DESIGN AND ANALYSIS OF A SHOCK ABSORBER OF TWO-WHEELER

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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 absorber's duty is to absorb or dissipate energy. In a vehicle, it reduces the effect of traveling over rough ground, leading to improved ride quality, and an increase in comfort due to substantially reduced amplitude of disturbances. When a vehicle is traveling 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 length and, 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 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 of spring in the suspension system is very important. In this project, a shock absorber is designed and a 3D model is created using solid works design software. Thus the model of two bikes splendor and Yamaha are modeled and structural analysis of both suspension springs is done in Ansys workbench by assigning two different materials such as alloy steel and chromium-vanadium steel.

Introduction

A shock absorber or damper is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy. The suspension system is the main part of the vehicle, where the shock absorber is designed mechanically to handle shock impulses and dissipate kinetic energy. In a vehicle, shock absorbers reduce the effect of traveling over rough ground, leading to improved ride quality and vehicle handling. While shock absorbers serve the purpose of limiting excessive suspension movement, their intended sole purpose is to damp spring oscillations.

Description

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

The shock absorber's 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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Vehicle Suspension System

Shock absorbers are important part of vehicle's suspension, which is fabricated to reduce Shock impulse. Shock absorbers work on the principle of fluid displacement on both the compression and expansion cycle. The modern motorcycle uses suspension to accomplish several things ; it provides a smooth comfortable ride absorbing bumps and imperfections in the road. It also allows the rider to fine tune the machine to give him/her better control over the machine when riding. Motorcycles with only one shock absorber are called mono shock motorcycles. When mono suspension is mentioned everyone should remember that it should be on the rear side. The performance of mono suspension motorcycles is vastly superior to twin suspension motorcycles .They are used not only in automotive industries but are also used in various other manufacturing and processing industries.

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.

Types Of Shock Absorbers

Shock Absorber types

There are a number of different methods of converting an impact /collision into relatively smooth cushioned contact.. Metal Spring Rubber Buffer Hydraulic Dashpot Collapsing safety Shock Absorbers Pneumatic Cylinders Self compensating Hydraulic

Metal springs

Fig: Metal springs

Simply locating metal springs to absorb the impact loads are a low cost method of reducing the collision speed and reducing the shock loading. They are able to operate in very arduous conditions under a wide range of temperatures. These devices have high stopping forces at end of stroke.

Elastomatic shock observer

Fig: Elastomatic shock observer

These are low cost options for reducing the collision speed and reducing the shock loading and providing system damping. They are conveniently moulded to suitable shapes. These devices have high stopping forces at end of stroke with significant internal damping.

Hydraulic Dashpot

Fig: Hydraulic Dashpot

This type of shock absorber is based on a simple hydraulic cylinder. As the piston rod is moved hydraulic fluid is forced through an orifice which restricts flow and consequently provides a controlled resistance to movement of the piston rod.

Collapsing Safety Shock Absorbers

These are single use units which are generally specially designed for specific duties. They are designed such that at impact they collapse and the impact energy is absorbed as the materials distort in their inelastic/yield range. They therefore are more compact compared to devices based on deflections within their elastic range.

Air (Pneumatic) spring

Fig: Air (Pneumatic) spring

These devices use air as the resilient medium. Air has a high energy storage capacity compared to metal or elastomer materials. For duties with high loads and deflections the air spring is generally far more compact that the equivalent metal or elastomer device.

Self compensating Hydraulic

These devices are similar to the hydraulic dashpot type except that a number of orifices are provided allowing different degrees of restriction throughout the stroke. These devices are engineered to bring the moving load is smoothly and gently to rest by a constant resisting force throughout the entire shock absorber stroke.

Explanation:

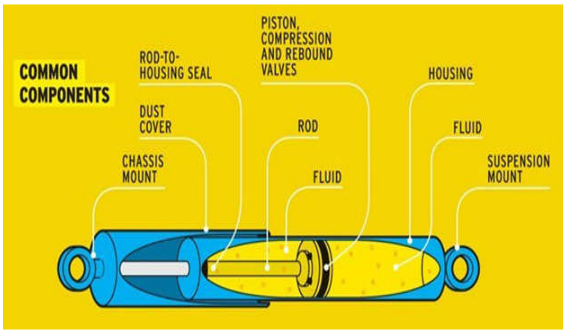

Fig: explanation of suspension system

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Important Properties:

Preload

Preload is a load placed on a spring before it’s used. It may have means to apply pressure on suspension to compress the spring without effecting suspension movement. It can be an adjuster in a front fork or a collar on rear shocks.

Load transfer:

on applying brakes on two wheeler vehicle, almost a large load(force) will be exerted on the front suspension parts. To avoid this load acting on front will be transferred to the rear suspension system parts. This phenomenon is known as LOAD TRANSFER.

7.3 Jacking Forces:

Vertical component of forces acting on the suspension system when load is acting in the vertical direction are resolved as JACKING FORCES

Design Calculations for Helical springs for Shock absorbers

Material: Steel(modulus of rigidity) G = 41000

Mean diameter of a coil D=62mm

Diameter of wire d = 8mm

Total no of coils n1= 18

Height h = 220mm

Outer diameter of spring coil D0 = D +d =70mm

No of active turns n= 14

Weight of bike = 125kgs

Let weight of 1 person = 75Kgs

Weight of 2 persons = 75×2=150Kgs

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

We Know that, compression of spring (δ) = × × /×

C = spring index = = = 7.75 = 8

(δ) = × × × /× = 282.698

Solid length, Ls=n1×d=18×8=144

Free length of spring,

Lf = solid length+maximum compression + clearance Between adjustable coils

= + + 0.15 = 144 + 282.698 + 0.15 × 282.698 = 469.102

Spring rate, K = = . = 5.719

Pitch of coil, P = = . = 26

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

τ = K×

K = + . = ×

× + . = 0.97

τ = K× = 0.97 × × ×

× = 499.519

Buckling of compression springs, = × ×

Values of buckling factor KB= 7.5

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

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.

Introduction To Solid Works

Solid Works is mechanical design automation software that takes advantage of the familiar Microsoft Windows graphical user interface

Solid works mechanical design automation software is a feature-based, parametric solid modeling design tool which advantage of the easy to learn windows ™ graphical user interface. We can create fully associate 3-D solid models with or without while utilizing automatic or user defined relations to capture design intent.

Design Of Suspension Spring:

Modeling Of Suspension Spring

Spring Specifications

Wire diameter (d) =8 mm,

Coil outer diameter (D) =40 mm,

Coil free height (h) =200 mm,

No.of active coils (n)=12,

Pitch (P) =15 mm

For splender plus

coil diameter =8mm,

total length=208mm

spring length=192mm

no. of turns= 13

For Yamaha

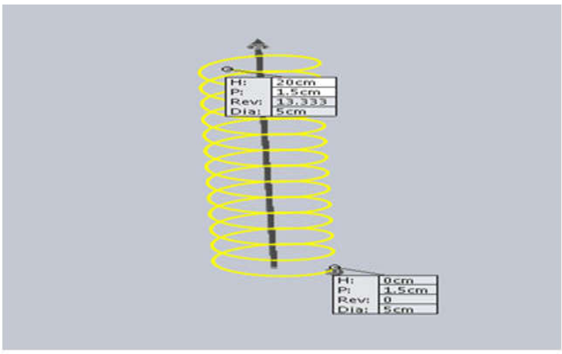
coil diameter =8mm,

total length=192mm

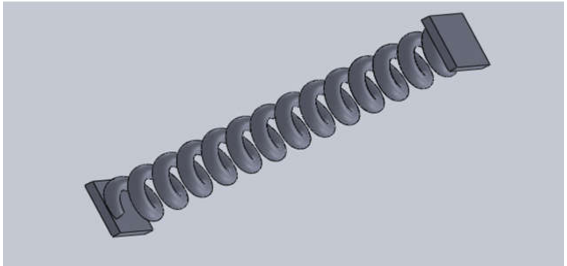
spring length=182mm

no. of turns= 12

After drawing a profile you have to select the helix command in the feature menu bar to expand path with required length and rotations or with pitch and length as shown below.



Suspension spring



Theoretical calculations of spring

At LOAD=800 N

Spring Index, $(C) = \frac{D}{d} = \frac{40}{8} = 5$

Whal's Stress Factor $(K) = \frac{4c-1}{4c-4} + \frac{0.615}{c}$

$$= \frac{4(5)-1}{4(5)-4} + \frac{0.615}{5}$$

$(K) = 1.3105$

Maximum Shear Stress $(\tau) = \frac{KX8WD}{\pi d^3}$

$$= \frac{1.3105X8X800X40}{\pi X(8)^3}$$

$$(\tau) = 208.57255 \text{ Mpa}$$

Deflection of Spring $(\delta) = \frac{8WC^3 n}{Gd}$

$$= \frac{8X800X(5)^3X12}{87500X8}$$

$$(\delta) = 13.714 \text{ mm}$$

Introduction to Fem

Many problems in engineering and applied science are governed by differential or integral equations. The solutions to these equations would provide an exact, closed form solution to the particular problem being studied. However, complexities in the geometry, properties and in the boundary conditions that are seen in most real world problems usually means that an exact solution cannot be obtained in a reasonable amount of time. They are content to obtain approximate solutions that can be readily obtained in a reasonable time frame and with reasonable effort. The FEM is one such approximate solution technique.

Introduction To Ansys

ANSYS 14.5 delivers innovative, dramatic simulation technology advances in every major Physics discipline, along with improvements in computing speed and enhancements to enabling technologies such as geometry handling, meshing and post-processing. These advancements alone represent a major step ahead on the path forward in Simulation Driven Product Development. But ANSYS has reached even further by delivering all this technology in an innovative simulation framework ,ANSYS Workbench14.5The ANSYS Workbench environment is the glue that binds the simulation process; this has not changed with version.14.5 In the original ANSYS Workbench, the user interacted with the analysis as a whole using The platform's project page: launching the various applications and tracking the resulting files employed in the process of creating an analysis.

Simulations Is Done On Two Different Bike Suspensions Springs

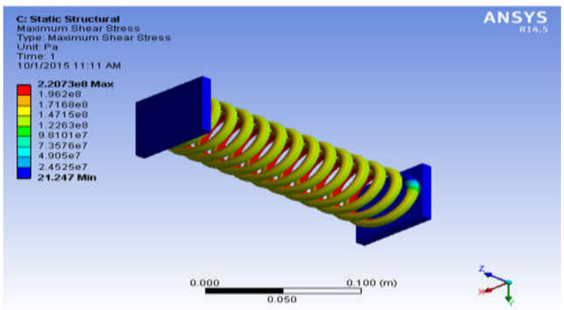
- Splendor Bike
- Yamaha Bike

Simulations On Splendor Bike Suspension System

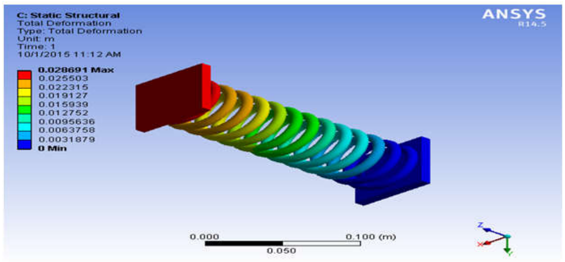
Material – Alloy Steel

Load – 700N

Maximum Shear Stress



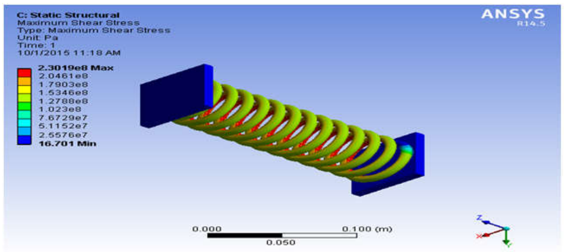
Total deformation



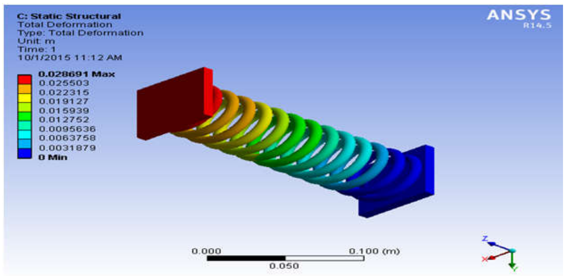
Material – Chromium Vanadium Steel

Load – 700N

Maximum Shear Stress



Total deformation:

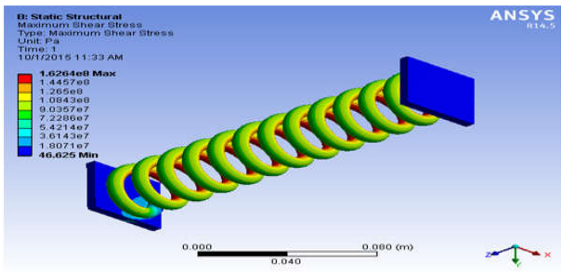


Simulations On Yamaha Bike Suspension System

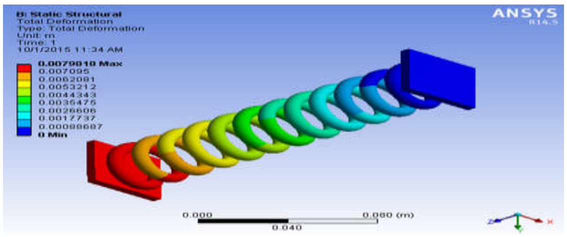
Material – Alloy Steel

Load – 700n

Maximum Shear Stress



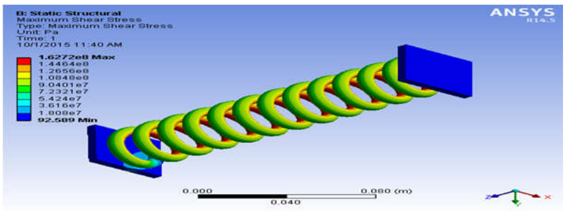
Total deformation



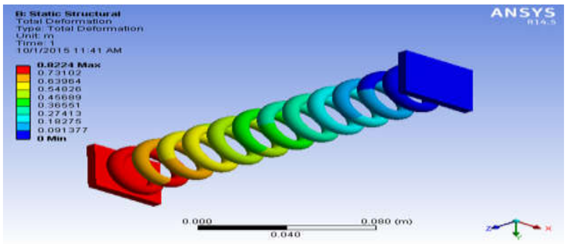
Material – Chromium Vanadium Steel

Load – 700n

Maximum Shear Stress



Total deformation



Results table:

For splendor bike

material	Max shear stress	Total deformation
Alloy steel	2.2073e8	0.0206698
Chromium vanadium steel	2.3019e8	0.029691

For Yamaha

material	Max shear stress	Total deformation
Alloy steel	1.6265e8	0.0079810
Chromium vanadium steel	1.6272	0.0224

Conclusion:

- Modeling and analysis of suspension spring is done
- Modeling of suspension spring is done in solid works by using various commands
- Suspension spring for splendor and Yamaha with various dimensions is done.
- Thus the geometry is saved to igs files to import in ansys work bench
- Structural analysis is carried out in ansys workbench with two different materials alloy and chromium vanadium steel at load 700n
- Maximum shear stress and total deformation are noted
- From the analysis results we can conclude that alloy steel is showing best results in two vehicles (among two for Yamaha alloy steel got the least stress)
- Thus alloy steel is preferable compared to chromium vanadium steel.

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