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Design and Analysis of Laminated Spring

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Abstract - *Springs are elastic members which compress on elongate under the action of force and re-gain in its original shape when load is removed, springs are generally used in automobile industries, in measuring instruments, in medical instruments etc. The main function of springs to absorb the shock or impact load in automobiles. To store energy as in case of clock spring, to apply forces and to control the motion as in case of brake and clutches. This research paper studies an optimized design of laminated spring which aim at reducing the weight without compromising the strength. The aim of this paper to study the laminated spring under three materials that is High Carbon Steel, Low Carbon Steel and AL-7075 T6. Laminated spring are mainly used in heavy truck to supporting and absorbing the impact load. Model of laminated spring is generated in Solidwork and analysis in ANSYS 19.0. The result of our research paper we can say that AL-7075 T6 is best for the analysis of laminated spring.*

1. INTRODUCTION

A leaf spring could be a straightforward style of spring, regularly utilized for the suspension in wheeled vehicles. Initially called a covered or carriage spring. A leaf spring acts as a damper when a vehicle encounters shock. The general motivation behind a leaf spring is to offer help for a vehicle. It likewise accommodates a smoother ride retaining any knocks or potholes in the street. Leaf springs are likewise used to find the hub and control the tallness at which the vehicle rides and helps keep the tires adjusted out and about. A spring appears as a slim bend formed length of spring steel of rectangular cross-area. It's the foremost well-known design, the point of interest of the circular segment gives area to the hub, while circles framed at either end accommodate appending to the vehicle suspension. For exceptionally heavy vehicles, the spring is often produced by employing a few leaves stacked on head of one another during a few layers, frequently with continuously shorter leaves. The leaf spring goes about as a linkage for holding the hub in position and in this way independent linkages are redundant. It makes the development of the suspension straightforward and solid. Since the situating of the hub is completed by the leaf springs, it is disadvantageous to utilize delicate springs for example springs with low spring consistent. In this way, this sort of suspension doesn't give great riding solace. The inter-leaf friction between leaf rubbing between the leaf springs influences the riding solace. Increasing speed and slowing down force cause wind-up and vibration. Likewise wrap up causes backside squat and nose-jumping. The inter-leaf friction between leaf contacts damps the spring's movement and diminishes bounce back, which until safeguards were broadly embraced was an extraordinary favorable position over helical springs.

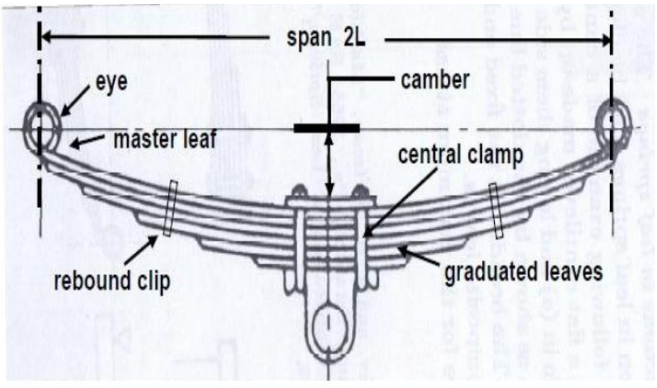

Figure 1:- Leaf Spring

2. LITERATURE REVIEW

M.Mahmood, e.tal [1] have presented the design and analysis of laminated spring and the material for spring is fibre glass composite. The result of this paper was replaced the steel laminated spring with a composite to get a spring with minimum weight that capable of the support without any failures.

A.Strzat and T.Paszek [2] have performed a contact analysis i.e., bonded contact region between the car leaf spring by the static structural contact problem of the leaf spring and then comparing the different models by experimental data.

Rajendran and S.Vijayarangan [3] has performed FEM analysis of different types of laminated spring of a car. With the help of FEM analysis is easily to determine the natural frequency and model shapes of laminated spring.

M.Venkatesan e.tal [4] have presented the design and analysis of laminated spring which is made up of glass fibre composite material and after analysis done them comparing the laminated spring with OEM design of steel laminated spring.

3. DESIGN OF LAMINATED SPRING

Formulae used for analysis of leaf spring –

1. Uniform width leaf spring equation :

   $\sigma_{max} = 6FL / bh^2$
   $\delta_{max} = 4FL^3 / Ebh^3$

2. Non- Uniform width leaf spring equation :

   $\sigma_{max} = 6FL / bh^2$
   $\delta_{max} = 6FL^3 / Ebh^3$

   $b_N = b / N$

Where: - N – Number of springs

B – Width of springs

4. MATERIAL SELECTION

The Properties of the materials which we have selected for the analysis of the leaf spring have been listed below in the tabular form.

Table -1: Material Properties

Properties			
Material	Density (lb/in^3)	Ultimate Tensile Strength (psi)	Yield Tensile Strength (psi)
High Carbon Steel	0.284	92100	71100
Low Carbon Steel	0.284	63800	53700
AL-7075 T6	0.102	83000	73000

Analysis 1 – all layers with HCS (High Carbon Steel)

Analysis 2 – all layers with LCS (Low Carbon Steel)

Analysis 3 – all layers with AL-7075 T6

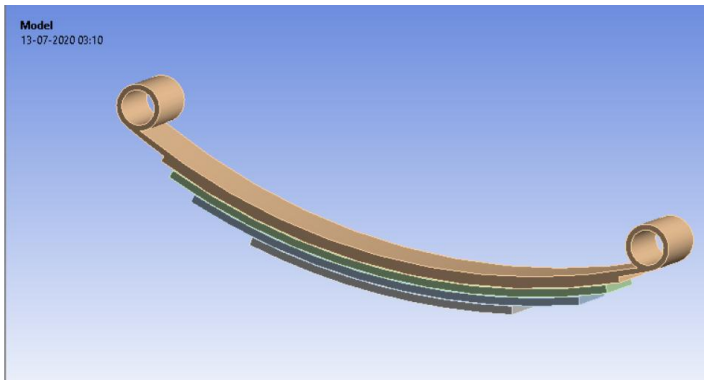

Fig -1: Model of Laminated Spring

5. MESHING

The design was simulated for the below conditions using following mesh parameters.

Mesh Parameters	
ELEMENT SIZE	1 mm
ELEMENT TYPE	2D
ELEMENT QUALITY	0.94
TOTAL NODES	186243
TOTAL ELEMENTS	99537

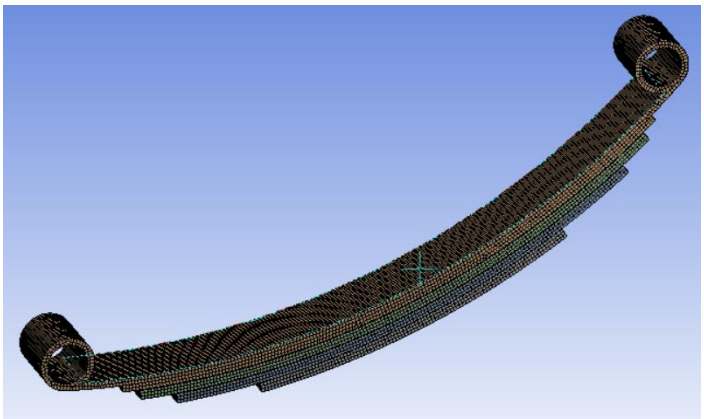

Fig -2:- Meshing Model

6. RESULTS

Analysis 1 – From simulation result, it is observed that the equivalent stress, total deformation and Safety factor is 522.35 MPa, 0.30159 mm , 1.2157 respectively.

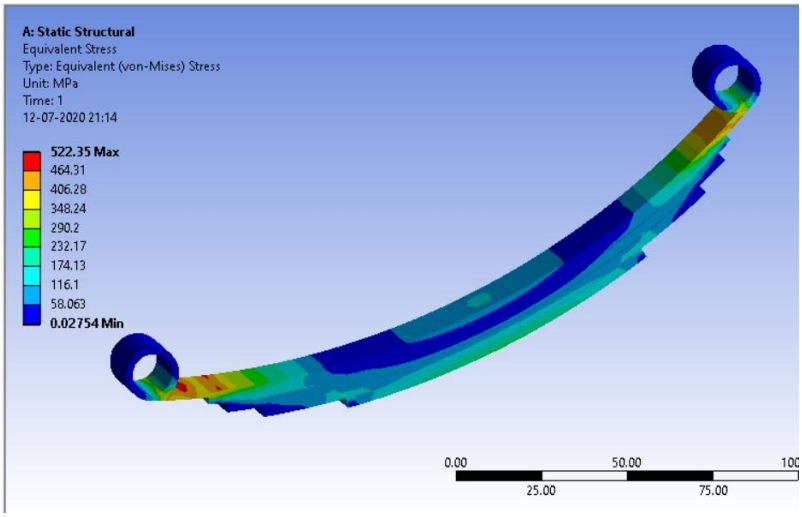

Fig -3:- Equivalent Stress

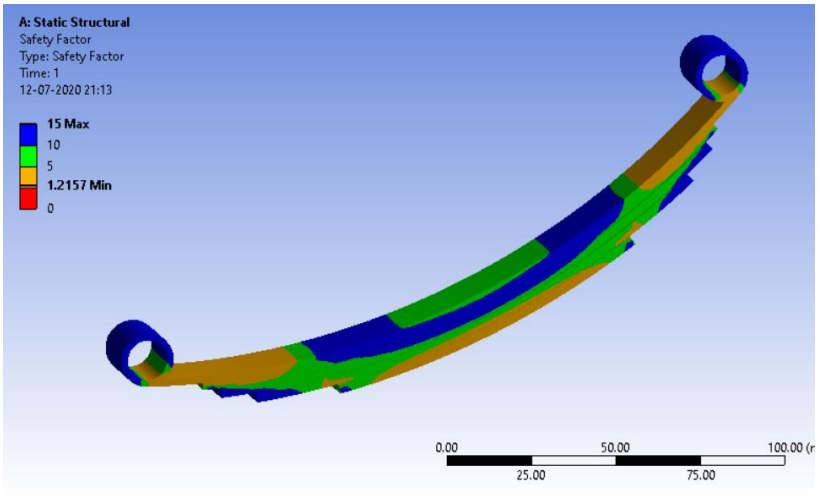

Fig -4:- Safety Factor

Analysis 2 - From simulation result, it is observed that the equivalent stress, total deformation and Safety factor is 569.35 MPa , 0.00029451 mm , 0.727 respectively

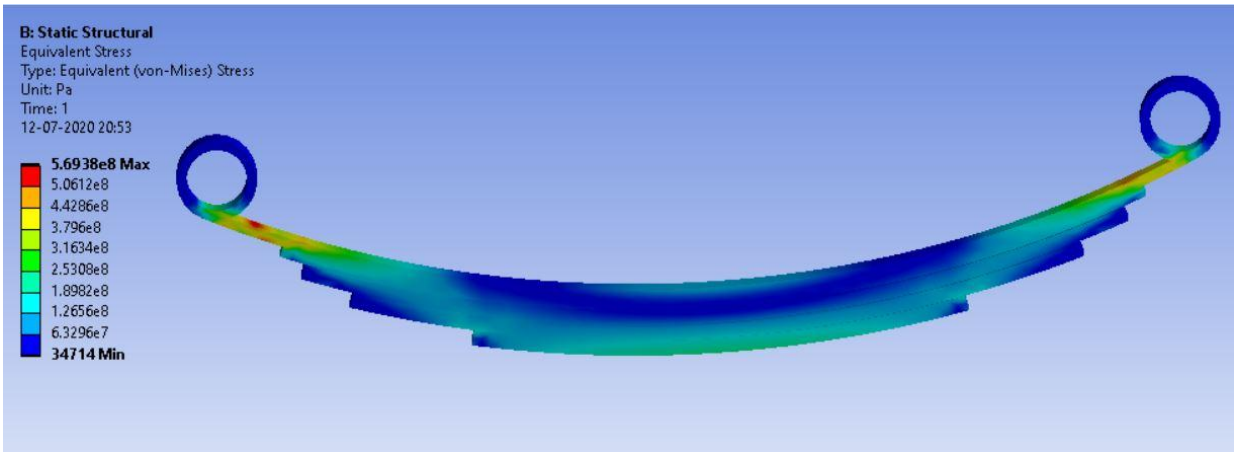

Fig -5:- Equivalent Stress

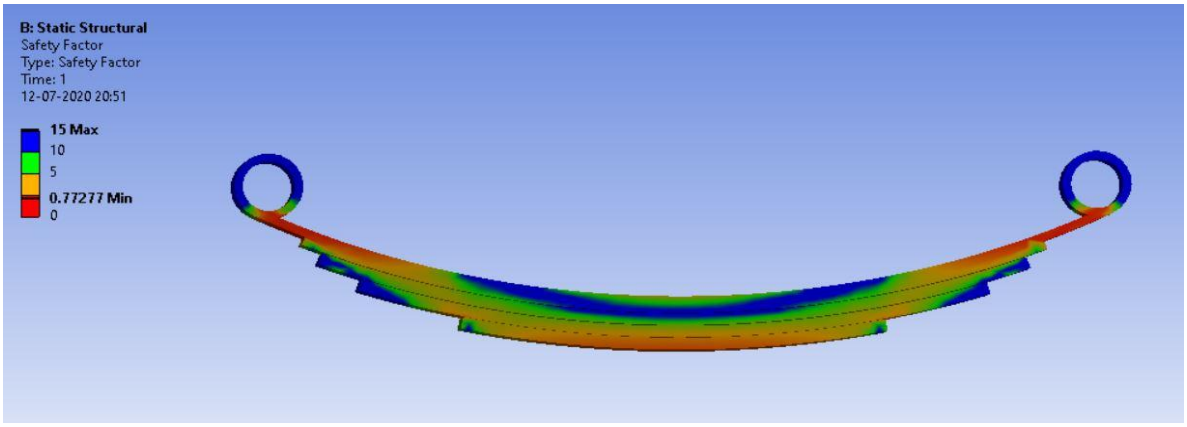

Fig -6:- Safety Factor

Analysis 3 - From simulation result, it is observed that the equivalent stress and Safety factor is 55.476 MPa and 8.29 respectively.

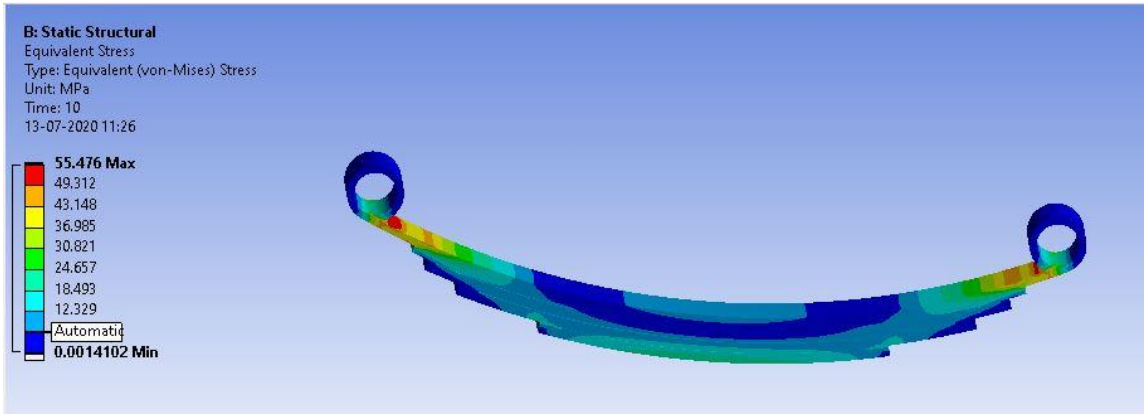

Fig -7:- Equivalent Stress

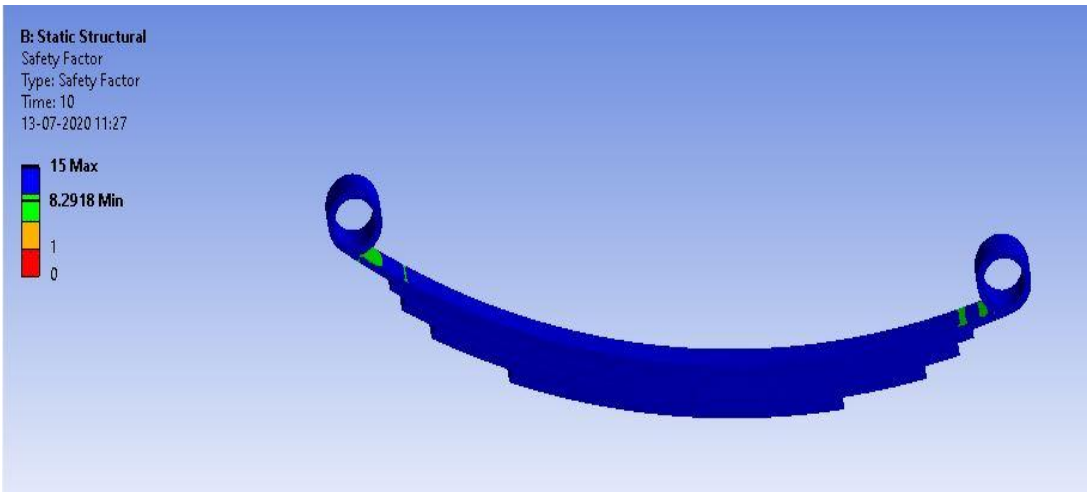

Fig -8:- Safety Factor

7. CONCLUSION

According to the simulation results for deformation , equivalent stress, factor of safety and from our research paper we can conclude that material aluminum 7075 T6 is best suitable for the leaf spring as we have compared the simulation results for

Al 7075 T6 in each case with low carbon steel and high carbon and Al 7075 T6 comes to be the best as in this stress is coming low and because of density factor of Al 7075 T6 the weight of leaf spring is also coming less.

8. REFERENCES

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9. BIOGRAPHIES

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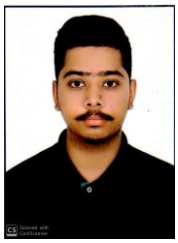

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