Computational Static and Dynamic Analysis of Leafspring

[1] Sagargowda S.R, [2] Priyanka Sairam, [3]Chethan K.Y
[1]PG Student, [2]Assistant Professor, [3]Assistant Professor
[1]Department of Mechanical Engineering, New Horizon College of Engineering, Bangalore – 560103
[3]Vemana Institute of Technology, Bangalore –560034.

***Abstract* - A leaf spring is a basic type of spring, usually utilized for the suspension as a part of wheeled vehicles. Leaf Springs are long and contract plates joined to the casing of a trailer that rest above or beneath the trailer's hub. For sheltered and happy with riding, to keep the street stuns from being transmitted to the vehicle segments and to defend the inhabitants from street stuns it is important to decide the most extreme safe anxiety and diversion. The goal is to discover the hassles and distortion in the leaf spring by applying static burden on it and decide the normal recurrence of the leaf spring with various cell strong basic leaf spring. These qualities are figured logically, by utilizing limited component investigation. Along these lines in the present work, leaf spring is composed by considering static burden on vehicle. The outcome for anxiety, Strain, twisting and normal frequencies are contrasted and leaf spring with non-cell strong structure and investigation result.**

***Index Terms* – ANSYS, Leaf spring, Static and Dynamic analysis**

I.INTRODUCTION

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.

Honeycomb is a structure made up of hexagonal cells (Figure 1). It derives its name from its close resemblance to a bee honeycomb, though there is no variation in the depth direction. The honeycombs of hexagonal cell structure are characterized by considerable rigidity in shear, high crushing stress, almost constant crushing force, long stroke, low weight and relative insensitivity to local loss of stability.

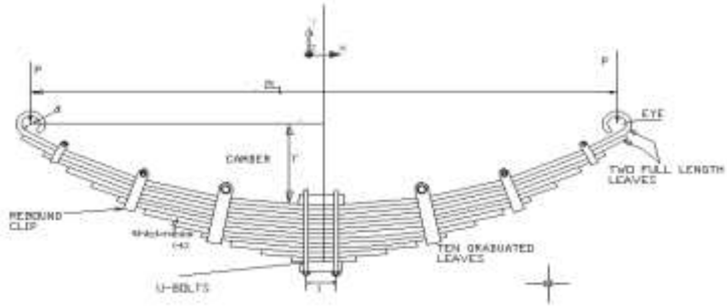

Fig 1.1 Leaf Spring.

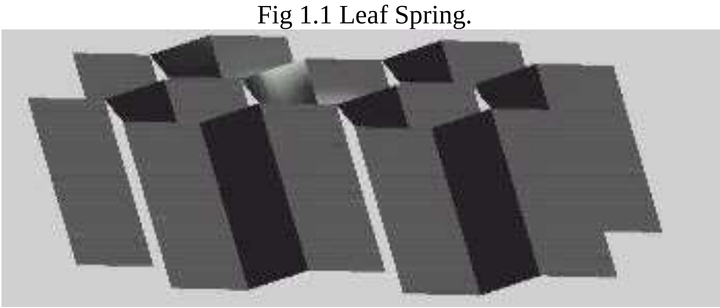

Fig.1.2 Cellular structure

The honeycomb sandwich construction is one of the most valued structural engineering innovations developed by the composites industry. Used extensively in aerospace and many other industries, the honeycomb sandwich provides the following key benefits over conventional materials:

- Very low weight
- High stiffness
- Durability
- Production cost saving pressure.

II.ANALYSIS OF LEAFSPRING

In the last few years SOLID WORKS software has become increasingly popular and is nowadays intensively used in geometric modeling. Since their conceptual simplicity allows for more flexible and highly efficient processing.

By obtaining the manufacturing and geometric dimensions of the component, draw the section of the component create the solid model by direct extrusion. All of the models were built in SOLID WORKS , converted into .igs files, and imported into Static Structural projects within ANSYS Workbench 15 within Design Modeler, the geometry was slightly modified before it was imported into ANSYS Mechanical. as shown in Figure .

Tetrahedron Method is used as well as Mapped Face Meshing on select faces. Edge sizing and face sizing were also used to get more elements on faces of interest and reduce the elements on less important faces such as the outer surface of the block.

After achieving an appropriate mesh, boundary conditions were applied to the model. The displacement boundary conditions are detailed in Figure 2.1

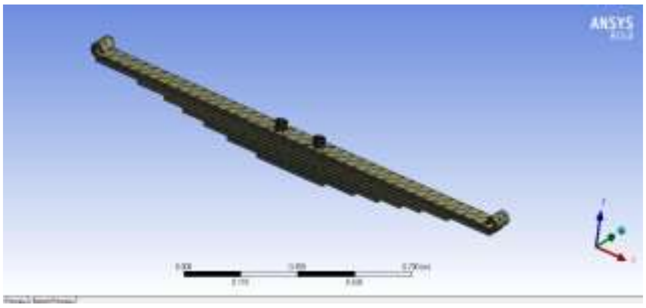

Fig.2.1 Meshing of leaf spring

2.1 Vibration Analysis

The differential stiffness matrix is a function of the geometry, element type and applied loads. This is the reason why the differential stiffness is also called the geometric stiffness matrix.

2.2 PROCEDURE FOR FREE VIBRATION ANALYSIS

ANSYS WORKBENCH is used to solve Natural frequency, following is the procedure listed below

1. Select modal analysis.
2. Import model igs file.
3. Imported model should be mesh of 100 relevance.
4. Apply the boundary conditions.
5. Solve the current model
6. Get the solution of total deformation for 6 modes.
7. Note down the natural frequency of the component at different modes.
8. Repeat the same procedure for the components of solid structure, cell structure and foam filled cell structure.

2.3 STATIC ANALYSIS SIMULATION

Leaf spring Analysis

Figure: Shows model of Structural steel view

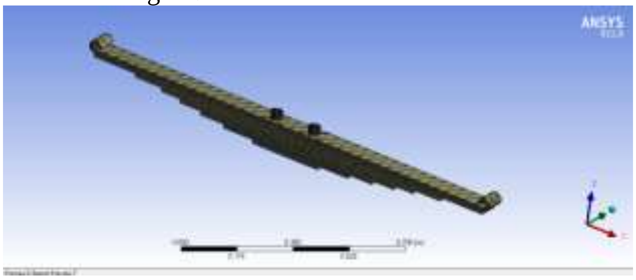

Figure: Shows model of Structural steel view

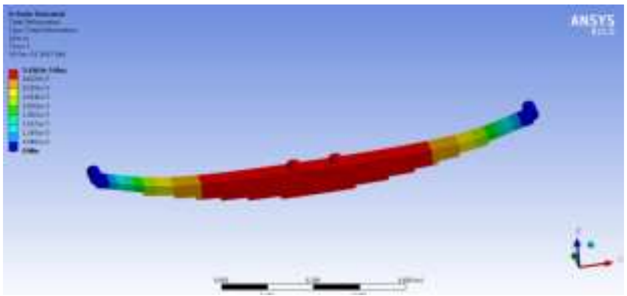

Figure: Shows deformation results of Structural steel

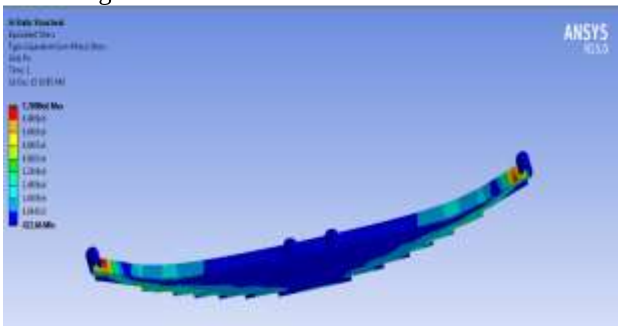

Figure: Shows von misses stress results of Structural steel

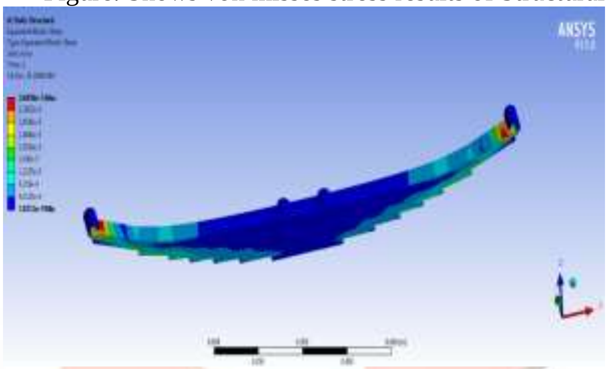

Figure: Shows von misses strain results of Structural steel

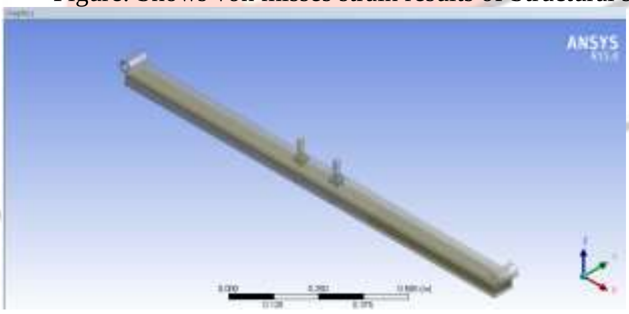

Figure: Shows single plate honeycomb model view

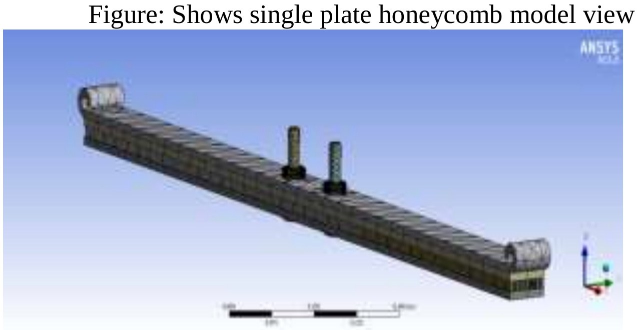

Figure: Shows single plate honeycomb meshed model view

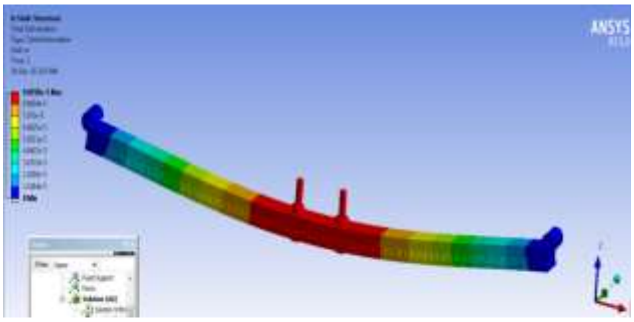

Figure: Shows deformation results of Single plate honeycomb view

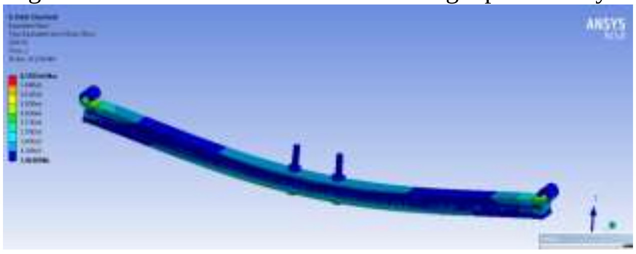

Figure: Shows von misses stress results of Single plate honeycomb view

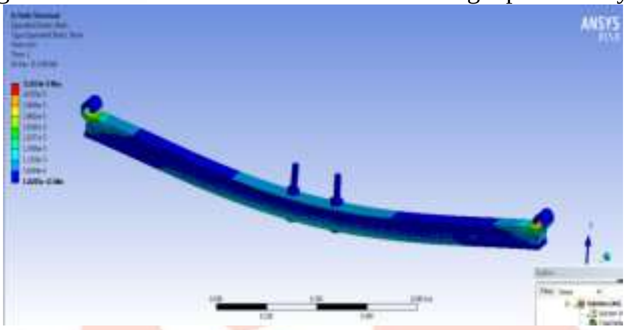

Figure: Shows von misses strain results of Single plate honeycomb view

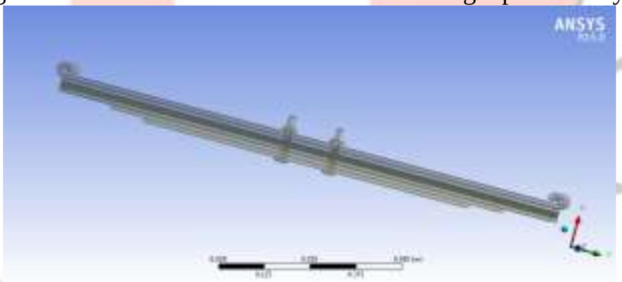

Figure: Shows 3 plate honeycomb model view

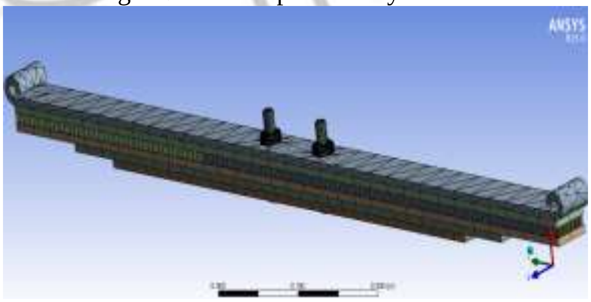

Figure: Shows 3 plate honeycomb meshed model view

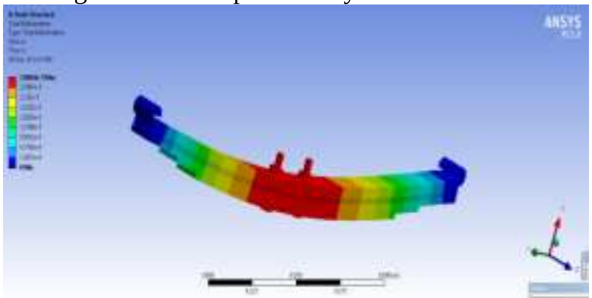

Figure: Shows 3 plate deformation results of Single plate honeycomb view

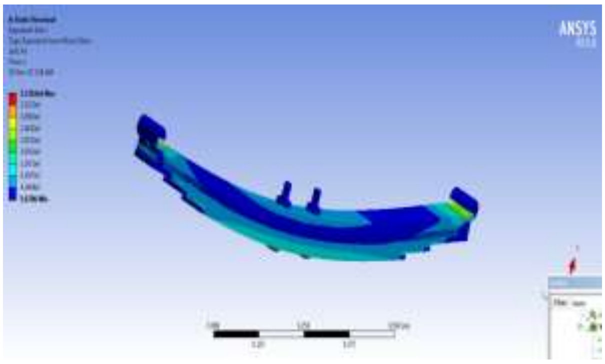

Figure: Shows 3 plate von misses stress results of Single plate honeycomb view

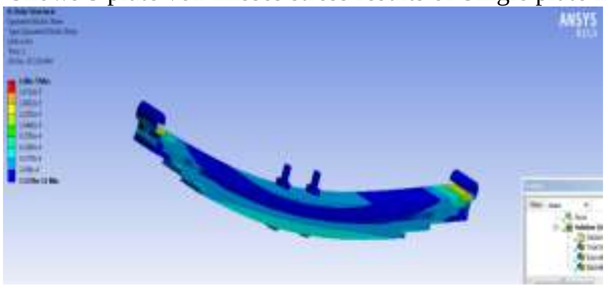

Figure: Shows 3 plate von misses strain results of Single plate honeycomb view

2.4 MODAL ANALYSIS SIMULATION

a).Structural Steel leaf spring simulation

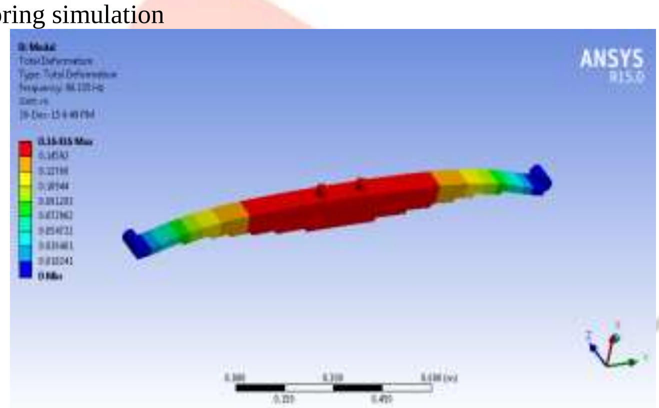

Figure: Shows the mode 1 total deformation result

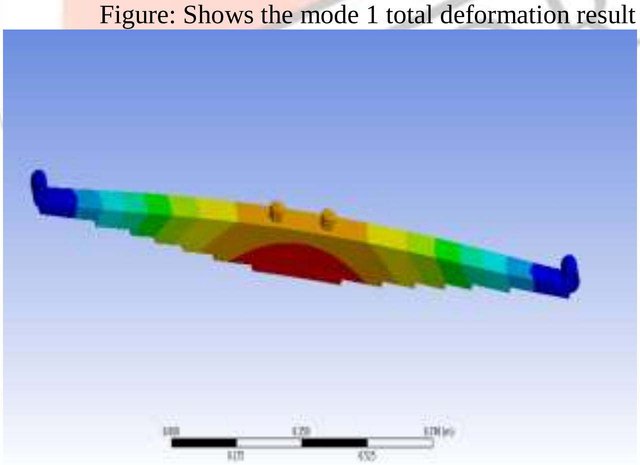

Figure: Shows the mode 2 total deformation result

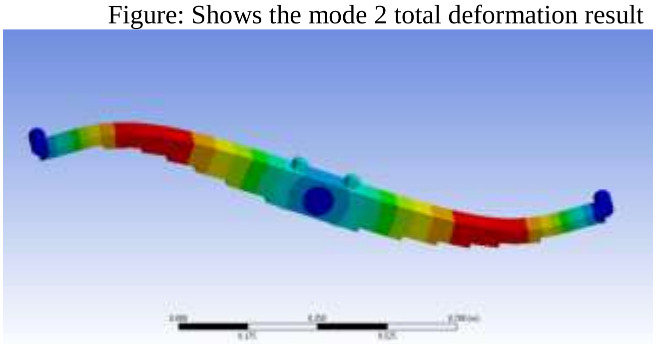

Figure: Shows the mode 3 total deformation result

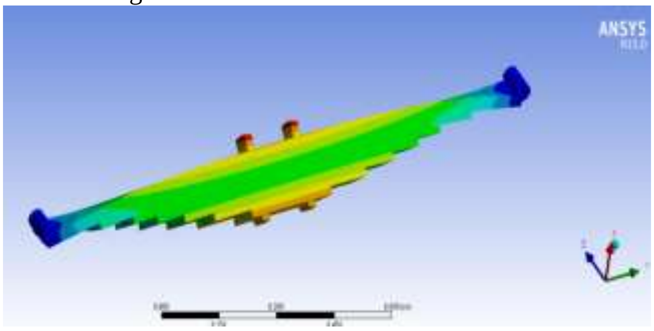

Figure: Shows the mode 4 total deformation result

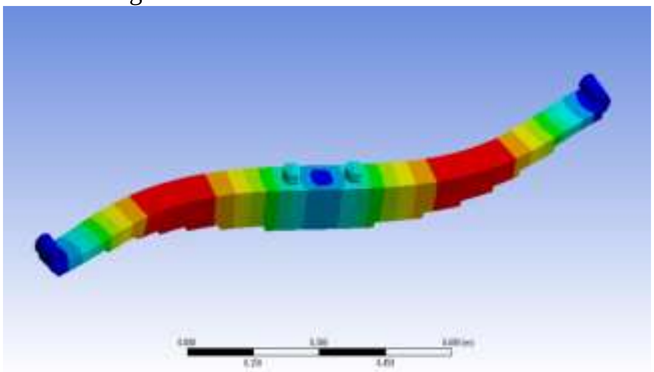

Figure: Shows the mode 5 total deformation result

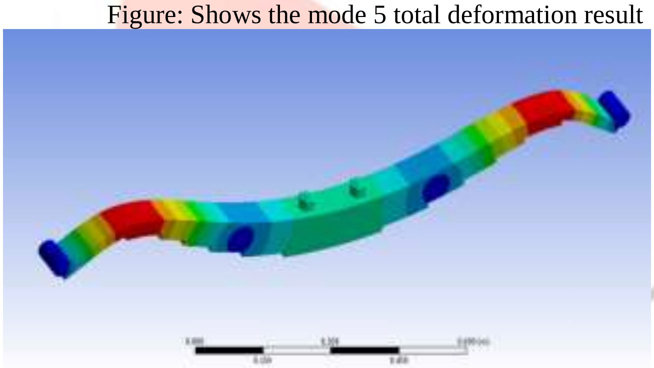

Figure: Shows the mode 6 total deformation result

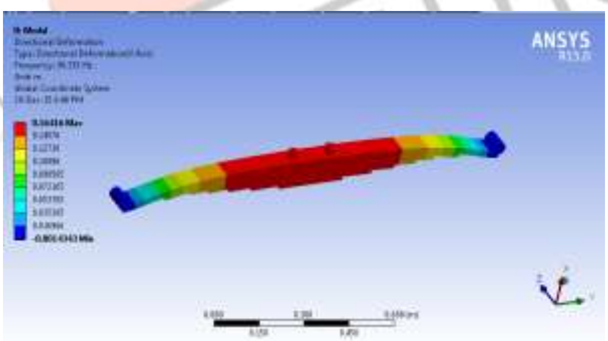

Figure: Shows the X directional deformation result

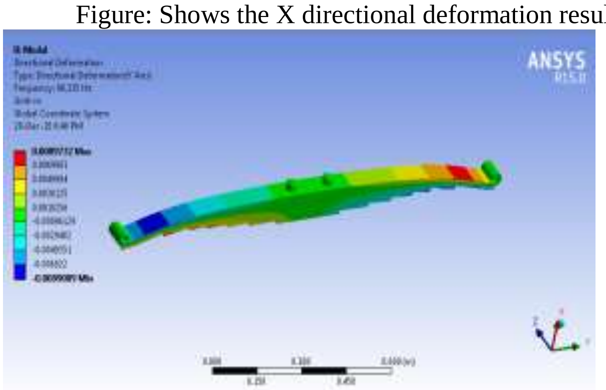

Figure: Shows the Y directional deformation result

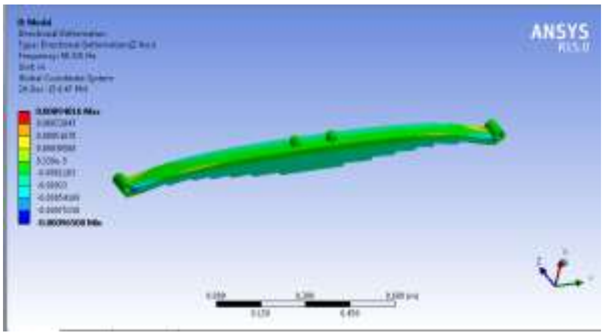

Figure: Shows the Z directional deformation result

b).Single plate honeycomb leaf spring simulation

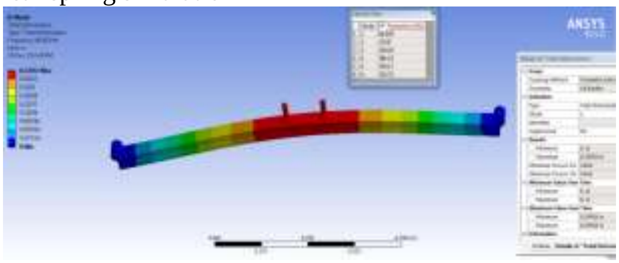

Figure: Shows the mode 1 total deformation result

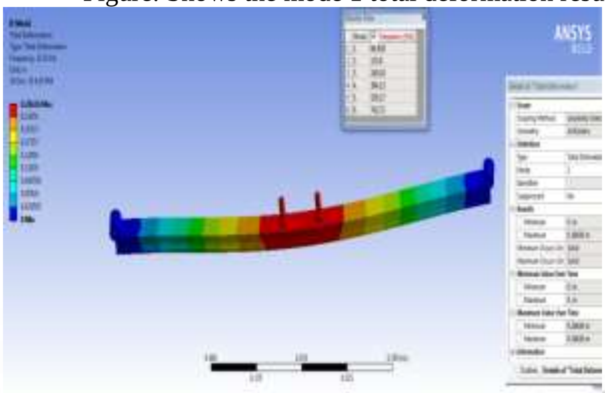

Figure: Shows the mode 2 total deformation result

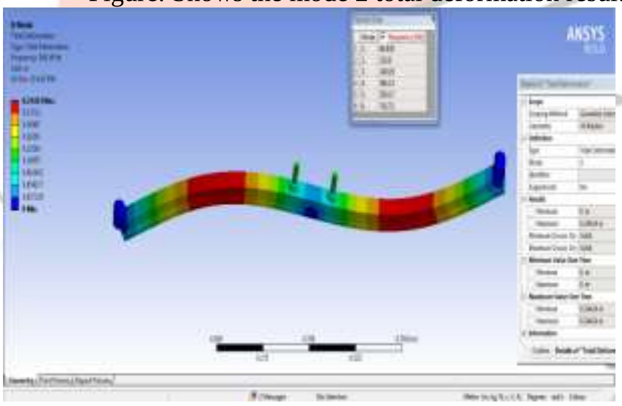

Figure: Shows the mode 3 total deformation result

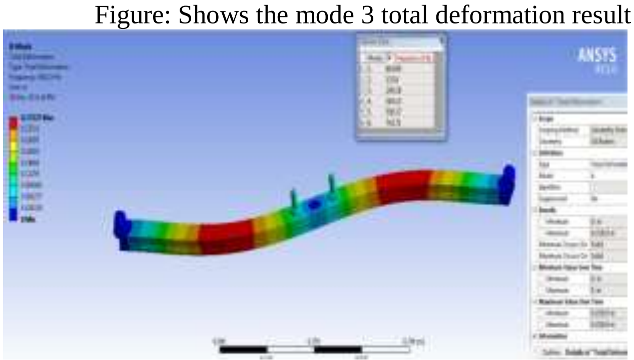

Figure: Shows the mode 4 total deformation result

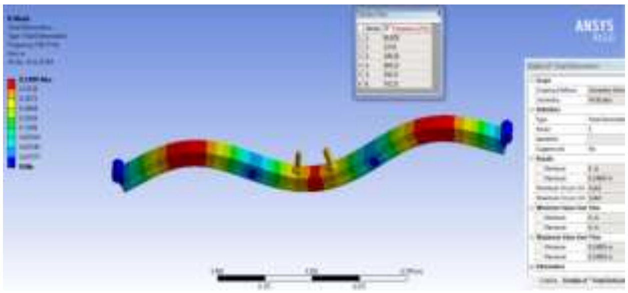

Figure: Shows the mode 5 total deformation result

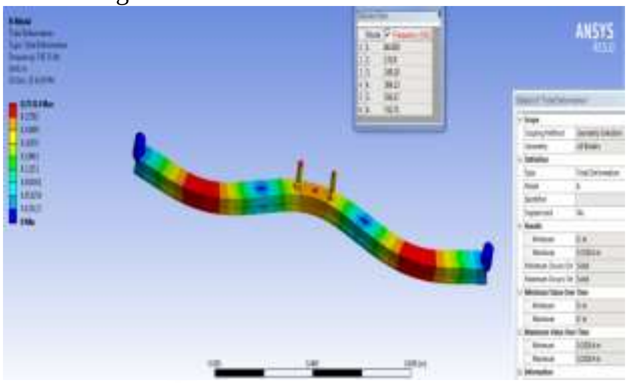

Figure: Shows the mode 6 total deformation result

c).Honeycomb 3 plate leaf spring simulation

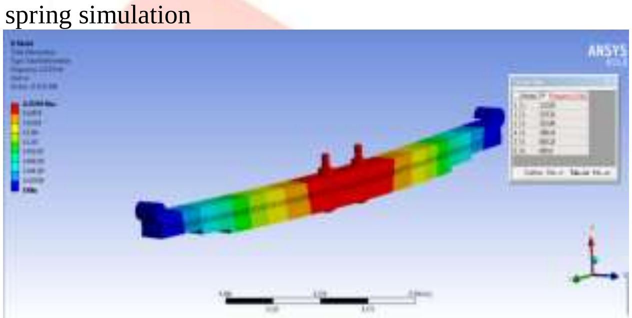

Figure: Shows the mode 1 total deformation result

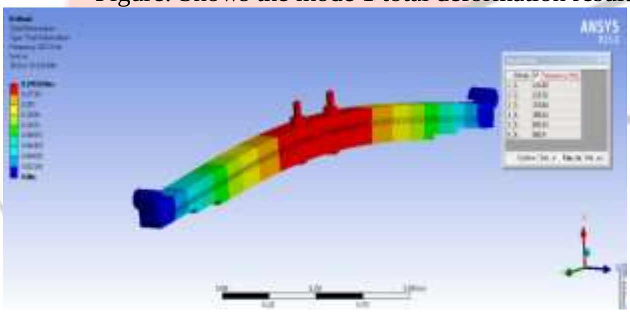

Figure: Shows the mode 2 total deformation result

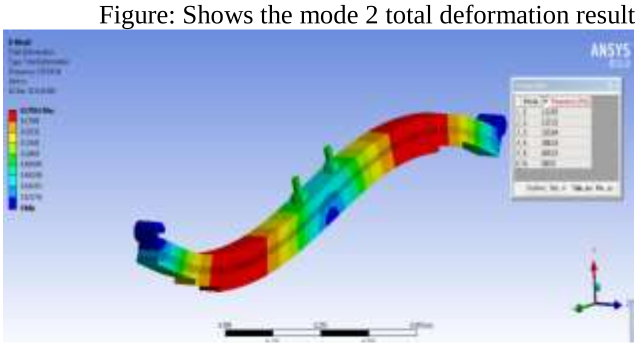

Figure: Shows the mode 3 total deformation result

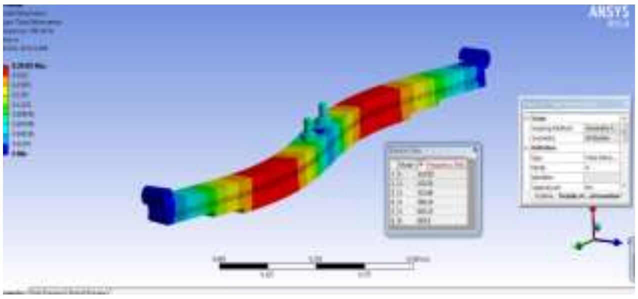

Figure: Shows the mode 4 total deformation result

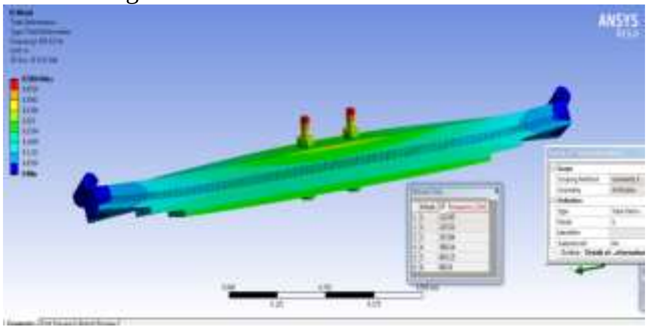

Figure: Shows the mode 5 total deformation result

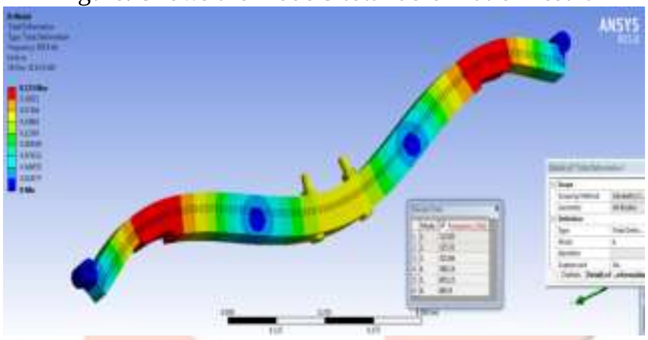

Figure: Shows the mode 6 total deformation result

III. Result And Discussion

Deformation

Table 3.1: Shows deformation results

Type of Model	Deformation in m
Structural steel	5.4363e-5
Single plate honeycomb	9.0938e-5
Honeycomb with 3 plate	2.8684e-5

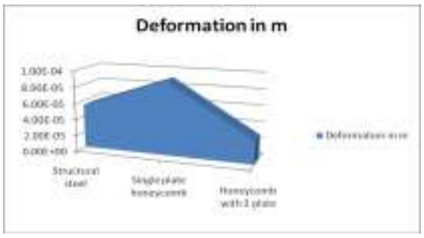

Figure 3.1: Shows deformation results

Above analysis observation shows that deformation is decreases in honeycomb of 3 plates.

Strain

Table 3.2: Shows equivalent elastic strain results

Type of Model	Equivalent Elastic Strain in m/m
Structural steel	3.6958e-5
Single plate honeycomb	5.1024e-5
Honeycomb with 3 plate	1.88e-5

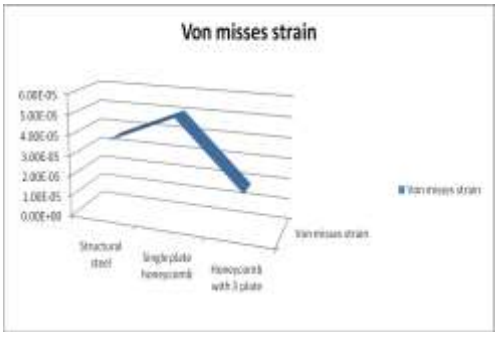

Figure 3.2: Shows equivalent elastic strain results

Above analysis observation shows that equivalent elastic strain is goes on decreasing by increasing the number of plates with cellulor sloids

Above analysis observation shows that equivalent elastic strain is goes on decreasing by increasing the number of plates with cellulor sloids

Stress

Table 3.4: Shows stress results

Type of Model	Von mises Stress in Pa
Structural steel	5.07E+07
Single plate honeycomb	4.44E+07
Honeycomb with 3 plate	3.93E+07

Figure 3.4: Shows stress results

Above analysis observation shows that stress is decreases in honeycomb of 3 plates.

Modal analysis

WITHOUT FOAM FILLED CELLS

Table 3.5: Shows modal analysis results

Type of Model	MODE 1 In Hz
Structural steel	98.335
Single plate honeycomb	86.929
Honeycomb with 3 plate	122.83

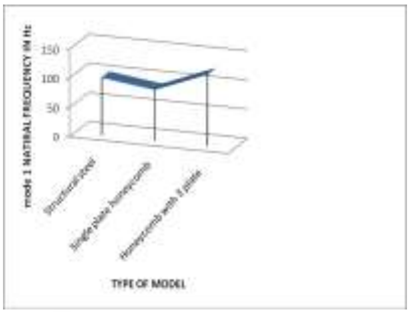

Figure .3.5: Shows modal analysis results

The above observation shows that natural frequency of the cellular solids leaf spring increases due to reduction of mass it induces more vibration.

WITH FOAM FILLED CELLS

Table 3.6: Shows modal analysis results

Type of Model	MODE 1 In Hz
Structural steel	98.335
Single plate honeycomb	66.929
Honeycomb with 3 plate	40.83

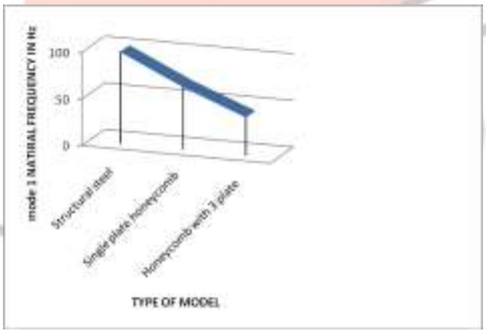

Figure 3.6: Shows modal analysis results

The above observation shows that natural frequency of the cellular solids with foam filled leaf spring decreases due to increases of mass it prevents more vibration.

IV. Conclusions

1. Deformation goes on decreases by introducing cellular solid structure leaf spring.
2. Stress and strains also decreases by introducing cellular solid structure leaf spring.
3. Use of cellular solid's structural leaf spring increases the self-vibration because of mass reduction.
4. Use of weight less foam filled cellular solid's structural leaf spring decreases the self
5. Vibration because of increasing the mass without increase of weight.
6. Use of cellular solids 'structural leaf spring gives the better structural strength and foam
7. Filled cellular solids 'structural leaf spring gives both structural strength and better damping capacity.

V. Scope For Future Exploration

1. Above analysis can be done for different models with different aerospace structural materials.

2. Above analysis can be done for different models with composite materials.
3. Above analysis can be done for different models with Z-directional loading.

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