Design and Analysis of Bumper for Safety using Unconventional Compressor

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Abstract

The main objective of the project is to provide the safety to the vehicle by reconstructing the bumper of the vehicle using unconventional compressor. In this the compressed air is generated from the oscillation of suspension system by unconventional means. The compressed air produced is stored in the air reservoir of 30 liters, which results in producing of pressure of 10 PSI. The compressed air is passed through tubing's behind the bumper. As a result some of the collision energy produced during collision is absorbed by this reconstructed bumper. The bumper is designed in CATIA modelling software and crash analysis of the bumper is done on LS dyna software which shows the results of energy absorbed during collision, deformation, plastic strain energy and gives the internal energy and kinetic energy graph.

I. Introduction

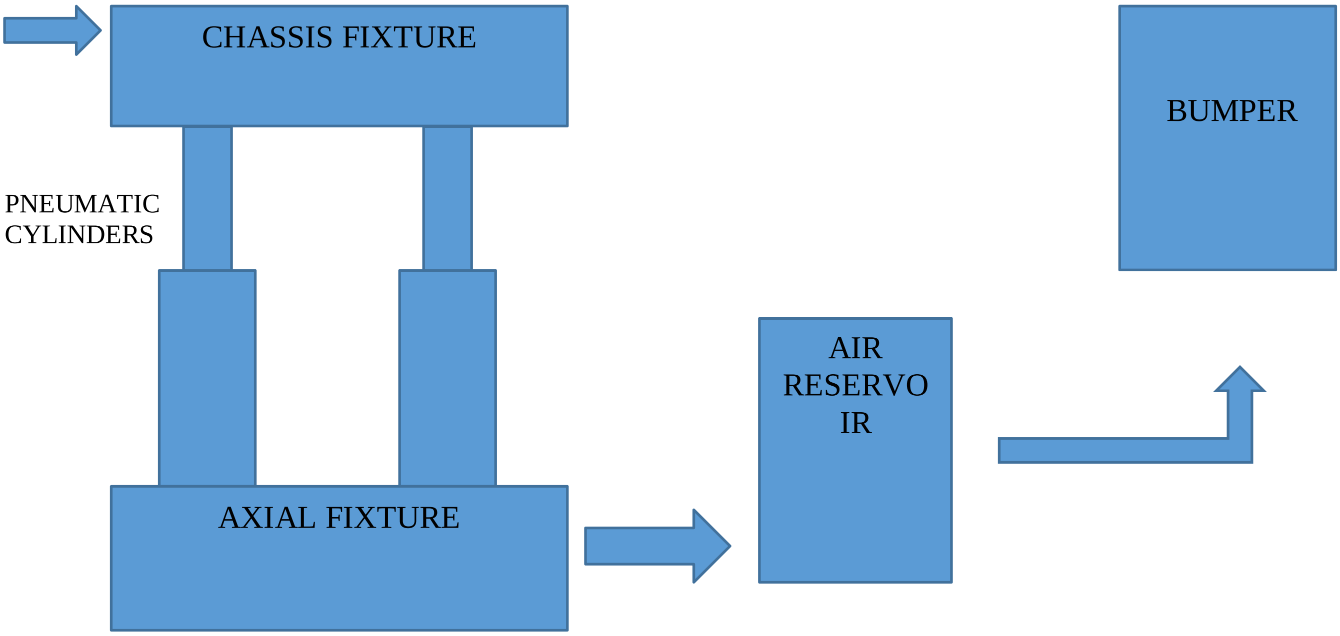
BUMPERS
Bumpers are generally beams, stays, shock absorber and fascia. Bumpers are structural components installed to reduce physical damage to the front and rear end of a passenger motor vehicle from low-speed collisions. Vehicle bumpers could be expected to play a major role in preventing or limiting the damage. However, regulatory requirements for car bumpers are inadequate, and many passenger vehicles are not even required to have bumpers. In many a cases, vehicles involved in front to rear crashes sustained significant damage to safety equipment's and cosmetic parts. Review of real-world crash damage indicates main components of good bumper design that currently are lacking on many passenger vehicles: compatible geometry, stability during impacts, effective energy absorption, cost reduction, higher fuel efficiency, and recycle-ability. Once engaged bumper systems should offer a stable interface and remain engaged throughout the impact. The Gas tube bumper system is a proposal for small passenger cars to answer today's important issues that automotive society is facing with.

HYPER MESH
Hyper mesh is a FE Modelling software tool. Altair Engineering is a product design and development, engineering software and grid computing software company. Altair was founded by Jim Scape, George Christ, and Mark Kistner in 1985. Over its history, it has had various locations near Detroit, Michigan, USA. It is currently headquartered in Troy, Michigan with regional offices throughout America, Europe and Asia. Altair Engineering is the creator of the Hyper Works suite of CAE software products.

LS-DYNA
LS-DYNA is an advanced general-purpose multi physics simulation software package that is actively developed by the Livermore Software Technology Corporation (LSTC). While the package continues to contain more and more possibilities for the calculation of many complex, real world problems, its origins and core-competency lie in highly nonlinear transient dynamic finite element analysis (FEA) using explicit time integration. LS-DYNA is being used by the automobile, aerospace, construction, military, manufacturing, and bioengineering industries.
LS-DYNA is widely used by the automotive industry to analyze vehicle designs. LS-DYNA accurately predicts a car's behavior in a collision and the effects of the collision upon the car's occupants. With LS-DYNA, automotive companies and their suppliers can test car designs without having to tool or experimentally test a prototype, thus saving time and expense.

UNCONVENTIONAL COMPRESSOR
The objective of the unconventional compressor is to improve the productivity of vehicle in various aspects such as the safety of the vehicle and increasing the performance of the vehicle. automobile industries prefer to increase the productivity by use of unconventional parts which doesn't affect the engine power. Internal combustion engines involve mechanical losses due to relative motions among the components such as Piston, crank and valve trains or bearings. A mechanical efficiency of internal combustion engine (ICE) is 0% at idling and about 90% at high operating load. At the early stage of design, mechanical losses optimization is always a difficult task. A model for simulation of mechanical losses and their extrapolation from the known point is required for estimation of mechanical losses. As the internal parts of an engine move, they rub against each other and lose energy due to friction. The drain of power is the piston rubbing against the cylinder walls. As power output and spin rate increase, the losses due to friction account for a larger portion of the engine's gross output. This is why efficiency falls off above the "sweet spot". Oil is circulated in the engine to reduce friction, but the primary goal is to reduce wear

to an acceptable level. Until recently, engine design did not go to great lengths to further reduce friction and as a result improve efficiency. Ironically, friction becomes more of a problem as engines get smaller. So, when we make an engine smaller to address the partial power problem, we give up some of the gain to increased friction losses.



II. Experimental

The compressed air generated is stored in air reservoir, the output of the air reservoir has 10 PSI, this pressurized air is passed through the back of the bumper through the pipe linings, the bumper is remodeled by constructing of fluid flow pipelines behind the bumper, this pipe lines are surrounded by butyl rubber which is a great absorber of force. by using all components of this an opposite force is generated by the system which gives counter to the collision force. As a result during collision some of the force is absorbed by the compressed air behind the bumper, which leads to slow in propagation of energy to the vehicle body.

III. Results and Discussions

The figures are obtained from the crash analysis done by Ls dyna software. Each diagram shows the individual value on the right hand side which are the energy absorbed values. Both conventional bumper and Gas tube bumper values are shown and compared in the following graphs.

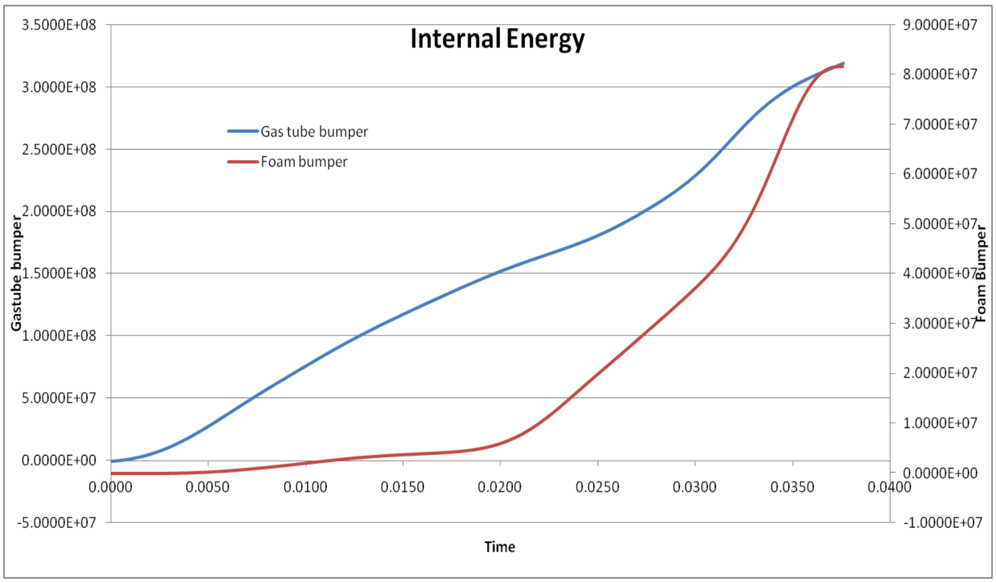


Fig: 3.14: Internal Energy for Gas tube bumper vs Conventional bumper

The internal energy of the Gas tube bumper increases smoothly whereas the conventional Bumper increases suddenly after a particular period of time. Energy absorbed at each individual point of the bumper respective to the time is efficient for gas tube bumper compared to conventional bumper. The red line represents the energy absorbed by the foam bumper, where as the blue line represents the energy absorbed by the gas tube bumper. The graph shows that energy absorbed by the gas tube bumper is higher compares to conventional bumper. The damage caused during collision is lower compared to conventional bumper. The internal energy absorbed by gas tube bumper is 52% higher than conventional bumper.

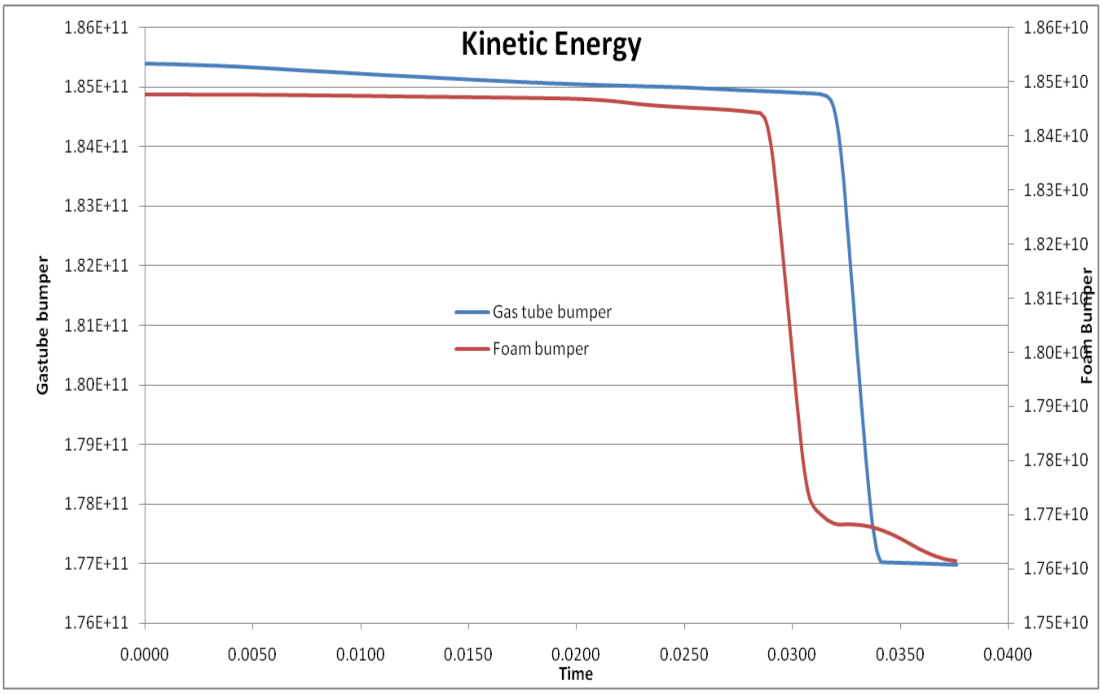


Fig: Kinetic Energy for Gas tube bumper vs Conventional bumper

The above graph shows the value obtained from both the conventional bumper and the gas tube bumper. The value obtained by the gas tube bumper is more which shows that energy can be absorbed more in gas tube bumper is 52% more than the conventional bumper with respect to time. The internal energy of the Gas tube bumper increases smoothly whereas the conventional Bumper increases suddenly after a particular period of time.

CONCLUSION

The internal energy and effective plastic strain at the beam are comparatively lesser while using pressurized rubber tubes instead of foam between the bumper and beam. This means the pressurized rubber tubes are able to absorb stresses and dissipate as gas pressure. The effective plastic strain of conventional bumper compared to gas bumper is also less. Thus we can conclude that the reactions forces are lesser that of the bumpers using foam. Further work shall be carried out using the fluid flow and failure of the tubes. This requires subsequent iterations using the variations of pressure inside the tube and release of the fluid. A coupled analysis of the fluid and structure need to be carried out for such work which may require workstations of higher configuration and may take more time to solve.

ADVANTAGES:

1.Minimizes the cost of bumper.

2.Improves the damageability and reparability of bumper.

3.Bumpers can be recycled and used for further use.

4.Reduces the damage caused to the radiator and other parts.

5. Energy resources is properly utilized over here

References

1. Borse S.H., 2Satpute A.G., 3Mude J.M., 4Pokale R.S., 5Prof. Wabale A. D., 6Prof. Bhane A.B in “Air conditioning system using vehicle suspension" on IJRDET (ISSN 2347-6435(Online) Volume 4, Issue 4, April 2015)
2. Borse.s.h, 2015 “Air conditioning system using vehicle suspension” (ISSN 2347-6435(Online) Volume 4, Issue 4, April 2015),
3. Bruce R. Denison, “Advanced Polyolefin Bumper Systems” SAE Transaction, Document Number: 930543.
4. David J. king, “Automotive bumper behavior in low speed impacts” SAE Transaction, Document Number: 930211.
5. Horst Lanzerath, “Crash Simulation of Structural Foam” SAE Transaction Document Number: 2003-01-0328.

6. Javad Marzbanrada, “Design and analysis of an automotive bumper beam in low-speed frontal crashes” School of Automotive Engineering,. 16846-13114, Narmak, Tehran, Iran

7. Kay Ogiyama, “Beam-less bumper system” SAE Transaction. Document Number: 2003-01-0212.

8. Mark N. Bailey, “Automobile Bumper Behavior in Low-Speed Impacts” SAE Transaction, Document Number: 930211.

9. Paul L. Sabol, “A design procedure for thermoplastic bumper” SAE Transaction, Document Number: 870109.

10. rajesh kumar sahu, “Fabrication of a Device Used For Producing Compressed Air Using Vehicle Suspension” ISSN No:2395-0900

11. Rajput, R. K. (2007). A textbook of automobile engineering. Laxmi Publications. p. 410. ISBN 9788170089919.