Design and Analysis of Coil Spring Shock Absorbing Bumper to Reduce Impact Stress in Automobiles

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Abstract*—To convert Impact Energy to Spring Potential Energy during accidents and release to the environment leads toincreasing bumper efficiency and passenger safety. For that we designed out a Mechanism by using modelling software SOLIDWORKS 2013 Premium and Analysis done by ANSYS 14.5.*

Keywords— Impact stress calculations; design; analysis.

1. INTRODUCTION

Automotive design with economy, safety and aesthetics have been a great challenge to design engineers. Augmenting to these factors today environment impact is an upcoming research area. The safety of the passengers during vehicle crashes can be ensured to a certain limit by using good bumpers. At the same time these automotive parts should not be massive in terms of weight contributing to the increase in total the weight of the vehicle. By Increasing the performance of Bumper to improve Absorbing capacity of impact load and ensuring passenger safety. By Absorbing the Impact Energy in the Bumper which cause deformation, we can able to reduce the damages in Automobile. To Attain this, A mechanism is to be designed to convert nearly 80% of Impact Energy to Spring Potential Energy and release to the environment. For that we designed out a Mechanism which can control impact load without causing more stress to vehicle.

2. EXISTING MODEL AND MODIFICATION

A. Existing Model and Associated Problems

To reduce impact stress, damage to front and rear portion of automobiles and to increase the passenger safety, they are many already existing systems. They are namely, (i) Hydraulic Shock Absorbing Bumpers (ii) Pneumatic Shock Absorbing Bumpers (iii) Longitudinal Coil Spring Shock Absorbing Bumper. Even though they are many systems to absorb impact stress they also contains their equivalent problems associated. Leakage of fluids, weight of the system and spring back problems are the major problems exist between already available system.

B.Modified System

Our Concept is placing Transverse Coil Spring ShockAbsorbing Bumper. That is, the direction of motion of coil spring is right angle to the direction of Bumper and Impact. Even in this concept also spring back will exist. But to arrest this spring back we pivoted the arms of bumper and shock absorber.

3. LITERATURE REVIEW

• A.R. Mortazzavi Moghaddam., Design and Analysis of an Automobile Bumper with the Capacity of Energy Release using GMT materials, studied that a Mechanism is to be

designed to convert Impact energy into Spring potential energy by using Honey Comb Structure.

• M. Henson Wood., Hydraulic Shock Absorber for Automobile Bumper, studied placing of Hydraulic Shock Absorber between vehicle and bumper, the sleeve being attached to the other member so that size of orifice is reduced when shock absorber is shortend by an applied force.

• Q.H.Ma., Reasearch on the Crash Safety of Car Bumper Base on Different Standard, studied that the bumper is optimised by changing the structure size of the way. By increasing the thickness of metal bar bumper can improve its Safety performance, but its weight will be increased.

• Katkar et al., Design enhancement for Bumper of a Passenger car in FEA for effective compliance to the standard practices in the Industry, studied that the modification in (i)Performance Related parameters of bumper (ii)Deformation/ Energy absorption Capable (iii)

Shape/size/thickness will surely increases the safety performance.

• Patil et al., Low Impact Crash Analysis for Rear Bumper of a Passenger car to identify areas of Improvement during design process, studied that the statistics shows nearly 10,000 dead and 10,00,000 wounded for passengers are

happening and an effective Bumper will surely reduce this much of damage. Design improvement & impact analysis of Bumper will protect vehicle components and passenger life.

• Nitin S. Motgi., Impact Analysis of Front Bumper , studied that improvement in Bumper design is very important that leads to increase the performance of bumper by absorbing impact load and increases the protection of Front Car component economically.

4. DESIGN OF COMPONENTS

For Longitudinal Coil Spring Shock Absorbing Bumper the main Components to design are Spring with the stiffness

required to manage the impact and the arms that joins shock absorber and the bumper and the small link which pivots between the two arms at both the sides.

Fig. 1. This the Schematic diagram which shows how the shock absorber attached to the bumper with the help of arms and links.

5. Calculation for Analysis

A. Input Data:

Mass of the car =1554 kg
Average mass of 5 persons =350 kg
Total mass =1554+350 =1894 kg
Speed of the car =36 km/hour =10 m/s.
Assume this car is hitting at another identical one and it will stop in 0.1 seconds.

Deceleration of the car = (u-v)/t =(10-0)/0.1 = 100 m/s²
v= final velocity of car in m/s, u = initial velocity of car in m/s, t=time after which vehicle stopped in seconds.
Force acted during collision =m*a =1894*100 = 189.4 KN
m= mass of car in kg , a = acceleration of car in m/s²
For the easiness of calculation this force is converted into a pressure which is acted on the front surface of the modelled bumper.

Area of the front face of bumper =l*b =1132.25*64mm²
=0.072464m²

l= length of front face in mm , b = breadth of front face in mm

Pressure acted on the bumper = F/A =189400/0.072464
=2613711.64 N/m² = $2.61*10^6$ N/m²

F= Force acted during collision in Newton,
A = Area of the front face of bumper in m².
The impact having pressure $2.61*10^6$ N/m² is to be satisfied by the Spring attached to the bumper.

6. Analysis of Bumper

The analysis is done by ANSYS 14.5, and the calculated load values are applied on the respective figure

and corresponding stress and deformation are calculated.

For Direct Impact, Pressure of $2.61*10^6$ N/m² is applied and for Side Impact, Pressure of $1.3*10^6$N/m² is applied.

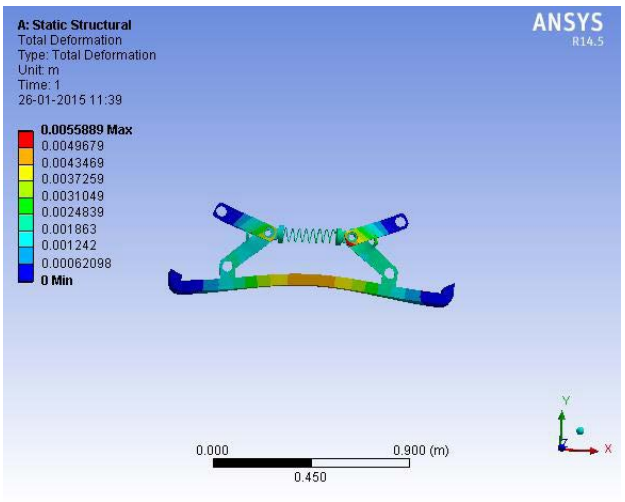

Fig. 2. Direct Impact Deformation Report

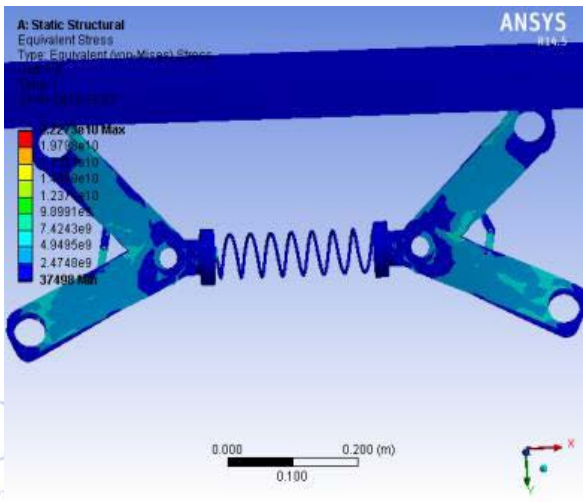

Fig. 3. Direct Impact Stress Report

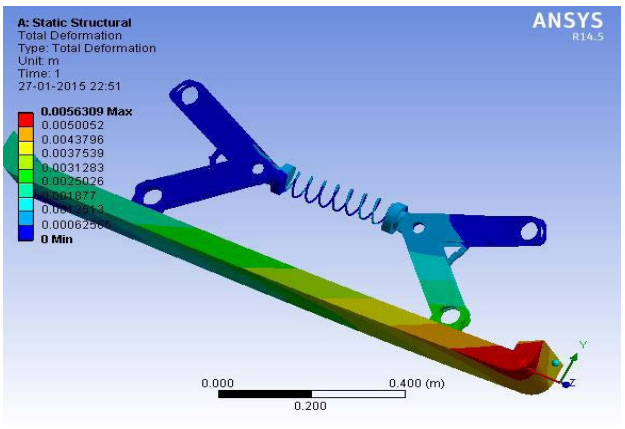

Fig. 3. Side Impact Deformation Report

Analysis for both Direct and Side Impact is done and their corresponding values are taken and it has been found that during Font Direct Impact Deformation of 5.5mm and for Front Side Impact Deformation of 5.6mm is reported

7. Conclusion

From the analysis made that the Deformation produced during Direct Front Impact of 5.5mm and Direct Side Impact of 5.6mm is comparatively less when compared to other type of system.

Placing of Two shock Absorber between the bumper

and chassis, Effective control of impact stress can be made. And this can ensure much passenger safety and Bumper efficiency.

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