DESIGN AND ANALYSIS OF SHOCK ABSORBER

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ABSTRACT

Shock absorber is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy. In a vehicle, it reduces the effect of traveling over rough ground, leading to improved ride quality, and increase in comfort due to substantially reduced amplitude of disturbances. In this work suspension system is designed and a 3D model is created using CATIA V5 R21. The model is also changed by changing the thickness of the spring.

Structural analysis and modal analysis are done on the shock absorber by varying different spring materials. Spring materials are Spring Steel, Phosphor bronze, Beryllium Copper and Titanium alloy. To validate the strength of the model, the structural analysis on the helical spring was done. The analysis is done by considering loads, bike weight, and single, double riding. Modal analysis is done to determine the displacements for different frequencies for number of modes. Finally comparison is done for different materials to verify best material for spring in Shock absorber. Modeling is done in CATIA and analysis is done in ANSYS.

INTRODUCTION

A **shock absorber** or **damper** is a mechanical device designed to smooth out or dampshock impulse, and dissipate kinetic energy. **Description**

Pneumatic and hydraulic shock absorbers commonly take the form of a cylinder with a sliding piston inside. The cylinder is filled with a fluid (such as hydraulic fluid) or air. This fluid-filled piston/cylinder combination is a dashpot.

Explanation

The shock absorbers duty is to absorb or dissipate energy. One design consideration, when designing or choosing a shock absorber, is where that energy will go. In most dashpots, energy is In hydraulic cylinders, the hydraulic fluid will heat up, while in air cylinders, the hot air is usually exhausted to the atmosphere. In other types of dashpots, such as electromagnetic ones, the dissipated energy can be stored and used later. In general terms, shock absorbers help cushion cars on uneven roads.

Applications

Shock absorbers are an important part of automobile and motorcyclesuspensions, aircraftlanding gear, and the supports for many industrial machines. Large shock absorbers have also been used in structural engineering to reduce the susceptibility of structures to earthquakedamage and resonance. A transverse mounted shock absorber, called a yaw damper, helps keep railcars from swaying excessively from side to side and are important in passenger railroads, commuter rail and rapid transit systems because they prevent railcars from damaging station platforms. The success of passive damping technologies in suppressing vibration amplitudes could be ascertained with the fact that it has a market size of around $ 4.5 billion.

Rear shock absorber and spring of a BMW R75/5 motorcycle

Vehicle suspension

In a vehicle, it reduces the effect of traveling over rough ground, leading to improved ride quality, and increase in comfort due to substantially reduced amplitude of disturbances. Without shock absorbers, the vehicle would have a bouncing ride, as energy is stored in the spring and then released to the vehicle, possibly exceeding the allowed range of suspension movement. Control of excessive suspension movement without shock absorption requires stiffer (higher rate) springs, which would in turn give a harsh ride. Shock absorbers allow the use of soft (lower rate) springs while controlling the rate of suspension movement in response to bumps. They also, along with hysteresis in the tire itself, damp the motion of the unsprung weight up and down on the springiness of the tire. Since the tire is not as soft as the springs, effective wheel bounce damping may require stiffer shocks than would be ideal for the vehicle motion alone.

Spring-based shock absorbers commonly use coil springs or leaf springs, though torsion bars can be used in torsional shocks as well. Ideal springs alone, however, are not shock absorbers as springs only store and do not dissipate or absorb energy. Vehicles typically employ both springs or torsion bars as well as hydraulic shock absorbers. In this combination, "shock absorber" is reserved specifically for the hydraulic piston that absorbs and dissipates vibration.

Structures

Applied to a structure such as a building or bridge it may be part of a seismic retrofit or as part of new, earthquake resistant construction. In this application it allows yet restrains motion and absorbs resonant energy, which can cause excessive motion and eventual structural failure.

Design Calculations for Shock absorbers

Material: phosphorous bronze

G = 41000 = modulus of rigidity

Mean diameter of a coil = D=62mm

Diameter of wire d = 8mm

Total no of coils n^1 = 18

Height h = 220mm

Outer diameter of spring coil D^0 = D +d =70mm

No of active turns n = 14

Weight of bike = 125kgs

Let weight of 1 person = 75 Kgs

Weight of 2 persons = 75

Weight of bike + persons = 275Kgs

Rear suspension = 65%

65% of 275 = 165Kgs

Considering dynamic loads it will be double

W = 330Kgs = 3234N

For single shock absorber weight = w/2= 1617N = W

C = spring index = 7.75

(δ) =8

Solid length = nlxd = 18 x 8 =144

Free length of the spring

Lf = 144+ 282.68 + 0.15 x 282.698 = 496.102

Spring rate K = 5.719 pitch of coil

Pitch of coil P = 26

Stresses in helical springs: maximum shear stress induced in the wire

τ = K

K = 499.519N/mm2

τ = K

Buckling of compression springs:

K = spring rate or stiffness of spring = 0.05

Values of buckling factor

K = 0.05 (for hinged and spring)

The buckling factor for the hinged end and built-in end springs

(Wcr) = 5.719×0.05×469.102=134.139N

Modification of existing design

The above description reveals that **CAD** technologies give the design engineer a powerful tool for graphical tasks . Modern **CAD** systems are based on interactive computer graphics communicates data and commands to the computer through the several input devices, to create an image or model on the computer screen by entering command to call and active the required software subroutines stored in the computer. In a 2-dimensional drafting system the images are constructed out of basic geometric elements or entities like points, lines, arcs, circles etc. These images can then be modified. Rotated, scaled or transformed in several ways depending upon the designer's requirement.

PRODUCT DEVELOPMENT THROUGH CAD PROCESS:

The product begins with a need that is identified based on costumer and market's demands . The product goes through two main processes from the idea conceptualization to the finished product the design process and the manufacturing process. Product development through CAD product. Synthesis and analysis are the main sub processes that constitute the deign process. Synthesis is crucial to design an analysis.

The philosophy, functionality and uniqueness of the product are all determined during the synthesis. The major financial commitment to turn the conceived product idea into reality is also made. Most of the information generated during the synthesis sod process is qualitative and consequently is hard to captured in a computer system expert and knowledge –based systems have made a great deal of progress in this regard and the interested conceptual design of the prospective product.

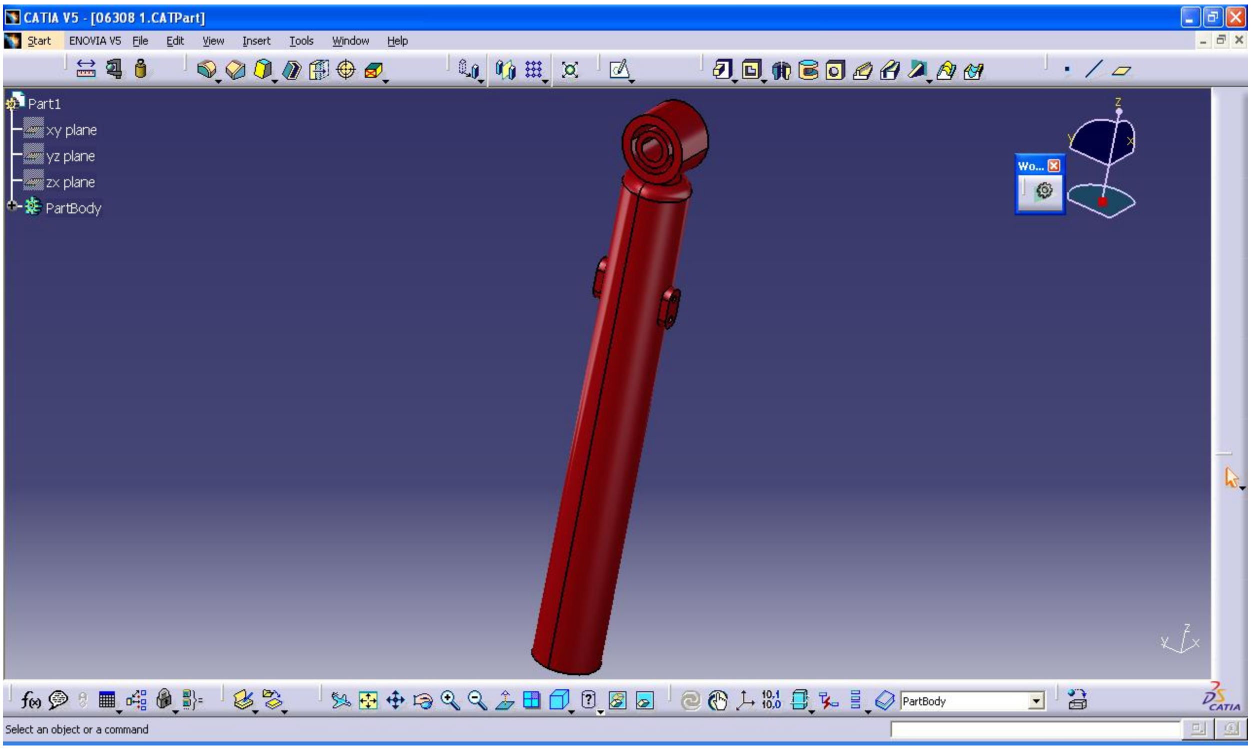
SOLID MODELING:

A solid model of an object is a completed representation of the object. This model is capable of complex geometry data representation that is the art completely defined ,solid modeling techniques based on information ally complete, valid and unambiguous of object solid modelers store more information (geometry and topology) than wire frame modelers of surface (geometry only). Both wire frame and surface modelers are incapable of handling special address ability as well as verifying that the model is well framed or not. Solid models can be quickly created without having to define individual locations as with wire frames. Solid modeling produces accurate designs, provides complete three-dimensional improves the quality of the design, improves and has potential for functional automation and integration.

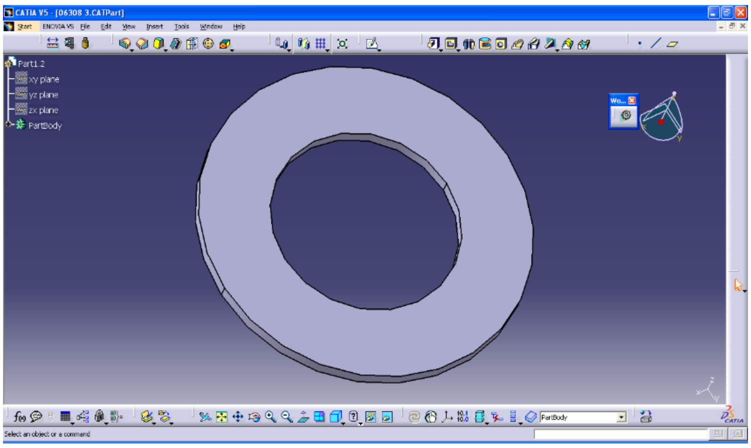
MODEL OF SHOCK ABSORBER

PARTS of a SHOCK ABSORBER

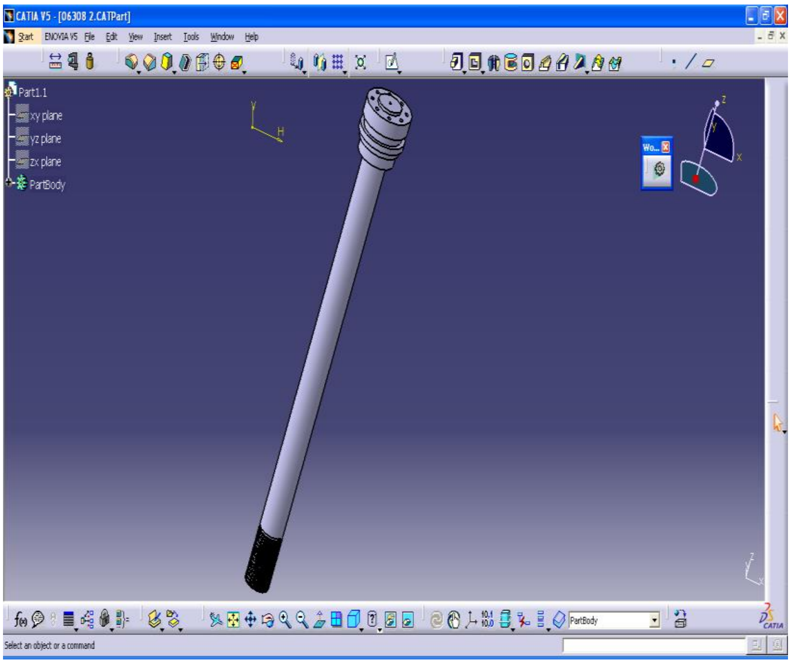
1. **TOP CYLINDER:**



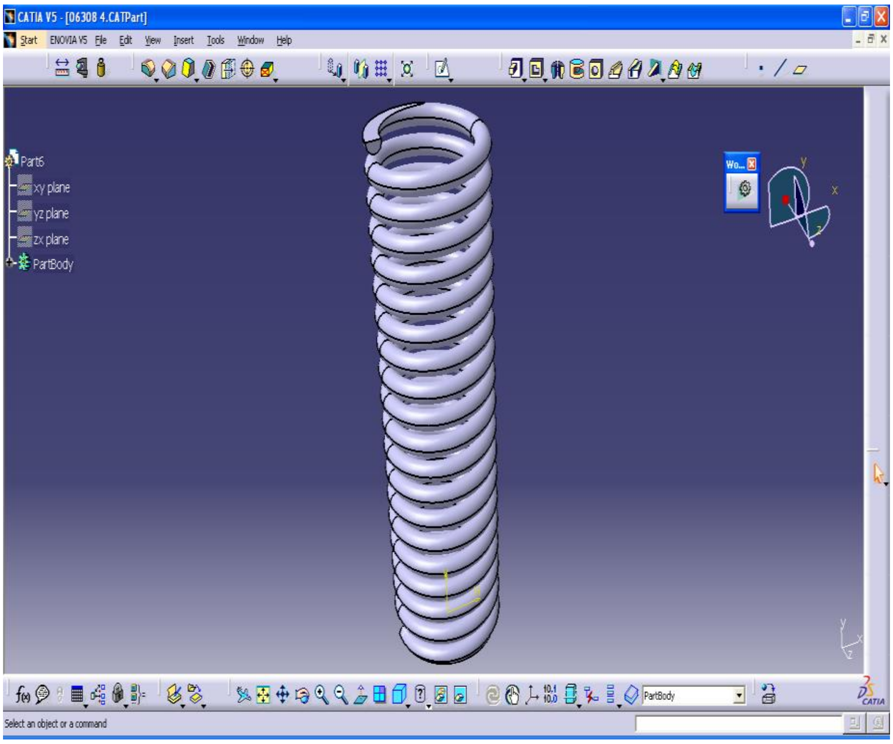
2.WASHER:



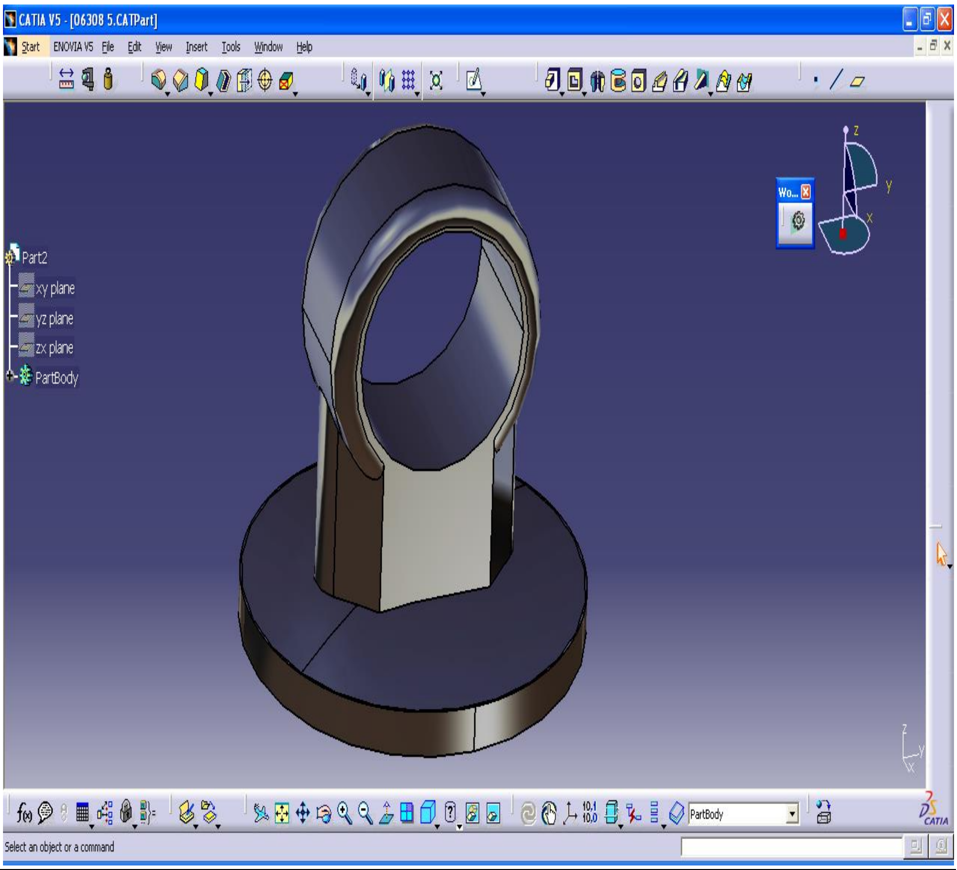
3.BOTTOM



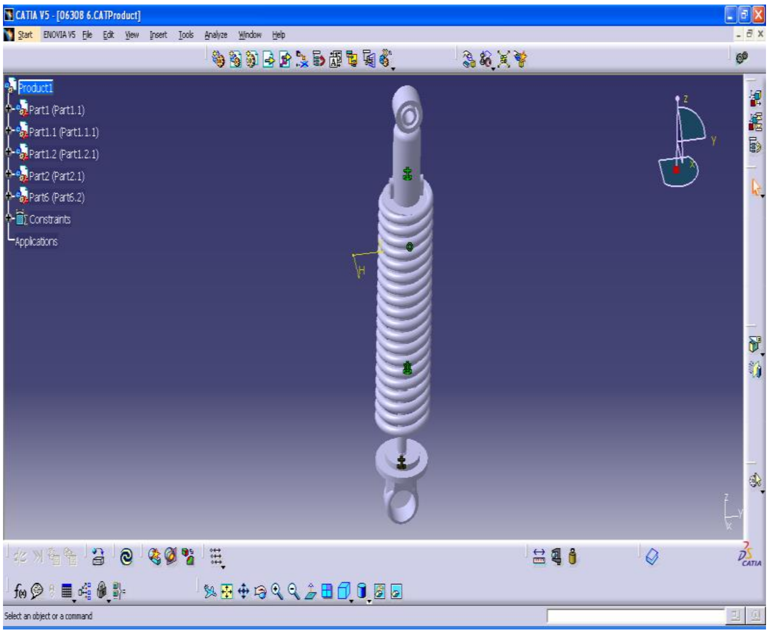
4.SPRING



5.COUPLING

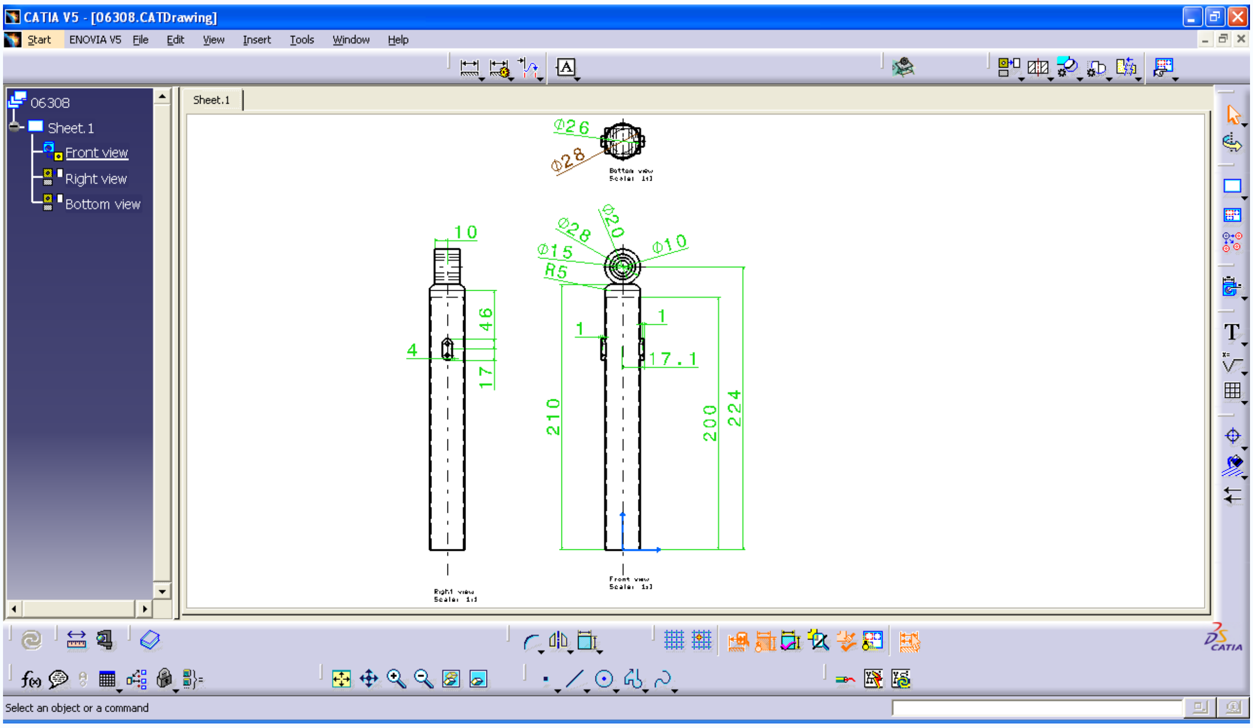


TOTAL ASSEMBLY

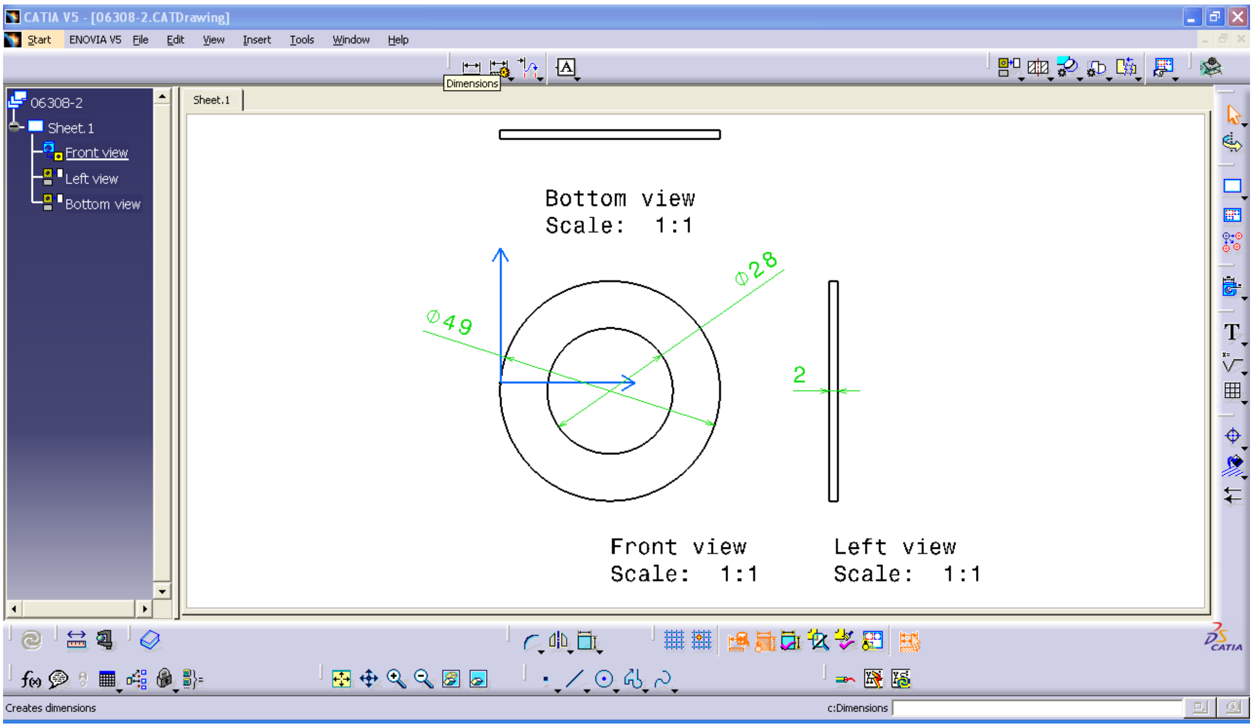


Views of the SHOCK ABSORBER:

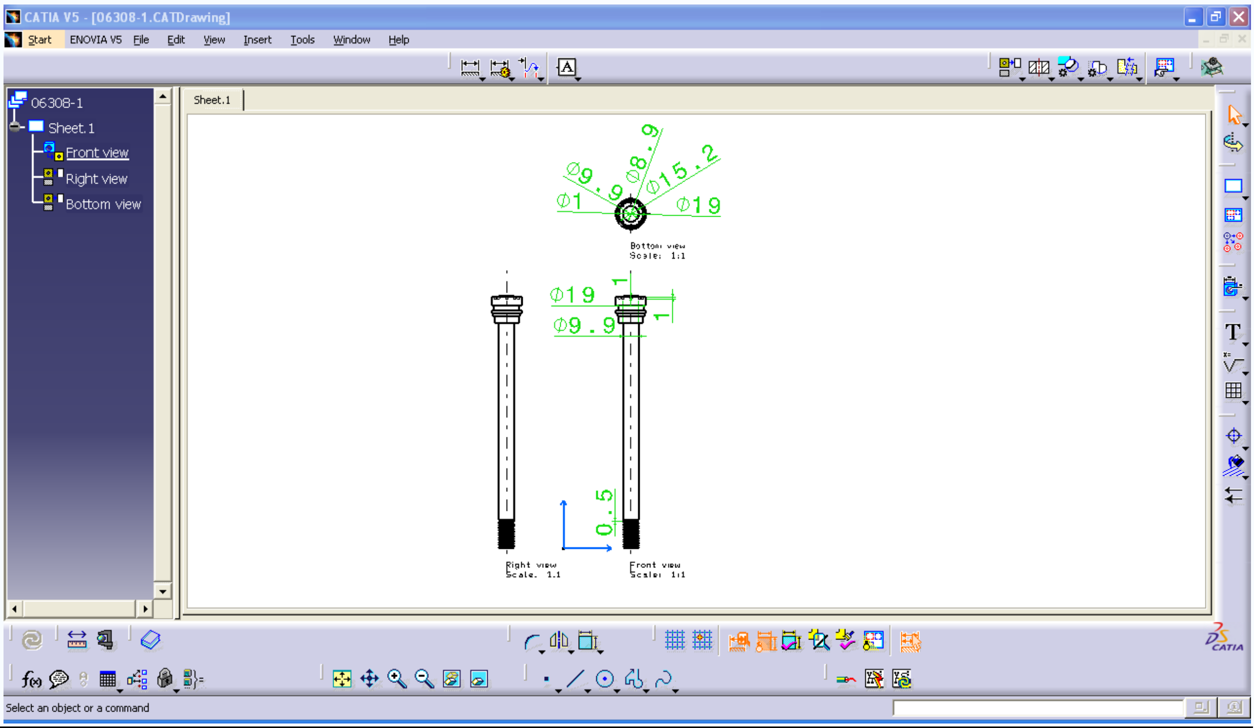
1.Top Cylinder:



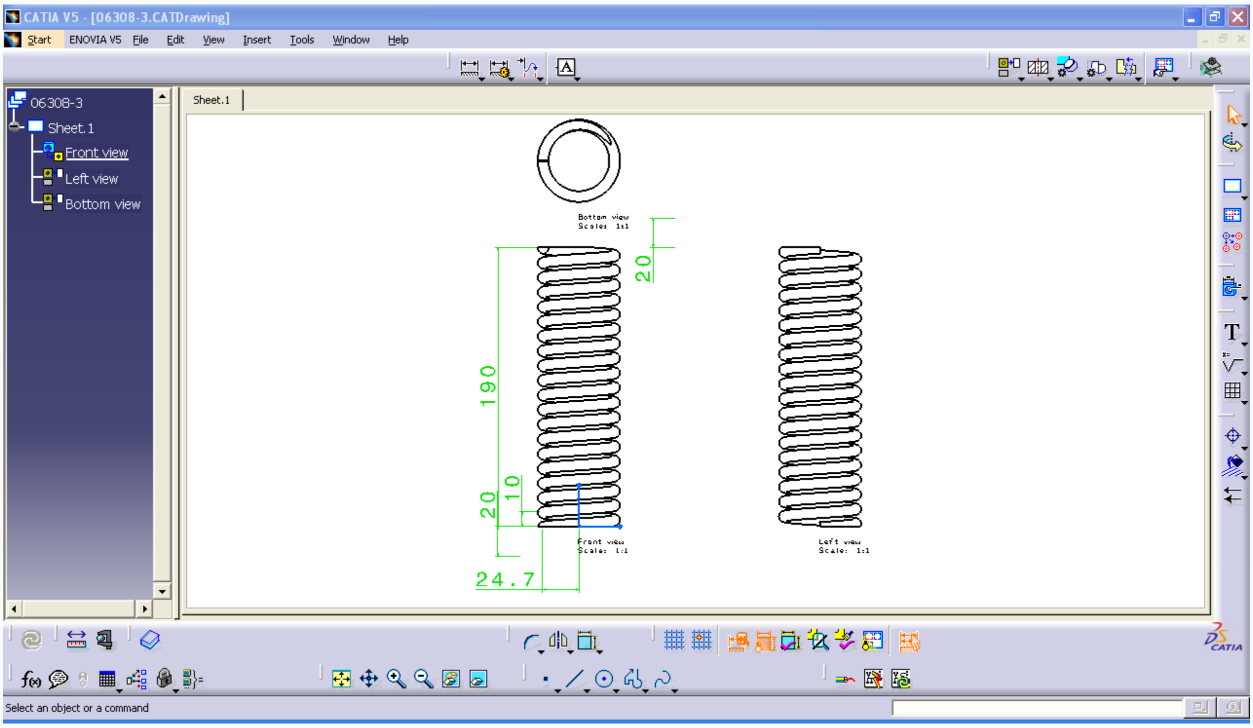
2.Washer



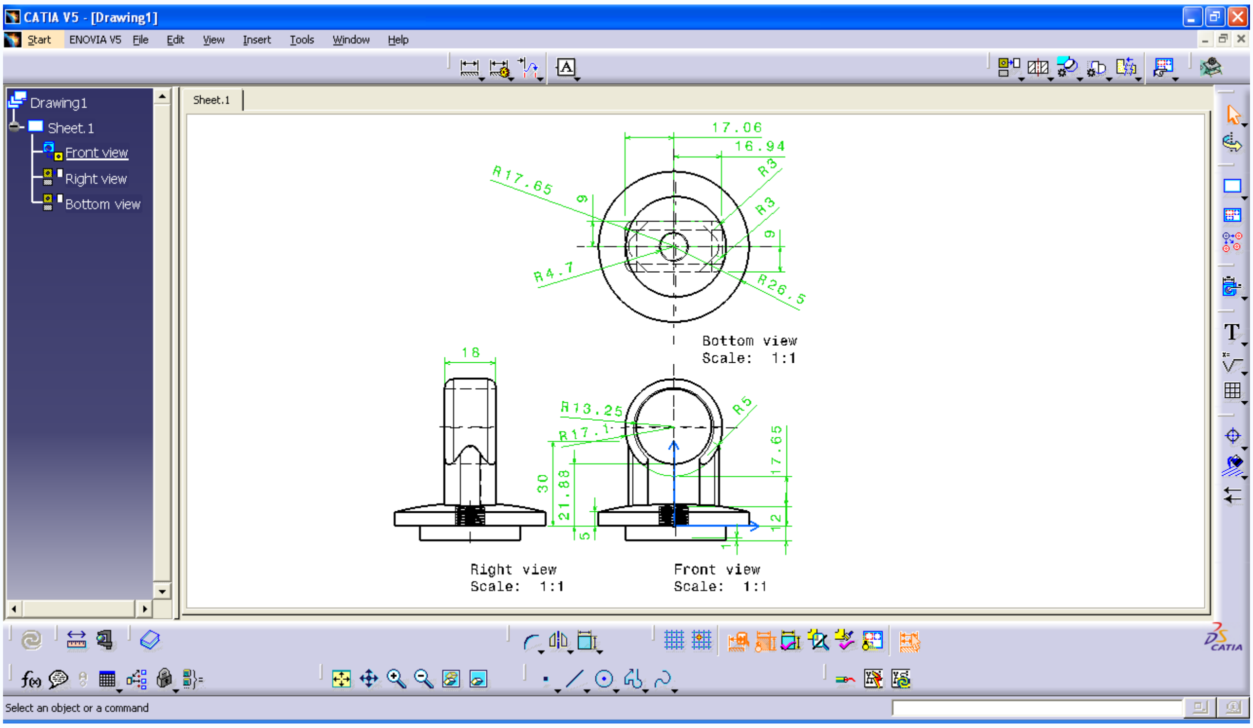
3. Bottom



4. Spring



5. Coupling



ASSEMBLY OF SHOCK ABSORBER

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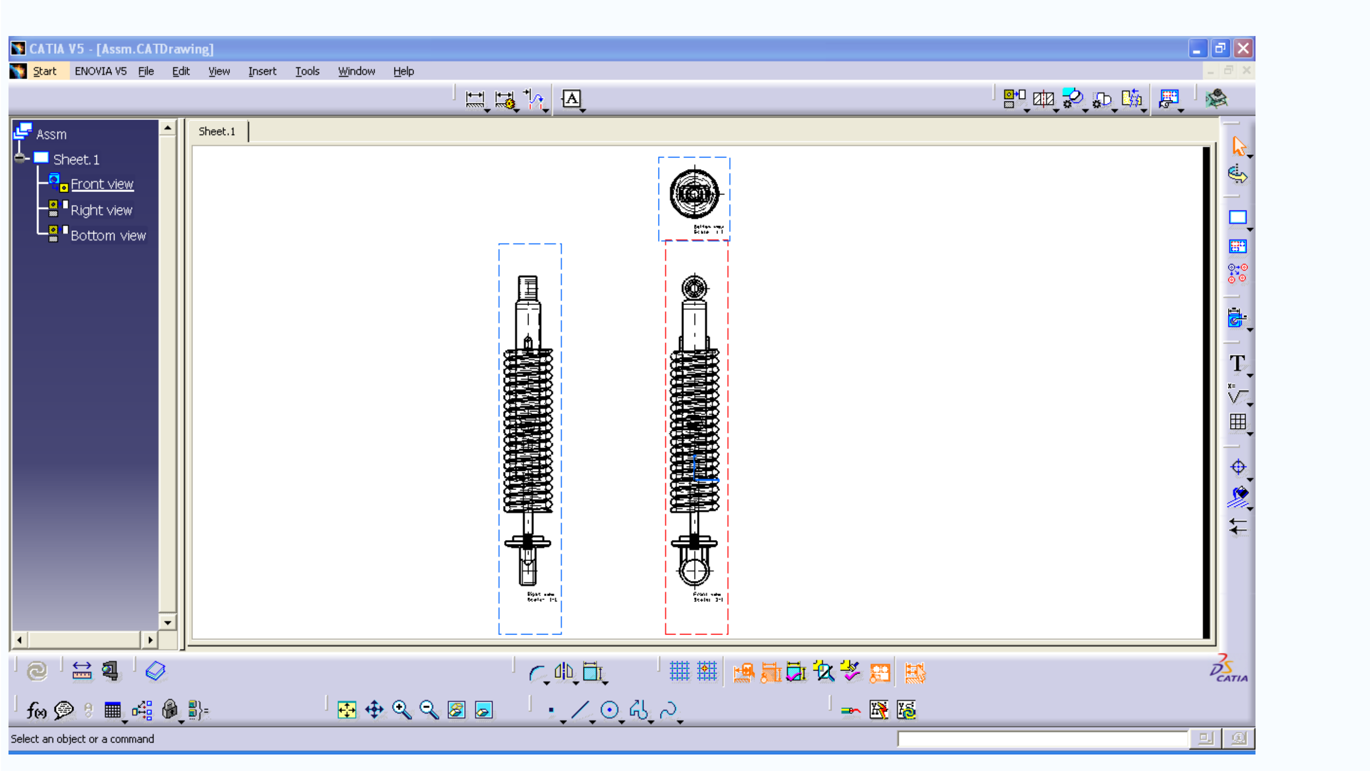

MATERIAL PROPERTIES:

NICKEL 200;

DENSITY Kg/mm-3	**8.8e-015**
YOUNGS MODULOUSMPa	**2.07e+005**
POISSION'S RATIO	**0.31**

INCONEL 750

DENSITY Kg/mm-3	**8.2e-015**
YOUNGS MODULOUSMPa	**2.15e+005**
POISSION'S RATIO	**0.29**

MONEL

DENSITY Kg/mm-3	**8.08e-012**
YOUNGS MODULOUSMPa	**1.79e+005**
POISSION'S RATIO	**0.3**

RESULT TABULATION:

NICKEL 200:

160 KG LOAD

	MINIMUM	MAXIMUM
TOT. DEF. (mm)	0	145.77
STRAIN (mm/mm)	5.38 E-14	0.0226
STRESS (MPa)	8.535 E-9	4447.3

INCONEL:

160 KG LOAD:

	MINIMUM	MAXIMUM
TOT. DEF. (mm)	0	138.59
STRAIN (mm/mm)	4.920E -14	0.0218
STRESS (MPa)	7.745 E-9	4455.7

MONEL:

160 KG LOAD:

	MINIMUM	MAXIMUM
TOT. DEF. (mm)	0	167.52
STRAIN (mm/mm)	6.412 E-14	0.0262
STRESS (MPa)	8.025 E-9	4451.7

CONCLUSION

From the analysis, the values of each material properties are applied and the static structural analysis is done. The results of each material are tabulated according to their total deformation, strain and stress. The materials analyzed are NICKEL 220, INCONEL AND MONEL Out of all these materials, MONEL has good damping effect compared to other materials. Thus monel can be optimized.

In our project we have designed a shock absorber used in a 150cc bike.We have modeled the shock absorber by using 3D parametric software CATIA.To validate the strength of our design, we have done structural analysis and modal analysis on the shock absorber by applying 240kgs load on shock absorber.

We have done analysis by varying spring material Spring Steel and Beryllium Copper.By observing the analysis results, the analyzed stress values are less than their respective yield stress values. So our design is safe.By comparing the results for both materials, the stress value is less for Spring Steel than Beryllium Copper.

So we can conclude that as per our analysis using material Spring steel for spring is best.