DESIGN AND ANALYSIS OF SPRING SUSPENSION SYSTEM

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Abstract:
In vehicles problem happens while driving on bumping road condition. The objective of this project is to design and analyze the performance of Shock absorber by varying the wire diameter of the coil spring. The Shock absorber which is one of the Suspension systems is designed mechanically to handle shock impulse and dissipate kinetic energy. It reduces the amplitude of disturbances leading to increase in comfort and improved ride quality. The spring is compressed quickly when the wheel strikes the bump. The compressed spring rebound to its normal dimension or normal loaded length which causes the body to be lifted. The spring goes down below its normal height when the weight of the vehicle pushes the spring down. This, in turn, causes the spring to rebound again. The spring bouncing process occurs over and over every less each time, until the up-and-down movement finally stops. The vehicle handling becomes very difficult and leads to uncomfortable ride when bouncing is allowed uncontrolled. Hence, the designing of spring in a suspension system is very crucial. In modeling the time is spent in drawing the coil spring model and the front suspension system, where risk involved in design and manufacturing process can be easily minimized. So the modeling of the coil spring is made by using SOLID WORKS. Later the model is imported to ANSYS for the analysis work.

Introduction
The suspension system is the main part of the vehicle, where the shock absorber is designed mechanically to handle shock impulse 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. Hysteresis is the tendency for otherwise elastic materials to rebound with less force than was required to deform them. Hence, the designing of suspension system is very crucial. In modeling the time is spent in drawing the coil spring model and the front suspension system, where risk involved in design and manufacturing process can be easily minimized. So the modeling of the coil spring is made by using SOLID WORKS. Later the model is imported to ANSYS for the analysis work.

Spring Suspension System
Explanation

Front suspension

Motorcycle's suspension serves a dual purpose: contributing to the vehicle's handling and braking, and providing safety and comfort by keeping the vehicle's passengers comfortably isolated from road noise, bumps and vibrations. The typical motorcycle has a pair of fork tubes for the front suspension. The most common form of front suspension for a modern motorcycle is the telescopic fork. Maintain balance of vehicle frames stability and secures straight running stability as well as rotationality of the vehicles. The front fork prevents excessive weight on the front wheel during drastic sudden applications the break, softens bumping when driving on rough road surfaces. The front fork maintains proper damping through traction with the road surface.

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.

Types Of Shock Absorbers

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 steel springs, 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.

Shock Absorber types

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
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.

**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. The load is decelerated with the lowest possible force in the shortest possible time eliminating damaging force peaks and shock damage to machines and equipment. These type of shock absorbers are provided with springs sufficient to return the actuator to its initial position after the impacting load is removed.

**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 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.

**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 = 8 mm,
- total length=208mm
- spring length=192mm
- no. of turns= 13

**For Yamaha**

- coil diameter = 8 mm,
- total length=192mm
- spring length=182mm
- no. of turns= 12

**For Tvs Motor**

- coil diameter = 8 mm,
- total length=210mm
- spring length=198mm
- no. of turns= 10

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.
Theoretical calculations of spring

At LOAD=800 N

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

Whall’s Stress Factor \( (K) = \frac{4e-1}{4e-4} + \frac{0.615}{c} \)

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

\( (K) = 1.3105 \)

Maximum Shear Stress \( (\tau) = \frac{KX0WD}{\pi d^3} \)

\[ = \frac{1.3105 \times 8 \times 800 \times 10}{\pi \times (8)^3} \]

\( (\tau) = 208.57255 \text{ MPa} \)

Deflection of Spring \( (d') = \frac{8WCr^4}{6d} \)

\[ = \frac{8 \times 800 \times (5)^3 \times 2}{87500 \times 8} \]

\( (d') = 13.714 \text{ mm} \)

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 Solidworks Simulation:

SolidWorks® Simulation is a design analysis system fully integrated with SolidWorks. SolidWorks Simulation provides simulation solutions for linear and nonlinear static, frequency, buckling, thermal, fatigue, pressure vessel, drop test, linear and nonlinear dynamic, and optimization analyses.

Simulations Is Done On Three Different Bike Suspensions Springs

- Splender Bike
- TVS Victor Bike
- Yamaha Bike

Simulations On Splender 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 Tvs Victor 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

Results table:

<table>
<thead>
<tr>
<th>Material</th>
<th>Max shear stress</th>
<th>Max principle stress</th>
<th>Normal stress</th>
<th>strain</th>
<th>Max Principle strain</th>
<th>Normal strain</th>
<th>Total deform</th>
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</thead>
<tbody>
<tr>
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TVs victor

<table>
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<tr>
<th>Material</th>
<th>Max shear stress</th>
<th>Max principle stress</th>
<th>Normal stress</th>
<th>strain</th>
<th>Max Principle strain</th>
<th>Normal strain</th>
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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, TVs 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, max principle stress, normal stress, strain, max principle strain, normal strain total deformation are noted
- From the analysis results we can conclude that alloy steel is showing best results in three vehicles (among three for Yamaha alloy steel got the least stress)
- Thus alloy steel is preferable compared to chromium vanadium steel.

References