Design and Analysis of Automobile Bumper Beam with Shock Absorber

S.Joseph Irudaya Raja[1], S.Sivaganesan[2], C.Gnanavel[3], G. Sathish kumar[4]

[1,3,4]*Assistant Professor, Department of Mechanical Engineering,*

[2]*Associate professor, Department of Mechanical Engineering*

[1,2,3,4]*Vels Institute of Science Technology & Advanced Studies-Chennai, India*

**Email: joerajj78@gmail.com*

Abstract

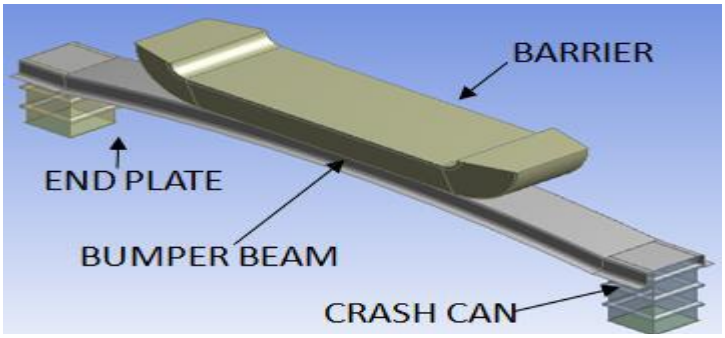
Low speed accidents were frequent now a days this don't cause more damages to passengers but leads to frontal damages. Frontal damages in normal sedan cost minimum of 5000 to 8000 rupees. So, in order to reduce this cost we planned to place damper along with crush can so that during low collisions that is less than 10 kmph speed the shock absorber absorbs the impact and it will damp the force and beam retracts when the car is reversed.The goal of this project is to mitigate the degree of damage during low end collisions of automobile and to reduce the cost required to repair the damages. A 3d model for bumper beam was developed in CREO parametric and simulation of impact on bumper beam against fixed barrier was performed using ANSYS 15. A shock absorber was introduced into the bumper beam and crush can assembly to improve the attenuation of impact and kinetic energy absorption capacity. A mathematical model of bumper-damper system was formulated, designed and simulated.As a result of placing shock absorber not only damps the low impact but also reduces risk of damage to the passengers.

Keywords: *BUMPER, ANSYS 15, Shock Absorber,CREO*

1. Introduction

1.1. Bumper Beam or Impact Beam

Automotive bumper beam assembly plays very important role in absorbing impact. Bumpers are fixed to the impact beam in order to distribute the impact to the chassis of the vehicle.



1.2. Crush Can

Crush can is one of the important crumple zone of automobiles. Crush cans are designed to absorb the impact during collision and it protect further damages to passenger by crushing itself.

1.3. Shock Absorbers Or Dampers

Shock absorber is widely used on vehicle. The purposes of the shock absorber are to dissipate the energy accumulated by the suspension spring displacement. The damping of the shock absorber for compression motion is usually less than that of rebound motion, in such a case, less force is transmitted to the vehicle when crossing a bump. By comparison, the shock absorber provides more damping force for re-bound motion in order to dissipate energy stored in the suspension system quickly.

1.4. Motivation For This Project

Car accidents are happening every day. Most drivers are convinced that they can avoid such troublesome situations. Nevertheless, we must take into account the statistics – ten thousand dead and hundreds of thousands to million wounded each year . These numbers call for the necessity to improve the safety of automobiles during accidents. Automotive bumper beam is one of the key systems in passenger cars. Bumper beam designed to prevent or reduce physical damage to the front or rear ends of passenger motor vehicles in collision condition. They protect the hood, trunk, grill, fuel, exhaust and cooling system as well as safety related equipment such as parking lights, headlamps and taillights, etc. A good design of car bumper must provide safety for passengers and should have low weight. This accidents leads to more damages.

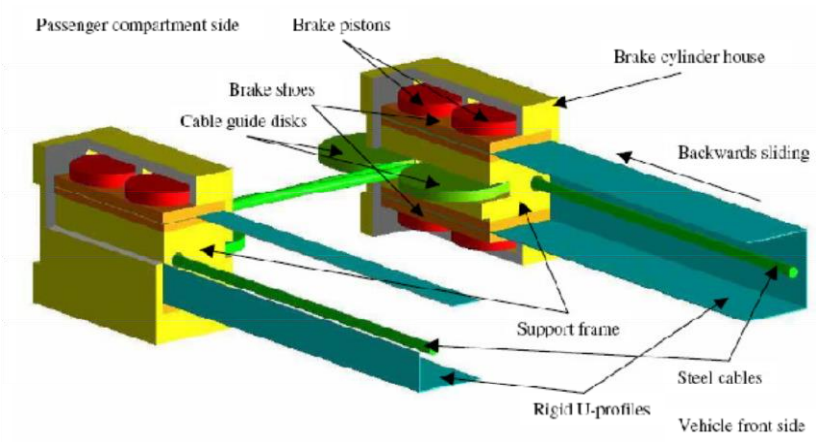
Low speed collisions were also frequent now a days this don't cause more damages to lives but leads to frontal damage. Frontal damages in normal sedan cost minimum of 8000 rupees. So in order to reduce this cost we planned to place damper along with crush can so that during low collisions that is less than 10 kmph speed the shock absorber absorbs the impact and it will damp the force and retracts when the car is reversed.

1.5. Goals And Objectives Of The Work

The specific objectives are to:

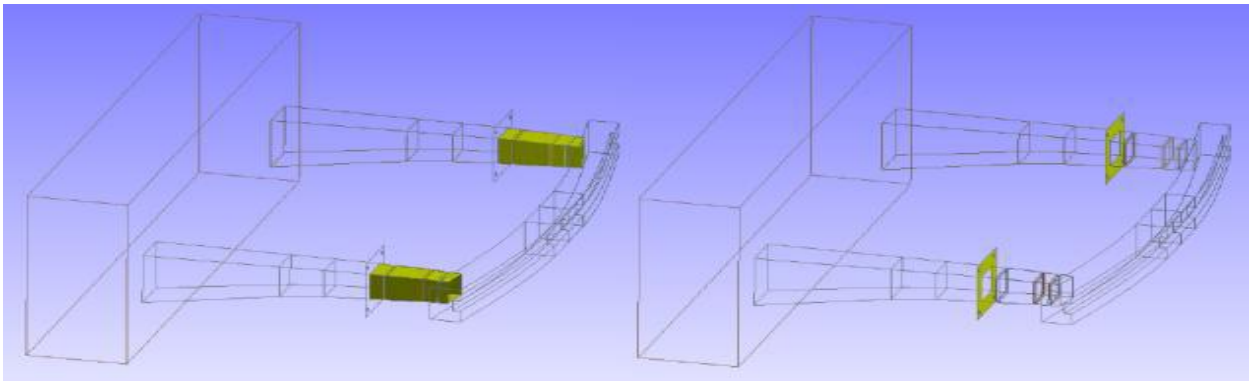
- Enhancing the vehicle bumpers to withstand impact even while travelling in very high speed compared to the old type or conventional bumpers.
- Using the results acquired from the simulation conducted the best design parameters are developed.
- Propose designs of a bumper that could attenuate the impact energy of vehicles traveling at speeds several times the specified speeds for the design of a conventional bumper.

Numerous numbers of crash energy absorption designs are been proposed. One design of them contains a special character. It is an adaptive vehicle structure that could change its stiffness for maximum energy absorption in numerous, possible crash situations. Figure 2.5 resembles the assembly of design of this concept which works on reducing the resulting crash impact of the vehicle. This concept is proposed and designed by Witteman, the definite quantity of energy could be consumed by the friction produced by hydraulic brakes on two rigid beams that are moving backwards. In case of an offset or oblique crash, a mounted cable system moves the missed beam backwards. Figure 2.6 shows the cable system. Bringing together the possible interactive controlled hydraulic brakes with this design (by regulating a normal force), an optimal vehicle deceleration pulse could be found for each crash velocity independent of the struck vehicle position. Figure shows the sketch of the controlled friction device of this concept.



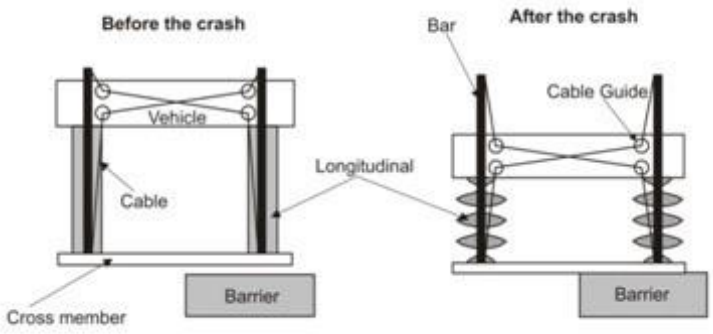
The design of this concept around the same stiffness for all overlaypercent and impact angles, concluding in one crash pulse that can be enhanced for further impact reduction on the passenger. Optimal longitudinal member must be functionally differentiated into two separate systems, is a design logic, this new concept is based on this logic. The first system is called as crushing part that assures the definite and stable energy absorption. Another system is called as the supporting part or enveloping tube, assures the desired stiffness in the transverse direction. The latter allows enough energy absorption during an off-axis collision and gives enough support with a sliding wall to protect the crushing part against a possible bending collapse. The components' square tubes are designed to slide into each other well

Figure shows the representation of the longitudinal members and its internal look. This design is based on a famous compact vehicle and it's both ends of the longitudinal members, these two functional parts are assembled with a rigid plate. The bending collapse of the crushing part in the larger rear parts of the telescope are prevented by using the two square rings.

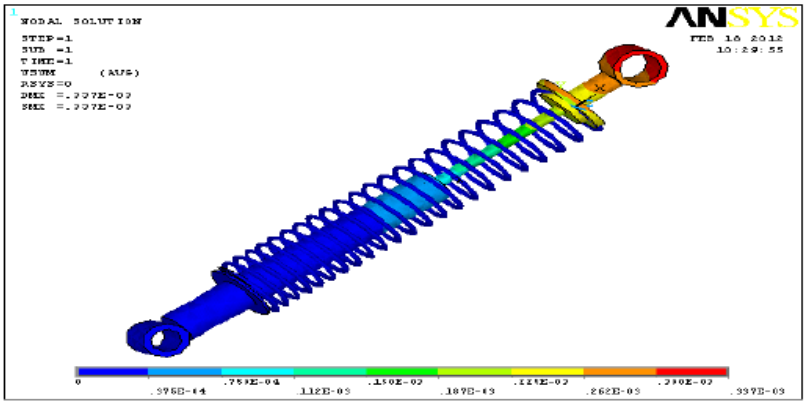


While collapsing the first supporting component of the support with the less inner dimensions comparing the second, slides incorporation with the folding front to the rear. After the complete change in shape all the folds would be packed in the first supporting component.

A form of cable connection system that consist of two sliding bars and two cables in a structure. That combines the rear of one bar inside one longitudinal member to the front of the other longitudinal member to transfer the crushing force from a loaded to an unloaded longitudinal member Figure 2.10 and Figure 2.11 show the cable connection system while Figure 2.12 shows the cross-section of the cable and its guide.



Thetelescopeof whiteman conceptual design could also be conducted by fitting it behind the bumper, such that on an impact, the bumper-telescopic collapsible structure could absorb the impact, and through deformation of the longitudinal structure, absorb the kinetic energy involved to reduce the impact on the occupant of the vehicle. Its length is the only disadvantage in this proposed application, since the space behind the bumper is rather limited.



The principle of operation of the vehicle suspension friction damper is not passive. Hydraulic oil will have to be pumped into the damper to control the pistons with the friction pads. There could be the risk of a leakage and also external power or energy is needed to pump the hydraulic oil. Therefore it does not meet the design requirement of the damper needed for this study.

2. Design Consideration and Modelling

2.1. Designing Software: Creo Parametrics 2.0

The energy equation governing the previous example is as
Follows:
Where m is mass, vo is initial velocity, and vf is the final velocity of objects 1 and 2. NC refers to non-conservative kinetic energy, or the sound and heat energy lost in the collision.
This phenomenon is expressed more formally through the application of Newton's second law of motion, or:
F=ma
Where a can be represented by the change in velocity over the change in time Δt, or:
a = (Vf – Vo)/Δt
m is mass, vo is initial velocity, and vf is the final velocity
Substituting the previous equation for *a* in Newton's second law yields:

$F = m \{(Vf – Vo)/\Delta t\}$

From this equation, it is clear that as the time of the collision decreases, the force experienced by the automobile increases dramatically. The resulting negative sign indicates direction of the force.

2.2. Calculation Of Low Impact Force

Considering a normal sedan type car weights 2000 kg moving at low speed of 10kmph

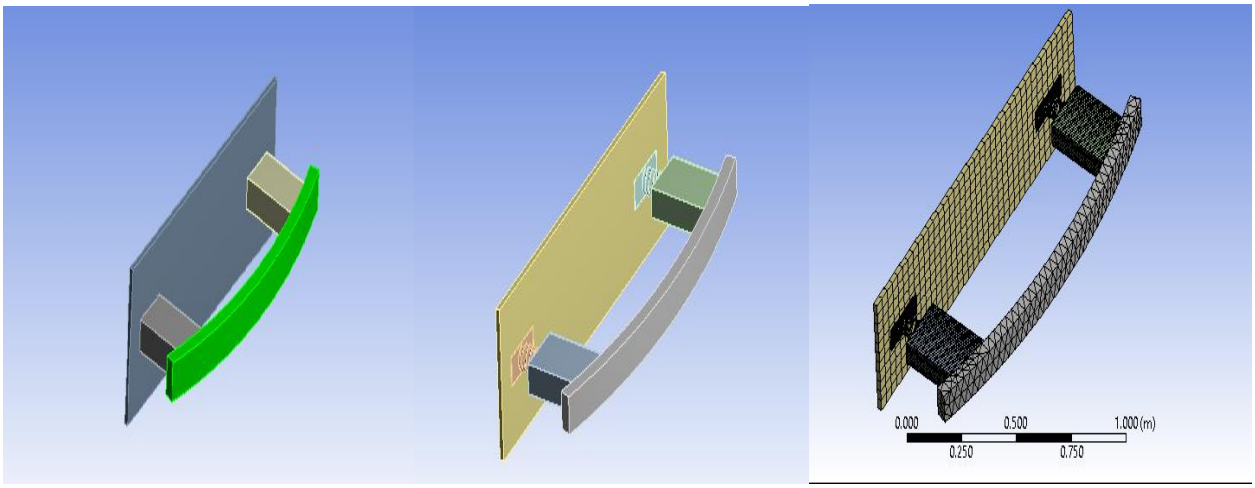
Mass of car = 2000kg

Acceleration of car = 10kmph
= 3m/s
= 60m/s^2

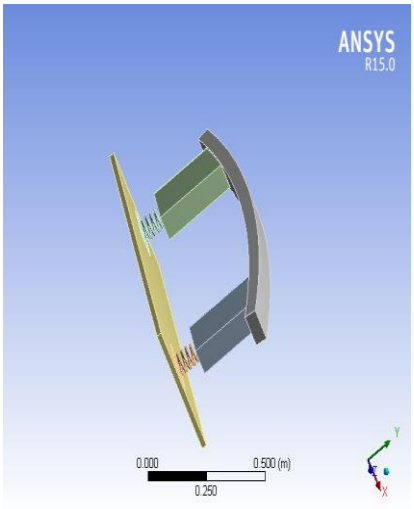
Force = mass * acceleration
= 2000*60
= 120 KN

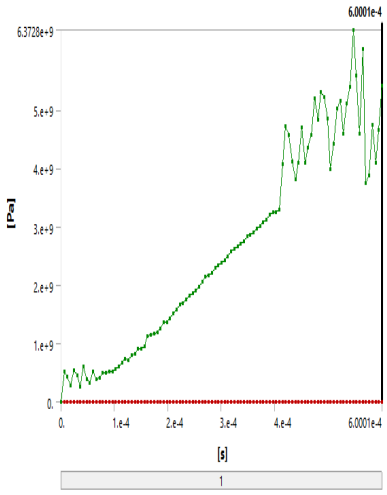
2.3. Creo Models

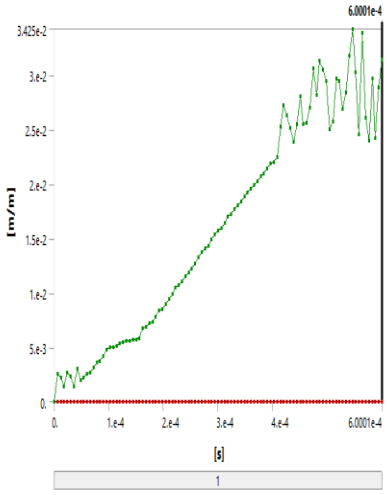
Impact Beam and Crush Can Assembly



Impact Beam Meshed AssemblySimulationIn Ansys

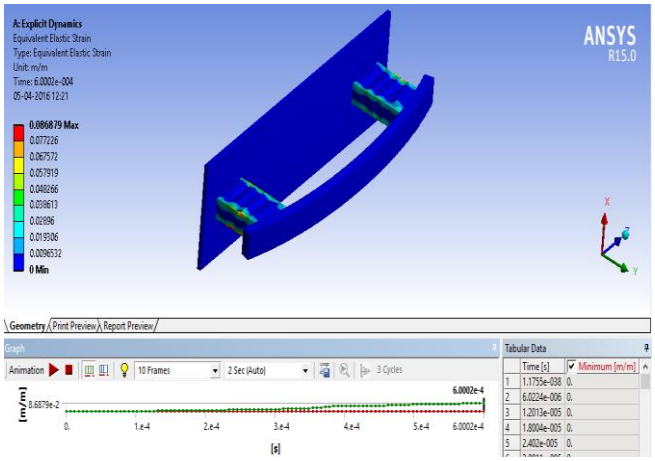


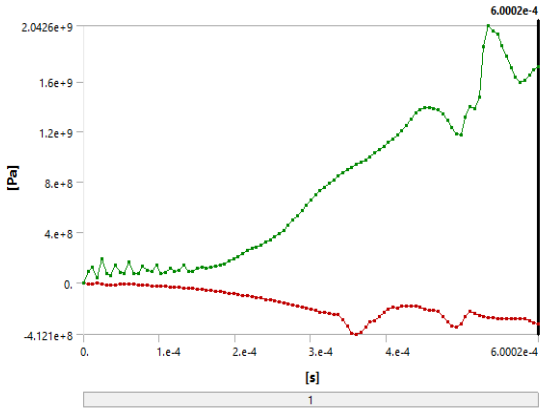




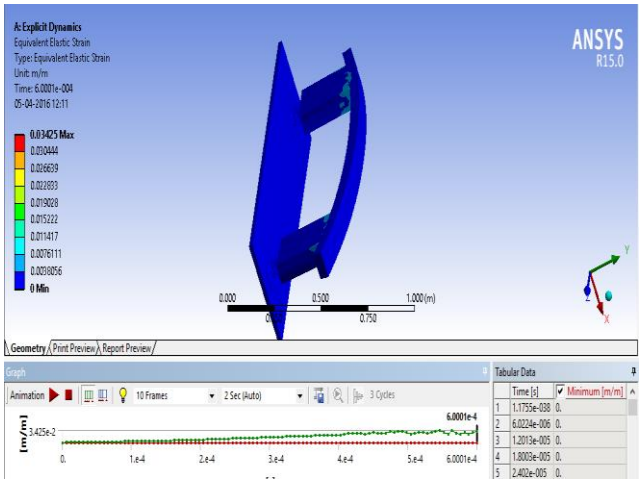
3. Result And Comparison

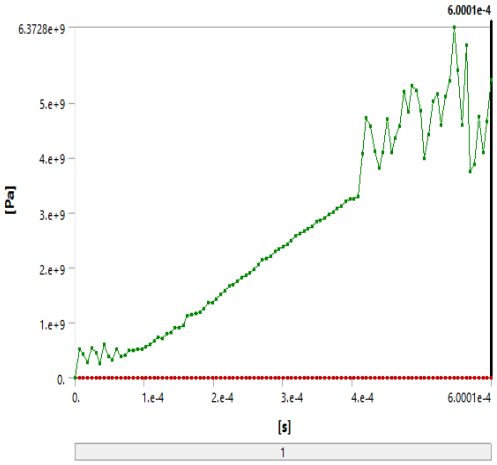
3.1. Impact on Crush Can





3.2. Impact on Shock Absorber





4. Conclusion

Thus from this report we conclude that introducing a shock absorber into the crush can and bumper beam assembly, so that the impact and damages are 60% attenuated at low speed collisions.
It also reduces the risk of lives of passenger.

References

[1]. How-Stuff-Works. (2007). http://www.howstuffworks.com/airbag1.htm. (Accessed 2007 April 12)
[2]. Huang, M. (2002), Vehicle Crash Mechanics, CRC Press, Boca Raton, London & New York, p. 100 -320.
[3]. Inman, D. J. (1996). Engineering Vibration. Upper Side River, NJ, Prentice Hall. p. 38 - 60
[4]. AASHTO (2001). A Policy on Geometric Design of Highways and Streets:
[5]. American Association of State Highway and Transportation Officials, Washington D.C.
[6]. Abe, G. and Richardson, J. (2006). Alarm timing, trust and driver expectation for forward collision warning systems: Applied Ergonomics; 37: 577-586.

[7]. Marcus Redhe and Larsgunnar Nilsson, EngineeringResearch Nordic AB Shape Optimization of Vehicle Crush box using LS-OP
[8]. ANSYS Explicit Dynamics- Springs, Remote Displacement, and Parallel Processing from youtube.com