JOURNAL OF INFORMATION, KNOWLEDGE AND RESEARCH IN MECHANICAL ENGINEERING
ISSN 0975 – 668X| NOV 16 TO OCT 17 , VOLUME –04, ISSUE – 02

DESIGN AND DEVELOPMENT OF AUTOMATIC PNEUMATIC BUMPER SYSTEM

[1]*PROF. M. B. BANKAR*, [2]*PROF. S. K. PAWAR*, [3]*PROF. R. V. LALGE*

[1, 2, 3] **Department of Mechanical Engineering,**
Shri Chhatrapati Shivajiraje College of Engineering, Dhangawadi, Bhor,
Pune-412206, Maharashtra, India.

[1]bankar_mangesh@yahoo.com, [2]sumodpawar@gmail.com, [3]rameshwari_lalge@yahoo.com

ABSTRACT :
India is the largest country in the use of various types of vehicles. As the available resources to run these vehicles like quality of roads, and unavailability of new technologies in vehicles are causes for accidents. Though there are different causes for these accidents but proper technology of braking system and technology to reduce the damage during accident are mainly affects on the accident rates. So today implementation of proper braking system to prevent the accidents and pneumatic bumper system to reduce the damage is must for vehicles. To achieve this system modification goal, design this "Automatic Pneumatic Bumper system". the work is a good solution to bridge the gates between institution and industries And able to understand the difficulties in maintaining the tolerances and also quality.

KEYWORDS: *Automatic Pneumatic Bumper system, Antilock Braking System (ABS), Electro-hydraulic system.*

1. Introduction

Today India is the most important under developed country in the world. India is the largest country in the use of various types of vehicles. As the available resources to run these vehicles like quality of roads, and unavailability of new technologies in vehicles are causes for accidents. The number of peoples which are dead during the vehicle accidents is also very large as compared to the other causes of death.

Though there are different causes for these accidents but proper technology of braking system and technology to reduce the damage during accident are mainly affects on the accident rates. So today implementation of proper braking system to prevent the accidents and pneumatic bumper system to reduce the damage is must for vehicles. To achieve this system modification goal, design this "Automatic Pneumatic Bumper system".

We have pleasure in introducing our new project "Automatic Bumper System for Four Wheelers", which is fully equipped by IR sensors circuit and Pneumatic bumper activation circuit. It is a genuine project which is fully equipped and designed for Automobile vehicles. This forms an integral part of best quality. This product underwent strenuous test in our Automobile vehicles and it is good.

1.1 Problem Statement

In conventional vehicles there are different mechanism operated for braking system like hydraulic, pneumatic, air, mechanical, etc. But all these braking mechanisms receive the signal or input power directly from the driver so it totally manual operated. When the driver saw the obstacle or any vehicle in front of his driving vehicle, he was irritated or becomes mazy.
Due to this the driver fails to give the proper input to braking system and proper working is not occurs. Also the driver may not able to pay the full attention during night travelling so there are many chances to accidents. After the accident occurs, there is no any provision to minimize the damages of vehicles. In currently used vehicles generally bumpers used are of rigid types.
These bumpers have specific capacity and when the range of the accidental force is very high then the bumpers are fails and these force transferred towards the passengers. So this system never reduces the damage of both vehicle and passengers. To overcome these unwanted effects design the Automatic Pneumatic Bumpers is important.

1.2 Objectives

The objective of this project includes:
1. To increase the sureness of braking Application.
2. To increase the response time of braking system.
3. To improve the pre-crash safety.
4. To avoid the percentage of passenger injury by using external vehicle safety.
5. To reduce the requirement of internal safety devices like air bags.

2. Literature Survey

The aim is to design and develop a control system based on pneumatic breaking system of an intelligent electronically controlled automotive braking system. Based on this model, control strategies such as an 'antilock braking system' (ABS) and improved maneuverability via individual wheel braking are to be developed and evaluated.

There have been considerable advances in modern vehicle braking systems in recent years. For example, electronically controlled ABS for emergency braking, electronically controlled hydraulically actuated individual brake-by-wire (BBW) systems for saloon cars and electronically controlled pneumatically actuated systems for heavy goods vehicles. The work of recent years shall form the basis of a system design approach to be implemented. The novelty of the proposed research programmed shall lie in the design and evaluation of control systems for achieving individual wheel motion control facilitated by BBW. In the case of BBW the brake pedal is detached from the hydraulic system and replaced by a 'brake pedal simulator'. The simulator provides an electrical signal for the electronic control system.

Preliminary modeling and simulation work considers a quarter cars initially followed by a natural progression to the half car and full four wheel station cases. The model is to be constructed in modular form thus allowing the replacement / interchange of the various blocks and their associated technologies. Upon completion of the full vehicle braking model, sensitivity analyses will be carried out. Once the preliminary simulation model has been thoroughly benchmarked and existing control system strategies evaluated, an audit of the technology used is to take place and this will provide a basis for comparison of iterative technologies / techniques.

The final phase of the new modern vehicle shall include:

- Development of improved ABS control systems
- Development and assessment of an electro-hydraulic-BBW (EH-BBW) system
- Individual wheel braking combined with traction control
- Assessing sensor failure and fault tolerant control system design
- Preliminary studies into an electrically actuated system

3. Components Used

The pneumatic bearing press consists of the following components to fulfill the requirements of complete operation of the machine.

3.1. Pneumatic Cylinder

Double-acting cylinders are used more often in pneumatic systems than single-acting cylinders. They are able to produce bigger forces and we can make use of the outstroke and in stroke for pushing and pulling.

3.2. Solenoid Valve

The directional valve is one of the important parts of a pneumatic system. Commonly known as DCV, this valve is used to control the direction of air flow in the pneumatic system. The directional valve does this by changing the position of its internal movable parts.

This valve was selected for speedy operation and to reduce the manual effort and also for the modification of the machine into automatic machine by means of using a solenoid valve. A solenoid is an electrical device that converts electrical energy into straight line motion and force. These are also used to operate a mechanical operation which in turn operates the valve mechanism. Solenoids may be push type or pull type. The push type solenoid is one in which the plunger is pushed when the solenoid is energized electrically. The pull type solenoid is one is which the plunger is pulled when the solenoid is energized.

Solenoid and spring mechanisms are used to displace the spool valve in case of the solenoid actuation directional valve (or simply solenoid directional valve) as shown in Fig. 6.4. Similarly, solenoid actuation can also be used with 3/2 ways directional valve.

There are three connections, or valve ports, labeled as A, B and C, respectively. As long as the valve remains in the left position, left rectangle, there is airflow from port A to C, while port B is blocked. When this valve is shifted to its right position, right rectangle, port A blocked, while port B and C are connected. The arrowheads shown on the symbol are optional, they indicating the airflow directions

3.3. Limit Switch

Limit switches use a mechanical actuator input, requiring the sensor to change its output when an object is physically touching the switch. Sensors, such as photoelectric, inductive, capacitive, and ultrasonic, change their output when an object is present, but not touching the sensor.

Mechanical limit switches, which will be covered in the next section, use a different set of symbols. Highlighted symbols are used for illustrative purposes only.

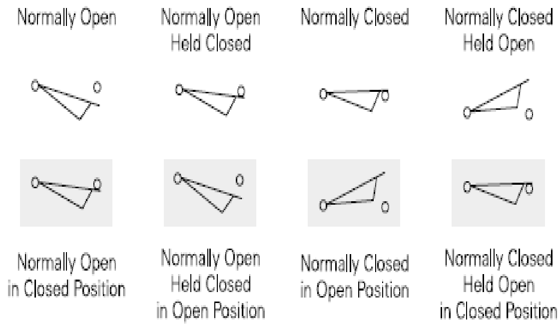

Fig.1. Limit Switches Symbols

3.4. Bumper

With the great number of pedestrian deaths and injuries occurring from automobile accidents, an effort is being made worldwide to establish automobile safety regulations for pedestrian protection. The hood and bumper, with which pedestrians come in frequent contact, can be designed and manufactured to be pedestrian friendly, effectively decreasing injuries [1-2]. During the development of a safe hood and bumper structures, experiments and computer simulations are used to evaluate their performances. Computer simulations contain many errors from inaccurate modeling and approximation of governing Equations. On the other hand, experiments are considered to be accurate even with the possibility of experimental errors and inaccuracies. In design, it would be the best if all the data could be obtained from experiments. However, an experiment is generally very costly. Therefore, limited experiments are performed in many application fields .Orthogonal arrays are exploited very well for experiments with a limited number. They are used for the matrix experiments in design of experiments (DOE) [3]. When an experiment is extremely expensive, even the experiments with an orthogonal array are almost impossible to conduct in order to find good design. In this case, some experiments can be replaced by computer simulations. As mentioned earlier, computer simulation has a large amount of errors [4].
A method is utilized to simultaneously use experiments and computer simulations in an orthogonal array. Experiments and simulations are assigned to the rows of an orthogonal array. The method of the assignment is proposed to minimize the error. The error is reduced since it is distributed evenly. The automobile hood and bumper structures are designed from the results of the orthogonal array. The results indicate that the proposed method finds design variables accurately.

3.5. Pedestrian impacts on vehicle

Pedestrian accidents make up a large portion of traffic accidents. In the year 2000, pedestrian casualties numbered 19.0% (7,000) in Europe, 11.3 %(4,739) in the U.S., 28.3% (2,605) in Japan, 38.0%(3,890) in Korea, and 50% (19,000) in China. There were also numerous cases of injuries - over 300,000 in Europe, 78,000 in the U.S., 86,000 in Japan and74,102 in Korea [1-2][6].Most pedestrian injuries (AIS 2-6) are head, face, and neck injuries, accounting for 36.9% and leg injuries accounting for 32.4% [7]. AIS (abbreviated injury scale) is an index used to classify injuries into 7levels, from AIS 0 (no injuries) to AIS 6 (death). The greatest causes for head injuries are automobile windshields (33.5%), hood and wing surfaces (19.5%), and window frame and A-pillar (17.2%). The causes for leg injuries are bumpers (61.2%) and vertical parts of the hood (12.1%).

3.6. Battery

The battery is an essential component of almost all aircraft electrical systems. Batteries are used to start engines and auxiliary power units, to provide emergency backup power for essential avionics equipment, to assure no-break power for navigation units and fly-by-wire computers, and to provide ground power capability for maintenance and preflight checkouts. Many of these functions are mission critical, so the performance and reliability of an aircraft battery is of considerable importance.

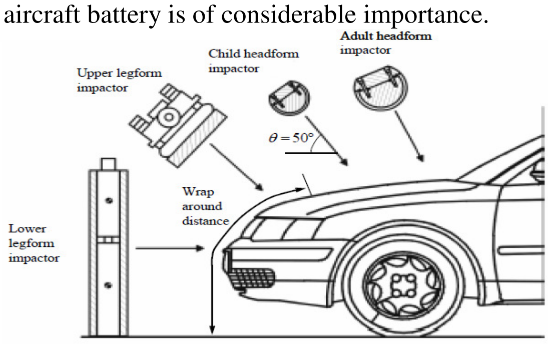

Fig.2. Pedestrian impacts on vehicle

Other important requirements include environmental ruggedness, a wide operating temperature range, and ease of maintenance, rapid recharge capability, and tolerance to abuse.

3.7. Air Compressor System

A compressed air supply within a manufacturing plant or an automotive collision and body shop often consists of one compressor that can meet the overall air requirements. Makes sense, right? But consider an alternative: multiple smaller horsepower compressors positioned at strategic points throughout the plant or shop. These compressors would feed into a common air line or into individual lines serving one or more points of use.
In the central system, the compressor is of a size to supply total compressed air requirements, at least in the beginning. This option has the advantage of one compressor, one point of maintenance, and one electric power connection. The potential disadvantage is the requirement of more piping, which causes the system to be costly to install and more costly to maintain.
In the alternate system, the plant or shop starts with a single small compressor installation. Then, as expansion takes place, instead of replacing the single unit with a larger capacity single unit, another unit of the same size is installed.
Initial cost is less in the smaller multiple units than in the larger central unit. Maintenance cost is less, and cost of operation is also less, since each unit operates independently of the others. This is the optimum compressor installation—one that has the lowest installation, maintenance, and operating costs, and also the flexibility to meet changing requirements of a

shop or plant. Hence, many plants have started to follow the trend towards smaller multiple compressor units.
Further advantages of multiple units are: one standby compressor can serve a number of departments; units are complete and ready for electric and air piping connections; no special foundation is required; units are usually air cooled, thus saving on water and installation cost; and units are easily moved from place to place. In addition, smaller units can meet a plant's special, occasional, or part-time requirements, with notable savings in cost of operation.

Specification of compressor:

Type: Rotary air compressor
Input voltage: 12volt 2.5 amp
Output pressure: 3bar capacity
Discharge: 25 cm^3/s

4. Construction & working of model

Our system includes vehicle frame with wheels and chassis only.On chassis we mountain the piston cylinder arrangement fixed by bolts. At the front of vehicle we mount bumper which can slide in its guide ways.Guide ways provided for its linear back and front linear sliding motion. We also create braking pedal system for actuation of limit switch. Its construction is illustrated as follows in figure**:**

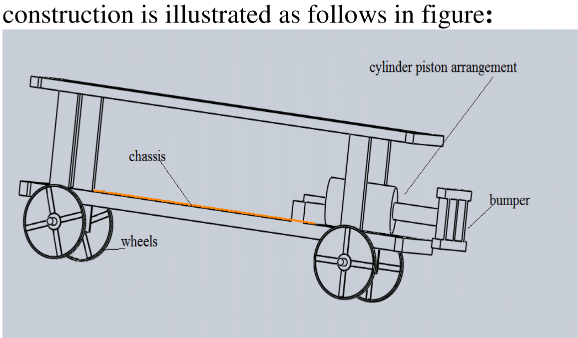

Fig.3. Construction of model

Working of model:

The working of model is much simpler that when driver applies brake more than its maximum braking limit it closes the limit switch contact points and generates output signal then it sends signal to direction control valve and it gets actuated. The solenoid direction control valve is used in this system. When it gets signal and opens the pneumatic valve as a result it pushes the piston forward along-with flexible bumper.
There by due to compressible properties it absorbs the sudden shocks on vehicle chassis and releases when obstacle rare.
The aim is to design and develop a control system based an intelligent electronically controlled automotive bumper activation system is called automatic bumper. This system is consists of IR transmitter and Receiver circuit, Control Unit, Pneumatic bumper system.
The system includes cylinder piston arrangement with flexible bumper system as follows:

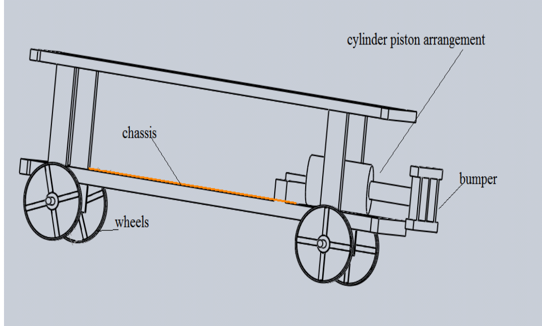

Fig.4. Working of model

5. Design Procedure

We should design this bumper piston cylinder assembly according to the stroke length and weight of bumper which has to be lift.

Weight and area calculation for bumper:
Frame of bumper has 3 flanges as follows:
2 flanges of 260mm×20mm
2flanges of 70mm×20mm

Area of bumper = (2×area of horizontal flange) + (2×area of vertical flange)
= (2×(260×20)) + (2×(70×20))
= 2×5200+2×1400
=10400+2800
=13200mm^2

Weight of bumper= 3.5 kg.
So we have to design cylinder piston which can pull 3.5 kg load.

Specifications of bumper as follows:
1. Weight of bumper: 3.5 kg
2. Required stroke length must be up to: 20 mm

Now we should design piston cylinder as it fulfills above requirement.

5.1. Cylinder piston design

Cylinders are used to convert fluid power into mechanical motion. A cylinder consists of a cylindrical body, closures at each end, movable piston, and a rod attached to the piston.

When fluid pressure acts on the piston, the pressure is transmitted to the piston rod, resulting in linear motion. The piston rod thrust force developed by the fluid pressure acting on the piston is easily determined by multiplying the line pressure by the piston area.

FORCE = PRESSURE x AREA or F = PA
First we select the air compressor which has capacity of 3bar pressure.
For this project according to factor of safety we should design the piston cylinder which can apply pull force load of 3.5 kg. So for trail we select 25mm diameter piston with 25 mm stroke.

Further calculations as follows:
The piston area has to be determined first to solve this problem. The area of a circular surface is πr^2, where "r" is the radius.

In the case of a 25 mm diameter piston, the area equals 490.87 square mm(πr^2). Since a pressure of acts 3bar on each square mm,

The total thrust force will be
= 490.87*10-6 * 3*105
=147.361 N.

To convert it into kg.devide by 9.81
147.361/9.81= 15.01 kg.

Thus the piston cylinder can lift up 15 kg load at 3 barthrough out 25 mm stroke length.
Hence we select

Piston cylinder specification:
Stroke length: 25 mm diameter
Diameter: 25 mm
Pull force capacity: up-to 15 kg

Direction control valve specification:
5*2 DCV
Actuation: solenoid operated DC coil
Coil voltage ratings: 12 volt (0.5 amp to 2 amp)

Specification of compressor:
Type: Rotary air compressor
Input voltage: 12volt 2.5 amp
Output pressure: 3bar capacity
Discharge: 25 cm^3 / s

Material used for chassis:
Square mild steel pipe of 20mm×20 mm

Battery:
Output: 12 volt 2.5 amp dc supply.

Drive:
Dc motor
Input: 12 volt 1 amp
Speed: 10 rpm

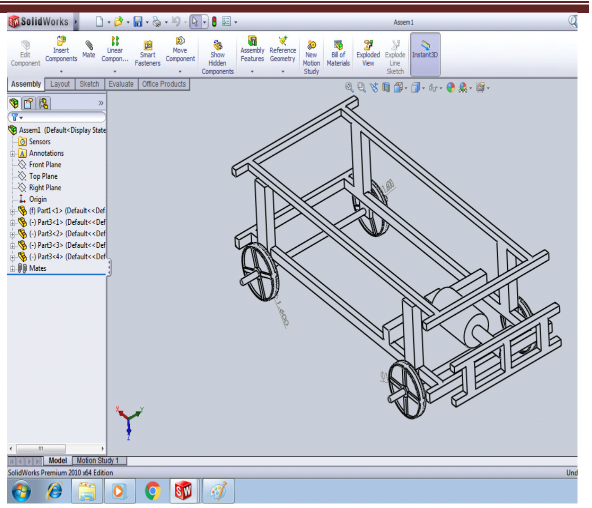

Fig.5. Actual Model

6. CONCLUSION AND FUTURE WORK

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between institution and industries. We are able to understand the difficulties in maintaining the tolerances and also quality. We have done to our ability and skill making maximum use of available facilities.
There is lot of scope for future development in vehicle. The technology of pneumatics has gained tremendous importance in the field of workplace rationalization and automation from old-fashioned timber works and coal mines to modern machine shops and space robots. It is therefore important that technicians and engineers should have a good knowledge of pneumatic system, air operated valves and accessories.
The aim is to design and develop a control system based an intelligent electronically controlled automotive bumper activation system is called "Automatic Bumper System for Four Wheelers". This system is consists of IR transmitter and Receiver circuit, Control Unit, Pneumatic bumper system. The IR sensor is used to detect the obstacle. There is any obstacle closer to the vehicle (within 4 feet) the control signal is given to the bumper activation system.

4. REFERENCES

[1] UNECE/TRANS/WP.29/AC.3/7,"Proposal to Develop a Global Technical Regulation Concerning the Protection of Pedestrians and Other Vulnerable Road Users in Collision with Vehicles, http, 2004.

[2] Schuster, P. J., "Evaluation of the Real-World Injury-Reduction Potential of the Proposed European Pedestrian 'Leg-form' Impact Test Using a Detailed Finite Element Model of the Lower Limb," Michigan Technological University, 2000.

[3] Phadake M. S., Quality Engineering Using Robust Design, Prentice Hall, Englewood Cliffs, New Jersey, USA, 1989.

[4] Park, G. J., "A Design Methodology with Orthogonal Arrays Using Experiments and Computer Simulations," J. of KSME (A), Vol.28, No.7, pp. 885-895(in Korean), 2004.

[5] Lee, J. W., "Vehicle Hood and Bumper Structure Design to Mitigate Casualties of Pedestrian Accidents," Ph.D. Dissertation, Hanyang University, Seoul, Korea (in Korean), 2004.

[6] EEVC Working Group 17 Report, "Improved Test Methods to Evaluate Pedestrian Protection Affected by Passenger Cars," European Enhanced Vehicle-Safety Committee, 1998.