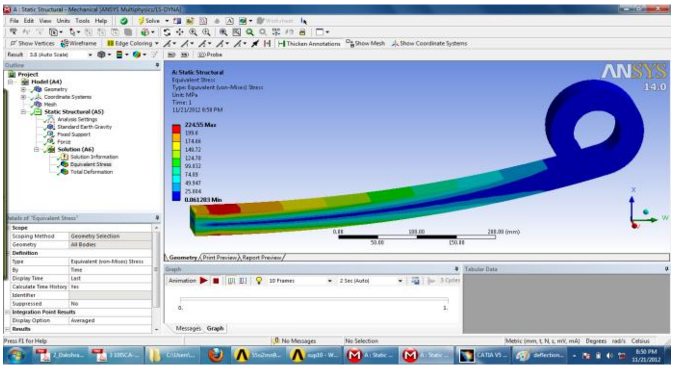

Figure 7: Von Mises Stress Analysis of SUP 10 Leaf Spring Stress Analysis of Steel Leaf Spring using Analytical & FEA

	ANLYTICAL		FEA	
Parameters	**55Si2Mn90**	**SUP 10**	**55Si2Mn90**	**SUP 10**
Load (N)	2943	2943	2943	2943
Maximum stress(MPa)	220.37	220.37	224.5	224.5
Maximum deflection, (mm)	5.9573	6.585	7.5452	8.341
Maximum stiffness (N/mm)	494.015	446.924	390	352.83

CONCLUSIONS

These work involves and comparison of conventional SUP10 and 55 Si 2 Mn 90 material leaf spring under static loading conditions the model is preferred of in CATIA and then analysis is perform through ANSYS 14.0 from the result obtained it will be concluded that stresses developed due to SUP 10 material is less as compared to 55Si2Mn90.

FUTURE SCOPE

1. Experimental work.
2. Harmonic analysis with finding and compression of first five natural frequencies.
3. Variable amplitude load.
4. Calculate thickness and width by Computer Algorithm

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REFERENCES

1. Gulur Siddaramanna Shiva Shankar, Sambagam Vijayarangan "Mono Composite leaf spring for Light Weight Vehicle –Design, End Joint Analysis and Testing" Journal-ISSN 1392-1320 MATERIAL SCIENCE(MEDZIAGOTYRA) Vol12. NO 3 2006
2. M Senthil Kumar And Vijayarangan "Static analysis and fatigue life prediction of steel and composite leaf spring for light passenger vehicles" Journal of scientific and Industries Research vol 66,February 2007,pp 128-134
3. F.N.Ahmad Refngah,S.Abdullah,and A Jalar ,L.B.,Chua "Life Assessment of a parabolic Spring Under Cyclic Strain Loading" European Journal of Scientific Research ISSN 1450-216X Vol.28 No.3 (2009), pp.351-363
4. M Senthil Kumar ,S Vijayarangan " Analytical and Experimental Studies on Fatigue Life Prediction of Steel and Composite Multi-leaf Spring for Light Passenger Vehicles Using Life Data Analysis" Journal- ISSN 1392-1320 MATERIALS SCIENCE (MEDZIAGOTYRA) Vol.13, No. 2.2007
5. M.L Aggarwal V.P.Agrawal, R.A.Khan " A stress approach model for predictions of fatigue life by shot penning of 55 Si 2 Mn 90A spring steel" International Journal of Fatigue 28 (2006) 1845–1853
6. S.Abdullah,C.K.E.Niz Wan and M.Z.Nuaw " A Study of Fatigue Data Editing using the Short-Time Fourier Transform(STFT)" Journal-American Journal of applied Sciences 6(4):565-575,2009 ISSN 1546-9239
7. R. W. Landgraf and R. C. Francis, "Material and Processing Effects on Fatigue Performance of Leaf Springs". Congress and Exposition Cobo Hall, Detroit February 26-March 2, 1979
8. ANSYS 14.0 Help