PERFORMANCE EVALUATION OF CIRCULAR AND HEXAGONAL SHAPED CRASH BOX FOR IMPROVED PASSENGER'S SAFETY

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Abstract : The automotive crash box is a safety device installed at the front of vehicle which safeguard the vehicle component and passengers during the frontal collision. The crash box serves this function by deforming itself and absorbs the energy of collision. The crash box shape and size plays a vital role in deformation and energy absorption property. Considering the same shape and size nature of crash box the author proposed the performance evaluation of two different shape crash boxes mainly circular and hexagonal for improved passenger's safety. In this study the CAD model is prepared and analyzed for deformation and energy absorbed. Later the same shape crash boxes are fabricated to study the behavior under loading experimentally for same parameters. The results obtained by analytical and experimental approach are compared and the optimum shape is proposed which has minimum deformation and maximum energy absorption property.

IndexTerms **– Crash box, Collision, Deformation, Energy, safety, etc.**

I. INTRODUCTION

The automotive crash box is the safety instrument which provides safety to the vehicle components and passengers during the frontal collision. It is generally mounted in front of vehicle body which deforms itself during collision and absorbs the impact energy. The shape and size of the crash box can be varied depends on the manufacturer and design consideration. The changes in shape of crash box leads to the variation in the deformation and energy absorption property. To perform the analysis, the circular shape and hexagonal shape crash boxes are modeled using CAD package CATIA and then analysis is performed using ANSYS and results are recorded for total deformation and strain energy absorbed. Later the same shape crash box i.e. circular and hexagonal are fabricated and experimentally tested under UTM for the same loading condition specified in the ANSYS and the results are recorded for the said parameters. The results obtained from both analytically and experimentally are compared for total deformation and the optimum shape of crash box is proposed which has minimum deformation and the maximum energy absorption property in order to safeguard the vehicle components and passengers.

II. MODELING OF CIRCULAR AND HEXAGONAL SHAPE CRASH BOX

The two crash boxes of Circular and Hexagonal shapes are modeled using CAD package Catia as shown in figure 1 and table 1 show the geometrical parameter used. While modeling the shape in Catia, it is necessary to make the slots at equal interval in both the crash box in order to have more accurate result.

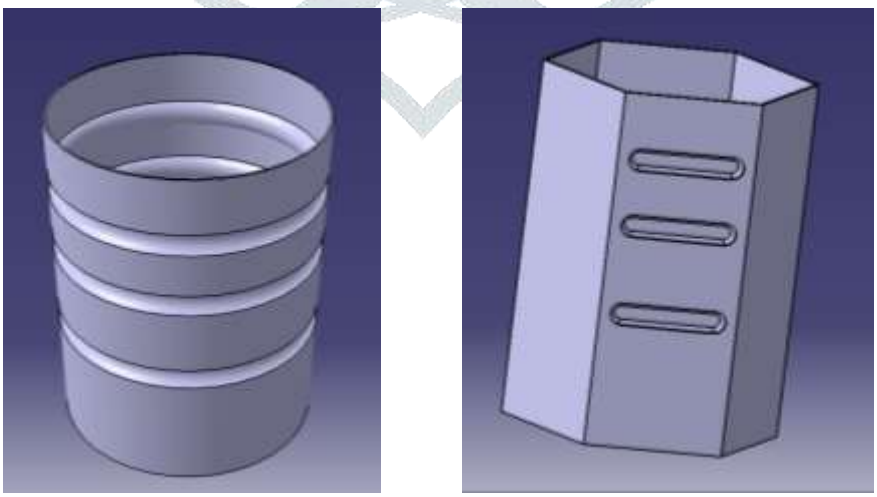

Fig.1 CAD Model of Circular and Hexagonal Shape Crash Box

Table 1. Geometrical Parameter

Crash Box Shape	Length (mm)	Diameter (mm)	Side (mm)
Circular	160	113	—
Hexagonal	160	—	62

III. ANALYSIS OF CIRCULAR AND HEXAGONAL SHAPE CRASH BOX

After the modeling the model is then imported into ANSYS in .igs format for further analysis. The analysis is performed by considering the force magnitude as 70KN in order to get the considerable result. The figure 2 shows the total deformation and figure 3 shows the strain energy for both the crash box shape. And table 2 shows the corresponding values of total deformation and strain energy.

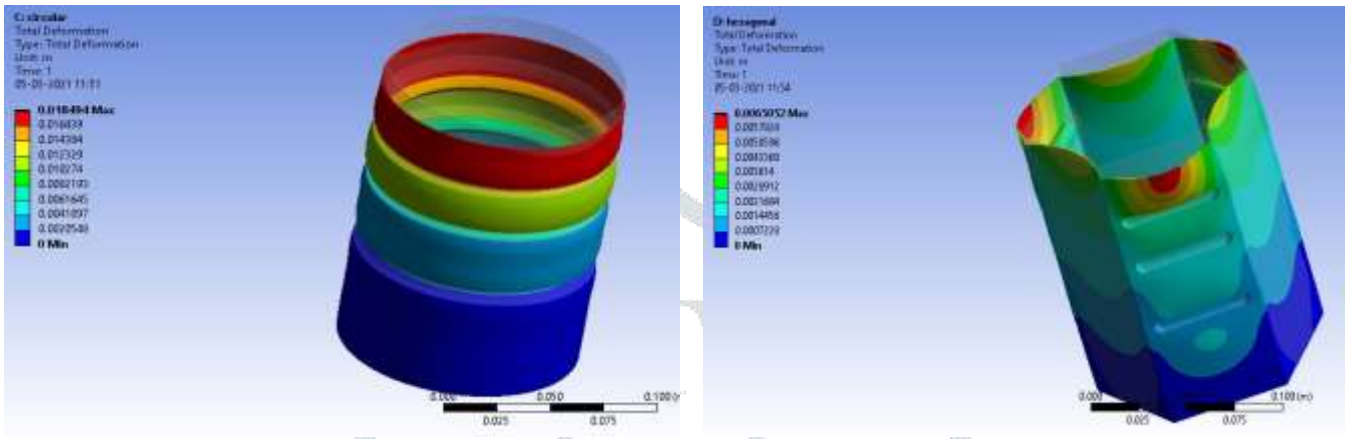

Fig. 2 Total Deformation of Circular and Hexagonal shape Crash Box

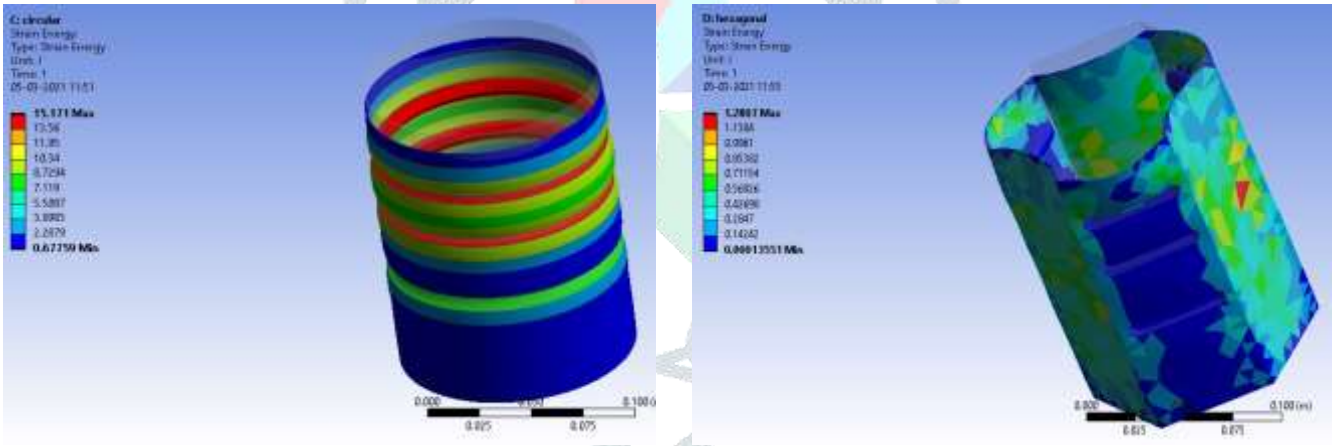

Fig. 3 Strain Energy of Circular and Hexagonal shape Crash Box

Table 2. Total Deformation and Strain Energy of Circular and Hexagonal Crash Box

Crash Box Shape	Total Deformation (mm)	Strain Energy (J)
Circular	18.49	15.171
Hexagonal	6.50	1.2807

IV. EXPERIMENTAL ANALYSIS OF CIRCULAR AND HEXAGONAL SHAPE CRASH BOX

The Circular shape and Hexagonal shape are fabricated with the same parameter and tested under UTM under the same loading condition as specified in Ansys. The figure 4 shows the crash box after tested under UTM for total deformation and table 3 gives the deformation value under loading.

Fig. 4 Total Deformation of Circular and Hexagonal shape Crash Box Experimentally

Table 3. Total Deformation and Strain Energy of Circular and Hexagonal Crash Box Experimentally

Crash Box Shape	Total Deformation (mm)
Circular	30
Hexagonal	10

IV. RESULTS AND DISCUSSION

The values measured for strain energy analytically and for the total deformation analytically and experimentally for circular and hexagonal shape crash box are tabulated in table 4 and table 5 respectively.

Table 4. Strain Energy of Crash Box Analytically

Crash Box Shape	Strain Energy (J)
Circular	15.171
Hexagonal	1.2807

Table 5. Total Deformation of Crash Box Analytically and Experimentally

Crash Box Shape	Total Deformation Experimentally (mm)	Total Deformation Analytically (mm)
Circular	30	18.49
Hexagonal	10	6.50

The values from the table 5 clears that the strain energy of circular shape crash box is much higher than that of the hexagonal shape crash box also from table 6 it is cleared that the total deformation of hexagonal shape crash box is lower than that of the circular shape crash box.

From the result table it is concluded that the circular shape crash box has considerable deformation but at the same time the energy absorption is more. On the other hand the hexagonal shape crash box has much lower deformation but also the energy absorption is very less. Therefore the circular shape crash box is selected as an optimum crash box shape which has minimum deformation and maximum strain energy.

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