DESIGN AND ANALYSIS OF HELICAL SPRING WITH CREO AND ANSYS

A REPORT SUBMITTED TO MSME CENTER DURG

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ABSTRACT

A helical spring is a mechanical device which is typically used to store energy and subsequently release it, to absorb shock, or to maintain a force between contracting surface. They are made of an elastic material formed into the shape of a helix which returns to its natural length when unloaded. The purpose of this project is to modelling and analysis of helical spring and to increase the stiffness of it by using the new materials to reduce the vehicle problem that happens while driving on bumping road condition. The comparative study is carried out between existed spring and new material spring. Static analysis determines the stress and deflection of the helical compression spring in finite element analysis (FEA). The model is used to analyse the spring on the ANSYS under different materials conditions. Finite element analysis methods (FEA) are the methods of finding approximate solution to a physical problem defined in a finite region or domain. FEA (WORKBENCH) is a mathematical tool for solving engineering problems. In this the finite element analysis values are compared to the experimental values. A typical two-wheeler suspension spring is chosen for study. The modelling of spring is developed on CREO 4.0 and analysis is carried out on ANSYS.

INRODUCTION

Spring is an elastic or resilient body, whose function is to deflect or deform when load is applied and recover its original shape when load is removed. Spring has a multiple area of application, with their different types. They are widely used for different purpose, their basic types are given below as follows,

1. Helical spring
2. Conical or volute spring
3. Disc or Belleville springs
4. Leaf or laminated spring

Among all these types of springs, leaf springs and helical springs are mostly used in automobile suspension system. Out of which helical spring is mostly used in motorcycle suspension because the coil spring are used to deliver more comfort as compared to leaf spring and the load on two wheelers or the motorcycle is less compare to the heavy vehicle. In the suspension system of two wheelers, damper is used along with the helical coil spring. When the load or shock vibrations are exerted on the spring it compresses and absorbs the vibration and reduces the amplitude of disturbances. As a result of absorption of shock vibration, the spring in turn starts to oscillate and here the damper is used for progressively diminishing these oscillation of the spring or else it will continuously oscillate.

Project Objectives

- To create a model of helical compression spring in creo 4.0 .
- To create a finite element analysis (FEA) model of the spring and simulate the model using different type of material.
- To practice design and analysis with creo and ansys.

ANALYSIS ON HELICAL SPRINGS

The helical spring are made up of a wire coiled in the form of a helix and is primarily intended for compressive or tensile load. The cross-section of the wire from which the spring is made may be circular, square or rectangular.

Helical springs are two types-

Compression helical spring and tensile helical spring.

Spring constant dependencies-

For the spring in this discussion, HOOK'S law is typically assuming to hold,

$$F = k\Delta$$

We can expand the spring constant k as a function of the material properties of the spring. Doing so and solving for the spring displacement gives,

$$\Delta = F/k = 8FD^3N/Gd^4$$

Where G is the material shear modulus N is the number of active coil D is the mean diameter of coil d is the wire diameter.

Number of active coils = total number of coils – the number of end coils

$$N = N_t - N^*$$

The value of N* depends on the ends of spring.

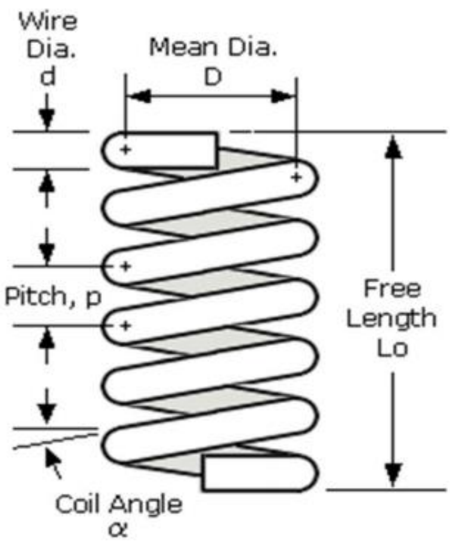


Figure-1

Deflection in the spring

The spring index C, can be used to express the deflection,

$$C = D/d$$

$$\Delta = 8FC^3N/Gd = F/k$$

The useful range for C is about 4 to 12, with an optimum value of approximately 9. The wire dia. d should conform to a standard size if at all possible.

The active wire length L can also be used to form an expression for the deflection,

$$L = \pi DN$$

$$\Delta = 8FD^3L/\pi Gd^4$$

Shear stress in the spring

The maximum shear stress τ_{max} in a helical spring occurs on the inner face of the spring coils and is equal to,

$$\tau_{max} = 8FCW/\pi d^2 = 8FDW/\pi d^3$$

Where W is the Wahl Correction Factor which accounts for shear stress resulting from spring curvature,

$$W = \{(4C - 1) / (4C - 4)\} + 0.615/C$$

Stiffness of the spring

The stiffness of the spring is given by

$$k = F/\Delta$$

Table: 1 Result by analytical method

S. No.	Material	Deflection (mm)	Stiffness (N/mm)
1.	Stainless Steel	91.52	10.92
2.	Titanium Alloy	225.41	4.44

METHODOLOGY

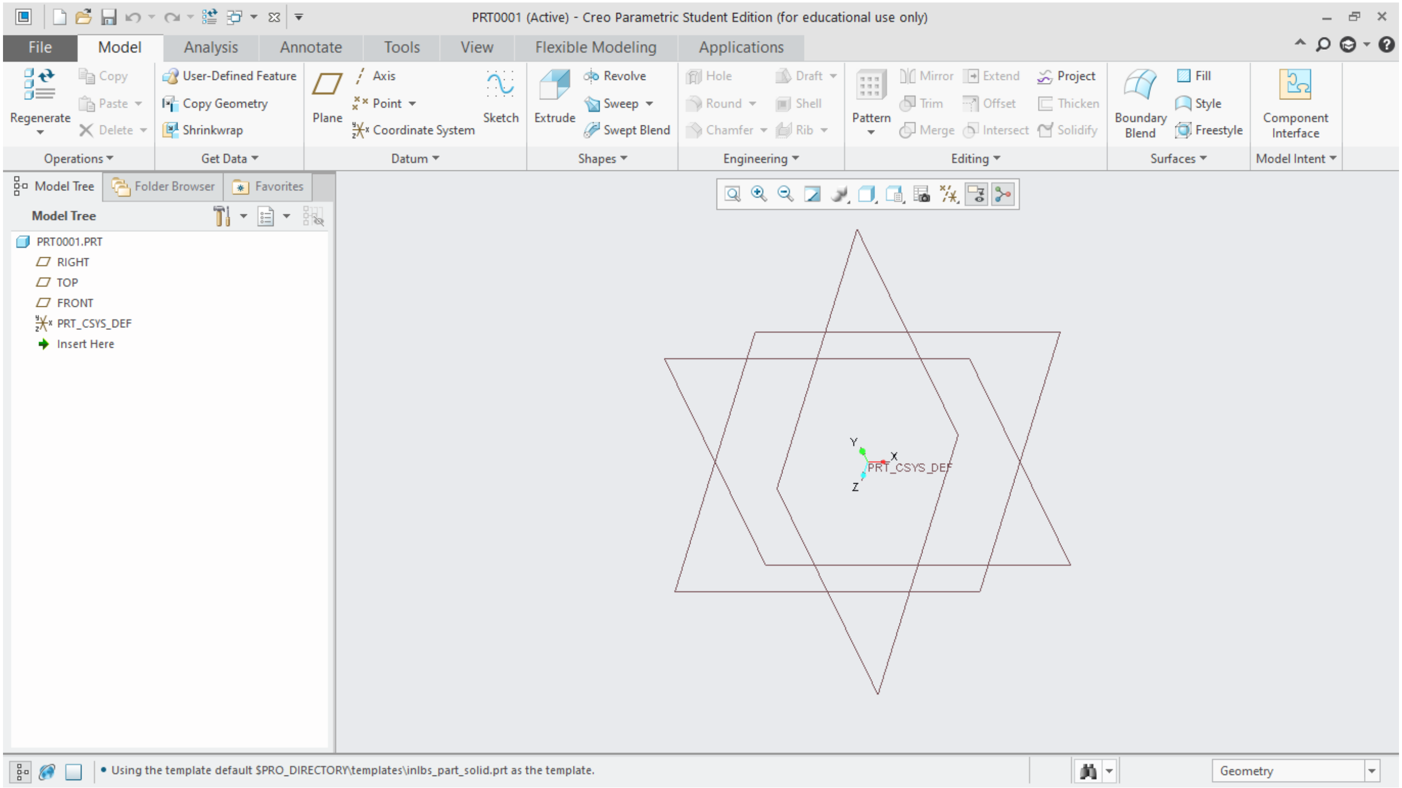
Model Designing in CREO

Creo is a family or suite of Computer-aided design (CAD) apps supporting product design for discrete manufacturers and is developed by PTC. The suite consists of apps, each delivering a distinct set of capabilities for a user role within product development.

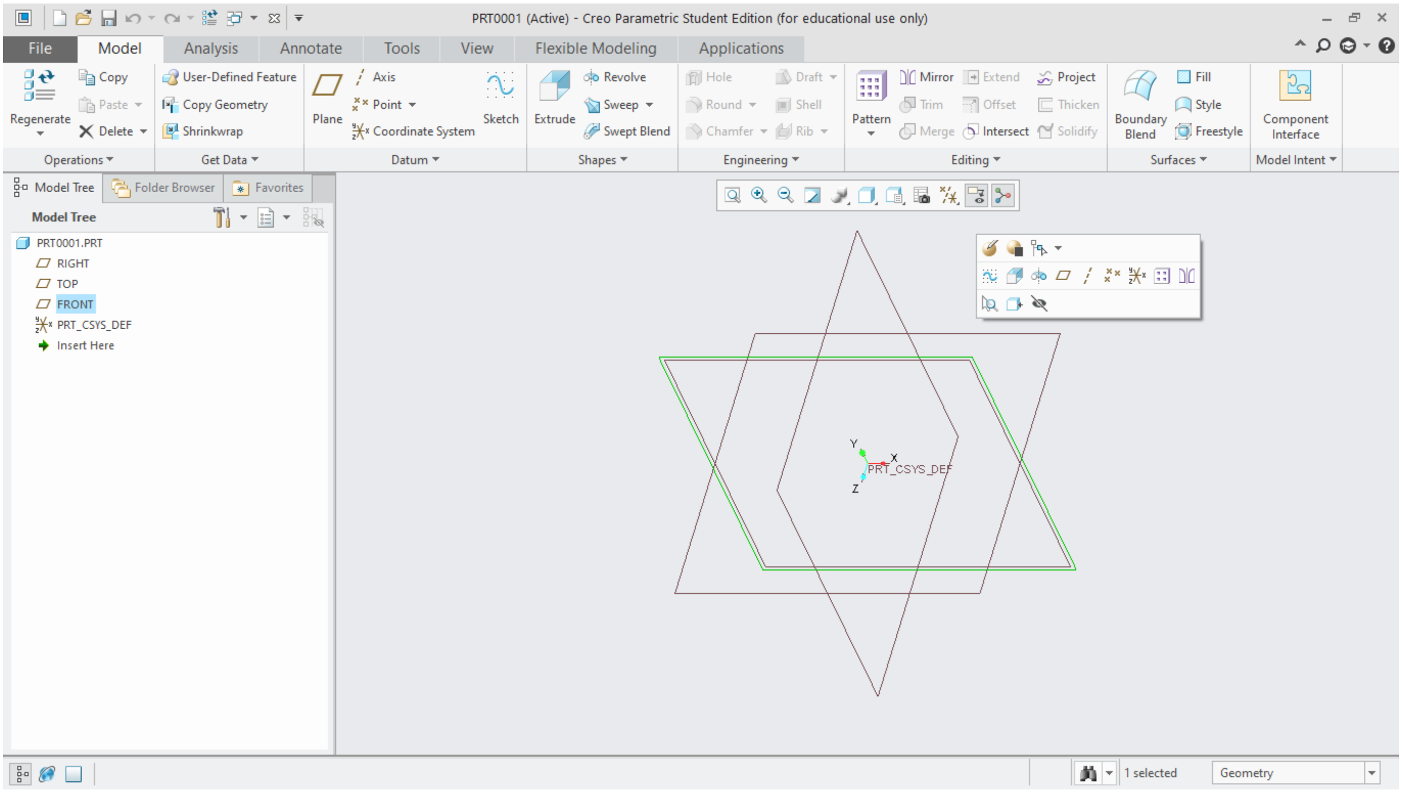
Creo runs on Microsoft Windows and provides apps for 3D CAD parametric feature solid modelling, 3D direct modelling, 2D orthographic views, Finite Element Analysis and simulation, schematic design, technical illustrations, and viewing and visualization.

1) **Modelling Technology:** CREO is a solid modeller, and utilizes a parametric feature-based approach to create models and assemblies. The software is written on Para solid-kernel. Building a model in CREO usually starts with a 2D sketch (although 3D sketches are available for power users). The sketch consists of geometry such as points, lines, arcs, conics (except the hyperbola), and splines. Dimensions are added to the sketch to define the size and location of the geometry. Relations are used to define attributes such as tangency, parallelism, perpendicularity, and concentricity. The parametric nature of CREO means that the dimensions and relations drive the geometry, not the other way around. The dimensions in the sketch can be controlled independently, or by relationships to other parameters inside or outside of the sketch.

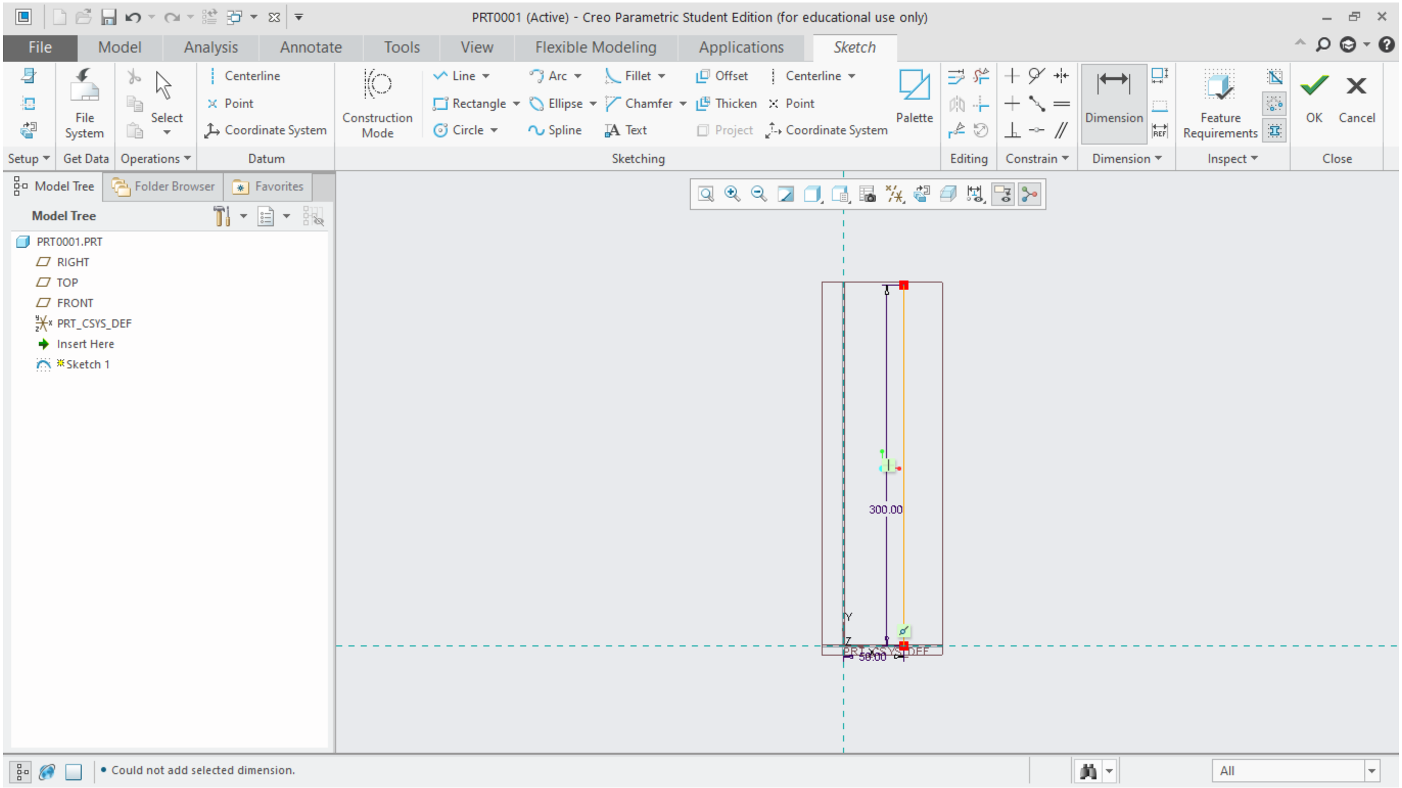
2) CREO Home Page:



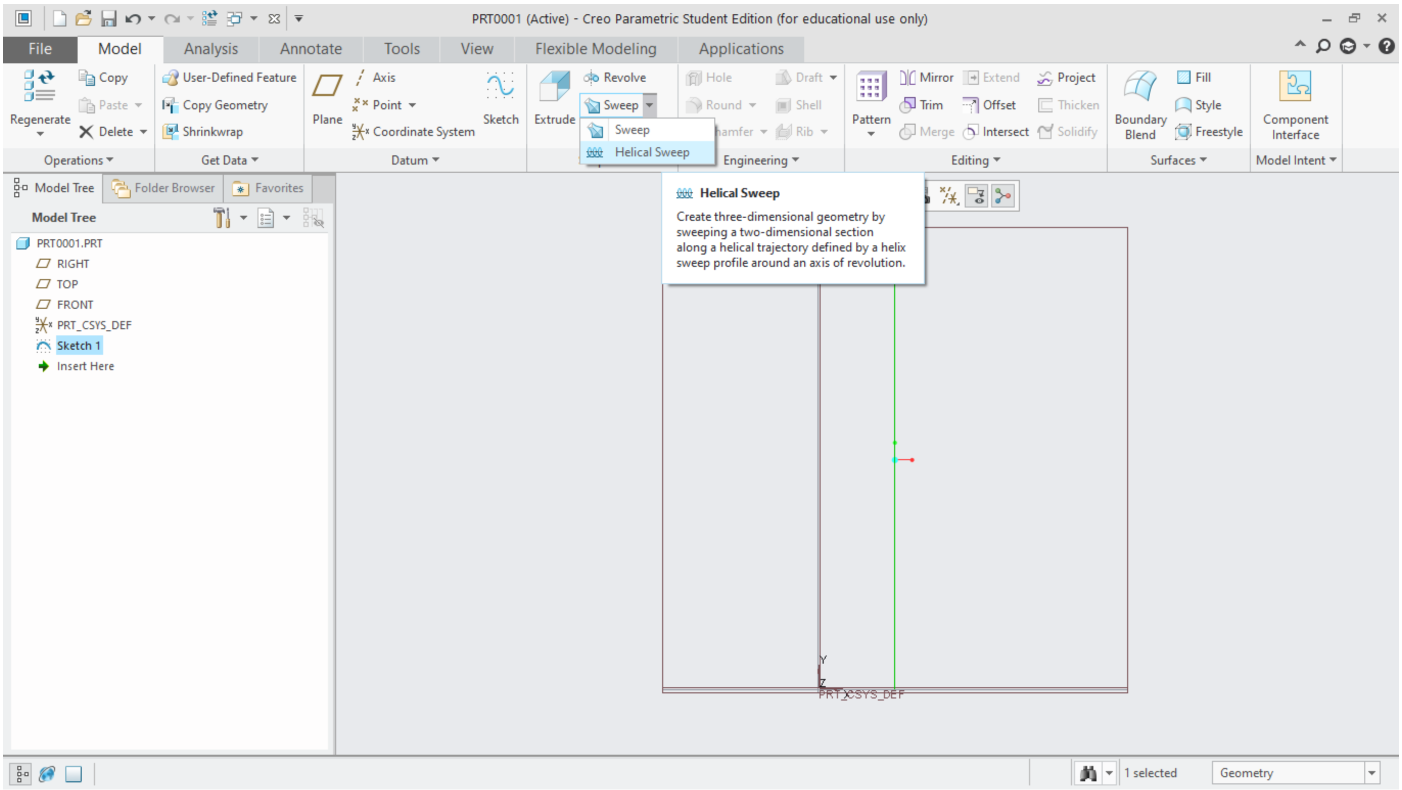
3) Select Front plane for creating sketch



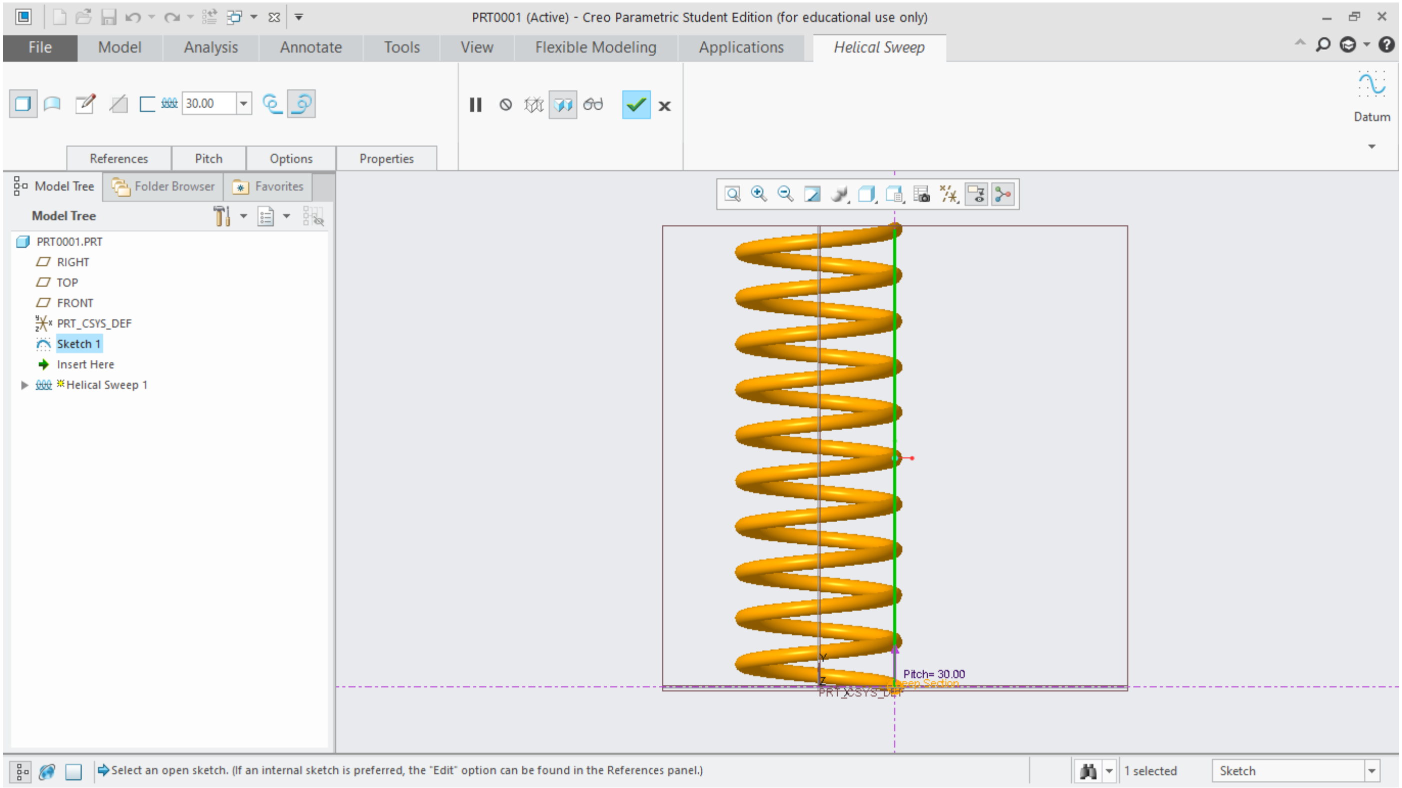
4) Prepare 2D sketch of helical spring

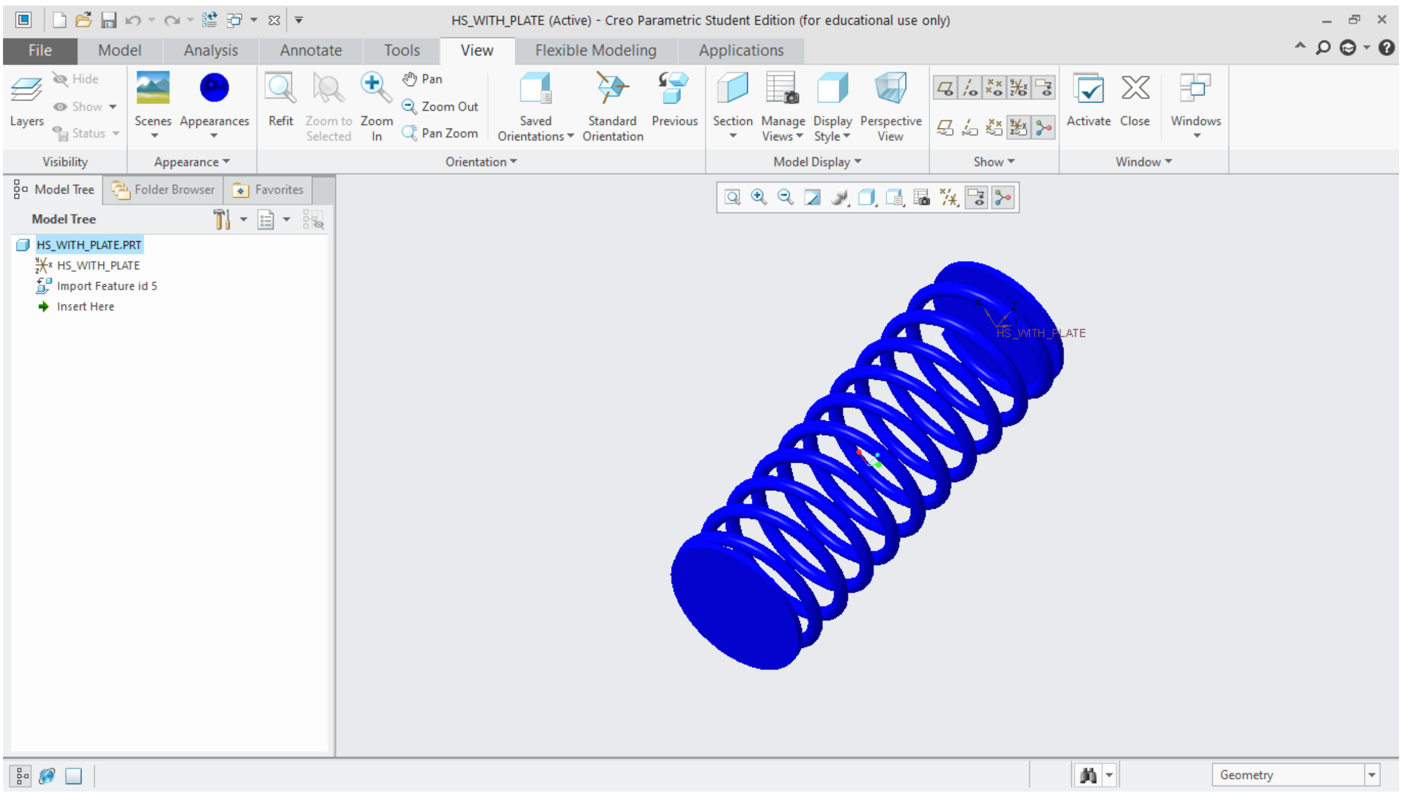


5) Select Helical Sweep



6) Complete 3D Helical Spring

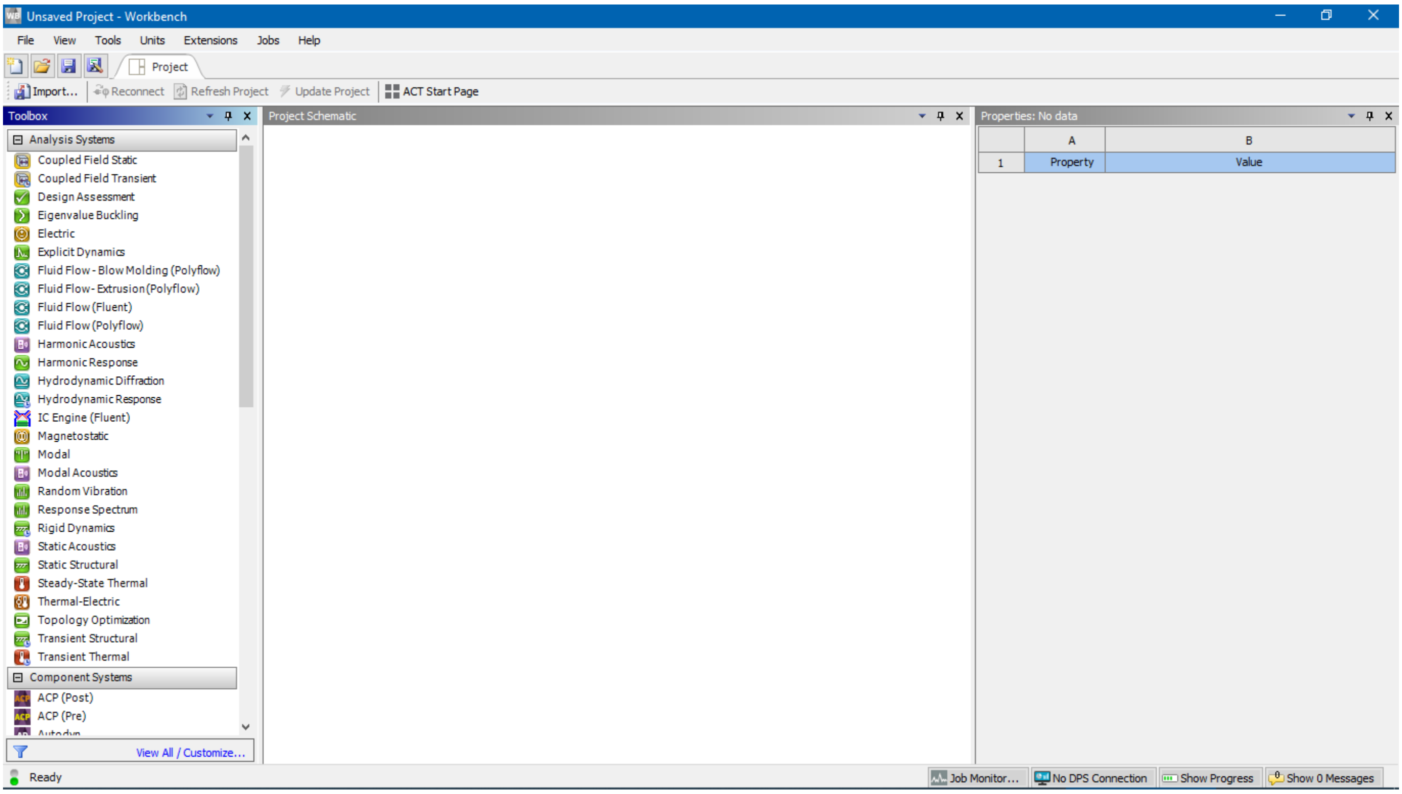




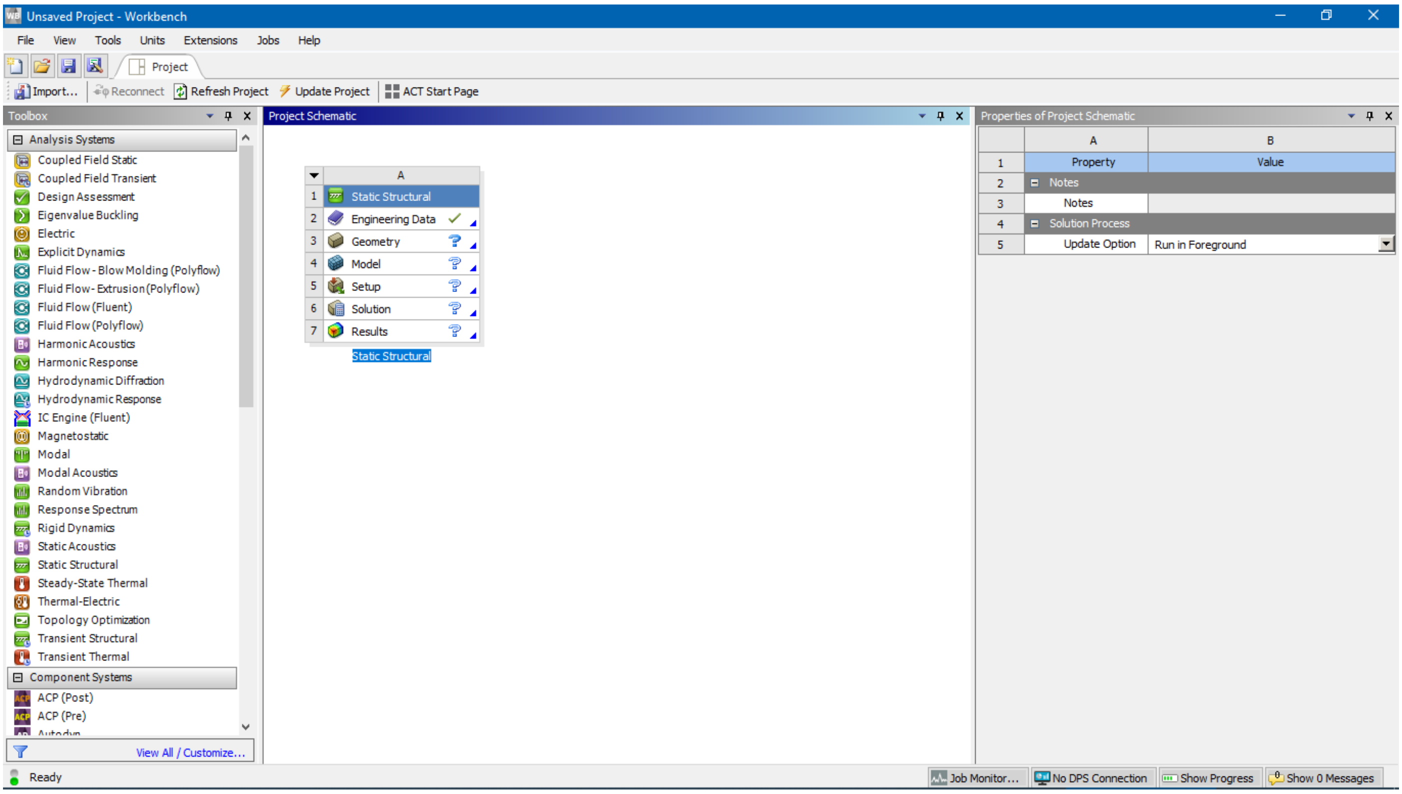
Analysis of deformation of helical spring at ANSYS workbench

1) **Introduction to Ansys:**

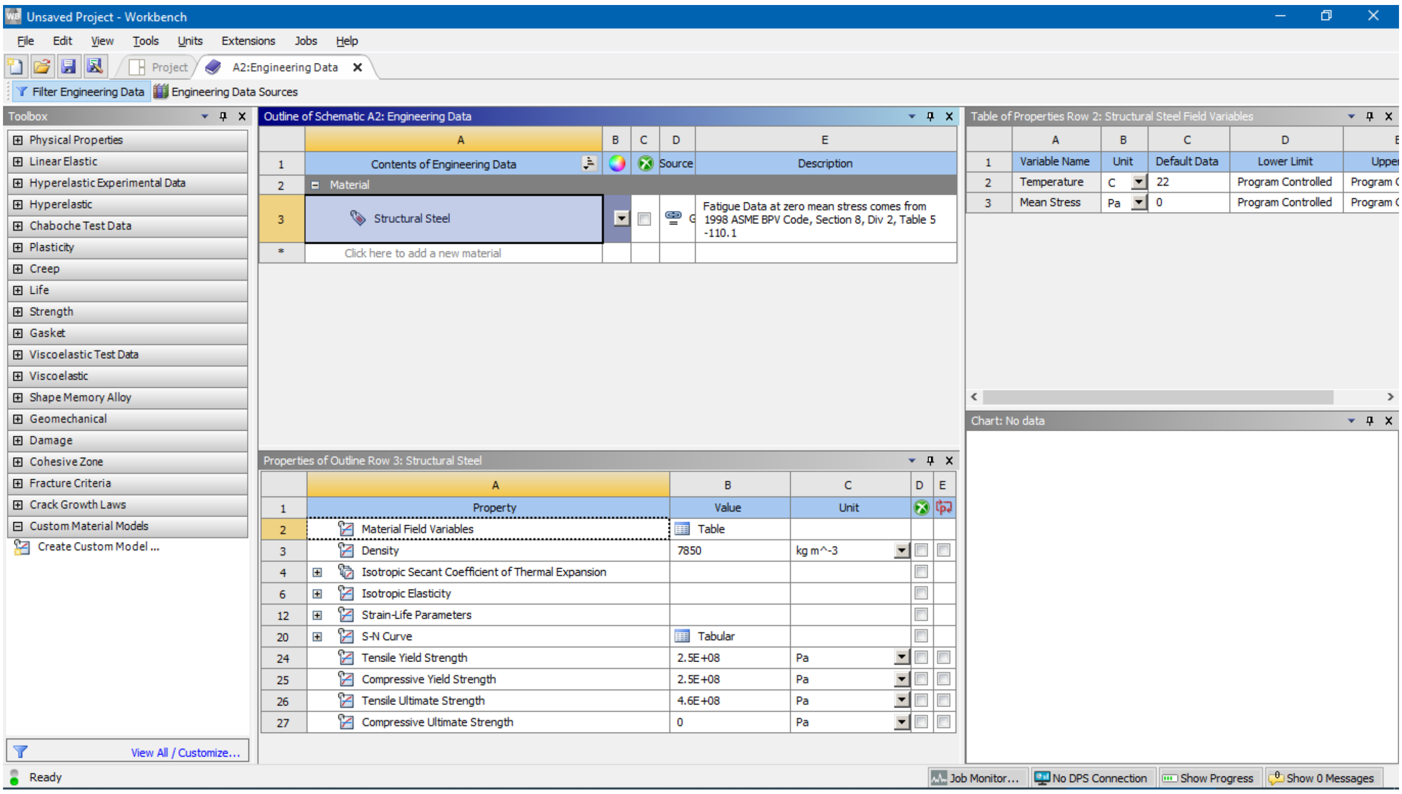
Ansys is an analysing software. It is used to check design feasibility of the design almost in all aspect. Ansys as a software is made to be user-friendly and simplified as much as possible with lots of interface options to keep the user as much as possible from the hectic side of programming and debugging process. A glimpse of Ansys workbench is shown below



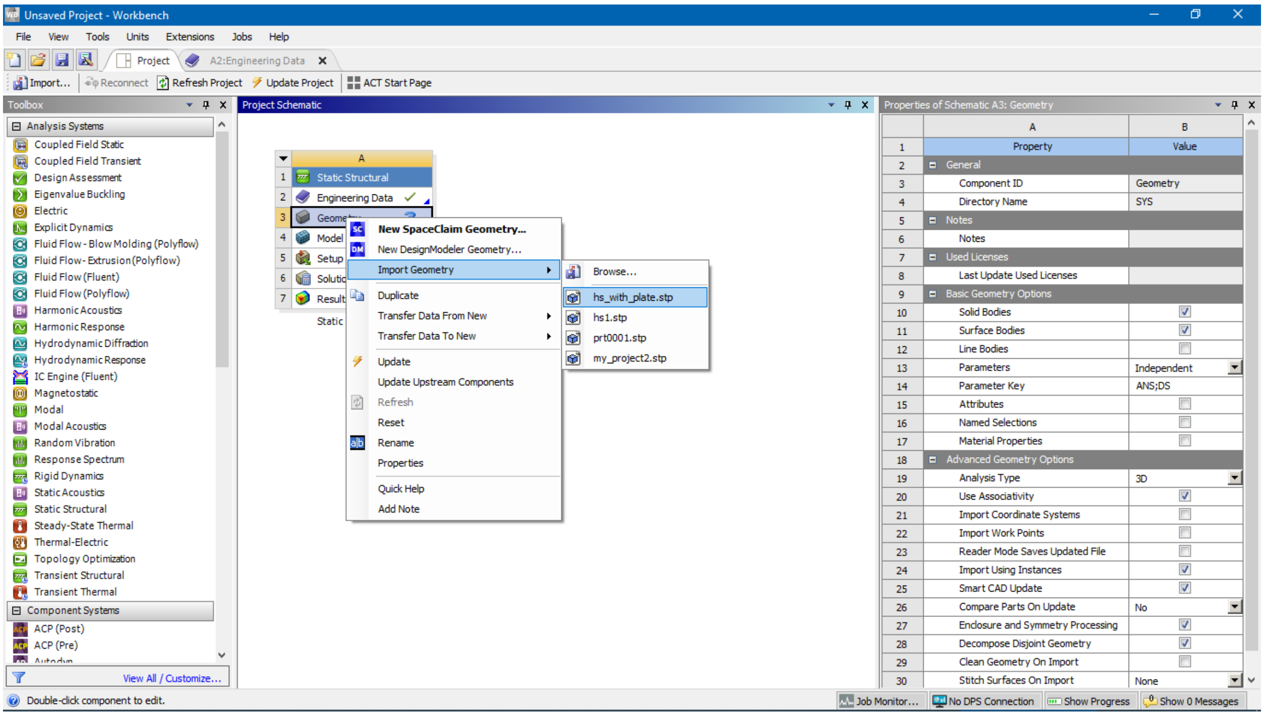
2) Create Analysis System: Take one of the readymade stencil from the tool box according to the need of the project. In this project we took static structural as analysis system for the analysis of connecting rod. To analysing connecting rod using different material at Ansys workbench 16.2 following step have been followed



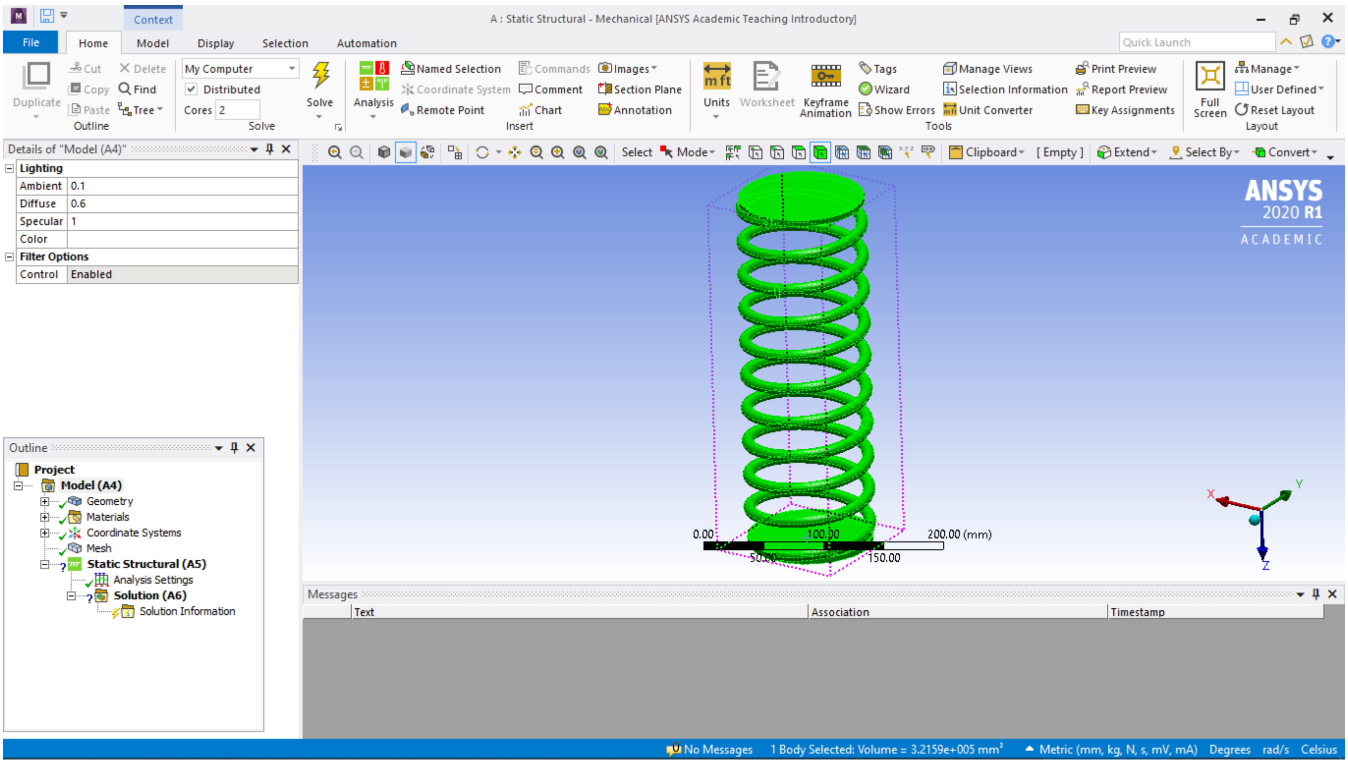
3) Define Engineering Data: In this section material for the current project is assigned. In Ansys by default structural steel is selected. To assign new material turn on the engineering data source



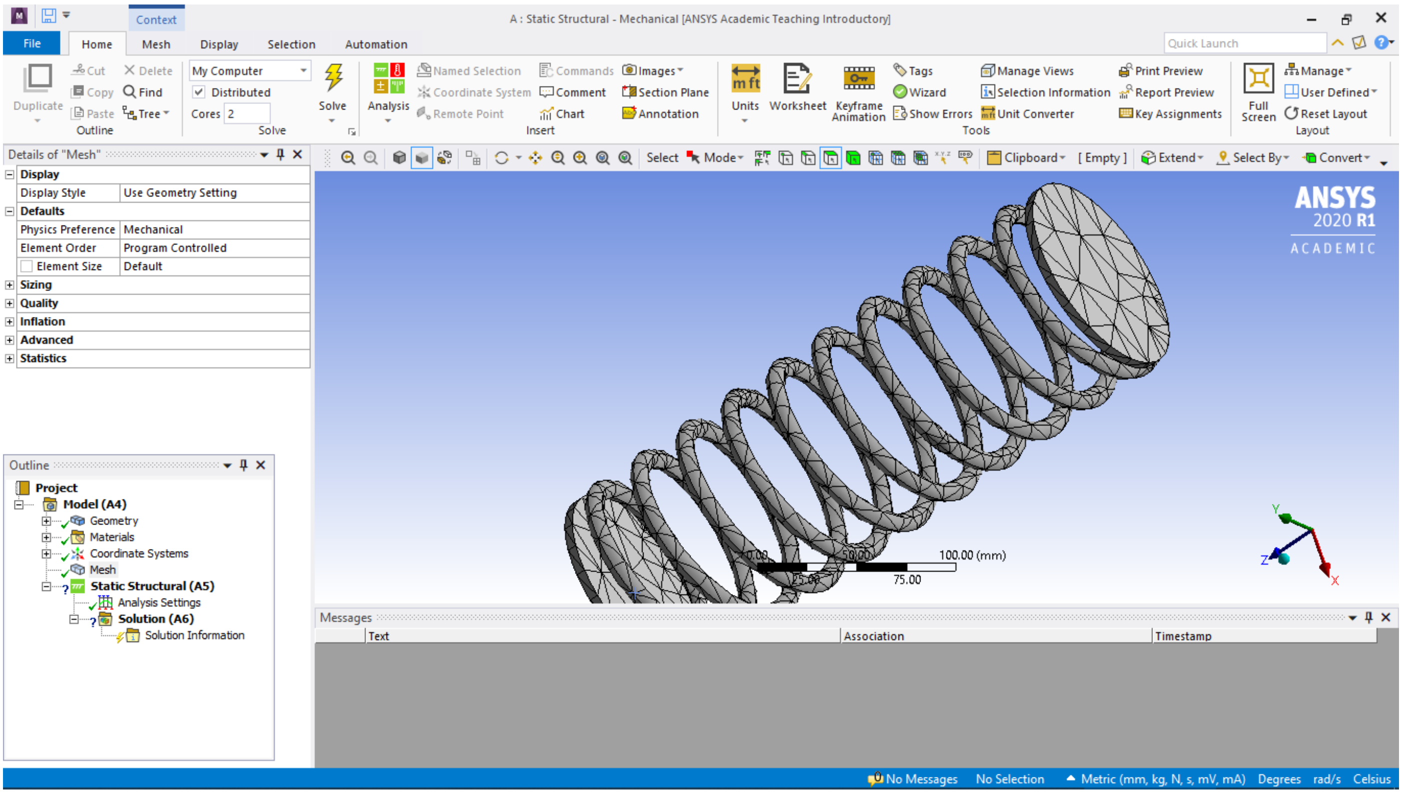
4) Importing External Geometry. As design of Helical Spring is done on CREO is imported as shown below



5) Working on Model: After choosing geometry file click on the MODEL and then follow the following step Check the geometry as assembled geometry comprises three components as shown below. Choose global coordinate as coordinate system. Connection is already defined during its design at CREO as contact 1 and contact 2 as shown in the given figure below.



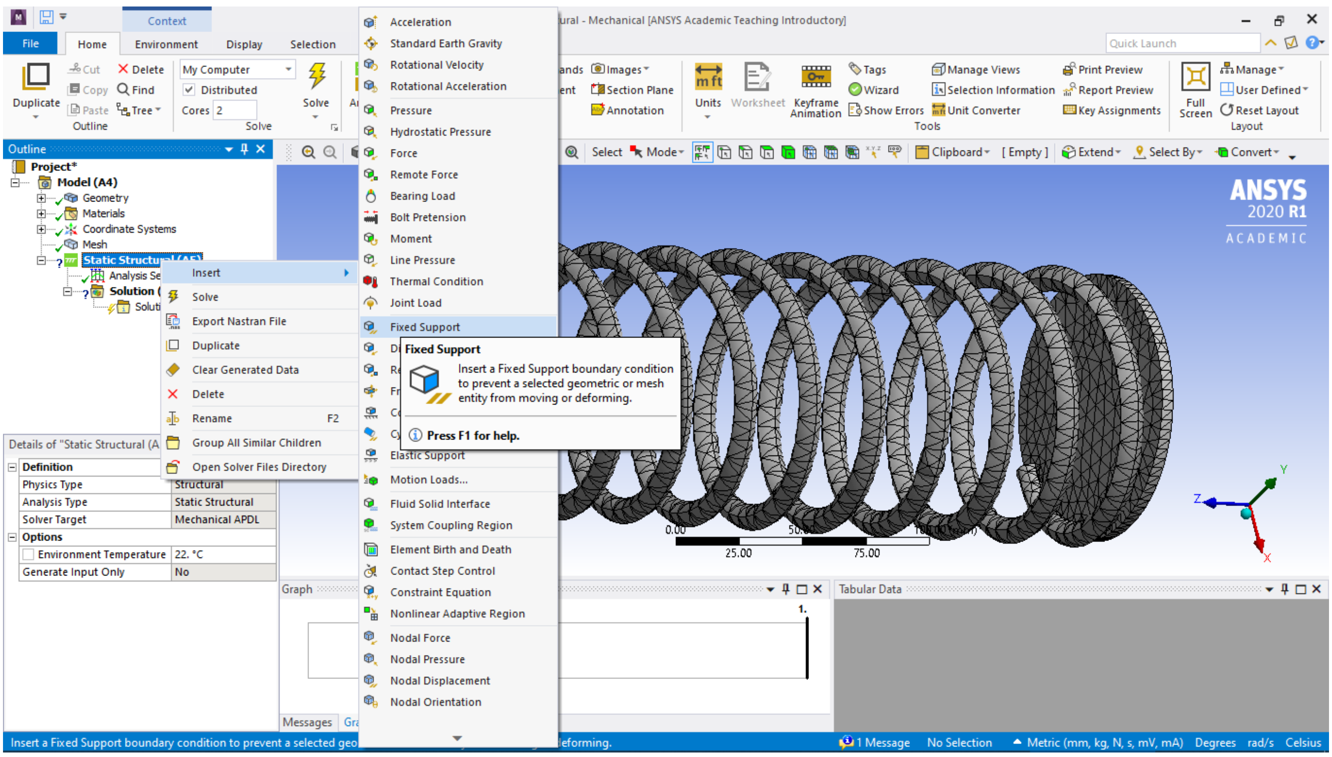
6) Meshing



Apply working environment

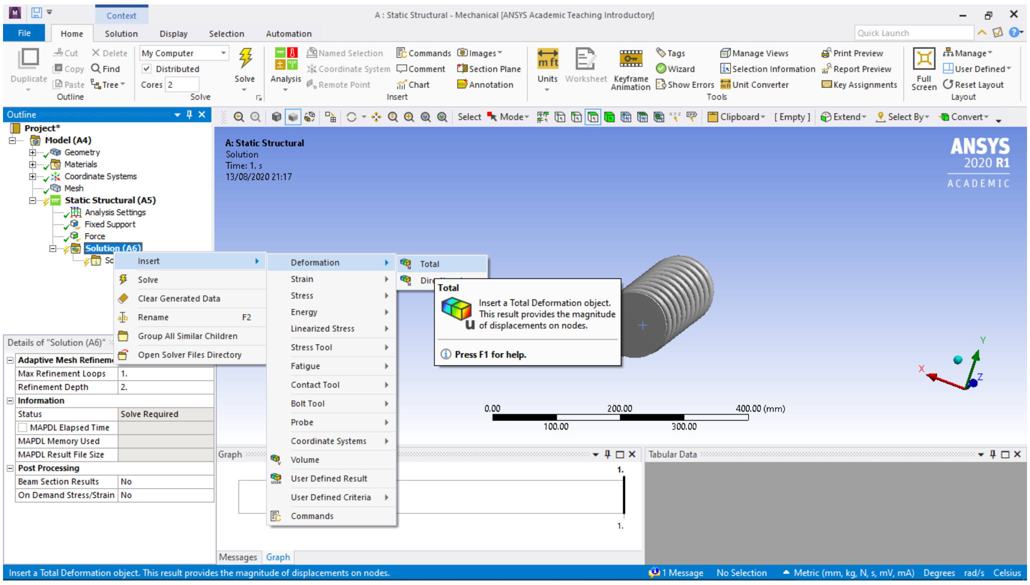
Following working condition will be applied on the geometry: -

7) Fixed Support: Fixed support is applied at one side of the spring component. To apply fixed support right click on static structural (A5) and insert fixed support as shown in figure below:

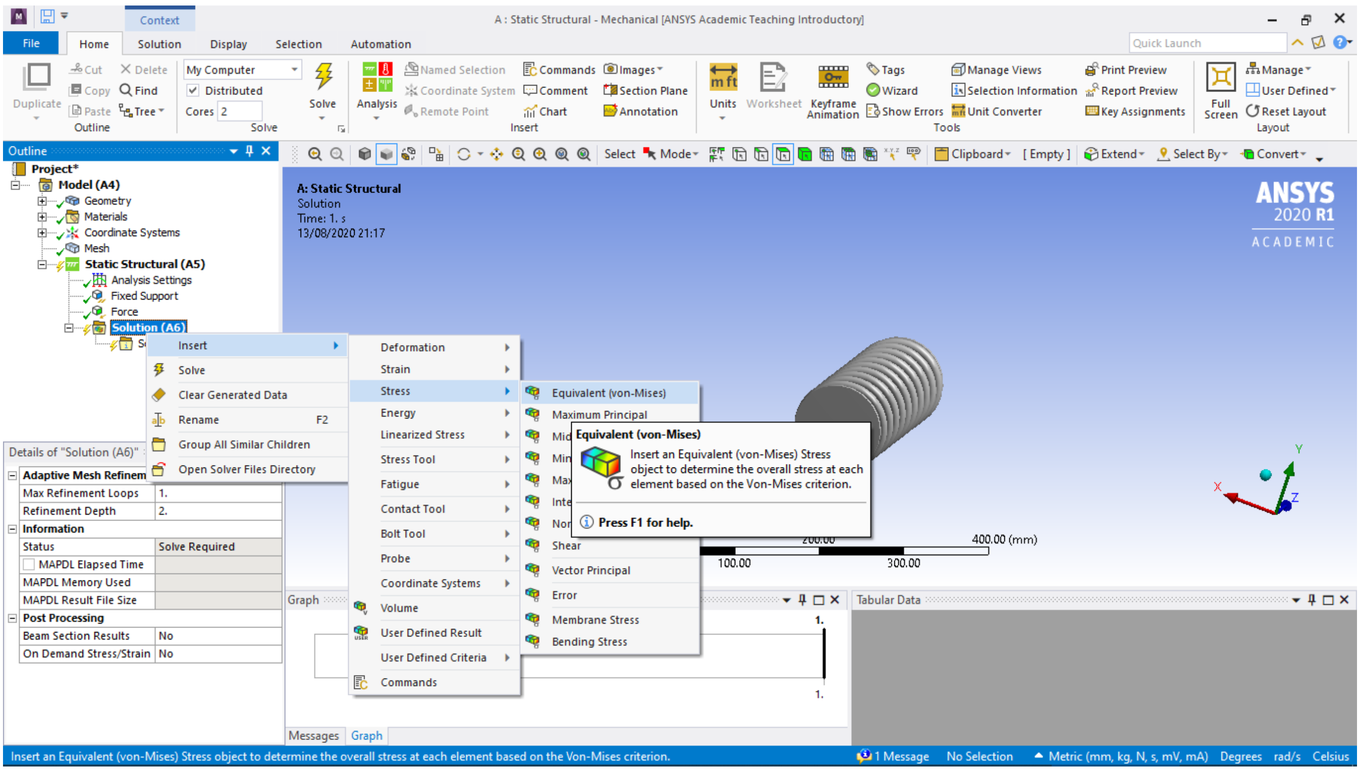


8) Apply force: Force is applied at one of the face of spring (say component 2). Generally spring absorb energy when applied force and release it when remove force.

9) Solution setting of helical spring on Ansys Analysis setting: In analysis setting we have to define the terms which we want get from the software. In this project we need to analyze the stress and deformation due to application of the axial force.



10) Definition of stress: To define stress various theories have been already assigned in the Ansys like von mises, maximum principal etc. In this project, maximum shear stress is use as stress theory



Structural Analysis of Spring Material at Ansys

1. **Stainless Steel:**

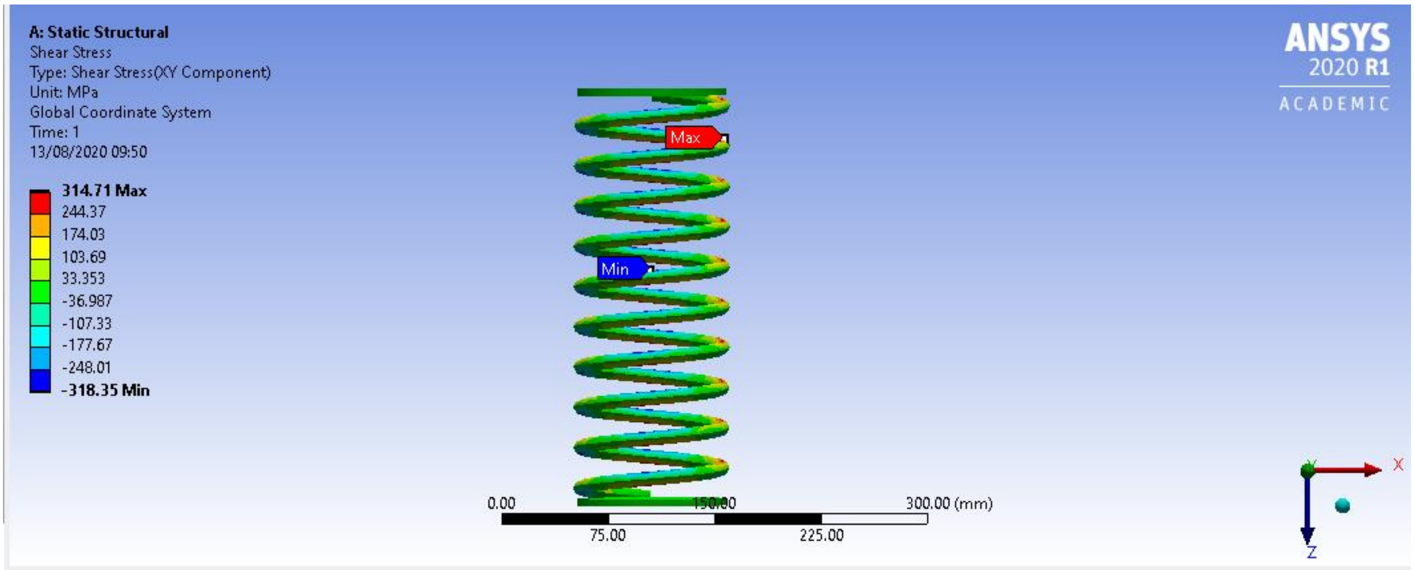
   Poison ratio (μ) = .31

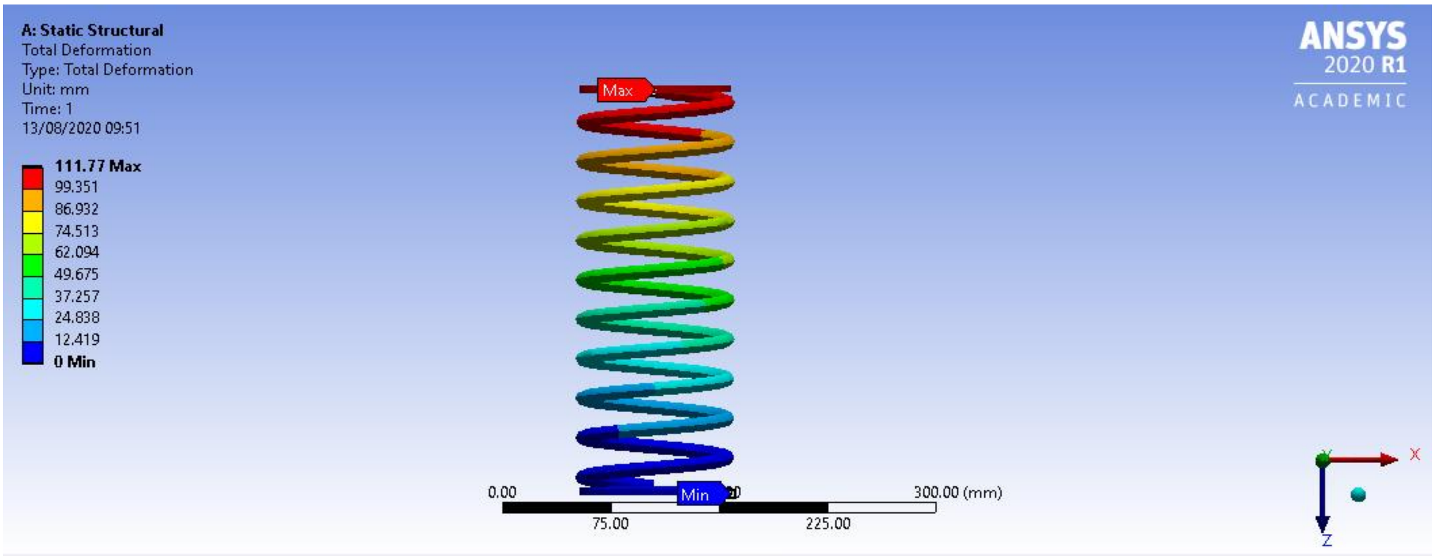
   Density = 7.75e-006 kg mm^{-3}

   Young's modulus = 1.93e+005

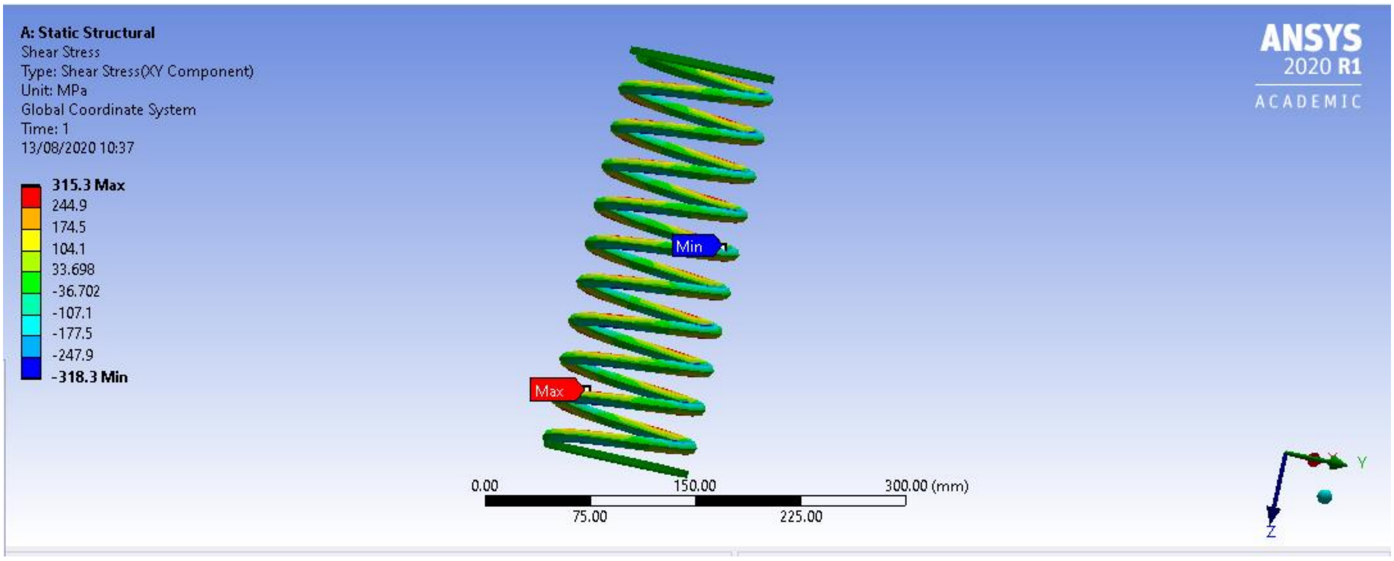
   Shear modulus = 73664

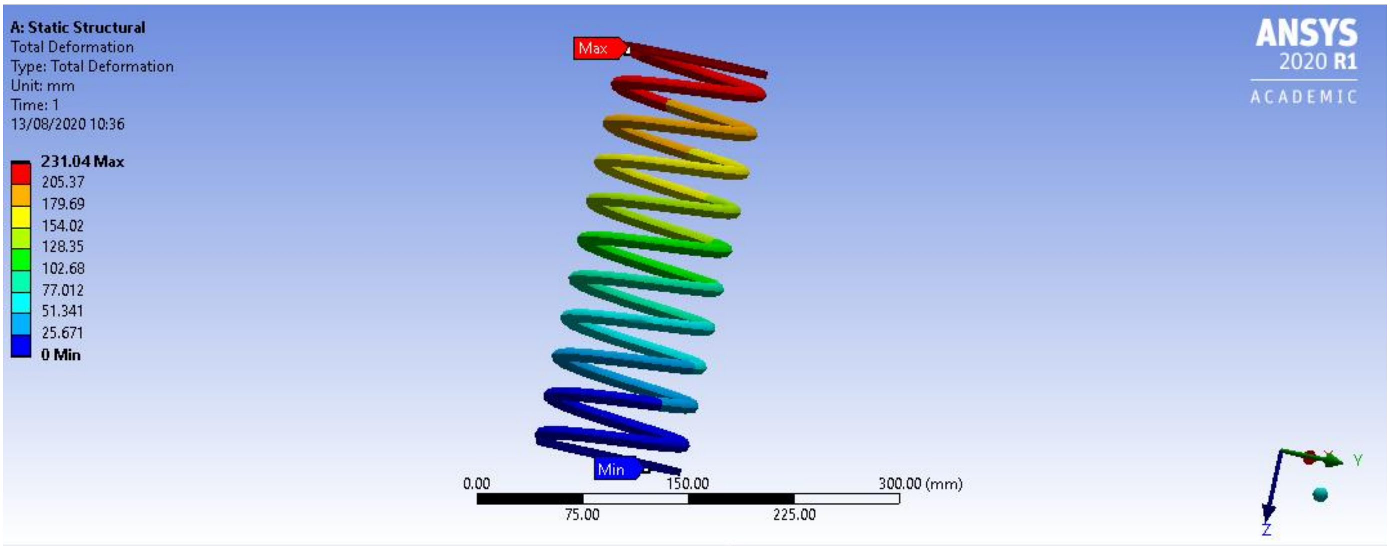
   Force applied = 800-1000 N





2. **Titanium Alloy:**
3. Poison ratio (μ) = .36
4. Density = 4.62e-006 kg mm^{-3}
5. Young's modulus = 96000
6. Shear modulus = 35294
7. Force applied = 800-1000 N





Result table

S. No.	Material	Deflection (mm)	Maximum shear stress(Mpa)	Load (N)	Stiffness(N/mm)
1.	**Stainless Steel**	**111.77**	**314.71**	**1000**	**9.00**
2.	**Titanium Alloy**	**231.84**	**315.3**	**1000**	**4.32**

CONCLUSION

So, according to the analysis done through ANSYS, titanium alloy is better than stainless steel for helical compression spring formation.

REFERENCE

[1] Anil Kr. Yadav, Satya Prakash Kanaujiya, Manoj kumar, Vinay Kumar, Abhinesh Bhaskar, “Analysis of Helical Spring of Two-Wheeler Suspension System Using Ansys Workbench 16.2”.

[2] "PTC Announces Creo 5.0, the Latest Version of its Award-Winning CAD Solution". 19 March 2018