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Design and Manufacturing of Automatic Screw Jack Stepney for Automobiles Car

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Abstract- As the technology is growing so rapidly, the efforts required to do any work is going on decreasing day by day. By implementation of better design the efforts which are required to achieve the desired output can be effectively and economically be decreased. A person an lift heavy load for certain limit of weight, so in this case to lift the overweight screw jack is needed. It becomes more convenient to use when it is motorised. In order to implement this idea, we have designed and developed a system called automatic screw jack stepney. In this system we have used IR (Infrared sensor) and screw jack with small wheel attached to the vehicle axel.

Keywords- Battery , DC Motor, Gear Drive ,Lead Screw, Screw Jack.

I. INTRODUCTION

When we travel in four-wheeler and if there is puncture in tyre, then problems are face by the user like cannot reach in proper time at the destination and to change the punctured tyre or Stepney. We cannot control and manage the vehicle in puncture situation burst leads to stop the further movement of the car. Our research survey in this regard revealed that in several automobile garages, revealed the facts that mostly some difficult methods were adopted in lifting the vehicles for repair and maintenance. This fabricated model has mainly concentrated on this difficulty. There are mainly two types of jacks- Hydraulic jacks and Mechanical jacks. A Hydraulic jack consists of a cylinder and piston mechanism. The movement of the piston rod is used to raise or lower the load. Mechanical jacks are either hand operated or power driven. The main parts of mechanical screw jack (cylindrical) jack are Body, Screw, Nut and Thrust Bearings. In this type of a jack, the nut remains stationary while the screw rotates and helps in lifting or lowering the load. A screw jack is a portable device consisting of a screw mechanism used to raise or lower the load. The principle on which the screw jack works is similar to that of an inclined plane. Jacks are used frequently in raising cars so that a tire can be changed. A screw jack is commonly used with cars but is also used in many other ways, including industrial machinery and even airplanes. They can be short, tall, fat, or thin depending on the amount of pressure they will be under and the space that they need to fit into. The jack is made out of various types of metal, but the screw itself is generally made out of lead. Some screw jacks are built with anti-backlash. The anti-backlash device moderates the axial backlash in the lifting screw and nut assembly to a regulated minimum.

II. PROBLEM DEFINITION

Most of the time while travelling problems like leakage of air through tire or puncture of tire occurs. When we are travelling by four-wheeler or more wheeler vehicles and if suddenly the tire gets flat i.e. (puncture), then at that time problems faced by the user like they cannot reach in proper time at their destination & also main problem is it can cause accident. Then at that time we use manual screw jack to lift the car. This process is time consuming and if person don’t know that how to change stepeny then it might be a big problem.

III. OBJECTIVES

The main objectives of this project are

- To study the working of motorized screw jack mechanism.
- Develop the model of the automatic screw jack stepney.
- Designing of effective mechanism for LMV.

IV.MATERIAL and CONSTRUCTION

A. Lead Screw

The lead screw used as a linkage in a machine to turning motion into linear motion. The size and shape (i.e. short, tall, fat & thin) of lead screw depends on the load under they work and space in which they need to fit. Due to sliding contact of the lead screw, a large amount of heat is generated.

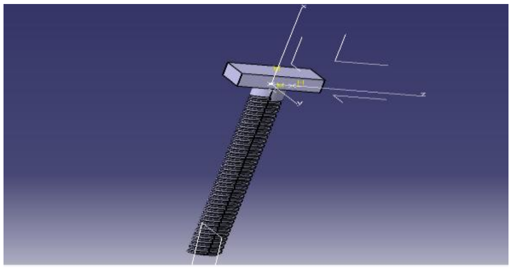

Fig.1. Lead Screw

B. DC Motor

This machine is used to converts electrical energy into mechanical energy. It works on the principle of electromagnetic induction i.e. when current carrying conductor placed in a magnetic field it experiences a magnetic force whose direction is given by Flaming right-hand rule.

C. Control Switch

This is the switch used to operate the DC motor by which the entire operation of the jack is to be controlled. The commonly used switch is Toggle Switch.

D. IR Sensor

An infrared sensor is an electronic instrument that is used to sense certain characteristics of its surroundings. It does this by either emitting or detecting infrared radiation. Infrared sensors are also capable of measuring the heat being emitted by an object and detecting motion.

Fig.2. IR Sensor

F. Base and frame

It is a rigid construction on which all the parts are assembled.

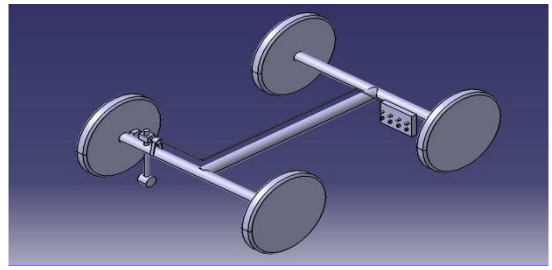

Fig.3. Full Assembly

G. Wheels

There is one small wheel with lead screw attached to motor which is placed to each front and rear wheel of the car. In that first IR (infrared sensor) sense the level of the tire then as per level, motor rotate and small wheel goes down and maintain the level of the vehicle.

V. DESIGN and CALCULATION.

For Lifting Mechanism.

We considering the weight of object is 70 kg.

Total weight = weight of object + weight of Car

=70+180

=250 kg

Mass carrying (m) = 250 Kg

Length of screw = 250 mm

Factor of safety (FOS) = 3

Total Load (W) = Mass (m) × Acceleration due to gravity (g)

= 250×9.81

= 2450 N

1. Material = (Mild steel)

Material properties,

S_{yt}=400 Mpa

E=210Gpa

2. Permissible compressive stress (σ_c)-

$$\sigma_{c}=\frac{Syt}{FS}$$

$$=\frac{400}{3}$$

=133.33 (N/mm^2)

2. Permissible compressive stress (σ_c)-

$$\sigma_c = \frac{Syt}{FS}$$

$$\sigma_c=\frac{W}{\frac{\pi}{4}\times d_c{}^2}$$

$$=\frac{400}{3}$$

=133.33 (N/mm2)

3. Core Diameter of Screw (dc)

$$\sigma_c = \frac{W}{\frac{\pi}{4} \times {d_c}^2}$$

$$133.33 = \frac{2450}{\frac{\pi}{4} \times {d_c}^2}$$

$$d_c = 4.836 \text{ mm}$$

Basic dimensions for square threads are in mm

There are additional stresses due to torsional and bending moments. The diameter should be increased to account for these stresses. As a square threaded screw with 22 mm nominal diameter and 5 mm pitch is selected.

We know, d= 22 mm, p= 5 mm

4. Core Diameter of Screw (d_c)

$$d_c = (d - p) = 22 - 5 = 17 \text{ mm}$$

5. Mean Diameter of Screw (d_m)

$$d_m = d - p/2 = 22 - 5/2 = 19.5 \text{ mm}$$

It is assumed that the screw has single start threads. l = p = 5 mm

6. Helix Angle (α)

$$\tan \alpha = \frac{np}{\pi dm}$$

$$\alpha = \tan^{-1} \frac{1 \times 5}{\pi(19.5)}$$

$$\alpha = 4.666^\circ$$

7. Friction Angle (Ø)

The possible value of the coefficient of friction between screw and nut is 0.35

$$\tan Ø = \mu = 0.35$$

$$Ø = 19.29^\circ$$

Since Ø > α screw is self- locking.

8. Torque required to lifting & lowering the load

$$M_t = \frac{W d_m}{2} \times \tan(Ø \pm \alpha)$$

For Lifting –

$$M_t = \frac{(2450 \times 19.5)}{2} \times \tan(19.29 + 4.666)$$

$$M_t = 10613.43 \text{ Nmm}$$

For lowering –

$$M_t = \frac{(2450 \times 19.5)}{2} \times \tan(19.29 - 4.666)$$

$$M_t = 6232.91 \text{Nmm}$$

$$\tau = (16Mt)/ \pi (dc^3) = (16 \times 10613.43)/(\pi(17)^3) = 11 \text{ N/mm}^2$$

$$\sigma_c = W/[\pi/4 \times dc^2] = 2450/(\pi/4 \times (17)^2 = 10.79 \text{ N/(mm)}^2$$

Checking for Buckling Failure

- Moment of Inertia (I) –

$$I = \pi/64 \times dc^4 = \pi/64 \times (17)^4 = 4099.82 \text{ mm}^4$$

- Cross Sectional Area (A) –

$$A = \pi/4 \times dc^2 = \pi/4 \times (17)^2 = 226.98 \text{ mm}^2$$

- Radius of Gyration (K)

$$K = \sqrt{\frac{I}{A}} = \sqrt{\frac{4099.82}{226.98}} = 4.249 \text{ mm}$$

- Slenderness Ratio (l/k) –

$$(l/k) = 250/4.249$$

$$(l/k) = 58.83$$

Since one end of screw is fixed and another end is free, the end fixity coefficient (c) is 0.25. The borderline between the short and long column is given by,

$$\frac{S_{yt}}{2} = \frac{c\pi^2 E}{(\frac{l}{k})^2}$$

$$\frac{400}{2} = \frac{0.25 \times \pi^2 \times 210 \times 10^3}{(\frac{l}{k})^2}$$

(l/k) c = 50.89

The critical slenderness ratio is 50.89. The slenderness ratio of screw (58.83) is greater than critical slenderness ratio (50.89). Therefore, the screw should be treated as long column and Euler's equation is applied.

- Critical load on buckling (W_{cr}) –

$$W_{cr} = \frac{C \times \pi^2 \times E \times A}{(\frac{l}{k})^2}$$

$$= \frac{0.25 \times \pi^2 \times 210 \times 10^3 \times 226.98}{(58.83)^2}$$

=33982.006 N

Factor of Safety for Buckling Failure –

FOS = W_{cr}/W

= 33982.006 /2450

=13.87

9. Selection of Motor –

- Required torque of motor (M_t) = 10613.42 N-mm

10613.42/(9.81 ×10) = 108.1 kg-cm

Required speed of motor shaft in rpm = 60 rpm

Torque required to raise maximum load in Kg-cm = (M_t)raise / (9.81 ×10)

We have to search market carefully then we find no motor available with this specification so we choose a motor with 100 rpm 100 Kg-cm torque motor.

Required speed of motor (N) = 60 rpm Type of supply to motor = 12 Volt D.C.

VI. CONCLUSIONS

The project carried out by us made an impressing task in the field of automobile industry. Our project basically reduces an effort which is required to replace the punctured stepney automatically simply by pressing the control switch which will be placed inside the vehicle.

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