Design And Analysis Of Helical Spring In Two-Wheeler Shock Absorber By Changing Its Geometric Parameters And Material

D. Ravichandran1, R. Barathkumar[2], S. Gowtham[3], T. Guna[4], V. Janashwaran[5]
[1]Assistant Professor, Dept of Mechanical Engineering
[2, 3, 4, 5]Dept of Mechanical Engineering
[1, 2, 3, 4, 5] Nandha Engineering college Erode, Tamilnadu-638052.

Abstract- *Transportation is one of the crucial things that the growth of mankind depends on. We use many modes of transportation systems. But the roads are mostly dominated by two-wheelers. Suspension systems play a major role while riding the two-wheeler. It's designed to smooth out or damp shock impulse and road bumps. It gives a smooth and comfortable ride. The defects and malfunctions of the shock absorber led to riding discomfort and loss of control. Our country's terrain, road conditions, and climate change test the shock absorber to its extreme. That is why we proposed our project.This Design and analysis process is to compare various materials and geometric parameters under different load cases with existing material and design to get an optimized design and Material for the spring. Change in geometric parameters like spring index, wire diameter, and the number of turns to get better results. The designing is to be done in Solid works and Analysis is to be done in Ansys workbench is used for accurate results and output.*

Keywords- Helical spring, Shock absorber, Two-wheeler,Solid works, Ansys

I. INTRODUCTION

The act of sporting people, merchandise, and animals from one area to another is known as transportation. Motors, buses, trucks, spacecraft, helicopters, ships, airplanes, and other automobiles have been invented to replace in advance ways of transportation as time handed. Transportation is an unavoidable part of lifestyles, and without it, any kind of mobility from one factor to some other will become not possible. Scooters and other non-geared two-wheelers are lightweight cars that can move fast on nicely-maintained roads beneath great driving situations. A vehicle of this length and space is generally thought to be 1/2 the dimensions and space of a compact car. Saves time inquisitors - using a -wheeler in congested locations reduces travel time notably.

The suspension of a bike contributes to the car's managing and braking, as well as offering protection and luxury by setting apart the car's passengers from street noise, bumps, and vibrations. While surprise absorbers are meant to dampen spring oscillations, additionally they serve to control immoderate suspension movement. Helical compression springs are usually utilized in mild cars and locomotives around the sector for suspension. Motorbike shock absorbers are pressured under fuel strain, the fluid is injected, and the fluid and gasoline stress are saved aside with the usage of a piston. This aspect is either immediately constant to the top of the shock absorber or held in a separate reservoir.

This pressurization prevents the fluid from cavitating, that's beneficial for greater balanced surprise absorption. A shock absorber additionally called a damper, is a mechanical or hydraulic device that absorbs and dampens surprise waves. That is performed by way of converting the shock's kinetic power into any other sort of power, which is in the end dispersed. Dashpots are the most commonplace form of surprise absorber. Shock absorbers in a vehicle lower the effect of going over choppy terrain, resulting in progressed ride pleasant and vehicle management. Whilst surprise absorbers are meant to hose down spring oscillations, they also serve to manipulate excessive suspension movement.

Shock absorbers take in extra power from the springs via using oil and gasoline valves. Shocks are every so often used to trade spring charges, but this is not the proper approach. Wheel leap damping might also necessitate best-tuning shocks to provide the greatest resistance. Coil springs or leaf springs are widely hired in spring-based surprise absorbers, at the same time as torsion bars also are utilized in torsional shocks. Perfect springs, then again, don't surprise absorbers because they simply store electricity and do now not discharge or absorb it.

Hydraulic shock absorbers, as well as springs or torsion bars, are regularly used in cars. The hydraulic piston that absorbs and dissipates vibration is explicitly referred to as a "shock absorber".

II. MATERIAL

The properties of an ideal spring material include high strength, a high elastic limit, and a low modulus. Spring material must have a high elastic limit because springs are resilient structures designed to withstand large deflections. Other attributes to examine include fatigue strength, cost, availability, formability, corrosion resistance, magnetic permeability, and electrical conductivity, all of which must be weighed against the cost/benefit ratio.

The material used in the spring should have good fatigue strength, ductility, and resilience, as well as be creep-resistant. It primarily depends on the type of service they provide, such as harsh, ordinary, or light. Average service, including engine governor springs and car suspension springs, has the same stress range as severe service but only operates intermittently. Light-duty springs, such as safety valve springs, are subjected to static or infrequently changing loads.

III. LITERATURE REVIEW

K. Sataynarayana et.al., Helical springs were designed and analyzed using a variety of materials, including stainless steel, phosphor bronze, chrome vanadium, and Inconel. For design, SOLID WORKS 2019 is utilized, while for FEA, ANSYS 18.1 is used. They examine the helical spring's circular and square cross-sections. Inconel and chrome vanadium are significantly more suited and optimized spring materials, as evidenced by this. However, because Inconel is so expensive, we prefer chrome vanadium for spring design **[1]**.

K. Vinay Kumar et.al., Under a constant load of 850 N, the current study compares standard spring materials for a popular two-wheeler vehicle to novel spring materials such as alloy steel, stainless steel, and chromium-vanadium steel. The spring design is modeled in Solid works and PProE5, with FEA, performed in Ansys 14. This emphasizes that, when compared to chrome vanadium and stainless steel, alloy steel, with a tensile strength of up to 2550 N, is significantly more suitable for spring material **[2].**

M. Sreenivasan et.al., To achieve the best design and static analysis, the approach presented here completely transforms traditional materials into composite materials. The composite's superiority over traditional materials is highlighted in this way. Because of its lightweight and simplicity of manufacture. The three types of fiber material used in this project are e-glass fiber, carbon fiber, and Kevlar fiber. FEA was performed on each design under specific loads of 2500N, 3000N, and 3500N. The result proves that E-glass outperforms the other two options **[3].**

N. Lavanya el.at., The current project entails the development and testing of a suspension spring for a vehicle undergoing helical spring static analysis. The spring's strain and stress behavior, as well as fatigue cyclic failure, is demonstrated in this observation. Modeling is done with PRO E, and FEA is done with ANSYS 12.0. When compared to other spring materials, chrome vanadium produces the best and most consistent results, according to the findings **[4].**

Raviraj N. Rathod and Milind S. Bodhke, Oil-tempered spring steel and beryllium copper were used to make this sculpture. The FEA procedure is performed with ANSYS software, and the modeling is done with CATIA software. In the FEA, the weight of the bike without any other loads, a single person's weight, and two people's weight are 797N, 1275N, and 1353N, respectively. Oil tempered steel is subjected to more stress than beryllium steel, according to the findings. This demonstrates the superiority of beryllium over oil-tempered steel **[5]**.

Setty Thriveni et.al., This research focuses on the helical spring found in the YAMAHA FZ and HONDA UNICORN mono suspension systems. The spring model was created using SOLID WORKS, and the spring specs were taken from existing YAMAHA and HONDA UNICORNS suspension springs. HYPER MESH and ANSYS are used to analyze the spring model. The goal of this project is to determine an existing spring's compressibility by determining its maximum shear stress and deformation **[6].**

Vidya S. Visave and J. R. Mahajan, Mono suspension springs are being tested to see how far they deflect under different weights ranging from 50 to 400 kilograms. Ansys is used for analytical analysis. They use the mono suspension spring from a Honda unicorn for this experiment. They conduct theoretical research to come up with relevant results. The Universal Testing Machine is used to conduct theoretical experiments. The transmissibility machine is used to test the transmissibility of the spring while it is under load **[7].**

IV. DESIGNING OF THE SPRING

The most crucial step in the modeling and analysis process is designing. Solid Works, a computer-aided design program, was used to create the suspension design. Solid works provide us with a wide range of tools for designing and modeling mechanical components. The criteria for designing the suspension system are derived from the rear suspension of an existing motorcycle. All of the design criteria differ from bike to bike.

The spring's design and specifications could be adapted from the HONDA UNICORN REAR SUSPENSION's current spring. Vernier Caliper and Screw Gauge will be used to measure the spring. Solid works 2014 was used to model the spring.

4.1. Existing Spring's Specification:

1.Spring Ends-Square and ground end
2.Maximum Diameter (D_o)=69.30mm
3.Original Length of Spring=195mm
4.Wire diameter(d)=12.25mm
5.Mean Diameter (D_m)=57.05mm;
6.D_m = Do-d=69.30- 12.25=57.05mm
7.Spring Index=(D_m/d) = (57.05/12.25) =4.657

Fig.1: Existing Spring's Model

4.2. Redesigned Spring's Specification:

1.Spring Ends-Square and ground ends
2.Maximum Diameter (D_o)=69.30mm
3.Wire diameter(d)=13.51mm
4.Mean Diameter (D_m)=55.03mm;
5.Spring Index=(D_m/d) = (57.05/13.51) =4.07

Fig.2: Redesigned Spring's Model

V. ANALYSIS

ANSYS is a 3D design and engineering simulation software. The software Ansys Workbench 2022 was used to conduct the analysis. In Finite element analysis, a complex system is subdivided into various standard small pieces called elements. The behavior of the elements is governed by a set of equations included in the software. The layout model becomes imported into the analysis software program. The model will then be imported into FEA analysis, which employs a complex system of nodes that form a grid known as a mesh.

This mesh is pre-programmed with the material and structural properties that determine how the structure will respond to various loading conditions. Depending on the expected stress levels of a particular area, nodes are assigned at a certain density throughout the material. This model incorporates static analysis with various materials to optimize stress levels. To achieve precise results, a mesh model with a finite number of nodes and elements was created. The suspension is fixed at the bottom end, while the load is applied at the top, thanks to boundary constraints. The specific loads are 891.9N, 1401.4N, and 1911N used for the FEA analysis process.

5.1. Load Calculation:

Mass of bike = 140kg
Mass of one person = 80kg
Mass of two persons = 160kg
Mass of bike + 2 persons = 140+160 = 300 kg

Out of total mass, 65% mass is acting on the rear suspension,

Load of two-person + bike = 1911N

5.2. Material Properties:

Table 1: Material Properties

Material Name	**Density (kg/m^3)**	**Young's Modulus (GPA)**	**Poisons Ratio**
Steel	7850	200	0.3
ASTM-A228	7861.1	210	0.29
ASTM–A401	7810	210	0.313
Chrome Vanadium	7860	200	0.27

VI. RESULT & DISCUSSION

6.1. Steel:

Table 2: Steel's result for the Load of 1911N,

Model of Spring	Deformation (m)	Equivalent Elastic Strain (m/m)	Equivalent Stress (Von-mises) (Pa)
Existing Spring	0.063341	0.0070804	1.3698e9
Redesigned Spring	0.02898	0.0050335	9.923e8

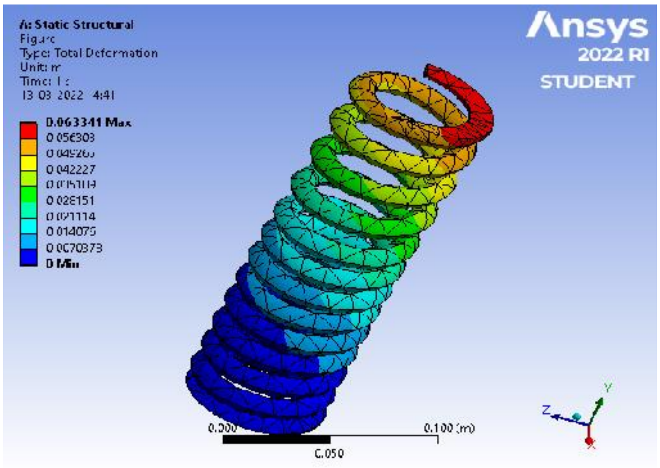

Fig.3: Total Deformation of Existing Spring at 1911N

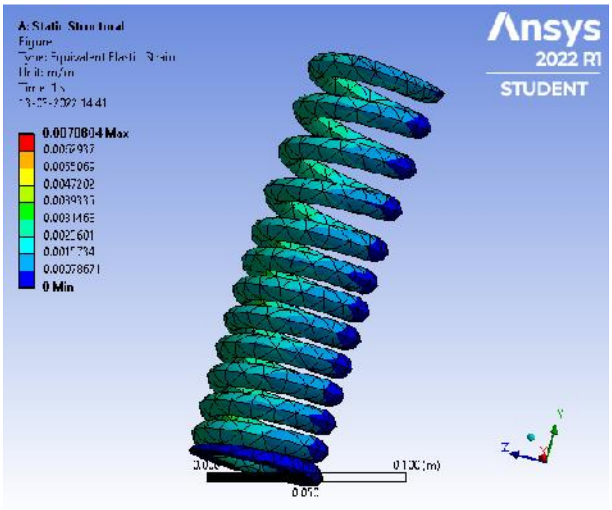

Fig.4: Elastic Strain of Existing Spring at 1911N

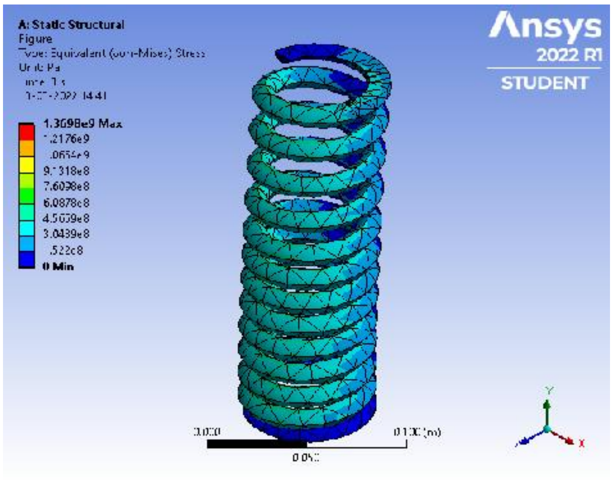

Fig.5: Stress of Existing Spring at 1911N

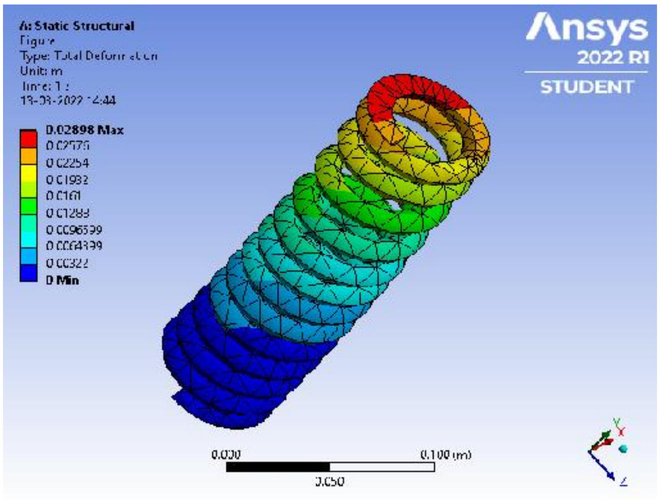

Fig.6: Total Deformation of Redesigned Spring at1911N

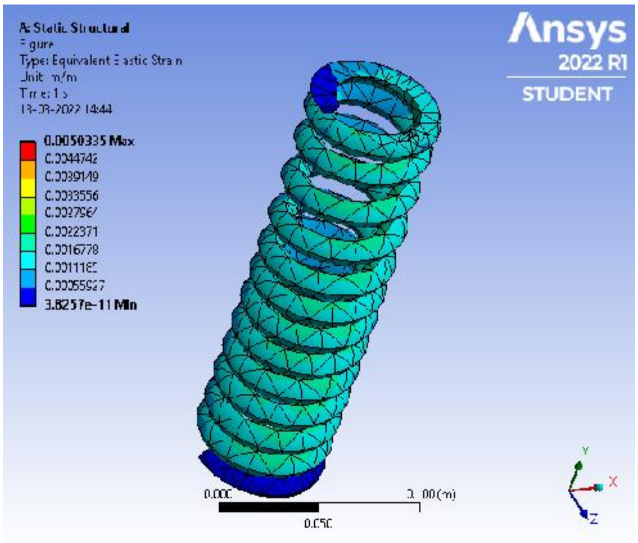

Fig.7: Elastic Strain of Redesigned Spring at 1911N

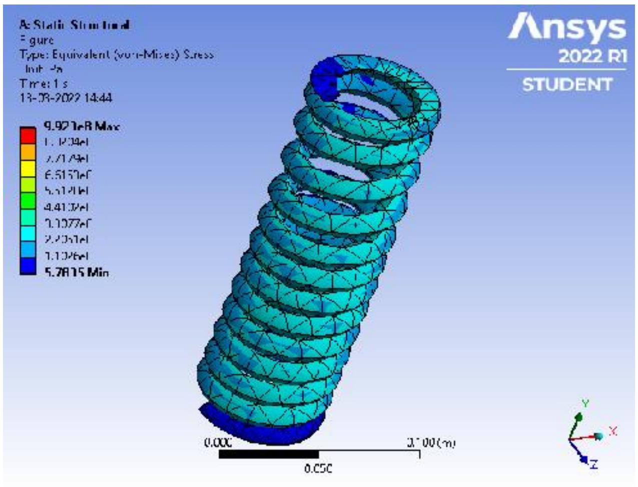

Fig.8: Stress of Redesigned Spring at 1911N

6.2. ASTM - A228:

Table 3: ASTM – A228's result for the Load of 1911N

Model of Spring	Deformation (m)	Equivalent Elastic Strain (m/m)	Equivalent Stress (Von-mises) (Pa)
Existing Spring	0.060065	0.006756	1.3751e9
Redesigned Spring	0.027474	0.0048354	1.0008e9

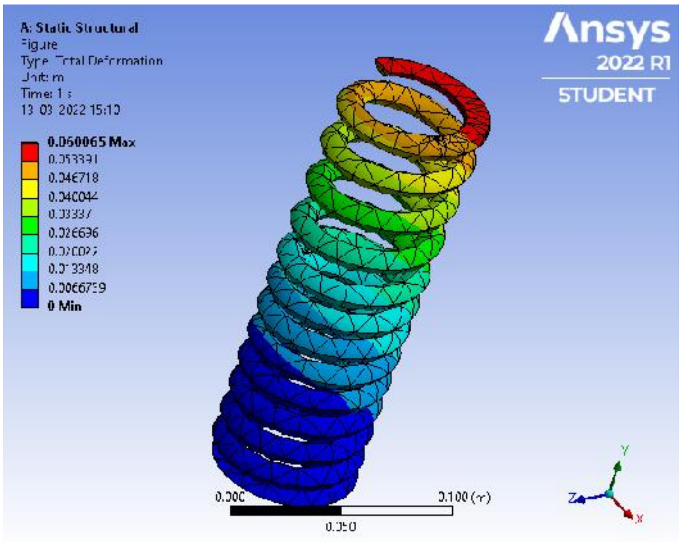

Fig.9: Total Deformation of Existing Spring at 1911N

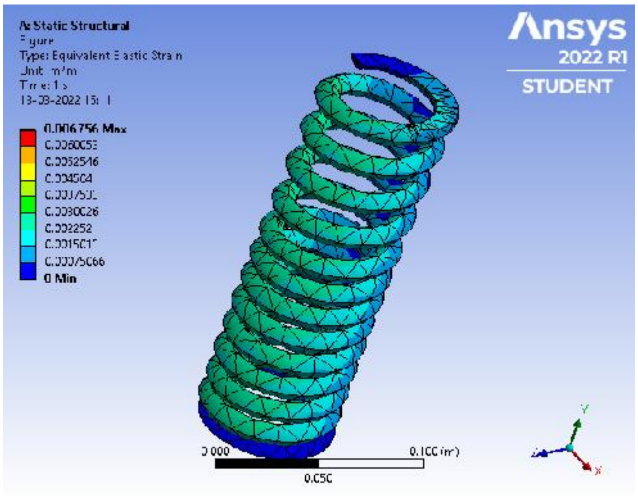

Fig.10: Elastic Strain of Existing Spring at 1911N

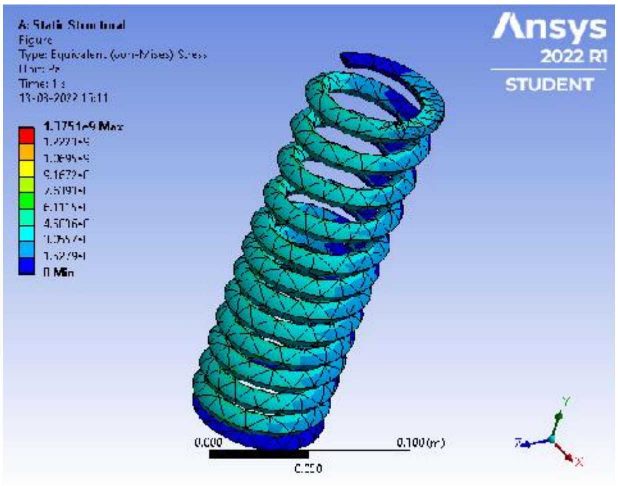

Fig.11: Stress of Existing Spring at 1911N

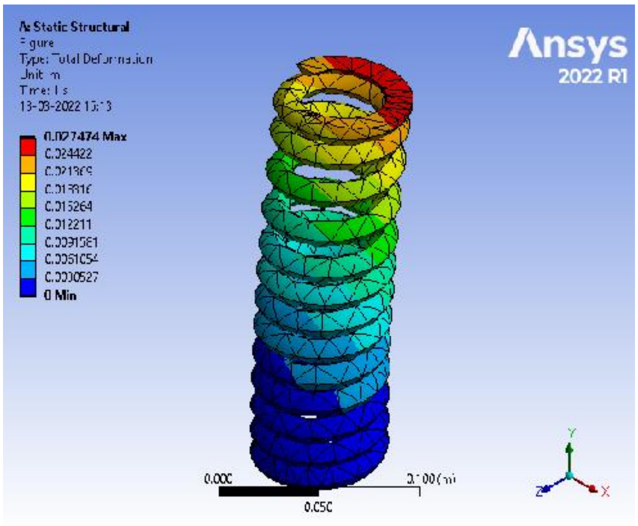

Fig.12: Total Deformation of Redesigned Spring at 1911N

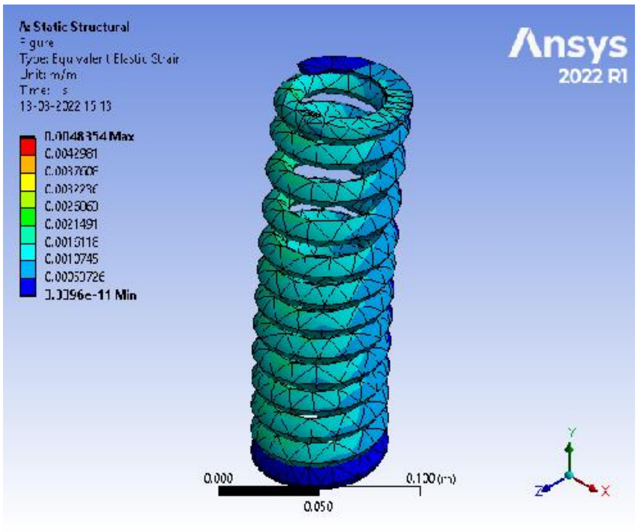

Fig.13: Elastic Strain of Redesigned Spring at 1911N

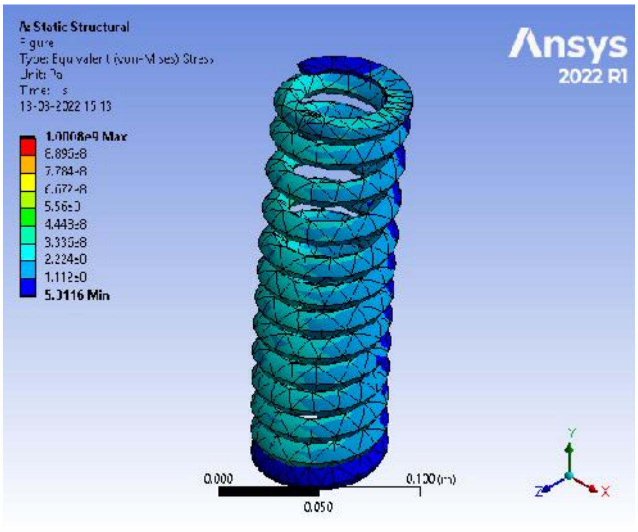

Fig.14: Stress of Redesigned Spring at 1911N

6.3. ASTM – A401:

Table 4: ASTM – A401’s result for the Load of 1911N

Model of Spring	Deformation (m)	Equivalent Elastic Strain (m/m)	Equivalent Stress (Von-mises) (Pa)
Existing Spring	0.060655	0.0067253	1.3625e9
Redesigned Spring	0.02776	0.004737	9.8065e8

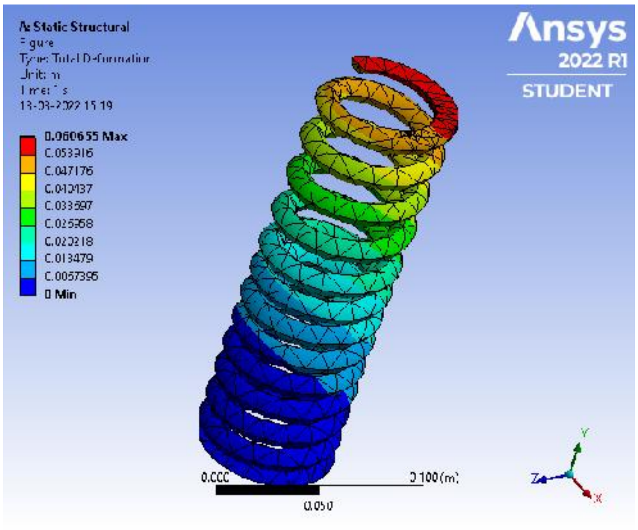

Fig.15: Total Deformation of Existing Spring at 1911N

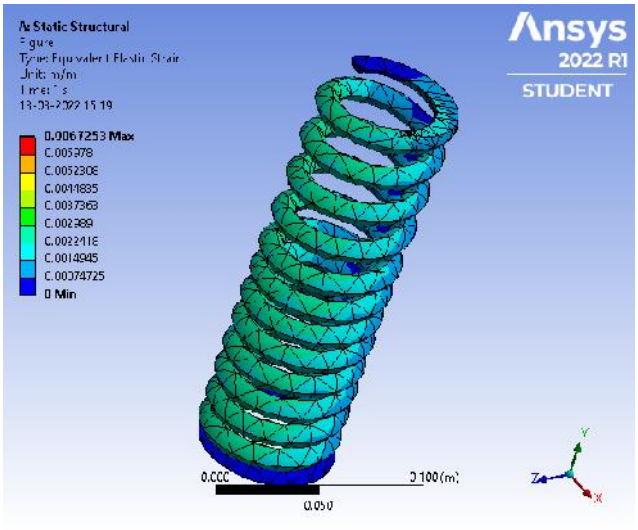

Fig.16: Elastic Strain of Existing Spring at 1911N

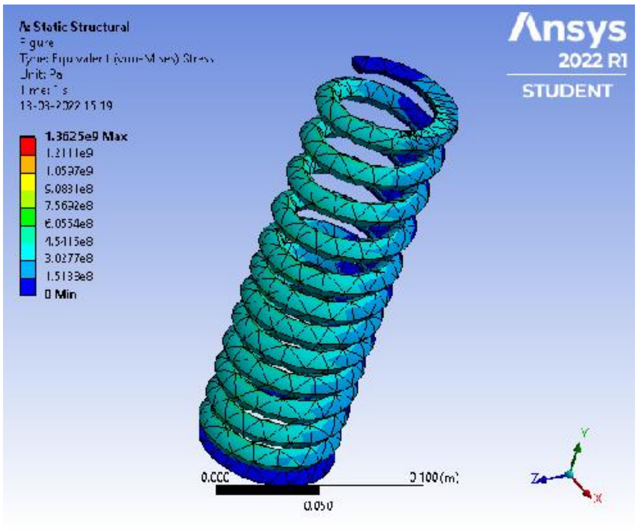

Fig.17: Stress of Existing Spring at 1911N

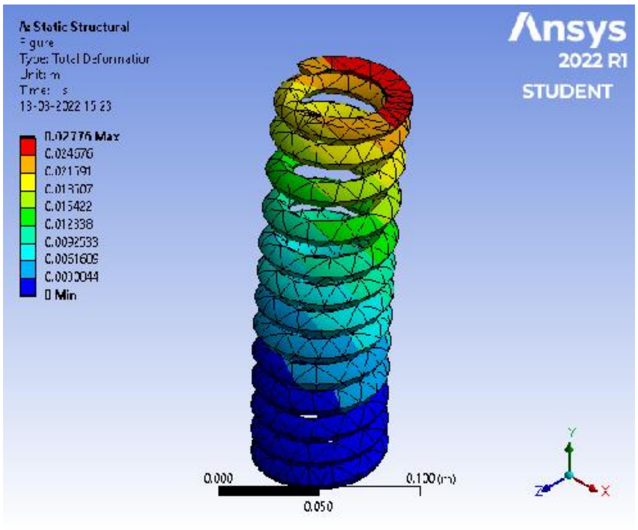

Fig.18: Total Deformation of Redesigned Spring at 1911N

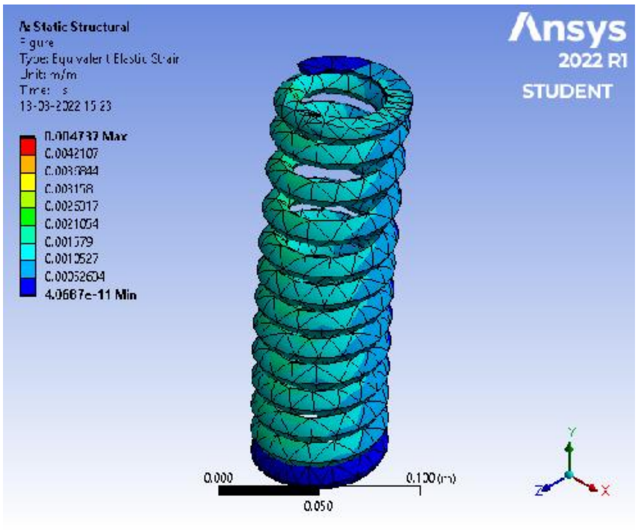

Fig.19: Elastic Strain of Redesigned Spring at 1911N

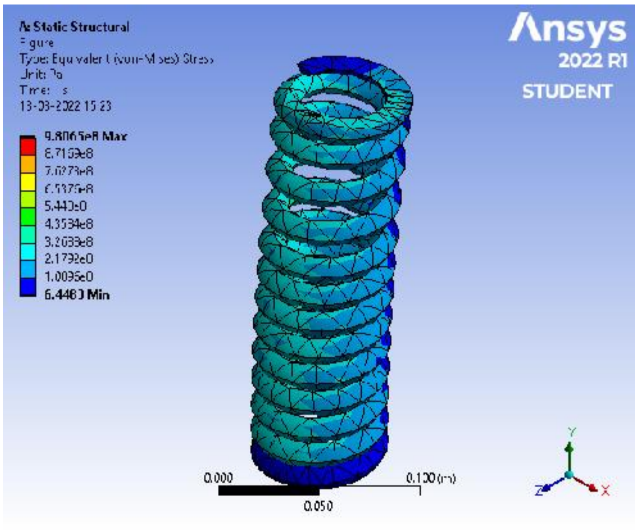

Fig.20: Stress of Redesigned Spring at 1911N

6.4. Chrome Vanadium:

Table 5: Chrome Vanadium's result for the Load of 1911N

Model of Spring	Deformation (m)	Equivalent Elastic Strain (m/m)	Equivalent Stress (Von-mises) (Pa)
Existing Spring	0.062514	0.0071365	1.385e9
Redesigned Spring	0.02898	0.0050335	9.923e8

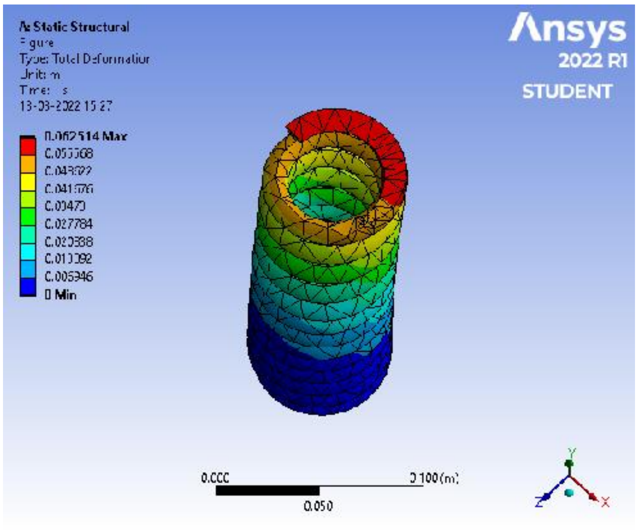

Fig.21: Total Deformation of Existing Spring at 1911N

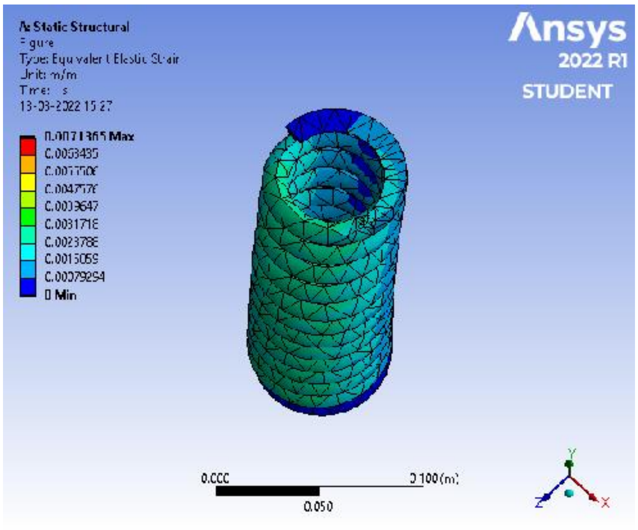

Fig.22: Elastic Strain of Existing Spring at 1911N

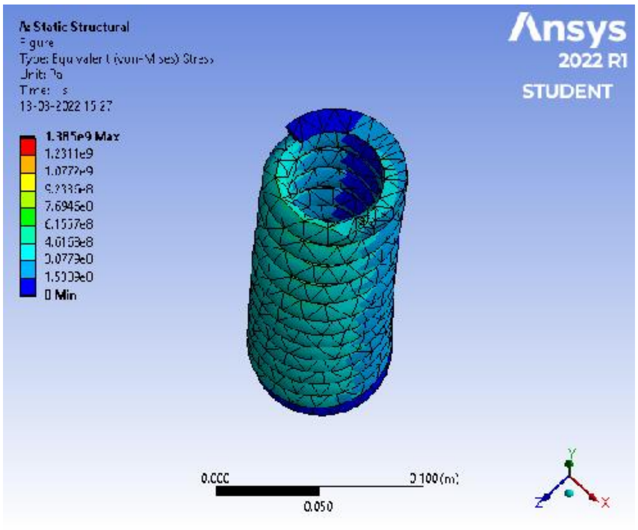

Fig.23: Stress of Existing Spring at 1911N

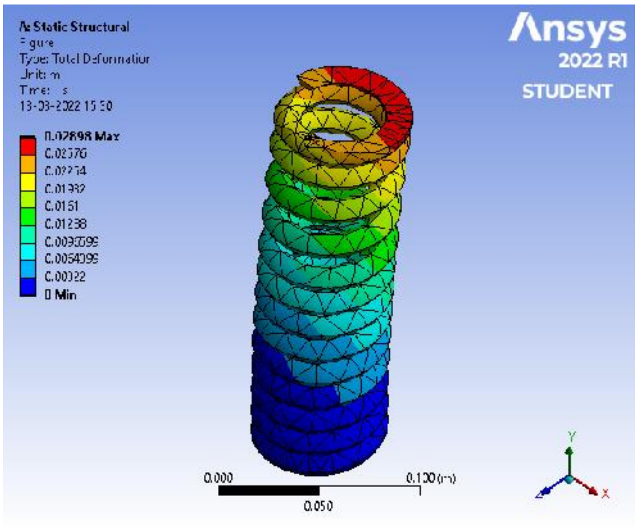

Fig.24: Total Deformation of Redesigned Spring at 1911N

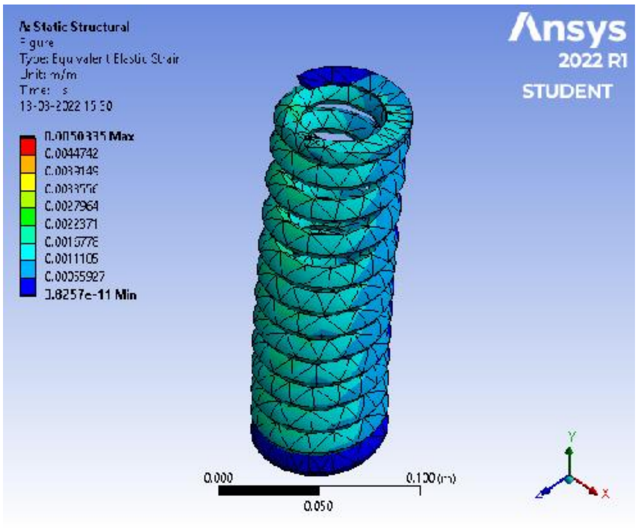

Fig.26: Elastic Strain of Redesigned Spring at 1911N

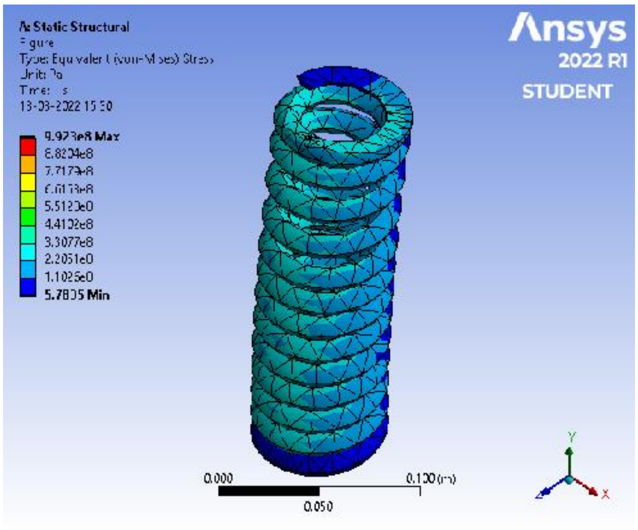

Fig.27: Stress of Redesigned Spring at 1911N

Table 6: Redesigned Spring Result Comparison

Material Name	Deformation (m)	Equivalent Elastic Strain (m/m)	Equivalent Stress (Von-mises) (Pa)
ASTM A228	0.027474	0.0048354	1.0008e9
ASTMA401	0.02776	0.004737	9.8065e8
Chrome Vanadium	0.02898	0.0050335	9.923e8
Steel	0.02898	0.0050335	9.923e8

VII. CONCLUSION

We can deduce the following from the previous findings:

1. We may deduce from the results that the ASTM – A228 has a lower overall deformation than the other materials.
2. As a result, we may conclude that the stiffness of the ASTM – A228 spring material is superior to that of the other materials. However, because the stresses created in ASTM – A228 are slightly higher than those developed in ASTM – A401, we infer that ASTM – A401 is a safer material for maximum loading than ASTM – A228.

REFERENCES

[1] K. Sataynarayana, T. Ugesh, B. Gowri, D. Sai Adhitya Ganesh, K. Bharath, Design and Static analysis on a helical spring for a two-wheeler, Journal of Composition Theory, Vol - 13, Issue - 3, 2020.

[2] K. Vinay Kumar, R. Rudhra AbhiRamu, CH. Siva Rama Krishna, Design and analysis of helical spring in the two-

wheeler suspension system, International Journal of Research in Engineering & Technology, Vol - 4, Issue - 7, July 2016.

[3] M. Sreenivasan, M. Dinesh Kumar, Ram Krishna, T. Mohanraj, G. Suresh, D.Hemanth Kumar, A. Sai Charan, Finite element analysis of coil spring of a motorcycle suspension system using different fiber material, Elsevier, April 2020.

[4] N. Lavanya, P. Sampath Rao, M. Pramod Reddy, Design and Analysis of a suspension coil spring for automobile vehicle, International Journal of Engineering research and application, Vol- 4, Issue - 9(version 5), September 2014.

[5] Raviraj N. Rathod, Milind S. Bodhke, Design and analysis of a two-wheeler shock absorber coil spring, International Research Journal of Engineering and Technology, vol - 5, issue - 10, Oct - 2018.

[6] Setty Thriveni, G. Ranjith Kumar, Dr. G. HarinathGowd, Design Evaluation & Optimization of a Two-Wheeler suspension system, International Journal of Emerging Technology and Advanced Engineering, Vol - 4, Issue - 8, August 2014.

[7] Vidya S. Visave, J. R. Mahajan, Experimental Investigation of Mono suspension spring, International Research Journal of Engineering and Technology, vol-5, issue-1, January - 2018.