Design and Analysis of Two Wheeler Suspension System Using Different Materials on ANSYS

Bhanu Prakash Bhavare[1], Pratesh Jayaswal[2]

[1]*Student, Mechanical Engineering, Madhav Institute of Technology and Science, Gwalior [M.P.], India*
[2]*Professor, Dept. of Mechanical Engineering, Madhav Institute of Technology and Science, Gwalior [M.P.], India*

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***Abstract** - A suspension system or a shock absorber is a mechanical device that is used to absorb shocks when riding in rough terrains. The use of shock absorbers in vehicles leads to comfort in ride. A two-wheeler suspension system joins the vehicle chassis to the tires. It prevents vehicle chassis and rider from bumps experienced by tires by absorbing bumps and shocks. A no. of studies has been proposed on two-wheeler suspension systems for different designs of springs, different materials, and other parameters.. All those research papers are studied and the best combination of materials is taken for analysis. In this project, we are trying to find out the best material for a two-wheeler suspension system by comparing the deformations and stresses produced in each material under identical loading conditions. A model of a two-wheeler suspension system or shock absorber is designed using SOLIDWORKS 2015. The IGS file of this model was imported on ANSYS 2020 and then analysis was done on this model for different materials and loading conditions. The results for deformations and stresses produced in different materials were compared and finally, conclusions were drawn.*

Key Words: **two- wheeler suspension system, shock absorber, ANSYS, Design, Analysis.**

1.INTRODUCTION

A suspension system or a shock absorber is a mechanical device that is used to absorb shocks when riding in rough terrains. The use of shock absorbers in vehicles leads to comfort in ride. Without shock absorbers, the ride will be bouncy. The vehicle will vibrate with an amplitude same as the amplitude of rough terrains.

Generally, the rear suspension system used in two-wheelers is Twin shock absorbers. During 1970-1980, there was a lot of advancement in rear suspension design. At end of this period, a rear suspension system with only one suspension system was in use and was universally accepted. At the same time, the use of twin shock absorbers was limited to only vintage motorcycles. Slowly its use came to low-budget vehicles and is now popular in use.

The overall function of a two-wheeler suspension system is to isolate the vehicle body and rider from shocks generated due to irregularities of the road. A good suspension system should produce a minimum amount of deflection on the application of load, should have low cost, should have minimum weight, should have low operating cost and low maintenance cost, should work in such a way that it causes minimum wear in tires.

2. Working of a two wheeler suspension system

There are two main components of a two-wheeler suspension system:

1. Helical compression spring
2. Hydraulic damper and piston combination

A two-wheeler suspension uses both these components to provide a smooth and easy ride to the passenger. A helical compression spring is an elastic material made element made by twisting a wire in a helix shape. It deforms when a load is applied to it axially. By use of helical springs, the vehicle chassis moves almost independently from tires. In other words, the vehicle chassis is prevented from up and down motion of tires on rough terrain. A damper absorbs all the shock received by spring and slows down the motion of spring. This damping action takes place by use of hydraulic fluid. A piston reciprocates inside a cylinder containing the fluid. The Kinetic energy generated by the motion of spring gets converted into heat energy by a damper. This heat is later dissipated to the surrounding. In this way effect of bumps gets reduced and the rider experiences a comfortable ride.

3. Previous research data available about the proposed study

a) In 2013, a researcher named, K Pagan Kumar did a static analysis of a two-wheeler suspension system spring on ANSYS with two materials Chromium-Vanadium alloy and 60 Si2 Mn A Steel. 60 Si2 Mn A is already used as a manufacturing material (conventional steel helical spring) for steel and Chromium-Vanadium alloy is not presently in common use. The conventional material 60 Si2 Mn A was proved as the best material after final analysis as it gave lower values of deflection and stress.

b) In 2018, Raviraj N. Rathod a student of Mechanical Engineering from DBNCOET Yavatmal, Maharashtra, India along with assistant professor Milind S. Bodkhe published a research paper on "Design and analysis of a two-wheeler shock absorber coil spring". They analyzed two materials Oil tempered spring steel and Beryllium Copper on ANSYS and concluded Beryllium copper as the best material for a two-wheeler shock absorber based on static structural analysis.

c) In 2019, assistant professor A. Vamsi Krishna from GPREC, Kurnool, and professor Dr. G. Janardhana Raju from NNRG, Hyderabad published a study on "Structural And Modal Analysis Of Two Wheeler Shock Absorber". They analyzed two materials carbon steel and Beryllium Copper on ANSYS and concluded Beryllium copper as the best material for a two-wheeler shock absorber based on static structural analysis.

d) In 2020, Abu Sufyan Malik, A. Aravind Reddy, and Mohammed Rizwanuddin three students of Mechanical Engineering from Mahaveer Institute of Science and Technology, Hyderabad, India published a research paper on " Design and Analysis of Shock Absorber for 150cc Bike". They analyzed two materials structural steel and Beryllium Copper on ANSYS and concluded structural steel as the best material for a two-wheeler shock absorber based on static structural and modal analysis.

4. Specification of the Problem

Past research data and studies had shown that there are no. of materials that are used to manufacture springs for two-wheeler shock absorbers or suspension systems by different manufacturing industries in India and abroad.

Different researches that have been conducted show different materials as the best material for manufacturing springs for two-wheeler shock absorbers.

We have taken four such materials for analysis which were considered as best materials for manufacturing springs for two-wheeler shock absorbers by different research papers. We aim to find the best material among the four by comparing deformations and stresses produced in each material.

5. The objective of the project

- Analyze a two-wheeler suspension system to find out the deformations and stresses produced.
- CAD model of a two-wheeler suspension system will be created in SOLIDWORKS and the FEA analysis is done to determine the deformations and stresses produced under different loading conditions using Finite Element Analysis software (ANSYS).
- To find out the best material for a two-wheeler suspension system among the four materials such that deformation and stress produced in it are minimum under identical loading conditions.

6. Geometric Dimensions of two wheeler suspension system model

Mean diameter of a coil (D) =36 mm

Diameter of wire (d) = 7.25 mm

Total no of coils = 8

Height = 120 mm

Outer diameter of spring coil = D +d =43.25 mm

Solid Length =no. of turns * d

=8*7.25 = 58 mm

7. Loads used for analysis

Weight of bike = 130kg
Let weight of one person = 75Kg
Weight of two persons = 75×2=150Kg
Weight of bike and one person = 205Kg
Weight of bike and two persons = 280Kg
Load on rear suspension = 65% of the total load

Weight of bike and one person = 205 kg

Total load = 205*9.81 = 2011.05 N

Load on rear suspension = 65% of 2011.05 = 1307.18 N

This much load acts on two shock absorbers

For single shock absorber, load = 1307.18/2 = **654 N**

Weight of bike and two persons = 280Kg
Total load = 280*9.81 = 2746.8 N

Load on rear suspension = 65% of 2746.8 = 1785.42 N

This much load acts on two shock absorbers

For single shock absorber, load = 1785.42/2 **= 893 N**

7. Materials used for analysis

a) Stainless steel AISI 302 (conventional material for spring)

Cr = 17-19 %, Ni = 8-10%

Young's Modulus	193 Gpa
Tensile strength	830 Mpa
Yeild Strength	620 Mpa
Density	7750 kg/m^3
Poison's Ratio	.31
Elongation	55%

b) INCONEL 718 (High temp. alloy)

Ni = 52.5%, Cr = 18.6%, Fe = 18.5%

Young's Modulus	150 Gpa
Tensile strength	1240 Mpa
Yeild Strength	1035 Mpa
Density	8200 kg/m^3
Poison's Ratio	.29
Elongation	12%

c) ASTM A227 Spring Steel (High carbon spring steel)

C = .85-1.3 %, Mn= .6-1.6%

Young's Modulus	190 Gpa
Tensile strength	2000 Mpa
Yeild Strength	1600 Mpa
Density	7800 kg/m^3
Poison's Ratio	.29
Elongation	12%

d) Beryllium Copper ASTM B197 Spring Steel (non-ferrous alloy)

Cu= 98%, Be= 2%

Young's Modulus	128 Gpa
Tensile strength	1140 Mpa
Yeild Strength	1000 Mpa
Density	8260 kg/m^3
Poison's Ratio	.25
Elongation	12%

8. Steps of analysis

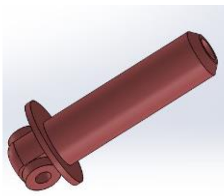
In ANSYS a model is analyzed by creating similar environment conditions around a component to which it is exposed to.

- Model of two-wheeler suspension system was made on SOLIDWORKS and IGS file was imported in ANSYS for analysis purpose.
- Specify Material Properties: Now that the part is already imported, all the materials used for analysis purposes are created by providing respective properties of materials or can be selected from the library if available.
- Generate Mesh: Now since materials are assigned already, the component is broken into small elements by using mesh.
- Define Boundary Conditions: Now after meshing is done, boundary conditions are applied to the model to restrict the motion of the two-wheeler suspension system spring on applying load.
- Apply Loads: Now since the model is fully designed, the last task before the solution is to apply loads based on calculations.
- Obtain Solution: Now after all materials are applied, boundary conditions are applied, loads are applied, the final step is to obtain solutions. Total deformation and Von – mises Stresses are selected to obtain final solutions.

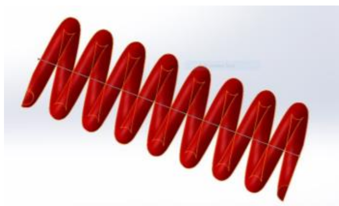
- Results: After the solution is done results are seen by clicking on Total deformation and Von – mises Stresses.
- Obtain Report: After analysis is done, solutions are obtained final report showing all the deformations and stresses are obtained.

9. Modeling of two wheeler suspension system on SOLIDWORKS

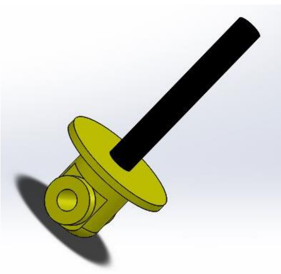
Following fig. shows the part geometry of two wheeler suspension system designed using SOLIDWORKS-



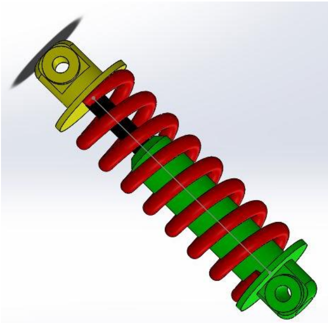
Top Rod



Spring

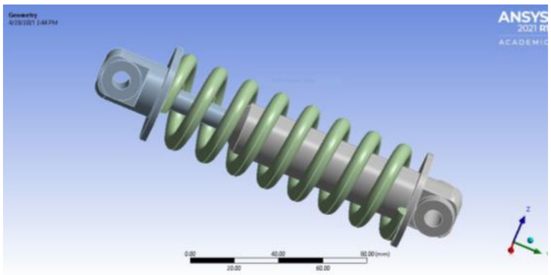


Base



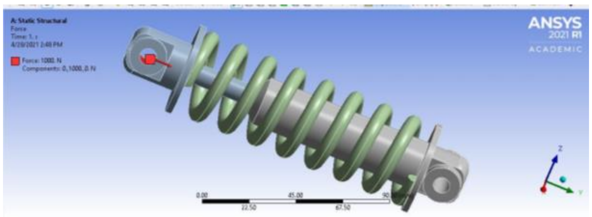
Final Assembly

10. Analysis of two wheeler suspension system on ANSYS

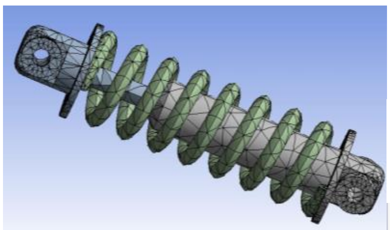


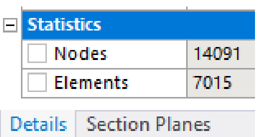
Model Imported on ANSYS

10.1 Force Applied



10.2 Meshed model of two wheeler suspension system



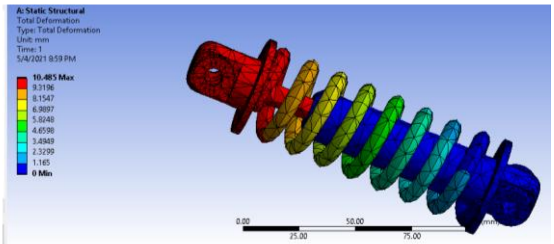


Statistics	
Nodes	14091
Elements	7015

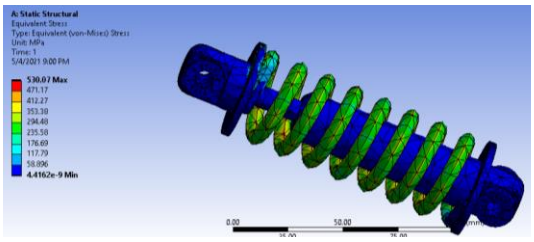
Details Section Planes

10.3 Results of Static Structural Analysis

10.3.1 Stainless steel AISI 302 at 654 N Load

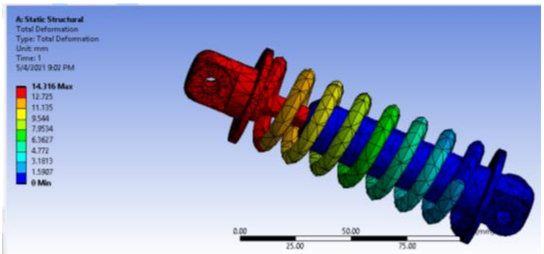


Total Deformation

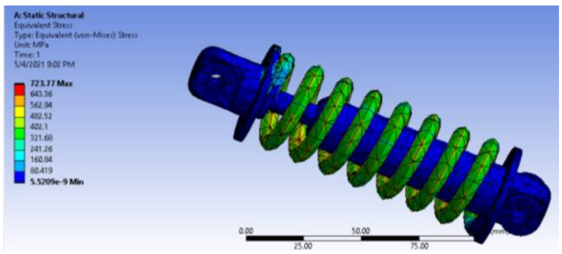


Stresses Produced

10.3.2 Stainless steel AISI 302 at 893 N Load

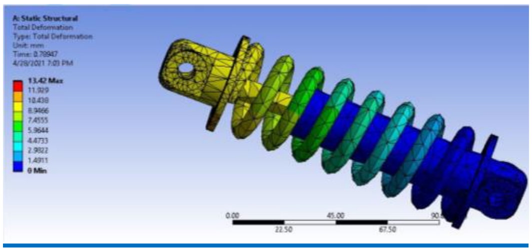


Total Deformation

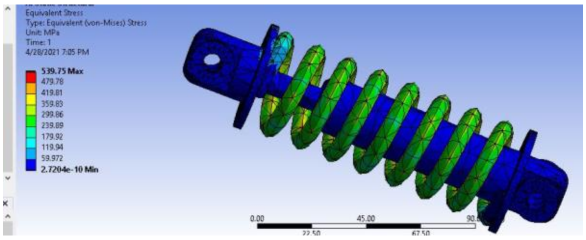


Stresses Produced

10.3.3 INCONEL 718 at 654 N Load

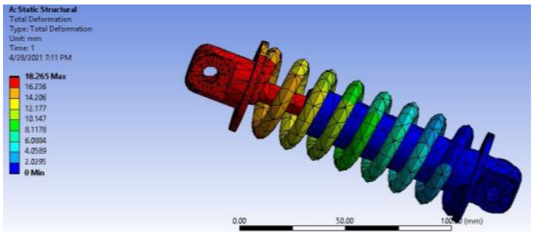


Total Deformation

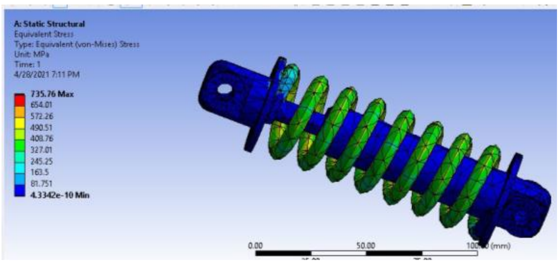


Stresses Produced

10.3.4 INCONEL 718 at 893 N Load

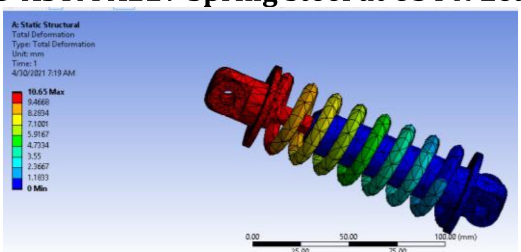


Total Deformation

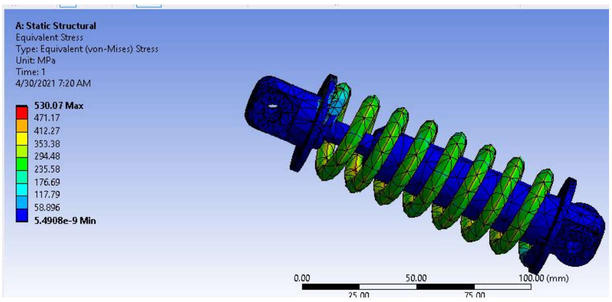


Stresses Produced

10.3.5 ASTM A227 Spring steel at 654 N Load

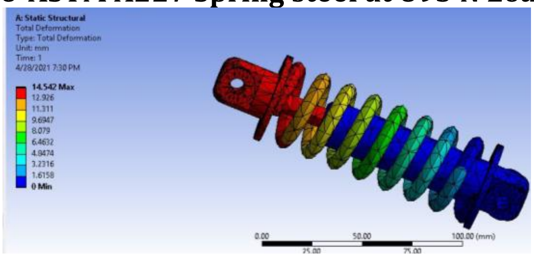


Total Deformation

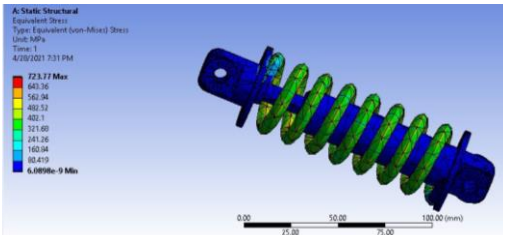


Stresses Produced

10.3.6 ASTM A227 Spring steel at 893 N Load

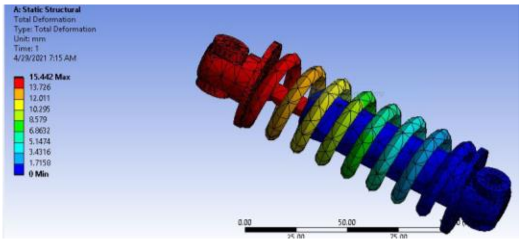


Total Deformation

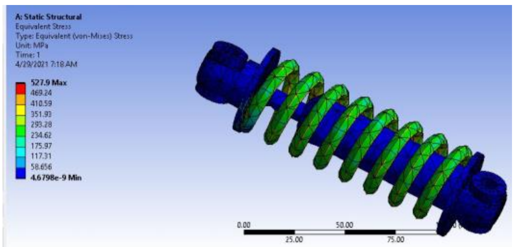


Stresses Produced

10.3.7 Beryllium Copper ASTM B197 at 654 N Load

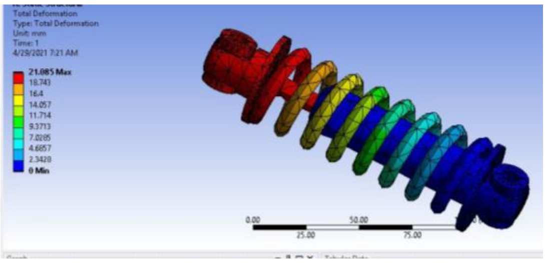


Total Deformation

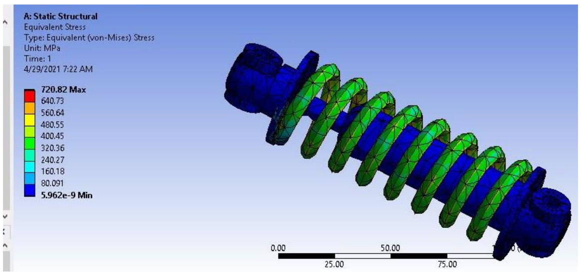


Stresses Produced

10.3.8 Beryllium Copper ASTM B197 at 893 N Load



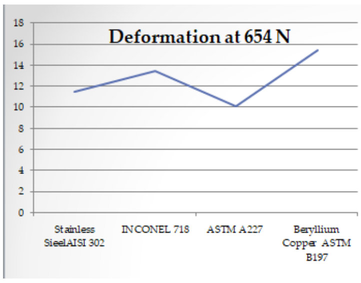
Total Deformation

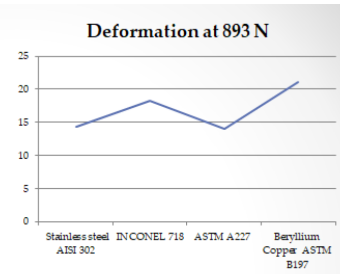


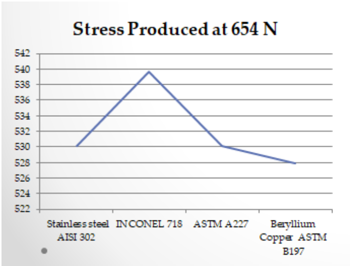
Stresses Produced

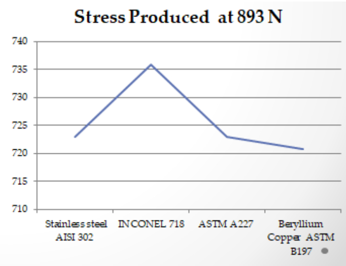
11. Result Summary

Materials	Load Applied (N)	Max. Deformation (mm)	Max. Stresses (MPa)
1. Stainless steel AISI 302	654	10.85	530.07
	893	14.316	723.77
2. INCONEL 718	654	13.42	539.75
	893	18.265	735.76
3. ASTM A227 Spring Steel	654	10.65	530.07
	893	14.542	723.77
4. Beryllium Copper ASTM B197 Spring Steel	654	15.442	527.9
	893	21.085	720.82









12. CONCLUSIONS

ASTM A227 Spring steel has minimum deflection and Beryllium Copper ASTM B197 Spring Steel has minimum stresses produced among the four materials. Also, deflection in Beryllium Copper ASTM B197 and INCONEL 718 is much higher than ASTM A227 (about 40 %), and stresses produced in both materials do not have much difference (about 0.6 %). Also, ASTM A227 is cheaper than Beryllium Copper ASTM B197 and INCONEL 718. Also, ASTM A227 has higher tensile strength and elasticity than Beryllium Copper ASTM B197, INCONEL 718, and Stainless Steel.

Based on the above conclusions ASTM A227 Spring steel can be used as a substitute for Structural steel for manufacturing two-wheeler suspension systems.

13. REFERENCES

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