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Integrated Brake Safety System Ensures Maximum Vehicle Safety through Combination of ABS and EBA Systems of Braking

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Abstract: *Anti-lock braking system (ABS) is an automobile safety system that allows the wheels on a motor vehicle to maintain tractive contact with the road surface according to driver inputs while braking, preventing the wheels from locking up (ceasing rotation) and avoiding uncontrolled skidding. It is an automated system that uses the principles of threshold braking and cadence braking which were practiced by skillful drivers with previous generation braking systems. It does this at a much faster rate and with better control than a driver could manage. ABS generally offers improved vehicle control and decreases stopping distances on dry and slippery surfaces for many drivers; however, on loose surfaces like gravel or snow-covered pavement, ABS can significantly increase braking distance, although still improving vehicle control. Many accidents caused by ignoring right-of-way, driving on the wrong side of the road, inappropriate speed, insufficient distance from other vehicles and so on might have been prevented had the vehicles been able to brake faster, Studies have shown that many drivers do not apply the brakes sufficiently in emergency situations due to lack of experience. That means that the greatest possible braking effect is not attained because the drivers did not press the brake pedal hard enough. Therefore, the brake assist system was developed to support the driver in critical braking situations. Emergency brake assist (EBA) based on the speed and force with which the brake pedal is pressed, the brake assist system detects an emergency. The brake assist system increases the brake pressure until the ABS regulation intervenes to prevent the wheels from locking. This way the greatest possible braking effect can be achieved and the brake path can be shortened significantly. The system comprises of the brake lever which when operated at first operate the conventional solenoid braking of ABS type i.e. The brake will cycle between 'ON' & 'OFF' condition to prevent the skidding of the vehicle, preventing accidental locking of braking owing to excessive heating as a result of continuous contact of disk brake and caliper shoes. But In case of emergency when the driver forces the pedal beyond predetermined limit the EBA-sensor (proximity sensor) will detect the condition and actuate the electro-hydraulic thruster which will operate at high speed to develop brake force in multiples of the human effort and apply the brake to bring the vehicle to stop. Objective of the project is determination of braking force required for emergency braking at three operating speed conditions and selection of the braking system arrangement i.e., disk brake and caliper arrangement suitable for derived conditions. Design Development & analysis of electro - hydraulic thruster mechanism with three step operation modes. 3-D cad modelling using Unigraphics and analysis for strength of critical components of the thrusters using ANSYS. Development of Emergency brake assist system test rig to test the electro-hydraulic thruster to determine braking distance determination for individual stages i.e., three individual vehicle speeds and carry out comparative study of the theoretical braking force and braking distance to experimental braking force and braking distance and there by validation of result. Iterative methods will be used to predict safe braking distance at various vehicle speeds for different settings of EBA thruster mechanism.*

Keywords: Anti-Lock Braking System, Emergency Braking System, etc.

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I. INTRODUCTION

Stopping a car in a hurry on a slippery road can be very challenging. Anti-lock braking systems (ABS) take a lot of the challenge out of this sometimes-nerve-wracking event. In fact, on slippery surfaces, even professional drivers can't stop as quickly without ABS as an average driver can with ABS.

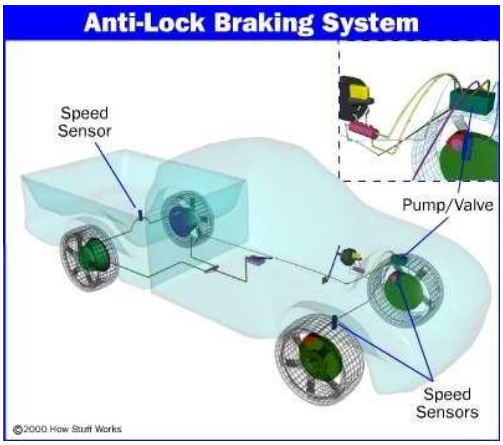

Figure 1: Anti-lock Braking System

Working of Anti-lock Braking System

There are many different variations and control algorithms for ABS systems. We will discuss how one of the simpler systems works. The controller monitors the speed sensors at all times. It is looking for decelerations in the wheel that are out of the ordinary. Right before a wheel locks up, it will experience a rapid deceleration. If left unchecked, the wheel would stop much more quickly than any car could. It might take a car five seconds to stop from 60 mph (96.6 kph) under ideal conditions, but a wheel that locks up could stop spinning in less than a second. The ABS controller knows that such a rapid deceleration is impossible, so it reduces the pressure to that brake until it sees an acceleration, then it increases the pressure until it sees the deceleration again.

It can do this very quickly, before the tire can actually significantly change speed. The result is that the tire slows down at the same rate as the car, with the brakes keeping the tires very near the point at which they will start to lock up. This gives the system maximum braking power. When the ABS system is in operation you will feel a pulsing in the brake pedal; this comes from the rapid opening and closing of the valves. Some ABS systems can cycle up to 15 times per second When the brake is applied within the ABS limit the speed sensor is active, gear pump is started and the hydraulic oil is pumped onto the brake calliper and brake is applied this will try to retard the axle suddenly. this is sensed by the speed sensor, it will cut off supply to the gear pump hence, brake will be off, due to momentum of vehicle axle will again gain speed, sensor will be off now again pump will start and apply the brake thus, the braking will keep on turning 'ON' & 'OFF' is quick succession…which is expected from the ABS to prevent locking of the brake.

Need for Emergency Brake Assist

Many accidents caused by ignoring right-of-way, driving on the wrong side of the road, inappropriate speed, insufficient distance from other vehicles and so on might have been prevented had the vehicles been able to brake faster. Studies have shown that many drivers do not apply the brakes sufficiently in emergency situations. Due to lack of experience. That means that the greatest possible braking effect is not attained because the drivers did not press the brake pedal hard enough. Therefore, the brake assist system was developed to support the driver in critical braking situations.

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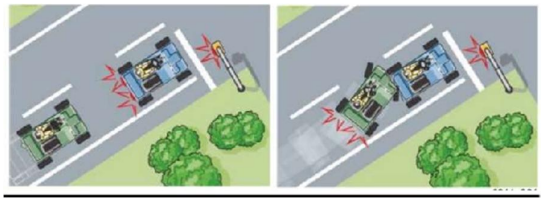

Figure 2: Brake Assist System

A driver is surprised by the car in front of him braking suddenly. After a momentary shock, he recognizes the situation and applies the brakes. Perhaps because he has not had to brake in critical situations very often and therefore has no feel for how hard he must break; he does not press the pedal with all his might. Consequently, the greatest possible brake pressure will not be developed in the system and valuable braking distance is lost. The vehicle may not come to a stop in time.

Emergency Brake Assist

In comparison, let's look at a car in the same situation but with a brake assist system. As before, the brakes are not applied with sufficient force. Based on the speed and force with which the brake pedal is pressed, the brake assist system detects an emergency. The brake assist system increases the brake pressure until the ABS regulation intervenes to prevent the wheels from locking. This way the greatest possible braking effect can be achieved and the brake path can be shortened significantly.

Actual working of the EBA-system

When the brake is pressed beyond the ABS limit the EBA-limit switch is operated which will actuate the solenoid mounted on the master cylinder of the EBA system. The master cylinder injects high pressure oil into the brake calliper, this will close the calliper fully thereby applying emergency brake and preventing the head on collision with the front vehicle.

Hybrid Braking System with combination of ABS-EBA With Electro-Hydraulic Thruster

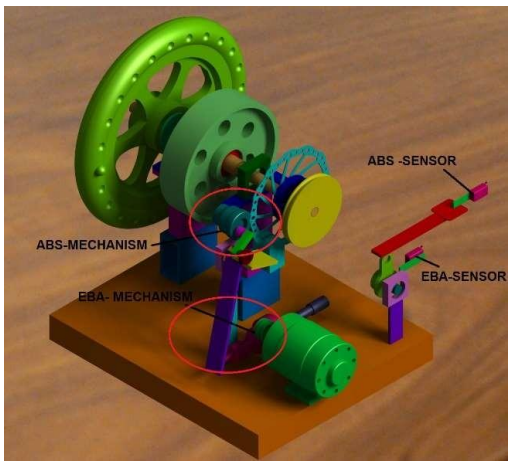

Figure 3: CAD Design

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Hybrid system has three components

1. ABS – Braking Mechanism
2. EBA – Braking mechanism with electro hydraulic thruster
3. Low-cost automation circuit using limit switches to indicate the ABS and EBA limits of braking.

Applications

1. Light commercial cars
2. Motor Bikes
3. Medium commercial vehicles
4. Sports cars
5. Heavy trucks etc.

Problem statement

Many accidents caused by ignoring right-of-way, driving on the wrong side of the road, inappropriate speed, insufficient distance from other vehicles and so on might have been prevented had the vehicles been able to brake faster. Studies have shown that many drivers do not apply the brakes sufficiently in emergency situations due to lack of experience. The greatest possible braking effect is not attained because the drivers did not press the brake pedal hard enough. Therefore, the brake assist system was developed to support the driver in critical braking situations.

Objectives

Objective of project is determination of braking force required for emergency braking at three operating speed condition and selection of the braking system arrangement i.e., disk brake and calliper arrangement suitable for derived conditions. Design Development & analysis of electro -hydraulic thruster mechanism with three step operation modes. 3-D cad modelling using Unigraphics and analysis for strength of critical components of the thrusters using ANSYS. Development of Emergency brake assist system test rig to test the electro-hydraulic thruster to determine braking distance determination for individual stages i.e., three individual vehicle speeds and carry out comparative study of the theoretical braking force and braking distance to experimental braking force and braking distance and there by validation of result. Iterative methods will be used to predict safe braking distance at various vehicle speeds for different settings of EBA thruster mechanism.

Design of Project

Design consists of application of scientific principles, technical information and imagination for development of new or improvised machine or mechanism to perform a specific function with maximum economy & efficiency.

Hence a careful design approach has to be adopted. The total design work, has been split up into two parts;

- System design
- Mechanical Design.

System design mainly concerns the various physical constraints and ergonomics, space requirements, arrangement of various components on main frame at system, man + machine interactions, No. of controls, position of controls, working environment of machine, chances of failure, safety measures to be provided, servicing aids, ease of maintenance, scope of improvement, weight of machine from ground level, total weight of machine and a lot more.

In mechanical design the components are listed down and stored on the basis of their procurement, design in two categories namely,

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- Designed Parts
- Parts to be purchased

For designed parts detached design is done & distinctions thus obtained are compared to next highest dimensions which is readily available in market. This amplifies the assembly as well as postproduction servicing work. The various tolerances on the works are specified. The process charts are prepared and passed on to the manufacturing stage.
The parts which are to be purchased directly are selected from various catalogues & specified so that anybody can purchase the same from the retail shop with given specifications.

System Design:
In system design we mainly concentrated on the following parameters:

1. **System Selection Based on Physical Constraints**
   While selecting any machine it must be checked whether it is going to be used in a large-scale industry or a small-scale industry. In our case it is to be used by a small-scale industry. So, space is a major constrain. The system is to be very compact so that it can be adjusted to corner of a room. The mechanical design has direct norms with the system design. Hence the foremost job is to control the physical parameters, so that the distinctions obtained after mechanical design can be well fitted into that.

2. **Arrangement of Various Components**
   Keeping into view the space restrictions the components should be laid such that their easy removal or servicing is possible. More over every component should be easily seen none should be hidden. Every possible space is utilized in component arrangements.

3. **Components of System**
   As already stated, the system should be compact enough so that it can be accommodated at a corner of a room. All the moving parts should be well closed & compact. A compact system design gives a high weighted structure which is desired.

4. **Man, Machine Interaction**
   The friendliness of a machine with the operator that is operating is an important criterion of design. It is the application of anatomical & psychological principles to solve problems arising from Man – Machine relationship. Following are some of the topics included in this section. Design of foot lever. Energy expenditure in foot & hand operation Lighting condition of machine.

5. **Chances of Failure**
   The losses incurred by owner in case of any failure is an important criterion of design. Factor safety while doing mechanical design is kept high so that there are less chances of failure. Moreover, periodic maintenance is required to keep unit healthy.

6. **Servicing Facility**
   The layout of components should be such that easy servicing is possible. Especially those components which require frequents servicing can be easily disassembled.

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7. **Scope of Future Improvement**
   Arrangement should be provided to expand the scope of work in future. Such as to convert the machine motor operated; the system can be easily configured to required one. The die & punch can be changed if required for other shapes of notches etc.

8. **Height of Machine from Ground**
   For ease and comfort of operator the height of machine should be properly decided so that he may not get tired during operation. The machine should be slightly higher than the waist level, also enough clearance should be provided from the ground for cleaning purpose.

9. **Weight of Machine**
   The total weight depends upon the selection of material components as well as the dimension of components. A higher weighted machine is difficult in transportation & in case of major breakdown, it is difficult to take it to workshop because of more weight.

II. PROBLEM STATEMENT

Many accidents caused by ignoring right-of-way, driving on the wrong side of the road, inappropriate speed, insufficient distance from other vehicles and so on might have been prevented had the vehicles been able to brake faster. Studies have shown that many drivers do not apply the brakes sufficiently in emergency situations due to lack of experience. The greatest possible braking effect is not attained because the drivers did not press the brake pedal hard enough. Therefore, the brake assist system was developed to support the driver in critical braking situations.

III. OBJECTIVES

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IV. CONCLUSION

This paper has described the design and implementation of an integrated brake safety system ensures maximum vehicle safety through combination of ABS and EBA systems of braking system provides substantial transport benefits in terms of protection, performance, affordability and accessibility and the environment in order to achieve its growth objectives It is an indication of the advanced state of the art that these methods have achieved a level that could be widely used in this project. This system is very economical relative to the systems used in luxury vehicles. This aims to reduce the number of facilities due to fatal injuries. This is applicable to low-cost vehicles, which can result in a major decrease in the death rate due to accidents.

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