Analysis of Square Shaped Vehicle Crash Box with Linear and Taper Area for Minimum Deformation

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Abstract: In technological development keen attention is given in order to improve the safety and automobile is not an exception. In automobile number of element are provided for safety improvement while driving, parking, accidental dashing, etc. one of the safety element provided to the vehicle is crash box. Crash box is a box like structure generally provided at the front bumper of almost all passenger vehicles. The main function of crash box is, it deforms itself when subjected to impact and absorbs the energy of impact and reduces the force transmissibility. By observing this nature of crash box author proposed analysis of crash box generally square shaped using ANSYS in order to check the minimum deformation on same impact load of crash box with linear shape and with taper shape and the optimum shaped is proposed.

Index Terms **– Safety, Crash Box, Dashing, Passengers Vehicles, Analysis, ANSYS, etc.**

I. INTRODUCTION

Crash box is a device used to improve the safety of the vehicle during frontal collision. It is generally provided at the front side of the vehicle which absorbs energy of collision during frontal dash, collapse itself to deform and provide safety. As per the manufacturer design and the availability of space also the energy absorption capacity there are many types of crash box like carbon fiber crash box, Aluminium honeycomb sandwich crash box, Steel crash box, etc. a typical crash box of square section is shown in the figure 1.1 which is directly attached to the front bumper of vehicle.

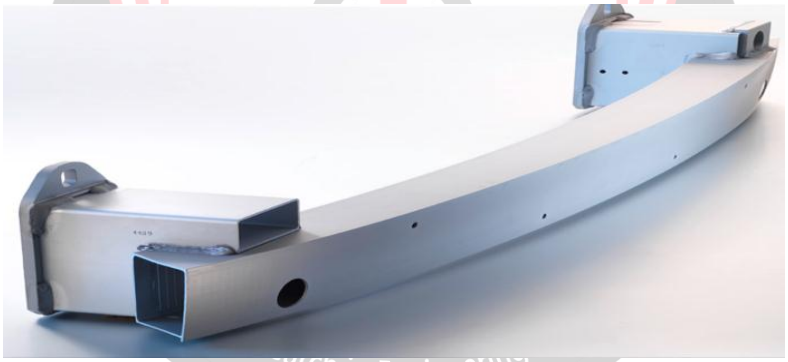

Fig.1.1 Square Shaped Vehicle Crash Box

A part from the types stated above there are different shaped crash box are also available for different capacity of energy absorption and the deformation. In addition all the crash boxes are provided with the slots of either side from where the actual deformation begins. It is observed that the performance of the crash box is dependent on the shape and length of it. By varying either parameter the deforming capacity also the energy absorption capacity can be varied. By considering the variation in performance with shape and size the author proposed analysis of square shaped crash box having with linear and taper section by keeping the length same by using ANSYS in order to study the behavior of the crash box with two said condition to improve the performance.

II. DESIGN OF SQUARE SHAPED CRASH BOX

The square shaped crash box with linear and taper section is modeled using Catia-v5 by keeping the base and length same. These two also provided with the slots on the same distance in order to initiate the deformation. Table 1.1 shows the dimensions of the two crash box as below.

Table 1 Crash Box Dimensions

Crash Box Type	Base Dimension	Length	Upper Dimensions
Linear	100mm *100mm	160mm	NA
Taper	100mm *100mm	160mm	50mm *50mm

And the figure 2.1 shows both the crash box modeled using Catia.

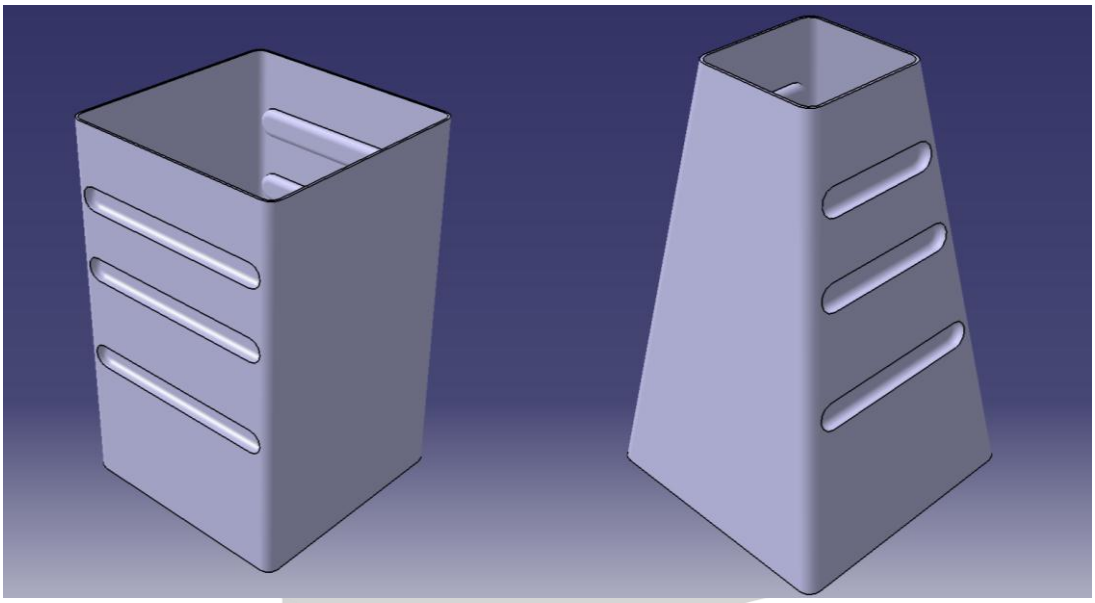

Fig. 2.1 Different Shaped Square Crash Box

III. ANALYSIS OF CRASH BOX

The created model is imported in ANSYS in .igs form and then analysis is carried out. The analysis is of two types. 1) Analysis of crash box for total deformation and 2) Analysis of crash box for strain energy.

For analysis of crash box using ANSYS it is consider that the car is moving with 13.5m/s and dashes with a stationary object and then the force of impact is 474.6KN. Hence by applying such value of force in ANSYS the result is evaluated and the optimum design in proposed.

3.1 Analysis of Square Shape Linear Crash Box

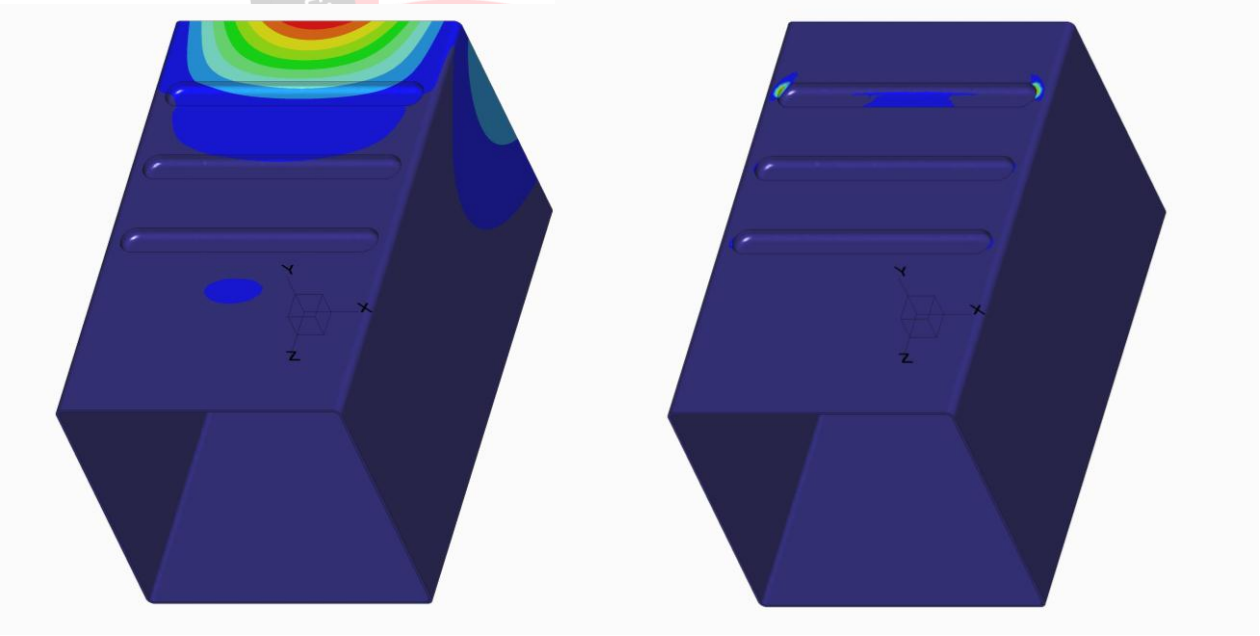

Fig. 3.1 Square Shaped Linear Crash Box Showing Total Deformation and Strain Energy

After applying the stated force by keeping the bottom side of crash box fix the result is evaluated for Total Deformation and Strain Energy and tabulated in table 2.

Table 2 Total Deformation and Strain Energy of Linear Crash Box

Total Deformation	19.66 mm
Strain Energy	973.6 MPa

3.2 Analysis of Square Shape Taper Crash Box

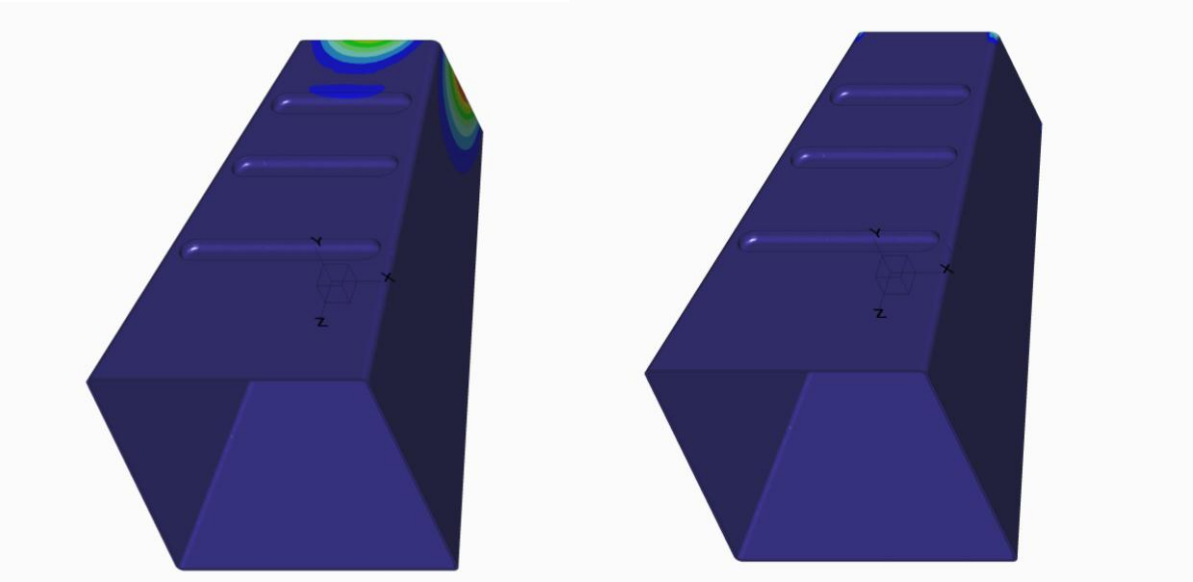

Fig. 3.2 Square Shaped Taper Crash Box Showing Total Deformation and Strain Energy

After applying the stated force by keeping the bottom side of crash box fix the result is evaluated for Total Deformation and tabulated in table 3.

Table 3 Total Deformation and Strain Energy of Taper Crash Box

Total Deformation	31.35 mm
Strain Energy	13130.2 MPa

IV. RESEARCH METHODOLOGY

The survey of safety devices in automobile is done later the crash box is selected as a design outcome. Data is collected related to development and availability of crash box in vehicle. Study of different shaped crash box is done in order to have the relation between shape and energy absorption or deformation. Selection of any one shape for further study with change in area like in this work author selected linear and taper area. Modeling of selected shape in Catia and convert to .igs format in order to open for analysis in ANSYS. Later analysis is performed on both the crash box by keeping the material and impact force parameters same. Then the result is evaluated to have optimum shape of square crash box for reduced deformation and increased energy absorption capacity.

V. RESULTS AND DISCUSSION

5.1 Results

Table 4 shows the Total Deformation and strain energy for the square linear shaped and taper shaped crash box respectively.

Table 4 Total Deformation and Strain Energy of Both Crash Box

Crash Box Type	Total Deformation	Strain Energy
Linear	19.66 mm	973.6 MPa
Taper	31.35 mm	13130.2 MPa

From the result table it is clear that as the shape of crash box changes the corresponding values of performance parameters also changes. The result table shows that the linear shape crash box has less deflection also the energy absorption is less compared to the taper section. While the taper shaped square crash box has more deflection than the linear one but the energy absorption capacity is greatly improved. Hence it is concluded that the square shaped crashed box with taper area deforms more but at the same time absorbs more amount of energy and reduces force transmissibility compared to linear shaped. Hence the square shaped crash box having taper shape is optimum design.

VI. ACKNOWLEDGMENT

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