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Design and static structural analysis of car door by using epoxy carbon woven

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Abstract
A car door is a type of door, typically hinged, but sometimes attached by other mechanisms such as tracks, in front of an opening which is used for entering and exiting a vehicle. A vehicle door can be opened to provide access to the opening, or closed to secure it. These doors can be opened manually, or powered electronically. Powered doors are usually found on minivans, high-end cars, or modified cars.

Keywords: car doors, modified cars, catia, ansys

Introduction

Unlike other types of doors, the exterior side of the vehicle door contrasts in its design and finish from its interior side (the interior part is typically equipped with a door card (in British English) or a door panel (in American English) that has decorative and functional features. The exterior side of the door is designed of steel or other material like the rest of the vehicle's exterior. In addition, its decorative appearance, typically colored with a design, is intended to match with the rest of the vehicle's exterior, the central purpose being to add to the overall aesthetic appeal of the vehicle exterior.

A vehicle typically has two types of doors: front doors and rear doors. Loosely related are: vehicle hoods and vehicle trunk lids. There are also doors known as a hatch. A major safety issue with opened vehicle doors is the assumption at night vehicle doors can provide a warning to other vehicle drivers. Unfortunately it is estimated over 50 percent of all vehicle doors have nothing applied to the interior of the vehicle door such as light and/or a reflector. Unfortunately these devices need not meet any US Federal Motor Vehicle Safety Standards since no standards apply. To make matters worse it was reported by the Fatal Accident Reporting System that in the year 2014 not one single death was reported with a person outside the opened vehicle door at night in the entire United States of America. New safety technology such as providing to the lower interior edge of the vehicle door a highly reflective tape provides the ability of other vehicle drivers to see the opened vehicle door at night.

Materials and methods

1. Design calculations

Side length =90.4cm
Left side height =70.2cm
Right side height =120.3cm
Middle length =90.4cm
Glass height =40.67cm
Bottom thickness =9 cm
Right side thickness =10.58cm
Left side thickness =10.14cm
Top side thickness =5cm
Radius =50cm

2. Design model

To design a car door part model here created Catia V5 R20 software used. Open the Catia module and create required dimensions of door part model and then assembled as an assembly design.

3. Material selection

In this paper consists of five different materials were selected. There are many types of plastic materials, we are choosing. Only five types as given below, Polyethylene terephthalate, Epoxy carbon woven prepreg, High density polyethylene, Polystyrene of Styrofoam, Polypropylene. CATIA is an acronym for Computer Aided Three-dimensional Interactive Application.

4. Analysis

ANSYS is the standard FEA teaching tool within the Mechanical Engineering Department at many colleges. This type of product development is termed virtual prototyping. With virtual prototyping techniques, users can iterate various scenarios to optimize the product long before the manufacturing is started. The multifaceted nature of ANSYS also provides a means to ensure that users are able to see the effect of a design on the whole behavior of the product, be it electromagnetic, thermal, mechanical etc.

Results & Discussion

The first step is engineering data that is apply the material properties and select the material then the next step is geometry, now import the new geometry of car door.

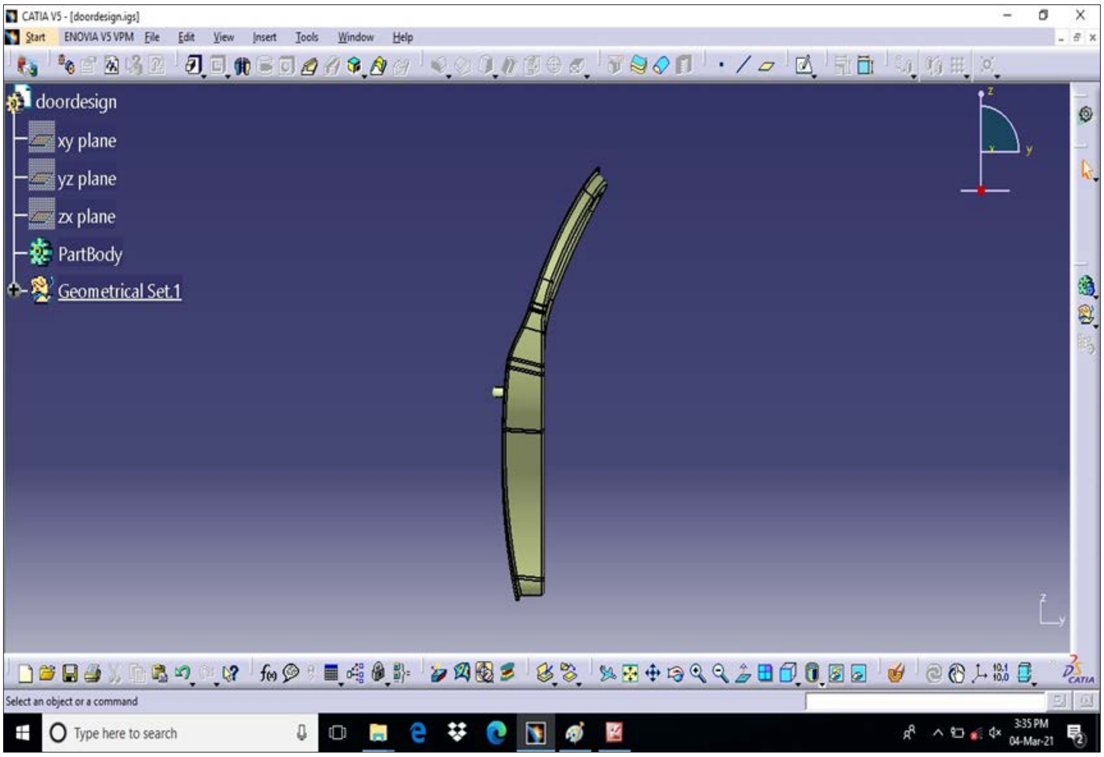

Fig 1: front view of car door

Case (i)

Modulus of elasticity (E) =210000 N/mm^2

Shear modulus (G) =81000 N/mm^2

Poisson's ratio (V) =0.3

Thermal expansion (α) =12x10^{-6} /^{0}c

Yield strength (σ_t) =50 N/mm^2

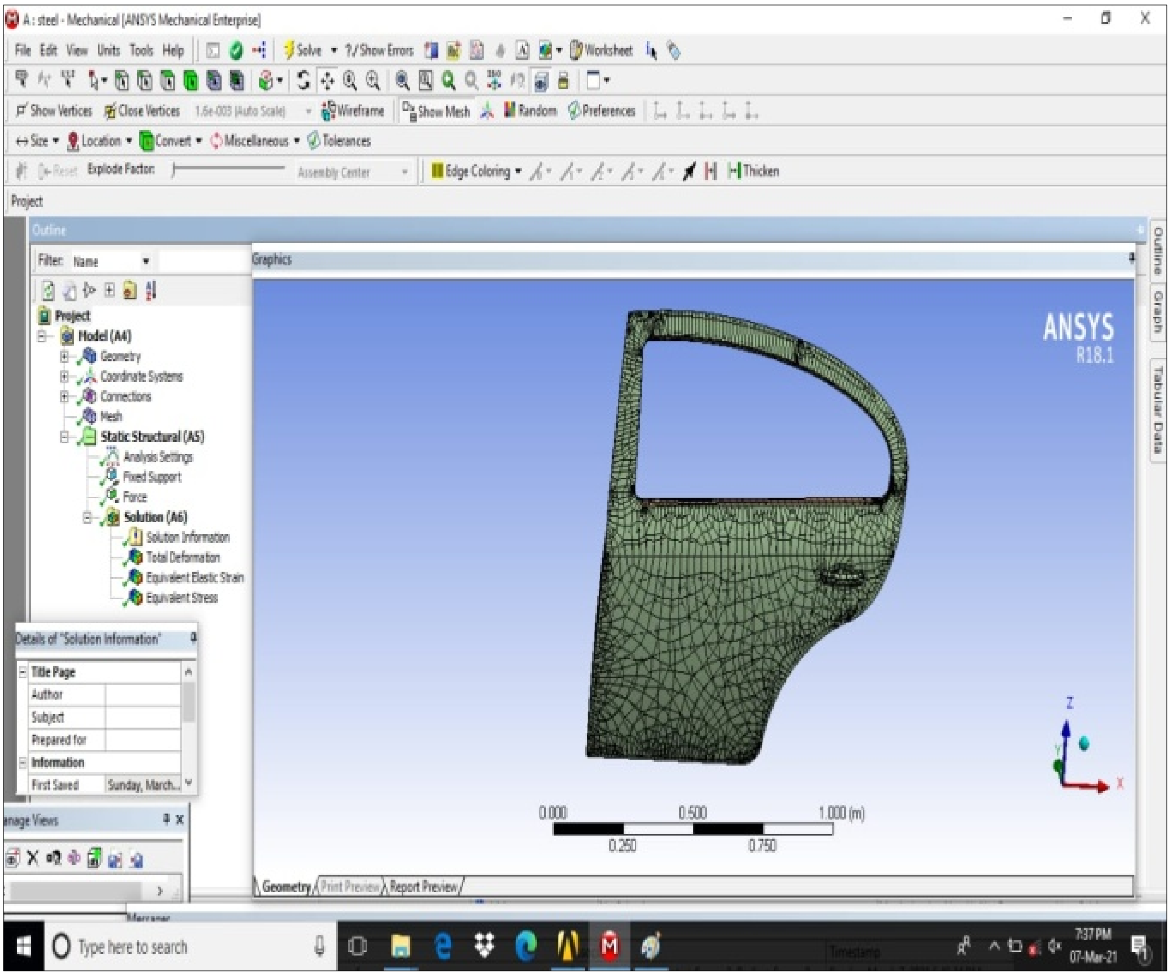

Fig 2: Structural steel Meshing of car door

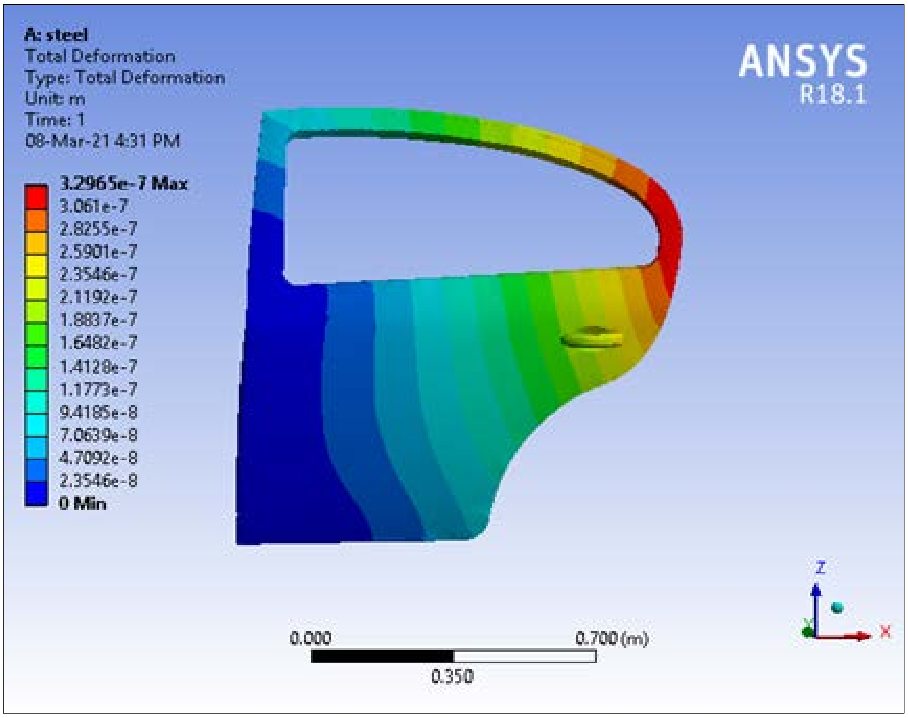

Fig 3: Total deformation

Case (ii)

Properties of Polyethylene terephthalate

Density (ρ) =1.38g/cm^3

Young's modulus (E) =3000Mpa

Tensile strength (σ_t) =72Mpa

Compressive strength (σ_C) =120Mpa

Poisson's ratio =0.3

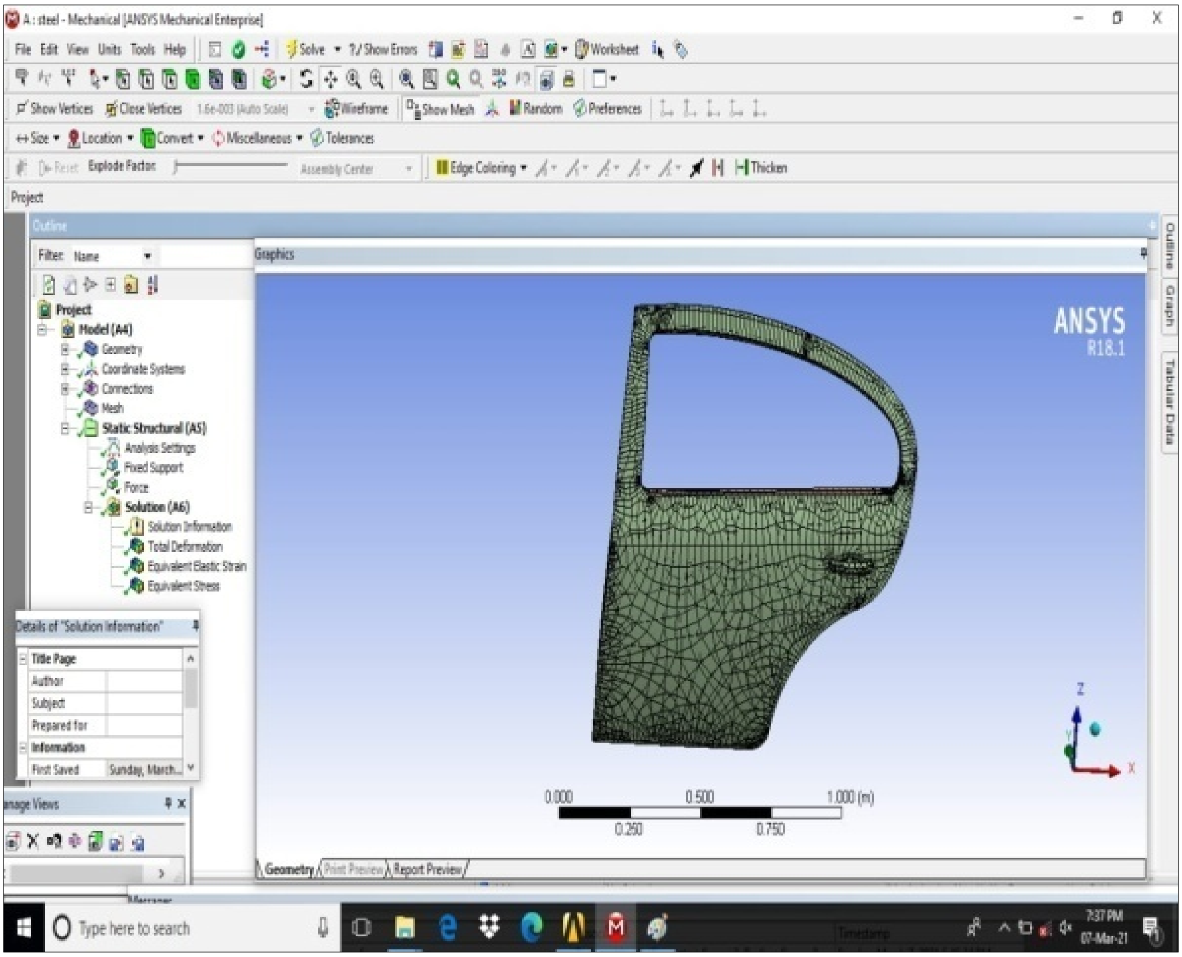

Fig 5: meshing of car Polyethylene terephthalate

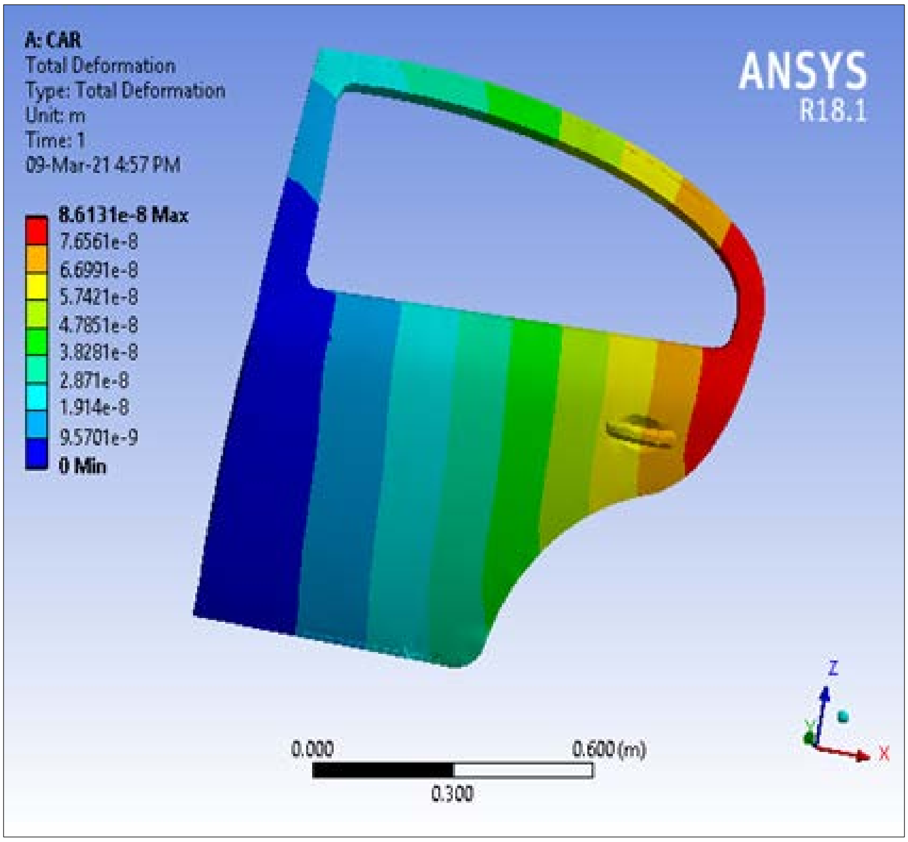

Fig 6: Total Deformation

Case (iii)

Properties of Epoxy carbon woven prepreg

Density (ρ) =1.48g/cm^3

Young's modulus (E) =91820Mpa

Tensile strength (σ_t) =829Mpa

Compressive strength (σ_C) =439Mpa

Poisson's ratio =0.3

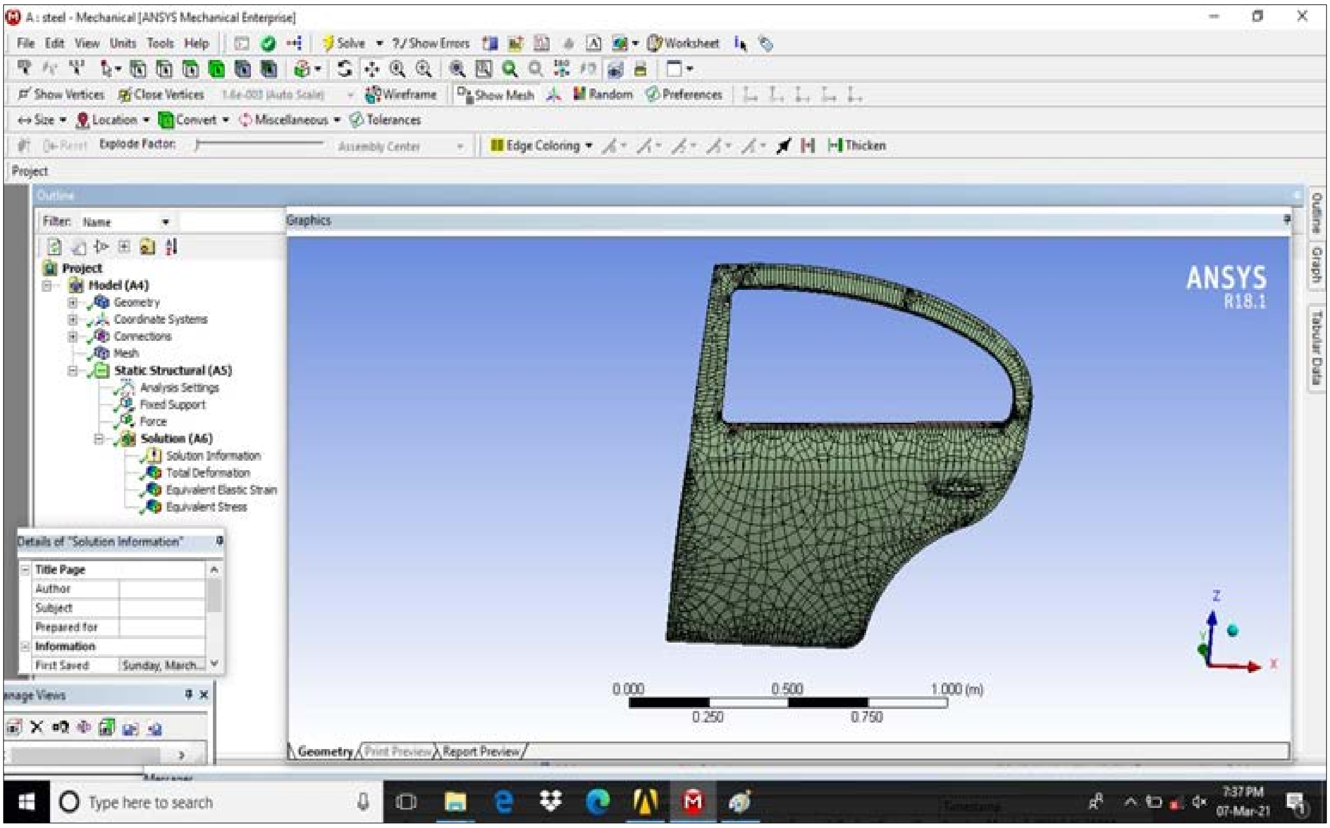

Fig 7: Epoxy carbon woven prepreg meshing of car door

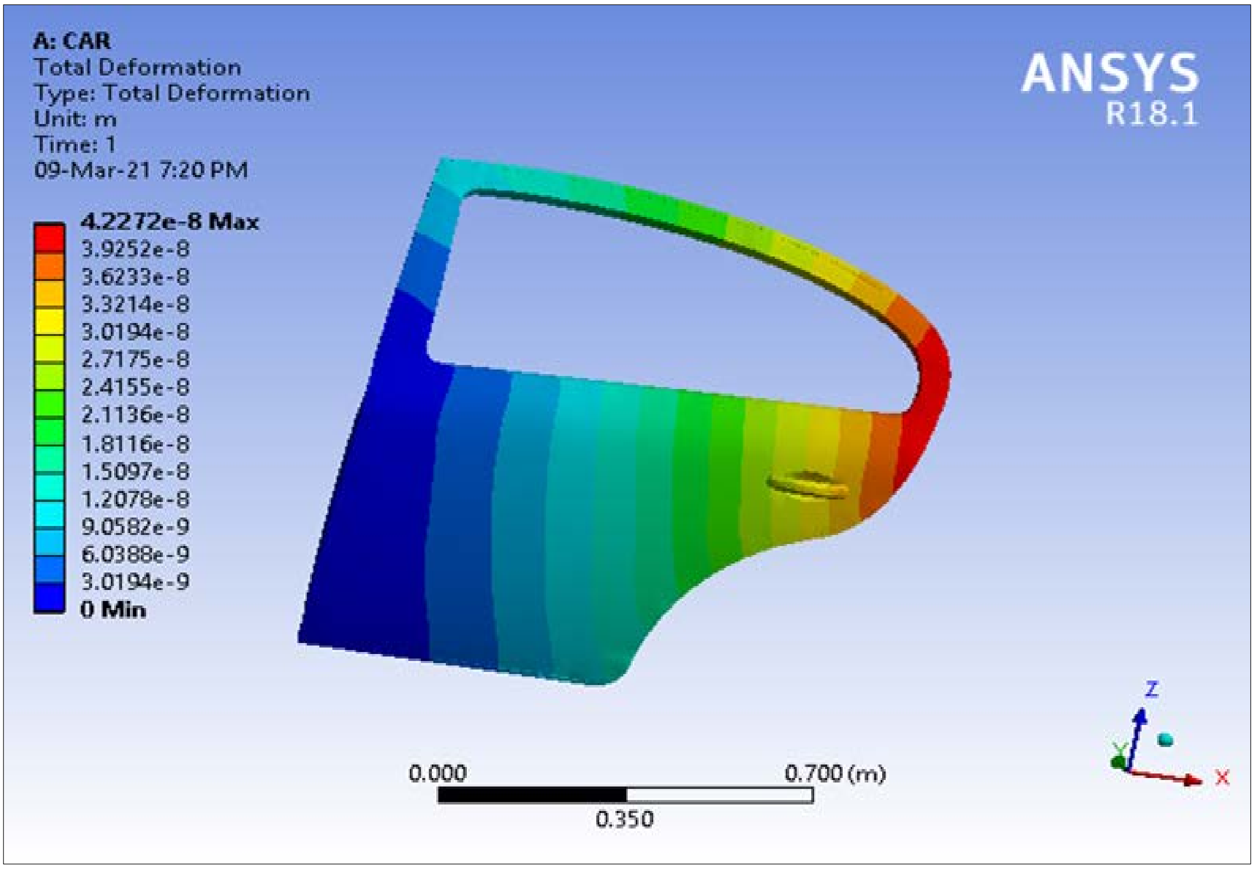

Fig 8: Total deformation

Chart Comparison of materials

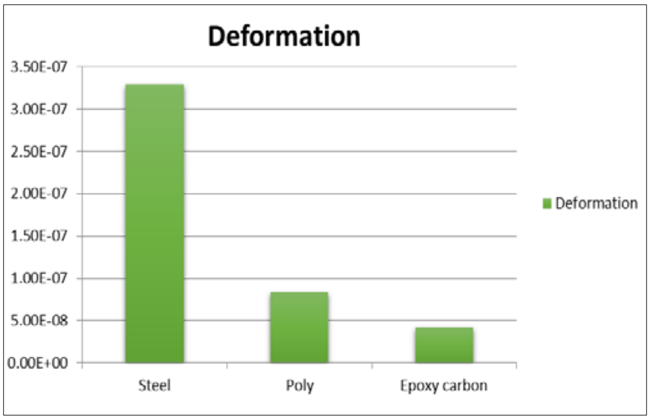

Fig 9: Deformation

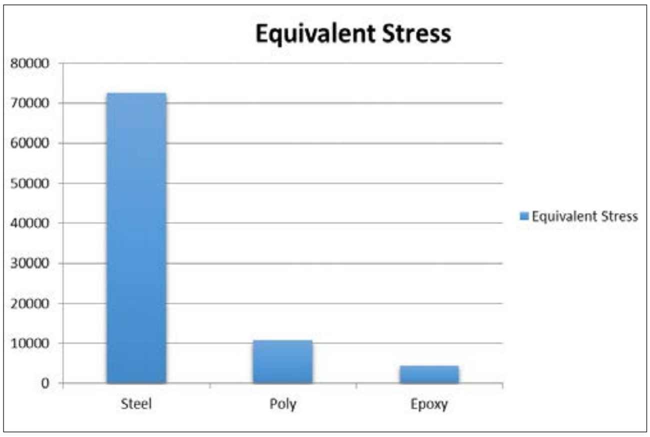

Fig 10: Equivalent stress

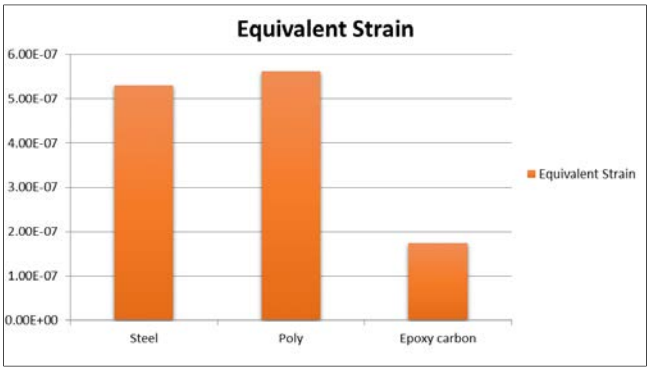

Fig 11: Equivalent strain

The car door panel impact analysis is carried out in static analysis option in Ansys with respect Total deformation, Equivalent elastic strain and Equivalent stress are been tabulated as follows:

Table 1: comparison of results (load: 20N)

S.No	Materials	Total deformation (m)	Equivalent stress (Pa)	Equivalent strain
1.	Structural steel	$3.2965X10^{-7}$	72746	$5.2912X10^{-7}$
2.	Polyethylene terephthalate	$8.3161X10^{-8}$	10688	$5.6233X10^{-7}$
3.	Epoxy carbon woven prepreg	$4.2272X10^{-8}$	4412.5	$1.7503X10^{-7}$

Conclusions

According to this study of static structural analysis of the car door panel shows the response of car door panel with respect to the load condition with composite and fully construction outer and inner panel. The stress and displacement behavior under the different impact force condition used to find the crash resistant of the door panel to satisfy the Ansys. The deformation allowed is $4.2272X10^{-8}$m at initial load condition of average 20N load condition. Based on the analysis report of the car door panel. We can conclude that the concept of Epoxy carbon woven are light weight and satisfy the deformation.

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