Design & Analysis of Mono shock absorbers in two wheelers

M.Shobha

PG student- Mechanical engineering, CAD/CAM specialization, Intell Engineering College Anatapur 515004, India

Abstract

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. In a vehicle, it reduces the effect of travelling over rough ground, leading to improved ride quality, and increase in comfort due to substantially reduced amplitude of disturbances. 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 Pro/Engineer. Structural analysis and modal analysis are done on the shock absorber by varying material for spring, Spring Steel, Phosphorus bronze and Beryllium Copper. The analysis is done by considering loads, Structural analysis is to validate the strength and modal analysis is to determine the displacements at different frequencies for number of modes. Comparison between the materials to verify the best material for spring in Shock absorber.
The software used is PRO/E Creo for modeling and ANSYS for analysis.

KEYWORDS: Mono shock absorbers, Suspension system, FEM,Pro/E,Ansys

INTRODUCTION

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. In a vehicle, it reduces the effect of travelling over rough ground, leading to improved ride quality, and increase in comfort due to substantially reduced amplitude of disturbances.

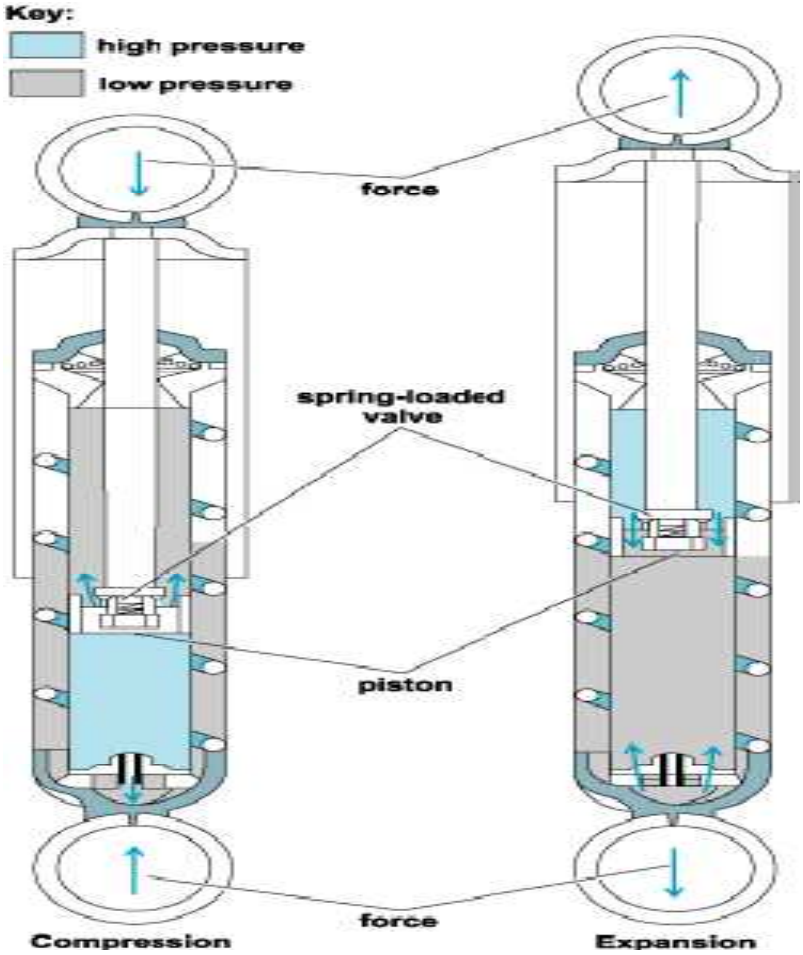
SUSPENSION SYSTEM

Suspension is the term given to the system of spring, shock absorbers and linkages that connects a vehicle to its wheels and allows relative motion between the two.Suspension system provides safety and driving pleasure, and provides comfort to rider and avoids the vehicle from road noise, bumps, and vibrations, etc. The suspension also protects the vehicle itself and any cargo or luggage from damage and wear.

MONO SHOCK ABSORBER:

Shock absorbers are important part of vehicle's suspension, which is fabricated to reduce shock impulse.The shock absorbers duty is to absorb or dissipate energy.In a vehicle, it reduces the effect of traveling over rough ground, leading to augmented ride quality, and increase in comfort due to substantially reduced amplitude of disturbances.

Working of Shock Absorber



Shock absorbers work on the principle of fluid displacement on both the compression and expansion cycle. The compression cycle controls the motion of a vehicle's unsprung weight, while expansion controls the heavier sprung weight. There are two cycles in which Shock Absorber works.

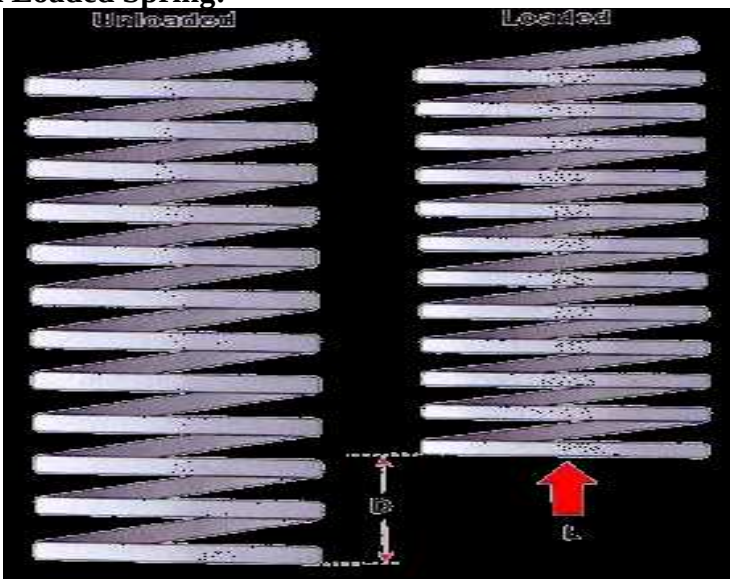
CompressionIn the compression cycle the piston moves downward and compresses the hydraulic fluid in the chamber which is situated below the piston. In this cycle or downward movement, the fluid flows to upper chamber from down chamber through piston. Some of the fluid also flows into reserve tube through the compression valve. Flow is controlled by valves in the piston and in the compression valve.

ExpansionIn the extension cycle the piston moves upwards toward the top of the pressure tube. The upward Movement results in the compressing of the fluid in the chamber lying above the piston. The extension cycle generally provides more resistance than compression cycle

General features of shock absorbers:

- Shock absorber has seals that keep the oil in and contaminant out.
- The metal used is stronger and harder. Modern shock absorber uses sintered metal which provides durability and longer life.
- Flat metals are used for constructing most of the cylinders which are welded at the seam.
- Shock Absorbers are velocity sensitive

Unloaded and Loaded Spring:



The main function of suspension springs are to support the motorcycle above its wheels and to isolate the chassis and rider from the up and down motion of the wheels as they roll over bumps.A spring's rate is a measure of how much force is required to compress the spring a given distance.The higher threaded, the more force it takes to compress it a given distance, and the less it compresses under a given force.A common spring rate is 100 pounds per inch; this means it takes 100 lbs to compress it one inch; 200 lbs to compress it two inches, and so on until it's completely compressed.

MATERIALS USED:

- **Plain carbon steel**
  - Hardness is high
  - Wear resistance is high
- **Spring steel**
  - Applications include piano wire, spring clamps, antennas, and springs. It is also commonly used in the making of knives
- **Phosphorus bronze**
  - Phosphor bronze is an alloy of copper with 3.5 to 10% of tin and a significant phosphorus content of up to 1%.

These alloys are notable for their toughness, strength, low coefficient of friction, and fine grain

- **Beryllium alloy**
  - It has excellent metalworking, forming and machining qualities.
  - It has many specialized applications in tools for hazardous environments, musical instruments, precision measurement devices, bullets, and aerospace.
  - Beryllium-containing alloys create an inhalation hazard during manufacturing due to the toxic properties.

PROPERTIES OF THE MATERIALS:

MATERIALS	YOUNG'S MODULUS (Gpa)	POISSONS RATIO	DENSITY(kg/m3)
HIGH CARBON STEEL	190	0.3	8.03
BERYLIUM COPPER	130	0.3	8.25
PHOSPORUS BRONGE	120	0.3	8.90
SPRING STEEL	210	0.3	7.85

INTRODUCTION TO CAD/CAM

CAD is used to design and develop products, which can be goods used by end consumers or intermediate goods used in other products. CAD is also extensively used in the design of tools and machinery used in the manufacturer of components.CAD is used though out the engineering process from the conceptual design and layout, through detailed engineering and analysis of components to definition of manufacturing methods.

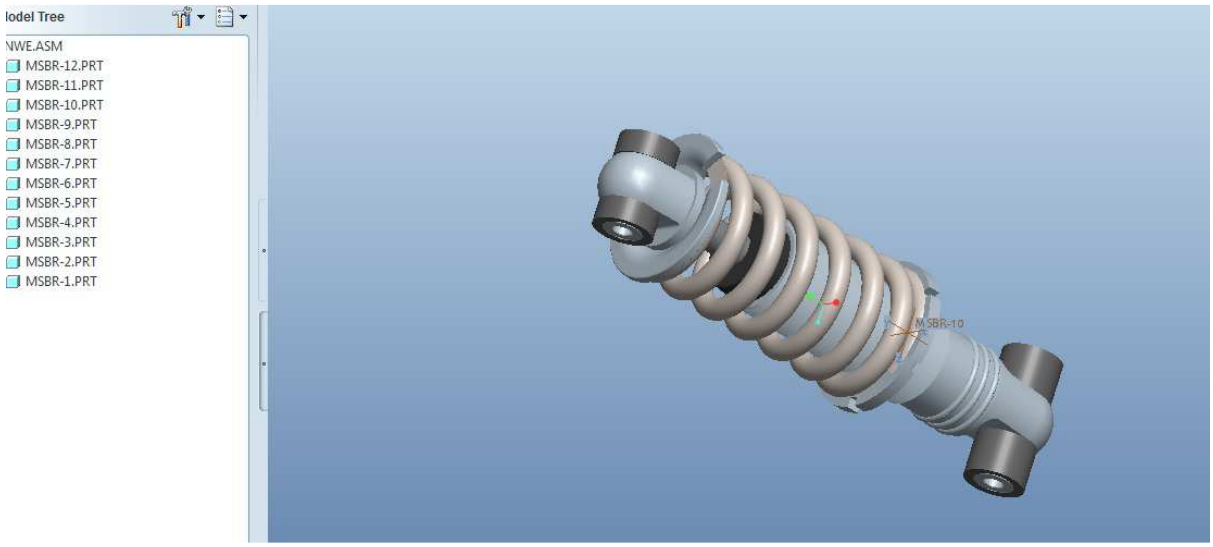
PRO/E

It is the world's leading CAD/CAM /CAE software, gives a broad range of integrated solutions to cover all aspects of product design and manufacturing.*PRO/E* provides easy to use solution tailored to the needs of small medium sized enterprises as well as large industrial corporations in all industries, consumer goods, fabrications and assembly. Electrical and electronics goods, automotive, aerospace, shipbuilding and plant design. It is user friendly.Solid and surface modeling can be done easily.

The main modules are:

- Sketcher
- Part Design
- Assembly
- Drafting
- Sheet metal

ASSEMBLY VIEW OF MONO SHOCK ABSORBER:



The components of mono shock absorbers are

- Bottom connecting pin
- Connecting head
- Lower support
- Main rod
- Spring supporter
- Helical spring
- Supporter

2. FINITE ELEMENT METHOD / ANALYSIS

The basic idea in the Finite Element is to find the solution of complicated problem with relatively easy way.In the Finite Element Method the solution region is considered as built up many small, interconnected sub regions called finite elements.It has been successfully applied to solve several type of engineering problems like heat conduction, fluid dynamics, seepage flow and electric and magnetic fields.The final goal of FEA is to find the large deformations and maximum stress occurring in the structure.

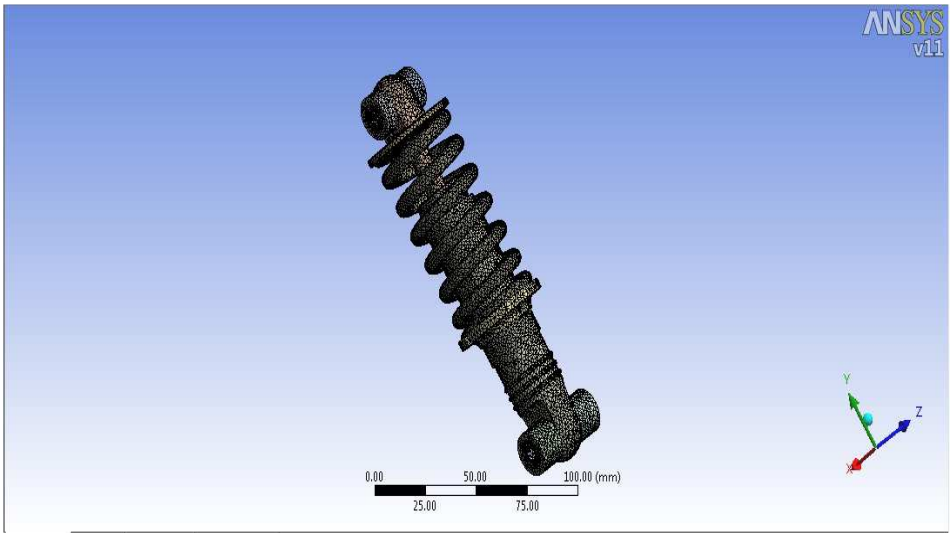
PROCEDURE FOR ANSYS

Static analysis is used to determine the displacements stresses, stains and forces in structures or components due to loads that do not induce significant inertia and damping effects.The kinds of loading that can be applied in a static analysis include externally applied forces and pressures, steady state inertial forces such as gravity or rotational velocity imposed (non-zero)displacements, temperatures (for thermal strain). A static analysis can be either linear or nonlinear. In our present work we consider linear static analysis.

MESH GENERATION

In the finite element analysis the basic concept is to analyze the structure, which is an assemblage of discrete pieces called elements, which are connected, together at a finite number of points called Nodes. Loading boundary conditions are then applied to these elements and nodes. A network of these elements is known as mesh.Generally,

automatic mesh generating capabilities of preprocessor are used rather than defining the nodes individually.

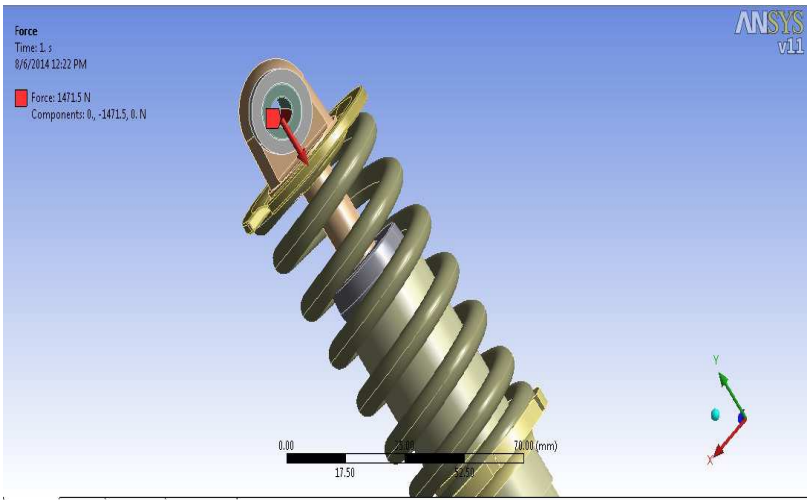


Mesh Generation of the Modal

BOUNDARY CONDITIONS AND LOADING

After completion of the finite element model it has to constrain and load has to be applied to the model. User can define constraints and loads in various ways. All constraints and loads are assigned set ID. This helps the user to keep track of load cases.

- **Modal display**
- **Material Defections**



Boundary Conditions and Loading

SOLUTION

The solution phase deals with the solution of the problem according to the problem definitions. All the tedious work of formulating and assembling of matrices are done by the computer and finally displacements are stress values are given as output.

THERMAL ANALYSIS A thermal analysis calculates the temperature distribution and related thermal quantities in brake disc. Typical thermal quantities are:

- The temperature distribution
- The amount of heat lost or gained
- Thermal fluxes

Types of Thermal Analysis

- Steady state thermal analysis.
- Transient thermal analysis

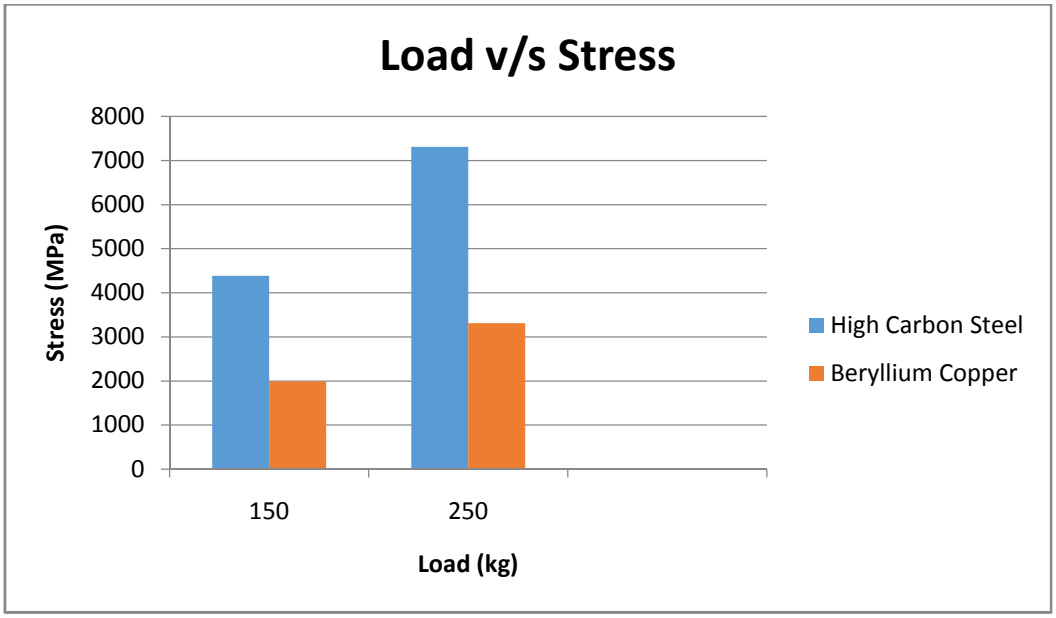
STRUCTURAL ANALYSIS

Structural analysis is the most common application of the finite element analysis. The term structural implies civil engineering structure such as bridge and building, but also naval, aeronautical and mechanical structure such as ship hulls, aircraft bodies and machine housing as well as mechanical components such as piston, machine parts and tools.

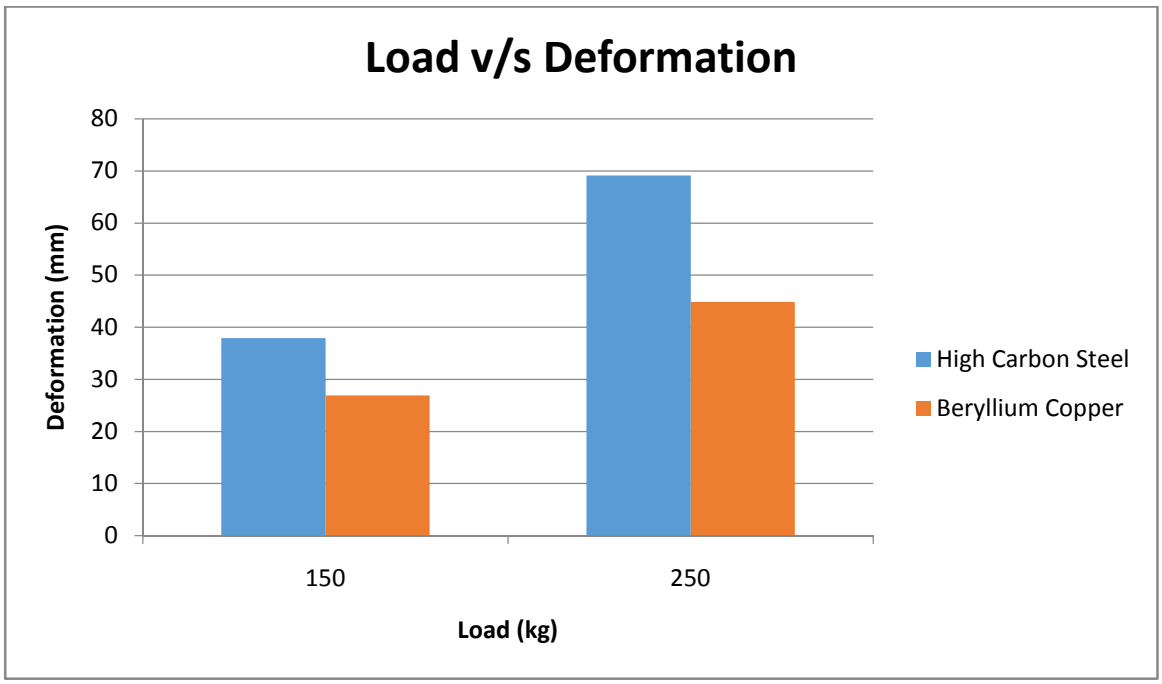
VALIDATION OF THE RESULTS:

Here by taking existing materiali.e. 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.

	High Carbon steel	**Beryllium copper**
Cost	Reasonable cost	Reasonable cost
Life period	**1 Time**	**3 Times**
Stress (Mpa)	**7307.6**	**3311.6**



Load v/s Stress



Load v/s Deformation

So finally conclusion is beryllium copper is best material when compared to high carbon steel.

CONCLUSION

Modeling and analysis of a suspension system has been done by taking High Carbon Steel and Beryllium Copper.As both High Carbon Steel and Beryllium Copper are available at reasonable cost. Hence in this project Beryllium Copper is recommended as best material, because by taking Beryllium Copper the stress concentration is reduced and as well as life time is increases by comparing with High Carbon Steel

which is existing material. Here Beryllium Copper is recommended for suspension system whose modal have been satisfactorily analyzed.

ACKNOWLEDGEMENT

I take this opportunity to express my gratitude to my respected and beloved guide **Mr. R.Sudheer Kumar, Assistant professor** in the Mechanical Engineering Department for his valuable guidance, persistent, encouragement and suggestions in completing this paper work successfully. I express my sincere and heart full thanks to principal **Dr. S M JameelBasha** and **HEAD OF MECHANICAL ENGINEERING** for providing an excellent academic climate in the institute which made this work possible.

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