Design and analysis of conical shock absorber

Kalaveni Srinath, KaleruArunpal M-Tech, Student,Department of Mechanical Engineering,JNTUH college of Engineering, Jagtial, Telangana.
Dr. Suresh. Arjula Associate Professor, JNTUH college of Engineering, Jagtial, Telangana.

Abstract*—A mechanical component known as a shock absorber is utilised to deflect energy when an impact load is acting on a vehicle. It is utilised for a comfortable and smooth ride when moving over uneven terrain. Typically, helical springs are used to create shock absorbers; but, in this project, we'll be employing conical springs. In comparison to helical springs, conical springs have more lateral stability, which lowers the buckling stress. The shock absorber's spring is crucial for providing the desired suspension. The Creo programme is used to create the 3D shock absorber model. by utilising several substances for spring-like spring steel. ANSYS is used for static structural and modal analysis in order to confirm the effectiveness of the shock absorber.

Keywords—Helical spring, conical spring, shock absorber, Creo and ANSYS.

I. INTRODUCTION

A mechanical or hydraulic device used to attenuate and absorb shock impulses is referred to as a shock absorber or damper. To do this, it transforms the shock's kinetic energy into another sort of energy, usually heat, which is subsequently squandered.The majority of shock absorbers are dashpots (a damper that blocks motion by creating viscous friction).

Pneumatic and hydraulic shock absorbers are used in conjunction with cushions and springs. In vehicle shock absorbers, spring-loaded check valves and orifices regulate the flow of oil through internal pistons.

When making or choosing a shock absorber, where that energy goes is a design consideration. Inside the viscous fluid of shock absorbers, energy is often converted to heat. The heated air in air cylinders is frequently evacuated into the atmosphere, while the hydraulic fluid inside those cylinders warms up. Electromagnetic shock absorbers, among other types of shock absorbers, can employ the conserved lost energy in the future. Vehicles can frequently be cushioned on uneven roads thanks to shock absorbers.

1.1 Vehicle suspension

Shock absorbers mitigate the effects of driving over uneven terrain, enhancing ride comfort and vehicle control. Although shock absorbers' main purpose is to lessen spring oscillations, they are also employed to manage excessive suspension movement. Shock absorbers employ oil and gas valves to absorb additional energy from the springs. Based on the weight of the vehicle both loaded and unloaded, the manufacturer chooses the spring rates. Although shocks can be used to modify spring rates, this is not the right usage for them. They reduce hysteresis in the tyre as well as the energy stored in the motion of the upsprung weight going up and down. Shocks may need to be adjusted to the right resistance for the best wheel bounce dampening.

In spring-based shock absorbers, coil springs or leaf springs are typically used, and torsional shocks also use torsion bars. Ideal springs, however, cannot function as shock absorbers on their own since they only store energy; they cannot absorb or release it. Vehicles typically use hydraulic springs, torsion bars, and shock absorbers. In this combination, the hydraulic piston that dampens and dissipates vibration is specifically referred to as a "shock absorber". Currently, 2-wheelers mostly use composite suspension systems, while 4-wheelers also use composite leaf springs.

Because there are significantly fewer disturbances, it improves ride quality and increases comfort when driving over uneven terrain. Without safeguards, the car would probably go over the permitted range of suspension development because of the energy held in the spring that is subsequently released, giving the ride a bobbing sensation. To control unnecessary suspension movement without shock retention, which would lead to an uncomfortable ride, stronger (higher err ate) springs are required. Shock absorbers, which also control how quickly the suspension reacts to bumps, allow for the use of sensitive (lower rate) springs. They also reduce the movement of the unspring weight over the springiness of the tyre, in addition to hysteresis in the tyre itself. Effective wheel skip damping may require utilising harsher shocks than would be optimum for only vehicle movement because the tyre is less brittle than the springs.Curl springs or leaf springs are primarily utilised in safety measures based on springs, while suspension bars can also be used in tensional shocks. Ideal springs alone, however, are insufficient as shock absorbers because they merely serve to store energy and do not disperse or absorb it. Aside from water-powered safety mechanisms, most automobiles also employ springs and suspension bars. In this mixture, the vibration-absorbing and -dissipating water-powered cylinder is particularly referred to as a "shock absorber."

II. Calculations for designing shock absorber

Spring steel (modulus of rigidity) G = 210000 N/mm2
Spring steel has a density of 7850 kg/m3.

2.1 Helical spring:

Mean diameter of a coil D= 26mm

Diameter of spring wire d = 8mm

Total no of coils for helical spring = 10

Helical spring is designed with pitch variation of 10mm at one end and 14mm at another end.

Height h = 100mm

Outer diameter of spring coil D0 = D +d =42mm

2.2 Conical spring:

Mean diameter of a coil D= 26mm

Outer diameter of spring coil D_1 = D +d =42mm

Outer diameter of taper end of the spring D_2= 32mm

Diameter of wire d = 8mm

Height h = 100mm

Spring steel (modulus of rigidity) G = 210000 N/mm^2

Total no of coils for conical spring, n= 10

A conical spring has a pitch that ranges from 10mm at one end to 14mm at the other.

2.3 Load calculation

Let weight of bike be 125kgs and Weight of one person be 75Kgs.

Then total weight= weight of bike + weight of person =140+195Kgs = 335 Kgs

Considering Factor of Safety (FOS) = 1.5

Total weight = 200 × 1.5 = 300Kgs

Rear suspension = 65%

Weight acting on rear suspension = 65% of 335 = 217.75Kgs = 220 Kgs

Considering dynamic loads, it will be double W = 2 × 335Kgs = 3822N

For single shock absorber weight = w/2=3822N/2= 1911N

III. Introduction to Creo

Creo Parametric is one of the most effective software packages for computer-aided design (CAD), computer-aided analysis, and computer-aided manufacturing (CAM) available today. A collection of additional software tools for engineering and product development, including Creo, was developed by PTC Corporation. Examples include Creo Simulate, Creo Layout, and others. The primary industries for utilisation include shipbuilding, construction, product design, aerospace, and mechanical engineering.

Creo Parametric was the previous name for Pro/Engineer (or Creo). wildfire as well. Intricate three-dimensional 3D objects and assemblages can be created, verified, and shared using a variety of tools included in the software's core.To help with the creation of engineering drawings, mould designs, NC machine simulations, sheet metal designs, piping and wiring designs, harness designs, structural strength, thermal and CFD analyses, kinematic and dynamic analyses, feasibility and optimisation studies, and other tasks, there are integrated applications that work in tandem with the 3D model geometry. This extensive list of applications is not intended to terrify the user, but rather to demonstrate the breadth and complexity of a modern CAD/CAM programme.

The main objective of this book is to describe the basic CAD/CAM methodology and ideas that form the basis of the programme. The book is organised into a number of important courses that provide the reader a head starts and point them in the right direction as they learn the basics of 3D CAD modelling.

According to the authors, if the reader masters Creo, he or she will be able to quickly pick up other CAD/CAM programmes. This is due to the striking similarities between Creo's core concepts and 3D modelling mindset and those ofsystems like SolidWorks, Siemens NX, and Autodesk Inventor. You can build Basic Solid Parts and Assembly, NC Simulation, Mould Design, and Drawings using the 10 classes in the book.

IV. MODEL OF SHOCK ABSORBER

4.1 BOTTOM PART

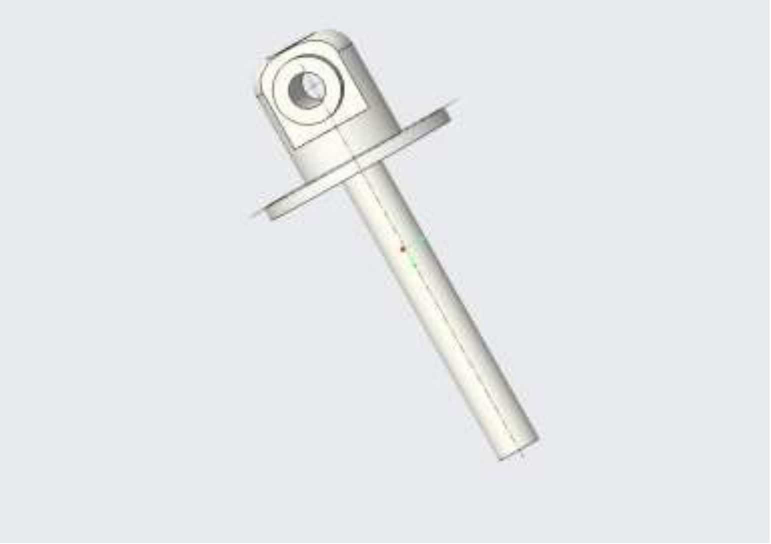

Fig. 1: Bottom part

4.2 TOP PART

Fig. 2: Top part

4.3 HELICAL SPRING

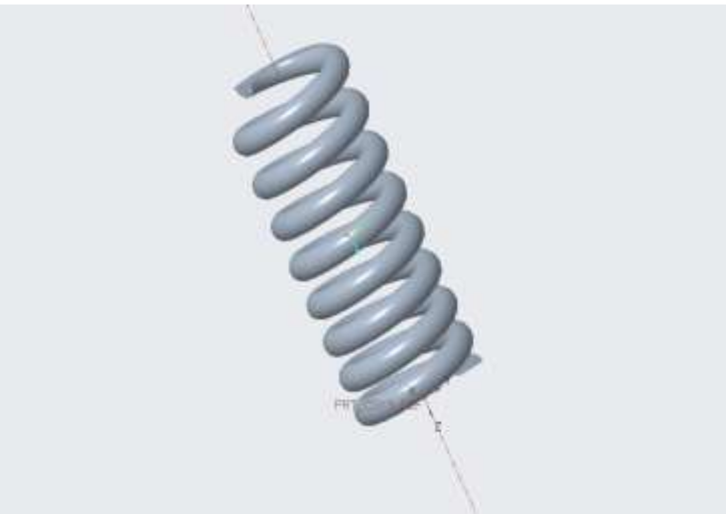

Fig.3: Helical spring

4.4 CONICAL SPRING

Fig.4: Conical spring

4.5 TOTAL ASSEMBLY

By using Creo parametric, all the components are assembled.

4.5.1 Conical shock absorber

Fig.5: Conical shock absorber

4.5.2 Helical shock absorber

Fig.6: Helical shock absorber

V. Analysis of shock absorber

ANSYS is a tool for engineering simulation (computer aided Engineering). Its tools include those for finite element analysis of thermal, static, dynamic, and fatigue inaddition to others that are all meant to support the development of the product. Swanson Analysis Systems, Inc., or SASI, was founded by Dr. John A. Swanson in 1970. Dr. John A. Swanson established Swanson Analysis Systems, Inc., or SASI, in 1970. Its main objective was to create and market structural physics finite element analysis software that could model static, dynamic, and thermal issues.SASI expanded its business at the same time that computer technology and engineering requirements grew. Before being sold in 1994, the company experienced annual growth of 10% to 20%.

5.1 STATIC ANALYSIS OF Shock absorbers

Creo Model, save it as .iges file to carry out the analysis.

Open the workbench, choose the analysis system, next choose the static structural, and finally, open the Ansys software.

Open the static structural component after selecting the geometry, then import the shock absorber geometry from the desired folder before opening the component. Choose the mesh option for meshing, then adjust the type of mesh as necessary.

5.2 Meshing of conical shock absorber

Fig:7 Meshing of Conical shock absorber

5.2.1 Meshing of helical shock absorber

Fig.8: Meshing of Helical shock absorber

5.3 Static analysis of conical shock absorber

Force is acting at the top end, while the lower end is assumed to be a fixed support.
Static analysis is carried out at load 1911N to determine the total deformation, von-misses strain, von-misses stress, and maximum shear stress values.

5.3.1 Total deformation

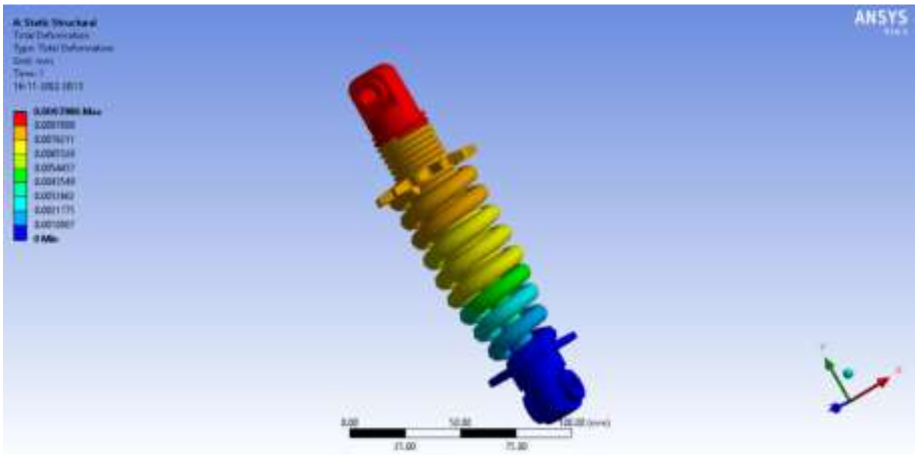

Fig.9: Total deformation

5.3.2 Equivalent elastic strain

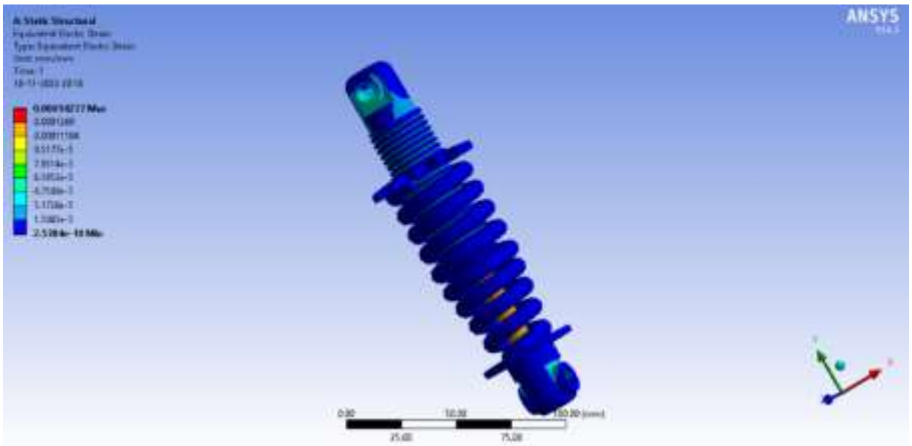

Fig.10: Equivalent elastic strain

5.3.3 Equivalent (von-mises) stress

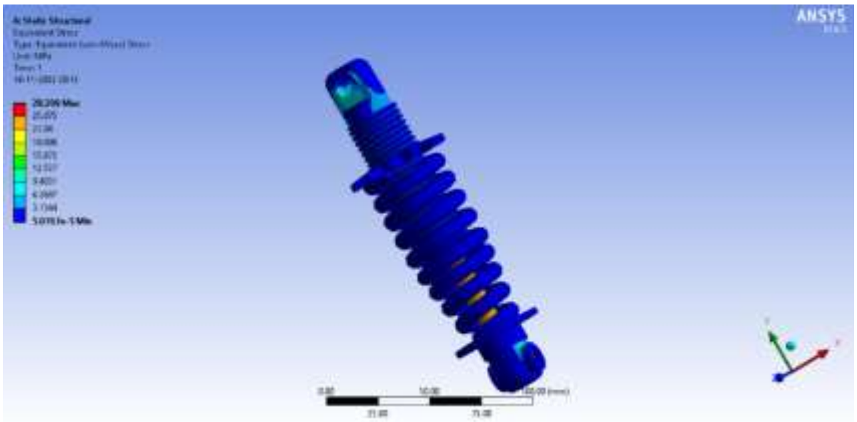

Fig.11: Equivalent (von-mises) stress

5.3.4 Maximum shear stress

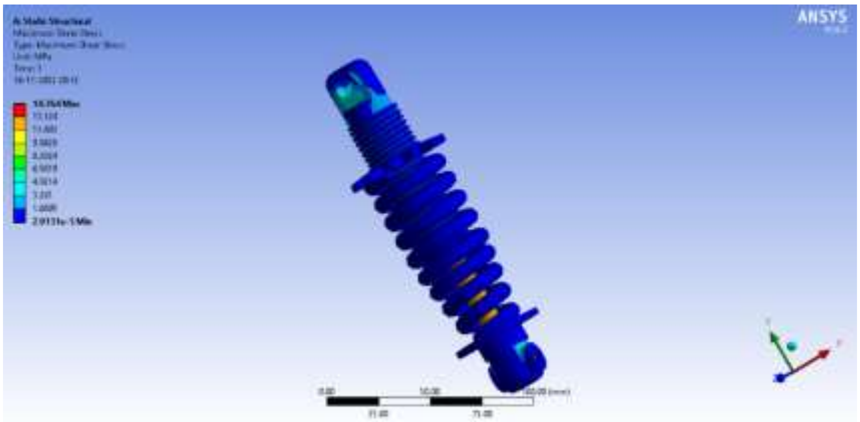

Fig.12: Maximum shear stress

5.4 Static structural of helical shock absorber

Force is acting at the top end, while the lower end is assumed to be a fixed support.

Static analysis is carried out at load 1911N to determine the total deformation, von-misses strain, von-misses stresses, and maximum shear stress values.

5.4.1 Total deformation

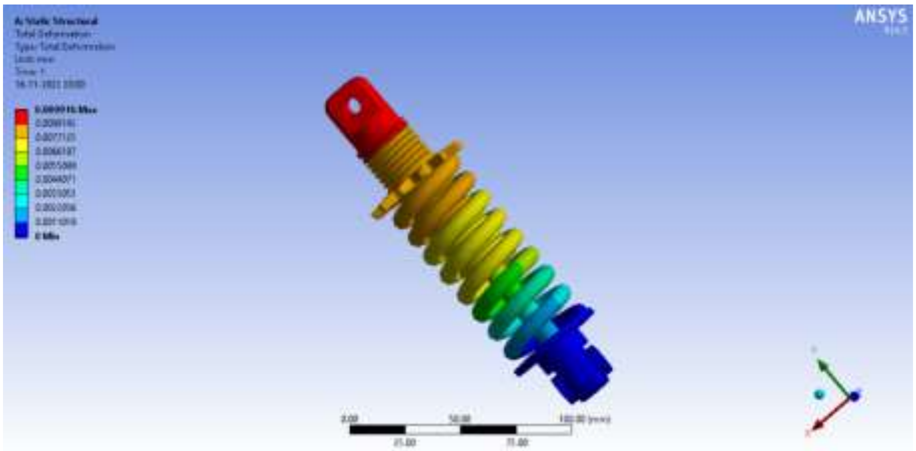

Fig.13: Total deformation

5.4.2 Equivalent elastic strain

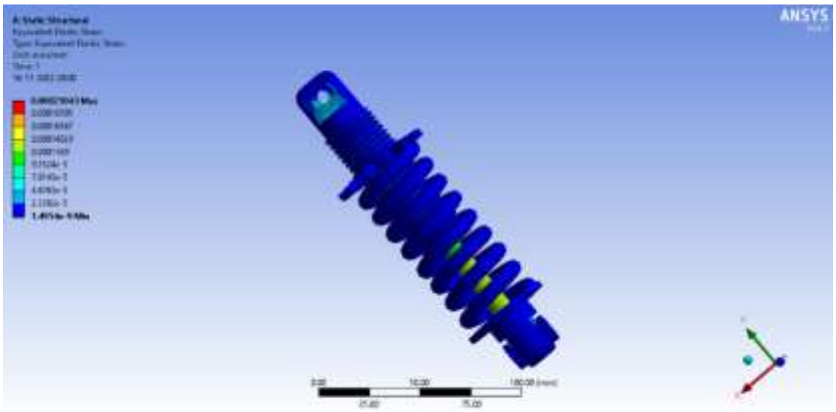

Fig.14: Equivalent elastic strain

5.4.3 Equivalent (von-mises) stress

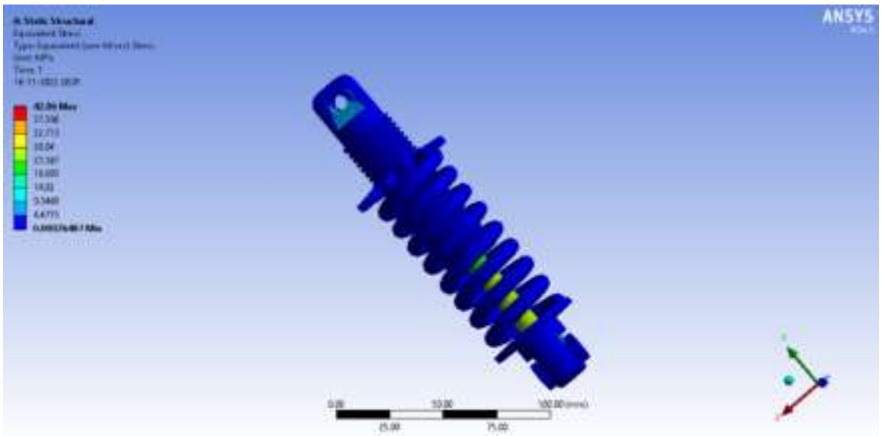

Fig.15: Equivalent (von-mises) stress

5.4.4 Maximum shear stress

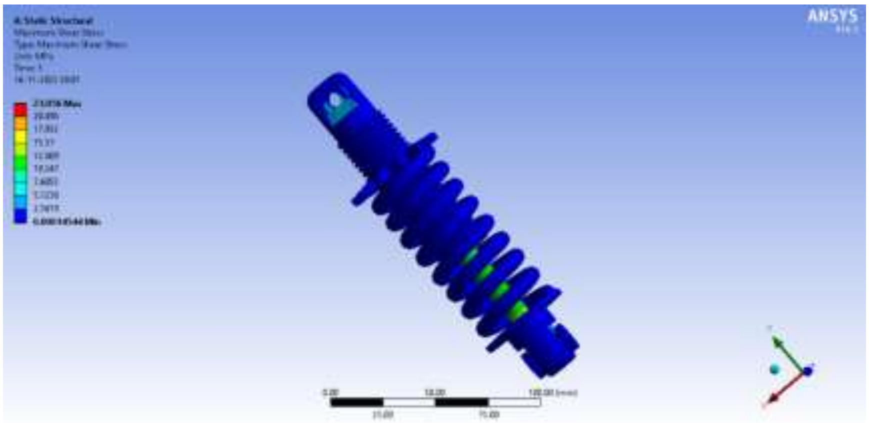

Fig.16: Maximum shear stress

VI. Modal analysis of conical shock absorber

For modal analysis, we chose 10 modes with various frequencies, and each mode captured the entire deformation. The deformation of the shock absorber as a whole in 10 modes at different frequencies is shown below.

6.1 Modal analysis of conical shock absorber

6.1.1 Total deformation 1

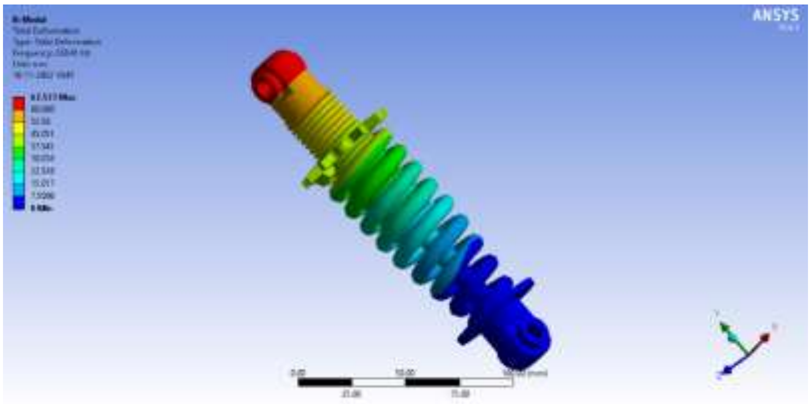

Fig.17: Total deformation 1

6.1.2 Total deformation 2

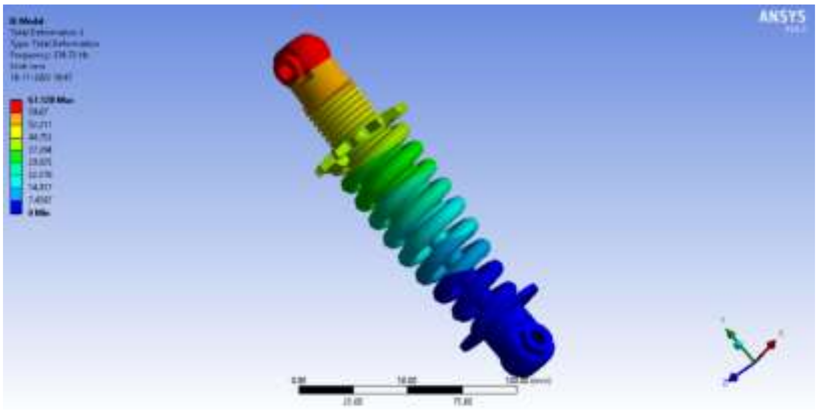

Fig.18: Total deformation 2

6.1.3 Total deformation 3

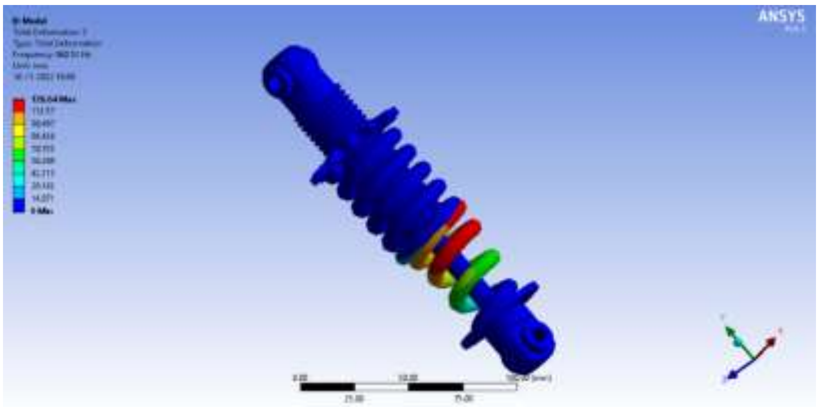

Fig.19: Total deformation 3

6.1.4 Total deformation 4

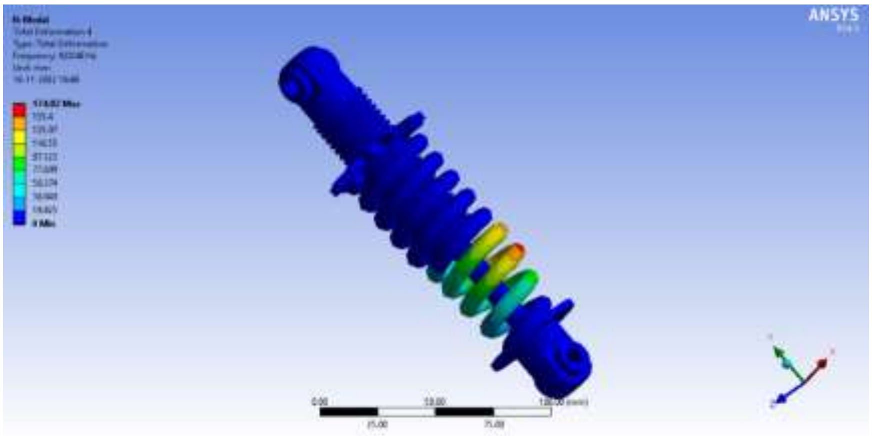

Fig.20: Total deformation 4

6.1.5 Total deformation 5

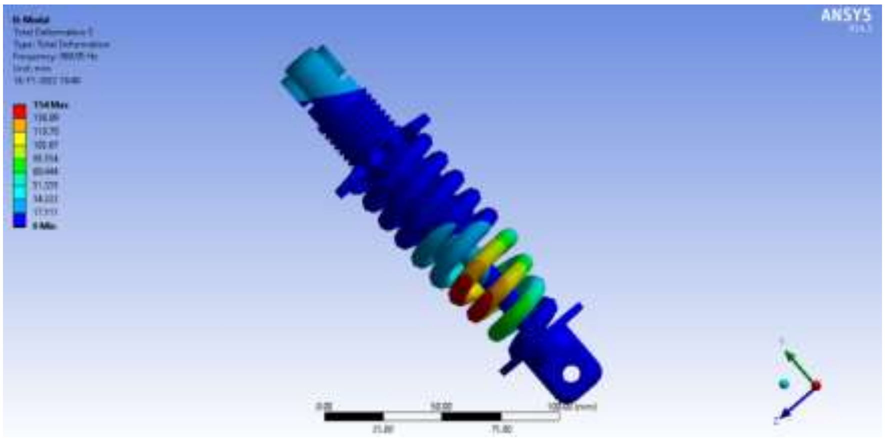

Fig.21: Total deformation 5

6.1.6 Total deformation 6

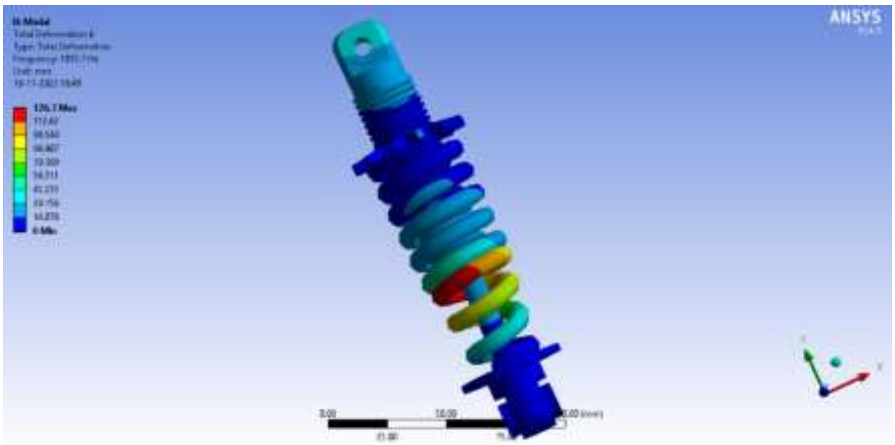

Fig.22: Total deformation 6

6.1.7 Total deformation 7

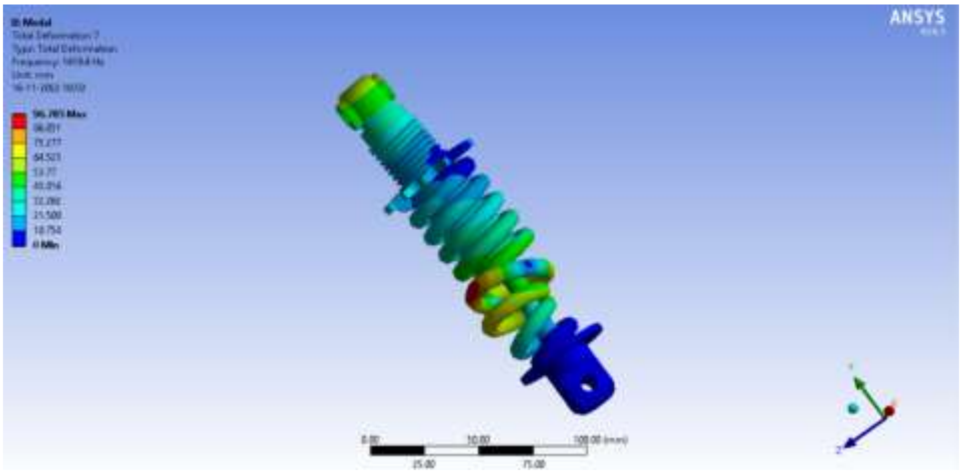

Fig.23: Total deformation 7

6.1.8 Total deformation 8

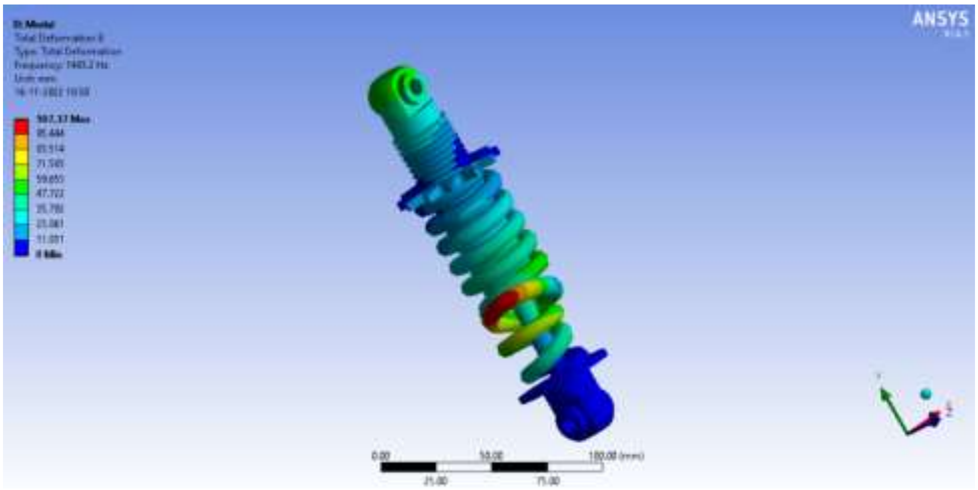

Fig.24: Total deformation 8

6.1.9 Total deformation 9

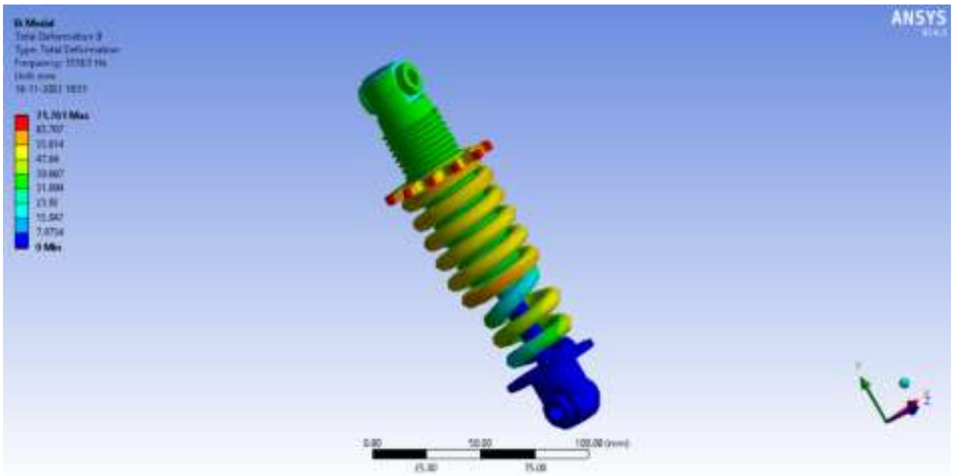

Fig.25: Total deformation 9

6.1.10 Total deformation 10

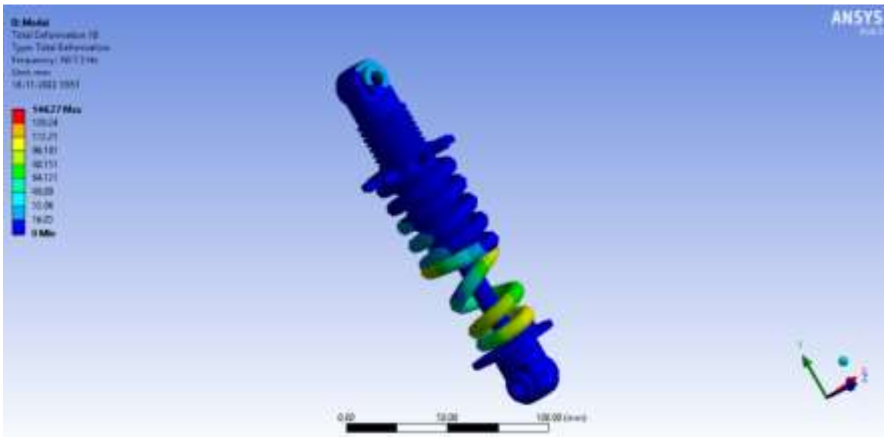

Fig.26: Total deformation 10

6.2 Modal analysis of helical shock absorber

We selected 10 modes with different frequencies for modal analysis, and each mode recorded total deformation. The following illustrates the shock absorber's overall deformation in 10 modes at various frequencies.

6.2.1 Total deformation 1

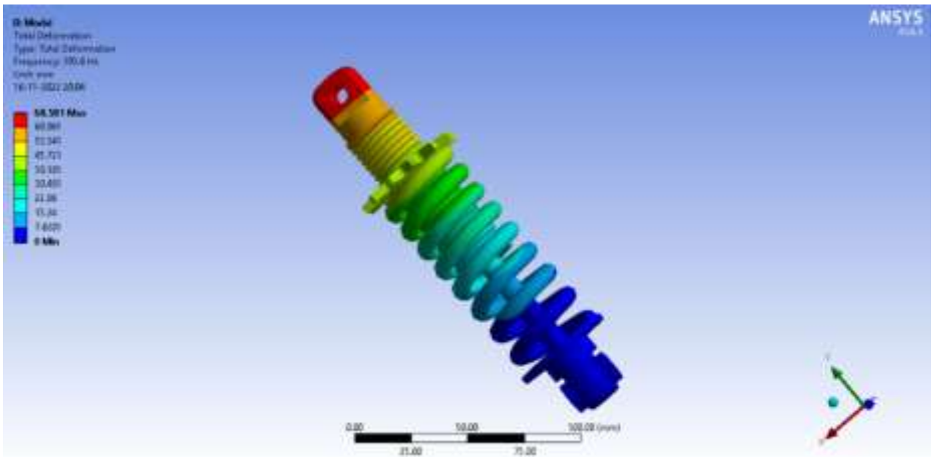

Fig.27: Total deformation 1

6.2.2 Total deformation 2

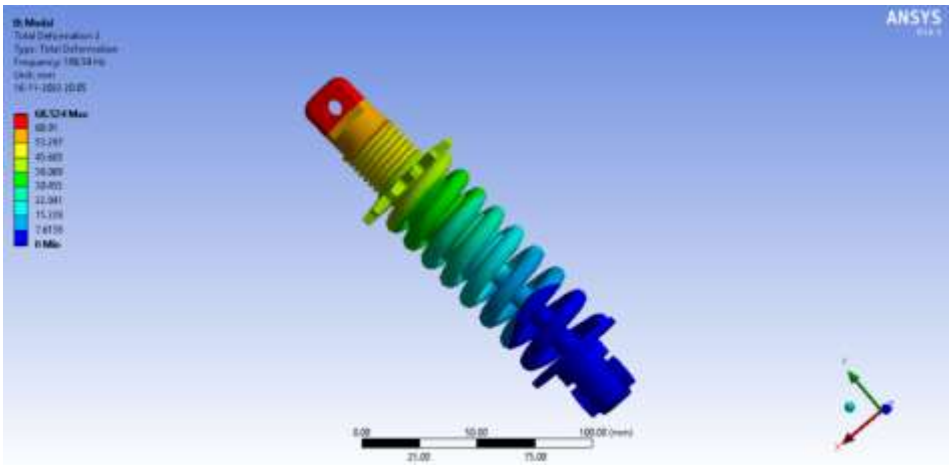

Fig.28: Total deformation 2

6.2.3 Total deformation 3

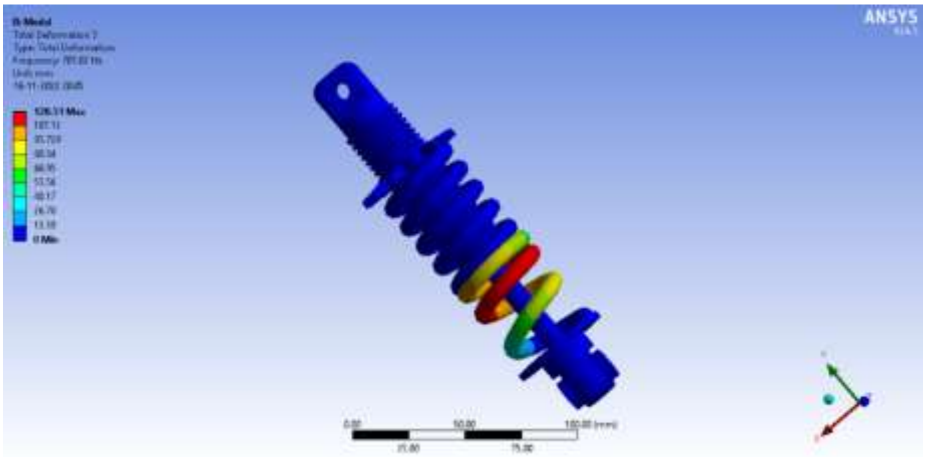

Fig.29: Total deformation 3

6.2.4 Total deformation 4

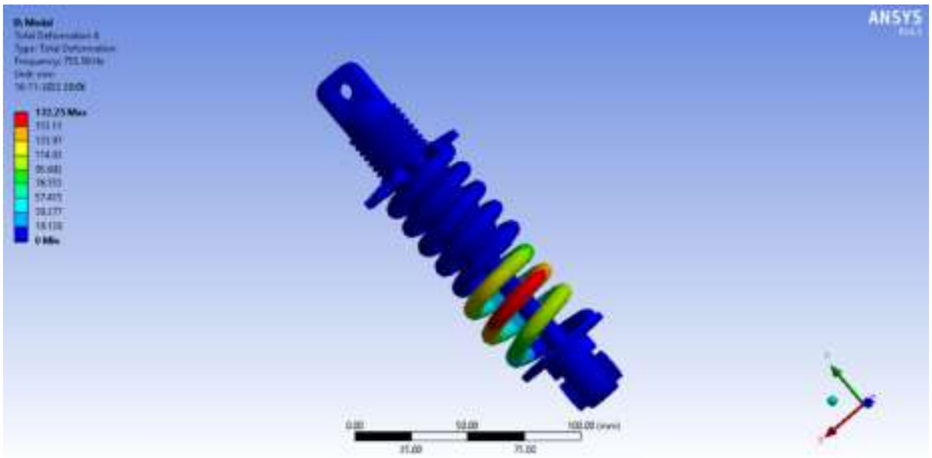

Fig.30: Total deformation 4

6.2.5 Total deformation 5

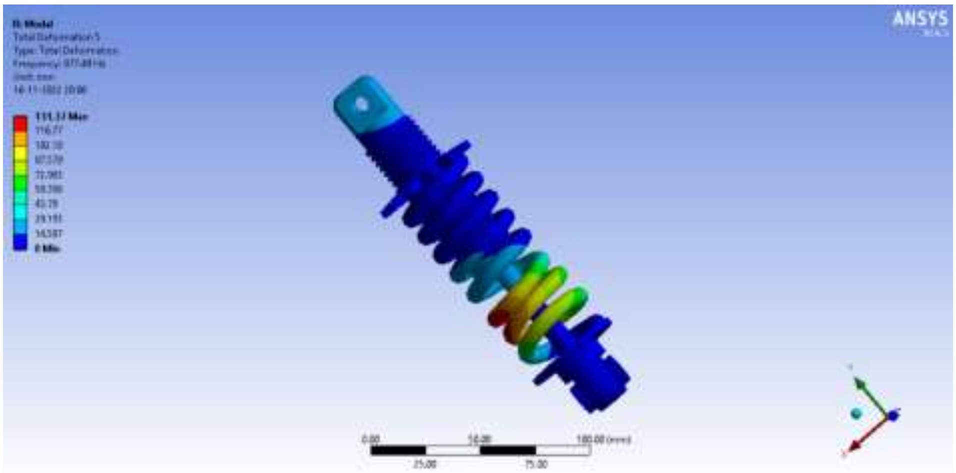

Fig.31: Total deformation 5

6.2.6 Total deformation 6

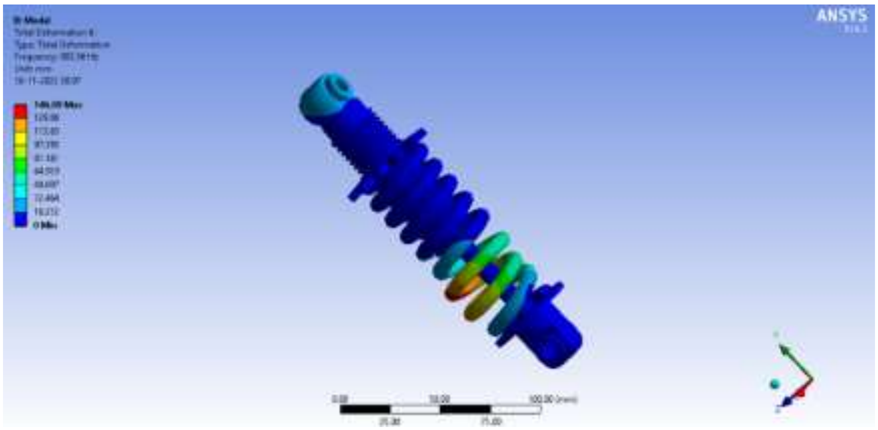

Fig.32: Total deformation 6

6.2.7 Total deformation 7

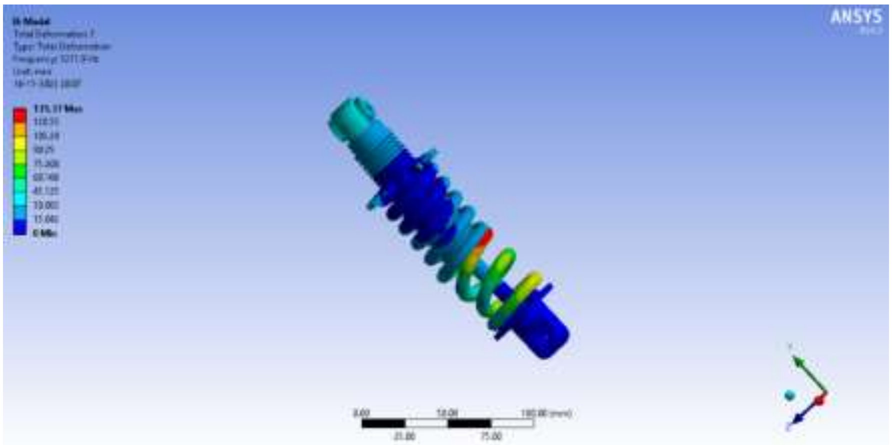

Fig.33: Total deformation 7

6.2.8 Total deformation 8

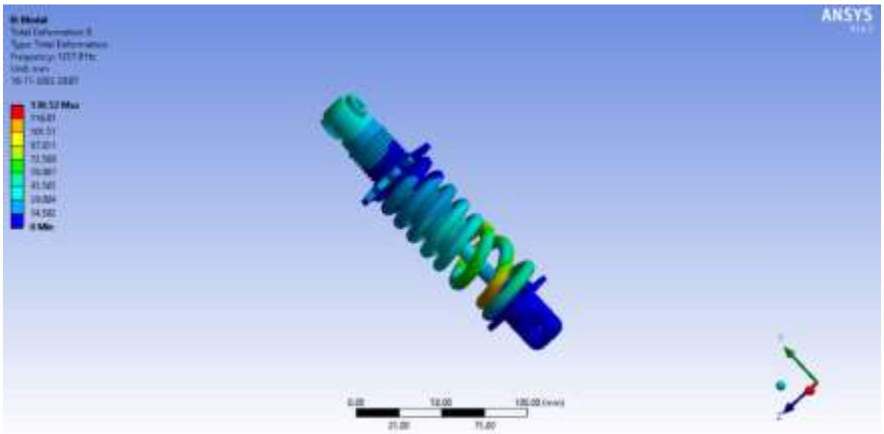

Fig.34: Total deformation 8

6.2.9 Total deformation 9

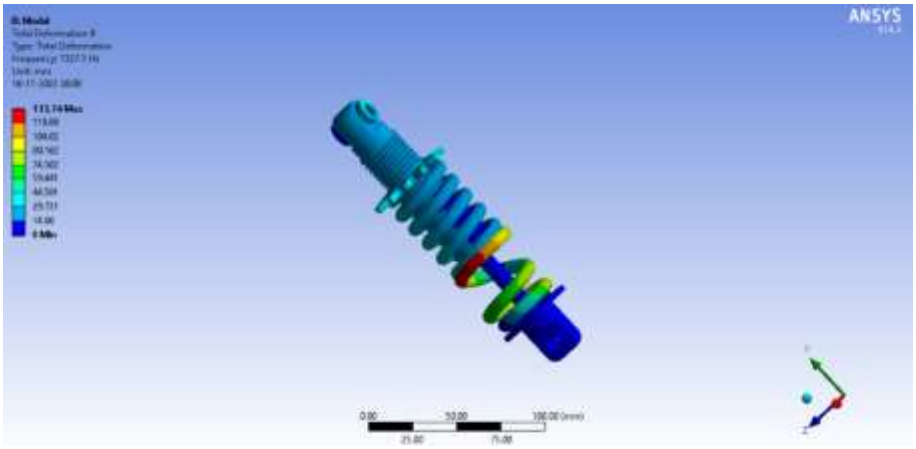

Fig.35: Total deformation 9

6.2.10 Total deformation 10

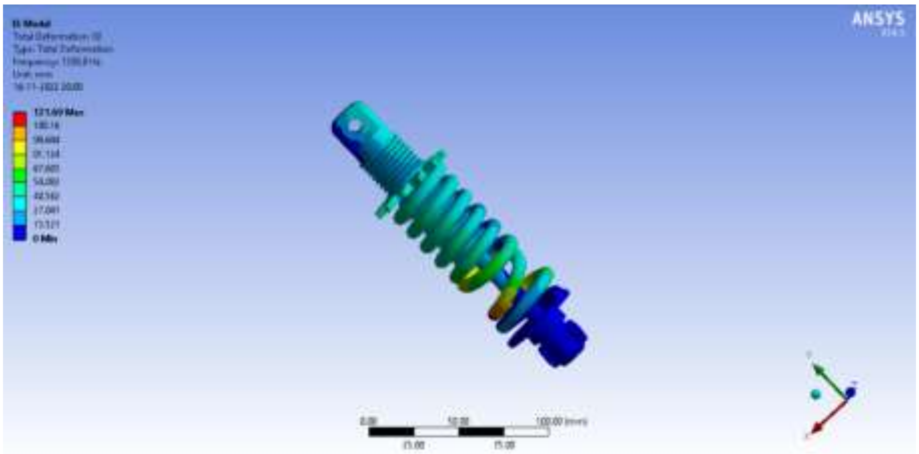

Fig.36: Total deformation 10

VII. RESULTS

7.1 Static analysis of shock absorbers

The applied load for both shock absorbers is 1911N.

S.No	Static analysis	Deformation values of conical shock absorber(max)	Deformation values of helical shock absorber (max)
1	Total deformation (mm)	**0.0097986**	0.0098179
2	Equivalent elastic strain	**0.00014272**	0.00021043
3	Equivalent (von-mises) stress	**28.209**	42.06
4	Max Shear stress (MPa)	**14.764**	23.056

Table.1: Static structural analysis of shock absorber

7.2 Modal analysis of shock absorber

For modal analysis, we chose 10 modes with various frequencies, and each mode captured the entire deformation. The deformation of the shock absorber as a whole in 10 modes at different frequencies is shown below.

S.No	Modal analysis	Frequency of conical shock absorber (Hz)	Deformation values of conical shock absorber (mm)	Frequency of helical shock absorber (Hz)	Deformation values of helical shock absorber (mm)
1	Total deformation 1	220.41	67.577	193.6	68.581
2	Total deformation 2	234.72	67.128	196.54	68.524
3	Total deformation 3	860.52	126.64	707.82	120.51
4	Total deformation 4	920.46	174.86	753.38	172.25
5	Total deformation 5	989.95	154	877.49	131.37
6	Total deformation 6	1033.7	126.7	883.36	146.09
7	Total deformation 7	1419.4	96.785	1211.9	135.37
8	Total deformation 8	1443.2	107.37	1257.9	130.52
9	Total deformation 9	1516.5	71.761	1327.3	133.74
10	Total deformation 10	1617.3	144.27	1338.8	121.69

Table.2: Modal analysis of shock absorbers

VIII. CONCLUSION

We are contrasting the helical shock absorber and conical shock absorber in this project.

We discovered that the overall deformation of the conical shock absorber is less than the helical shock absorber by comparing the analysis findings of the two shock absorbers.

The conical shock absorber has lower stress, strain, and maximum shear stress values than the helical shock absorber.

I observed that the overall deformation values of the conical shock absorber are lower at high frequency compared to the helical shock absorber by taking the 10 modes and altering the shock absorber with different frequencies.

From this we can conclude that conical shock absorber is superior than the helical shock absorber

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