Comparative Analysis of the Suspension System of Automobile using Different Materials on ANSYS

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Abstract— Suspension system plays an important role in any automobile. Suspension system counters the jerk & pits whenever we run the vehicle on the road. Suspension system for the cars and trucks is made up of leaf spring. In leaf spring we have 5-6 leaves of any metal normally cast iron placed one over other in order to counter the jerk during traction. Now since the Leaf spring is made up of cast iron, it consists of a lot of weight which affects the efficiency of traction adversely. Because of its weight it can carry several other factors which are significant in reducing the speed & efficiency of the vehicle. So, to counter this adverse effect a new kind of composite materials are being tried now a days so that the overall weight reduction may be achieved with ease. The variety of composite materials includes Carbon epoxy, E-glass Epoxy carbon, Carbon fibre etc. These materials are quite lighter in weight than the cast iron so we need to check them for other type of responses except weight. Hence, we need to compare the cast iron with these composite materials. For the comparison a cast iron leaf spring will be designed using mathematical formulae & then this design will be validated using ANSYS 19.2 workbench. After validating the mathematically calculated results with ANSYS 19.2 results we will go for composite material leaf springs & similar kind of analysis will be run on these materials too.

Keywords: Carbon epoxy, E-glass Epoxy carbon, Carbon fiber, ANSYS 19.2, CATIA

I. INTRODUCTION

In today's world the fuel productivity and heaviness of cars are two important problems. So, to counter this issue researchers have tried hard to develop new kind of materials which may help them. The primary ideal approach to improve the fuel effectiveness is to lower the heaviness of the vehicle. The load reduction may be accomplished basically using low weight material. The accomplishment of weight drop-off with adequate change of mechanical properties has created composite a good swap material for normal steel.

A. Leaf Spring

A spring may be explained as an elastic component, whose characteristic is to get distorted if loaded and to get better its unique form whilst the weight is eliminated. Springs are considered to be the type of bodies which can be deformed in to & fro pattern & rotation with the help of some force. They go back to their original form as & when the force is released. Leaf spring may be manufactured with the help of flat plates. The primary advantage of leaf spring over coil springs is that it may be made move along a definite path a restore its original position upon releasing the force.

B. Why a Composite

Over the last thirty years' composite substances, plastics and ceramics were the dominant rising materials. The quantity and wide variety of applications of composite materials have grown step by step, penetrating and conquering new markets relentlessly. Modern composite materials represent an enormous percentage of the engineered materials marketplace starting from regular merchandise to sophisticated niche applications.

While composites have an already demonstrated their well worth as weight-saving materials, the current undertaking is to lead them to cost powerful. The efforts to provide economically attractive composite components have resulted in numerous modern production strategies presently being used the composites industry.

Further, the want of composite for lighter construction substances and more seismic resistant systems has positioned high emphasis on the use of latest and superior substances that now not most effective decreases lifeless weight however additionally absorbs the surprise & vibration. Composites are now extensively being used for rehabilitation/ strengthening of pre-existing structures that ought to be retrofitted to lead them to seismic resistant, or to restore harm as a result of seismic interest.

II. PROBLEM STATEMENT

Although a lot has already been done in case of leaf spring optimization but this optimization has been limited to composite materials only. Primary objective of the material optimization is due to the heavy weight of steel: 60Si7 being currently used in leaf spring. We can look for some other materials too when optimizing the material for leaf spring manufacturing. In this dissertation work we will look for aluminium & aluminium alloys both linear & non-linear as the materials for leaf spring manufacturing. The results will be examined & analysed on the basis of following process parameters-

– Equivalent (von-mises) stress
– Total deformation
– Principal stress
– Elastic strain
– Strain energy
– Weight

For the analysis purpose leaf spring of Ashok Leyland Vikings chassis bus will be used. Component dimension will be as follows-

– Distance between eyes = 1372 mm
– Camber = 200
– Spring type = Semi elliptical
– Total no of leaves = 10
– No of full-length sleeves = 2

– No of graduated Sleeves = 8

III. ANSYS SIMULATION OF THE SPRING

– Begin with the analysis process of the 3D model in ANSYS & drag the icon of module for static structural.
– Select material steel: 60SI7.

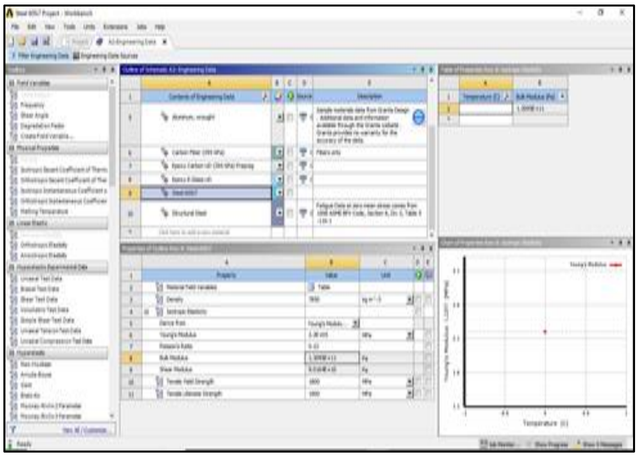


Fig. 1: Applying material to the model

– Assign the material to the assembly.

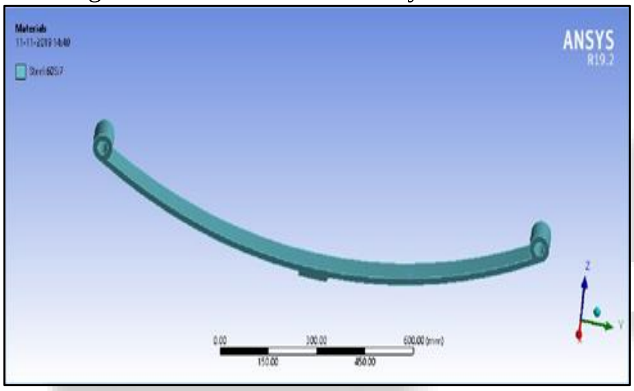


Fig. 2: Assign material

– Complete the meshing of the component.

After applying the material to the assembly, the process of meshing is performed in order to convert the assembly into large number of small parts which are either one dimensional, two dimensional & three dimensional. All the parts consist of 2 components namely nodes & elements as shown in figure. Number of elements used are 41767 & and number of nodes used are 67010.

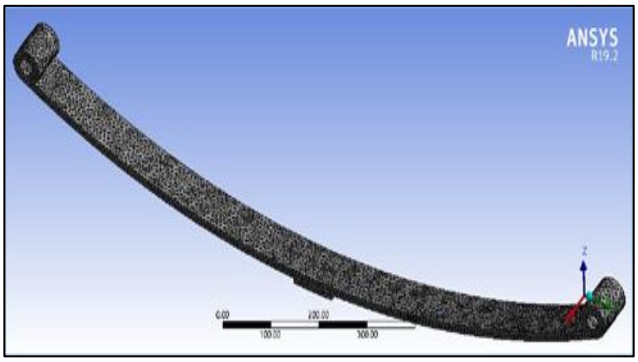


Fig. 3: Applying meshing

– Apply boundary conditions

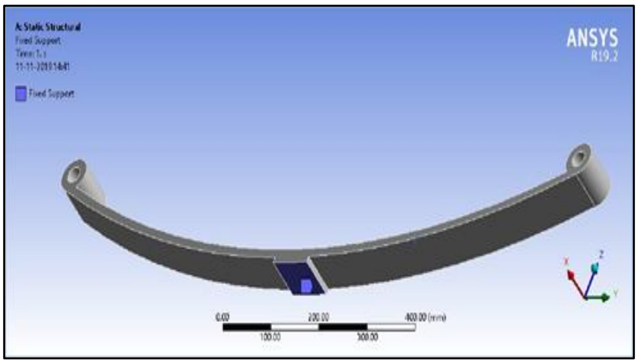


Fig. 4: Applying boundary condition

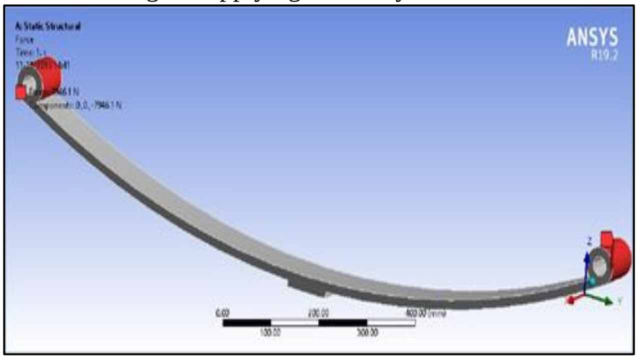


Fig. 5: Applying loads

– Run the analysis
– Get the results.

A. Results Analysis

Primary objective of the study was to design & optimize the material being used for leaf spring hence 6 other materials have been tried & tested here to examine whether some other material can be used in place of steel or not. Materials which have been tried here are wrought aluminium, aluminium alloy, aluminium alloy NL, carbon fibre, carbon epoxy & carbon E-Glass epoxy. All the materials have been compared on the basis of equivalent stress, weight & total deformation.

Here results for wrought aluminium are being shown for the reference purpose-

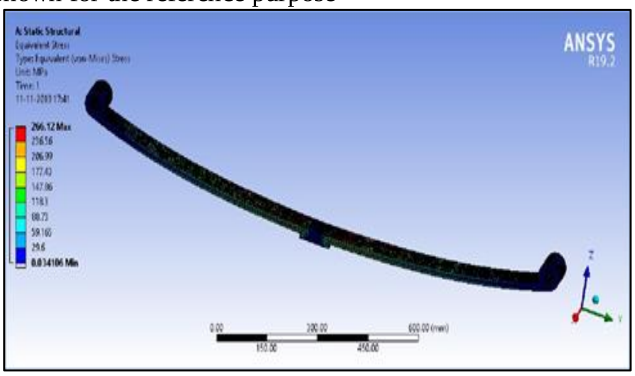


Fig. 6: Equivalent stress pattern

Above figure shows the pattern of equivalent stress.

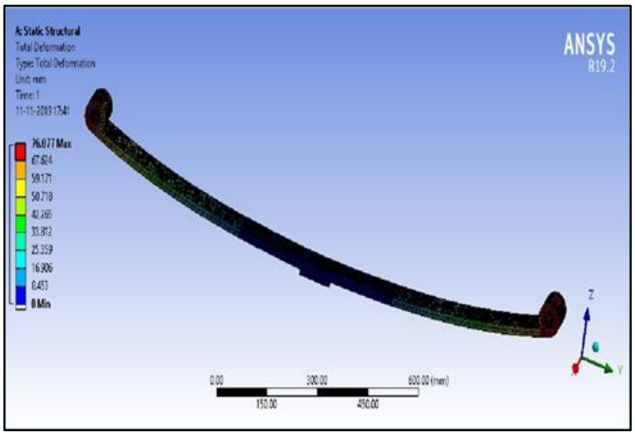


Fig. 7: Total deformation pattern

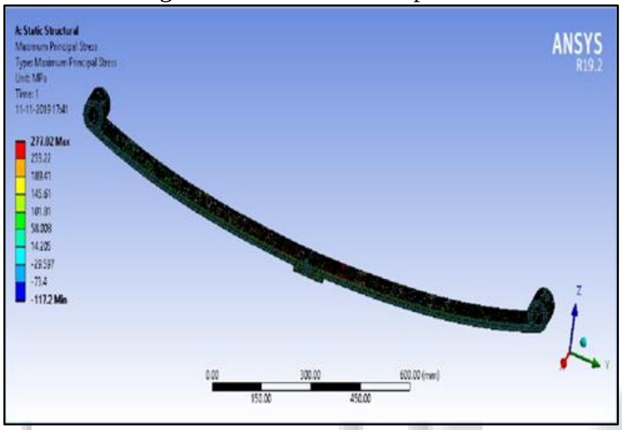


Fig. 8: Maximum Principal Stress Pattern

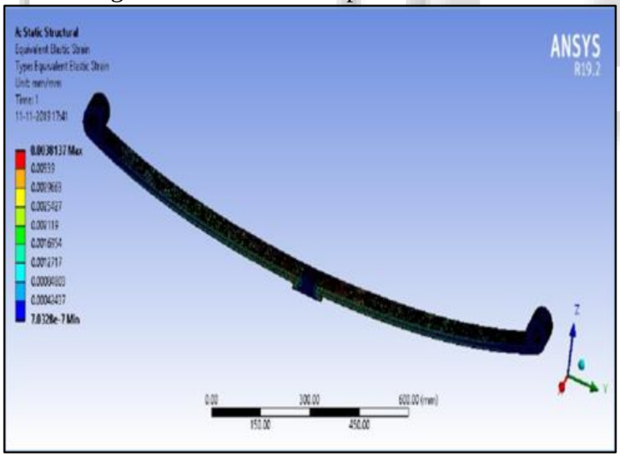


Fig. 9: Elastic strain pattern

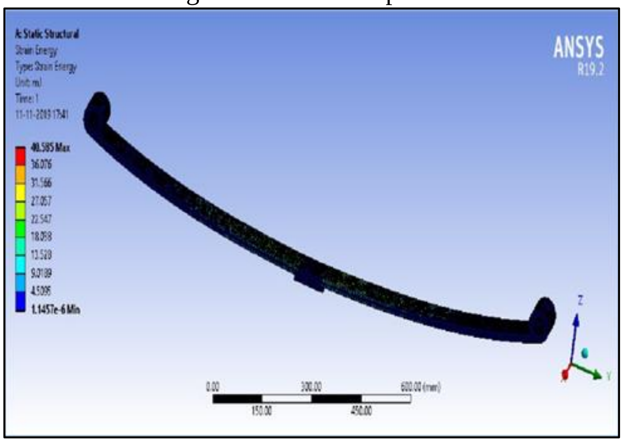


Fig. 10: Strain energy pattern

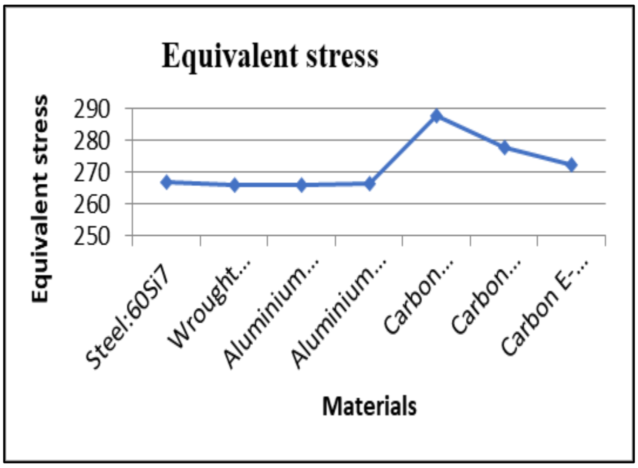
S. No.	Material	Maximum Equivalent stress in MPa	Total Deformation in mm
01	Steel:60Si7	266.78	24.532
02	Wrought Aluminium	266.12	76.077
03	Aluminium Alloy	266.12	75.541
04	Aluminium Alloy NL	266.53	75.542
05	Carbon Fibre	287.7	903.42
06	Carbon Epoxy UD	277.81	568.28
07	Carbon E-Glass Epoxy UD	272.55	538.94

Results obtained are shown below-

Material	Max. Principal stress in MPa	Equivalent elastic strain in mm/mm	Strain Energy in mJ	Weight in Kg
Steel:60Si7	271.15	0.0012	13.426	17.469
Wrought Aluminium	277.02	0.0038	40.585	6.03
Aluminium Alloy	277.02	0.0038	40.3	6.16
Aluminium Alloy NL	277.04	0.0038	40.316	6.16
Carbon Fibre	266.81	0.058	449.24	4.0055
Carbon Epoxy UD	267.28	0.036	287.69	3.4269
Carbon E-Glass Epoxy UD	267.1	0.033	277.76	4.45

Table 1: Results of the Analysis

IV. RESULTS ANALYSIS



graph of equivalent (von-mises) stress distribution is indicating that for aluminium & aluminium alloys the value of equivalent (von-mises) stress approximately equal to that of steel:60Si7 but as one moves towards composite materials there is a sudden increment in equivalent stress value. Overall figure shows that for carbon fibre equivalent stress is maximum & for Steel:60Si7 & aluminium along with its alloys equivalent stress is minimum.

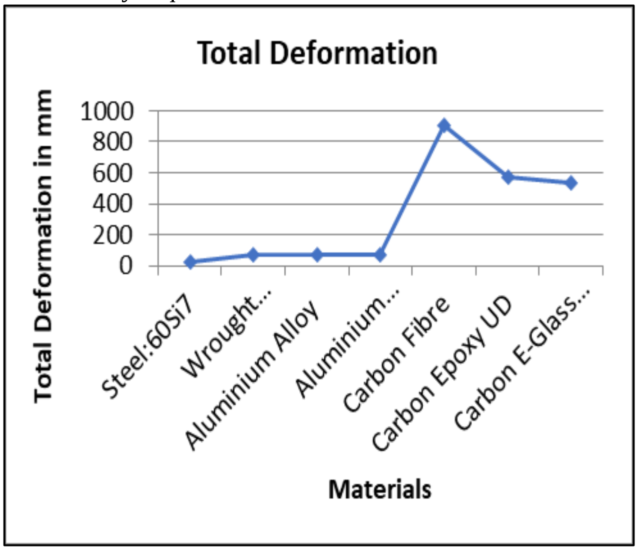


Fig. 11: Total deformation pattern

Above graph of total deformation distribution is indicating that for aluminium & aluminium alloys the value of total deformation is approximately equal to that of steel:60Si7 but as one moves towards composite materials there is a sudden increment in total deformation value. Overall figure shows that for carbon fibre total deformation is maximum & for Steel:60Si7 & aluminium along with its alloys total deformation is minimum.

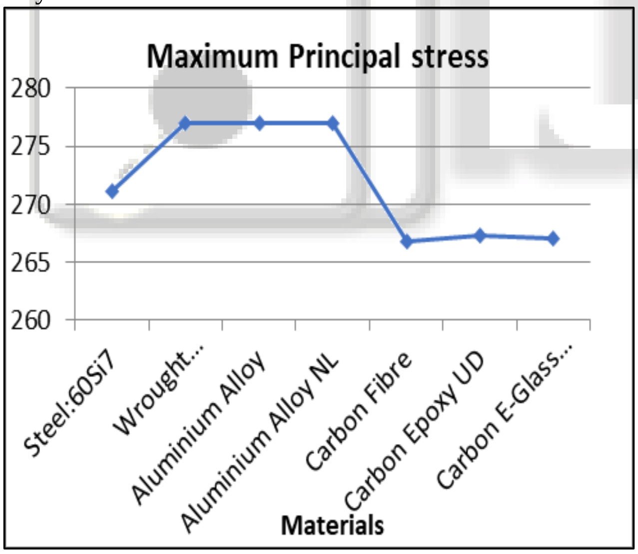


Fig. 12: Maximum Principal Stress Pattern

Above graph of maximum principal stress distribution is indicating that for aluminium & aluminium alloys the value of maximum principal stress increases suddenly as compared to that of steel:60Si7 but as one moves towards composite materials there is a sudden decrement in maximum principal stress value. Overall figure shows that for aluminium & aluminium alloys maximum principal stress is maximum & for composite materials maximum principal stress is minimum.

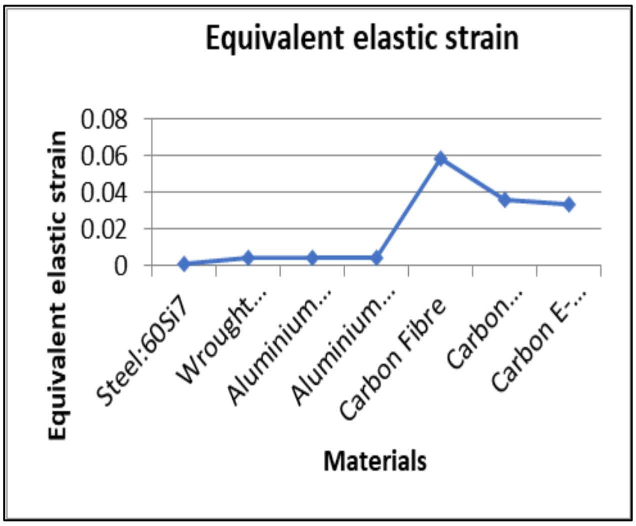


Fig. 13: Equivalent Elastic Strain pattern

Above graph of equivalent elastic strain distribution is indicating that for aluminium & aluminium alloys the value of equivalent elastic strain approximately equal to that of steel:60Si7 but as one moves towards composite materials there is a sudden increment in equivalent (von-mises) stress value. Overall figure shows that for carbon fibre equivalent stress is maximum & for Steel:60Si7 & aluminium along with its alloys equivalent stress is minimum.

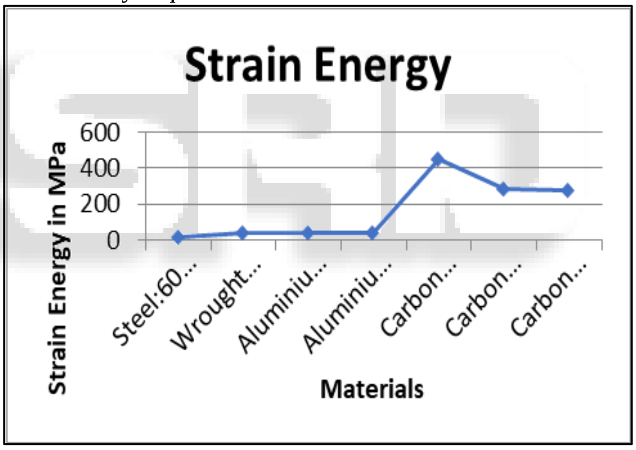


Fig. 14: Strain Energy Pattern

Above graph of strain energy distribution is indicating that for aluminium & aluminium alloys the value of strain energy approximately equal to that of steel:60Si7 but as one moves towards composite materials there is a sudden increment in strain energy value. Overall figure shows that for carbon fibre strain energy is maximum & for Steel:60Si7 & aluminium along with its alloys strain energy is minimum.

Graph of weight distribution is indicating that for aluminium & aluminium alloys the value of weight suddenly decreases as compared to steel:60Si7 & it further lowers when we choose composite materials. Overall figure shows that for aluminium along with its alloys & composite materials there will be a drastic reduction in weight in comparison to the weight of steel: 60Si7.

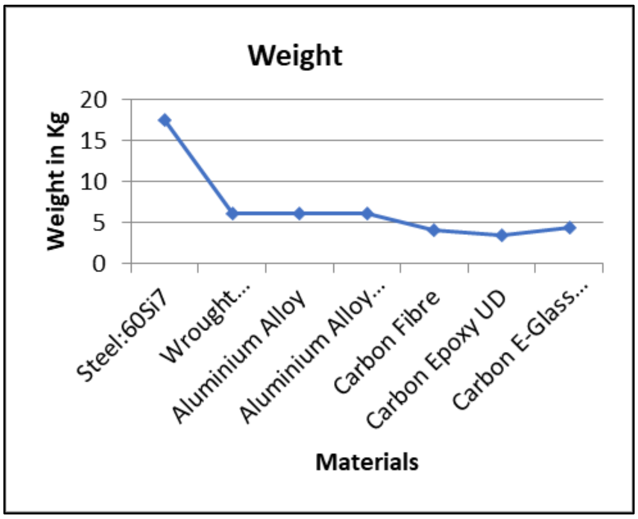


Fig. 15: Weight Comparison

V. Conclusions

Looking at the results of different process parameters we can conclude that-

- Equivalent (von-mises) stress is nearly similar for all the materials used in this dissertation work but it is minimum in case aluminium & aluminium alloys.
- Total deformation in case of aluminium & aluminium alloys increases as compared to steel: 60Si7 but not much & it is in permissible range. For composite materials value of total deformation increases drastically. According to these criteria also Aluminium & aluminium alloys may be used as replacement materials.
- Similarly evaluating & analyzing all the other results we can see that Aluminium & aluminium alloys are the materials which we can use for this particular application.
- Primary objective of the dissertation work was to find a material which can lower the weight of given component. In this work it has been found that both aluminium & composite materials will reduce the weight. According to this criterion too Aluminium & aluminium alloys have been found to be the optimum material used for leaf spring.

Hence, I propose that in place of steel: 60Si7, one can use wrought aluminium & aluminium alloys as the materials for leaf spring manufacturing because the results found in case of aluminium & aluminium alloys are far much better than steel: 60Si7.

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