

DESIGN AND CALCULATION OF AUTOMATIC PARKING BRAKE SYSTEM

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Abstract : With each going year it is reported that there's a rapid increase in road accidents, it has been officially reported that 147,913 people have lost their lives in 2017. Road safety measures seek some drastic change as well as vehicles on the road should have equipped with safety equipment's and not only that but this should be re-evaluating and new technologies to be adopted. In this field our project is capable enough to bring a drastic change and should be adopted to bring safety for the lives on road. This paper is focused on automatic parking brake/hand brake system and remove manually operated parking brake. Sometimes driver forget to apply the hand break and it can lead to some serious injuries, mainly in incline and decline plane. In this project there is a sensor which will be placed under the seat of driver to detects the load. If someone is sitting on the seat then it will detect the load and send signals to break in order to deactivate it. But there may be some unforeseen situations where the driver wants to apply a parking brake while sitting on the seat, this can happen in any mounting, downward or in emergency situations, a switch provided inside the cabin that is controlled manually. To operate these two systems simultaneously an OR gate is provided and wherever positive signals came from OR gate will operate accordingly and further operated through linear servomotor in order to apply the brakes of vehicle.

Keywords: Parking brake, Load sensor, OR gate, Linear actuator servomotor

I. INTRODUCTION

In road vehicle, the parking brake is also known as a hand brake or emergency brake. It is apparatus used to retain the vehicle assured stationary when parked. This was also used to perform emergency stop should the main hydraulic brake fail. Parking brake behaves only on the rear wheel. Parking brake frequently comprises of cable connected to a servo motor. Most of the parking brake rear wheel, thus it reduced traction when it is parked. The apparatus which are operated may be, hand operated lever, a straight pull handle located near the steering column or foot operated pedal located with the other pedal.

After studying to various research papers which are pointing towards our projects are taken into consideration for the literature review. In literature review we considered different paper and by summarizing there's review and concept which are applied for Automatic parking brake system.

1. 2014: - Sumant Mayank: - Electromechanical parking brake system equipped with electric motor and gear train used motor to transmit motion from to a lead screw which break down pads. This braking system become obsolete because they used wire to apply brake, it may chance that wire get fail by any time this braking system replace brake which linkages with electric motor driven, but they did not use any sensing element so, in case of driver may get forgot to apply brake so that automatic brake can apply.
2. February 2014 - Sunterra Banerjee, this project using the concept of fuzzy logic and artificial natural network. It used ultrasonic sensor which produce and receives ultrasonic waves to determine distance between car and obstacle this system is designed in such a way that car gets automatically stop when it is parking.
3. S. THIVAGAR, C. NATH KUMAR (2016): - In this project they mainly focus on manual brake system which is the main limitation of their project.
4. May 2016- Sachin S Dharia, Sachin S Bhople, Partmesh P Kumbhar, Kedar S Pathak Now a day's manual braking system replaces by manual hand braking system. it is used component like actuator solenoid switch master cylinder this system apply the brake without skidding the rear wheel drive it is most effect system over the hand release brake system because of automatic work and assist the car to park.
5. July 2016: - AMIT B MASKE: - This parking brake system referred to as brake by-wire, replace conventional parking brake hand lever with electronic switch.
6. May 2017 Rohan E Dalvi- Ramesh G Sutar, Prashant H Karke, Jitendra Babasaheb satpute, this project consists of Electric motor. Motor is used for transmitting motion from the motor to the break lever which pushes restraint. It is controlled by ECU (electric control unit) this replaces hand break with electric motor system which has high performances and durability. It is operated by a switch which is available in center.
7. April 2019: A parking brake is an important tool of any automotive system. This automatic parking brake system require hydraulic pressure of 33.66 KPa to ensure to park 25% gradient although instead of using hydraulic system simply use servo motor which has power range of 2052.34 N which is bit cheaper than hydraulic system.

1. Methodology

In today's time, only expensive cars use electronic brakes which are not fully automatic yet. Cheap cars only have a hand brake that is fitted with the help of a lever, which people often forget to apply while parking. To overcome this problem, an automatic parking brake was thought of and created an automatic parking brake with the help of a sensor and motor. It featured a sensor under the driver seat that was attached to the seat belt. The same sensor is used to make the automatic parking brake which is connected to the OR gate and its output is connected to a servomotor which is connected to the drum brake with a lever joined. Studied this entire mechanism on the Creo which got the complete details and made a safe automatic hand brake, which can easily tolerate the torque applied by the motor and the brake is easily connected.

2. Design and Calculation

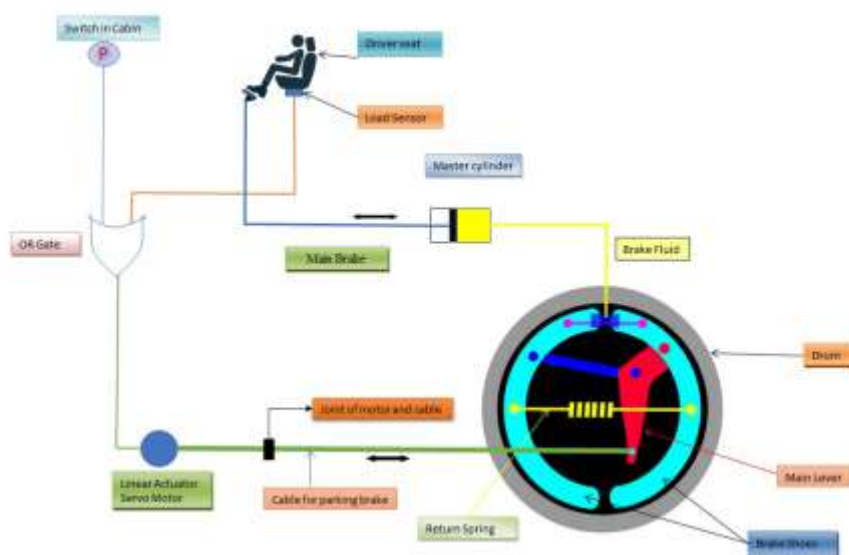


Figure1. Systematic Working and Line Diagram

3.1 Load Sensor

[1]. A sensor has been used here for a weight of 30 kg. If a person of more than 30 kg sits on this seat then only this sensor will be active and if a person weighing less than this sits, then it will not be active, this is done for protection from young children.

[2]. This sensor is further connected to the OR gate, one end of the OR gate is connected to the load sensor and the other end is connected to the switch.

[3]. When a person is sitting on this seat, whose weight will be more than 30 KG, then the hand brake will not be applied, but as soon as that person gets up from the seat the automatic hand brake will be applied.

[4]. The same sensor is being used for the seat belt, there is no separate sensor being installed on it, just a slight change has been made in that sensor So that the value of this mechanism does not increase much.



Figure 2. Load Sensor

3.2 Linear actuator servomotor –

It is a type of servomotor which converts rotational motion in motors into linear or straight push/pull movements. It is used in all types of applications such as- tilting, lifting, pulling or pushing with pounds of force are required. Generally, these types of servomotors are used for simple scenarios where high precision, smooth functioning and safety is a priority.

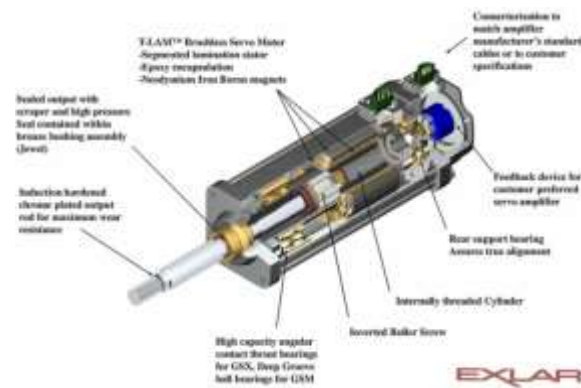


Figure3. Servomotor

3.3 Working of Drum break

When the break is applied by the driver then break booster get activated and after that it goes into master cylinder and from master cylinder brake fluid passes with high pressure and goes into wheel cylinder, two pistons is attached with the wheel cylinder and both the cylinders helps to expand the brake shoes. There's also a brake lining which is attached on the outer surface of brake shoes when the brake shoes expands and it holds the brake lining, there's a frictional force is generated which is used to stop the brake drum and because the brake drum is fixed up on the inner surface of wheel it is also tends to stop the vehicle too.

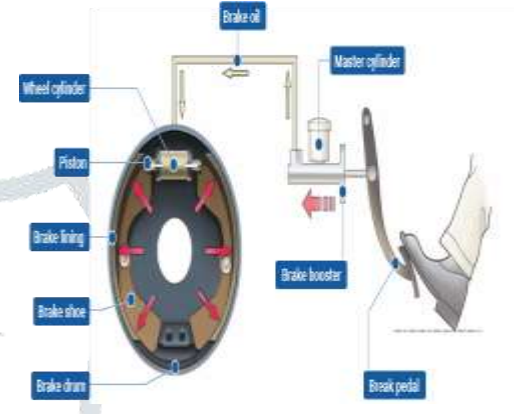


Figure4. Working of Drum break

3.4 Main lever

This lever is attached with the brake shoes one with the pin joint and another with the linkage and the end of lever connected with the cable and cable is attached with the motor. With the help of this actuating lever driver use the parking/Emergency break. The use of main lever is to securely hold the vehicle while parking and it is also used in emergency scenarios as well.

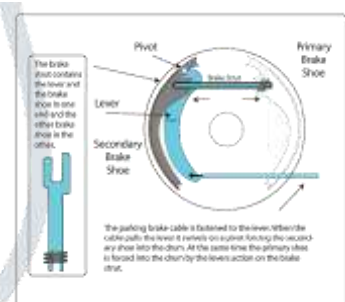


Figure5. Main Lever

4. CALCULATION FOR PRODUCING TORQUE BY SERVOMOTOR

$$\begin{aligned} w &= 50 \text{ mm} \\ m &= 0.32 \\ P_{\max} &= 1 \text{ N/mm}^2 \\ R &= 160 \text{ mm} \end{aligned}$$

In the above case there's an assumption that the maximum normal pressure will happen between the lining on the right-hand shoe and the brake drum for the right-hand shoe.

$$\theta_1 = 0 \quad \theta_2 = 120^\circ \quad \Phi_{\max} = 90^\circ$$

$$\sin \Phi_{\max} = 1$$

The distance from the axis of the brake drum to the axis is given by h

$$\begin{aligned} h &= \sqrt{(86.6^2 + 50^2)} = 99.9977 \text{ mm} \\ h &= 100 \text{ mm} \end{aligned}$$

$$M_f = \frac{\mu P_{\max} R w [4R(\cos \theta_1 - \cos \theta_2) - h(\cos 2\theta_1 - \cos 2\theta_2)]}{4 \times \sin \Phi_{\max}} \dots \dots \dots \text{eq (i)}$$

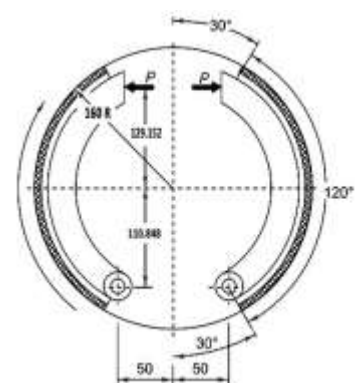


Figure6. Drum break

$$= \frac{0.32(1)(160)(50)[4 \times (160) \times (1 - \cos 120^\circ) - 100 \times (1 - \cos 240^\circ)]}{4 \times 1}$$

$$= 518400 \text{ N-mm}$$

$$M_n = \frac{P_{\max} \times R_{wh}[2(\theta_2 - \theta_1) - (\sin \theta_2 - \sin \theta_1)]}{4 \times \sin \theta_{\max}} \dots \dots \dots \text{eq(ii)}$$

$$= \frac{1(160)(50)(100)[2(\frac{120\pi}{180}) - \sin(240^\circ)]}{4 \times 1}$$

$$= 1010936.122 \text{ N-mm}$$

$$P = \frac{M_n - M_f}{C} \dots \dots \dots \text{(iii)}$$

$$= \frac{1010936.122 - 518400}{129.152 + 110.848}$$

$$P = 2052.34 \text{ N}$$

$$\text{Torque} = \text{Force} \times \text{Perpendicular distance}$$

$$= 2052.34 \times 80$$

$$= 164187.2 \text{ N-mm}$$

This calculated torque is generated by the **Servomotor** that is attached with the OR gate.

Analysis of Actuating lever in Creo

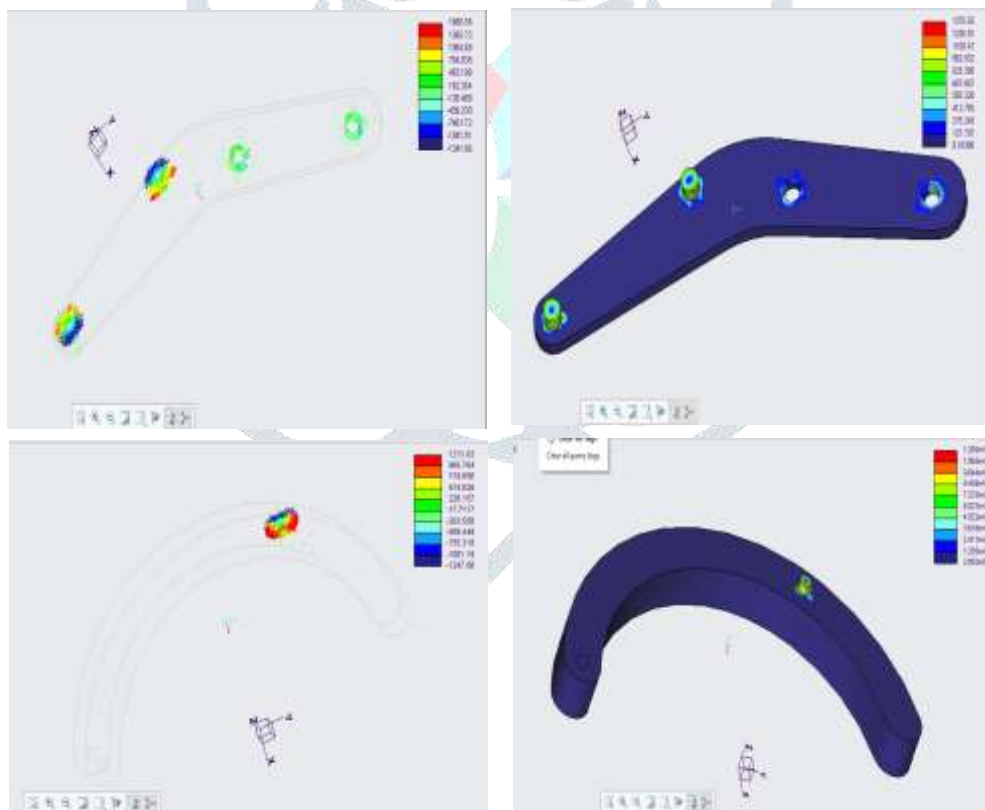


Figure7. Stresses in main lever and brake shoes

RESULT

- It is a redesigned parking brake system, with the lever completely finished. There will be no need to pull and push. The action of the parking brake will be active and passive only by sensors and switches.
- In this redesigned parking brake system, more free space is available in the driver's cabin, in this empty space can accommodate a small seat for a small child. The inner beauty will increase.

- The old system used to take time to pull and release the lever, but this new mechanism will also save time. In this new device, the servo motor acts as a braking device.
- This newly designed parking brake system is very easy and safe which is fully automatic. The load sensor will only activate when it is over 30KG, so that the brakes will not be removed if very young children sit on the seat, so that there is no chance of an accident

CONCLUSION

- The maximum stress on the steel through the torque and power of the servomotor can easily be tolerated by this steel
- Driver will be worry free while parking the car and more safety given to the vehicle because wheel is locked by the sensor.
- Accident on the road will be less, which will save lives and goods.

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