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Comparison and Analysis of different types of Shock Absorbers

Tanay M Jadhav[1], Rajesh A Dongare[2], Kaif P Shikalgar[3], Ritesh H Patil[4]

Student, ME, AITRC, Vita, India[1]

Student, ME, AITRC, Vita, India[2]

Student, ME, AITRC, Vita, India[3]

Student, ME, AITRC, Vita, India[4]

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.

Keywords*:* Static, Transient Dynamic, Buckling, CATIA V5 R21, ANSYS.

I. INTRODUCTION

A shock absorber or damper is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy. 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. The shock absorbers duty is to absorb or dissipate energy. These are an important part of automobile suspensions, aircraft landing 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 earthquake damage 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 commuter railroads and rapid transit systems because they prevent railcars from damage station platforms. In a vehicle, it reduces the effect of traveling over rough ground, leading to improved ride quality, and increase 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. Damp the motion of the upspring 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 tensional 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 springs and torsion bars as well as hydraulic shock absorbers.

1.1 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.

1.2 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 converted to heat inside the viscous fluid. 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.

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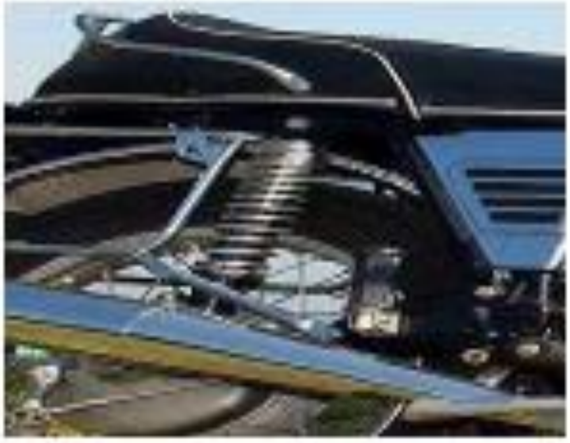
1.3 Applications

Shock absorbers are an important part of automobile and motorcycle suspensions, aircraft landing 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 earthquake damage 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.



1.4 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 unspring 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 tensional 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 springs and 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.

1.5 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.

1.6 Types of shock absorbers

There are several commonly-used approaches to shock absorption:

♣ Hysteresis of structural material, for example the compression of rubber disks, stretching of rubber bands and cords, bending of steelsprings, or twisting of torsion bars. Hysteresis is the tendency for otherwise elastic materials to rebound with less force than was required to deform them. Simple vehicles with no separate shock absorbers are damped, to some extent, by the hysteresis of their springs and frames.

♣ Dry friction as used in wheel brakes, by using disks (classically made of leather) at the pivot of a lever, with friction forced by springs. Used in early automobiles such as the Ford Model T, up through some British cars of the 1940s. Although now considered obsolete, an advantage of this system is its mechanical simplicity; the degree of damping can be easily adjusted by tightening or loosening the screw clamping the disks, and it can be easily rebuilt with simple hand tools. A disadvantage is that the damping force tends not to increase with the speed of the vertical motion.

♣ Solid state, tapered chain shock absorbers, using one or more tapered, axial alignment(s) of granular spheres, typically made of metals such as nitinol, in a casing.

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♣ Fluid friction, for example the flow of fluid through a narrow orifice (hydraulics), constitutes the vast majority of automotive shock absorbers. An advantage of this type is that using special internal valving the absorber may be made relatively soft to compression (allowing a soft response to a bump) and relatively stiff to extension, controlling "jounce", which is the vehicle response to energy stored in the springs; similarly, a series of valves controlled by springs can change the degree of stiffness according to the velocity of the impact or rebound. Specialized shock absorbers for racing purposes may allow the front end of a dragster to rise with minimal resistance under acceleration, then strongly resist letting it settle, thereby maintaining a desirable rearward weight distribution for enhanced traction. Some shock absorbers allow tuning of the ride via control of the valve by a manual adjustment provided at the shock absorber. In more expensive vehicles the valves may be remotely adjustable, offering the driver control of the ride at will while the vehicle is operated. The ultimate control is provided by dynamic valve control via computer in response to sensors, giving both a smooth ride and a firm suspension when needed. Many shock absorbers contain compressed nitrogen, to reduce the tendency for the oil to foam under heavy use. Foaming temporarily reduces the damping ability of the unit. In very heavy duty units used for racing and/or off road use, there may even be a secondary cylinder connected to the shock absorber to act as a reservoir for the oil and pressurized gas. Another variation is the Magneto rheological damper which changes its fluid characteristics through an electromagnet.

♣ Compression of a gas, for example pneumatic shock absorbers, which can act like springs as the air pressure is building to resist the force on it. Once the air pressure reaches the necessary maximum, air dashpots will act like hydraulic dashpots. In aircraft landing gear air dashpots may be combined with hydraulic damping to reduce bounce. Such struts are called oleo struts (combining oil and air).

♣ Magnetic effects. Eddy current dampers are dashpots that are constructed out of a large magnet inside of a non-magnetic, electrically conductive tube.

♣ Inertial resistance to acceleration, for example prior to 1966 the Citroën 2CV had shock absorbers that damp wheel bounce with no external moving parts. These consisted of a spring-mounted 3.5 kg (7.75 lb) iron weight inside a vertical cylinder and are similar to, yet much smaller than versions of the tuned mass dampers used on tall buildings

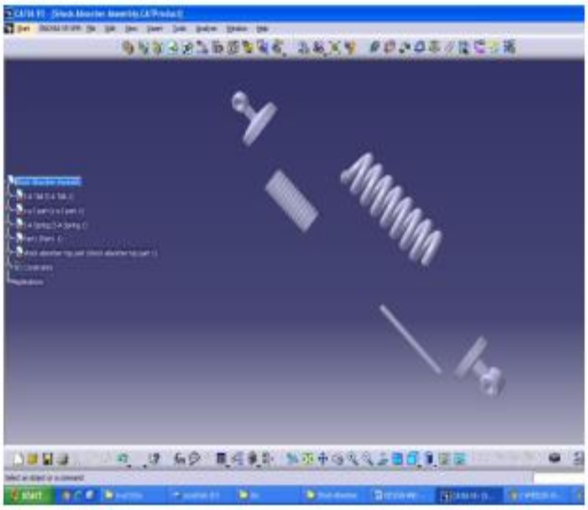
♣ Composite hydro-pneumatic devices which combine in a single device spring action, shock absorption, and often also ride-height control, as in some models of the Citroën automobile.

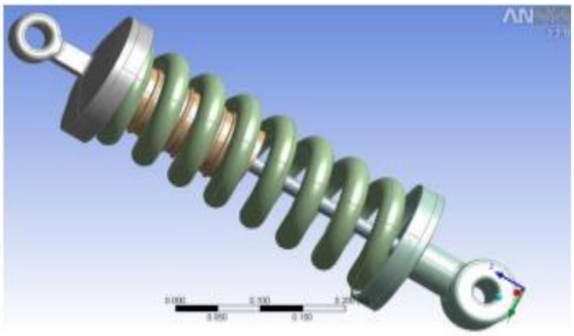
♣ Conventional shock absorbers combined with composite pneumatic springs with which allow ride height adjustment or even ride height control, seen in some large trucks and luxury sedans such as certain Lincoln and most Land Rover automobiles. Ride height control is especially desirable in highway vehicles intended for occasional rough road use, as a means of improving handling and reducing aerodynamic drag by lowering the vehicle when operating on improved high speed roads.

♣ the effect of a shock absorber at high (sound) frequencies is usually limited by using a compressible gas as the working fluid and/or mounting it with rubber bushings.

♣ The detailed analysis of shock absorber/isolation systems is very complicated and involves assessment of the dynamic response of the equipment to different types of activating energy inputs. The notes below relate only to illustrating the benefits of using shock absorbers to reduce the forces experienced by equipment to impacts. The more complicated scenarios involving systems continuously operating and withstanding sudden changes of loading and acceleration e.g., car suspension systems and aircraft landing gear, are outside of the scope of this work. Moving objects have kinetic energy related to their velocity and their mass. If the velocity of an object is significantly changed in a short time span e.g. it impacts on a stationary body, then high forces result. These forces can be useful e.g., a forging press using the kinetic energy to form metal. However real life impact forces (shock loads) are generally very destructive and are avoided. Kinetic energy increases in a direct ratio to the mass and to the velocity squared.

♣ The heavier the object or the faster it travels, the more energy it has. Methods of energy absorption include rubber buffers, metal springs, air springs, and hydraulic shock absorbers. When the systems have to continuously operate under the influence of shock loads the shock isolation system generally includes spring-dashpot isolation systems. For simple shock absorber applications required to mitigate the effect of a single events then viscous dampers which dissipate the energy, as heat rise of a fluid, are often preferred. In normal everyday life simple examples of shock absorber systems include crash helmets, steel toe caps in industrial boots, collapsible bumpers on cars, motor way barriers. The notes below are general in nature provided to show the benefits of using shock absorbers. For more detailed information - links are provided to shock absorber supplier.





II. CONCLUSION

In this project we have designed a shock absorber used in a 150cc bike. We have modeled the shock absorber by using 3D parametric software Pro/Engineer. To validate the strength of our design, we have done structural analysis and modal analysis on the 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. Also the shock absorber design is modified by reducing the diameter of spring by 2mm and structural, modal analysis is done on the shock absorber. By reducing the diameter, the weight of the spring reduces. By comparing the results for both materials, the stress value is less for Spring Steel than Beryllium Copper. By comparing the results for present design and modified design, the stress and displacement values are less for modified design. So we can conclude that as per our analysis using material spring steel for spring is best and also our modified design is safe.

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