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Analysis of Rear Shock Absorber spring of a Two Wheeler

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Abstract
Automobile suspension arrangement plays a significant role for the comfort and stability of the vehicle. In this study, a two wheeler rear suspension spring is studied related to the uniform load effect and its life. Model of the two wheeler suspension spring is demonstrated using the existing design of bullet bike with modelling software SOLIDWORKS. This study deals with the analysis of spring using ANSYS 17.0. Results are compared on the basis of static structural and life results obtained. Further results using another material is compared.

***Keywords:** ANSYS, fatigue life, static structural, spring*

INTRODUCTION

A suspension and spring arrangement is used in the automobile manufacturing to handle the shock impulse and kinematic energy. It contributes to the vehicle's control providing safety and ease by absorbing the energy through bumps and pot holes on the road while proving smooth ride. The role of shock absorber is to dissipate kinetic energy into upright motion. Spring is a flexible body whose purpose is to store energy when deflected by force and return to the initial position as before. Springs performance optimization plays significant part in improvement of automobile dynamics. The automobile industry tends to Advance the comfort of user and reach applicable stability of comfort riding qualities and economy. Generally helical coil is utilized for spring. Coil is prepared from a sole length of wire which is heated and curled on a spindle to produce the required shape. The load carrying capability of the spring depends on different factors like diameter of wire, outer diameter, pitch, strength of the material and few further design constraints. SOLIDWORKS is a computer based software which is used to model the 2D and 3D CAD models respectively. Then the CAD model is transferred into ANSYS for analysis. ANSYS WORKBENCH is computer based software which helps in obtaining the different structural behavior like static, modal, fatigue for different loading parameters [1].

***Figure 1:** Helical coil spring.*

Objective

- To determine the stresses developed due to applied load
- Dynamic Analysis for different cycles.
- Minimum fatigue life of spring and to increase the life by changing the material.

LITERATURE SURVEY

Suraj R. Bhosle [2], in this research paper, comparatively studied the suspension helical coil spring with changed materials using finite element analysis. He build the shock absorber model in Creo Parametric 2.0 and structural analysis of the similar is completed using ANSYS 17.0. The comparative study shows the best material to be used for the spring by proper analysis of the deflection and stresses of the helical spring. They used four different material of spring are Chrome vanadium, Hard drawn spring wire, steel, Oil tempered carbon steel and Stainless steel. After the analysis the chrome vanadium stands out to be effectual material for spring especially at higher loads.

Vijayeshwar BV [3], in this research paper, evaluated the manufacturing of helical coil suspension springs as per requirement. The objective of this work is a comparative study and analysis of suspension helical coil spring with two different materials like Chrome Silicon and Hard drawn carbon steel. They designed the shock absorber model using Pro/E Creo 2.0 and analysis of stress and deflection they used ANSYS 15.0. After the theoretical and ANSYS results shows that Chrome silicon spring steel is the optimum suitable material with low weight and high stiffness for helical spring applications like mono shock suspensions in bikes.

N. Sai Kumar and Prof. R. Vijay Prakash [4], in this research paper, have design and analyze the performance of the shock absorber by varying the wire diameter of the coil spring. They explain all types of shock absorber properties and using metal spring wire. They consider various types of motorbike spring specification and modeling of suspension springs. They used alloy steel and Chrome vanadium steel of spring materials. The results of alloy steel are showing the best results in three vehicles the alloy steel is preferable compared to chrome vanadium steel.

M.Lavanya [5], in this research paper, studied the comparison of mono shock absorbers in two wheelers by changing the materials. A shock absorber is designed and 3D model is made in pro/engineer and ANSYS for analysis. They used high carbon steel and beryllium copper. After the analysis, it was concluded that here by taking high carbon steel in suspension system, by comparing it with beryllium copper. The stress concentration in beryllium copper is low compared to high carbon steel and also life period of beryllium copper is more than high carbon steel.

METHODOLOGY

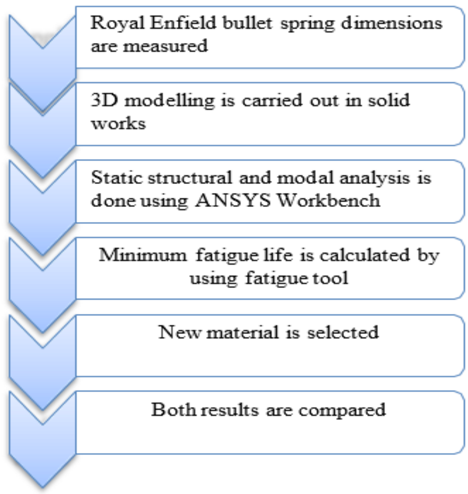

Figure 2: *Methodology.*

DIMENSIONS FOR SPRING

Maximum Diameter (D_O) = 54mm
Minimum Diameter (D_i) = 40mm
Mean Diameter (D_m) =47mm
Spring Index= (D_m/d) = (47/7) =6.7mm

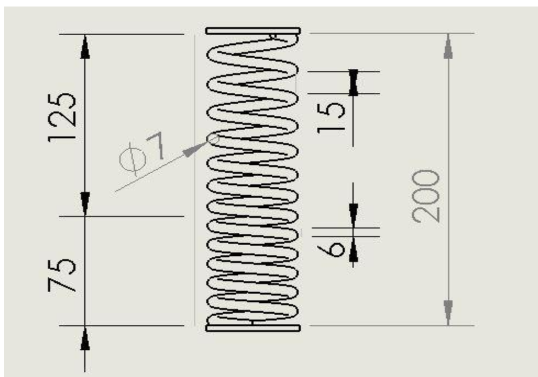

Figure 3: *2D model.*

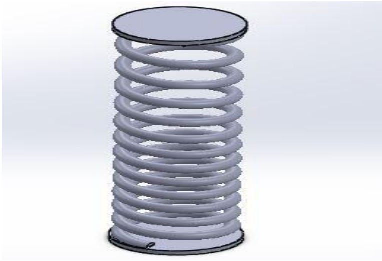

Figure 4: *3D model.*

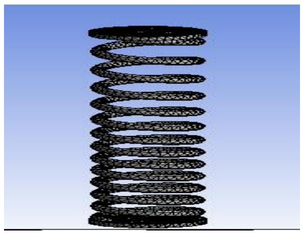

Figure 5: *Meshed model.*

ANALYSIS OF SPRING

Material: SAE 9254

Elastic Modulus: 206 GPa, Poisons ratio: 0.29, density: 7700 kg m^3, Yield Strength: 1870 MPa; Tensile Strength: 2050 MPa.

Load: 183kg+150 kg= 333kg

333/4=83.25kg

83.25x9.81= 816.6N

P=F/A= 816.6/2463 = 0.33 MPa

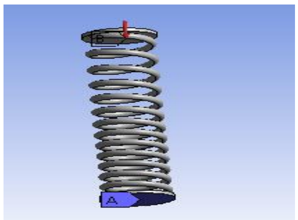

Figure 6: *Boundary condition.*
(Fixed at bottom and pressure on top surface)

Static Structural

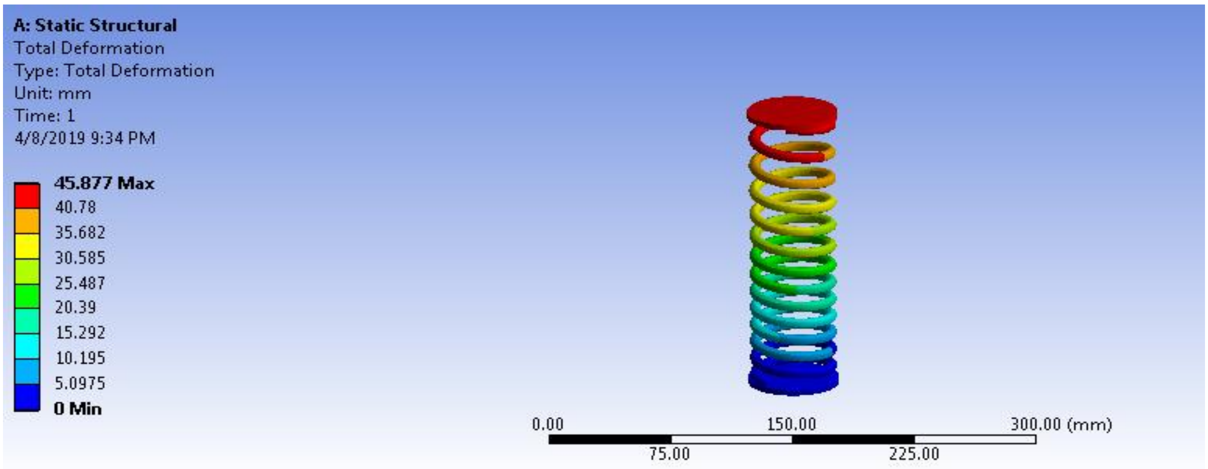

Figure 7: *Deformation.*

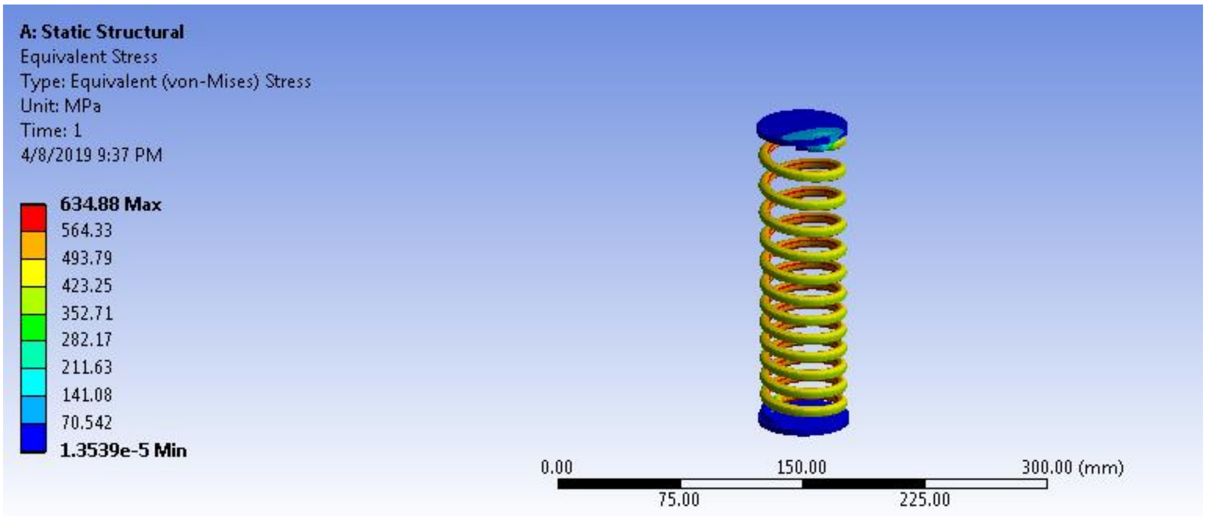

Figure 8: *Stress.*

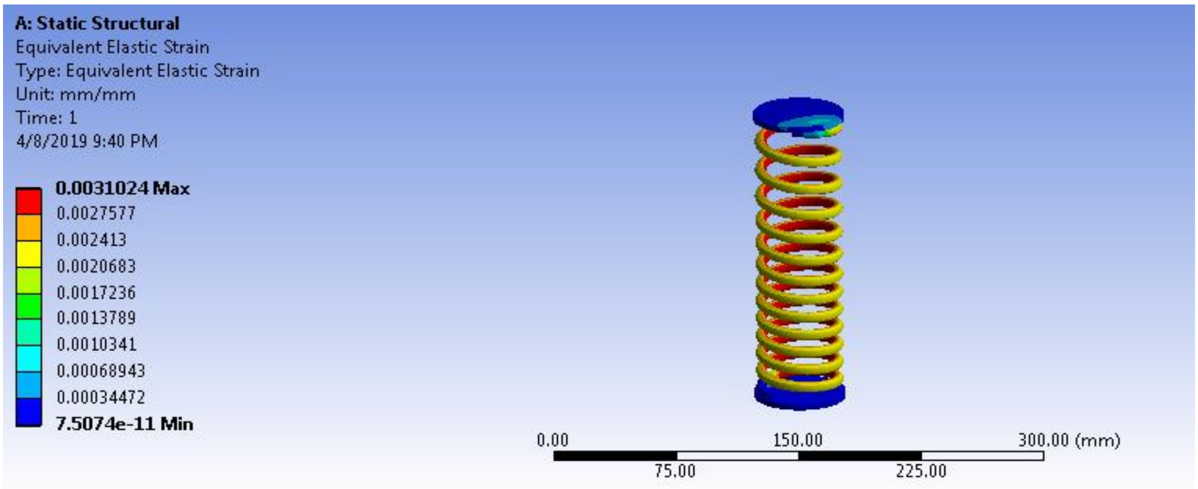

Figure 9: *Strain.*

Table 1: *Result of stress and strain.*

Deformation	**45mm**
Stress	634MPa
Strain	0.0031024

Modal Analysis

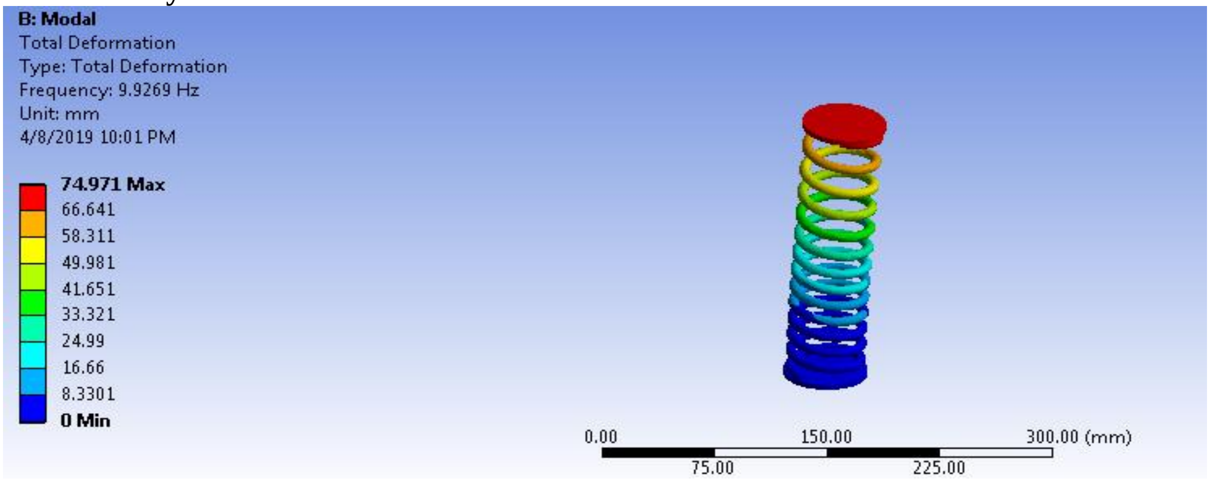

Figure 10: *Mode 1.*

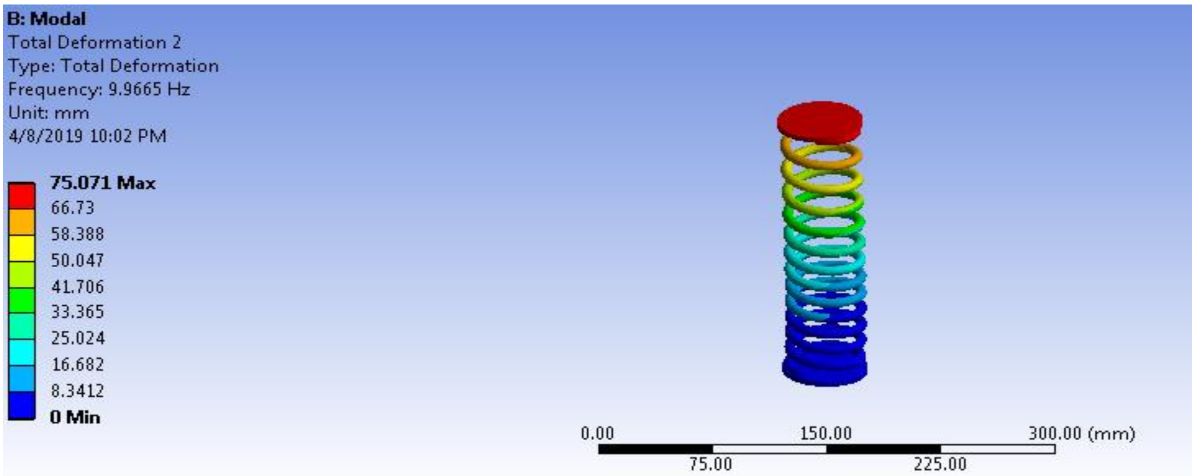

Figure 11: *Mode 2.*

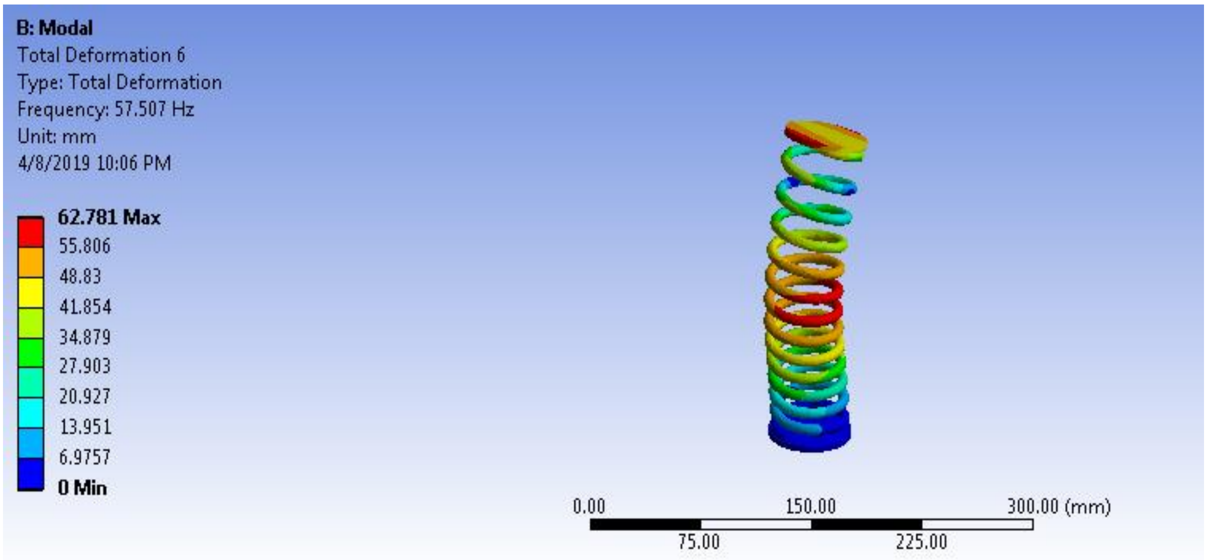

Figure 12: *Mode 3.*

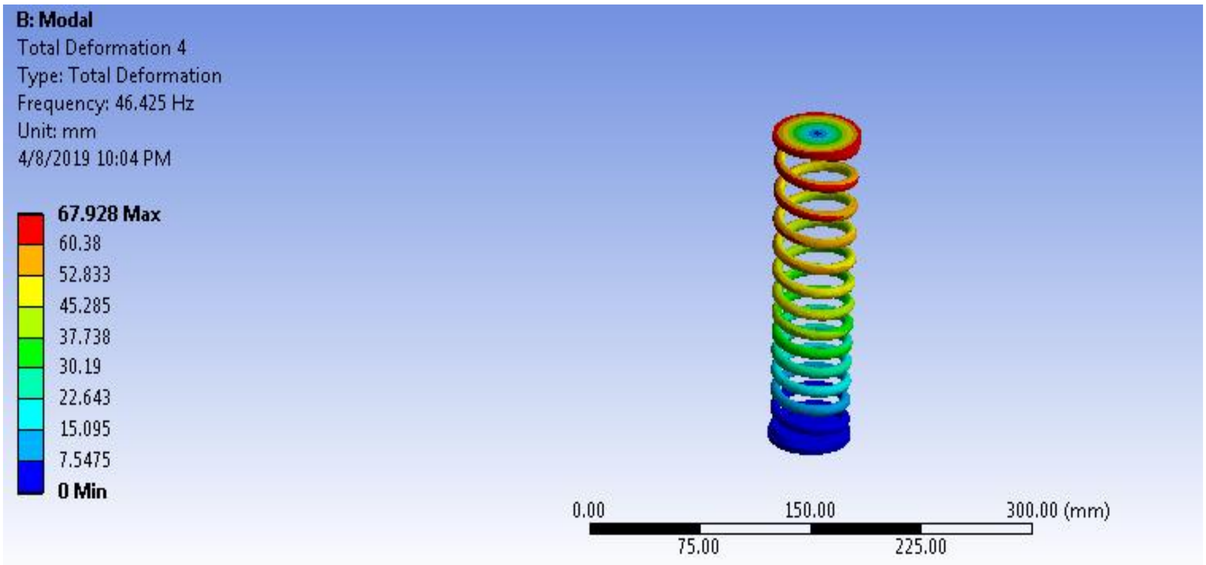

Figure 13: *Mode 4.*

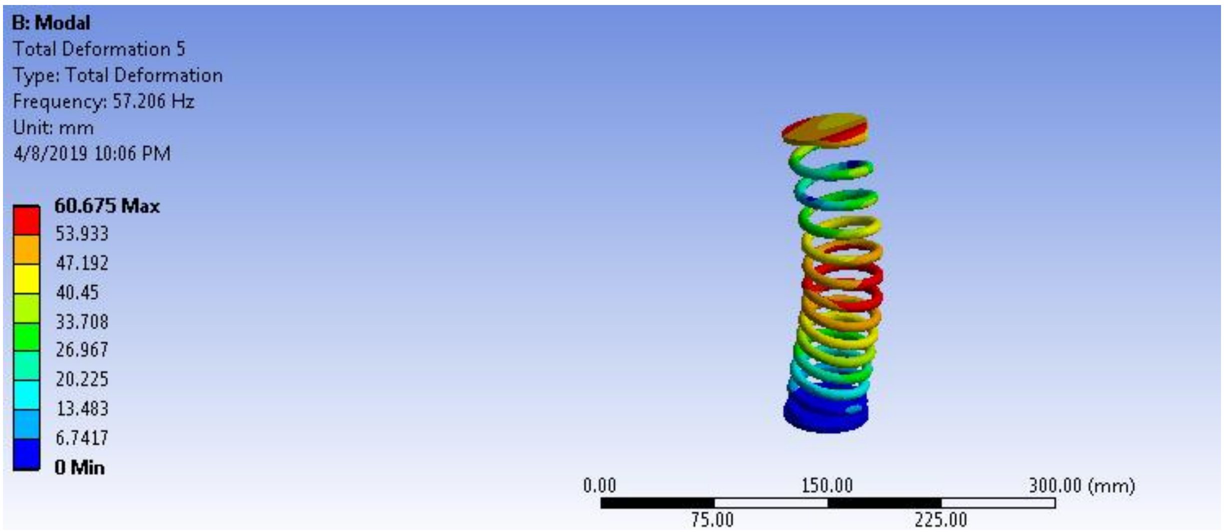

Figure 14: *Mode 5.*

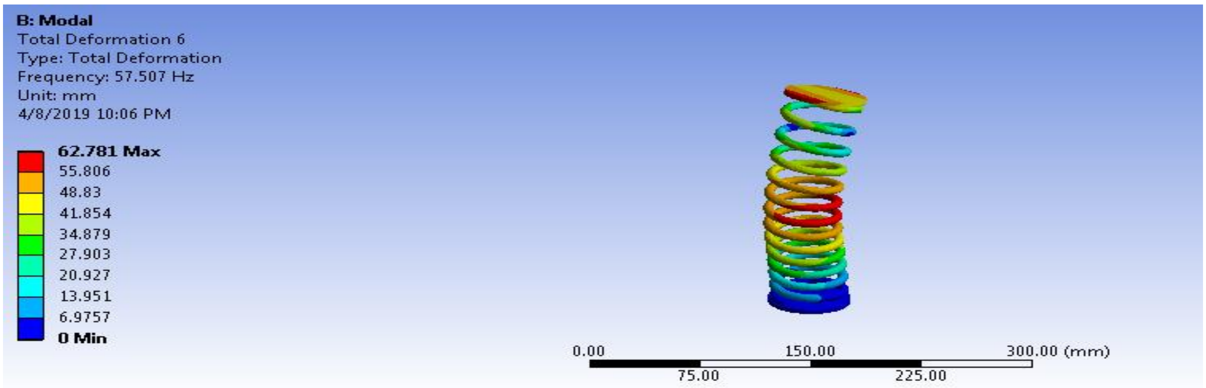

Figure 15: *Mode 6.*

Table 2: *Dynamic Analysis*

Modes	Frequency Hz	Deformation mm
1	9.9269	74.197
2	9.9665	75.071
3	39.945	56.96
4	45.425	67.9
5	57.206	60.6
6	57.507	62.78

Dynamic Analysis

Dynamic analysis is performed to know how he structure will behave under constant load but for different cycles.

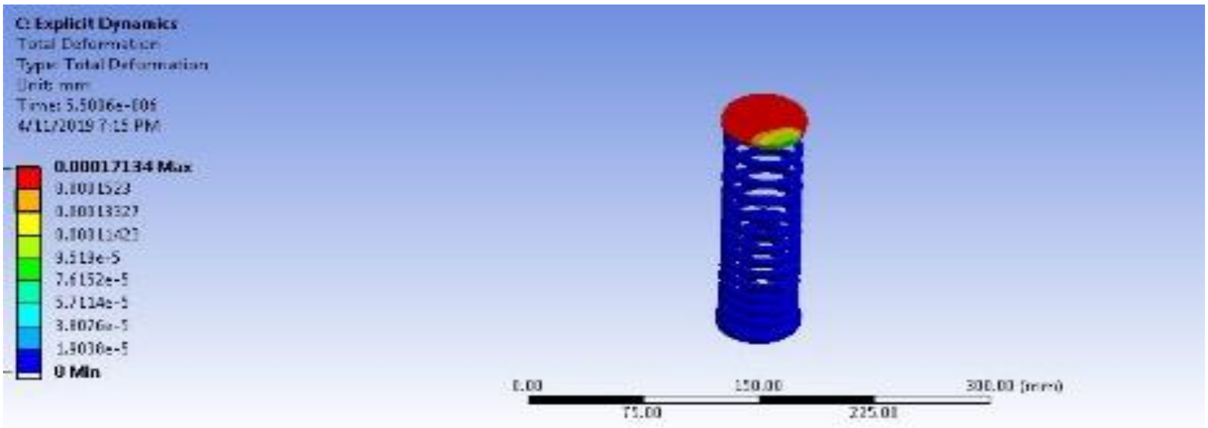

Figure 16: *Deformation for 100 cycles.*

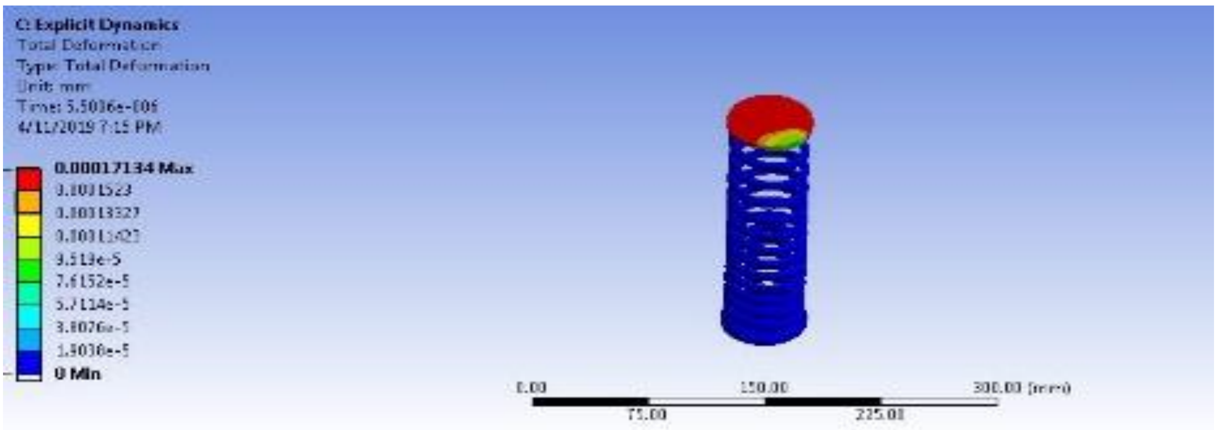

Figure 17: *Deformation for 100 cycles.*

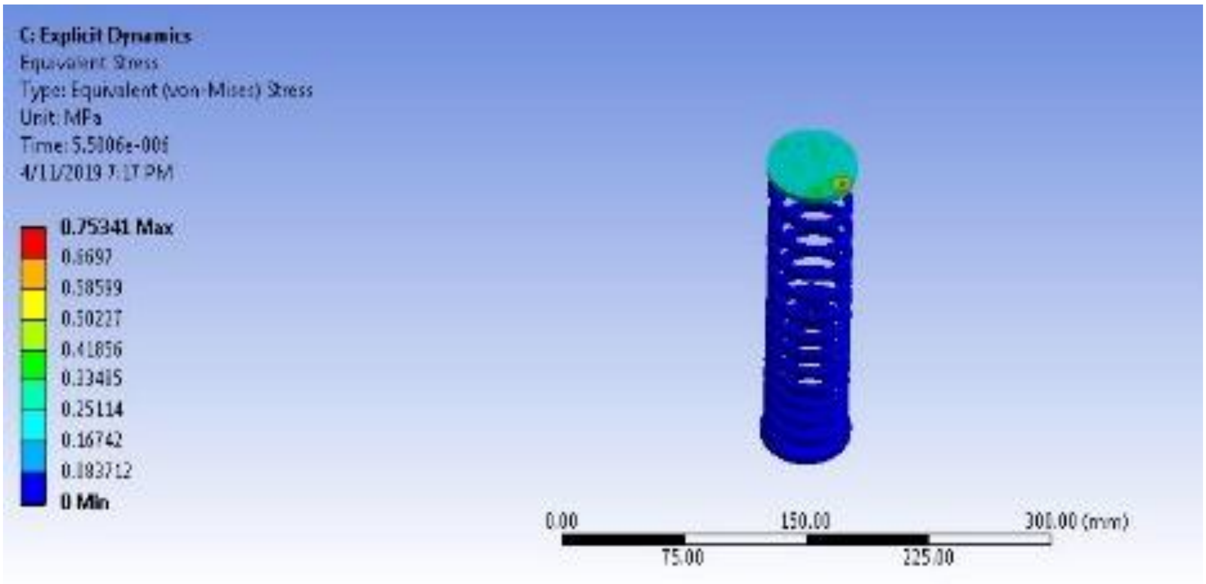

Figure 18: *Stress for 100 cycles.*

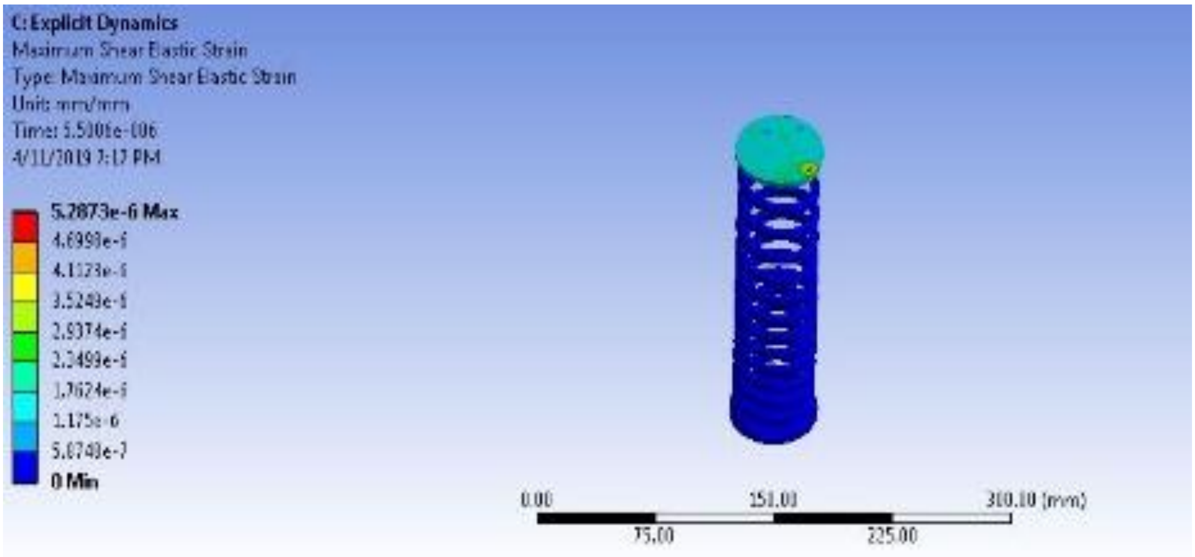

Figure 19: *Maximum shear strain for 100 cycles.*

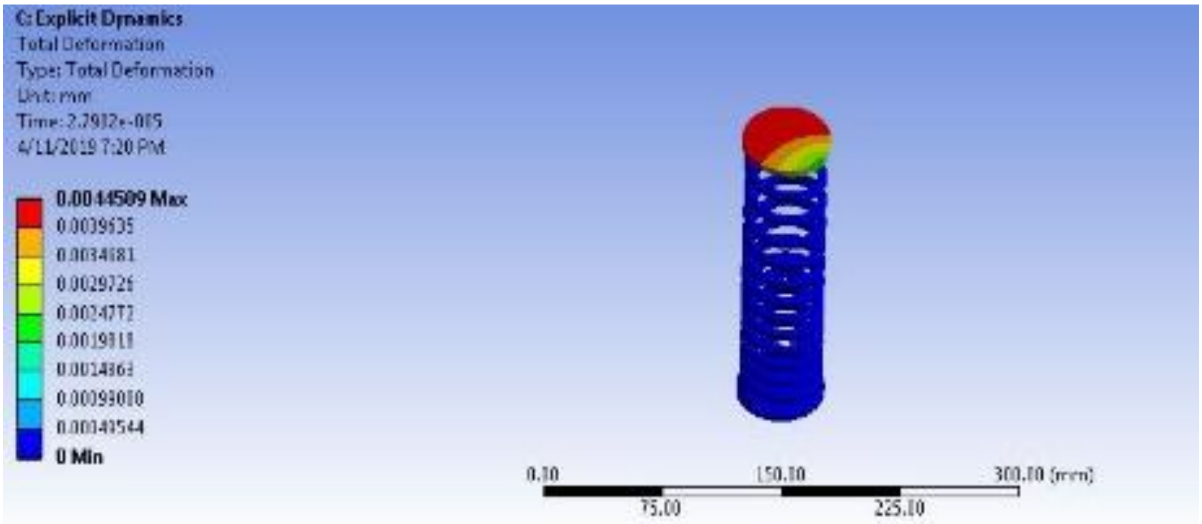

Figure 20: *Deformation for 500 cycles.*

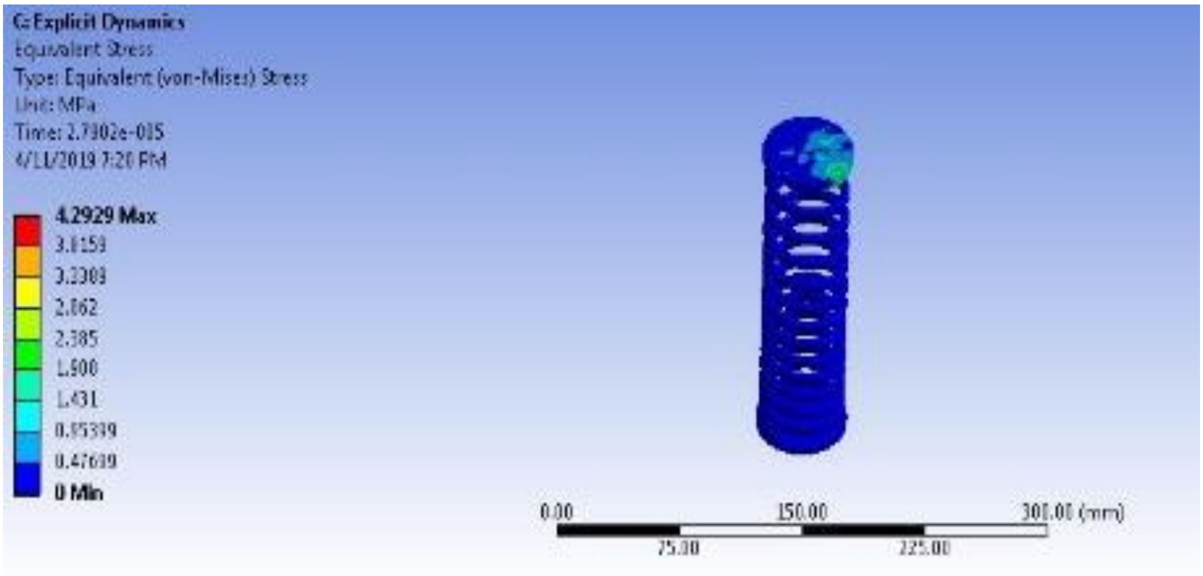

Figure 21: *Stress for 500 cycles.*

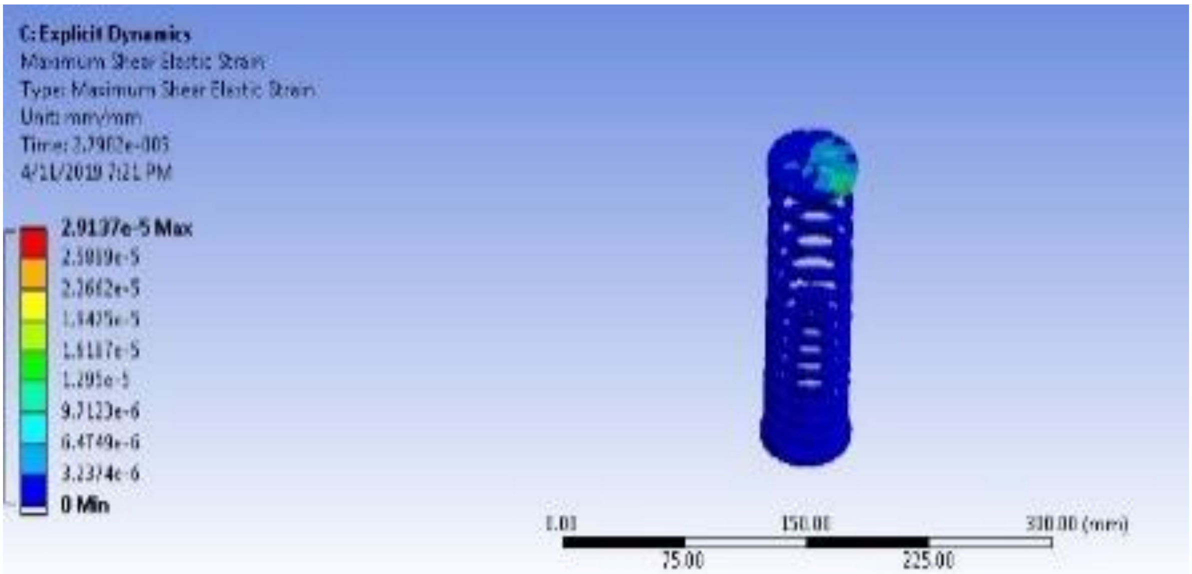

Figure 22: *Maximum shear strain for 500 cycles.*

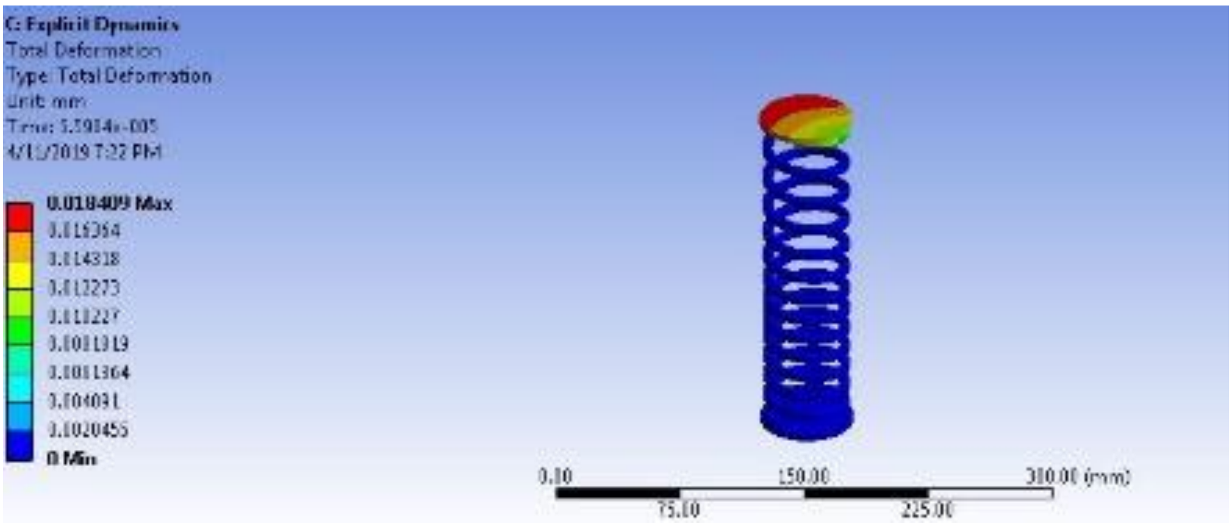

Figure 23: *Deformation for 1000 cycles.*

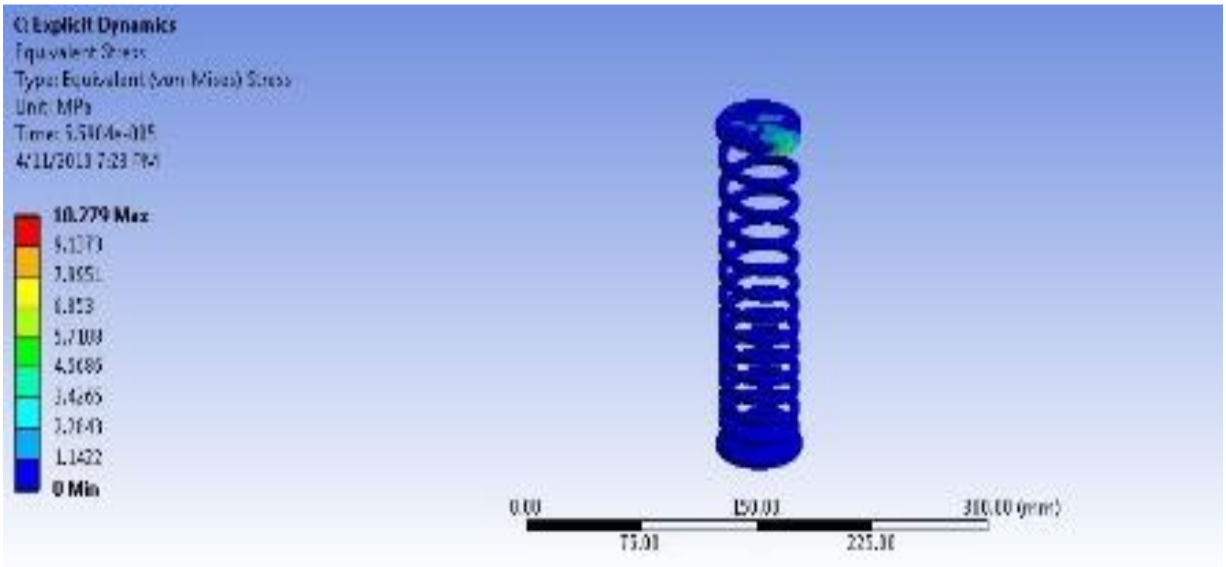

Figure 24: *Stress for 1000 cycles.*

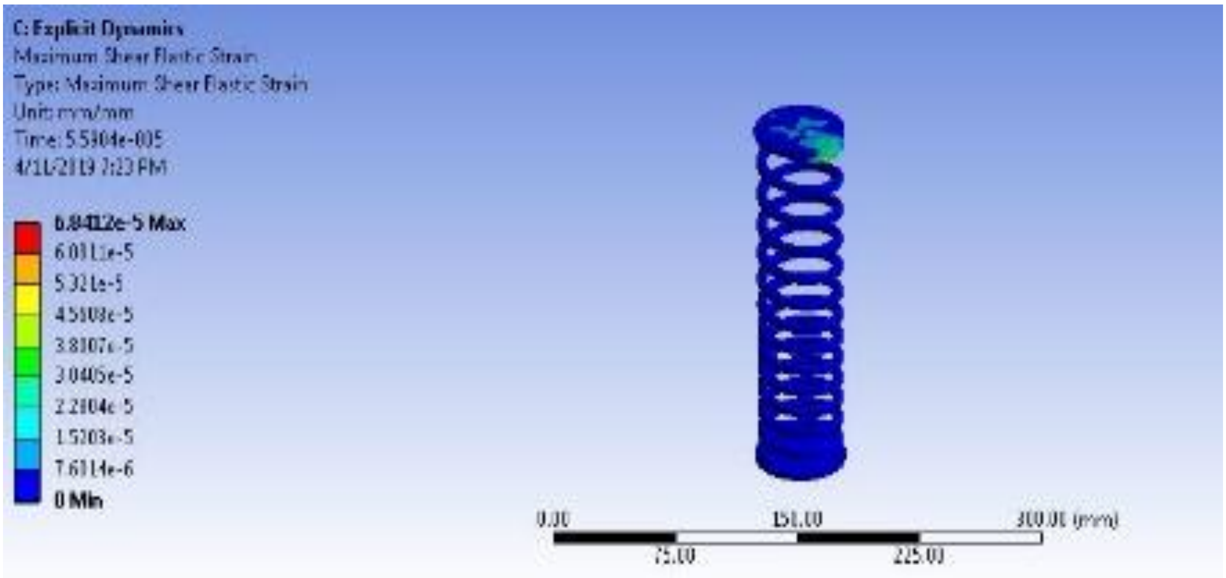

Figure 25: *Maximum Shear strain for 1000 cycles.*

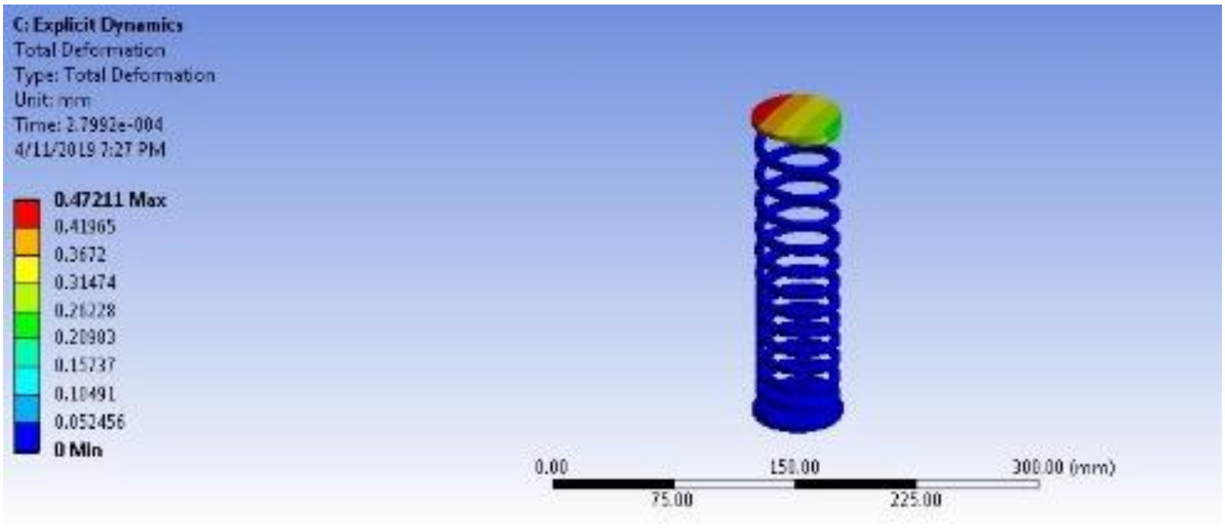

Figure 26: *Deformation for 5000 cycles.*

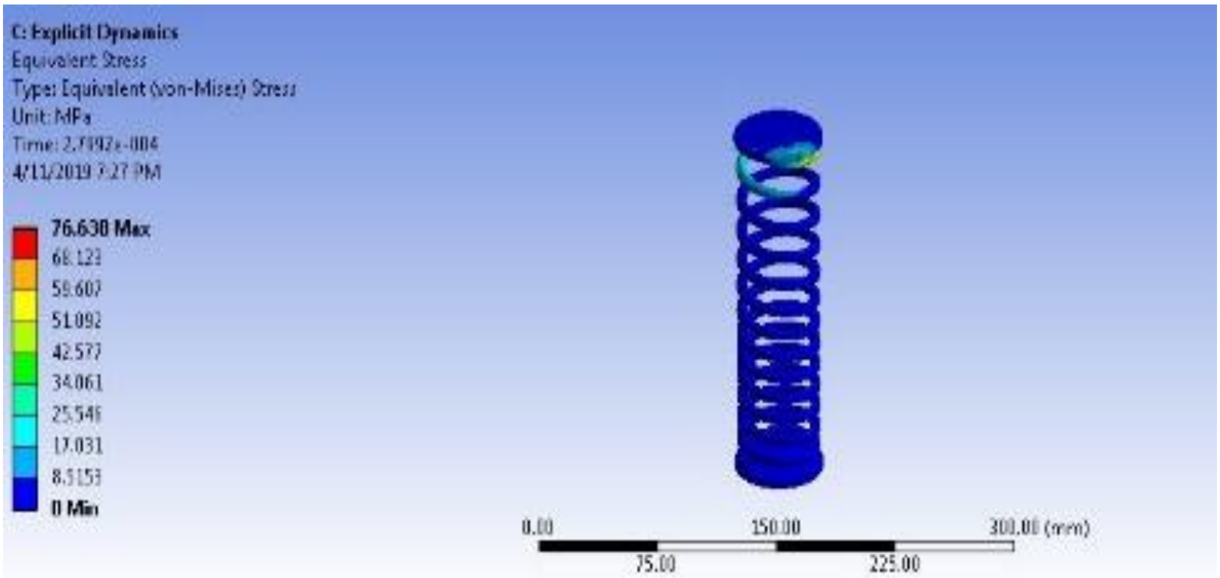

Figure 27: *Stress for 5000 cycles.*

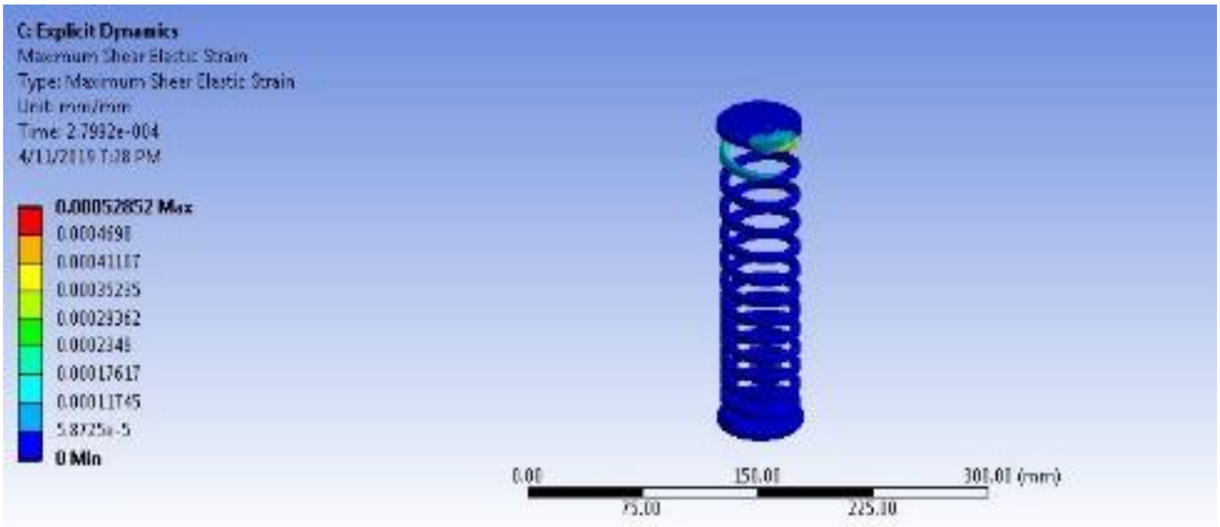

Figure 28: *Maximum shear strain for 5000 cycles.*

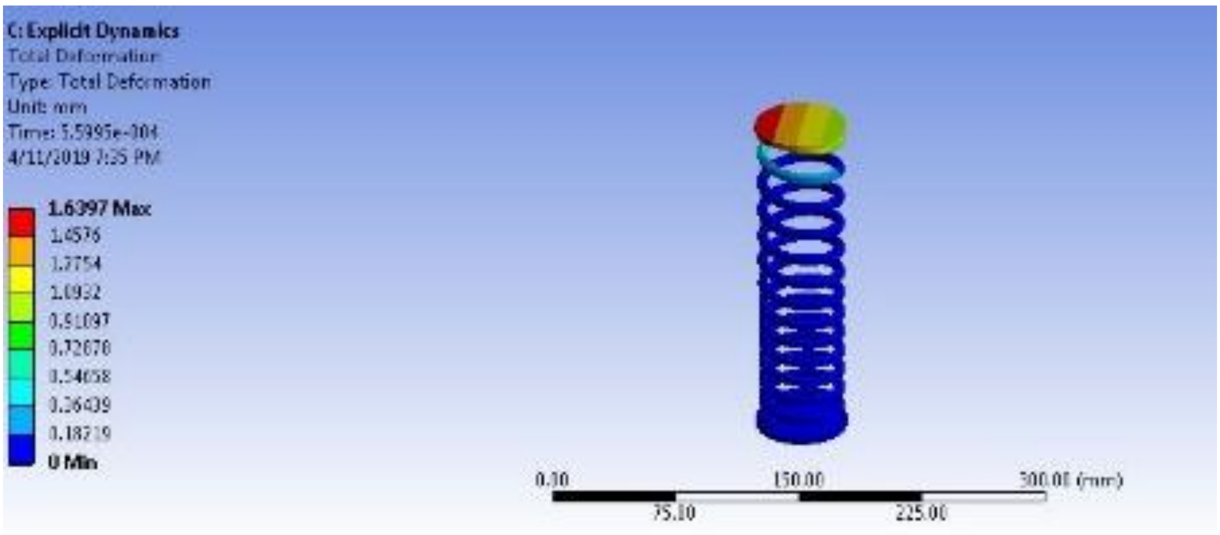

Figure 29: *Deformation for 10000 cycles.*

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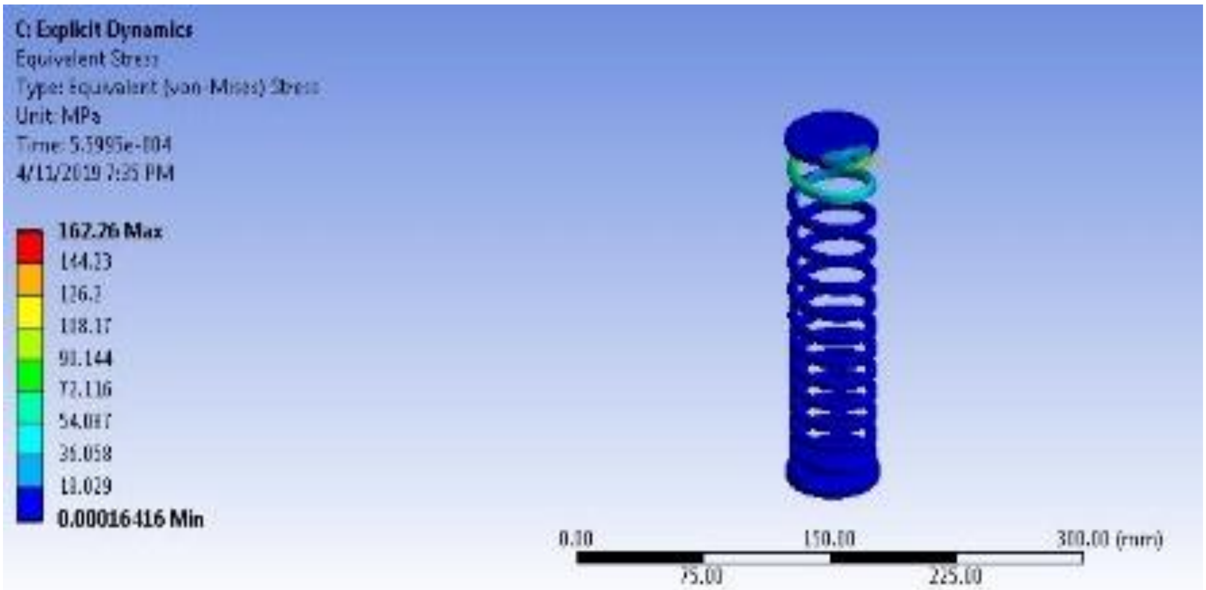

***Figure 30:** Stress for 10000 cycles.*

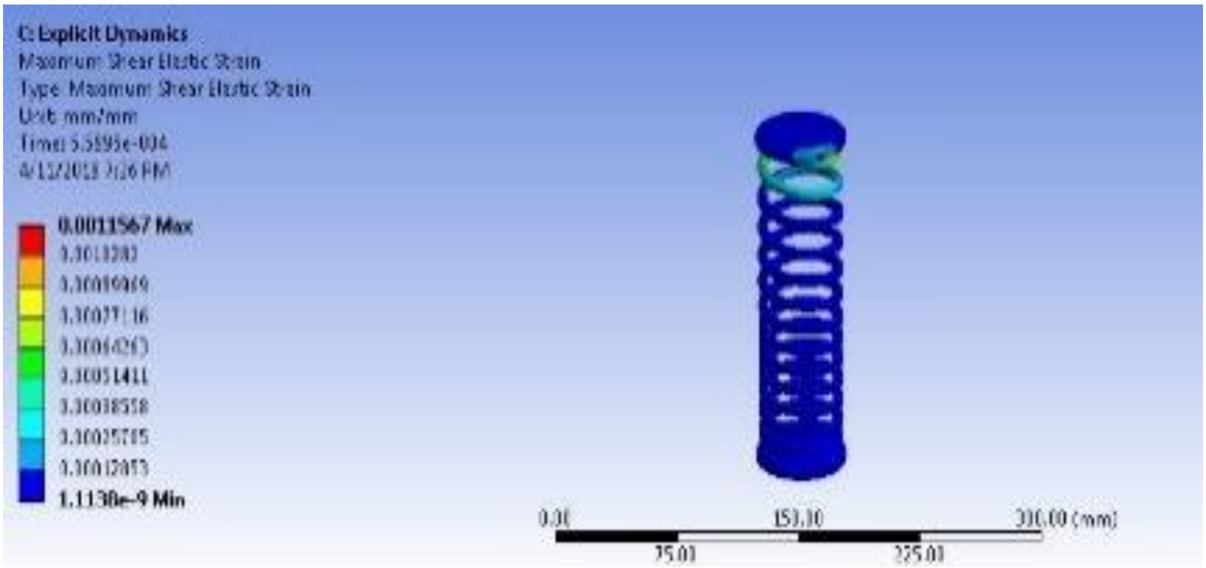

***Figure 31:** Maximum shear strain for 10000 cycles.*

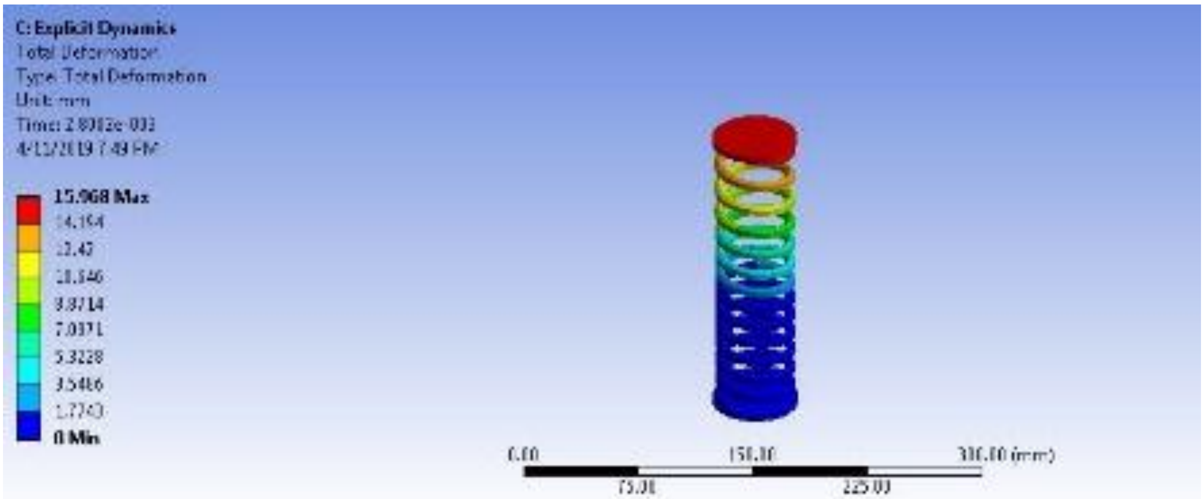

***Figure 32:** Deformation for 50000 cycles.*

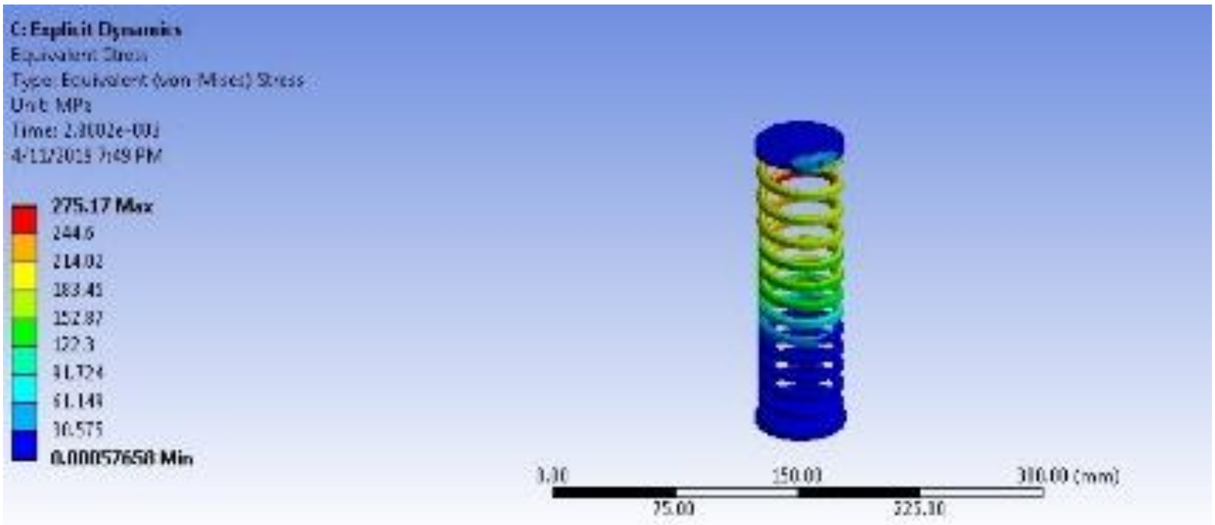

Figure 33: *Stress for 50000 cycles.*

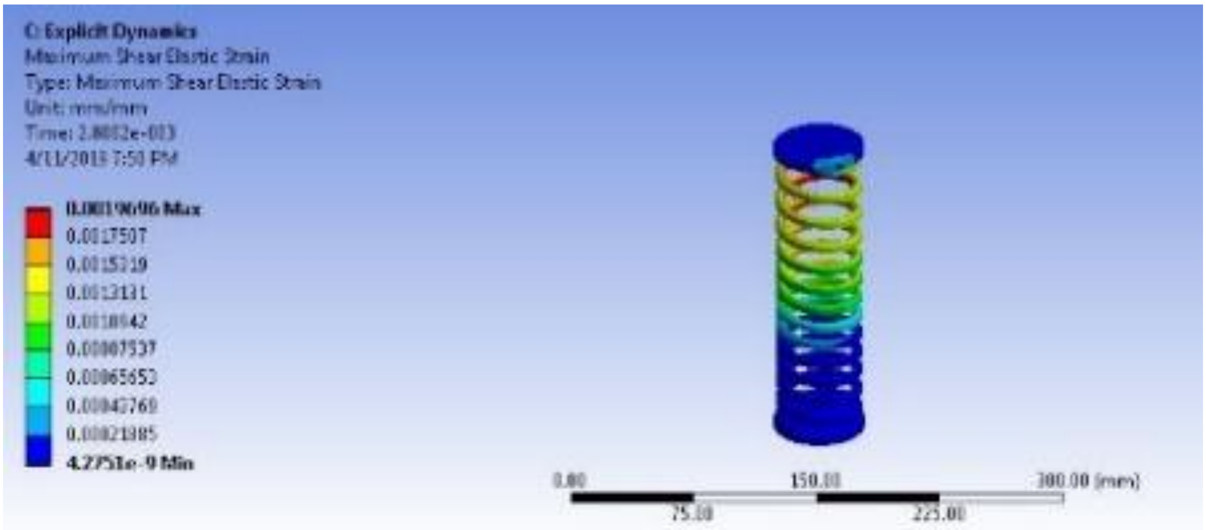

Figure 34: *Maximum shear strain for 50000 cycles*

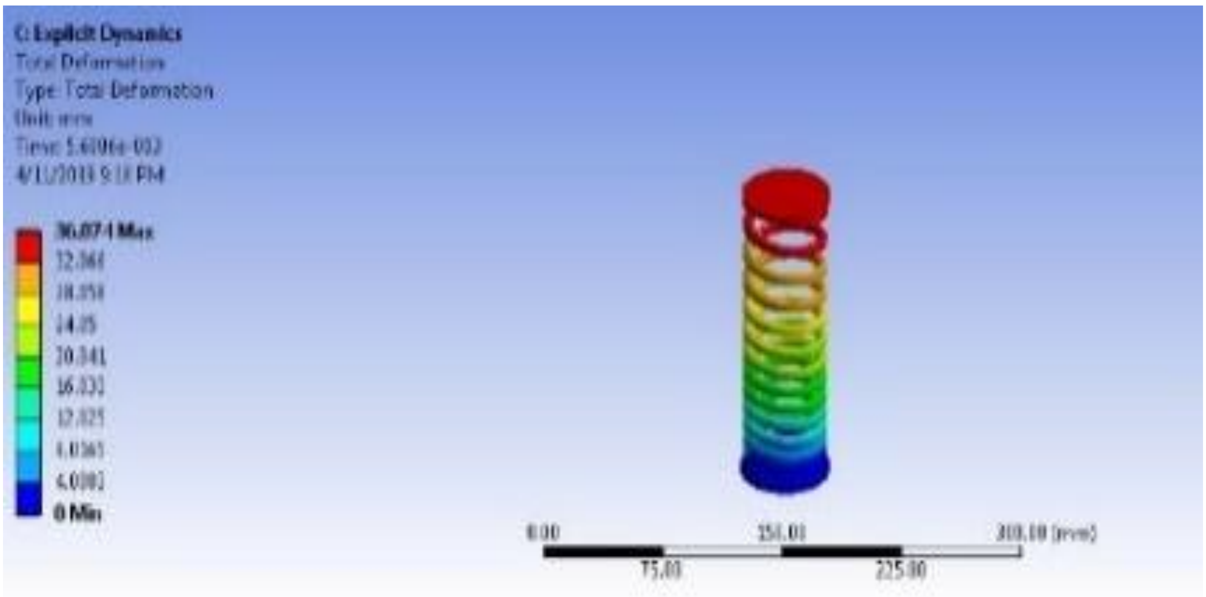

Figure 35: *Deformation for 1e5 cycles.*

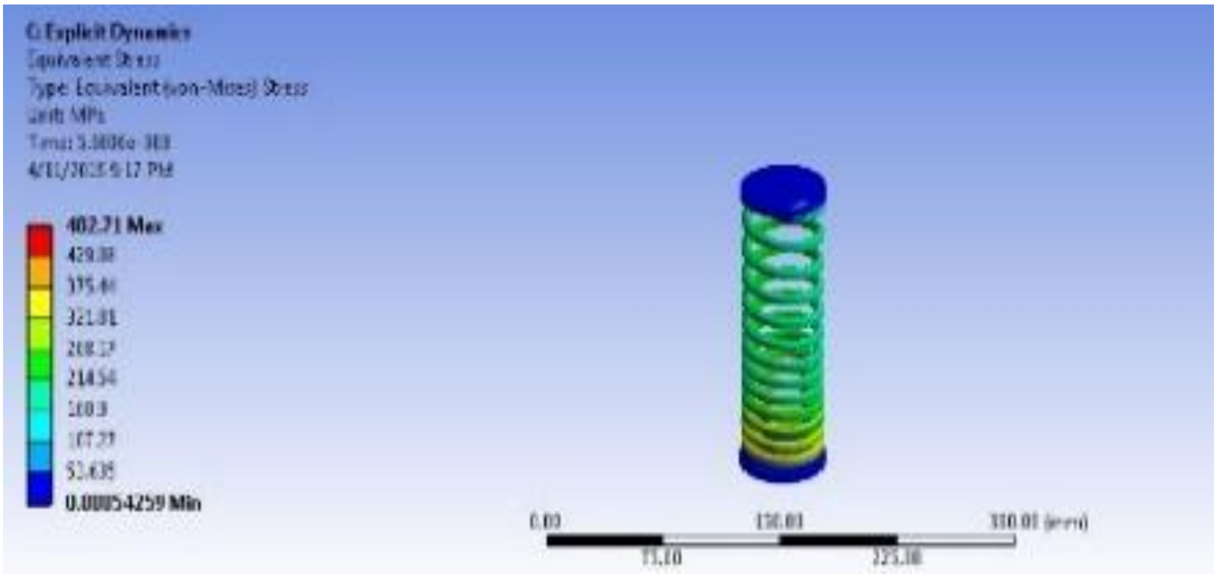

Figure 36: *Stress for 1e5 cycles.*

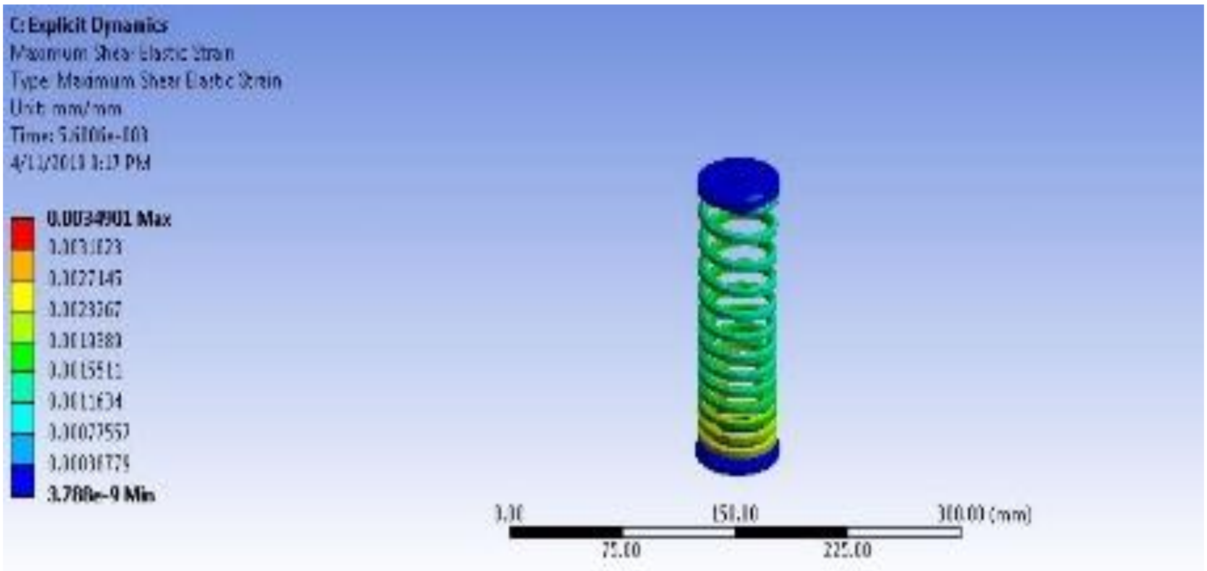

Figure 37: *Maximum shear strain for 1e5 cycles.*

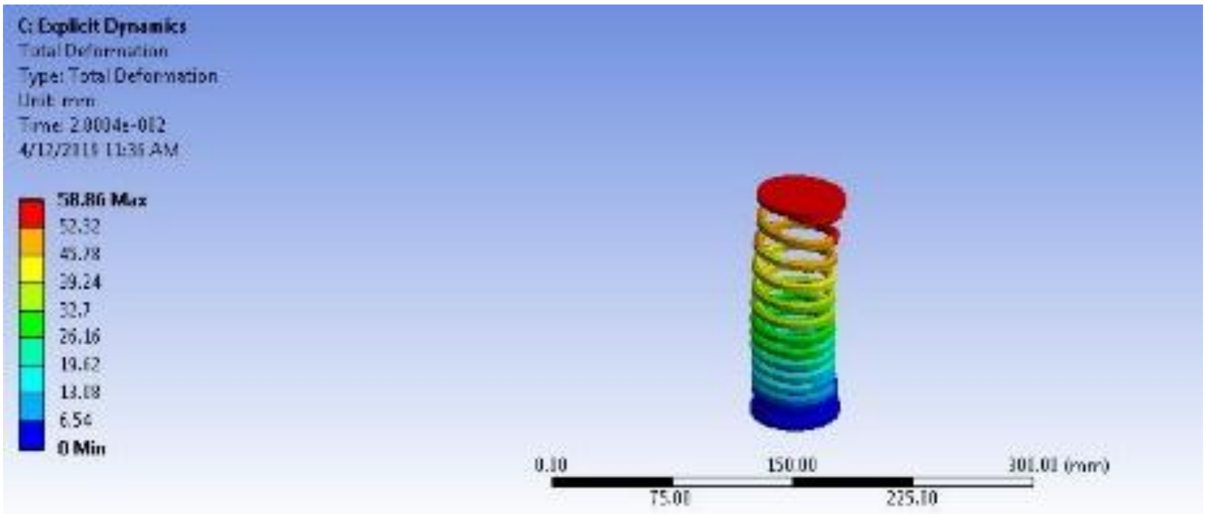

Figure 38: *Deformation for 5e5 cycles.*

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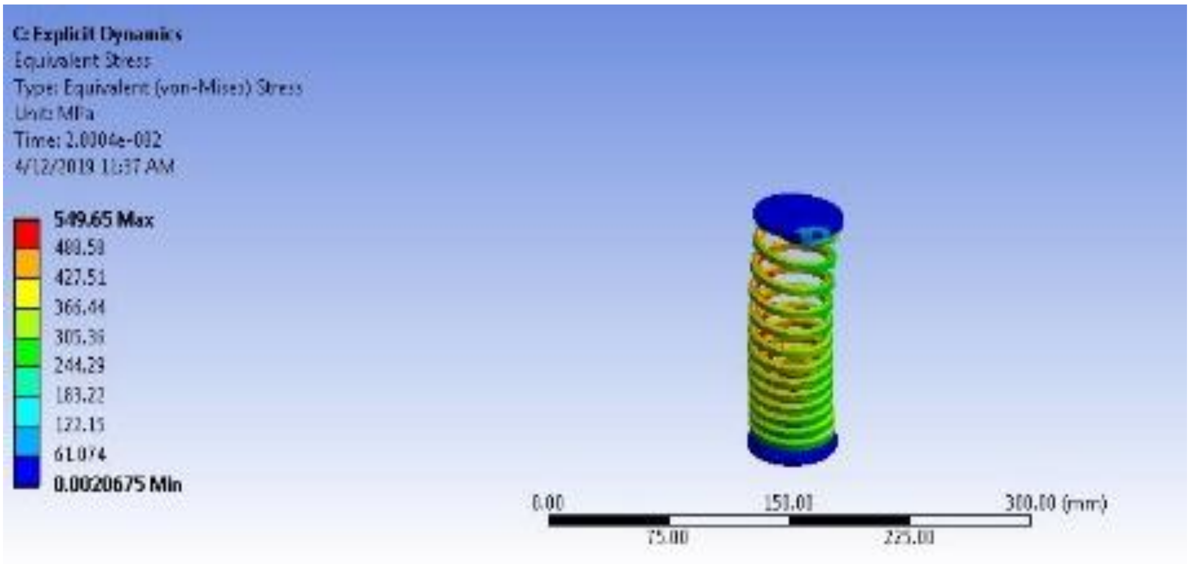

Figure 39: *Stress for 5e5 cycles.*

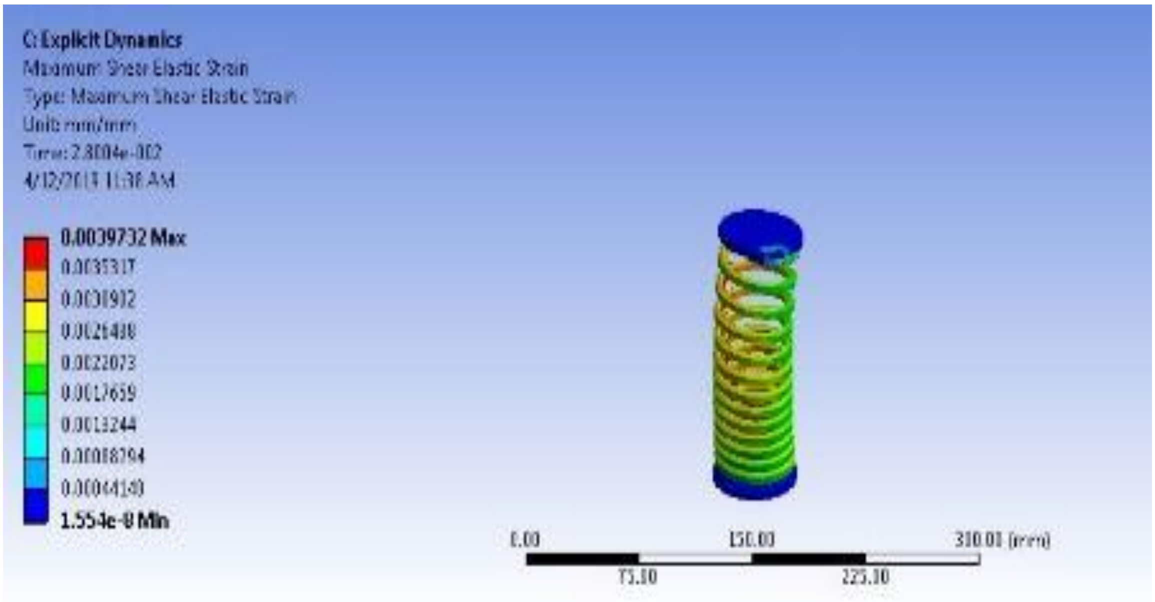

Figure 40: *Maximum shear strain for 5e5 cycles.*

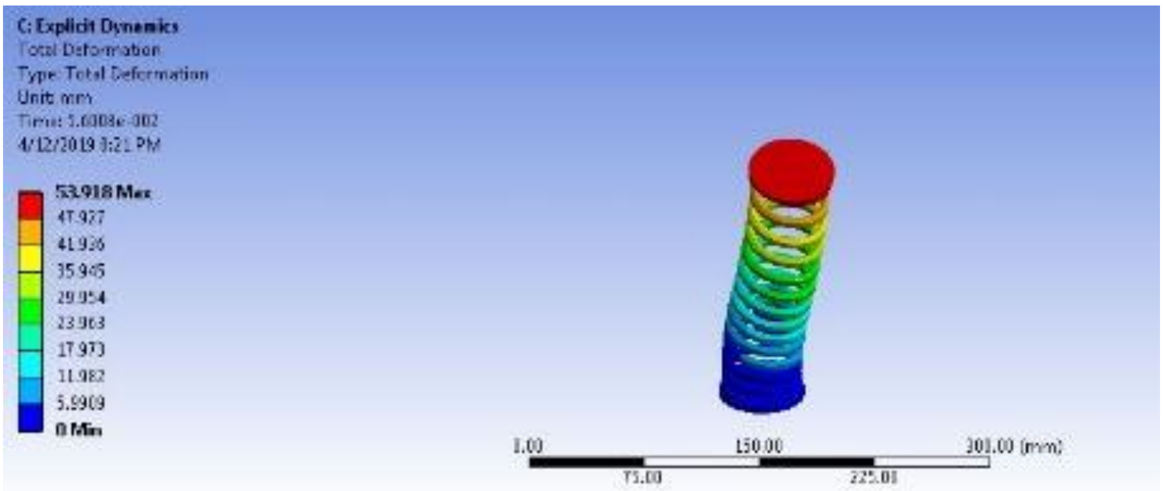

Figure 41: *Deformation for 1e6 cycles.*

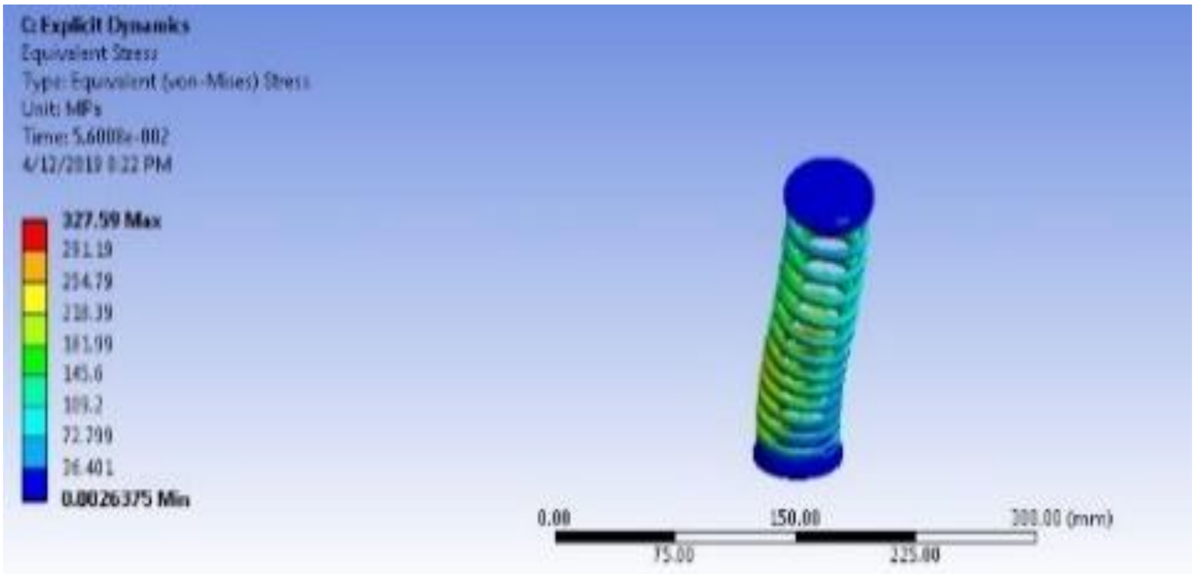

Figure 42: *Stress for 1e6 cycles.*

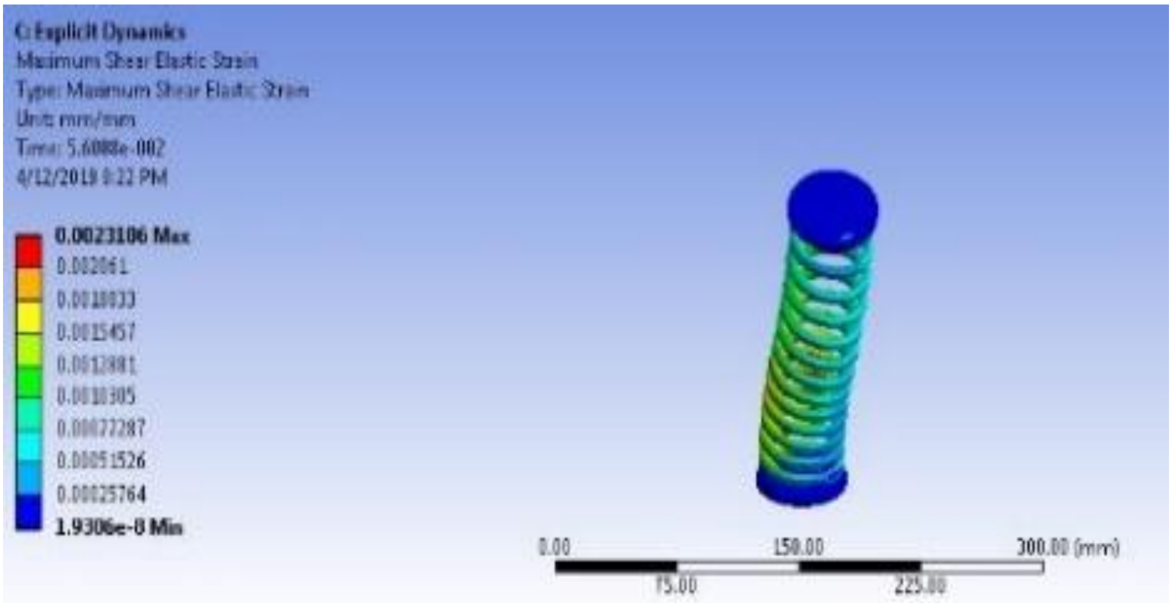

Figure 43: *Maximum shear strain for 1e6 cycles.*

As it can be seen from dynamic analysis, how the structure behaves under cyclic loading condition. It also represent that the structure changes its shape from 1e6. Now, we will use fatigue tool to know the critical area or critical life of the structure using SWT method for maximum shear stress.

Fatigue Life Analysis

Monotonic Properties: Elastic Modulus: 206 GPa; Yield Strength: 1870 MPa; Tensile Strength: 2050 MPa; Elongation: 16.2 %; Reduction in Area: 35.1 %; True Fracture Strength: 2118 MPa; True Fracture Ductility: 40.0000 %; Strength Coefficient: 2413 MPa; Strain Hardening Exponent: 0.0420; Hardness(HB): 536; Hardness(HRC): 54; Microstructure: Martensite (%): 100

Cyclic yield strength σy´ (MPa)	Cyclic strain exponent, n´	Cyclic strength coefficient K´ (MPa)	Fatigue strength coefficient σf´ (MPa)	Fatigue strength exponent b	Fatigue ductility coefficient εf´	Fatigue ductility exponent c
1354	0.076	2168	2914	-0.0973	4.17	-0.926

Figure 44: *Strain life properties. [6]*

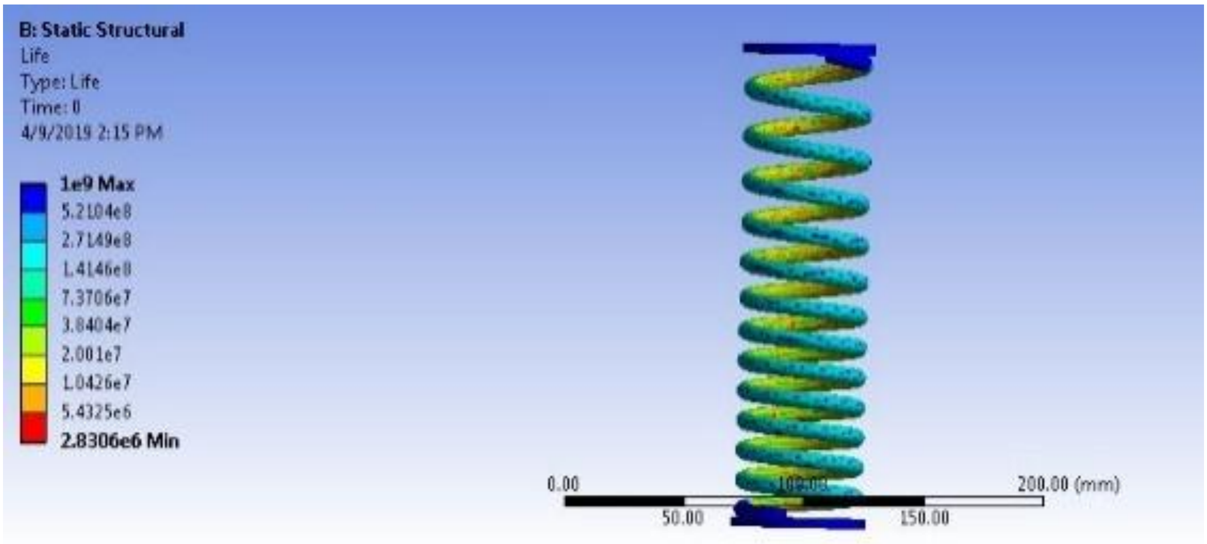

Figure 45: *Fatigue life using strain life method.*

The above fig 45 shows the fatigue life of the structure. The internal part has the minimum life where the failure starts initially, red color area represent the critical part or the minimum life part.

CONCLUSION

In this project, we have modelled a shock absorber used in a bullet 350cc bike. The shock absorber was modelled using 3D parametric software solid works and performed different analysis like static structural, modal, dynamic and fatigue life. It has been studied how the structure behave under cyclic loading, further the life is predicted using fatigue tool. The future work is to be done by choosing a specific material to increase the life of the structure.

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