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Design & Development of Automatic Lifting System in Automobile

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Abstract:

The project is designed to develop a automatic lifting system in automobile with a linear actuator. For example, it can safely lift a wheel very carefully to accident explosion while catching. The lifting system is electrical operated and very convenient to use.At the lifting the actuator travels to the desire wheel with the help of motor driver. The motor driver is consists of four dc motor and wheels connected to it which moves it to particular location. When the motor driver reaches it desire location actuator starts and lift the required wheel. The main advantage of this project is that it is easy to use and required less effort to change the wheels.

Keywords — **Chassis, Jack, Actuator, Assembly, motor driver.**

I. Introduction

Jack is a mechanical device used to lift heavy loads or apply great forces. A mechanical jack employs a square thread for lifting heavy equipment. The most common form is a car jack, floor jack or garage jack which lifts vehicles so that maintenance can be performed. Mechanical jacks are usually rated for a maximum lifting capacity (for example, 1.5 tons to 3 tons). More powerful jacks use hydraulic power to provide greater lift.

Available jacks present difficulties for the elderly people and women and are especially disadvantageous under adverse weather conditions. Presently available jacks further require the operator to remain in prolonged bent or squatting position to operate the jack which is not ergonomic to human body. It will give physical problems in course of time. Moreover, the safety features are also not enough for operator to operate the present jack.

Furthermore, available jacks are typically large, heavy and also difficult to store, transport, carry or move into the proper position under an automobile. The purpose of this project is to overcome these problems. An electric car jack which has a frame type of design by using electricity from the car will be developed. Operator only needs to press the button from the controller without working in a bent or squatting position for a long period of time to change the tire.

II. Components of Lifting System

2.1 Linear Actuator

A linear actuator is an actuator that creates motion in a straight line, in contrast to the circular motion of a conventional electric motor. Linear actuators are used in machine tools and industrial machinery, in computer peripherals such as disk drives and printers, in valves and dampers, and in many other places where linear motion is required. This is an electrically operated device which helps push or pull objects. These actuators can handle a lifting capacity of 200 – 12,000 Newton.

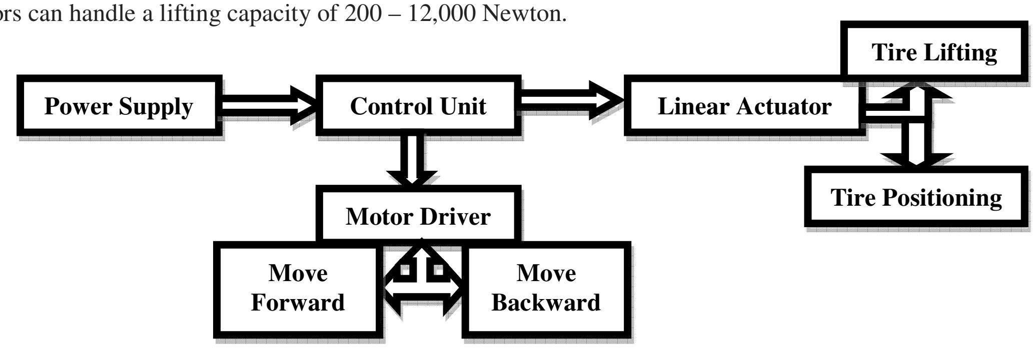


Fig.2.1.1 Block diagram of lifting system

Specifications:

- Dynamic push load- 6000N
- Dynamic pull load - 4000N
- Speed at full load - 3mm/s
- Stroke length - 100mm to 400mm

- Duty cycle - 10% max 2min_continuous use
- Limit switch - Built in
- Operating Temp. – +5°C to +40°

1.2 Material Selection

The selection of material was a tedious task for us as it had many constraints of weight, structural resilience towards various types of forces, torsional rigidity, factor of safety under application of various loads and also market availability with pricing and cost constraints.

Table No.1 Properties of Materials

PROPERTIES	AISI1018
Density (gm/cc)	7.87
Tensile Strength (Mpa)	440
Yield Strength (Mpa)	370
Modulus Of Elasticity (Gpa)	205
Shear Modulus (Gpa)	80
Poisson Ratio	0.29
Elongation in Break (50mm)	15%
Thermal Conductivity (W/mK)	51.9

III. Design Calculation of Chassis

Let,

For O.D. =26.5 mm and I.D = 21 mm, thickness 2.7 mm.

Mass of chassis =22.914 kg.

Volume =0.003 mm2

C.G. of chassis - Gx =24.308 mm, Gy = -910.497 mm, Gz =53.41mm

If consider

Chassis = 30 kg, Driver = 60 kg, Steering = 10 kg, Rear axle & brake = 30 kg, Engine = 30 kg, Fuel tank & battery =10 kg

Total weight=170 kg.

Now take total weight of vehicle=170 kg.

Front impact=170*4*9.81= 6670.80 N

RA +RB-6670.8=0

MA=0

-RB*381+6670.8*381/2=0

RB=3335.4 N

RA=3335.4 N

FBR = 0 N

FBL= 3335.4 N

FAR= 3335.4 - 6670.8 = -335.4N

FAL= 0 N

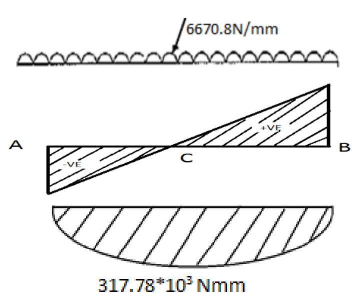


Fig.4.2 SFD & BMD Diagram

MC = 0

MC=-3335*381/2+17.5*381/2*381/4=0

MC = -635317. 5+317539.69

MC = -317.78*103N.mm

Now by taking σ yield and calculate,

σ_{Yeild} **=370 N/mm²**

σ_b = M *b* y / I
370 = (317.78*103 *13.25)/ (π/64[26.44-di4]
18.16 = 4.21*106/ (26.54-di4)
Di=22.61 mm
Thickness=26.5-22.6=3.89/2=1.92 mm
Check the design for dimensions of pipes available in market that are as follows…
Now for thickness =2.7mm and di=21.1mm, do=26.5 mm
σ_b=4.21*106/ (π/64*[26.54-21.14])
σ_b=4.21*106/ (14.48*10)
σ_b=290.75 N/mm^2
Working σ_b< σ_b yield FOS =370/290.75
Factor of safety =1.27.

Table No.2 Specification of Chassis

Sr. No.	CHASSIS MATERIAL	SPECIFICATIONS
1	Type (Seam or Seamless) & Grade	Seamless
2	OD (outer diameter)	26.5mm
3	Wall Thickness	2.7mm
4	Cross Section	Circular
5	Material Testing Certificate (Yes/No)	Yes

TABLE NO.3 Vehicle Dimensions

SR. NO.	VEHICLE DIMENSIONS	MEASUREMENT
1	Max width of vehicle with wheels pointing forward direction	51 inches
2	Length of vehicle (front to rear bumper max extended length)	70 inches
3	Wheel base (42 inches to 56 inches)	43 inches
4	Wheel track (At least 75% of minimum wheel base)	33inches
6	Ground Clearance (Minimum 1 inch)	2 inches

IV. Design And Analysis of System

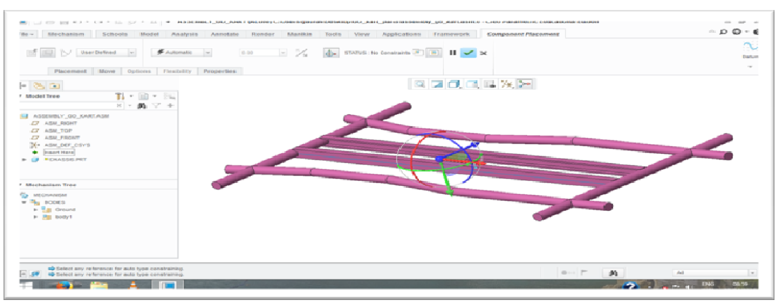


Fig.4.1 Chassis

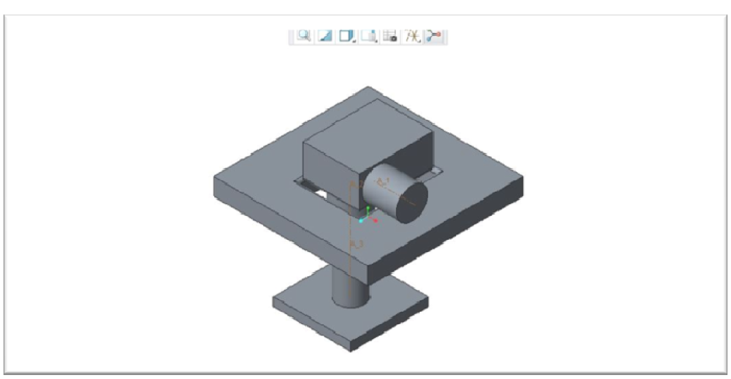


Fig.4.2 Motor driver with actuator

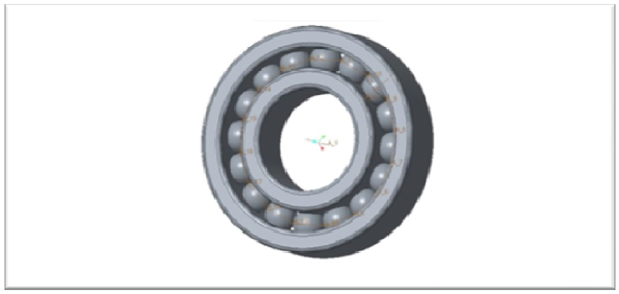


Fig.4.3 Ball Bearing

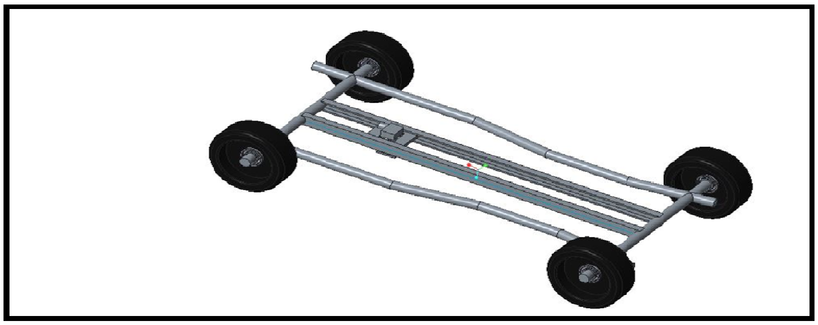
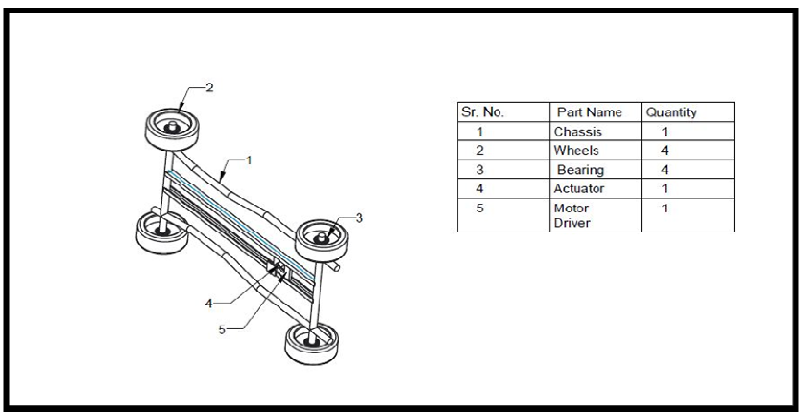


Fig. 4 .4Assembly



Sr. No.	Part Name	Quantity
1	Chassis	1
2	Wheels	4
3	Bearing	4
4	Actuator	1
5	Motor Driver	1

Fig. 4.5 Assembly drawing

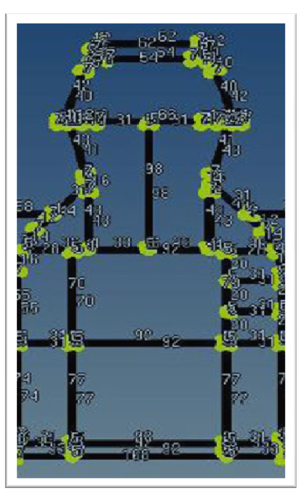


Fig. 4.6 Setup & meshing up

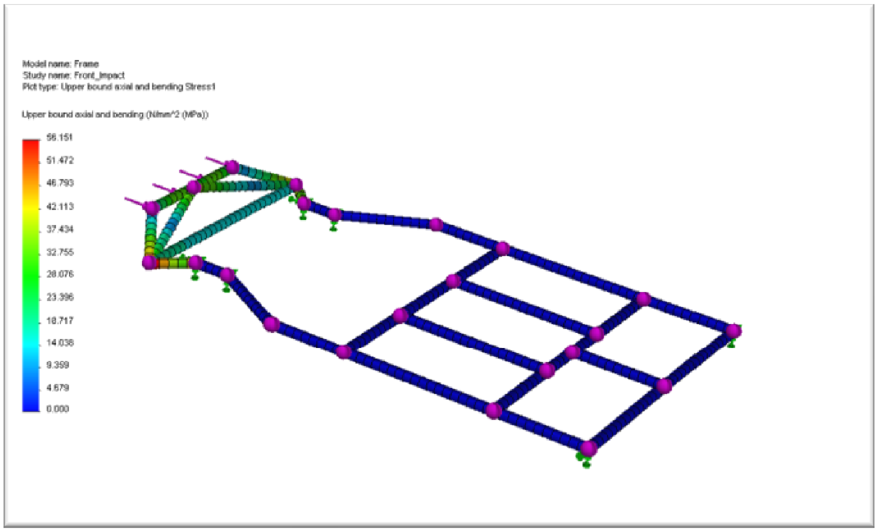


Fig.4.7Equivalent (von-Mises) Stress

V. Conclusion

FEA analysis Shown that, the the chassis to be design can sustain the load and it have higher factor of safety. The linear actuator used in this process is capable to lift the assembly when tire is to be remove or change. Also keeping the manufacturing in mind, I have tried to make the design optium and simple, thus it give higher strength and longer life to system.

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