STRUCTURE ANALYSIS OF LEAF SPRING

[1]Asst. Prof. Ankit Prajapati ,[2]Samir Sabasara,[3]Urjit Shah,[4]Milan Kundalia

[1]Automobile Department,Swarrnim Institute of Technology,Gandhinagar,Gujarat,India
[2,3,4]Student Automobile Department,Swarrnim institute of Technology, Gandhinaagr,Gujarat,India

ABSTRACT

The objective of this present work is to estimate the deflection, stress and mode frequency induced in the leaf spring of a jeep design by the ordinance factory. The emphasis in this project is on the application of computer aided analysis using finite element concept. The leaf spring, which we are analyzing, is a specially designed leaf spring used in jeeps. This spring is intended to bare heavy jerks and vibrations reduced during military operations. In analysis part the finite element of leaf spring is created using solid tetrahedron elements, appropriate boundary conditions are applied, material properties are given and loads are applied as per its design, the resultant deformation, mode frequencies and stresses obtained are reported and discussed.

Keywords: *Leaf Spring, Car body, Design, Analysis, CAD*

1. INTRODUCTION

A leaf spring is a simple form of spring commonly used for the suspension in wheeled vehicles. Originally called a laminated or carriage spring, and sometimes referred to as a semi-elliptical spring or cart spring, it is one of the oldest forms of springing, appearing on carriages in England after 1750 and from there migrating to France and Germany.A leaf spring takes the form of a slender arc-shaped length of spring steel of rectangular cross-section. In the most common configuration, the center of the arc provides location for the axle, while loops formed at either end provide for attaching to the vehicle chassis. For very heavy vehicles, a leaf spring can be made from several leaves stacked on top of each other in several layers, often with progressively shorter leaves. Leaf springs can serve locating and to some extent damping as well as springing functions. While the interleaf friction provides a damping action, it is not well controlled and results in station in the motion of the suspension. For this reason, some manufacturers have used mono-leaf springs.

Fig.1.1 leaf spring

A leaf spring can either be attached directly to the frame at both ends or attached directly at one end, usually the front,with the other end attached through a shackle, a short swinging arm. The shackle takes up the tendency of the leaf spring to elongate when compressed and thus makes for softer springiness.The leaf spring has seen a modern development in cars. The new Volvo XC90 (from 2016 year model and forward) has a transverse leaf spring in high tech composite materials, a solution that is similar to the latest Chevrolet Corvette. This means a straight leaf spring that is tightly secured to the chassis and the ends of the spring bolted to the wheel suspension, to allow the spring to work independently on each wheel. This means the suspension is smaller, flatter and lighter than a traditional setup.

2. DESIGN AND ANALYSIS OF AUTOMOBILE LEAF SPRING USING ANSYS

Work: Design and analysis of composite leaf spring has been done in the present paper. ANSYS 14.5 has been used to conduct the analysis. Static structural tool has been used of ANSYS. A three layer composite leaf spring with full length leave. E-Glass/epoxy composite material has been used. Conventional steel leaf spring results have been compared with the present results obtained for composite leaf spring. E-glass/epoxy material is better in strength and lighter in weight as contrast with conventional steel leaf spring. A wide amount of study has been conducted in this paper to investigate the design and analysis of leaf spring and leaf spring fatigue life

3. Problem statement and objective :

Problem statement:

The present work is to estimate the deflection, stress and mode frequency induced in the leaf spring of an army jeep design by the ordinance factory. The emphasis in this project is on the application of computer aided analysis using finite element concept. The leaf spring, which we are analyzing, is a specially designed leaf spring used in military jeeps. This spring is intended to bare heavy jerks and vibrations reduced during military operations. In analysis part the finite element of leaf spring is created using solid tetrahedron elements, appropriate boundary conditions are applied, material properties are given and loads are applied as per its design, the resultant deformation, mode frequencies and stresses obtained are reported and discussed.

Objective:

The automobile industry is showing increased interest in the replacement of steel spring with fiberglass composite leaf spring due to high strength to weight ratio. Therefore; this project aims at comparative study of design parameters of a traditional steel leaf spring assembly and mono composite leaf spring with bonded end joints. By performing static analysis using ANSYS software and mathematical calculations, the maximum bending stress and corresponding payload have to be determined by considering the factor of safety. Determining and assessing the behavior of the different parametric combinations of the leaf spring, their natural frequencies are compared with the excitation frequencies at different speeds of the vehicle with the various widths of the road irregularity. These excitation frequencies are calculated mathematically. So our method is as below:

- Modeling of a leaf spring
- Structural analysis of a leaf spring in ANSYS.
- Analytical calculation
- optimization

4. Modelling of leaf spring

- **Modelling**

  After performing simple calculation, the modelling has been performed on the Solid works 2012 version and then after the analysis work has been performed on the ANSYS 12.0 version.

- **About Solid works**

Solid works is a computer graphics system for modeling various mechanical designs for performing related design and manufacturing operations. The system uses a 3D solid modeling system as the core, and applies the feature base parametric modeling method. In short solid works is a feature based parametric solid modeling system with many extended design and manufacturing applications

- **Technical data of a leaf spring:**

  The following are the model dimensions.

1. Camber = 80mm
2. Span = 1220mm
3. Thickness of leaves = 7mm
4. Number of leaves = 10
5. Number of full length leaves nF = 2
6. Number of graduated length leaves nG = 8
7. Width = 60

8. Ineffective length = 60mm

9. Eye Diameter = 20mm

10. Bolt Diameter = 10mm

Modeling of Cooling Tower Parts

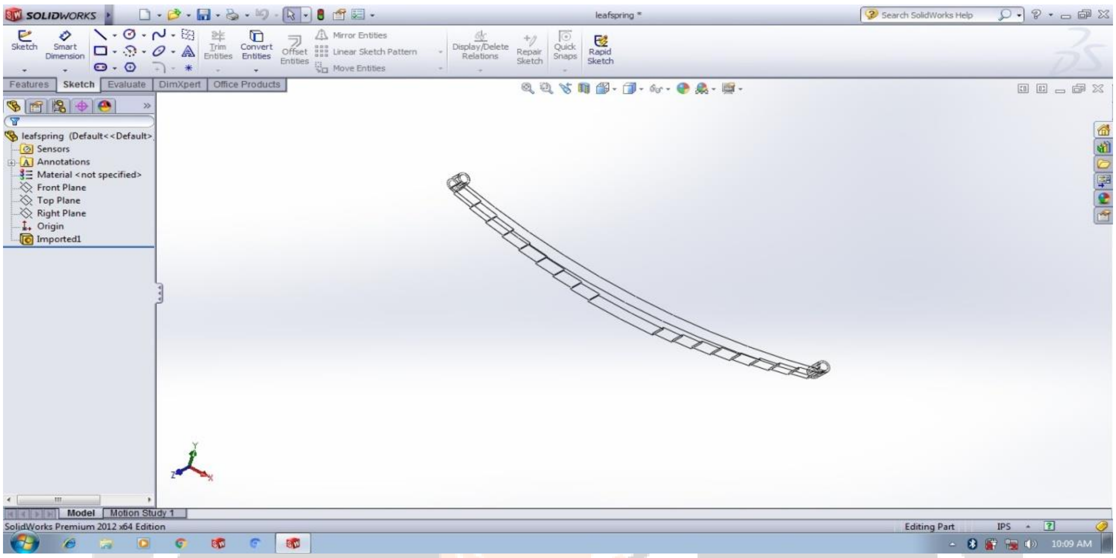


Fig.: wire frame modal of a leaf spring

`

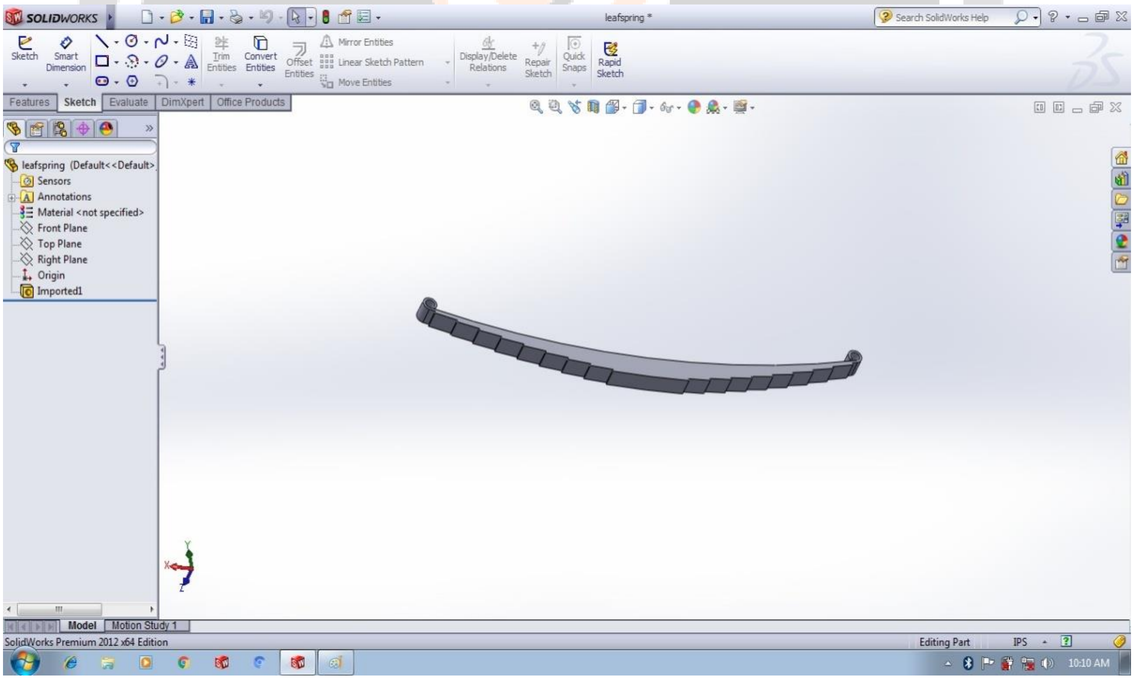


Fig.: Solid Frame Model of a leaf spring

4. Structural analysisof leaf spring

- Techniques For Numerical Discretization

In order to solve the governing equations of the fluid motion, first their numerical analogue must be generated. This is done by a process referred to as discretization. In the discretization process, each term within the partial differential equation describing the flow is written in such a manner that the computer can be programmed to calculate. There are various techniques for numerical discretization. Here we will introduce three of the most commonly used techniques, namely:

(1) Finite difference method

(2) Finite element method

(3) Finite volume method

5. METHODOLOGY

It is used to determine the performance of a component at the design stage, or it can be used to analyses difficulties with an existing component and lead to its improved design. For example, the pressure drop through a component may be considered excessive: The first step is to identify the region of interest: The geometry of the region of interest is then defined. If the geometry already exists in CAD, it can be imported directly. The mesh is then created. After importing the mesh into the pre-processor, other elements of the simulation including the boundary conditions (inlets, outlets, etc.) and fluid properties are defined. The flow solver is run to produce a file of results which contain the variation of velocity, pressure and any other variables throughout the region of interest. The results can be visualized and can provide the engineer an understanding of the behavior of the fluid throughout the region of interest. This can lead to design modifications which can be tested by changing the geometry of the CFD model and seeing the effect.

The process of performing a single CFD simulation is split into four components:

1. Geometry/Mesh

2. Physics Definition

3. Solver

4. Post-processor

GEOMETRY

The first task to accomplish in a numerical flow simulation is the definition of the geometry followed by the grid generation. This step is the most important step for the study of isolated impeller assuming an axis symmetric flow simplifies the domain to a single blade passage.

The geometry of the design needs to be created from the initial design. Any modeling software can be used for modeling and shifted to other simulation software for analysis purpose.

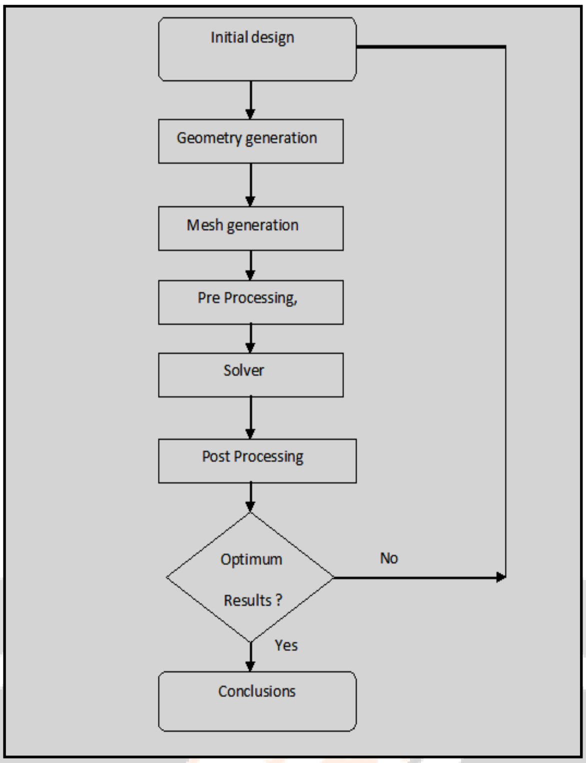
TYPES OF GRIDS

Grid generation is often considered as the most important and most time consuming part of CFD simulation. The quality of the grid plays a direct role on the quality of the analysis, regardless of the flow solver used. Additionally, the solver will be more robust and efficient when using a well constructed mesh. It is important for the CFD analyst to know and understand all of the various grid generation methods.

This pre-processing stage is now highly automated. In work bench geometry can be imported from most major pro-e or solid work a package using native format, and the mesh of control volumes is generated automatically.

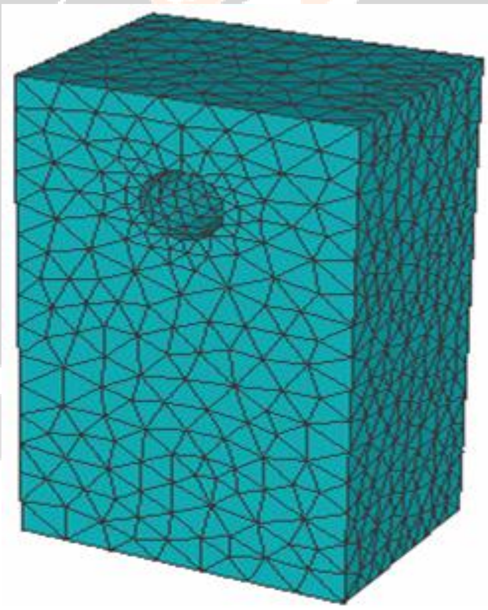
1. Structured Grid

2. Unstructured Grid



Flow chart showing methodology

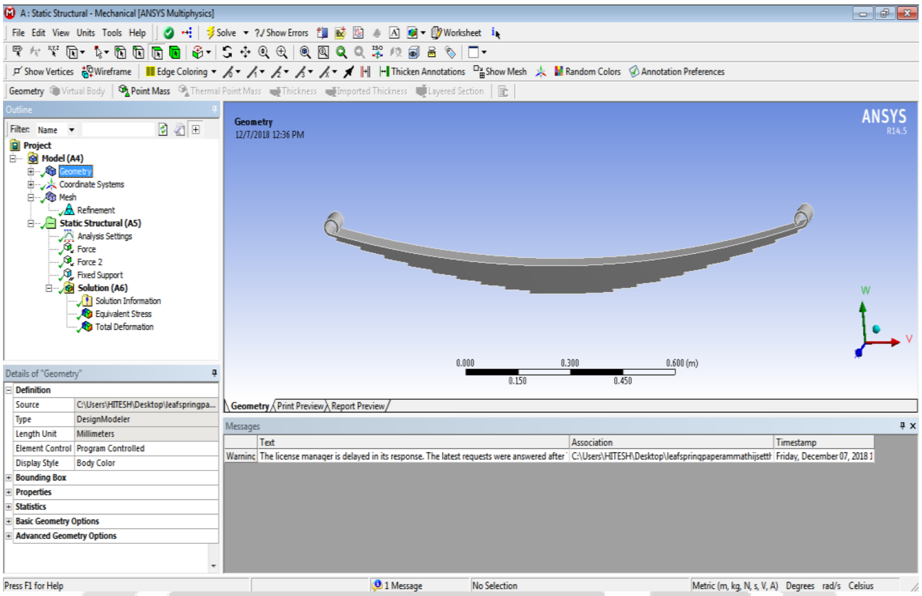
6. Structured Grid



The advantage of unstructured grid methods is that they are much automated and, therefore, require little user time or effort. The user need not worry about laying out block structure or connections. Additionally, unstructured grid methods are well suited to inexperienced users because they require little user input and will generate a valid mesh under most circumstances. Unstructured methods also enable the solution of very large and detailed problems in a relatively short period of time. Grid generation times are usually measured in minutes or hours. The major drawback of unstructured grids is the lack of user control when laying out the mesh. Typically any user involvement is limited to the boundaries of the mesh with the mesher automatically filling the interior. Triangle and tetrahedral elements have the problem that they do not stretch or twist well, therefore, the grid is limited to being largely isotropic, i.e. all the elements have roughly the same size and shape. This is a major problem when trying to refine the grid in a local area, often the entire grid must be made much finer in order to get the point densities required locally.

7. METHODOLOGY

CREATE A 3D MODAL AND IMPORTED IN ANSYS

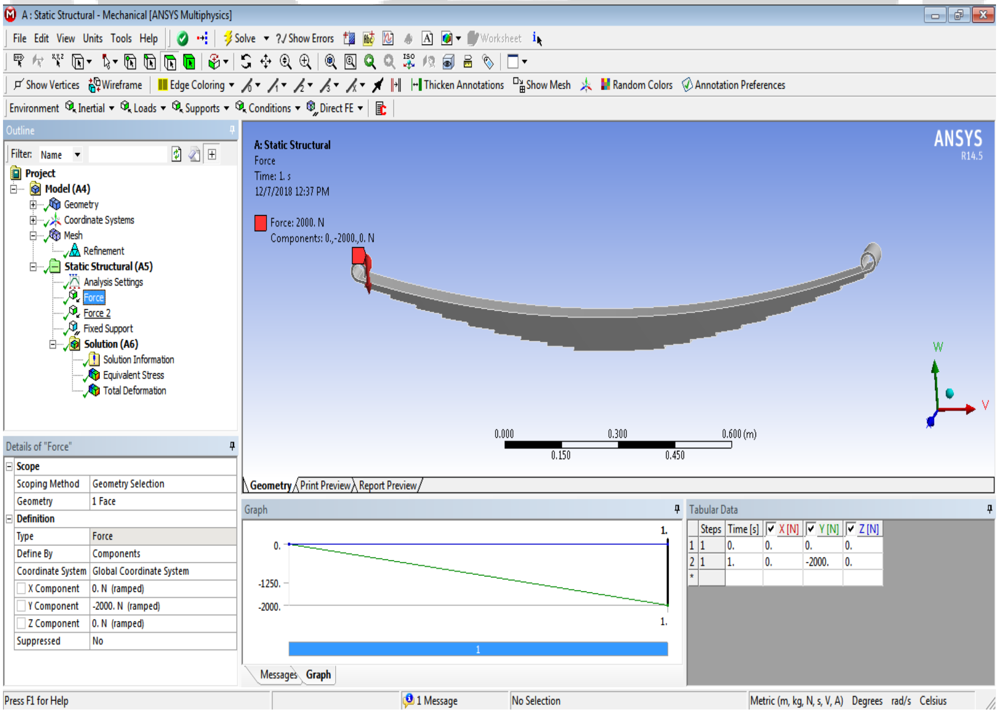


model imported in software

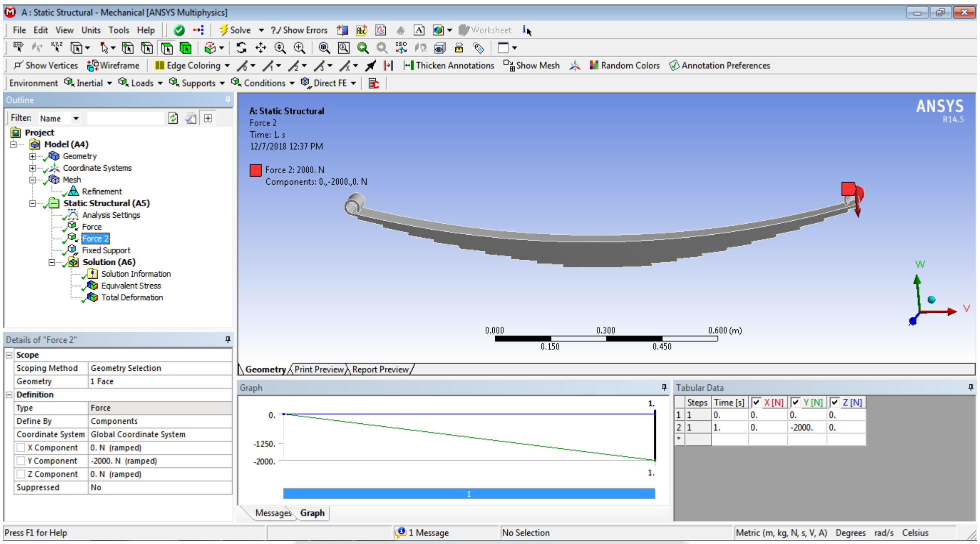
For steel leaf spring brick 20 node95 is well suited to modal irregular meshes (such as produced from various CAD/CAM Systems.) the element is defined by four nodes having six degrees of freedom at each node: translation in the nodal x, y, and z directions and rotations about the nodal x, y, and z directions. The element also has stress stiffening capability. A 10 – node tetrahedral element without rotational degrees of freedom is also available called solid 92.

For mono composite leaf spring Shell 99 linear layer 99 with 6 degrees of freedom is a typically used standard element type

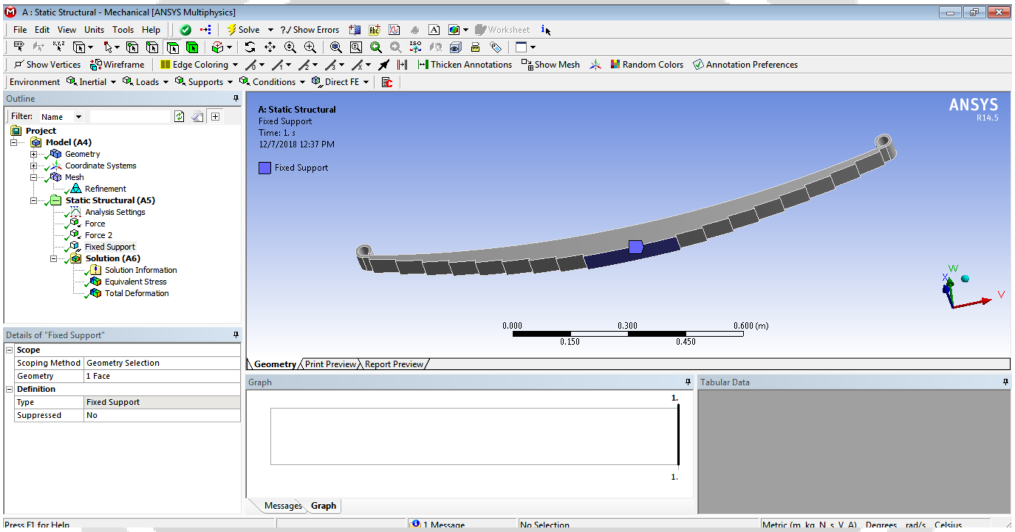
- **LOADING CONDITIONS:**



Loading conditions (1)

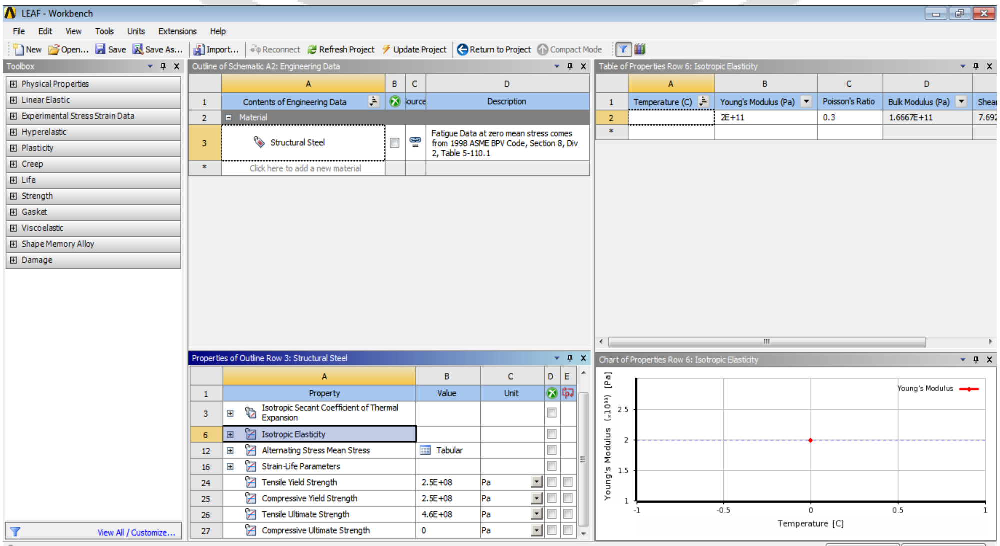


Loading conditions (2)



Loading conditions (3)

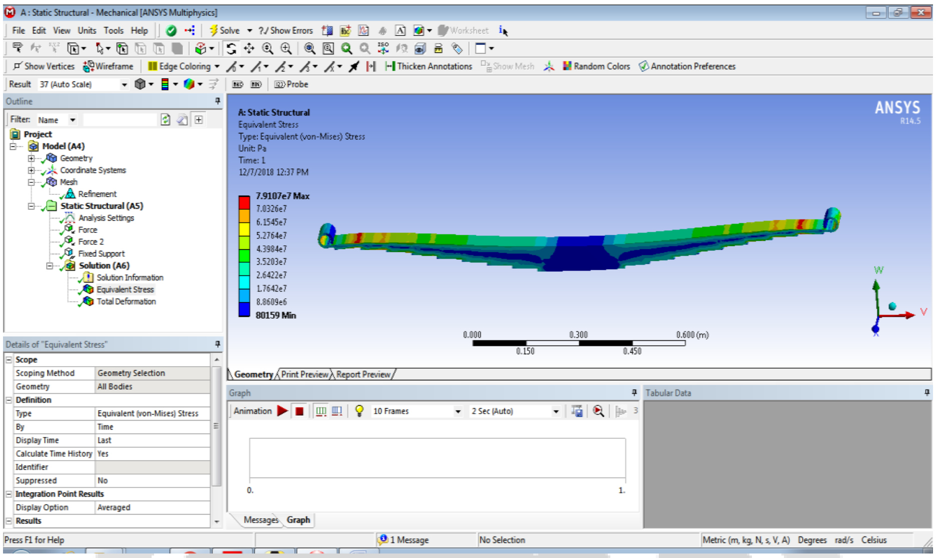
- **MATERIAL PROPERTY OF STEEL**



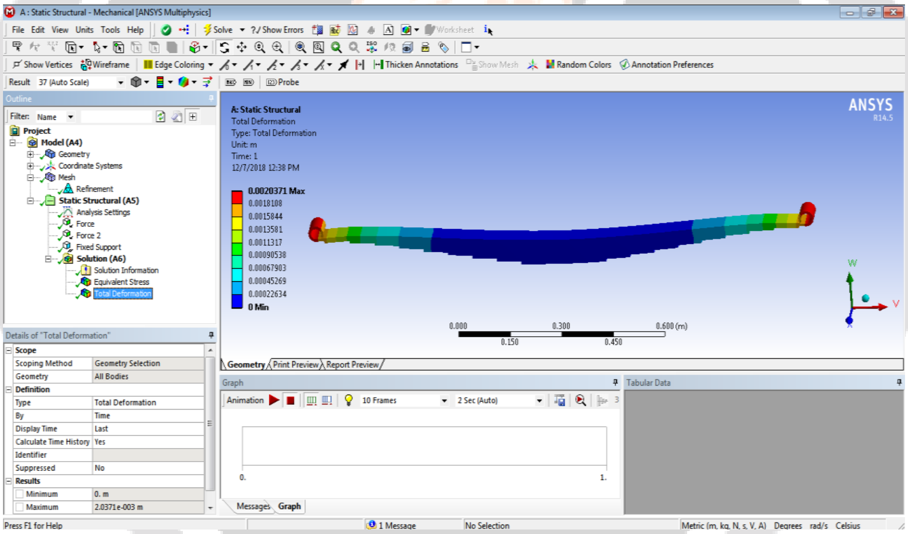
Material property of steel

RESULT:

- **STRESS IN LEAF SPRING**



DEFORMATION OF LEAF SPRING



Deformation of leaf spring

REFERENCES:

1. EliahuZahavi The Finite Element Method in Machine Design. Prentice Hall, Englewood Cliffs, N.J, 07632.
2. A Skrtz, T.Paszek,(1992) “Three dimensional contact analysis of the car leaf spring”, Numerical methods in continuum mechanics, 2003, Zilina, Skrtz republic.
3. Cheng Wang, (1999) “Design and Synthesis of Active and Passive vehicle suspensions.
4. I Rajendran, S. Vijayarangan, “Design and Analysis of a Composite Leaf spring”, Journal of Institute of Engineers India, 82, 2002, 180-187
5. GulurSiddaramanna, Shiva Shankar “Mono Composite Leaf Spring for Light Weight Vehicle – Design, End Joint Analysis and Testing, ISSN 1392–1320 MATERIALS SCIENCE (MEDŽIAGOTYRA). Vol. 12, No. 3. 2006
6. VinkelArora, Dr. M. L Aggarwal, Dr.GianBhushan (2011), A Comparative Study of CAE and Experimental Results of Leaf Springs in Automotive vehicles. Int. Jr. of Engineering Science and Technology Vol-3. page.no:5856-5866