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Design of Multilayer Bumper of Cars for reducing injuries to occupants

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ABSTRACT

In this project, two bumpers have been designed: one layer and multilayer. To analyze these two bumpers, two types of vehicle collision are modeled and analyzed by Ansys workbench 16.0. In these analyses, deformation of two bumpers is evaluated. At the end to reduce acceleration of the vehicle occupants and reduce losses from traffic accidents, selected bumper has been determined.

Keywords: *One Layer Bumper, Multilayer Bumpers, Traffic accidents, Ansys workbench.*

INTRODUCTION

In recent years, car accidents show an alarming situation. Toll road depends to human and cultural factors, vehicle safety and road. In the meantime, vehicle safety can affect to other factors. Also bumper have crucial role in vehicle safety.
In this project, a bumper was designed which damped kinetic energy of car after colliding with an obstacle.

2- Overview of the work done

In a paper on the review of new technologies about bumper designs, some of the new innovations in the design and construction of the bumper is investigated. These reviews were done from the perspective of energy absorbing mechanisms in car bumper and followed the prime duties of an appropriate bumper and a variety of vehicle collisions with pedestrians is classified. At the end, three new bumpers compared with each other and the advantages and disadvantages of each have been investigated [1].

This paper suggests that one of the testing of large companies is vehicle collision with a pedestrian. These tests are usually grouped in the following three areas:
(A) At the first group, an object at the form of lower extremity leg be replaced as a model.
(B) In the second group, an object can be built in the shape of the femur instead of the upper leg and pelvis.
(C) In the third group, objects are used into shape of children's heads during the collision with the upper part of the hood.

Figure 1 show a model of these three conditions. The intersection of pedestrians and vehicles in the above three modes is displayed at figure 2.

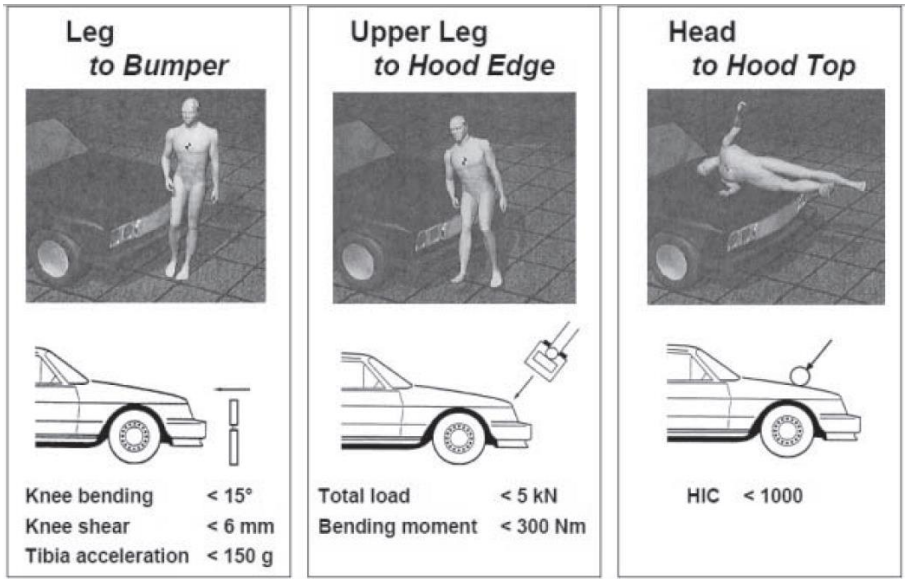

Figure 1. Three examples of pedestrian-vehicle collision modes

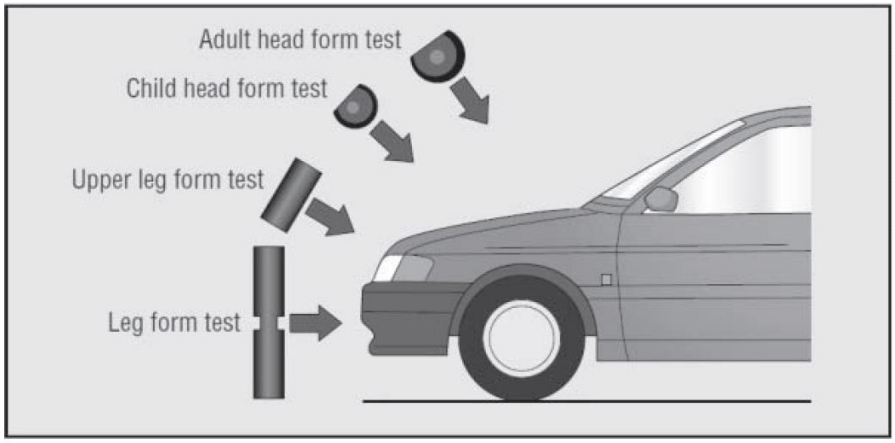

Figure 2. Examples of cases where the pedestrian with car

In another article, the effects of the materials used in the front of the vehicle are used as a check. In the end, the solution to the structural design of the front of the vehicle is presented, according to the safety of pedestrians in a frontal impact with a vehicle [2].

Another article on this subject determines that most fatal crashes are done by head collision of pedestrian to the front of the vehicle. One of the new methods of harm reduction is changes in material and body structure of the car and replaces the panel of a metal fabric panels laminated with metal and composites especially in the engine lid. These changing reduce of acceleration to pedestrian head significantly and thus reduce the death rate from traffic accidents.

Using laminated panels in automotive body structure also has other advantages, such as increasing absorption of crash energy and reducing this type of panel damage to the car seat and reducing vehicle weight and also reducing fuel consumption. This article describes how to use composites laminated steel panels in automotive body structure has been examined and benefits of implementing them expressed [3].

Another article was done about the use of multi-layer metal panel at car body with respect to characteristics such as high energy absorption, high strength and resistance to dents and very light weight and tangible reduction of the accident injuries considered occupant.

One of the key programs at the automotive industries is to reduce emissions and fuel consumption of vehicles using lightweight materials in vehicle body. This program is done by replacing the single-layer metal panels by the new multi-layer lightweight panel on the outside of the vehicle. These panels have been formed of two-layer thin metals on the sides and a core composite panel in the center of the panel usually [4].

3- Overall Characteristic of Designed Bumpers

Car bumpers generally are made in different dimensions. In this project a bumper is designed to be like bumper cars full production in terms of dimensions like and also has some differences with them.

Bumper is designed for passenger cars and its wide is in 176 cm. In order to select the top bumper, a type of bumper is designed to have a different number of layers. The thickness of the bumper is considered equal. Designed bumper are the same as much as possible in the other dimensions. Designed bumpers are in two types as follows:

A- Single Layer Bumper

B- Three Layers Bumper

(A) Single Layer Bumper

First type of designed bumper is single layer. This bumper is made of steel which have Poisson's ratio 0.3, Young's modulus 200 GPa and shear modulus 76.93 GPa. Bumper has dimensions as thickness 8 mm, width 176 cm and height 40 cm and two fins of each 50 cm long.

Figure 3 shows single layer bumper which has been designed in Solid works.

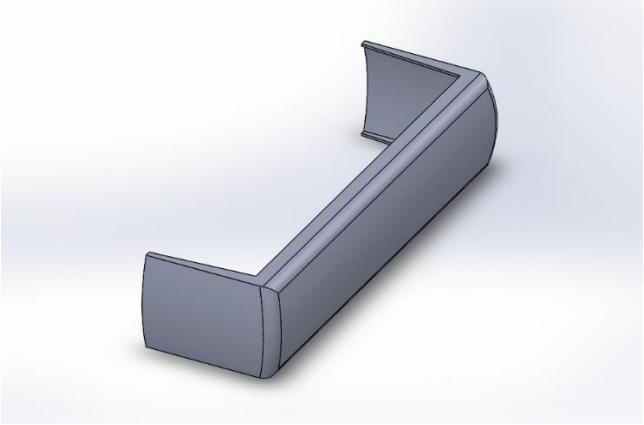

Figure 3. single layer bumper- above view

Designed bumper is made up of thirty plates and steel type of it has 116.71 kg mass.

(B) Three layer Bumper

Second type of designed bumper has three layers. Thickness of each layer of the three-layer is equal to one-third of the thickness of single layer bumper. Thus the thickness of each layer of the three layers is 2.67 mm. The distance between each of the layers is considered one centimeter.

This bumper is made of steel which have Poisson's ratio 0.3, Young's modulus 200 GPa and shear modulus 76.93 GPa. Bumper has dimensions as overall thickness 8 mm, width 176 cm and height 40 cm and two fins of each 50 cm long. Figure 4 shows three layer bumper which has been designed in Solid works.

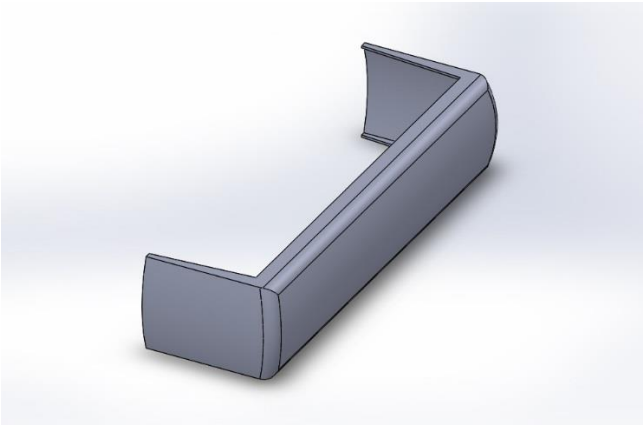

Figure 4. Three layer bumper- above view

As can be seen visually, two types of bumpers are very similar to each other.
Figure 5 shows a zoom view of three layer bumper. In this figure the three-layer bumper is displayed.

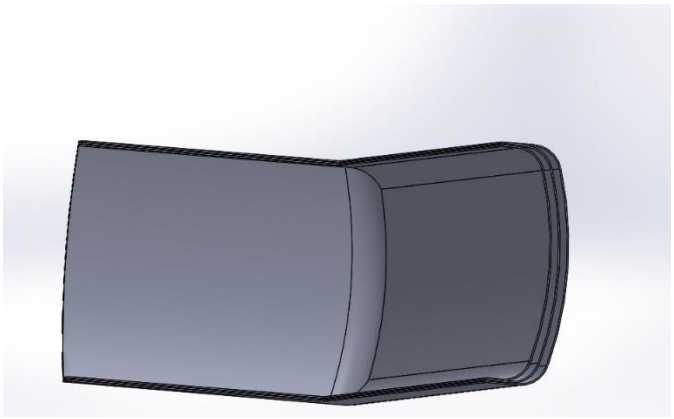

Figure 5. three layer bumper- zoomed view

Designed bumper is made up of 86 plates and steel type of it has 89.11 kg mass.

4- Modeling the Car, Shooting and Racing

Figure 6 shows model of simple car, shooting and road which is modeled at Abaqus.

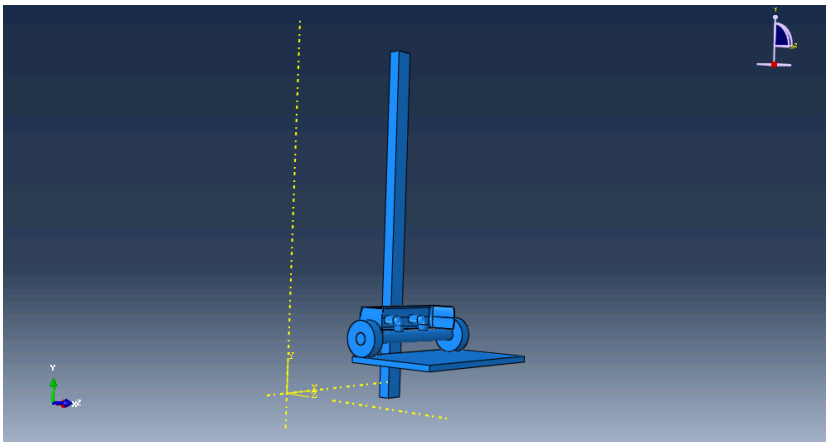

Figure 6. model of car collided with a beam

Designed model should be examined in analysis software such Ansys Workbench 16.
Aanalyzing designed model is done at Ansys Workbench 16.0. In this project, two types of analysis were performed:
A) Analyzing by changing the type of prevent colliding with bumper
B) Analyzing by changing the numbers of layers in bumpers

In this study, steel has been chosen for material of the bumper. Each body has one millimeter thickness and also its deformability was determined to be rigid except bumper which should be considered as deformable. One of the steps required to analyze any type of modeling is meshing. In this study, mesh analysis was performed automatically by the software Ansys workbench 16.0 as shown in figure 7.

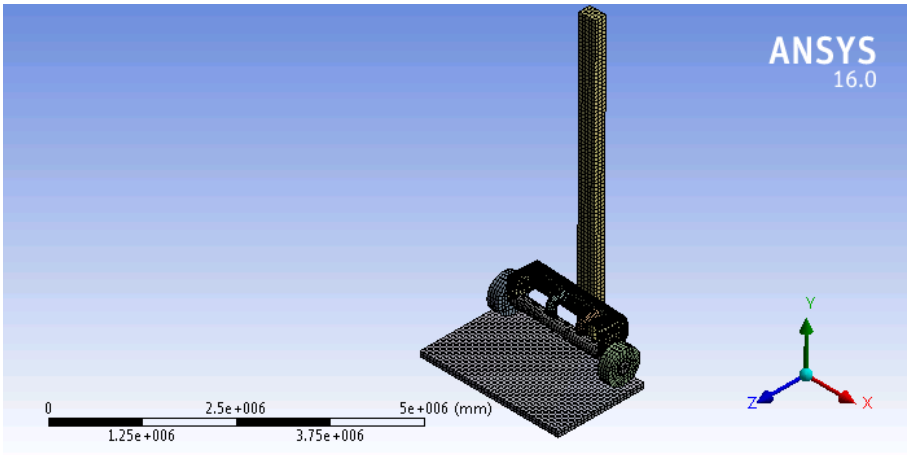

Figure 7. model meshing

Using the equation 1 average force that is applied to the bumper assuming a speed of 20 m/s can be achieved.

$F_{average}=m*a=m*\Delta V/\Delta t$ Eq. 1

Vehicle mass has been assumed to be 1000 kg according to normally passenger cars. It also assumes that the collision time is 0.2 seconds. Thus achieved force is 99955 N.

5- Analysis of model car collided with a bow at the speed of 20 m/s

Figure 7 describes the total deformation of a three layer bumper at front view.

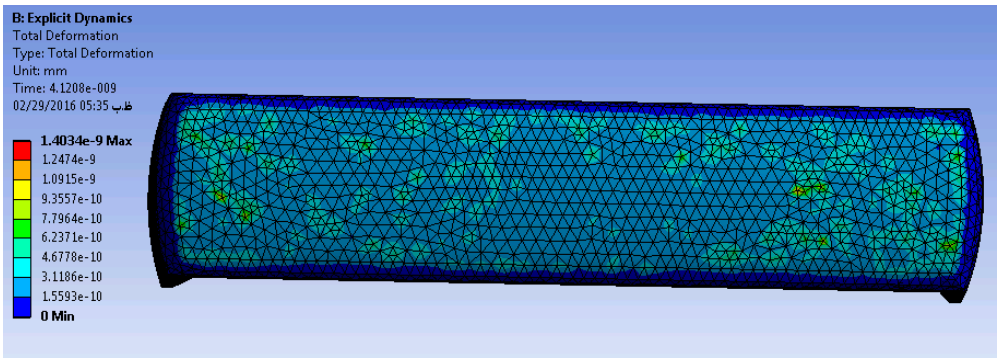

Figure 7. the total deformation of a three layer bumper

Deformation of bumper in red and blue points is respectively maximal and minimal. Greatest deformation of the three layer bumper is to be about 1.4034*10^(-9) mm.

Figure 8 describes the total acceleration of a three layer bumper at front view.

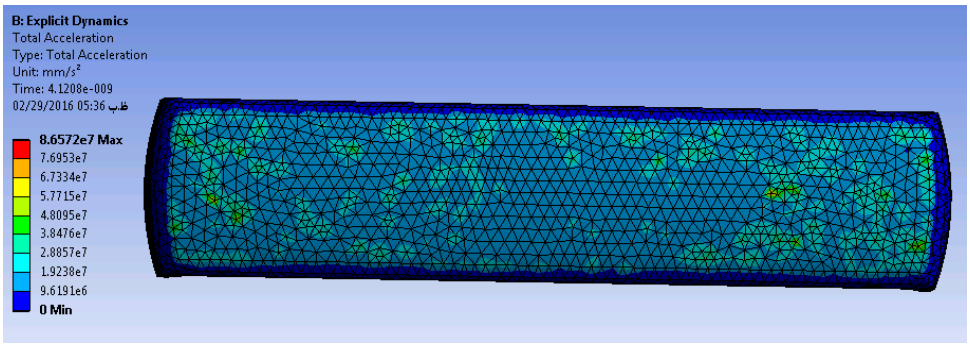

Figure 8. total acceleration of a three layer bumper

Acceleration of bumper in red and blue points is respectively maximal and minimal. Greatest acceleration of the three layer bumper is to be about 8.6572*10^(7) mm/s^2.
Figure 9 describes the total deformation of a single layer bumper at front view.

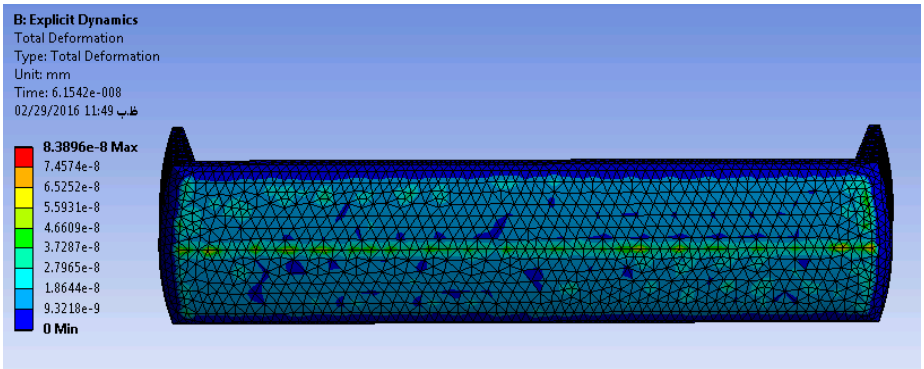

Figure 9. the total deformation of a single layer bumper

Deformation of bumper in red and blue points is respectively maximal and minimal. Greatest deformation of the three layer bumper is to be about 8.3896*10^(-8) mm.
Figure 10 describes the total acceleration of a single layer bumper at front view.

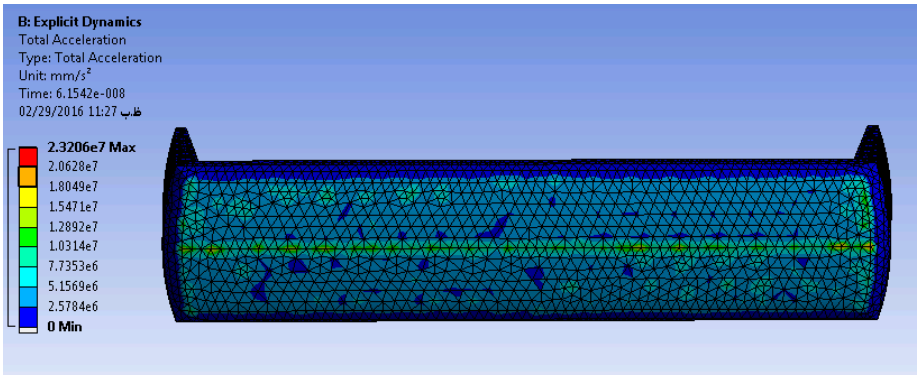

Figure 10. total acceleration of a single layer bumper

Acceleration of bumper in red and blue points is respectively maximal and minimal. Greatest acceleration of the three layer bumper is to be about 2.3206*10^7 mm/s^2.

6- Evaluation Results

After reviewing the results obtained from the software Ansys workbench 16.0 the following results were obtained:
1. The results showed that the acceleration entered into a three layer bumper is significant higher than single layer bumper. It shows that increasing the number of layers lead to increasing ability of the layers to absorb energy.
2. The results also indicated that the deformation created in a three layer bumper is much less compared with the deformation caused by one layer bumper. This is also the positive results of this study.
3. Mass of the three layers bumper and single layer bumper respectively is 89.11 kg and 116.76 kg. Increasing mass of bumper leads to increasing mass of vehicle.

Based on the above results it can be concluded overall that the three layers bumper is preferable than the single layer bumper. The single layer bumper in has less crime, less deformation and caused less acceleration on passengers. Also this bumper absorb kinetic energy and to amend reaction force there in accidents.

REFERENCES

1. Niknejhad A., Moeeenifard M., “Investigating new technologies, design and manufacture of bumpers”, scientific journal extension on Mechanical Engineering, Tarbiat Modarres University, Tehran, Iran, Volume 20, Number 76, Ordibehesht 1390 (Persian).
2. Sabouhi A., Hosseini Tehrani P., “A new strategy for designing the front of car to pedestrian safety”, promoting scientific journal on Mechanical Engineering, Volume 20, Number 76, Ordibehesht 1390 (Persian)

3. Marzban Rad J., Khalili H. R., "Using multi layer steel-composites panels at automotive body structure in order to increase pedestrian safety", traffic management Studies Quarterly, Issue 16, Spring 1389 (Persian).
4. Rahmati S., Khalili H. R., "Simulation and experimental study of modern multi-layer panels and its application in the vehicle body to reduce vehicle weight", the Journal of the House of Mechanical Engineering, Issue III, Spring 1390 (Persian).
5. Gintautas Dundulis et al, "Static analytical and experimental research of shock absorber to safe guard the nuclear fuel assemblies", Elsevier, Nuclear engineering and design, 239, 2008, pp. 1-8.
6. Ferreira et al, "a novel monolithic silicon sensor for measuring acceleration, pressure and temperature on a shock absorber", Procedia Chemistry, 1, 2009, pp. 88– 91.
7. Shinichi Nishizawa and Tadashi Sakai, "Reverse Engineering Based Coil Spring Design Method", NHK International Corporation.
8. Ping Yang et al, "Design, test and modeling evaluation approach of a novel Si-oil shock absorber for protection of electronic equipment in moving vehicles", Mechanism and Machine Theory, 43, 2008, pp. 18–32.
9. Alessandro Beghi et al, "Grey-box modeling of a motorcycle shock absorber for virtual prototyping applications", Simulation Modelling Practice and Theory 15, 2007, pp. 894-907.
10. A.K. Samantaray, "Modeling and analysis of preloaded liquid spring/damper shock absorbers", Simulation Modelling Practice and Theory 17, 2009, pp. 309–325.
,41(1),9-13.