

DESIGN AND ANALYSIS OF A SHOCK ABSORBER

Johnson*, Davis Jose, Anthony Tony

Abstract: -Shock absorbers are a critical part of a suspension system, connecting the vehicle to its wheels. The main function of vehicle suspension system is to separate the vehicle body and passengers from the oscillation created by the irregularities and to provide continuous contact of vehicle's wheel from the road surface. A suspension system or shock absorber is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy. The shock absorbers duty is to absorb or dissipate energy. So the design of spring in suspension system is very important.

In this project a shock absorber is designed and a 3D model is created using CATIA V5. CATIA V5 is the standard in 3D product design, featuring industry-leading productivity tools that promote best practices in design. Structural analysis is done in ANSYS. ANSYS is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements.

Analysis is done on the shock absorber by varying material for spring: Spring Steel and Beryllium Copper. Aim of the analysis is to validate the strength of spring and comparison is done for two materials to verify best material for spring in Shock absorber. So that we will be able to suggest which is better and also to tell which type of material will help to increase the ability of shock absorber.

Keywords: Shock Absorber, CATIA V5, ANSYS, FEA, Structural analysis

Introduction

A shock absorber is a mechanical device designed to smooth out or damp shock impulse, and dissipate energy. The shock absorbers duty is to absorb or dissipate energy. In a vehicle, it reduces the effect of travelling over rough ground, leading to improved quality, and increase in comfort due to substantially reduced amplitude of disturbances. [1][2] When a vehicle is travelling on a level road and the wheels strike a bump, the spring is compressed quickly.

The compressed spring will attempt to return to its normal loaded lengthened, in so doing, will rebound past its normal height, causing the body to be lifted. The weight of the vehicle will then push the spring down below its normal loaded height. This in turn, causes the spring to rebound again. This bouncing process is repeated

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over and over, a little less each time, until the up-and-down movement finally stops. If bouncing is allowed to go uncontrolled, it will not only cause an uncomfortable ride but will make handling of the vehicle very difficult. The design and selection of material of spring in suspension system is very important. [3]

GENERIC STEPS TO SOLVING ANY PROBLEM IN ANSYS:

Like solving any problem analytically, you need to define (1) your solution domain, (2) the physical model, (3) boundary conditions and (4) the physical properties. You then solve the problem and present the results. In numerical methods, the main difference is an extra step called mesh generation. This is the step that divides the complex model into small elements that become solvable in an otherwise too complex situation. Below describes the processes in terminology slightly more attune to the software.[4]

Build Geometry: Construct a two or three dimensional representation of the object to be modeled and tested using the work plane coordinates system within ANSYS.

Define Material Properties: Now that the part exists, define a library of the necessary materials that compose the object (or project) being modeled. This includes thermal and mechanical properties.

Generate Mesh: At this point ANSYS understands the makeup of the part. Now define how the Modeled system should be broken down into finite pieces

Apply Loads: Once the system is fully designed, the last task is to burden the system with constraints, such as physical loadings or boundary conditions.

Obtain Solution: This is actually a step, because ANSYS needs to understand within what state (steady state, transient... etc.) the problem must be solved.

Present the Results: After the solution has been obtained, there are many ways to present ANSYS' results, choose from many options such as tables, graphs, and contour plots.

Generalised Parameters for Helical spring

Material: Spring Steel, Beryllium Copper

Mean diameter of a coil $D = 64\text{mm}$

Diameter of wire $d = 8\text{mm}$

Total no of coils $n = 15$

Pitch = 14mm

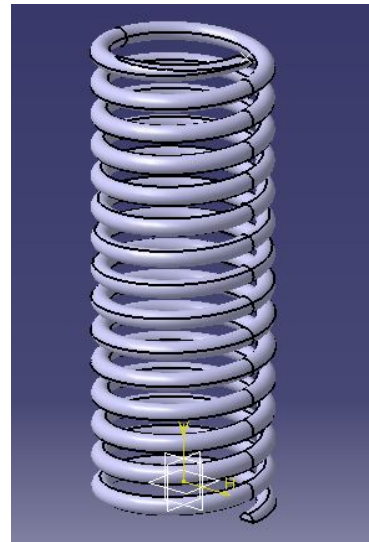
Let weight of bike be 125kgs and Weight of one person be 75Kgs .

Then total weight = weight of bike + weight of person
= 200Kgs

Considering Factor of Safety (FOS) = 1.5

Total weight = $200 \times 1.5 = 300\text{Kgs}$

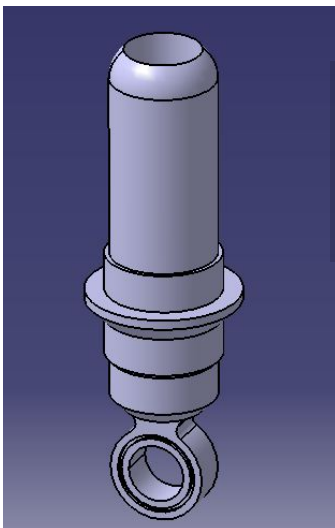
Therefore total load on Shock Absorber = 300×9.81
= 2943N



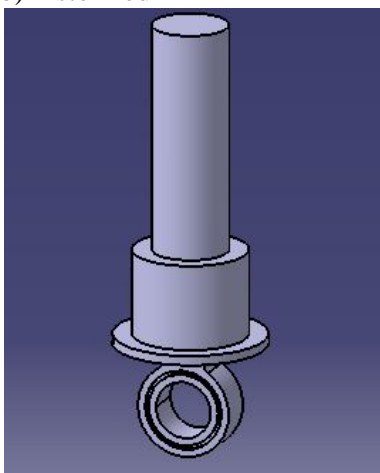
Model of Shock Absorber

Parts of Shock Absorber

a) Cylinder body

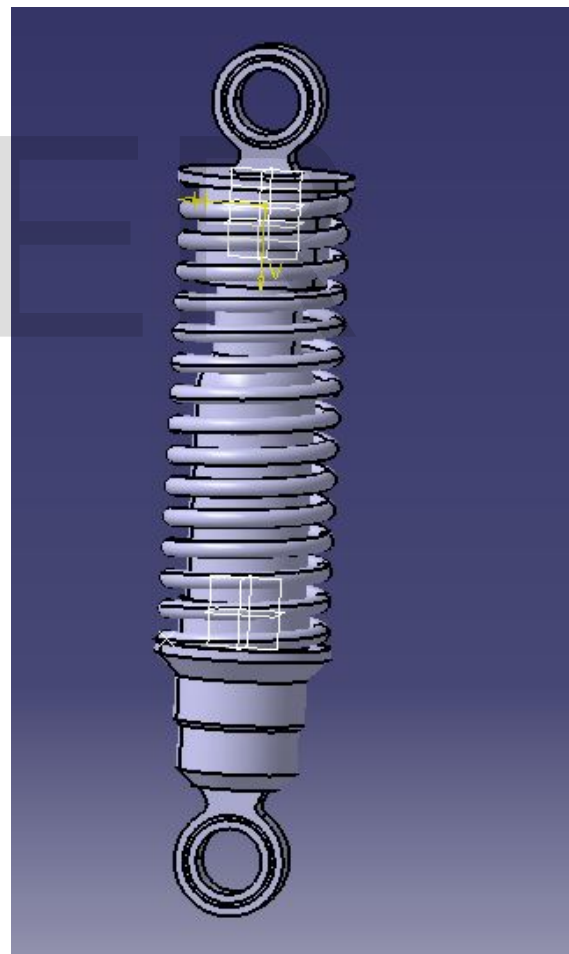


b) Piston rod



c) Spring

Assembly of Shock Absorber



Structural Analysis of Shock Absorber

1. Analysis using Spring Steel as spring material

Material Properties:

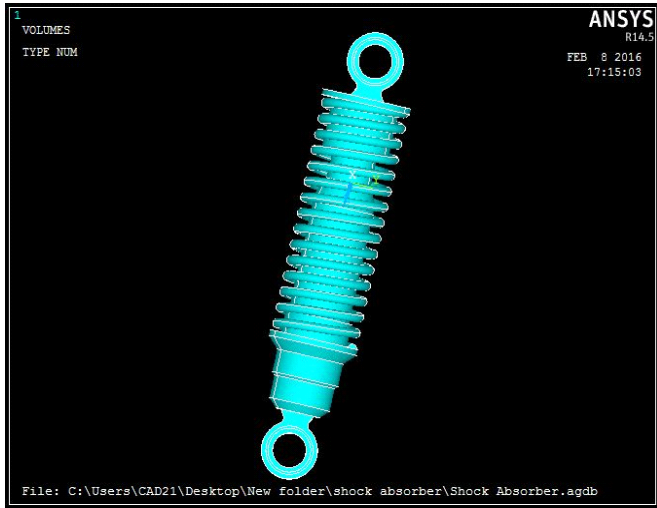
Young's Modulus (EX): 2.1×10^5 N/mm²

Poisson's Ratio (PRXY): 0.29

Density: 7.85×10^{-6} kg/mm³

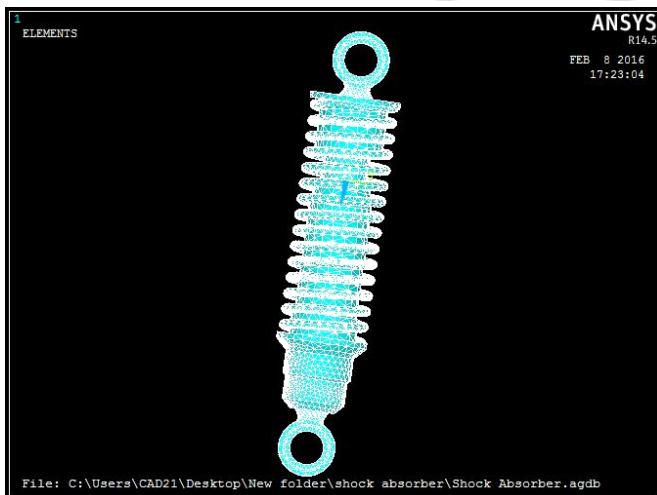
Load: 2943N

Step 1: Importing Shock Absorber Model in ANSYS Mechanical APDL and assigning the Material Properties.



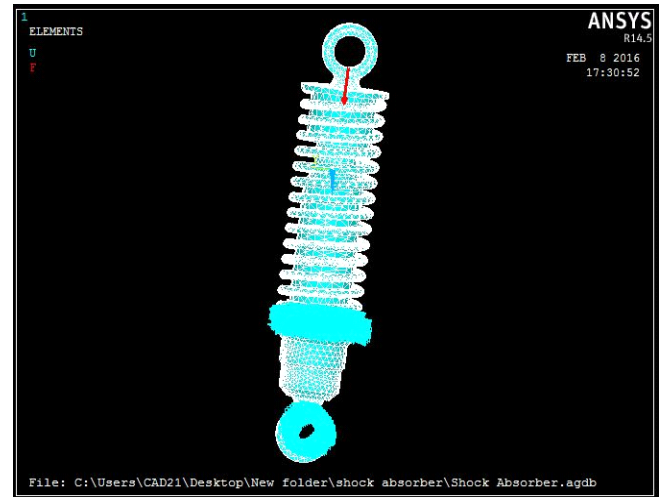
Shock Absorber Model imported in ANSYS

Step 2: Mesh the model using mesh tool.



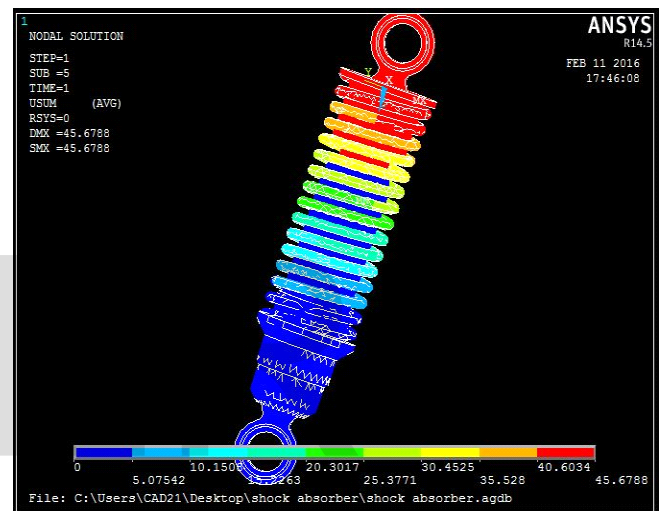
Model after meshing

Step 3: Applying the Loads and Boundary Conditions.

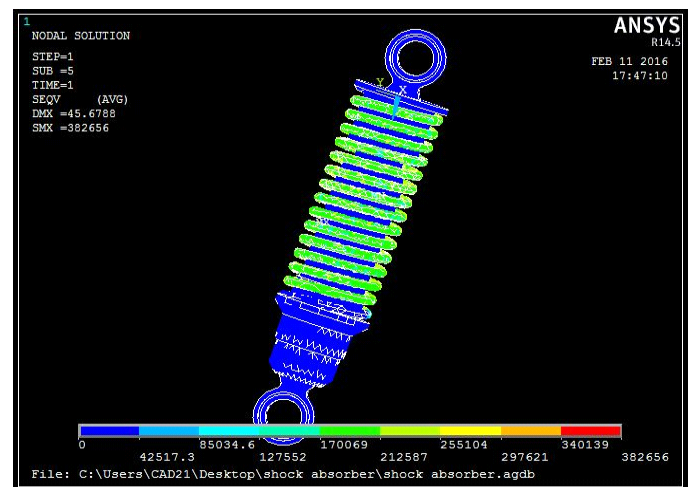


Model after applying boundary conditions and loads

Step 4: Obtaining results after applying loads.



Displacement



Von Mises Stress

2. Analysis using Beryllium Copper as spring material

Material Properties:

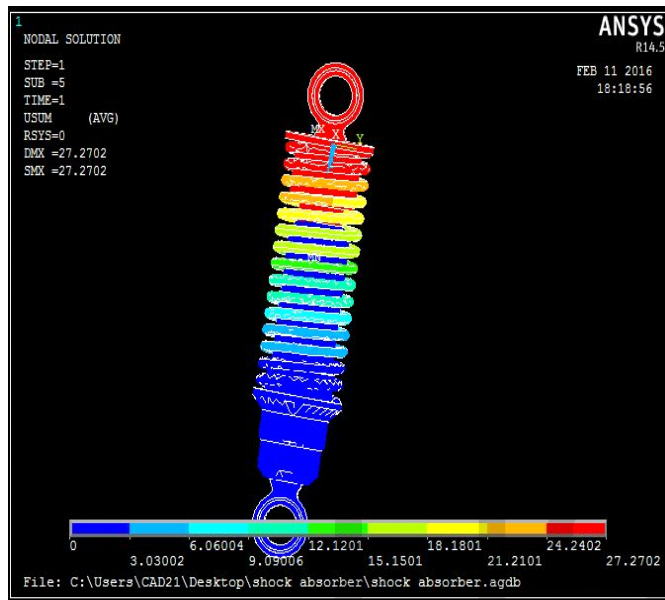
Young's Modulus (EX): $2.8 \times 10^5 \text{ N/mm}^2$

Poisson's Ratio (PRXY): 0.285

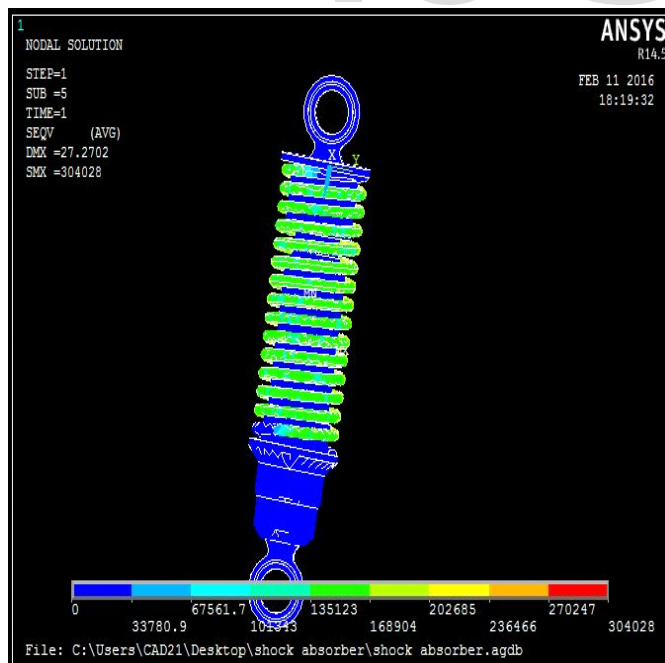
Density: $1.85 \times 10^{-6} \text{ kg/mm}^3$

Load: 2943N

Similar steps are followed as in previous case and results obtained are:



Displacement



Von Mises Stress

Results

Stress and Deflections with different materials as Shock Absorber Spring:

Material	Von Mises Stress (N/mm ²)	Deflection (mm)
SPRING STEEL	382656	45.67
BERRYLLIUM COPPER	304028	27.27

Conclusion

1. In this project we have designed a shock absorber used in a 150cc bike. We have modeled the shock absorber by using CATIA V5.
2. To validate the strength of our design, we have done structural analysis on the shock absorber by using ANSYS Mechanical APDL.
3. We have done analysis by varying spring material: Spring Steel and Beryllium Copper.
4. By comparing the results for materials, the stress and total deformation value is more for Spring Steel than Beryllium Copper. So stiffness is less for Spring Steel.
5. So we can conclude that as per our analysis, using Beryllium Copper as material for spring is the best option.

References

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