International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 4, Issue 6, June-2018

Analysis of Leaf Springs with Coil Using ANSYS

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Abstract— Leaf springs are normally used in the suspension system and are subjected to unstable stress cycles. The suspension system considerably affects the conduct of the automobile. The intention of this effort is to symbolize a common study on the design and analysis of leaf spring through SOLID WORKS and ANSYS16.0. A study on leaf spring with and without coil is analyzed and the corresponding stress, strain, deformation are found.

Keywords— ANSYS, Leaf spring, Coil spring, Finite Element Analysis.

I. INTRODUCTION

A suspension system in general anticipated to detach passengers from vibrations caused by the automobile wheels as it rolls over a road surface. A leaf spring is an uncomplicated form of spring universally used for the suspension in wheeled vehicles. Leaf springs are made of flat plates having multiple leaves (flat plates) in contact with each other with changeable length. The task of leaf spring is to bear vertical load and also to segregate road induced sensations. The end of the leaf spring is provided with the shackle for an elastic connection. For the purpose of analysis, the leaves are divided into two group's namely master leaf along with graduated-length leaves forming one group and extra full-length leaves forming the other. [1] Contrived a composite mono leaf spring with an integral eye and tested under static load conditions. [2] Described static analysis of steel and composite multi leaf spring made up of polymers reinforced with glass fiber. The dimensions of existing steel leaf springs of a light vehicle are taken for design calculations. [3] Including examining the leaf spring history, visual inspection of fractured specimens, characterization of various properties and simulation tests on real components, were used. [4] Performed genetic algorithm by achieving the least weight with ample strength and stiffness. A drop in weight is achieved by replacing no of steel spring with a mono-leaf composite spring under like conditions.

II. DIMENSIONS OF LEAF AND COIL SPRINGS

Finite element analysis has been carried out to determine natural frequencies and mode shapes of the leaf spring by considering a simple road surface model. The materials, details of software and dimensions for springs are shown in Table 2.1, 2.2, 2.3.

Table 2.1 Materials for springs and details of software.

Software	ANSYS 16.0
Workbench	Static Structural
Material	(C65 HIGH CARBON STEEL)
Load applied	9000N

Table 2.2 shows Coil Spring Dimension

D_O	Coil outer diameter	115mm
D_{mean}	Coil mean diameter	100mm
D	Wire diameter	15mm
C	Spring Index	6.67
P	Pitch	18mm
K	Wahl correction factor	1.22
N_{active}	Number of active coils	9

Table 2.3 shows Leaf Spring Dimension

n_f	Length of the master leaf	1220mm
T	Thickness of the Leaf	6mm
H	Height of the leaf set	54mm
N	Number of Leaf	9
B	Width of the leaf	70mm
O.D	Outer diameter of the eye	40mm
I.D	Inner diameter of the eye	20mm

III. DESIGN AND ASSEMBLY OF SPRINGS

1. Modeling of Leaf springs and Beam connector

The Master Leaf section has a uniform thickness of 6 mm throughout its length. Eye to eye centre distance is set for 1220 mm. Curvature of the arc is controlled by total distance between the beam and leaf springs. This cross section is extruded for 70 mm to get the part file of master leaf. After completing the part design of master leaf, successive leafs (or) graduated leaf are designed with respect to the position of master leaf. All leafs sections are extruded for same thickness as that of master leaf i.e., 6 mm without eye section. Decrease in length of successive leafs are in proportion. In this all the other 8 leafs are designed. A rigid beam having C-section is designed to mount the leaf spring. This beam section is extruded for a length of 1420 mm. A couple of holes are made by extrude cut on both ends of the beam. This has the purpose of connecting leaf spring with beam. A connecting element is designed to rigidly assemble leaf spring and beam. The holes are matched to those of beam. Design model for leaf, graduated leaf, beam and beam connector are shown in figure 1.

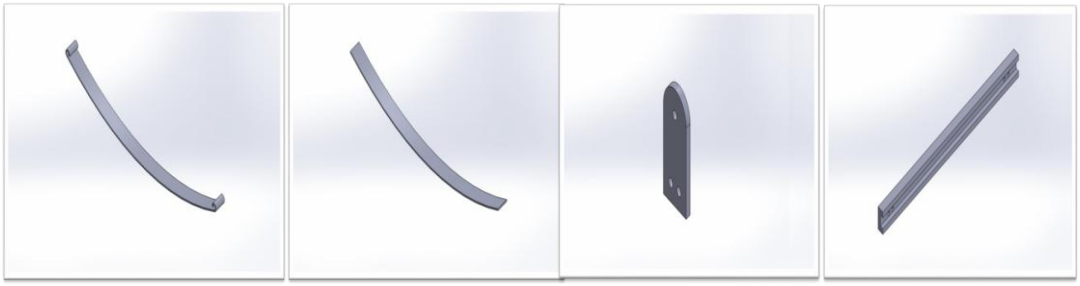


Figure 1: Design model of leaf, graduated leaf, Beam and Beam connector.

2. Modeling of Coil spring and Seating arrangement

Coil spring is drawn initially a circle is drawn for mean coil diameter. A helix is generated based on that circle, pitch and height. Then a circle of wire diameter is drawn on starting point of helix. By using Sweep Extrude helical spring is generated. After the completion of helical spring design, a seating arrangement is prepared for spring. It is simply designed to seat on the beam as well as to hold spring. This part is completed by extruding columns besides of beam and plates beneath of beam.

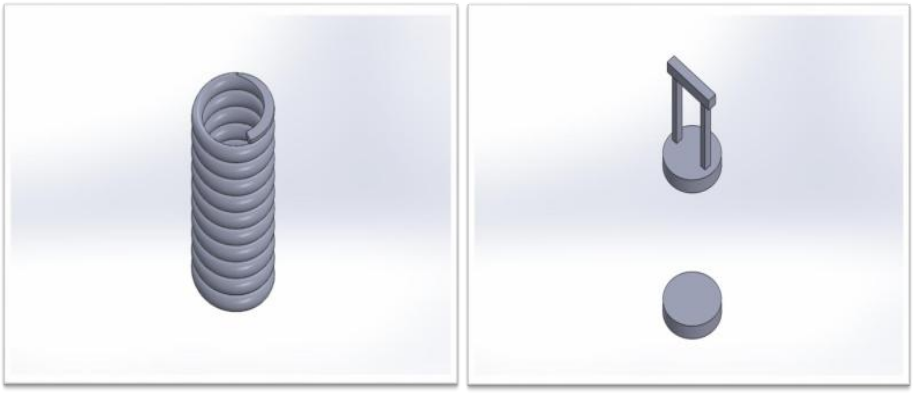


Figure 2: Design model of Coil and Seating arrangement.

3. Assembly of springs

For assembly beam is inserted in the seating arrangement for helical spring in exact middle of beam. Helical spring is inserted and then mated to the plates of seating. Then a set of beam connecters also assembled with beam. After this master leaf is inserted.. Once the master leaf is assembled, other leaves are successively assembled one by one. All leafs are mated in such a way that their side faces are correctly coincided.

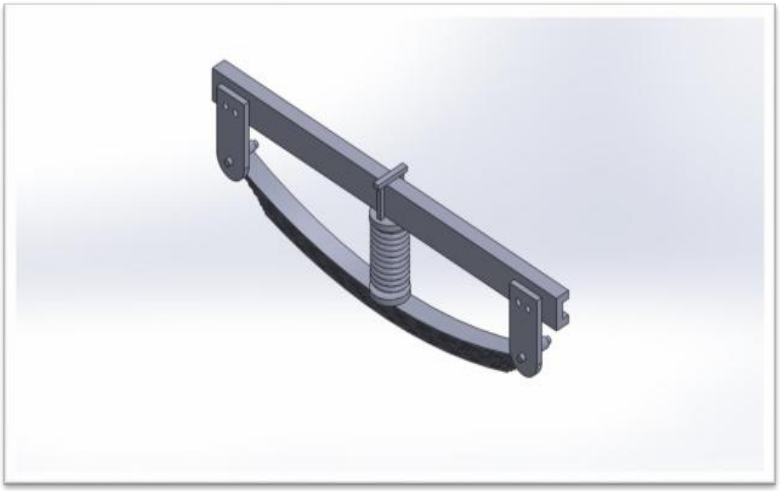


Figure 3: Assembled view of Leaf with Coil Spring.

IV. RESULTS AND DISCUSSION

As shown in figure 4 Stress, Strain and Deformation of Leaf without Coil Spring. The Maximum stress found at the specified area is 4.98E7 Pa, the maximum strain of 0.0003 at the mentioned area and the Maximum deformation is observed at the middle of beam and the value is 7.65E-5 m.

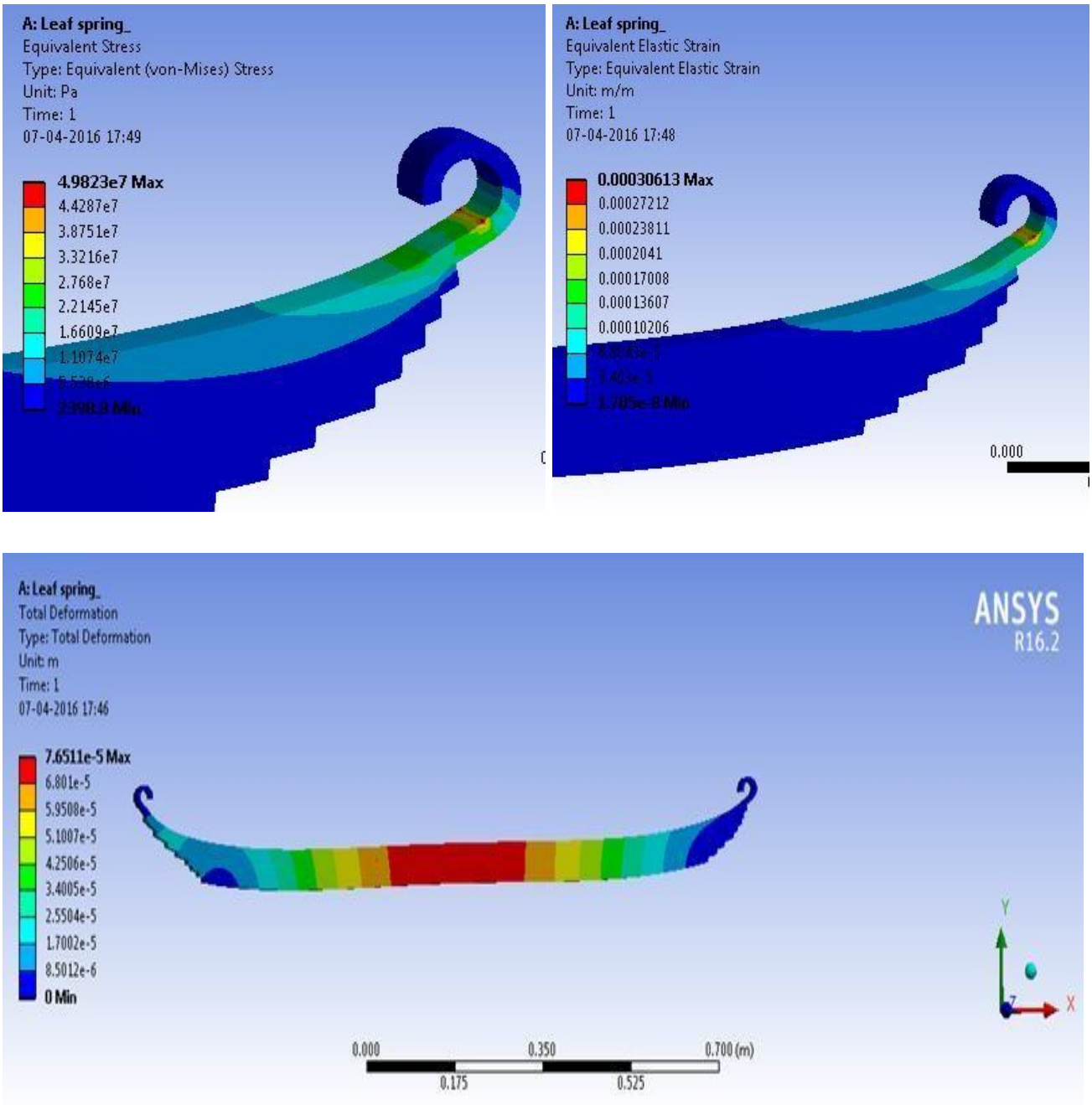


Figure 4: Stress, Strain distribution and deformation of Leaf without coil spring.

As shown in figure 5 Stress Strain and Deformation of Leaf with Coil Spring. The maximum stress found at the area is 4.3405E7 Pa. Maximum strain observed at the specified area is 0.000225 and the Maximum deformation observed at the specified is 6.835E-5 m.

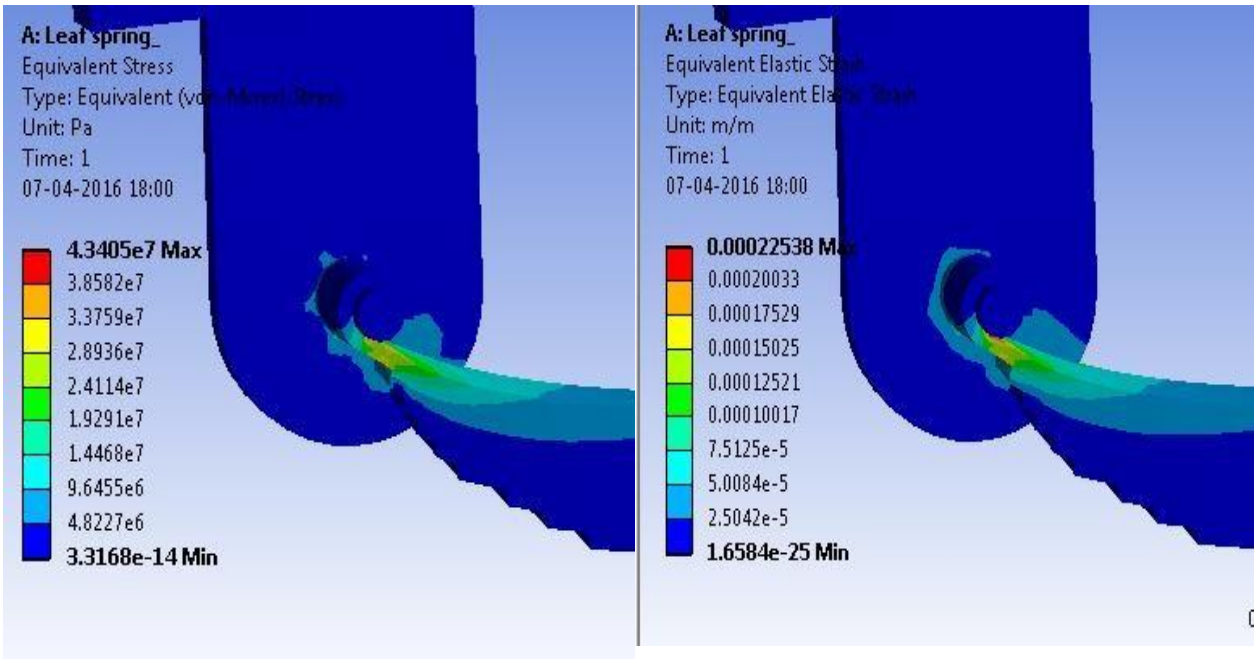
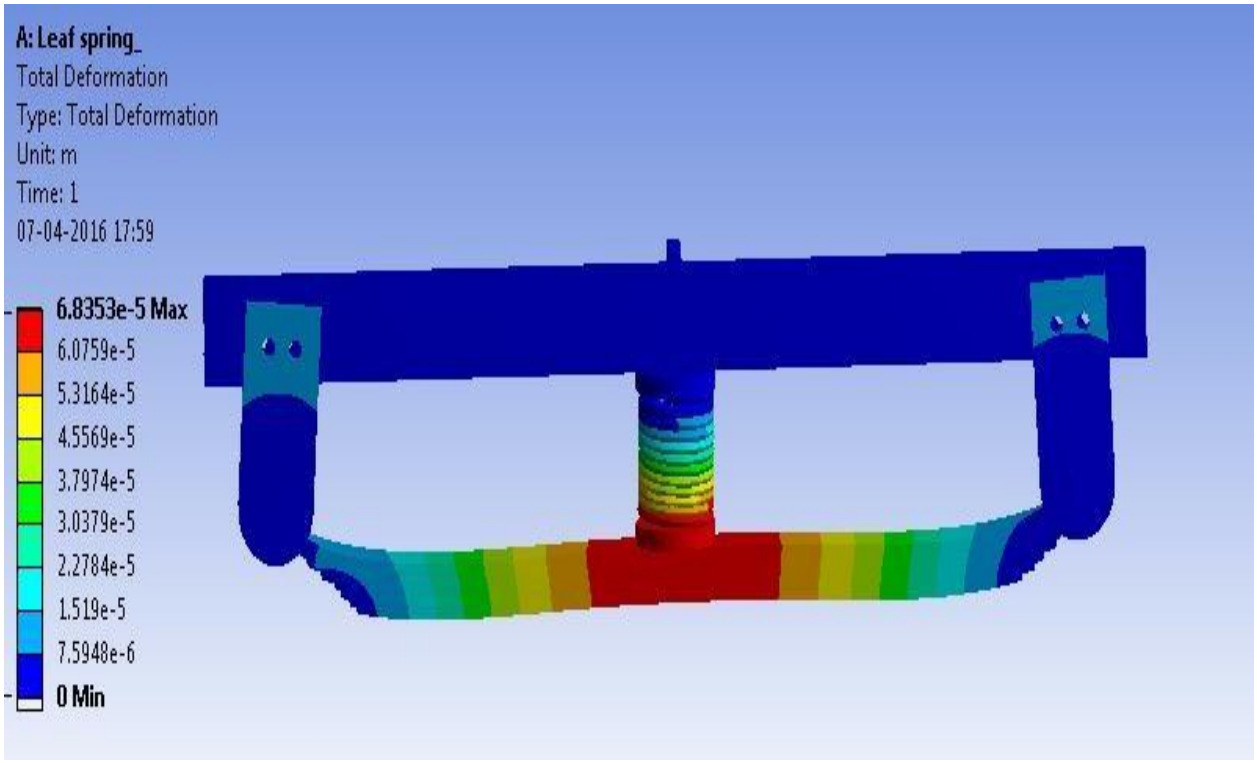


Figure 5: Stress, Strain distribution and deformation of Leaf with coil spring.

V. CONCLUSION

In this project the suitable alternate design has been identified and analyzed for the leaf with coil spring. Characteristics such as Stress, Strain and deformation were studied. From the results it can be observed that made leaf with coil spring is better than ordinary leaf spring in considering service.



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