International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 12 | Dec 2023 www.irjet.net p-ISSN: 2395-0072

Design and Fabrication of Inbuilt Hydraulic Jack for Four Wheelers

Piyush Nemade[1], Mayur Jadhav[2], Dr.Sachin Marjapure[3]

[1]Student IV semester B.E (Mechanical Engineering), D.Y.Patil College of Engineering,Akurdi,Pune-411044
[2]Student IV semester B.E(Mechanical Engineering), D.Y.Patil College of Engineering,Akurdi,Pune-411044
Associate Professor, Mechanical Department (Mechanical Engineering), D.Y.Patil College of Engineering, Akurdi, Pune-411044

Abstract - *Idea of "automatic inbuilt jack system in automobile (cars)" is to provide a novel jacking system attached to the chassis of the automobile itself. This inbuilt jack can be actuated from inside of the vehicle with the help of switches provided on the dash board. An Automobile inbuilt hydraulic jack can be easily operated by a single push button provided on the dash board. The jack will be installed on both the sides of chassis according to the weight distributions of the car. Similarly, it will be installed on the other side of the car. The jacks actuate separately for either side of car as per the breakdown condition. The car gets lifted and load gets distributed on three point i.e., plunger or ram of hydraulic cylinder and tires except which is being lifted.*

The motive behind using hydraulic system instead of a pneumatic system is the more power produced by the system and simple in design as compared to a pneumatic design. As the hydraulic oil is incompressible so the lifting capacity is more in comparison with the pneumatic system which operates on air which is compressible.

Key Words: **Hydraulic Jack or Cylinder, Linear Actuator, Pneumatic Pipes and Connector, Battery, Switch, Hydraulic Oil.**

1.INTRODUCTION

Our survey of various vehicle users found that the majority of tough methods were used in lifting the automobiles for reconditioning. Now, the project is primarily focused on overcoming this challenge, so that the vehicles can be uplifted from the floor land even without use of any impact force. The motorized screw jack was made for the benefit of small and medium-sized vehicle garages, which are typically man-powered and need little expert labour. In most garages, vehicles are lifted with a screw jack. This necessitates a large number of people and competent labour.

To eliminate all of these drawbacks, the built in jack should be designed in such a way that it can be utilized to lift the vehicle very smoothly without any impact force. The operation is made simple so that even unskilled labour can use it with ease. As the vehicle business expands, new concepts are being introduced to make cars more versatile and pleasant. Many concepts are being introduced on a daily basis to improve automobiles.

2. LITERATURE SURVEY

In their case study on Integrated Automated Jacks for 4-wheelers, P.S. Rana, P.H. Belge, N.A. Nagare and C.A. Padwad determined that an automobile hydraulic jack may be quickly operated by a single push button located on the dashboard. The jack will be fitted on both sides of the chassis in accordance with the weight distribution of the vehicle. Similarly, it will be fitted on the opposite side of the vehicle. The system is powered by hydraulics, which comprises of three major components: a hydraulic pump powered by an electric motor, a hydraulic cylinder to elevate the vehicle, and a hydraulic cylinder to lower the vehicle. According to the breakdown state, the hydraulic jacks actuate separately on either side of the car. The car is elevated, and the load is distributed on three points, namely the plunger or ram.

In DESIGN AND FABRICATION OF AUTOMATIC PNEUMATIC JACK FOR FOUR WHEELER, Professor. Mali P.K., Dept. of Mechanical, SGREF's G H Raisoni College of Engineering, Ahmednagar stated that fabrication is based on pneumatic, which deals with the study and application of pressurized air to produce mechanical motion. An air‐powered jack is a manufactured device that, when put in a four-wheeler, will alleviate the problems associated with conventionally operated jacks.

This type is made up of a small size piston air compressor that is powered by the four-wheeler's battery, an air tank to hold the compressed air, a pneumatic control valve that regulates the airflow, and a double-acting cylinder utilized as a jack that performs lifting. As a result, the car is lifted. using a jack and the problem related to tires such as puncture tires, tire replacement, and wheel balancing can be resolved with less effort and time.

3. PROBLEM STATEMENT

In everyday life, manually operating the jack is a highly laborious and time-consuming task. So, to make life easy for everyone, especially the elderly and female drivers. To develop a safe and simple automatic hydraulic jacking system that does not require physical labour. To develop a unique jacking mechanism that can be controlled from within the car using a display control panel. There are already technologies available for the same purpose, such as a screw jack, that have a definite ability to lift the automobile

on two wheels. However, the overall goal of the research is to reduce the amount of human labour required to operate the jack. to develop a new hydraulic jacking system that is directly and permanently incorporated into the vehicle frame in such a way as to prevent the additional risk of damage or weathering.

4. METHODOLOGY

The method used here is automatic which replaces manually operated screw jack. For the fabrication we use Mild Steel frame (1inch × 1inch) by using arc welding joining process on which all the parts are mounted. We casted two pulleys for power transmission from D.C motor to the vane pump. Attached the four nylon wheels to the frame by using two axels and axels supported by the four ball bearings. DC motor mounted one side on the frame by using fasteners and vane pump placed another side of the frame with the help of fasteners. Here we use two 2/2 solenoid valves for oil flow control these also mounted on the frame. Two MS plate box structures used for placing the oil reservoir and battery at front and back side of the frame. We made the sliding passage for the movement of the cylinder on the frame on which the cylinder slides with the help of DC motor the rotary motion of the DC motor is converted linear motion of slider. Here we use the switch for controlling the two solenoid valves separately. Hoses are used to connect the vane pump, oil reservoir, solenoid valves, and cylinder for the oil flow.

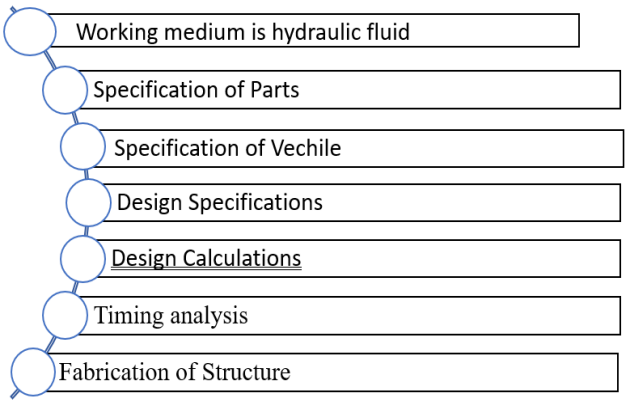

Table1: Methodology

5. MAIN COMPONENTS PRESENT IN PROTOTYPE

- Hydraulic Jack or Cylinder
- Wheels
- Frame
- D.C Motor
- Reservoir
- Pneumatic Pipes and Connector
- Battery
- Non-Return Valves

6. CALCULATIONS AND SPECIFICATIONS

Why Mild Steel C-45 is selected in our project.

- Easily available in all sections.
- Easy availability
- Machinability
- Cutting Ability
- Cheapest in all Metals

According to design data book:

Material = C 45 (mild steel)

Take FOS=2

$\sigma t = \sigma b = 540/FOS = 270$ N/mm2

$\sigma s = 0.5\ \sigma t$

$= 0.5 \times 270$

$\sigma s = 135$ N/mm2

- **Force generated by motor**

The linear actuator we will purchase will be of 150 lbs = 68 kg

L1 = 50 mm

L2 = 250 mm

F1 x L1 = F2 x L2

68 x 95 = F2 x 205

F2 = 6460/205

F2 = 31.5 kg = 309 N

P = force/area = 309/ 3.142 x 12.5^2 = 0.629 N/mm^2

By changing pivot point we can increase or decrease the speed of jack going up and down. Also weight carrying capacity can be changed.

- **Design of Cylinder Wall Thickness**

Name:	1060 Alloy
Model type:	Linear Elastic Isotropic
Default failure criterion:	Max von Mises Stress
Yield strength:	2.75742e+07 N/m^2
Tensile strength:	6.89356e+07 N/m^2
Elastic modulus:	6.9e+10 N/m^2
Poisson's ratio:	0.33
Mass density:	2,700 kg/m^3
Shear modulus:	2.7e+10 N/m^2
Thermal expansion coefficient:	2.4e-05 /Kelvin

Table 2: Aluminum cylinder material property

Based on theory of thin cylinders with modifications

$$\mathbf{t = (Pi\ x\ Di) \div ((2\ x\ \sigma t\ x\ \acute{\eta} t) - Pi)}$$

$$\mathbf{t = (0.629\ x\ 25) \div ((2\ x\ 68.9\ x\ 0.8) - 0.629)}$$

$$\mathbf{t = (15.75) \div (109.6)}$$

t = 0.14 mm

But we are using 2.5 mm thick wall, hence safe.

- **Design of Piston rod under bending**

M = WL = 309 × 100

= 30900 N-mm

Z= π/32 x d^3

Z= π/32 x 10^3

Z= 98.17 mm^3

σ_b (induced)= M/Z = 30900/98.17 = 314.74 N/mm^2

As induced bending stress is less then allowable bending stress i.e. 685 N/mm^2 for steel, design is safe.

- **Checking the failure of link under bending load**

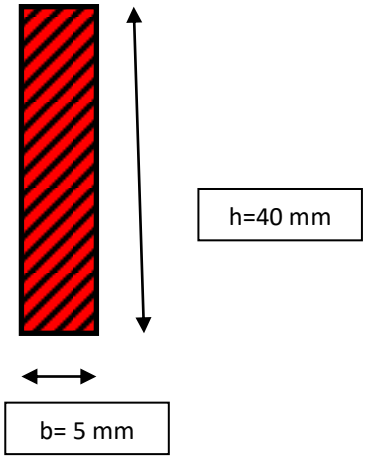

Figure 1: Mild Steel

F = maximum force applied = 680 N

For simply supported beam, M = F x L/4

M = 680 x 300 = 204000 N-mm

And section modulus = Z = 1/6 bh^2

Z = 1/6 x 5x40^2

Z = 1/6 x 80

Z = 1333.33 mm^3.

Now using the relation,

Fb = M / Z

Fb= 204000 / 1333.33 = 153 N/mm^2

Induced stress is less then allowable 260 N/mm^2 so design is safe

- **Design of bolt for sheer stress failure: -**

Bolt is to be fastened tightly also it will take load due to rotation. Stress for C-45 steel. Standard nominal diameter of bolt is 9.31 mm. From table in design data book, diameter corresponding to M10 bolt is 8 mm.

Figure 2: Nut bolt

Let us check how much load bolt can sustain -

P =? N is the value of force

Stress = load/area

$$\sigma = \frac{P}{A}$$

$$A = \frac{\pi}{4}d^2$$

$$A = \frac{\pi}{4}8^2 = 49.98$$

$$P = 135x49.984$$

P = 6747.84 N = 687 kg

The calculated load is much higher than any applied load, hence our design is safe.

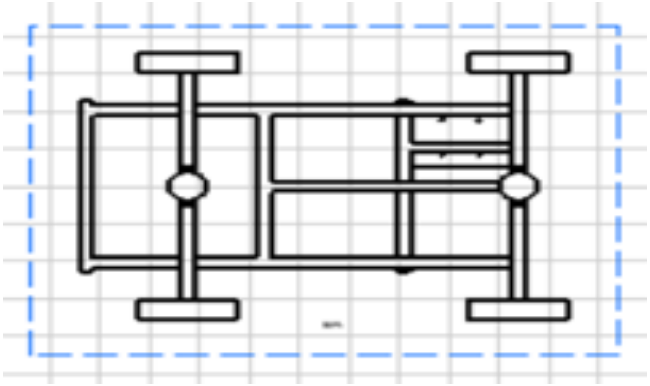

Figure 3: Schematic Layout

7. WORKING MECHANISM

Hydraulic jacks, as well as many other technological advances such as automotive brakes and dentist chairs, are based on Pascal's Principle. The principle basically implies that the pressure in a cylinder is the same at all places. Pressure is mathematically defined as Force divided by Area. Rearranging the pressure formula P = F/A to F = PA represents this. A hydraulic jack is simply two cylinders connected as previously mentioned. A pressured contained fluid applies that pressure throughout its volume and against any surface that contains it. This is known as 'Pascal's Principle.' With the assistance of motor power.

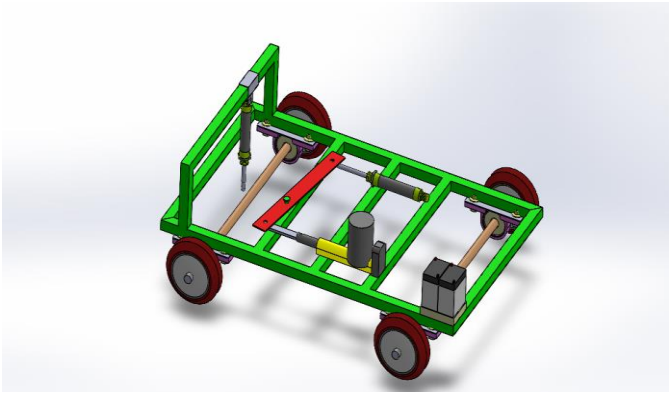

Figure 4: CAD Model

Inside a linear actuator is a number of different components, all of which work together to form the movements that are needed from the equipment. While electric screw actuators were specifically designed to have fewer moving parts, both to reduce the potential for breakdowns and maintenance, and also to make the actuators lighter and easier to use, there are many parts that are integral to its overall functioning.

Motor – the motor is what makes the motion possible, and what interacts with the other parts of an electric linear actuator. The most common type of motor is a 12v DC motor, but for stronger or weaker actuators, this can be switched to a different format. The motor provides the movement. The motor is also subject to what is called the duty cycle of the actuator, the length of time it can operate before needing to rest.

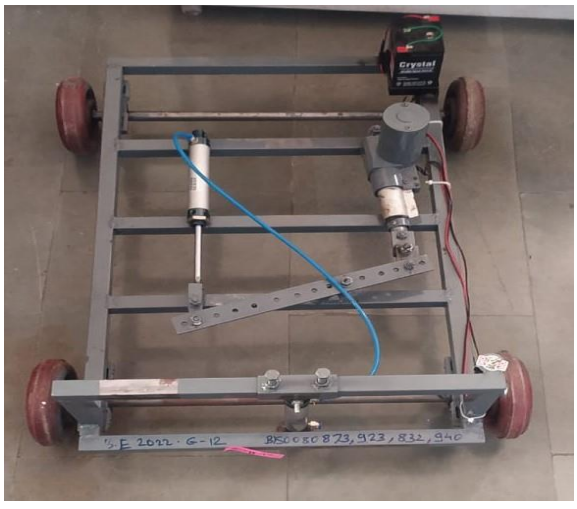

Figure 4(a): Assembled Prototype Model

Figure 4(b): Assembled Prototype Model

8. COSTING AND ANALYSIS

Cost estimation is done as under

(A)Material Cost

Sr No	Component	Quantity	Cost
1.	Hydraulic Cylinder	2	1500/-
2.	Linear Actuator	1	2000/-
3.	Battery	2	900/-
4.	Frame	-	1200/-
5.	Pneumatic Pipe and Connector	-	300/-
6.	Miscellaneous	-	2500/-
		Total	8400/-

Table 3: Raw Material Cost Analysis

(B)INDIRECT COST

INDIRECT COST

Transportation cost = 500/-

Coolant & lubricant = 350/-

Drawing cost = 500/-

Project report cost = 2000/-

Total Indirect Cost =3350/-

Total Cost of Project= Raw Material Cost + Indirect Cost

=8400+3350

=11750/-

9. CONCLUSIONS

The developed inbuilt hydraulic jack for four wheelers will help the ladies and old age people during the vehicle beak down. In future we expect this product to have a wide scope for development and improvement. The parts obtained for this project can be obtained through a large scale in the future, hence bringing down the overall costs. We anticipate that there will be a lot of room for improvement and development in the future for this product. The components used for this project can be obtained in the future on a big scale, lowering overall prices.

The inbuilt hydraulic jack system is designed and developed for small vehicles, but it can be utilized in future for heavy vehicles by making some small modification of the project. In our project we have the cylinder arranged vertically. In the future, we can have the cylinder both in the vertical and horizontal direction with the help of dc motor. Motor operated mechanical jacks are already in the market but the jack's design is the area of concern. In order to make built-in jack system practical, jack's shape and type need modification.

In our project we have used dc motor as a power source instead we can go with the rotating element of the vehicle which will not only be the power source but also will reduce the cost. This jack needs an initial investment which will give benefits in the long run to the driver by simplifying his job during the time of puncture and breakdown. After successful implementation of this idea in passenger cars, future developments can be made in design to apply the same in heavy duty automobiles also.

10.REFERENCES

[1] Mueller, Pamela, and Thomas L. Mueller. "Built In Power Jack." U.S. Patent Number 4,993,688, 1991

[2] Improving hydraulic system en –ergy efficiency by hydraulic fluid Lindon K Lee.

[3] T.Varun Kumar, S.Balaji, K.Mohan Babu and K.Hari Gautham (2015), Performance of Magnetic Fel Induction Technology to Reduce the Exhaust Emission, ARPN Journal of Enguineering and Applied Sciences, ISSN 1819-6608, Vol. 10, No 14 (2015), 6172- 6176.

[4] P.S. Rana, P.H. Belge, N.A. Nagrare, C.A. Padwad1, P.R. Daga, K.B. Deshbhratar N.K. Mandavgade. (2012), Integrated Automated Jacks for 4 wheelers, European Journal of Applied Engineering and Scientific Research, 1 (4):167-172.

[5] S. Akinwonmi and A. Mohammed. (2012), Modification of the Existing Design of a Car Jack, Journal of Emerging Trends in Engineering and Applied Sciences, 3 (4), 581-588.

[6]Parr, Andrew. Hydraulics and Pneumatics: A Technician's and Engineer's Guide. 1st Edition. Oxford: Butterworth-Heinemann, 1999.

[7] Patel, P. M., Patel, P. S., Shah, V. H., & Shah, S. R. (2016). Automatic Hydraulic Jack Inbuilt in a Four Wheeler. International Journal of Scientific & Technology Research, 5(8), 156-158.

[8] Prashant Kumar Srivastav, Vipin Kumar Pandey, Shailesh Kumar Maurya, Ajit Tiwari, Jawed Rafiq and S.K. Dwivedi. (2013), Highly Efficient Motorized Screw Jack, International Journal of Computational Engineering Research, 3(5), 35-41.