

# Design and Fabrication of Pneumatic Suspension System in Two Wheeler

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**ABSTRACT:** The suspension system plays a major role in every automobile to maintain comfort, vehicle position and ride quality. The commercial vehicles nowadays use helical coil type suspension system in two wheelers. This type of suspension system provides only low solace to the riders. The replacement of coil type suspension with an air suspension system in two-wheeler will provide better solace and maintain the ride height and ride quality. Considering the suspension system, air suspension is way better than the coil type suspension system. So we are going to use air suspension system in our project for the two wheelers will provide better solace to the riders. By using the compressor, the compressed air is made to pass into the rubber tube which serves as a better suspension system.

**KEYWORDS:** Rubber tube, tapered sleeve, compressor, solace, ride quality.

## I. INTRODUCTION

The automobiles are becoming the major demand for the people nowadays to travel from one place to another within short duration. Among the automobiles, two wheelers are becoming the demanding vehicles. So the innovations in two wheelers from olden days to present lot of innovations happened. But still now the only thing that stays back in that innovation is suspension system. Suspension system is the major part in an automobile to maintain ride quality and comfort. Suspension system nowadays uses helical coil spring type suspension which doesn't provide a good ride quality and comfort to the passengers.

So to avoid these difficulties from the former type of suspension, air suspension will provide better ride quality, comfort and solace. Air suspension uses rubber type of material that is completely closed and filled by compressed air from the compressor to the rubber tube of particular pressure. This compressed air can withstand the load of the passengers and other load and provides a good ride quality to them.

It is properly designed and manufactured without any air leakage. This suspension system will provide better ride quality, comfort, solace and better suspension when compared with the conventional systems.

## II. LITERATURE SURVEY

<sup>[1]</sup>In the paper, “**MONO AIR SUSPENSION FABRICATION IN TWO WHEELERS**” by *Pranav Badole* describes the usage of bellow tube air suspension will provide better ride quality and solace to the riders and the passengers. In this project, mounting of on-board compressor and off-board compressor to the mudguard of the rear wheel. By using off-board compressor, inflation of bellow tube is done. Another valve is used for pressure relief during compression. This will increase the solace for the riders.

<sup>[2]</sup>In the journal, “**DESIGN AND ANALYSIS OF A SHOCK ABSORBER**” by *Poorna Mohan* designed a 150cc bike shock absorber in pro-E and made structural and modal analysis in ANSYS for two different spring material spring steel and beryllium copper. By analysing the result beryllium copper is better than the spring steel.

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<sup>[3]</sup>In the paperwork of *G. R. Chavhan*, “ANALYSIS OF SHOCK ABSORBER USING DIFFERENT MATERIAL OF SPRING” describes the usage of different spring material like carbon fiber, beryllium copper and steel spring in the shock absorber to calculate the better spring material for the vehicle. They made an analysis of deflection and stress in CATIA and verified that carbon fiber (5.6mm&2.7GPa) is better than beryllium copper (4.2mm&2.9GPa) and steel spring (2.3mm&3GPa).

<sup>[4]</sup>In “MAGNETIC SUSPENSION SYSTEM FOR TWO WHEELER” by *Shende Vignesh* explains it by using electromagnets as passive dampers to reduce displacement of sprung mass in order to increase ride comfort. It can absorb more shocks and vibrations to increase accuracy. It is done by two magnets of same pole facing each other when they come into contact the repulsion force makes the magnet to separate by repulsive force. Since it is using magnets there is no leakage of oil like hydraulic suspension and making it maintenance free. Since the magnet power can be rechargeable it can be used for longer duration.

<sup>[5]</sup>The journal “ANALYSIS OF SEMI-ACTIVE SUSPENSION SYSTEM WITH BINGHAM MODEL SUBJECTED TO RANDOM ROAD EXCITATION USING MATLAB/SIMULINK” by *Mr. Amit A. Hingane* describes the analysis result of semi-active suspension system with Bingham model for MR model. The ride and handling performance of a specific vehicle with semi-active suspension system is compared with passive suspension system. The simulation results shows that semi-active suspension system with Bingham model gives lower value of maximum sprung mass acceleration for given random road excitation. Hence suspension model with semi-active suspension provides good passenger comfort and vehicle stability than passive suspension system.

### III. SUSPENSION SYSTEM

Suspension system consists of tire, tire air, shock absorbers and linkages that connects a vehicle to its wheels and allows relative motion between them. This system serves in contributing vehicle's road handling and braking for good active safety and driving pleasure by giving comfort and ride quality to the vehicle occupants.

Shock absorbers are an integral part of a suspension system, it connects the vehicle to its wheels. These are also called dampers. The need for dampers arises because of the roll and pitches associated with vehicle motion, and from the roughness of roads. The rapidly increasing power available from the internal combustion engine made higher speeds routine; this, plus the technical aptitude of the vehicle and component designers, coupled with a general commercial mood favouring development and change, provided an environment that led to invention and innovation of shock absorbers. Shock absorbers are devices that smooth out an impulse experienced by a vehicle, and appropriately dissipate or absorb the kinetic energy. Shock absorbers have become such an essential component of an automobile even then there has been no particular method to test it using Finite Element Analysis technique and most of the testing is done using the physical tests.

### IV. COIL SPRING SHOCK ABSORBER

Coil spring shock absorbers are used nowadays in most of the commercial two wheelers. This type of shock absorber consists of spring steel helical coil and piston with hydraulic type. It is generally made by open coil helical spring for compression purpose. Hence it is known as compression coil spring suspension.



a. Coil spring shock absorber

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This helical coil spring suspension can absorb load as energy and return to its original shape by distributing it to the parts of the vehicle.

### **A. DESIGN CALCULATIONS FOR COIL SPRING SHOCK ABSORBER**

Material: Steel,

Modulus of Elasticity,  $G=0.8 \times 10^5 \text{ N/mm}^2$ ,

Wire Diameter,  $d=7\text{mm}$ ,

Outer Diameter,  $D_0=45\text{mm}$ ,

Inner Diameter,  $D_i=31\text{mm}$ ,

Mean Diameter,  $D=38\text{mm}$ ,

Pitch of the Coil,  $p=20\text{mm}$ ,

Spring type: Helical Coil Spring with squared and ground ends.

Spring Index,  $C=5.4$ ,

Weight of the bike,  $w_1=150\text{Kg}$ ,

One person weight,  $w_2=80\text{Kg}$ ,

Total weight,  $W=(150+80)= 230\text{Kg}$ ,

Rear Suspension will have 65% of total weight,  $W=0.65 \times 230$

$W=150\text{kg}$ ,

Considering dynamic load, the load will be doubled

$$W=150 \times 2$$

$$W=300\text{kg}$$

$$P=300 \times 10$$

$$P=3000\text{N}$$

For single shock absorber,

$$P=1500\text{N}.$$

Compression of spring,  $\delta = \frac{8PD^3n}{Gd^4}$

$$\delta = \frac{8 \times 1500 \times 38^3 \times 13}{0.8 \times 10^5 \times 7^4}$$

$$\delta = 44.56\text{mm}$$

Solid Length,  $L_s = dN + 2d$

$$L_s = 105\text{mm}$$

Free Length,  $L_f = pN + 2d$

$$L_f = 20 \times 13 + 2 \times 7$$

$$L_f = 274\text{mm}$$

Spring rate,  $K = \frac{P}{\delta}$

$$K = \frac{1500}{33.56}$$

$$K = 33.66\text{N/mm}$$

Stress in Helical Springs,

$$\tau = K_s \frac{8PD}{\pi d^3}$$

$$K_s = \frac{4C-1}{4C-4} + \frac{0.615}{C}$$

$$K_s = 1.17 + 0.114$$

$$K_s = 1.3$$

$$\tau = \frac{1.3 \times 8 \times 1500 \times 38}{\pi \times 7^3}$$

$$\tau = 550.13\text{N/mm}^2$$

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### V. AIR SPRING SHOCK ABSORBER

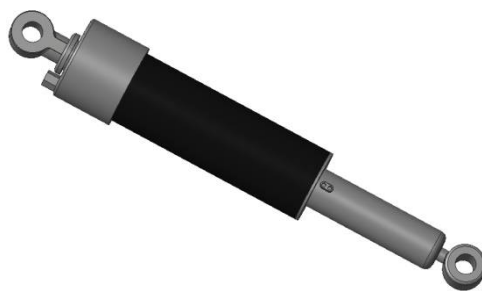
The air spring shock absorbers are used mostly in four wheelers and in heavy trucks. There are only three types of air suspension available. They are Bellow tube, rolling lobe and tapered sleeve. In this project, tapered sleeve is used as air spring in two wheeler. The air pressure inside the rubber material can hold the load of the two wheeler and the riders. The pressure inside the rubber tube in the air spring provides better suspension than the coil spring.



The rubber material used in tapered sleeve is flexible and return the load absorbed to the vehicle slowly which makes the suspension a better one when compared to conventional types.

#### A. DESIGN OF PNEUMATIC SUSPENSION IN TWO WHEELER

The design of pneumatic suspension system for two wheeler is done in the designing software called CREO. CREO is a designing and simulation software which helps to design a product or component in easy way. With the help of CREO, pneumatic suspension system in two wheeler is designed.



Since we are replacing the coil spring with air spring internal dimensions are taken similar to the coil spring. By replacement of that coil spring with air spring will provide better suspension to the riders.

#### B. CONSTRUCTION

1. To construct a tapered sleeve shock absorber in two wheeler, the coil shock absorber of the particular two wheeler is replaced with the rubber tube.
2. Initially the coil spring shock absorber is removed from the vehicle.
3. Then the coil is removed from the shock absorber.
4. The rubber tube made of butyl should be bent internally and to fit into the cylindrical iron piece placed and weld at the bottom of the shock absorber.
5. The top portion of the rubber tube is bent externally by fitting it to the cylindrical part.
6. After fitting the two ends of the rubber tube, the air tube is fitted to the compressor at one end and shock absorber to the other end.

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7. The compressor is connected to the 12V battery.
8. Now the shock absorber is fitted in the bike.

### C. WORKING

The 12V battery supplies the power to the compressor and the compressor compresses the air and sent it to the rubber tube. After reaching the particular pressure the compressor is switched off by disconnecting from the battery. Now the load is applied to the shock absorber by riding the two wheeler for suspension test.

### D. DESIGN CALCULATIONS FOR AIR SPRING SHOCK ABSORBER

For design calculations of an air spring dynamic spring rate formula should be calculated.

Material: Butyl

Dynamic Spring Rate,

$$K = \frac{\left\{ (P_g + 14.7) \left[ A_c \left( \frac{V_1^{1.38}}{V_c^{1.38}} \right) - A_e \left( \frac{V_1^{1.38}}{V_e^{1.38}} \right) \right] - 14.7(A_c - A_e) \right\} lbs}{1 \text{ inch}}$$

Where,

K=Vertical spring rate in lbs/inch

$P_g$ =Gauge pressure at design height (lbs/square.inch)

$A_c$ =Effective area at  $\frac{1}{2}$ inch below design height (square.inch)

$A_e$ =Effective area at  $\frac{1}{2}$ inch above design height (square.inch)

$V_1$ =Internal volume at design height (cubic.inch)

$V_c$ =Internal volume at  $\frac{1}{2}$  inch below design height (cubic.inch)

$V_e$ =Internal volume at  $\frac{1}{2}$  inch above design height (cubic.inch)

$P_g$ =40 psi

$A_c$ =28.3 Sq. inch

$A_e$ =12.6 Sq. inch

$V_1$ =141.5 cubic. inch

$V_c$ =84.9 cubic. inch

$V_e$ =166.7 cubic. inch

$$[54.7 \times (57.3 - 10.05) - 14.7 \times 15.7] lbs$$

$$K = \frac{\quad}{1 \text{ inch}}$$

K=2353.785 lbs/inch

**K=418.97 N/mm**

## VI. STATIC AND DYNAMIC METHODS OF DEFLECTION

### A. STATIC DEFLECTION

A static deflection is measured in static condition so that the load application comes to rest before the measurement is taken or the rate of deflection does not normally exceed 0.8mm/s (2 in/min). For example: coil spring and leaf spring.

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## **B. DYNAMIC DEFLECTION**

Dynamic deflection happens where we use the rubber material for suspension. Rubber is stiffer in dynamic state than in static state. By using rubber material in suspension system will provide better spring rate in static condition and it will get increased in dynamic condition but not greater than other type of suspension. So rubber material in air suspension will provide better solace to the riders.

## **VII. CONCLUSION**

By comparing the spring rate value and the type of deflection, air suspension will provide better solace than the coil suspension. So implementation of air suspension in two wheeler will provide better suspension to the two wheeler and increases the ride quality. By replacement of coil with rubber material the cost will not increase in huge rate. So it can be implemented in all type of conventional two wheelers without any fear of cost.

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