AE 227

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Topic:

1.Mechanics Problems in 2D

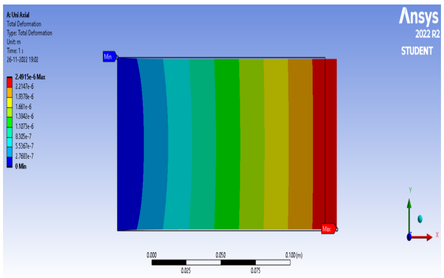
2. Analysis of a displaced Spring(A)

Mechanics Problems 2D

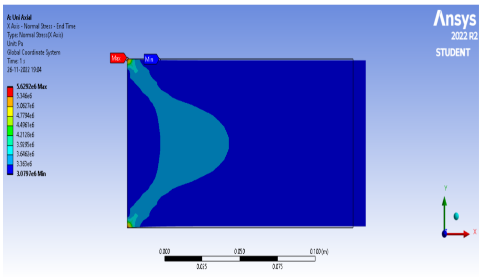
Uniaxial Problem:

1.Fixed Support:

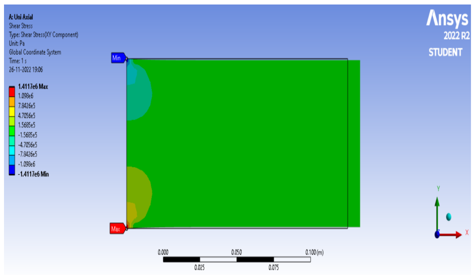
X Deformation



Normal Stress along X axis

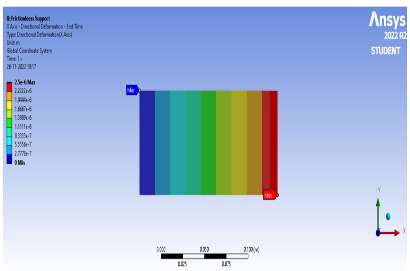


Shear Stress along XY

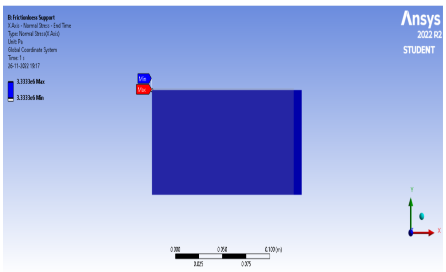


2 . Frictionless Support and Fixed vertex:

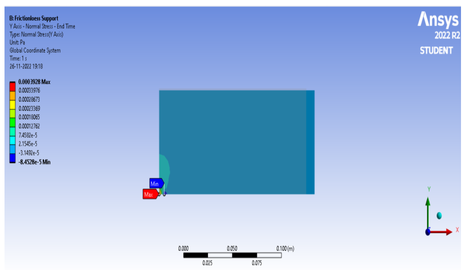
Deformation



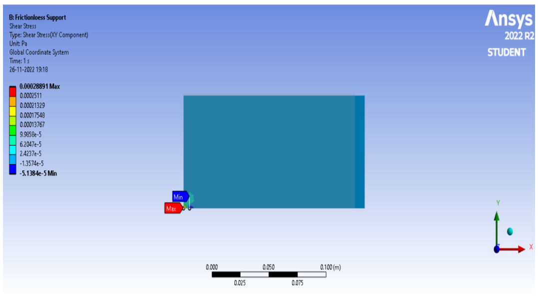
Normal Stress along X axis



Normal Stress along Y axis



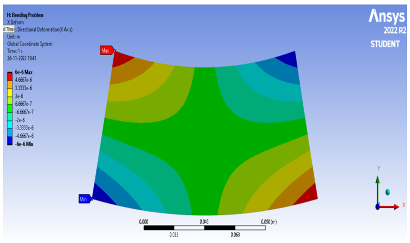
Shear Stress along XY



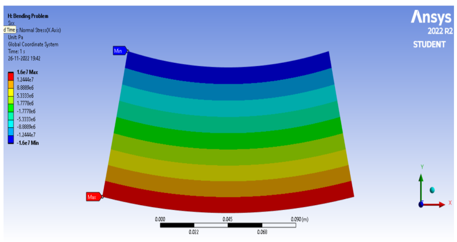
Statement : Since there is fixed support at one edge and force is along the x- axis, there is only normal stress along the X-axis.

Bending Problem:

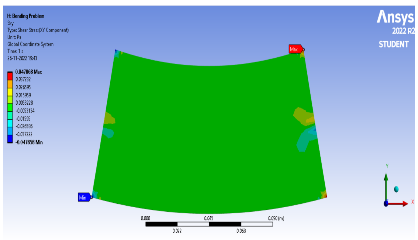
X Deformation



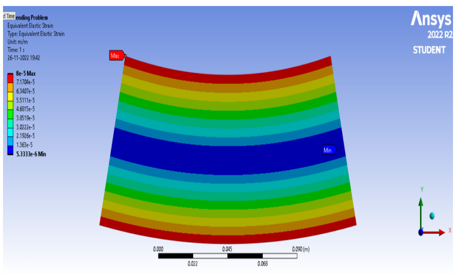
Normal Stress along X-axis



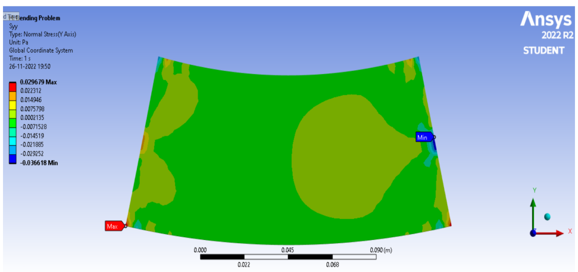
Shear Stress along XY



Equivalent Elastic Strain



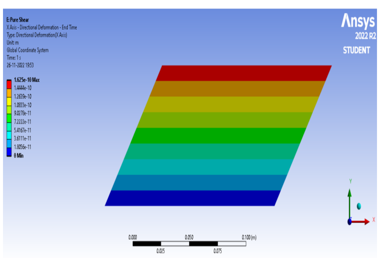
Normal Stress along Y-axis



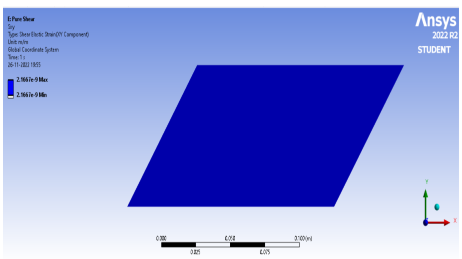
Statement : Here Syy and Sxy are approx. 0 as only Sxx gives moment distribution. Maximum Stress at the outer edge of the beam.

Simple Shear:

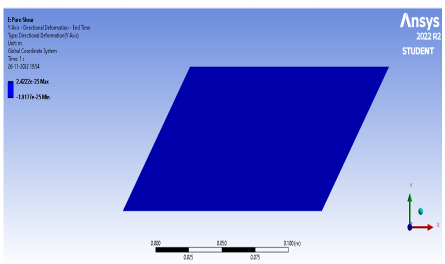
Total(X)- Deformation



Shear Stress



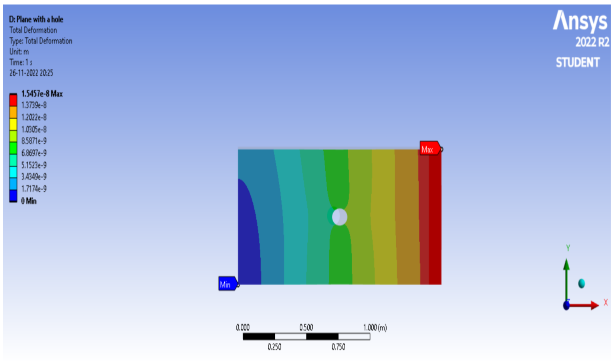
Y-Deformation



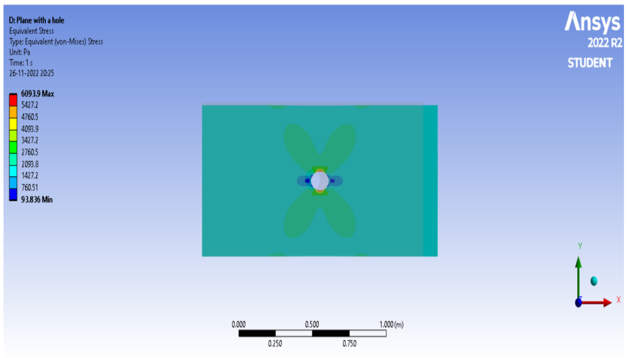
Statements: For pure shear we dont have y deformation and also there is purely Shear stress and other stresses are essentially 0, also maximum deformation at the other edge and minimum at the fixed end which is obvious .

Circular hole in a plane:

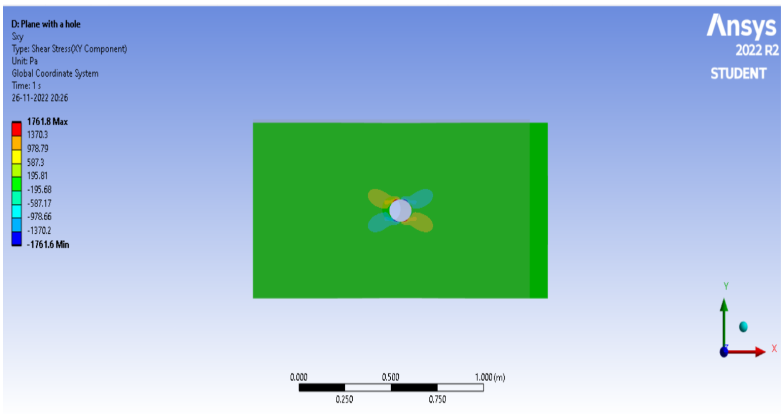
Total Deformation



Equivalent Stress



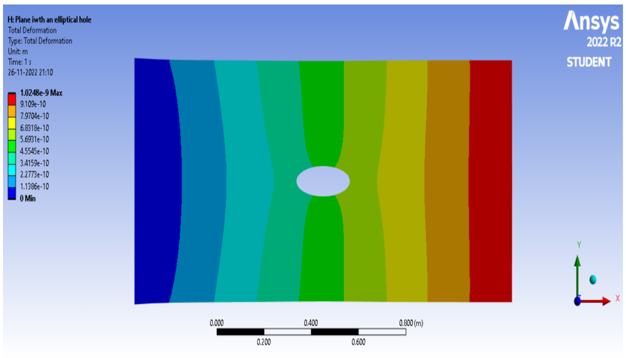
Shear Stress



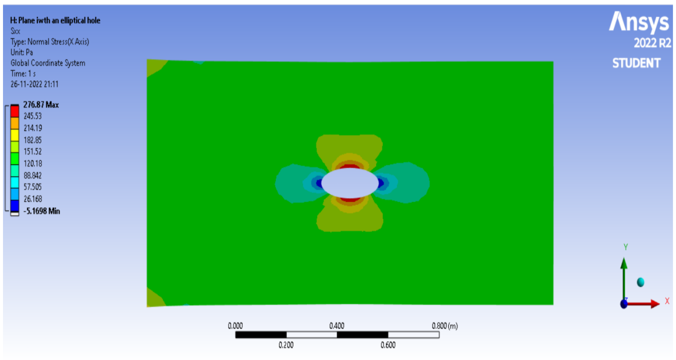
Statements: Deformation of circular hole into elliptical hole due to equivalent stresses

Plane with an elliptical hole:

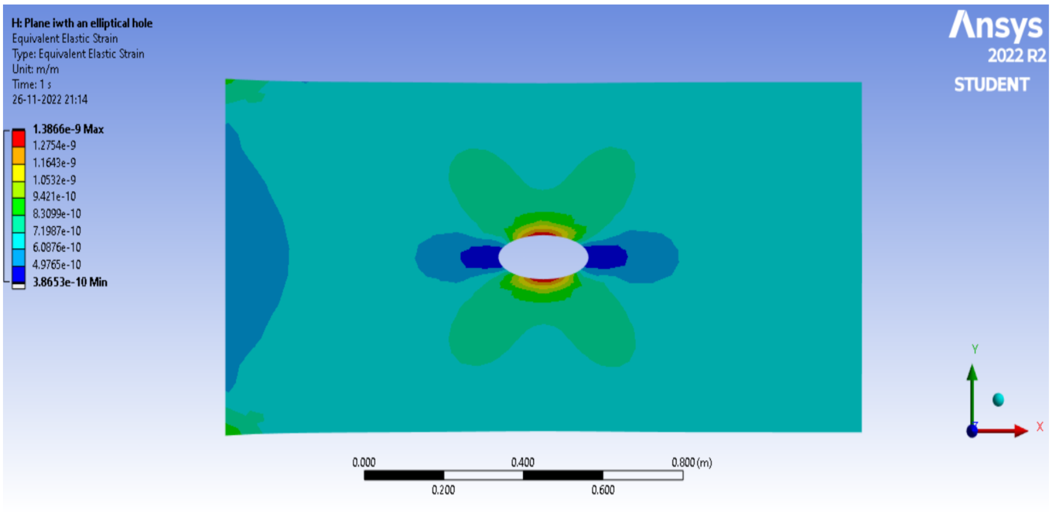
Total Deformation



Normal Stress along X-axis



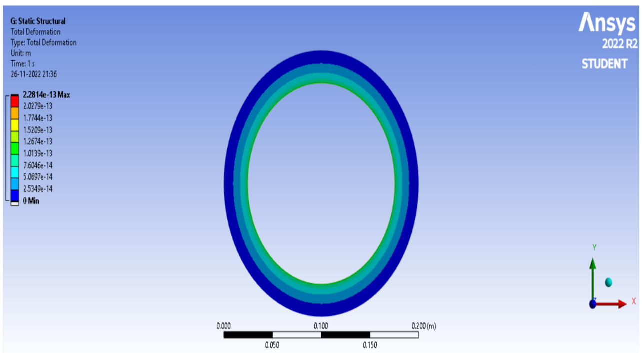
Equivalent Strain



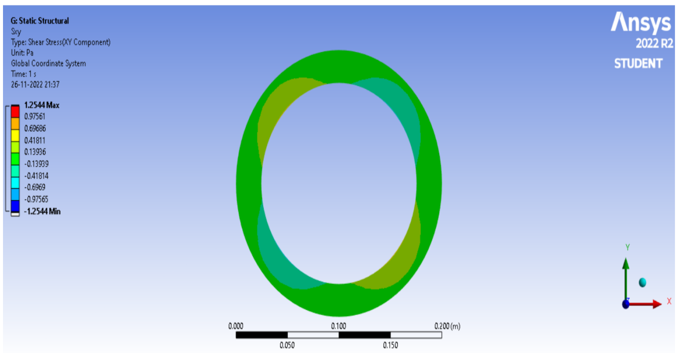
Statements: Very similar to that of plane with circular hole

Annular disk with outer surface fixed:

Total Deformation

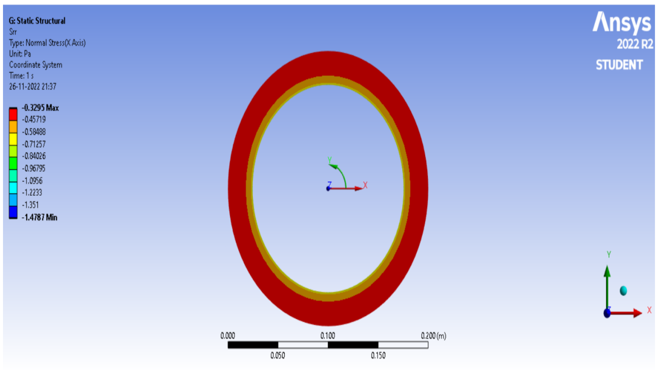


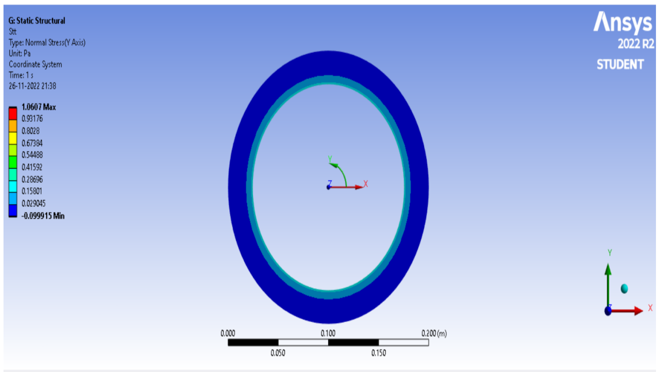
Normal Stress along X-axis



Normal Stress along r-unit vector

Normal Stress along theta-unity vector



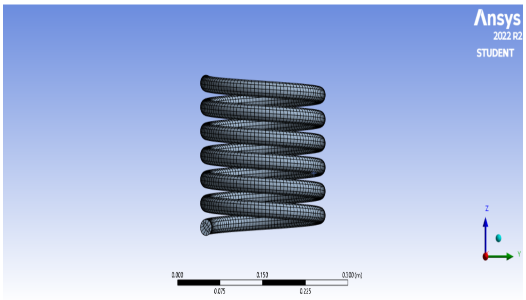


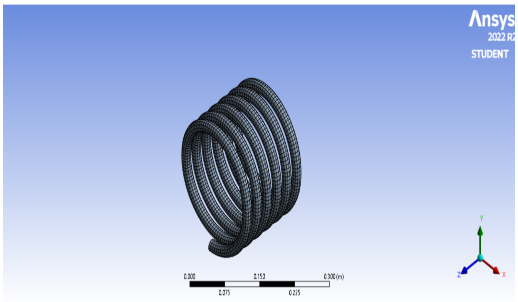
Statements : More important here is the analysis of stress and strain along radius and theta vector, expected stress along theta-cap to be 0

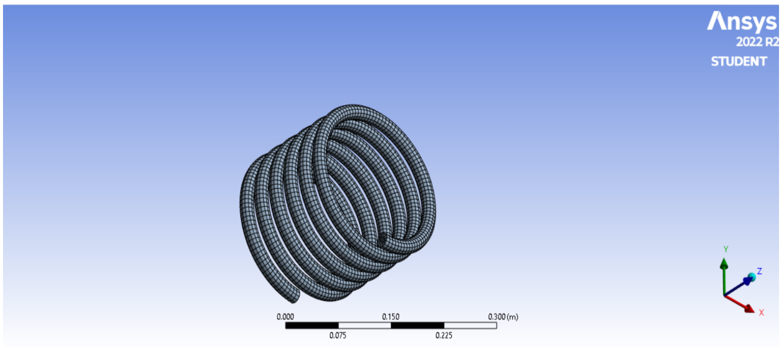
Group A Project Anaylysis

Material used : Steel
The **Young's modulus** and **Poisson's ratio** of steel are **205 GPa** and **0.28** respectively. The **density** is **7850 kg/m3**

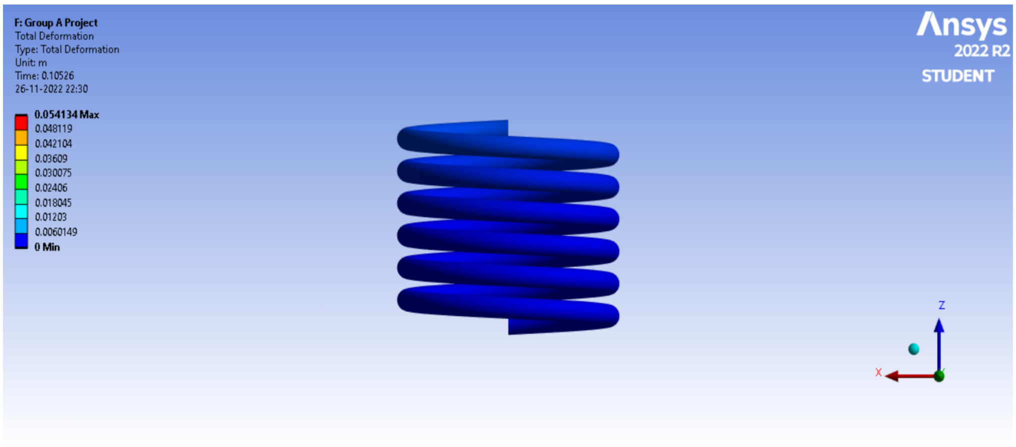
Mesh generation:





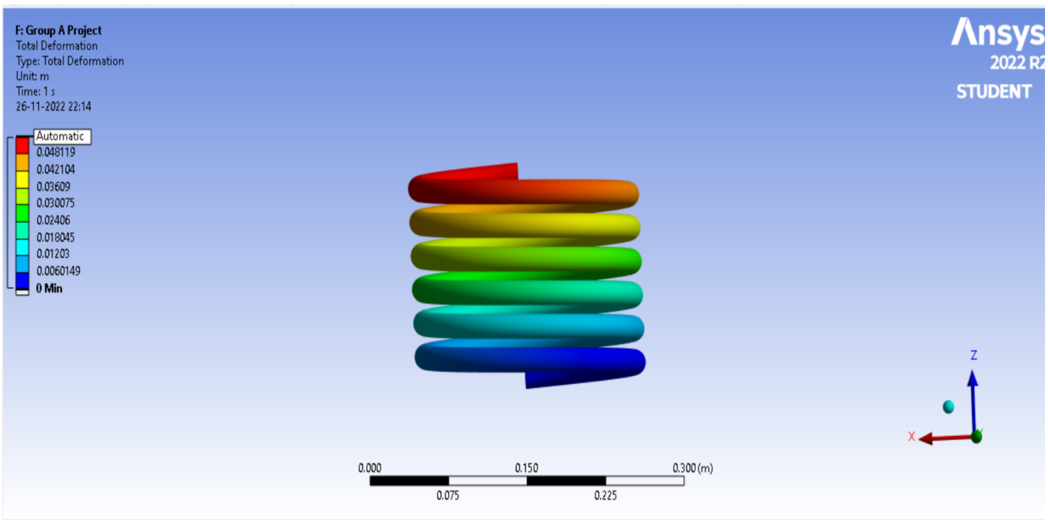


Undeformed State:



Statements: In the undeformed state the strain distribution is uniform throughout and is also zero as there is no deformation.

Deformed State:

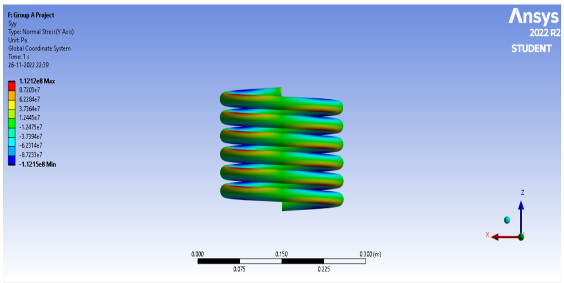


Statements: As there is fixed support at the lower end of the spring the deformation at that point is essentially zero, whereas the top point, where the displacement is applied is with the largest deformation in the whole of geometry.

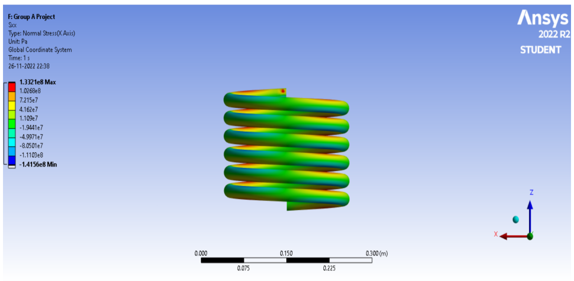
Stress Distribution:

As, here analysis of normal stresses along X , Y direction individually is difficult we prefer to study the equivalent stress distribution throughout the body

Normal Strain along Y axis



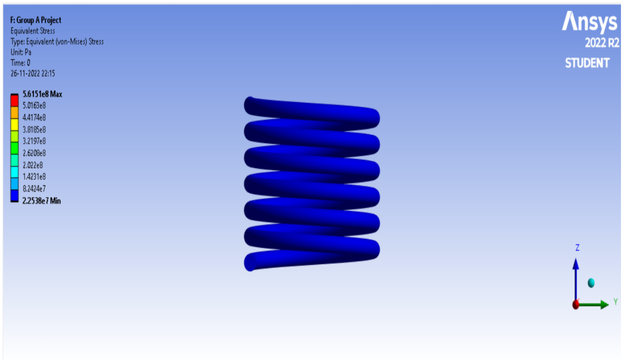
Normal Strain along X axis



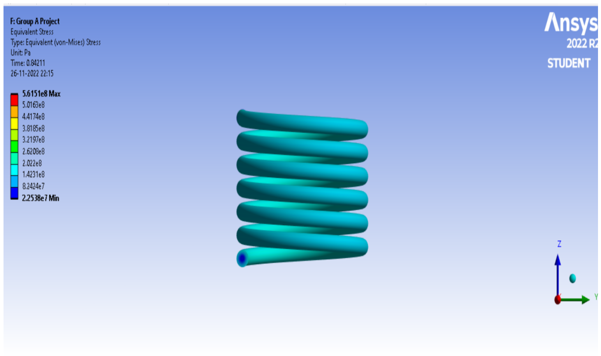
We observe periodic Stress distribution in every round of spring in both cases.

Equivalent Stress Distribution(undeformed and deformed state):

Undeformed State



Deformed State

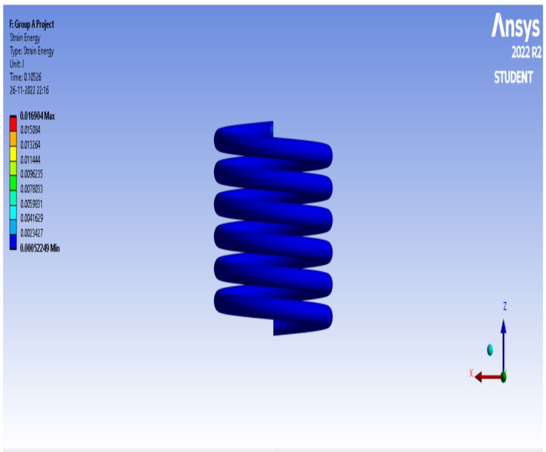


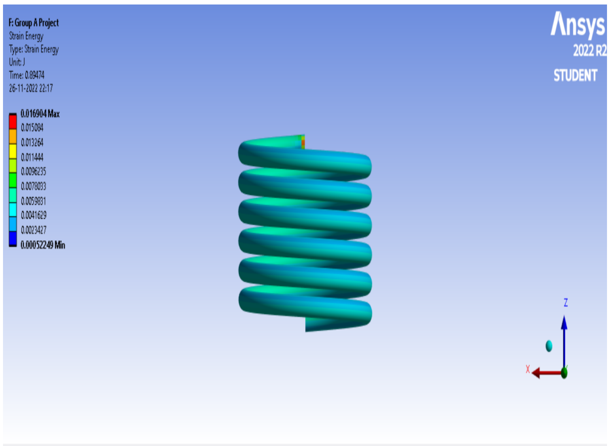
Clearly, the equivalent stress distribution is uniformly distributed as the spring is fully deformed, this is however much easier to study than studying the stress along X, Y individually.

Strain energy:

Undeformed state

Deformed state





As we look into the cycle of deformed and undeformed states we find the strain energy to be oscillating between the two states, or in simple terms we can take an analogy of potential energy stored in the string.

Uses of spring's structural properties:

Suspension Bridges: Springs are generally used in suspension bridges(more generally for suspensions) to stabilise the structure, if there are frictional or other irreversible effects, the oscillating energy eventually depletes overtime. By using this property we can avoid spontaneous exhaustion of energy which can be fatal to the system.

Springs and wire forms can be found in anti-climbing and safety measures for buildings, often in the form of fixing clips.

Springs are used in some larger and taller structures, such as several-storey hotels and office blocks, building structures that are resilient to earthquakes in parts of the world that are exposed to tremors is vital.