International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 6 Issue 7, November-December 2022 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Design and Performance Analysis of Hydraulic Cylinder Mounting Bracket

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ABSTRACT

Recent improvements in the water power business have transformed our ability to mechanise forms in the horticulture, development, and assembly domains. The study's main focus was on designing and manufacturing instructional equipment that would be utilised as a multi-purpose lifting device for motorcycle repair. The development is constructed with locally accessible resources, making it cost effective. In work study weight optimization, vibration analysis is considered as a major factor to design an optimized model for the existing design of hydraulic cylinder mounting bracket.

KEYWORDS: *Hydraulic, Motorcycle, Smooth ride, High level of comfort, Reduced jerk transfer*

How to cite this paper: Lakhan Gadge "Design and Performance Analysis of Hydraulic Cylinder Mounting Bracket" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-6 | Issue-7, December 2022, pp.653-656, URL: www.ijtsrd.com/papers/ijtsrd52406.pdf

IJTSRD52406

1. INTRODUCTION

Hydraulic cylinder is a part of a machine's hydraulic system. Simply said, hydraulic cylinder is a hydraulic actuator which creates linear movement by converting the hydraulic energy back to a mechanical movement [1-5]. Hydraulic cylinder can be compared to a muscle; with the machine's hydraulic system, it creates the movement – therefore it is like a muscle. Suspension systems, in the automotive application context, have been designed to maintain contact between a vehicle's tires and the road, and to isolate the frame of the vehicle from road disturbances. Dampers, or so-called shock absorbers, as the undeniable heart of suspension systems, reduce the effect of a sudden bump by smoothing out the shock. In most shock absorbers, the energy is converted into heat via viscous fluid. In hydraulic cylinders, the hydraulic fluid is heated up. In air cylinders, the hot air is emitted into the atmosphere. There are several common approaches for shock absorption, including material hysteresis, dry friction, fluid friction, compression of gas, and eddy currents.

During travelling on the normal motorbikes like Baja CT-100, Discover, Hero Spender and Honda Shine etc, the comfort level is not so good like in Royal Enfield, Honda Gold, Noton, Benelli, Hayabusa, Harley – Davidson, Triumph and Tork etc. because of one of the reason that from safety and comfort point of view available suspension system in the normal bikes is not up to the mark. The suspension perceives as most comfortable when the natural frequency is in the range of 60 to 90 cycles per minute (CPM), or it will be about 1 to 1.5 Hz [11-15]. When this frequency of suspension approaches to 120 CPM (i.e. 1.5 – 2.0 Hz), occupants perceives the harsh ride. A high performance sports motorbike is having stiffer suspension system with the natural frequency of about 120 – 150 CPM (i.e. 2 Hz – 2.5 Hz). So the suspension system available in the normal bikes will have to be redesigned for the achievement of the comfortable ride as per the standard range of comfort frequency of suspension i.e. 0.5 Hz to 1.5 Hz.

2. PROBLEM IDENTIFICATION AND SOLUTION

Passengers purchasing motorcycles in the light commercial vehicle range do not receive the same level of comfort as the amount paid, because the comfort range cannot be divided only in terms of money spent. As a result, it is critical for engineering students to focus on improving India's living and transportation conditions. The same fact motivates me to develop something with the same goal, which might be accomplished by creating a new type of suspension system.

The goal of this work is simply to improve the level of comfort for the average person travelling in light bikes or other modes of transportation (three wheeler passenger vehicles) that do not provide the same level of comfort and safety as the luxurious bike ranges such as Harley-Davidson, Kawasaki, BMW, Norton, Royal Enfield, Hayabusa, Honda Gold, and Ducati.

3. PREVIOUS WORK

The characteristics of hydropneumatic suspension have already attracted wide research attention in wheeled vehicles. To obtain maximum comfortable ride, the performance analysis of a shock absorber spring by varying stiffness can be done by optimizing on Pro-E and ANSYS, Dr. Dhananjay et al. [2]. On the basis of number of studies, researches and development of automotive suspension structures, models and features of various automotive suspension systems, cost, weight, reliability, ride comfort, cost, energy regeneration, commercial maturity and dynamics performance, the concept of suspension system suggested by Ansar Allauddin Mulla and Deepak Unaune et al. [3], provides the desirable results. An experiment performed by Ali M. Adb-El-Tawwab et al. [4] which reveals that an improved ride performance can be obtained by using active suspension system compared with passive suspension system. The article provided by L. KONIECZNY, R. BURDZIK, T. WEGRZYN et al [5], which reveals that the theoretical and experimental foundations which determines the parameters of gas spring with constant gas mass, provides good result.

4. DESIGNING PROCESS OF SUSPENSION

The most common springs used today in suspensions are the coil springs. The coil spring is nothing more than a steel bar that has been bent into a flexible coil. The shock forces will be absorbed by the spring and recoiling back to its original spring height. Coil springs can be located between control arms, frame in most strut assemblies. Most coil springs fail due to constant overloading, excessive up and down movement or just a general breakdown due to metal fatigue. Based on the researches and studies of previous work in this system helical coil spring with preferred End conditions is square and ground ends with varying pitch made up of Oil Tempered Chrome Silicon material will be used with 250 mm total length. It's cold drawn and heat treated before fabrication used for shock loads and moderately elevated temperatures, with Tensile strength of 300 psi x 106, Poisson's Ratio 0.29, available commercially with name ASTM A 401.[16-18]

4.1. Damping oil, gas type properties

The Viscosity Index is very important in suspension oil. "The viscosity index (V. I.) of oil is a number that indicates the effect of temperature changes on the viscosity of the oil. A low V.I. signifies a relatively large change of viscosity with changes of temperature. In other words, at high temperatures the oil becomes extremely thin and at low temperature it becomes extremely thick. On the other hand, a high V. I. signifies relatively little change in viscosity over a wide temperature range." So specifically with regard to suspension, the greater the VI, the more consistent the damping will be over a large temp change. So as per the American Society of Testing and Materials (ASTM) oil referred for damping in the suspension is high performance synthetic fork oil extra heavy 20 WT with gravity (D-1298) 35.4 (As per American Petroleum Institute).

4.2. Designing Process of Hydraulic, Pneumatic Cylinder

An air cylinder must be oversized to move a load. As per standard design procedure it is considered that a 3" bore air cylinder will balance a 1000 pound load with 80 psi of air pressure. To move this load at a slow rate of speed, the cylinder must be oversized. The designer should remember that when calculating cylinder force on the return (pull) stroke, the rod area must be deducted from the piston area. When a double rod end cylinder is used, deduct for both directions of stroke when calculating the thrust force [17-19] .So based on the above statement we are calculating that:

Cylinder Area = $\pi \times r^2$
Cylinder Volume = Cylinder Area x Stroke
Pressure = F/A
Cylinder Volume Capacity (gallons of fluid) = A x L/ 231
(Where L = Length of Stroke)

Calculations for Hydraulic cylinder are as follows:
Applied Pressure

$P_{Oh} = F/A_h = 1350/(\pi \times dh^2/4)$

$P_{Oh} = 1350/(\pi \times 0.045^2/4)$

$P_{Oh} = 848.826$ kPa

Volume,

$Vh = \pi \times rh^2 \times hh = \pi \times 0.0225^2 \times 0.070$

$Vh = 1.1133 \times 10^{-05}\ m^3$

Mass,

$mh = \rho h \times Vh = 7000 \times 1.1133 \times 10^{-05}$

$mh = 0.07839$ Kg

Now Area of Piston,

$Aph = 2 \times \pi \times rph \times hph$

$Aph = 2 \times \pi \times 0.0225 \times 0.138 = 0.0195\ m^2$

Now Pressure of Oil inside the cylinder to sustain the load

$P = Poh + (\text{Mass of Piston} \times g) / \text{Area of Piston}$

$P = 848.826 + (0.07839 \times 9.81) / 0.0195$

$P = 888.243\ kPa = 8.882\ Bar = 0.88\ N/mm^2$

5. PERFORMANCE OF HYDRAULIC CYLINDER

In this section we perform the design parameters and analysis of hydraulic cylinder. During testing considering the internal pressure on the cylinder 8.8 bar. Model is treated as solid body having volumetric properties like Mass – 1.16 kg, Volume – 1.167 x 10-4 m^3, Density-7000 kg/m^3, Weight – 11.6 N. The table 1 shows the design parameters of hydraulic cylinder. The figure 1 shows the design of meshing of hydraulic cylinder, figure 2 shows the Von mises stress on hydraulic cylinder and equivalent strain on hydraulic cylinder design as shown in figure 3.

Table 1: Design parameters of Hydraulic Cylinder

Mesh Type	Solid Mesh
Solver type	FFE Plus
Mesher Used	Standard Mesh
Jacobian Points	4
Element Size	6.75 mm
Total Nodes	30227
Total Elements	19214

A. Meshing of Hydraulic Cylinder:

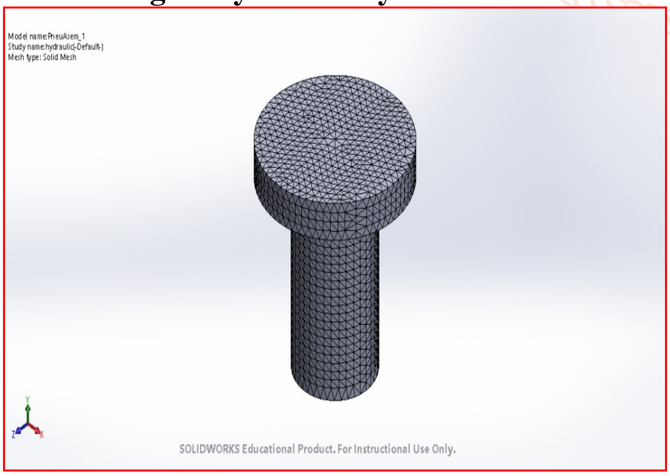

Figure 1: The meshing of Hydraulic Cylinder

B. Von Mises Stress on Hydraulic Cylinder:

Von Mises Stress maximum 785159 N/m^2 and nodes 26186.

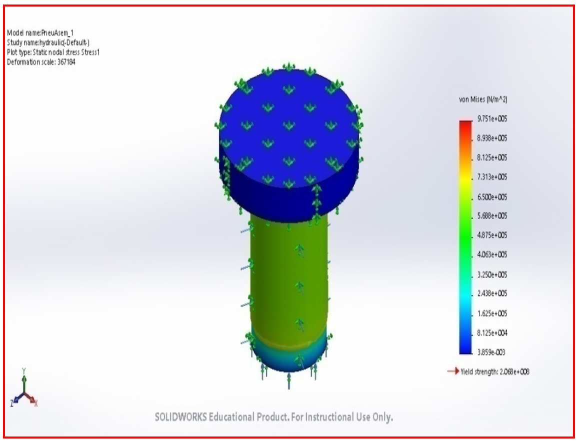

Figure 2: Von Mises Stress on Hydraulic Cylinder

C. Equivalent strain on Hydraulic Cylinder:

Equivalent Strain 2.7085e-012, element 11288.

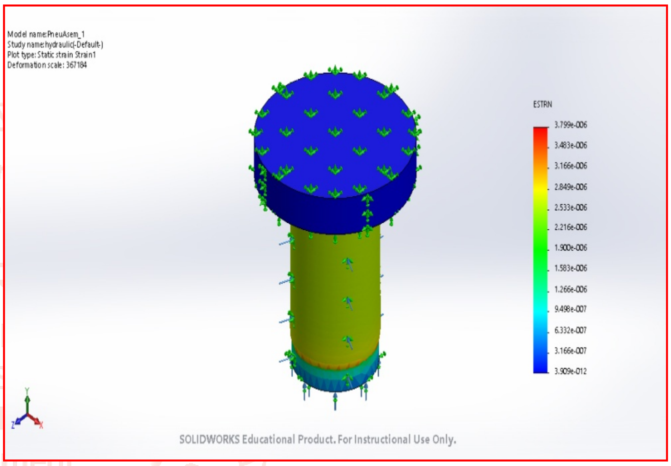

Figure 3: Equivalent strain on Hydraulic Cylinder

6. CONCLUSION

This paper has introduced the design of meshing on hydraulic cylinder, von-mises Stress on hydraulic cylinder and equivalent strain on hydraulic cylinder for system design for the tracked chassis of a road-rail vehicle. This work is to develop a new type of suspension system using Hydraulic Cylinder to provide higher level of comfort to the passengers those who are travelling in bikes with less effective suspension. That the proposed hydraulic Cylinder is very useful as well as affordable and as such, can be replicated in other SUCs and motorcycle repair shops.

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