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Automated Hand Brake Release System

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Abstract -An automatic hand brake system for a vehicle consists of an electric motor, associated with the motor for transmitting motion from the motor to a brake lever, which pushes the brake pads. This project provides a brand new concept design of the EMPB (electro mechanical parking brakes) system that has simple and low-cost characteristics. This project deals with designing and fabrication of Electromechanical Hand Brake Release system.Electromechanicalhand brake system also named to as brake by-wire, replace conventional parking braking systems with a total electrical component system. This occurs by replacing conventional linkages with electric motor-driven units. The braking force is generated directly at each wheel by high performance electric motors and auto control, which are controlled by an ECU. The electronic parking brake replaces the conventional handbrake. It is operated by a switch in the center console. The Electromechanical Parking Brake provides the following benefits over the conventional handbrake: Ease of use-the parking brake can be applied fully regardless of the strength of the driver. Safety- the electricalhand brake applies automatically when the key is not inserted in the ignition.

Key Words:EMPB, ECU, Safety.

1. INTRODUCTION

In cars, the emergency brake, also called hand brake, or e-brake, are the latching brake adapted to keep the vehicle stationary. It is sometimes also used in order to prevent a vehicle from rolling when the operator needs both feet,for operatingon the clutch and throttle pedals. Automobile hand brakes usually contain a cable directly connected to the brake mechanism on one end and to a lever or pedal at the driver's position. The mechanism is usually a hand-operated lever on the ground on either side of the driver seat, or a pull handle located below and near the steering column, or a (foot-operated) pedal located at far distance from the other pedals.

Although sometimes referred to as hand brake, using it in any emergency where the footbrake remains operational is perhaps getting to badly upset the brake balance of the car and vastly increase the likelihood of loss of control of the vehicle, e. g. by initiating a rear-wheel skid. Additionally, the stopping force provided by using the handbrake is little and wouldn't significantly aid in stopping the vehicle. The hand brake operates completely on the rear wheels, which have reduced traction while braking but in some cases, hand brake operates on front wheel, as exhausted Citroens manufactured. The hand brakes aremainly intended for use just in case of mechanical failure where the regular footbrake is inoperable or compromised. Modern brake systems are typically very reliable and equipped with dual-circuit hydraulics and low-brake-fluid sensor systems, therefore the handbrake is hardly adapted to stop a moving vehicle.

Conventional parking brake actuation involves the human interference. Without pulling or pushing the lever, the hand brake won't work. Also, sometimes due to negligence or in emergency conditions, we humans often forget to usehand brakes. This may cause rolling of vehicles just in case of slopes and collision with other vehicles in parking zone. Constant enhancements in active safety and enhancementsw.r.t. the reliability and comfortability of operation mean that mechanical handbrakes are increasingly being replaced by electromechanical systems.

This gave birth to ideas of electrical hand brake techniques. The fundamental function of the electrical hand brake is to activate and release the hand brake when the vehicle is at a standstill. In first generation of electricalhand brake fitted, a turn on the control panel replaces the normal handbrake lever used for operating the mechanical hand brake. This switch utilizes an electronic control unit (ECU) to trigger electromechanical actuators within the wheel brakes or central actuator that operates the rear wheel brake via a Bowden cable [1].

2. METHODOLOGY

The construction of automatic hand brake release consists a base frame created from L angle low-carbon steel. The cross section of Langle is 25*25*3 millimetre. The L angle mild steel area unit welded to form an oblong frame. On this frame

a low-carbonsteel shaft is welded that is connected with a motorbike wheel. The bike wheel encompasses a drum brakes placed at centrewhich is activated by pulling brake lever connected to that. This brake lever is connected to the 12 V DC motor via linkages. TheDC motor is of 12 V and 100 rate. The facility offer to the DC motor is given through a relay that switches its rotations.The relay is controlled by a microcontroller on 5 V DC supply. That receives input from a key switch that we tend to on or off to realize participating or disengaging of brake via DC motor. The whole system is hopped-up by 12 V lead acid battery.

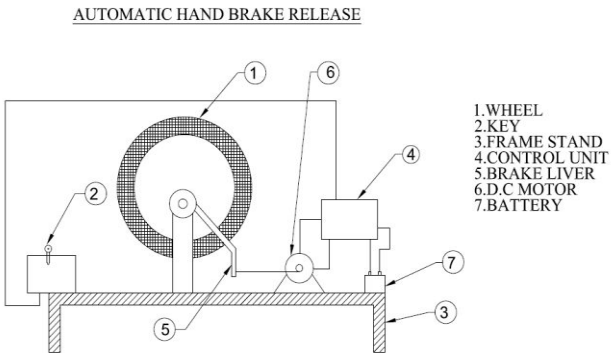


Fig-1: Design of Hand Brake Release

3. HARDWARE COMPONENTS

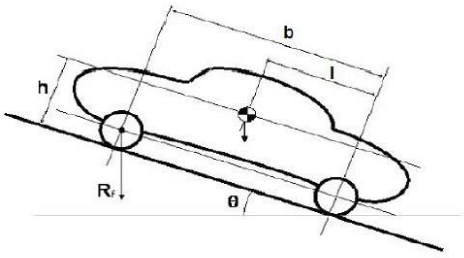
The major components that are employed in the fabrication of the automatic hand brake release system are as follows:

- Motor,
- Control unit,
- Wheel arrangement,
- Frame,
- Key inserting slot.
- Braking system.

4. DESIGN CALCULATION

Brake force:

When parking on an inclined road, the lower axle has a higher load than it does on the level road.



As per our assumptions (above sketch),

h = height of center of gravity (CG)

b = wheelbase

l = distance of CG from rear axle

R_f = load on front axle

$_{Rr}$ = load on rear axle

W = weight of the vehicle assumed =

Ɵ = angle of slope = 30o

Now,

$$R_t = \frac{W(I - h\tan\theta}{b}$$

And

$$R_r = W - R_t$$

Brake force required between road and tyre is *R*, where, μ = coefficient of friction between roadand tyre = 0.8

Tangential force (P) calculation: Tangential force required at circumference to

$$i.e. P = W\tan(\alpha + \phi) = W\left[\frac{\tan\alpha + \tan\phi}{1 - \tan\alpha\tan\phi}\right]$$

TORQUE REQUIRED BY MOTOR TO BRAKE THE WHEEL

The torque required to tilt the solar panel with frame structure is as follows:

- Total mass of WHEEL = 4 kg (consider structural mild steel system)
- WHEEL OUTER DIAMETER = 400 mm = 0.4 m
- Angular velocity of tilting is 100 rpm = 100/60 rps
- Amount of Torque required to apply brakes is:

$$T = M_g.\sin\theta + I\alpha$$

Where,

Mg=weight of the tilting mechanism.

I = Moment of Inertia I= mk^2,

α = angular acceleration of the tilting mechanism

To calculate torque required for braking and force required for that we need to find above values

1. Radius of gyration:

For rectangular object the radius of gyration can be obtained as,

$$k^2 = \frac{1}{3}\left(\frac{D}{2}\right)^2$$

Where D is diameter of wheel in m

D =400 mm = 0.4 m

So,

$$k^2 = \frac{1}{3}\left(\frac{D}{2}\right)^2 = \frac{1}{3}\left(\frac{0 \cdot 4}{2}\right)^2$$

$$k^2 = 0.0133\ m$$

$$k = 0.1154\ m = 115\ mm$$

To calculate I (inertia of the tilting mechanism)

$$I = mk^2$$

$$I = 4 * 0.115^2$$

$$I = 0.0529\ kg.m^2$$

2. To calculate angular acceleration:

Angular acceleration is the rate of change of angular velocity. In SI units, it is measured in radians per second squared (rad/s^2), and is usually denoted by the Greek letter alpha (α).
The angular acceleration can be defined as either:

$$\alpha = \frac{d\omega}{dt}$$

where ω is the angular velocity and r, (usually defined as the radius of the circular path of which a point moving along), is the distance from the origin of the coordinate system that defines θ and ω to the point of interest.

We need to find angular velocity.

Angular velocity:

The angular velocity is defined as the rate of change of angular displacement and is a vector quantity (more precisely, a pseudo vector) which specifies the angular speed (rotational speed) of an object and the axis about which the object is rotating. This speed can be measured in the SI unit of angular velocity, radians per second, or in terms of degrees per second, degrees per hour, etc. Angular velocity is usually represented by the symbol omega (ω, rarely Ω).

The direction of the angular velocity vector is perpendicular to the plane of rotation, in a direction which is usually specified by the right-hand rule.

In two dimensions the angular velocity ω is given by

$$\omega = \frac{d\phi}{dt} = 2\pi N$$

The angular acceleration is

$$\alpha = \frac{angular\ velocity}{time} = \frac{\omega}{t}$$

$$\alpha = \frac{2\pi N}{t}$$

For one t= minute = 60 sec.

= 2*3.142*100 / 60*60

= 1.74 rad/sec^2

On substituting the values in equation 1, we get,

T=Mgrsinθ + Iα

T= (4*9.81×0.2×sin90) + (0.0529 × 1.74)

T = 38.84 N-m

3. Amount of Force required for braking:

T = F r

38.84 = F*0.2

F= 194.24 N

5. SYSTEM DESIGN

The system is designed in CAD software to realize the modifications as below:

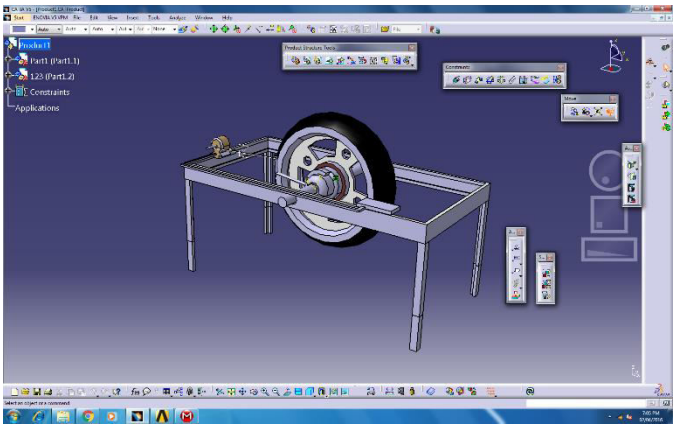


Fig-2: CAD Model of Hand Brake

6. CONCLUSIONS

The automatic hand braking system provides safe braking is assured in slopes and hill starts with the help of "HOLD" function. This system has complete automatic operation for effective drivability and safety. This system also gets some advanced options like hold function in head to go into traffic and inclined roads, which might promise the drivers and vehicle owners with a secure pleasure drive and stops. The response time of EMPB system is good. Hence, applies and releases the hand brake in very short period of time.

The EMPB system has greater relative advantages over the traditional parking system and can find maximum application in future due to its significance.

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