Crash Analysis on Automobile Bumpers

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Abstract: Bumper is one of the essential parts in an automobile. During collision, bumper is used as a protection shield to safeguard passengers and the body of the vehicle. We know that, death in accident is very common not only in India but also all over the world. Therefore, safety of passengers and automobile body must be considered as primary criteria at the time of vehicle design. ABS is a material which has high impact strength which is used for manufacturing automobile bumper. In this research, we endeavour to analyse three different front bumpers of expensive cars which are highly competitive in the automobile market. CATIA V5R21 is the software used for modelling the bumpers and ANSYS 19.2 is used for analysing each bumper with appropriate velocities. In this research, thickness of all the bumpers is considered as 5 mm and the concrete wall where it is collided to make impact collision is of thickness 10 mm. By using explicit dynamic condition with exact boundary conditions, we determine the best or optimistic design by comparing the results of various factors such as equivalent stress, total deformation, directional deformation and equivalent plastic strain.

Keywords: ABS (Acrylonitrile butadiene styrene), ANSYS19.2, CATIAV5R21, Analyse, Stress, Deformation

1. Introduction

In olden days vehicles are mostly used for transportation. As the years pass on vehicle becomes more essential member of a family. They consider vehicle has an additional asset for them so they are willing to buy an expensive vehicle. Nowadays automobile industries are updating themselves based on the customer satisfaction. Hence they improved their vehicle standards to become popular in the market. While buying a vehicle customer gives a high priority to safety features bumpers are one of the their essential safety features in automobile. During impact collision it prevent the damage of front and rear end. A good bumper design will have better aerodynamic property. Different companies make different bumper design to show their uniqueness.

The role of automotive bumpers has changed considerably over the past 70 years. The later performance is achieved by a combination of careful design, material selection to obtain a particular balance of stiffness, strength and energy absorption. Stiffness and Energy absorption are essential criterion. Stiffness is important because vehicle design consideration limits the packaging space for the bumper design to deform under load and Energy absorption is important because bumper must limit
the amount of the impact force transmitted to the surrounding rails and vehicle frame. Automotive bumper plays a very important role in absorbing impact energy (original purpose of safety) and styling standpoint aesthetic purpose. Now a day, automotive industry concentrates on optimization of weight and safety.

1.1. Standards for bumper
As bumper improves the aesthetic look of an automobile and also its design need to satisfy the roads condition. If bumper ground clearance is good it can travel easily in all road condition

1.2. India
India is the 10th largest producer of automobile in the world. In the year 2016 our country has registered 10 million trucks and 230 million cars. In 1989, the Central Motor Vehicle Rules (CMVR) became effective. Under Rule 126 of the CMVR, each manufacturer must pass the test for their original prototype. All the vehicle to be launched need to satisfy pollution control norms. generally Indian vehicle manufacturer can easily design based on it but foreign vehicle need a slight variation to meet with Indian standard.

1.3. Features of best bumper
- Good aerodynamic course
- Light in weight
- Easy to assemble
- Withstand load during impact collision
- Aesthetic design

1.4. Types of bumpers
- Steel bumper
- Carbon fibre bumper
- Plastic bumper

1.4.1. Steel Bumper
It can easily withstand impact load without complete deformation so the stress is induced inside the vehicle. It is tedious to manufacture it is also heavier in weight. Alloying of steel can improve the properties.

1.4.2. Carbon fibre bumper
It is highly expensive to manufacture and light in weight. it can easily withstand load compare to other material but it cannot be reformed

1.4.3. Plastic Bumper
Nowadays plastics are used to make bumper because they are lighter in weight and easy to manufacture. It is also cost efficient. It can be easily recyclable. It can also easily withstand impact load.

1.4.4. ABS Material in Automobile Bumpers
Early in 1870s bumpers were used as safety features in vehicles and those bumpers were made of steel and aluminium alloys. But those materials were so heavy to be recycled so the industries were searching for a new light weight material which has high strength to withstand the impact load and also capable of being recycled. In 1950s Automobile industries started manufacturing bumpers using polymers and plastics. Later on they discovered a new material called Acrylonitrile Butadiene Styrene (ABS) which has high impact strength to withstand collision.
In this research we have made both the extreme ends of the wall as fixed support and the bottom two layers of the model is also as displacement support and right and left edge of the model is also consider as displacement support.

2. Literature Survey
The bumper has been designed with different materials and analysis has been performed on the designed bumper in order to find out which has better durability. Previously crash analysis is performed on the cylindrical block with different velocities and they have also used only gravitational pull with friction coefficient zero for performing the crash test. In this project we have assumed a concrete wall with thickness 30mm and crash test is performed on the front bumper with its bottom layer as the fixed point.

3. Design of Bumper
The bumper has been designed using CATIA V5 with two different types with ABS material. The surface thickness of the bumper is 5mm and a concrete wall of 30mm thickness and bumper is made to be in contact with the concrete wall.

4. Boundary Conditions
The two ends of the concrete wall are fixed and the bumper bottom two layers are assumed to be a displacement support.

   The thickness of concrete wall is 30mm and thickness of bumper is 5mm and the velocity is assumed to be 55 km/hr
5. Results

5.1. Analysing of Bumper 1

Figure 3: Geometry of Bumper 1 in ANSYS 19.2

Figure 4: Meshing of Bumper 1

Figure 5: Equivalent Von mises stress on Bumper 1
5.2. *Analysing of Bumper 2*

*Figure 8:* Geometry of Bumper 2 in ANSYS 19.2
Figure 9: Meshing of Bumper 2

Figure 10: Equivalent Von mises stress on Bumper 2

Figure 11: Directional Deformation of Bumper 2
6. Bar Chart

**Figure 12:** Total Deformation of Bumper 2

**Figure 13:** Comparison of Von-Mises stress between two bumpers (N/mm²)

**Figure 14:** Comparison of Directional deformation between two bumpers
7. Conclusion

Thus from the above plotted results hereby we conclude that bumper 1 has more durability and highly safer than bumper 2. From this we have understand that the design is more essential factor for a product effectiveness. In this we have learnt that for a simple variation in design which made a huge difference in product life.

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