"Design and Manufacturing of Seat-Belt Assisted Hand Brake Release"

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Abstract-Hand brake is one of the most important components in vehicles. In general, the hand brake is operated manually. In our project we are developing hand brake when Seat belt is not acquired off for safety purpose. Major causes of death in road accidents are carelessness in safety while driving. Hence wearing seat belts might have reduced serious crash related injuries and saved life. Hence "Driver Assistive Safety System" (DASS) comprises of techniques which inculcate the mandatory safety precautions via hand brake. This project describes safety system which ensures that the driver and co-passenger wear safety seat belt while driving a car. The driver assistive safety system works on 'HAND BRAKE REALESE" concept.

I. INTRODUCTION

The most important part in the automobile is the handbrake which is also. known as a latching brake. It is used generally when the automobile is parked, thus the alternative name that is parking brakes is used to keep the car stationary also called as automobile e-brakes. The most common used of a parking brake is to keep the vehicle motionless when it is parked. The main function of brake system is to decelerate the vehicle, to maintain vehicles speed during downhill operation and finally to park the vehicle stationary either on a flat or slope road condition. In cars the hand brake is a latching brake usually used to keep the car stationary. Automobiles e-brakes usually consist of a cable directly connected to a brake mechanism on one end and to some type of mechanism that can be actuated by the driver on the other end of mechanism is often a hand operated lever, on the floor on either side of the driver, a pull handle located below and near the steering wheel column, or a pedal located far apart from the other pedals. In road vehicles the parking brake also called as hand brake, emergency brake or e-brake is used to keep the vehicle stationary. In normal vehicles a hand brake is consist of a cable connected to two-wheel brakes at one end and the other end to a pulling mechanism which is operated by human with hands.

Importance of Seat Belt in Cars.

Conventional parking brake actuation involves the human interference. Without pulling or pushing the lever, the parking brake will not work. Also, sometimes due to negligence or in emergency conditions, we humans often forget to apply parking brakes. This may lead to rolling of vehicle in case of slopes and collision with other vehicles in parking area. Constant enhancements in active safety and improvements with respect to the reliability and comfort of operation mean that mechanical handbrakes are increasingly being replaced by electromechanical systems.

How It Works

The car handbrake is designed to bypass the hydraulic braking system in the event of a failure. When you apply the emergency brake, the metallic cable it is connected to passes through an intermediate lever enhancing the power of the pulling. Then comes an equalizer that splits that power evenly between the brakes

Emergency Braking system

Although sometimes known as an emergency brake, using it in any emergency where the footbrake is still operational is likely to badly upset the brake balance of the car and vastly increase the likelihood of loss of control of the vehicle, for example by initiating a rear-wheel skid. Additionally, the stopping force provided by using the hand-brake is small and would not significantly aid in stopping the vehicle. The parking brake operates mostly on the rear wheels, which have reduced traction while braking. But in some cases, parking brake operates on front wheel, as done in most Citroens manufactured since the end of World War II. The hand brake is instead intended for use 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, meaning the handbrake are rarely used to stop a moving vehicle.

Electromagnetic brakes

Electromagnetic brakes (also called electro-mechanical brakes or EM brakes) slow or stop motion using electromagnetic force to apply mechanical resistance (friction). They were originally called "electro-mechanical brakes," but over the years the name changed to "electromagnetic brakes", referring to their actuation method.

In locomotives, a mechanical linkage transmits torque to an electromagnetic braking component.

Electric motors in industrial and robotic applications also employ electromagnetic brakes.

II Problem Statement

"Not wearing a seat belt causes the most devastating injuries today. Seatbelts save lives. Years of practice have neglected driving safety. Negligence causes most road deaths and tragedies. Use seatbelts or helmets to survive an accident. Seatbelts protect car drivers. Despite rules, more deaths from drivers not using seat belts. Our project mandates seatbelt use."

III OBJECTIVE

To ensure the motorist's safety; the seat belt and brakes are both disengaged at the same time.To develop a habit of wearing a seat belt with a efficient working system and economical. Create the proposed system's 3D modal in CATIA V5 software.

To perform analytical calculations on the components used? Conduct a market survey to determine component availability and specifications at the lowest cost. To get the same result as the original. It puts the built-in modal weather to the test. Reduce the cost of braking by using a correct mechanism for the demo modal.

VI. Research Methodology

We started the work of this project with literature survey. We gathered many research papers which are relevant to this topic. After going through many research papers, we learnt how can we use seat-belt assistance to release brake system and ensure safety for automobile.
The main aim of our project is to prevent accidents and ensure safety. We first started designing the project in CATIA V5. After the designing process we ran some tests through animation. After that we selected the materials and components based on dimensions and proper parameters. We started selecting the proper wheel size of an automobile, according to which we designed a shaft that will lock and un-lock the wheel and designed various components such as links and brake locking mechanism. Then we designed the frame work to support the wheel as well as other components. Then we selected the proper electric units like Wiper-motor, Arduino, Sonar senor, then we programmed the Arduino.
After that according to the design we manufactured the components and assembled them together. The experimental observations, testing and calculations were done and then the result was concluded.

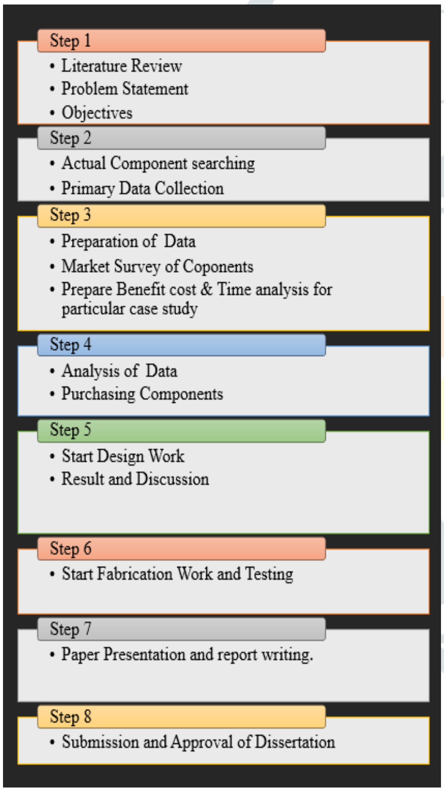


Figure.1: Methodology Flow

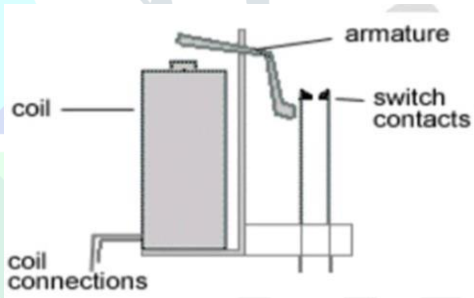
V. DESIGN AND CALCULATION

We had to go through various components and we selected these suitable components for our project design,. These are

Infrared sensor

An Infrared sensor is a light-emitting electrical gadget that detects objects in the environment. An infrared sensor can detect motion as well as measure the heat of an object. Almost all items emit some type of thermal radiation in the infrared range. These sorts of radiations are invisible to our sight, but they can be detected by an infrared sensor. The emitter is a simple IR LED (Infrared Light Emitting Diode), while the detector is a simple IR photodiode. The photodiode is sensitive to infrared light of the same wavelength as the IR LED. When infrared light strikes the photodiode, the resistances and output voltages change in response to the intensity of the IR light.

Relays



Relays are the electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principals are also used such as solid-state relays. Relays are used where it is necessary to control a circuit by low power signal (with complete electrical isolation between control unit and controlled circuits). We are using the relays for switching the motor ON or OFF. For making automatic hand brake system more efficient, these relays should be operated perfectly in all driving and climatic condition.

Motor

Wiper motors rotate in a continuous motion (not back-and-forth like you would naturally think based on the actions of your windshield wipers) and run-on DC voltage. Since they run on DC, the motors can be sped up and slowed down based on the voltage level applied to them, and the direction can be reversed by reversing the power leads. To get motions that are not circular (like an up and down motion), mechanical attachments (like cams) need to be added to the motor's shaft.

Control Unit

In automotive electronics, Electronic Control Unit (ECU) is a generic term for any. Embedded system that controls one or more of the electrical system or subsystems in a motor vehicle

Types of ECU include Electronic/engine Control Module (ECM), Power train Control Module (PCM), Transmission Control Module (TCM), Brake Control Module (BCM or EBCM), Central Control Module (CCM), Central Timing Module (CTM), General Electronic Module (GEM), Body Control Module (BCM), Suspension Control Module (SCM), control unit, or control module. Taken together, these systems are sometimes referred to as the car's computer. Technically there is no single computer but multiple ones. Sometimes one assembly incorporates several of the individual control modules.

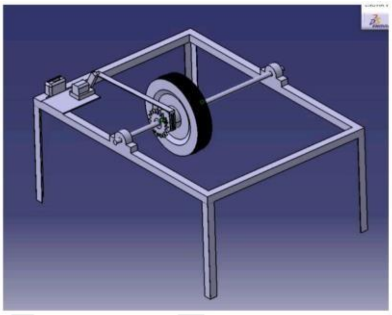
It is very simple in operation that. when the brake lock system is activated from the remote, the control unit switches on the motor and when it is deactivated from the remote, then the control unit reverses the motor direction.

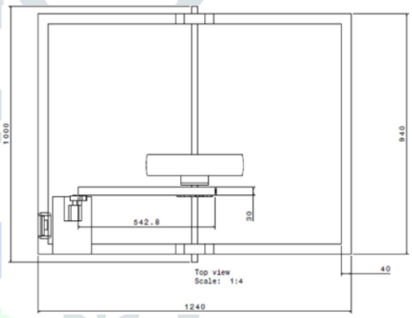
Wheel Arrangement

The simple wheel and braking arrangement fixed to the frame stand. Near the brake drum, the pneumatic cylinder piston is fixed. This wheel arrangement is setup for showing the successful working of our project. But the real implementation can be done in the automobile and the brakes can be applied to all the four wheels.

PROPOSED SYSTEM

The main aim of our project is to provide safety for the passenger to prevent accident incident 's. this system is a combination of electronic & mechanical branch which is mechatronics. The system consists of a support on which bearings are mounted on either side of the support from which central shaft is installed with a load of wheel tangentially acting upon the shaft. When the driver puts his seat belt the proximity sensor activates the brake is released. The braking system is connected to the wiper motor, when the motor rotates in clockwise direction brake is released, when it rotates in anticlockwise direction brake is applied the rotation of the motor is controlled via micro controller which is Arduino Uno upon the sensing of wearing & removing of seat belt.





Analytical Calculations

Design of Shaft

By using Bending Moment Formula

M/I=σb/Y ....(1)

Assume Wight of the tire as	=	5 Kg
Bearing load equals to	=	2 Kg
Brake weight	=	0.5 Kg
Other dead load assumed as	=	2.5 Kg extra
Perpendicular distance to be as	=	450 mm
Assume as angle of gyration r	=	600mm
Bending moment	=	Force * Perpendicular Distance
Total load in Newton	=	10 * 9.81
	=	98.1 N
Bending moment	=	98.1 * 450
	=	44145Nmm

Here we have selected the diameter of the shaft as 25mm so, we are calculating the max bending moment of the shaft weather it fails or not. To the given sustainable loads

And also, we have did trial & error method by changing the dia starting from 5, 10 & 15 to see the bending stress in 5 & 10 the value where passing but are actual nearer to the ultimate failure so we choose the dia as 25mm directly here

$I = \pi/64 * d^4$

$= \pi/64 * 25^4$

$= 19174.75\ mm^4$

Therefore,

Y = 25/2 = 12.5 half of the diameter

$44145/(19174.75) = \sigma b/(12.5)$

$= 28.77\ N/mm^2$

Therefore, design is safe.

The allowable shear stress for material is callow= Syt/fos

Where Syt = yield stress = 210 MPa = 210 N/mm^2

And fos is factor of safety = 2

So σallow=210/2= 105 MPa = 105 N/mm2

Comparing above we get,

σb < σallow i.e.

28.77<105 N/mm^2

So, Design is Safe

Design of Frame

By using Bending Moment Formula M/I=σb/Y

Force = 15 Kg

= 15*9.81

= 147.15 N

Perpendicular Distance = 600/2

= 300 mm

Bending Moment (M) = Force * Perpendicular Distance

= 147.15*300

Bending Moment (M) = 44154 Nmm

25*25*3 mm L-Shaped support is used for support’s

$I = b(h^3)/12$

$= 25(25^3)/12$

$I = 32552.08\ mm^4$

Y = Yield Area L cross section 25 mm = 25/2 = 12.5 mm

Therefore, above value use in equation No. (1)

(44145)/(32552.08) = σb/12.5

Therefore, σb = 16.95 Nmm^2

16.95 < 105

Hence Design is Safe.

Frame Base frame design

WE design a basic frame for a prototype by mild steel channel (L. beam). L Channel- MS Angles are L-shaped structural steel represented by dimension of sides & thickness. For e.g. 25x25x3 means, both the sides of angles are 25 mm & thickness is of 3 mm. There are various sizes of angles which are as follows:-(there. are also equal & unequal angles). Equal angles: They are angles having both the sides of equal dimensions. For e.g. refer below given diagram, in which both the sides are of dimensions "a".

By standard available sizes we select the 25 mm so because that will be easily available and have appropriate size for frame.

Torque Required by Motor to Break the Wheel

The torque required to stop the wheel with frame structure is as follows:

Total mass of WHEEL = 5 kg (consider)

Wheel outer diameter = 400 mm 0.4 m or =600mm = 0.6m availability in the market

Angular velocity of tilting is 100 rpm =100/60 rps

Amount of Torque required to apply brakes is:

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

Where,

Mg = weight of the tilting mechanism,

I = Moment of Inertia I = mk2,

α = angular acceleration of the tilting mechanism.

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

Radius of gyration

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

$k^2 = 1/3((D/2)^2)$

Where D is diameter of wheel in m

D = 600 mm = 0.6 m

So,

$K^2 = 1/3((D/2)^2) = 1/3((0.6/2)^2)$

$K^2 = 0.03$ m

K = 0.1732 m = 173.2mm

To calculate I (inertia of the tilting mechanism)

$I = m*k^2$

= 4*0.17322

= 0.1199 $Kg.m^2$

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 (es, 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 co is given by

$$\omega = d\Phi/dt$$

$$\omega = 2\pi N$$

Thew angular acceleration is,

α = angular velocity / time

= ω/t

= $2\pi N$

For one minute = 60 sec

= 2*3.14*100 / 60*60

= 1.74 rad/sec^2

On substituting the values in equation 1, we get,

T = Mgr.sinθ+ Iα

T = (4*9.81*0.6*sin30) + (0.11999*1.74) = 11.980N-m

Amount of Force required for breaking ;

T = F * r

11.980 = F * 0.6

= 19.986 N

= 19.986/9.81 = 2.03Kg

Motor selection

Consider force required by a human to apply the brake = 2.03 Kg

Wheel mass equals = 5 Kg

ratchet wheel mass equals to 0.5 Kg

total mass equals to 7.53 Kg equals to 8 Kg

So the force applied is equal to 8 x 9.81 newton.

F=78.48 N

Hence, the torque required= 78.48" 25.

25 mm is the shaft dia = 1962 N-mm-1.962 N-m

1.962 N-m will be as exact but we will consider the highest

20.006 Kg-cm torque

For better torque we are choosing wiper motor with self-gear installed 25 kg cm torque wiper motor according to availability of market research. It requires 6V two battery or one I V battery it can also be operated by bike battery.

Ref. V. B. Bhandari

Selection of bearing

For simplified calculations and to obtain an approximate value of the bearing life, the so-called "handbook method" is used to calculate the basic rating life. The basic rating life of a bearing according to ISO 281 is

L10 = (C/P)p

Where,

L10 basic rating life (at 90% reliability), millions of revolutions

C= basic dynamic load rating, KN

P = equivalent dynamic bearing load, KN

p = exponent for the life equation

= 3 for ball bearings

= 10/3 for roller bearings, as used typically in axle box applications

The basic rating life for a specific bearing is based on the basic dynamic load rating according to ISO 281. The equivalent bearing load has to be calculated based on the bearing loads acting on the bearing via the wheelset journal and the axle box housing. For railway applications, it is preferable to calculate the life expressed in operating

mileage, in million km

L10s= [(Pi x Dw)/1000)] x (C/P)p

Where,

L10s basic rating life (at 90% reliability), million km

Dw= mean wheel diameter, m

From design data book V. B. Bhandari-Page no-15.65 we can select bearing for the shaft diameter of 25 mm.

Here we select single row deep groove ball bearing designated as 6304(SKF)

Dimensions, load capacities of bearings are given as.

Inner Diameter of bearing 25mm

Outer diameter of bearing-38mm

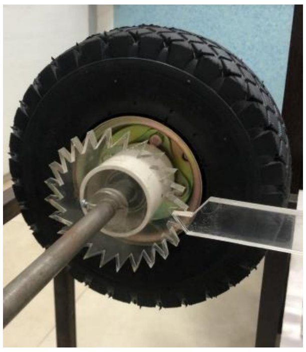
Width of bearing 15 mm Basic load ratings(C)=15500 N and (CO)=13200 N

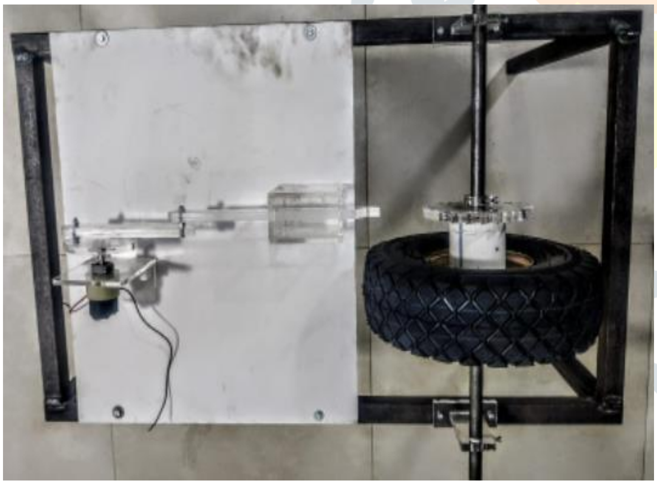
Ref. V. B. Bhandari

V TESTING

The testing process started after completing the fabrication process, as soon as we put the seat belt on, the sonar sensor detects the seat belt and sends the information to Arduino UNO, which then makes the wiper motor rotate clockwise and releases the brake.
And when we take off the seat belt the sensor detects the seat belt was detached and it transferred the information to Arduino Uno and brakes got engaged. Hence the working of our project was successful

We tested the sonar sensor by performing an experiment of placing an object in front of it to check the results. Then we tested the braking mechanism by rotating the wheel manually and checked how the brakes stop the wheel. We tested the frame work by putting load on it to see if it can sustains the weight of our project. From our project we ensure that driver compulsorily wear seat belt while driving if he tries to run without the seat belt the brakes could not be disengaged by this the driver safety will be ensured.





CONCLUSION

We developed and created our modal in software, as you can see in the Design section. We were able to effectively calculate the components required to create our project, such as their failure and forces at a certain moment, by assuming certain values. We will purchase the components required to execute the project based on the findings of the market study. Finally, we'll put the prototype modal together and test it to see if it works as expected.

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