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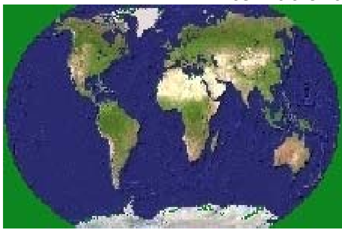

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Design and analysis on composite multileaf spring in heavy commercial vehicle

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Abstract
A leaf spring is a simple form of spring, commonly used for the suspension in wheeled vehicles. Leaf Springs are long and narrow plates attached to the frame of a trailer that rest above or below the trailer's axle. There are monoleaf springs, or single-leaf springs, that consist of simply one plate of spring steel. These are usually thick in the middle and taper out toward the end, and they don't typically offer too much strength and suspension for towed vehicles. Drivers looking to tow heavier loads typically use multileaf springs, which consist of several leaf springs of varying length stacked on top of each other. The shorter the leaf spring, the closer to the bottom it will be, giving it the same semielliptical shape a single leaf spring gets from being thicker in the middle.
The objective of this paper is to compare the load carrying capacity, stiffness and weight savings of composite leaf spring with that of steel leaf spring. The design constraints are stresses and deflections. The dimensions of an existing conventional steel leaf spring of a Heavy commercial vehicle are taken Same dimensions of conventional leaf spring are used to fabricate a composite multi leaf spring using E-GLASS/EPOXY, C- GLASS/EPOXY, S- GLASS/EPOXY unidirectional laminates. Pro/Engineer software is used for modeling and COSMOS is used for analysis. Static & Dynamic analysis of Leaf spring is performed using COSMOS.

Keywords: Design; Analysis; Composite Multileaf Spring; Heavy Commercial Vehicle.

1. Introduction
Multi-leaf springs are wisdely used for automobile and rail road suspensions. It consists of a series of flat plates, usually of semi- elliptical shape as shown in fig. 4.20. The leaves are held together by means of two U-bolts and a centre clip. Rebound clips are provided to keep the leaves in alignment and prevent lateral shifting of the plates during the operation. The longest leaf, called the master leaf, is bent at both ends to form the spring eye. At the center, the spring is fixed to the axle of the car. Multi- leaf springs are provided with one or two extra full length leaves in addition to the master leaf. These extra full-length leaves are stacked between the master leaf and the graduated-length leaves. The extra full-length are provided to support the transverse shear force.
For the purpose of analysis, the leaves are divided into two groups namely master leaf along with graduated-length leaves forming one group and extra full-length leaves forming the other. The following notations are used in the analysis:
n_f = number of extra full-length leaves
n_g =number of graduated-length leaves including master leaf
n= total number of leaves
b= width of each leaf (mm)
t= thickness of each leaf (mm)
L=length of the simply supported or half the length of semi- elliptic spring (mm)
F= force applied at the end of the spring (N)
F_f=portion of F taken by the extra full-length leaves (N)
F_g=portion of F taken by the graduated-length leaves (N)

2. Design of Leaf Spring
Model:- Ashok Leyland Viking
Number of leaf springs =4
Overall length of the spring=$2L_1$=137.2cm=1372mm
L_1=68.6cm=686mm
Width of leaves=76.2

Number of full length of leaves=2=N_f
Number of graduated leaves=12=Ng
Number of springs=14=Ng+ N_f
Center load=2W=15 tons=15000kg
2W=15000x9.8=147000
W=18375

3. Modeling of Leaf Spring

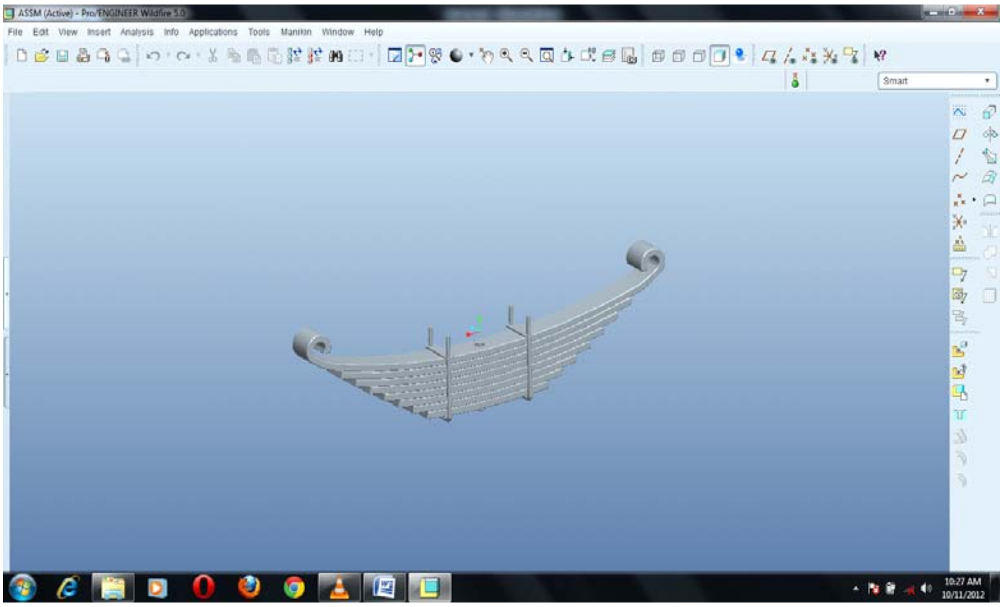

Fig 1: Model for 8-Leafs

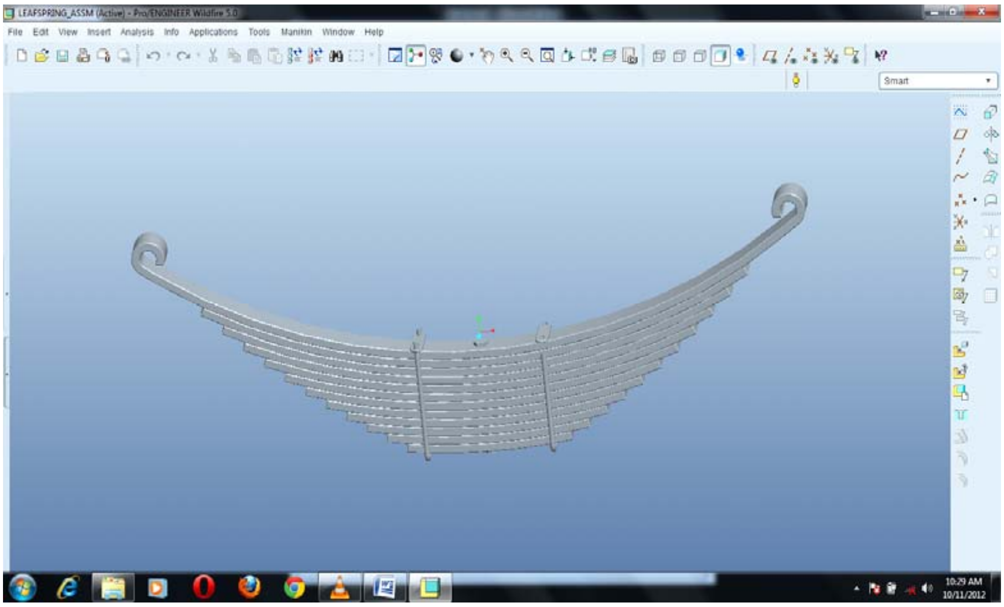

Fig 2: Model for 12-Leafs

4. Static Analysis for 8-Leafs
4.1 e-glass epoxy
Material properties:

Name : e-glass epoxy
Yield strength : 5e+008N/m^2
Tensile strength : 5.21e+008 N/m^2
Elastic modulus : 7.24e+010 N/m^2
Poisson’s ratio : 0.2
Density : 2600kg/m^3
Shear modulus : 3e+010N/m^2

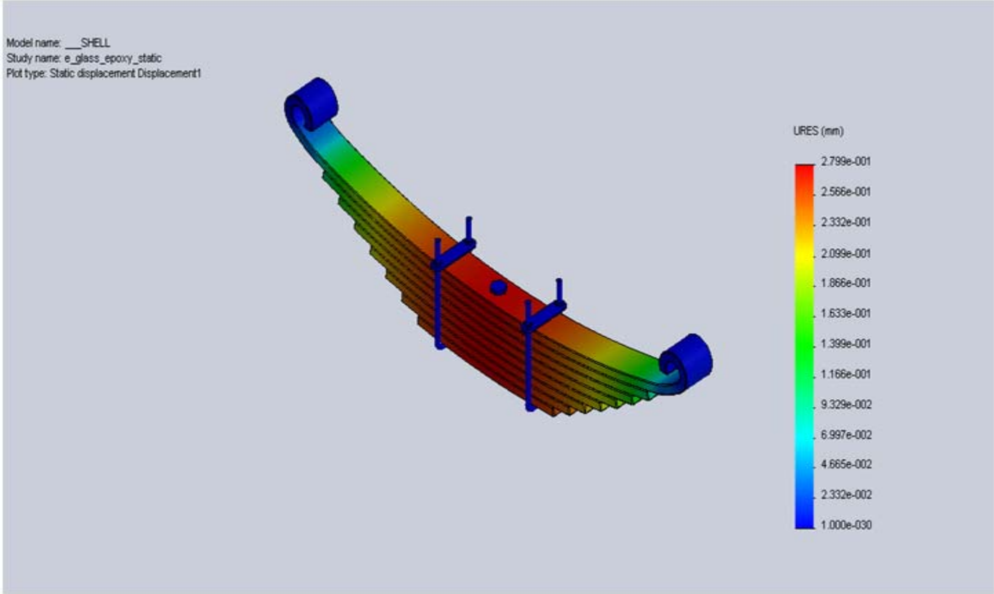

Fig 3: Displacement values due to loads acting for e-glass epoxy 8 –leafs Maximum displacement=0.002799.

4.2 Mild steel

Material Properties:

Name : Mild steel
Yield strength : 5.5e+008N/m^2
Tensile strength : 3e+007 N/m^2
Elastic modulus : 2.6e+011 N/m^2
Poisson's ratio : 0.266
Density : 7860kg/m^3
Shear modulus : 30189e+008N/m^2

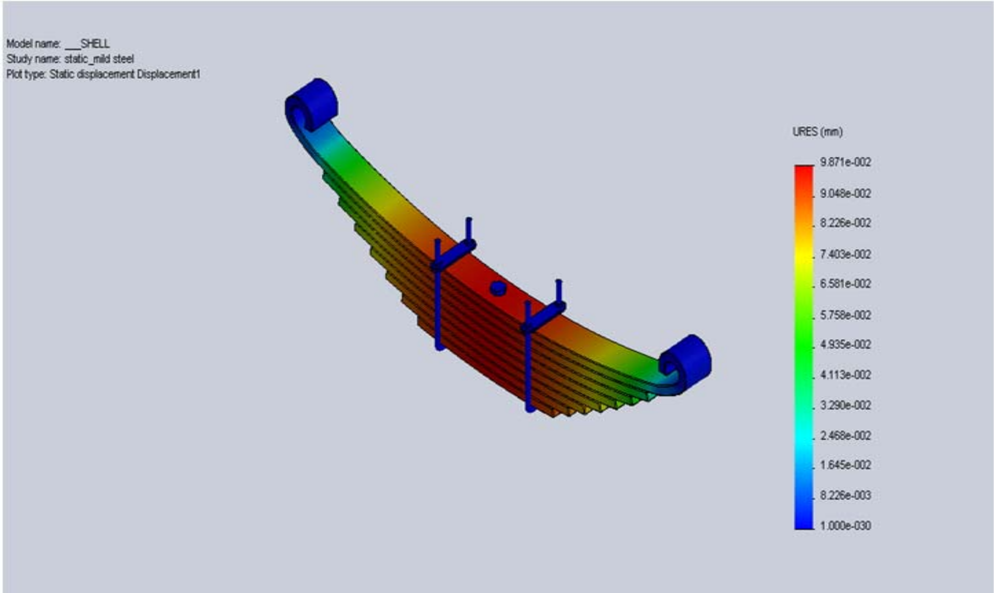

Fig 4: Displacement values due to loads acting for mild steel 8 –leafs Max displacement=0.0987089mm

5. Frequency Analysis for 8-Leafs

5.1 E-glass epoxy

Mode 1:

Name	Type	Min	Max
Displacement1	Mode1 (value=0.00272721Hz)	6.75871mm Node:38122	4522.02mm Node:39483

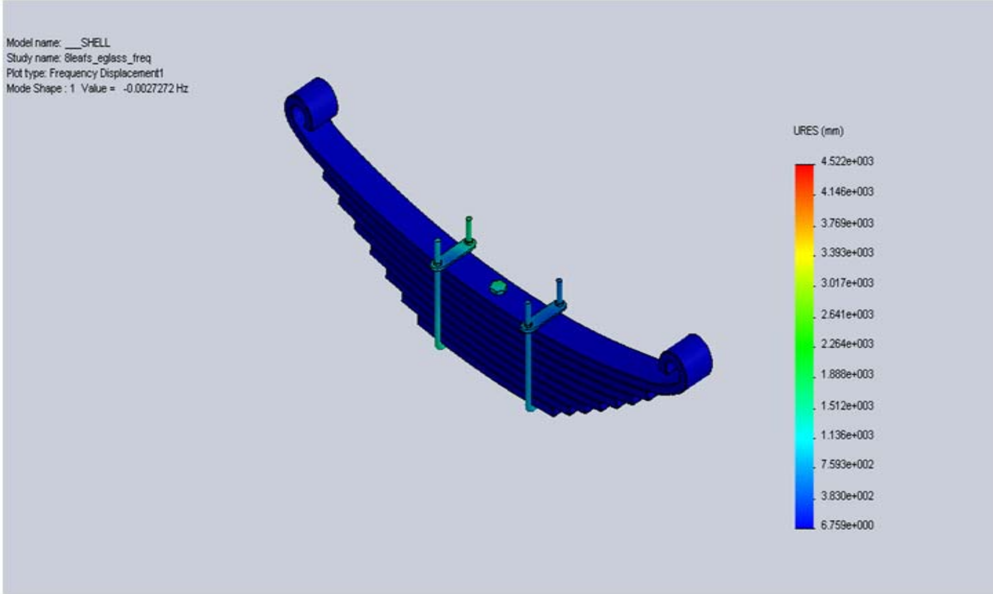

Fig 5: The image shown above is for Mode1.

5.2 Mild steel

Mode 1:

Name	Type	Min	Max
Displacement1	Mode1(value=0.00188569Hz)	7.74981mm Node: 18293	2329.78mm Node:39484

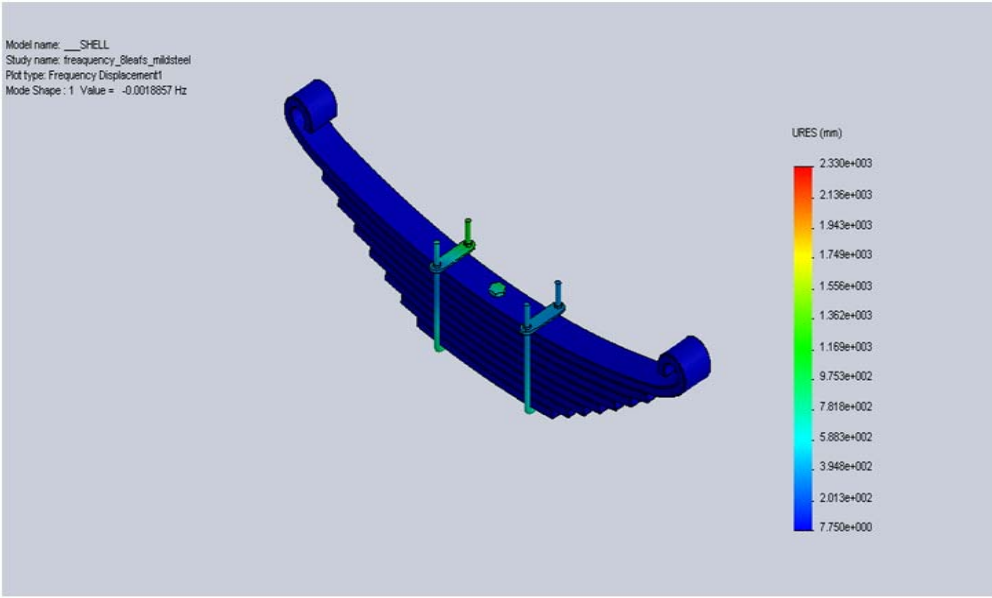

Fig 6: The image shown above is for Mode1.

6. Static Analysis for 12 Leafs
6.1 Mild steel

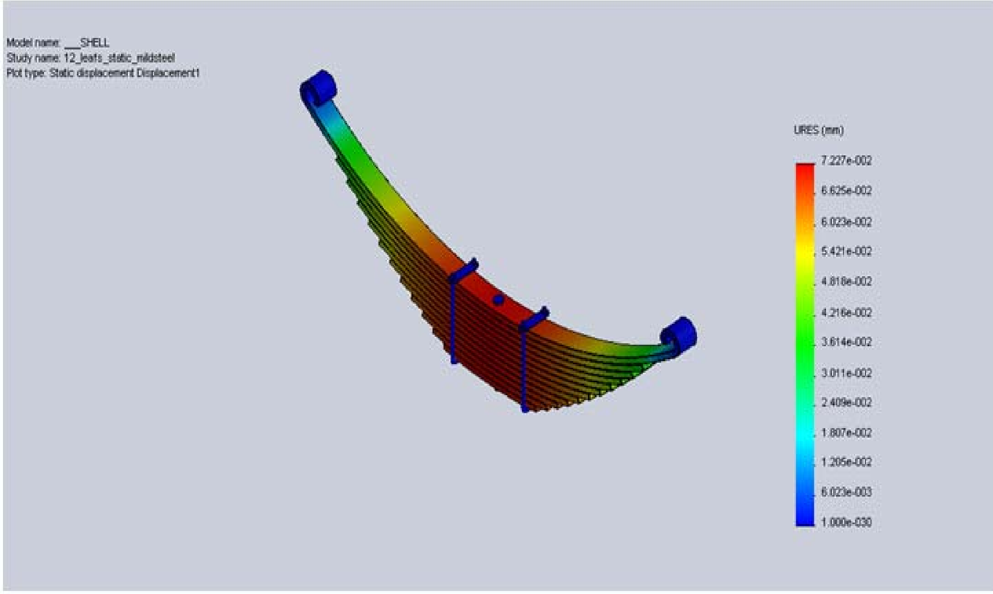

Fig 7: Displacement values due to loads for mild steel 12 –leafs Maximum displacement=0.0722712mm

6 .2 S-glass epoxy

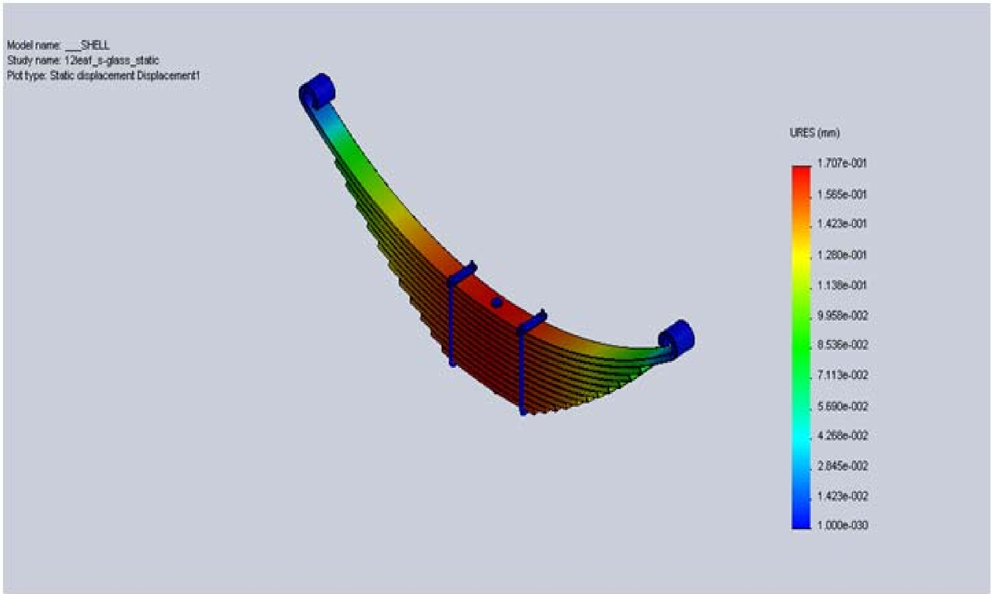

Fig 8: Displacement values due to loads for S-glass epoxy 12 –leafs Maximum displacement=0.17079mm

7. Frequency Analysis for 12 Leafs
7.1 Mild Steel

Mode1:

Name	Type	Min	Max
Displacement1	Mode1 (value=0.00729227Hz)	1.21322mm Node: 29792	1504.91mm Node:49664

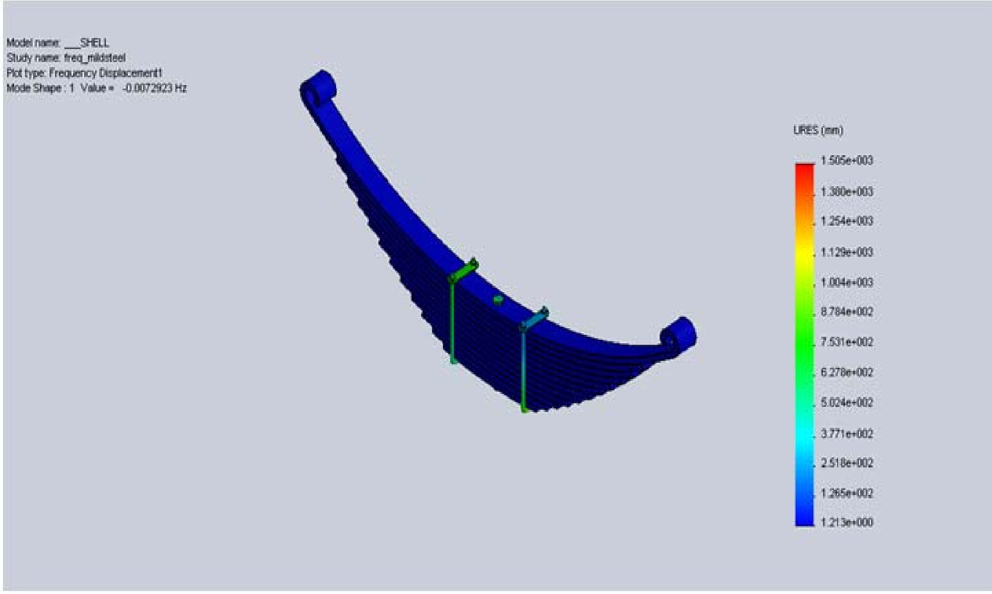

Fig 9: The image above shown is for mode1.

7.2 S-Glass Epoxy

Mode 1:

Name	Type	Min	Max
Displacement1	Mode1(value=0.00646057Hz)	3.3115mm Node: 45265	2800.27mm Node:48920

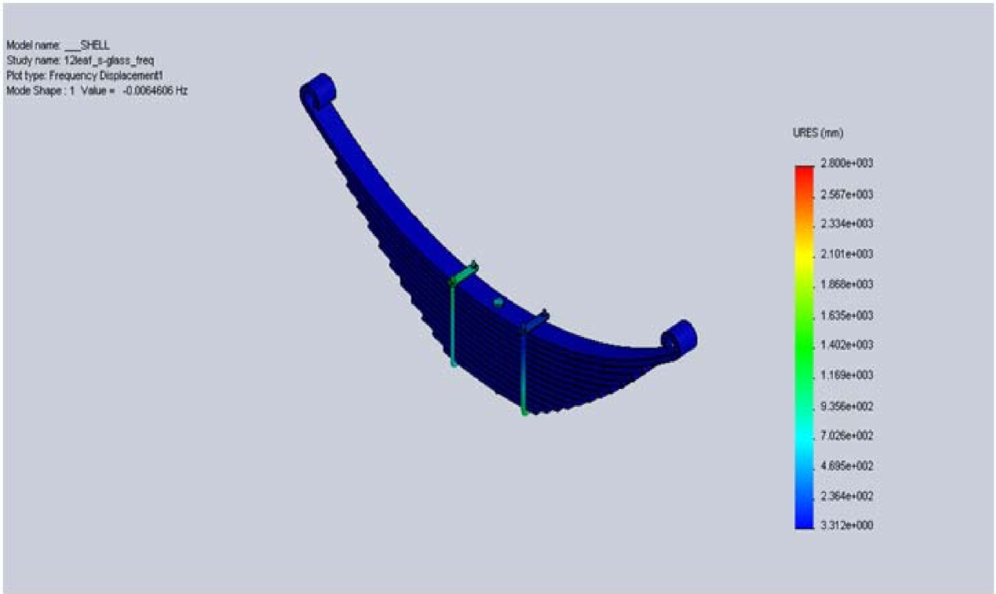

Fig 10: The above image shown is for mode1

7.3 E-Glass Epoxy

Mode 1:

Name	Type	Min	Max
Displacement1	Mode1(value=0.00451868Hz)	5.49202mm Node: 5740	4369.22mm Node:49590

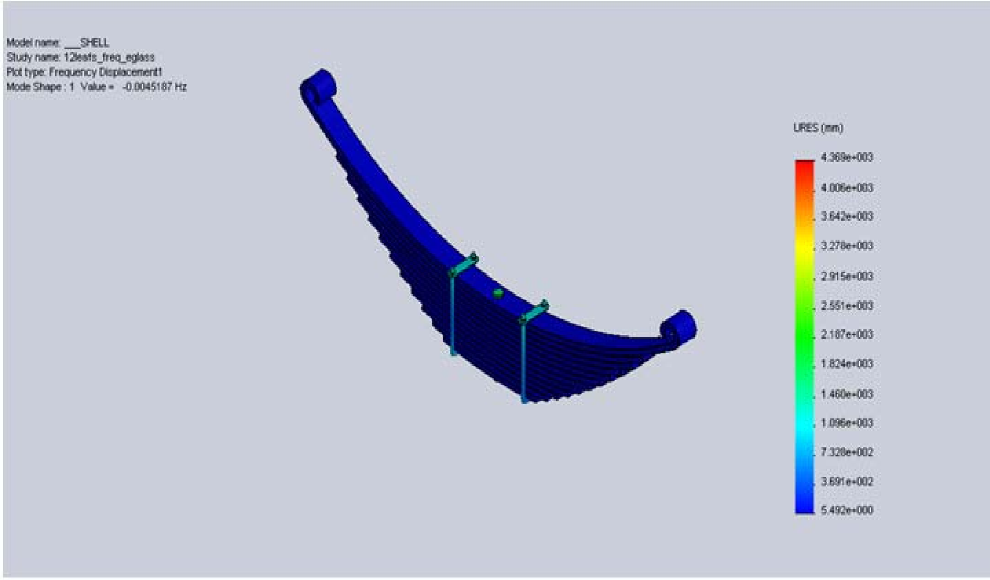

Fig 11: The image above shown is for mode1.

7.4 C-Glass Epoxy

Mode1:

Name	Type	Min	Max
Displacement1	Mode1(value=0.00147302Hz)	0.339829mm Node: 36808	2432.86mm Node:48960

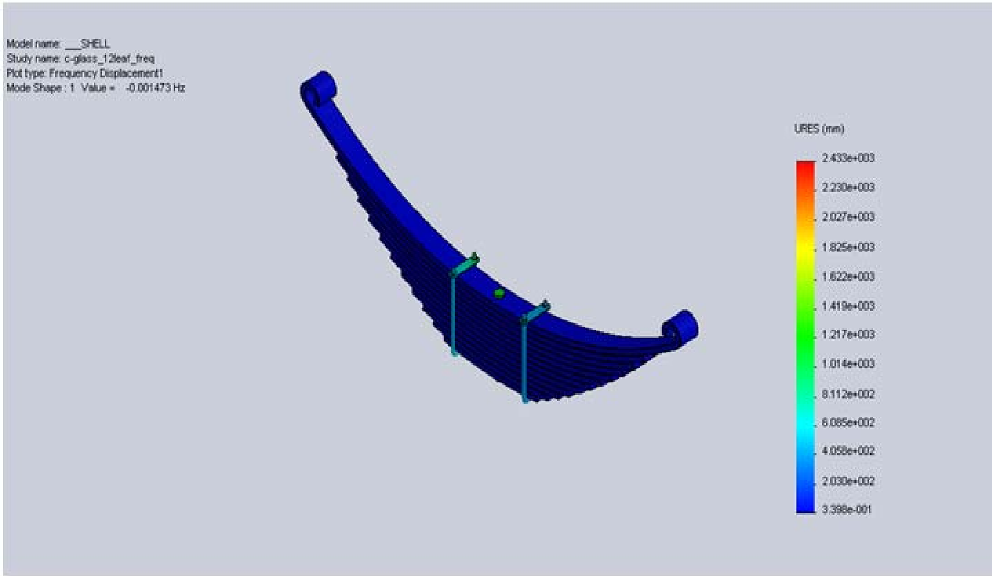

Fig 12: The image above shown is for mode1.

8. Results

8.1 8 Leaf Static Analysis

	Stress N/mm^2	Displacement (mm)	Strain
E-GLASS	72.4658	0.002799	0.0006132
MILD STEEL	67.9878	0.0987089	0.000270184

8.2 12 Leaf Static Analysis

	Stress	Displacement	Strain
MILD STEEL	55.3691	0.0722712	0.0001625
S-GLASS	51.2468	0.17079	0.0003403
C-GLASS	52.4102	2.15204	0.004452
E-GLASS	52.5425	0.204908	0.000402892

8.3 Harmonic Analysis

	Stress	Displacement
MILD STEEL	48.8102	0.06347
S-GLASS	48.5312	0.150024
E-GLASS	49.2034	0.180152
C-GLASS	52.5022	2.086002

9. Conclusion

In this paper we have designed and modeled a leaf spring using Mild steel, E-glass, S-glass, and C-glass. Modeling is done in pro-engineering. As per the static analysis on 8-leafs we can concluded that E-glass epoxy is better than using Mild-steel as though stresses are little bit higher than mild steel, E-glass epoxy is having good yield strength value ($5e+008N/m^2$) and also epoxy materialed components are easy to manufacture and this having very low weight while comparing with traditional materials and also we have analyzed leaf spring using 12 leafs. In that analysis S-glass is having better results while comparing with C-glass, E-glass and mild steel. So better to use S-glass epoxy (Carbon reinforced fiber) and also we have increased the number of leafs to reduce the stress for structural stability.

While comparing with the weight it is having less weight than traditional leaf spring (Mild steel).

After static analysis we have analyzed frequency analysis.

Model analysis is mainly used to match the frequency of previous leaf spring model.

In this analysis we got nearest values of frequency for all the materials so as per frequency also we can use epoxy material to manufacture leaf spring.

And also we have done harmonic analysis to find stress values on application of harmonic loads.

So finally we can conclude that S-glass epoxy is the best material to manufacture leaf spring because of good structural stability low production cost and good efficiency.

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