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Advanced Pneumatic Bumper For Vehicle Safety

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ABSTRACT : In automobiles, safety considered as a key thing while designing. The vehicle frontal structure has a bumper, structural parts, which resist and reduces damages due to vehicle frontal crashes and ensures safety by absorbing the impact. The Pneumatics plays a major role in the field of automation and actuation control techniques. The aim is to design and fabricate an automated pneumatic based vehicle bumper system that uses a sensor with a pneumatic operated bumper in order to avoid car dents and scratches. This system incorporated with an IR transmitter and Receiver circuit, Control Unit, Pneumatic bumper system. The IR sensor senses the obstacle, which approaches the vehicle. When there is any obstacle closer to the vehicle (within 2-3 feet), the control signal is given to the electronic circuit which actuates the bumper automatically to absorb the impact and stopping it from coming too close to the vehicle body. This prevents vehicle damage and ensures the safety of the inmates. This system only actuated when the vehicle speed is above 30-40 km/hr. This vehicle speed sensed by the proximity sensor and monitored continuously, this signal given to the control unit, and it actuates the pneumatic bumper system accordingly.

Index Terms: Bumper Design, Electronic Circuit, IR Sensor, Pneumatic Cylinder, Solenoid valve, Vehicle Bumper, Vehicle Safety.

INTRODUCTION

The target is a safety system based on the pneumatic actuation of the vehicle bumper. This system guarantees passenger safety within the vehicle. The ultimate objective of this model is to absorb impact force while a collision takes place without passing force to the car body. It minimizes the severity of the damage caused by the vehicle crash and improves the safety of vehicle insiders. Several scientists performed different experiments with stroke models and stroke content. The bumpers absorb the force of impact that is the cinematic energy generated by the collision during deformation. Therefore, the material for the bumper is important in restricting the impact force.

2. REVIEWOFBUMPERANALYSIS

2.1 Procedure for Static Analysis:

Code reaches the values of various features, such as mass density, Young's modulus, Poisson ratio, and thermal conductivity. A further major step is the meshing by selecting the part mesh using the C3D10 M element, which allows seeds and the global size of as 50 to be finer. The next step in the process is to integrate the code. This analysis based on the general analysis of the static form. After that, the boundary conditions and the load must be applied. The choice of the area where the motions were arrested also relevant while applying the boundary condition.

2.2 Procedure for Impact Analysis

Dynamic-explicit type of analysis used for completion of impact analysis in ABAQUS. Then the creation of a datum point at the center of the plate is necessary. For meshing, the seeding is important, in the seeding the entire geometry divided into small elements having size 35. The type of element used is C3D10M (10-node modified quadratic tetrahedron). The

meshing of the entire geometry results in 5873 nodes and 2762 elements. Meshing only needed to the bumper.

3. EFFECT OF THE BUMPER ON CRASHES

3.1 Bumper Test Configurations:

On each model vehicle, four different crash tests are carried out on the contoured, bumper-like barrier. Total simultaneous checks for front and rear were performed at 10 km / h and tests for the front and rear corner at 5 km / h. The four tests were conducted to facilitate reliable and stable interfaces between cars in the fleet and to ensure energy absorption.

In order to simulate a broader spectrum of impacts on actual road collisions, the barrier heights for the overlap and corner analysis differ. The four checks were conducted by two cars.

3.2 Impact Barrier Specifications:

The impact barrier with a radius of 3.404 mm and a flat vertical area of 102 mm has been applied to all bumper tests. The barrier is made of a steel plate of 12,5 mm and is mounted to a block of 145,150 kg of enhanced concrete. The upper surface of the buffer wall has a metal backstop. The rear end also has a 12.5 mm steel platform with a width of 1.524 mm with a radius of 3.404 mm and a flat vertical surface of 200 mm. The back-end positioned 25 mm from the rear of the barrier with its middle offset. The impact zone of the barrier face with nylon push-pin rivets is attached to a plastic energy absorber. Likewise, the upper and lower flanks with an overlying plastic cover are placed on the barrier by slots. Net Shape Company manufactures the energy absorber and cover and has a diameter of 152 mm from top to bottom. It has a length of 1.524 mm, a thickness of 102 mm and a width of 51 mm.

3.3 Photography:

Tests are recorded using at least one overhead and one digital image imager mount (500 fps) or film camera (125 fps) and the Sony Betacam video camera mounted on the floor (30 fps). After the test is done, a digital still camera is used to document any resulting damage. The vehicle is photographed More closing photographs are taken with ready visible damage; photographs are also taken in order to record concealed damage during the wear down / assessment process.

4. METHODOLOGYANDDESIGNDEVELOPMENT

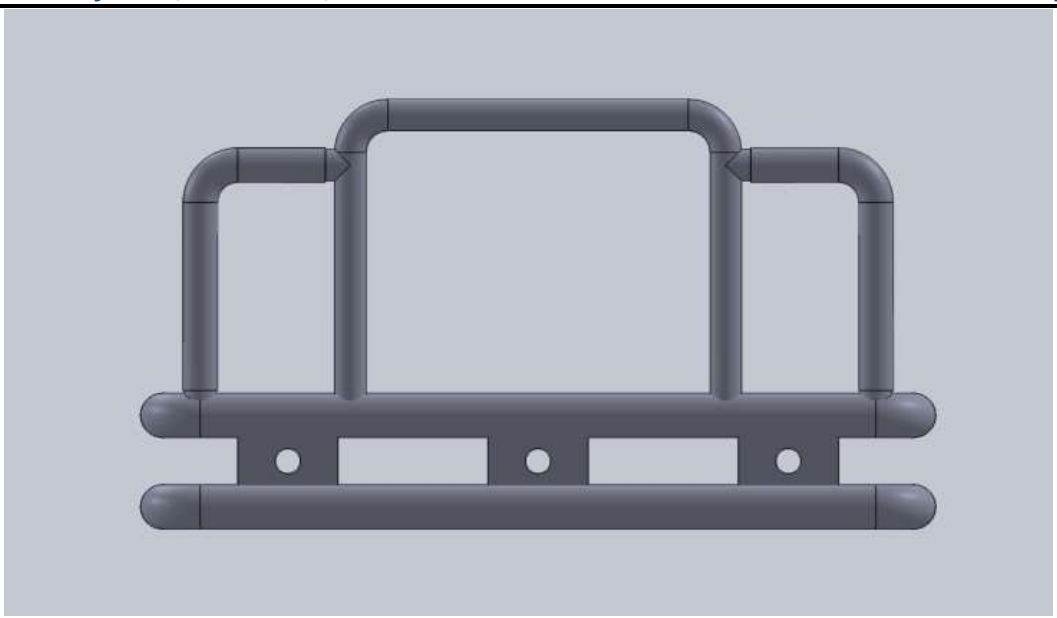
4.1 Methods of Concept Development:

The design is based on the design and development method of the products. Next, it is recognized the need for the automatic pneumatic bumper system. The different theoretical concepts were defined for the development of the process. A thorough analysis of the principles is carried out using a scoring matrix and the best product between various types of materials is chosen by the grading process. Finally, for the appropriate dimensions, the selected material and design shall be reviewed.

4.2 Concept Generation

The automated pneumatic bumper system is designed and developed using the “Concept Development process” method as shown in Fig 2. Concept generation is the process of introducing new ideas based on the inputs and complaints provided by the customers. The four steps involved in concept generation are listed below.

- Compressor – compressor used to create air and it is stored in the reservoir tank.
- IR sensor – IR sensor used for detects the object.
- Solenoid – solenoid actuates the DCV.
- Pneumatic cylinder – it is used to extend and retract the bumper .



5. Bumper Design

The design was slightly varied from the conventional bumper design. The circular channels were used in the design, which is uncommon among the commercially available in the vehicle bumper. The diameter of the channel used was 25 mm. The thickness used was around 3 mm. The front length of the bumper is 156 cm. The bumper is modeled using SOLIDWORKS software and the end product was reviewed.

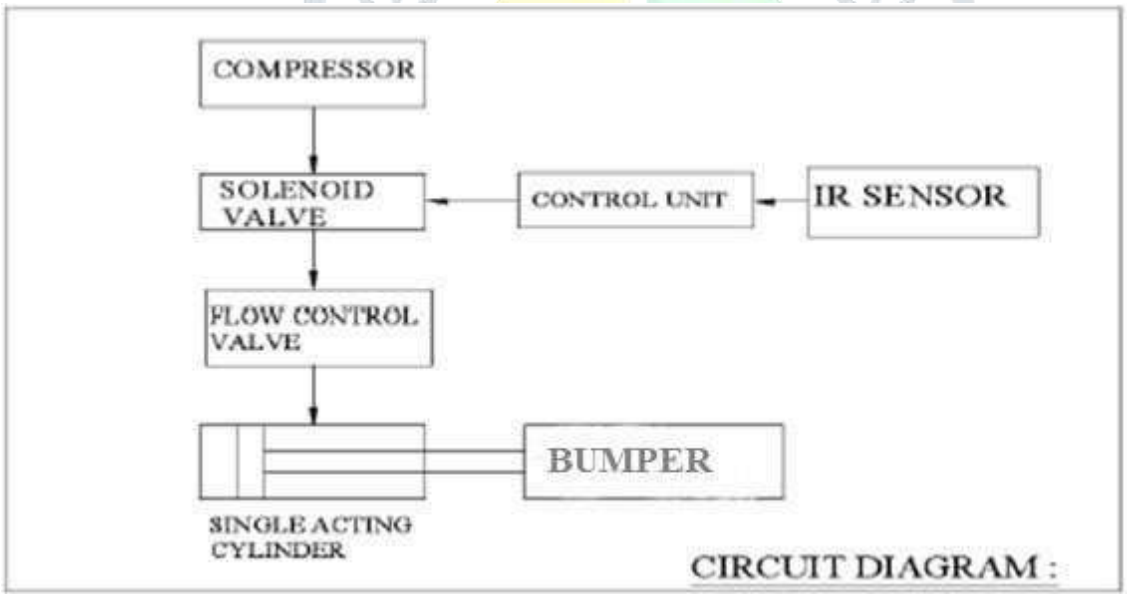


Fig 3. 3-D modeling of bumper

5.1 Concept :

The pumper first material is mild steel. It's containing approximately 0.05 – 0.25% carbon making it malleable and ductile. Mild steel has a relatively low tensile strength, but it is cheap and easy to form. Surface hardness can be increased through carburizing. Mild steel also has easy machinability . So the main reason behind using mild steel is manufacturing material is its excellent machinability . The most important properties of steel are great formability and durability. The density of the material is 7850 kg/m3and young's modulus is 206GPa and yield stress is 318MPa. The mild steel bumper is undergoing impact force and stress concentration analysis using ANSYS software.

Aluminum alloy is in which aluminum is the predominant metal. The typical alloying elements are copper, magnesium, manganese, silicon, and zinc.

spring dashpot system. GMT damping parameter of c=0.015.the above Table III shows that GMT is about 85% and 77% respectively lightweight and exceeding yield strength

6. DESIGN ANALYSIS OF BUMPER SYSTEM:

6.1 Load Analysis:

During vehicle collision, the impact force is calculated and then the calculated impact force is applied on the bumper materials. Impact force calculation mass of the vehicle and vehicle initial and final velocity are considered.

6.2 Impact force:

For calculating the impact force of the vehicle mass of the vehicle consider as 20kg and accidents are happen more than 30 km/hr. so vehicle speed is considered as 35 km/hr.

Mass of the vehicle = 20 kg (approx)
Acceleration = final velocity – initial velocity/time
Vehicle speed = 35 km/hr
When it hit an object, coming to a complete stop in 0.05 seconds = 0 - 9.72 /0.05 = - 194.44m/s2

Force = Mass*Acceleration = 194.44*20

Impact Force = 3888.8N

6.3 Aluminium Alloy Bumper Analysis:

The impact force of 3888.8 N applied in the steel bumper to deformation and stress concentrations are noted. During vehicle collision, aluminum alloy bumper get less deformation and stress concentration also less

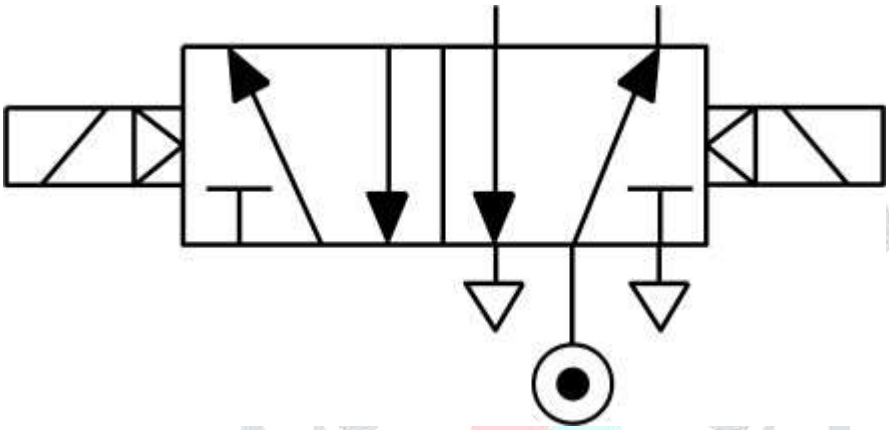


Fig 6. Aluminum Alloy Deformation

Pneumatic cylinder pulling capacity:

Force = Pressure x Area

Air compressor of 3 bars pressure.

Pneumatic cylinder piston diameter = 25mm

Area of the piston = лR2

= 490.87 mm2

Total thrust force = 490.87 x 10-6 m2 x 3 x 105 Nm2

= 140.36 N

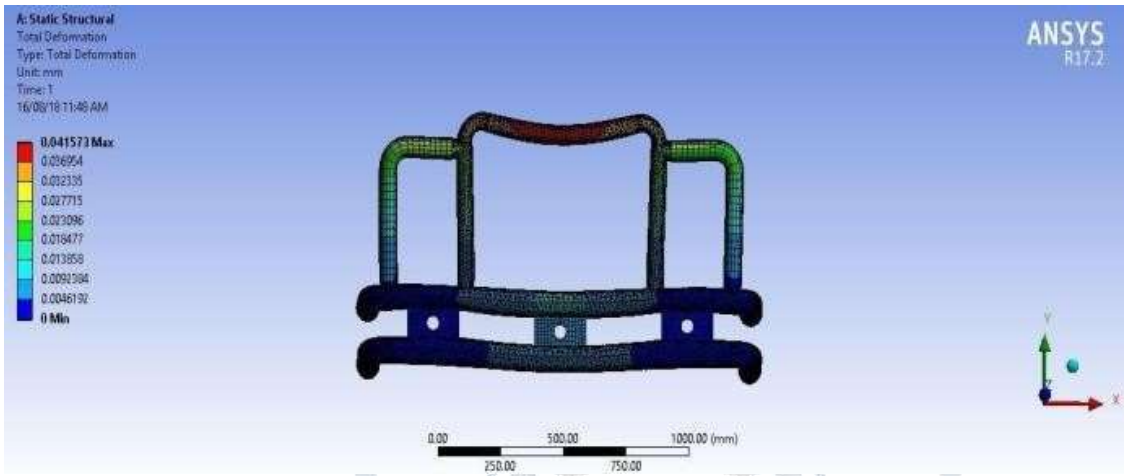
Load = 140.36/9.81

= 15 kg capacity of pull force.

The 25mm diameter of pneumatic cylinder pulling up to 15kg

7.2 Direction Control Valve

The directional valve is one of the important parts of a pneumatic system. A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid. In the case of a two-port valve, the flow is switched on or off, in the case of a three-port valve, the outflow is switched between the two outlet ports.



8.1 Electric work:

- Arduino Uno
- IR sensor
- Hall sensor

REFERENCES

[1]Hosseinzadeh RM, Shokrieh M, and Lessard LB, “Parametric study of automotive composite bumper beams subjected to low velocity impacts”, Composite Structures 68 (2005) 419–427, Elsevier Ltd.

[2]J. T. Wang General Motors Corporation, United States, Paper No. 05-0144, An extendable and retractable bumper (E/R bumper)

[3]Bradley E. Heinrichs, Jonathan M. Lawrence, and David J. King MacInnis Engineering Associates,” Low-Speed Impact Testing of Pickup Truck Bumpers”.

SAE Paper 2001-01-0893.

[4]Pneumatic Control System Stroll & Bernaud, Tata International Journal of
Innovative Technology and Exploring Engineering, ISSN: 2278–3075 (Online), Volume-9 Issue-1, November 2019, Page No. 126-133

9. CONCLUSION

Thus, the proposed project pneumatic bumper system is fabricated and developed as per the design and calculations are done for this system. The pneumatic bumper is to reduce vehicle damage during a vehicle collision

[5]M.M. Davoodia,b, S.M. Sapuan b, A. Aidy c, N.A. Abu Osman a, A.A. Oshkour a,

[6]W.A.B. Wan Abas," Development process of a new bumper beam for passenger car", Materials and Design 40 (2012) 304–313.

[7]Bradley E. Heinrichs, Jonathan M. Lawrence, Boyd D. Allin, James J. Bowler,
Craig C. Wilkinson, Kurt W. Ising, and David J. King MacInnis Engineering Associates," Low-Speed Impact Testing of Pickup Truck Bumpers". SAE Paper 2001- 01-0893.

[8]Sathiskumar S, Dhavaneeswaran N, Dhanush Guru R. Performance and Emission Testing of Methyl Ester of Aloe vera using Metal Oxide as Additive in CI Engine.