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A Front Rail Impact and Explicit Study of Truck Compairing Steel and Composites

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Abstract: The steel are commonly used material in bumpers for heavy truck. Weight reduction and fuel economy is the major in the design of today's automobiles. Fibre reinforced composites are materials that have advantages in cost and weight reduction compared to steel. Glass fiber reinforced polymer (GFRP) and carbon fiber reinforced polymer (CFRP) are used under various speed and time for impact study. These fiber reinforced materials low cost, light weight, energy absorption and crush under impact loading. In this various material under impact test is analyzed for various speed, time and angle. The safety assessment of rail is carried out with the aid of explicit non linear finite element analysis code LS-DYNA with steel and various fibres reinforced materials. In the present study steel and FRC'S under impact and explicit study with speed of 60 km/hr and a fraction of second impact is analyzed. In this orthotropic properties and orthotropic equation of FRC'S material is taken for analysis purpose. From the study, FRC'S material produce better impact and explicit analysis result compared to steel by focusing stress analysis, deformation and other properties.
Keywords: Impact study, Explicit study, Orthotropic properties, LS-DYNA

I. INTRODUCTION

Now a day's the transportation field is developing with new technologies. The transportation field is developing with major developing sector. As the vehicle is increasing, safety of the vehicle and driver is the main problem. The bumpers in vehicle are designed to produce physical damage to front and rear end of vehicle in collision condition. Bumpers avoid damage to chassis of vehicle as they are directly connected. Thu to limit the damage within in the bumper maximum limit, the greatest challenge is to produce high strength with light material to produce better fuel efficiency and low cost. The properties to obtain are less deformation, elastic and plastic strain and more internal energy absorption [3]. The energy absorption process of material control the impact force transmitted to chassis and vehicle frame. The steel is most commonly used materials in truck bumper which has high efficiency. Bumper play an important role in energy absorption process with less deformation [1]. The steel and aluminium structure are not suitable for bumper beam structure due to heavy weight. The increased weight of the material is 500% and 100% respectively. The bumper weight can be reduced by using FRC'S material which is analysed and compared. The main aim of this paper is to produce a composite bumper which has following requirements [10]:

1) By removing strengthening ribs of bumper the structure can be easily manufactured.
2) Low cost material and light weight material is used.
3) More or same impact behaviour is needed to be achieved compared to current structure.

Thus the impact and explicit analysis of steel and various composites is analysed and compared using LS-DYNA and the properties is compared. So crash of truck is done at various speeds and crash of various fractions of second is analysed.

II. LITERATURE REVIEW

Literature review for impact study by many researchers was observed that:

1) Bautista et al. examined that different impact value for specific material in which performance can be determined by software simulation. They also studied that energy absorption, maximum stress and deformation were used as design criteria.[7]
2) Hosseinzadeh, et al examined that bumper beam are on of the main structure of the vehicle that protect from front and rear collision. In this front bumper of Glass Mat Reinforced Thermoplastic (GMT) is analysed by LS-DYNA according to Economic Commission of Europe (E.C.E). Three main factors that is structure, shape, materials and shock condition were analysed and result is compared with steel and aluminium. [2]

3) Anderson (2002) studied that increased crash performance in automotive is needed to use new technologies and materials. The bumper should absorb energy should absorb energy. The geometry and material properties determine energy absorbing properties.[6]

III. METHODOLOGY

Modelling 3D model in solid works

↓ Para solid form (x.t)

Ansys design is modelled and convert solid model to surface model

↓ (.agb format)

In explicit dynamics, material properties is given and geometry is imported

↓

In explicit dynamics the coordinate system connections and mesh is done according to model and analysis is done

↓

Analysis process of solid mode l

↓

Case 2
In this case the truck bumper made up of steel 1006 material is collided with a rigid body of mass 2500 kg. The truck is stationary and rigid body is moving. The rigid body is moving at 80 km/hr, 60 km/hr, 40 km/hr and a fraction of 10 millisecond is analysed. The total deformation and internal energy absorption properties of material is taken and compared

Case 2
In this case the truck bumper made up of CFRP material is collided with a rigid body of mass 2500 kg. The truck is stationary and rigid body is moving. The rigid body is moving at 80 km/hr, 60 km/hr, 40 km/hr and a fraction of 10 millisecond is analysed. The total deformation and internal energy absorption properties of material is taken and compared

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IV. ANALYSIS OF TRUCK BUMPER BY ANSYS IN THE CASE OF STEEL

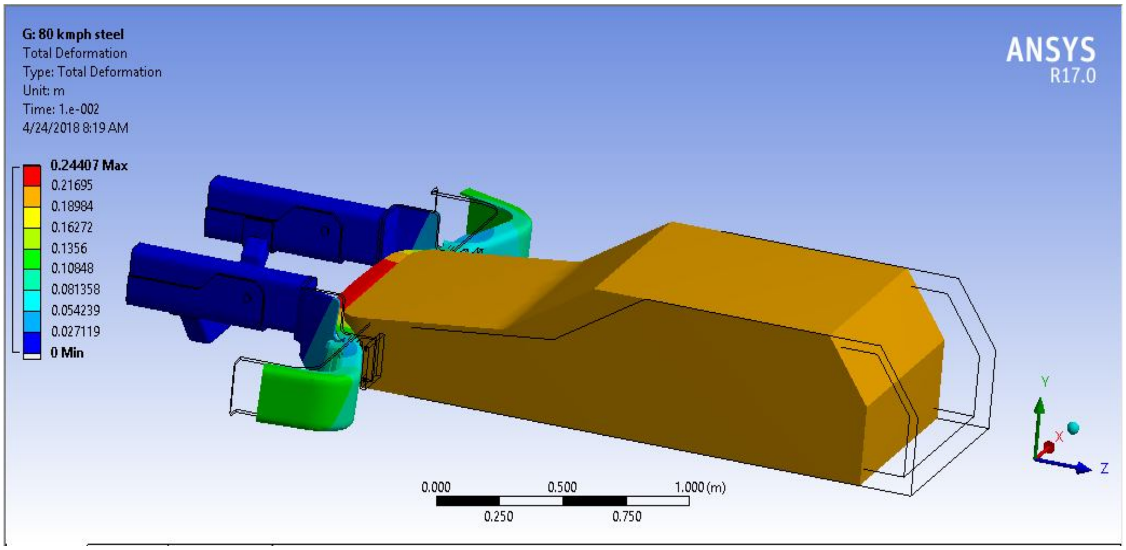

Fig .1 Total deformation of steel bumper when rigid body of mass 2500 kg strikes at 80 km/hr

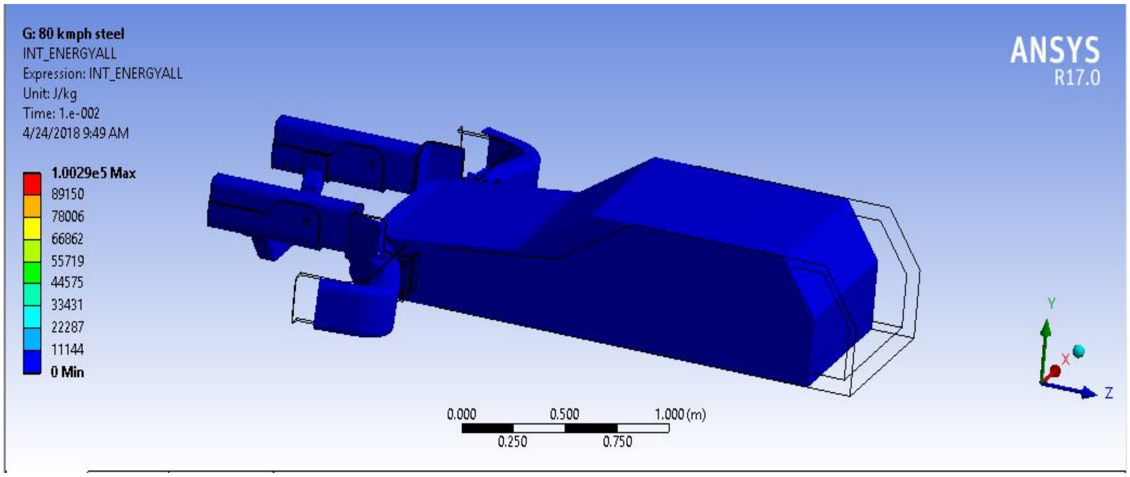

Fig. 2 Internal energy absorption of steel bumper when rigid body of mass 2500 kg strikes at 80 km/hr

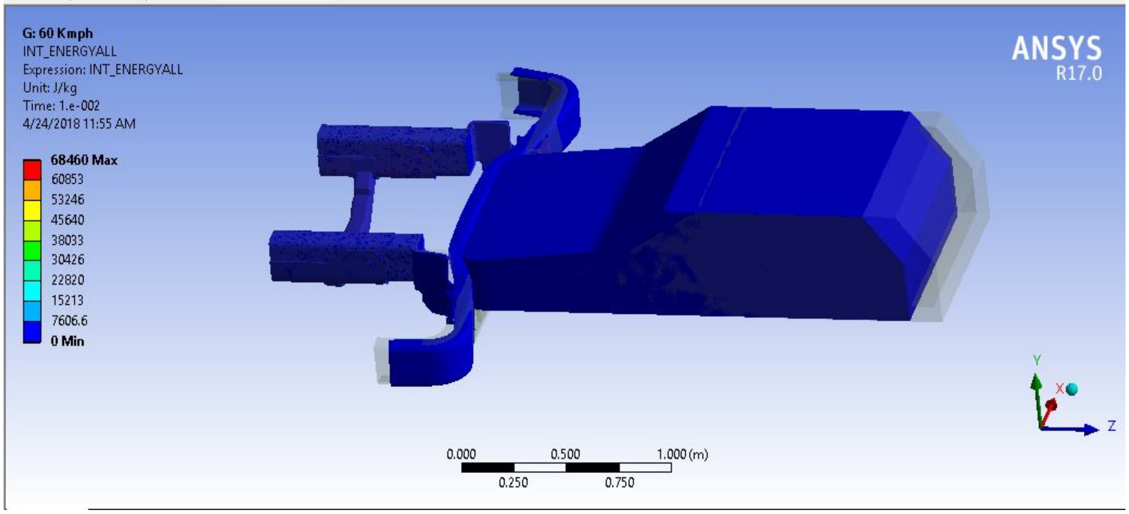

Fig. 3 Internal energy absorption of steel bumper when rigid body of mass 2500 kg strikes at 60 km/hr

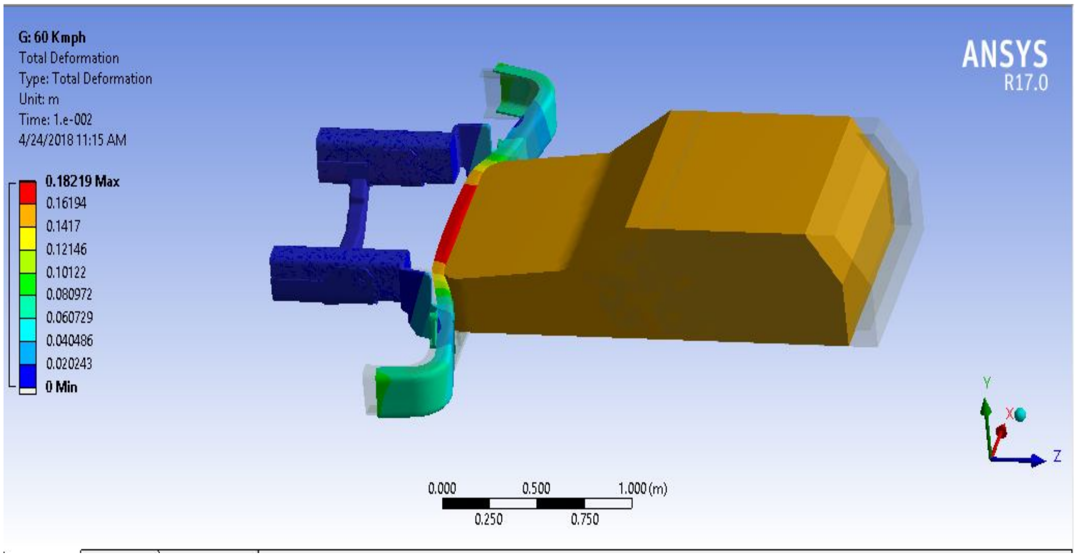

Fig. 4 Total deformation of steel bumper when rigid body of mass 2500 kg strikes at 60 km/hr

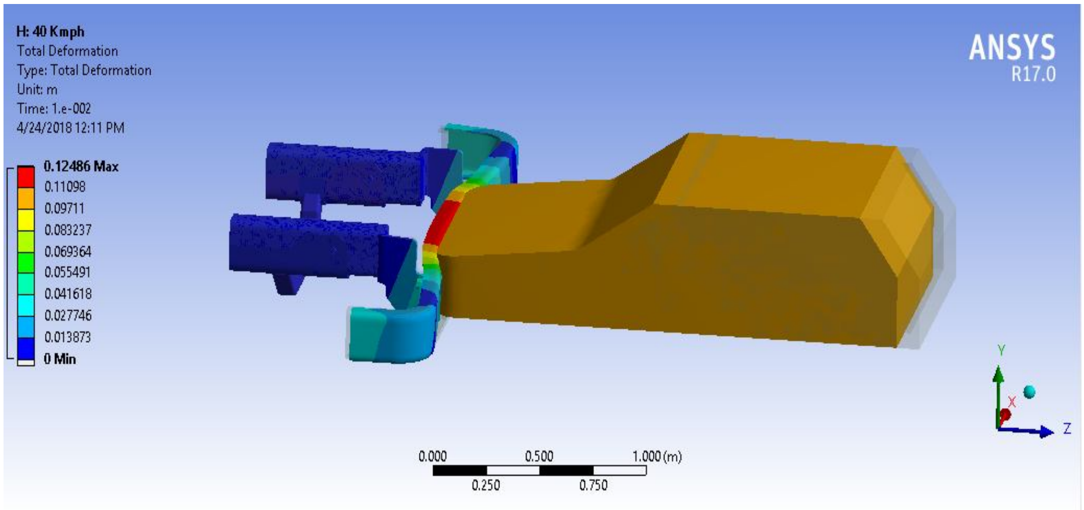

Fig. 5 Total deformation of steel bumper when rigid body of mass 2500 kg strikes at 40 km/hr

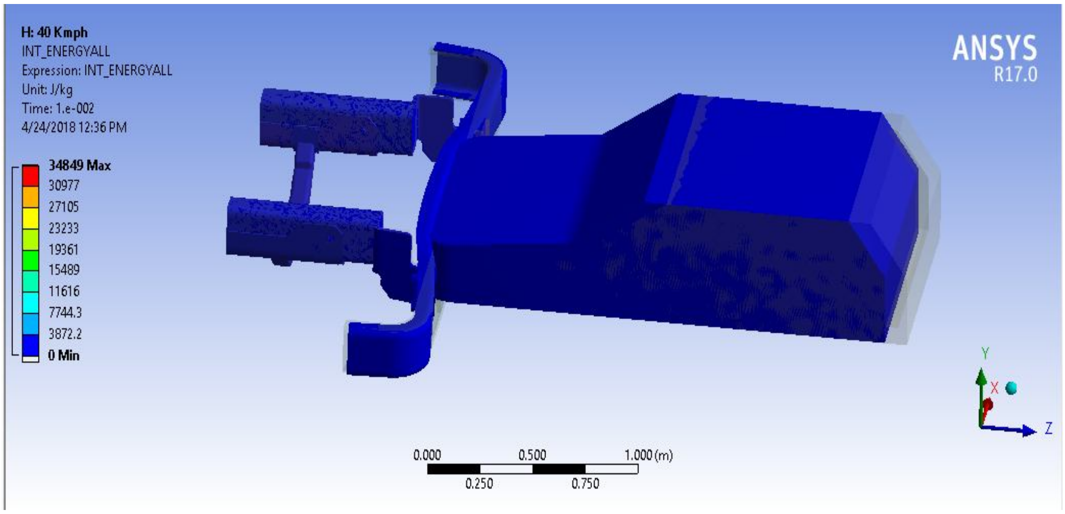

Fig. 6 Internal energy absorption of steel bumper when rigid body of mass 2500 kg strikes at 40 km/hr

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V. ANALYSIS OF TRUCK BUMPER BY ANSYS IN THE CASE OF CFRP

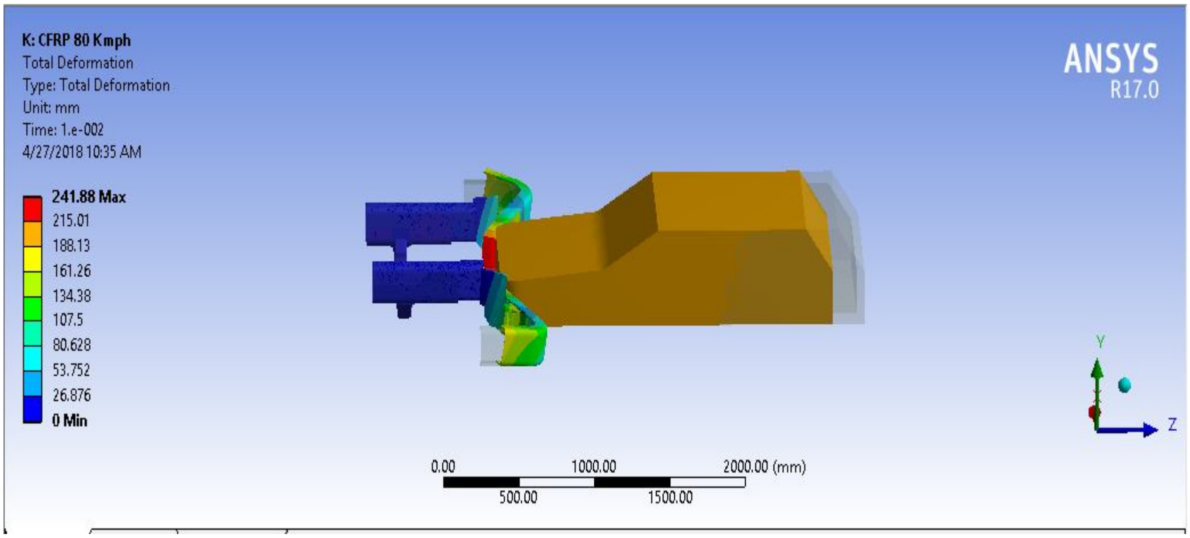

Fig.7 Total deformation of CRPF bumper when a rigid body of mass 2500 kg strikes at 80 km/hr

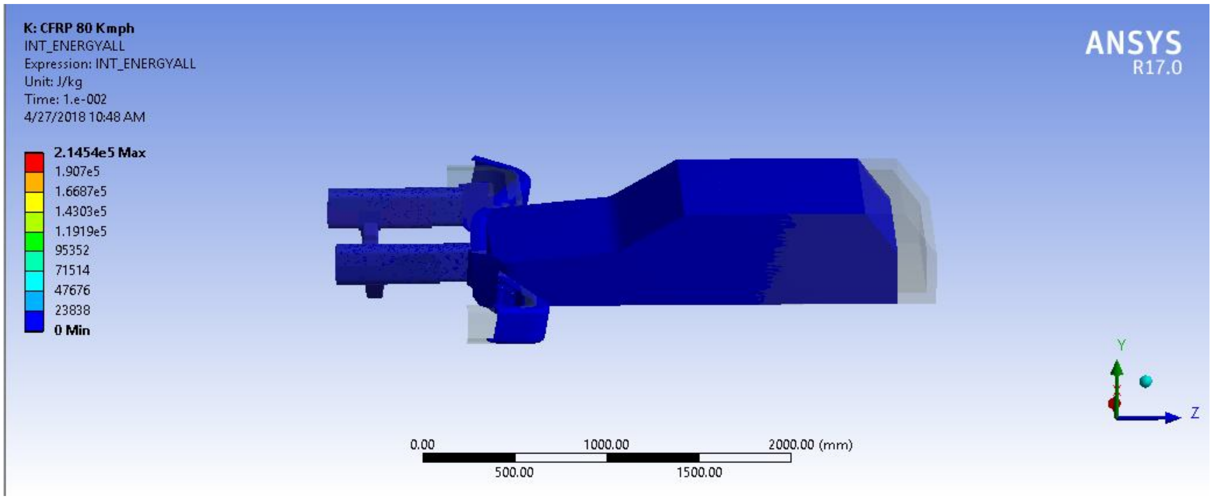

Fig. 8 Internal energy absorption of CFRP bumper when a rigid body of mass 2500 kg strikes at 80 km/hr

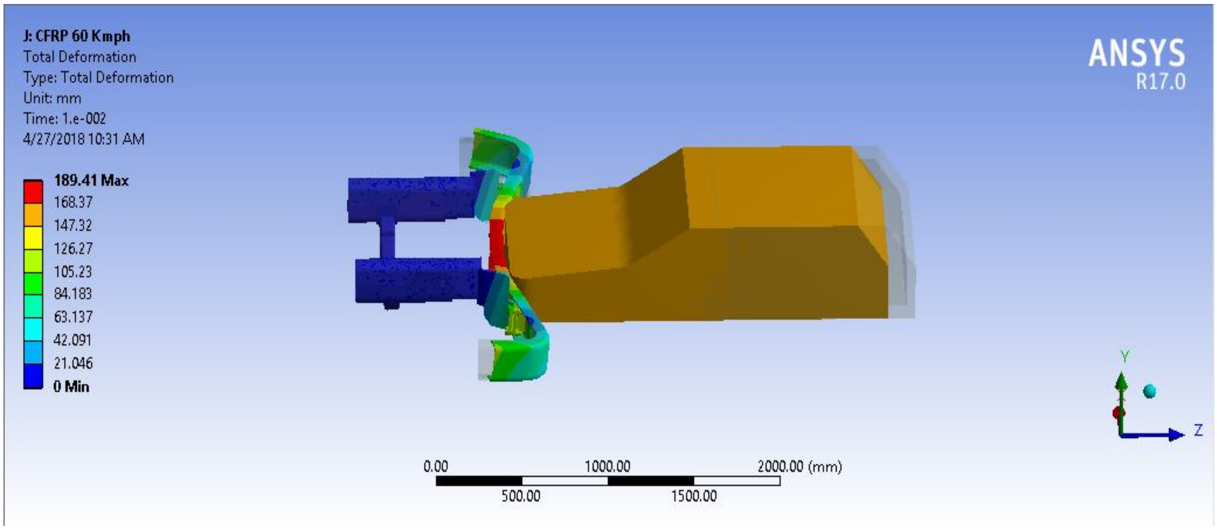

Fig. 9 Total deformation of CFRP bumper when a rigid body of mass 2500 kg strikes at 60 km/hr

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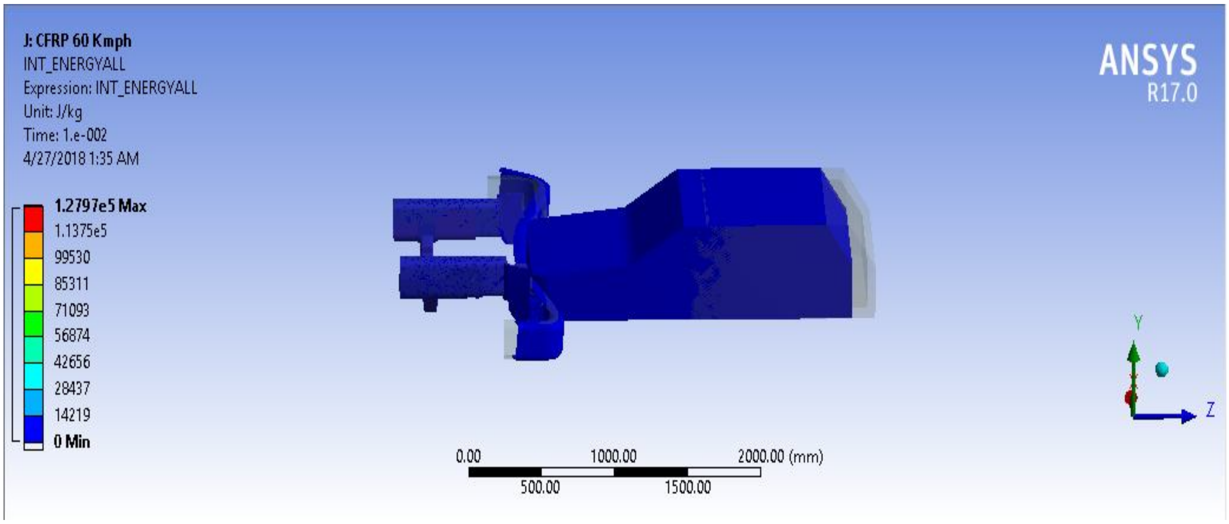

Fig. 10 Internal energy absorption of CFRP bumper when a rigid body of mass 2500 kg strikes at 60 km/hr

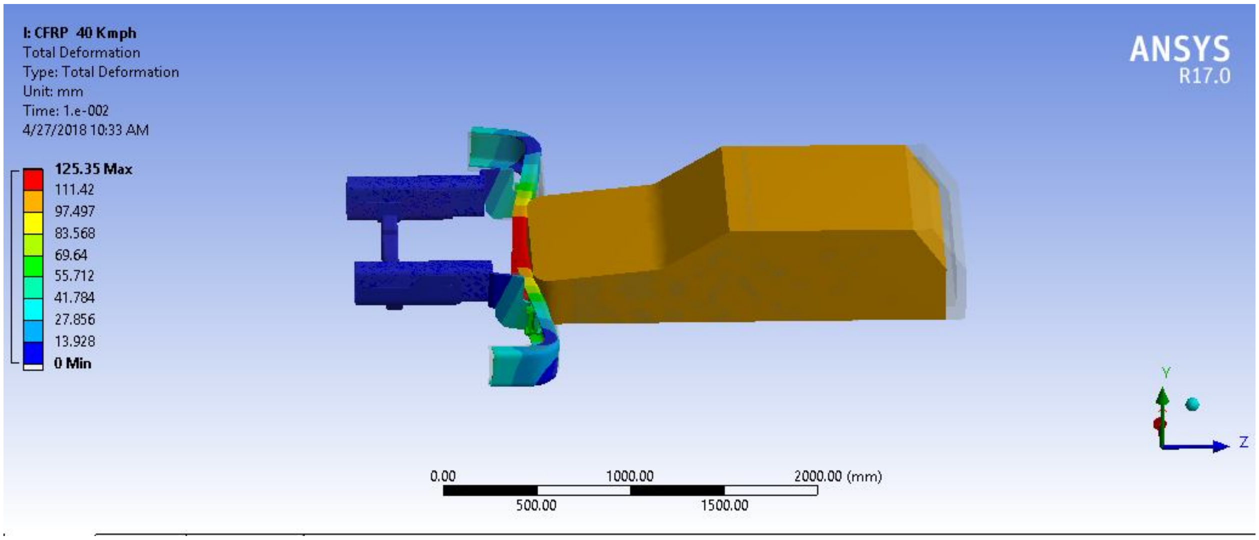

Fig. 11 Total deformation of CFRP bumper when a rigid body of mass 2500 kg strikes at 40 km/hr

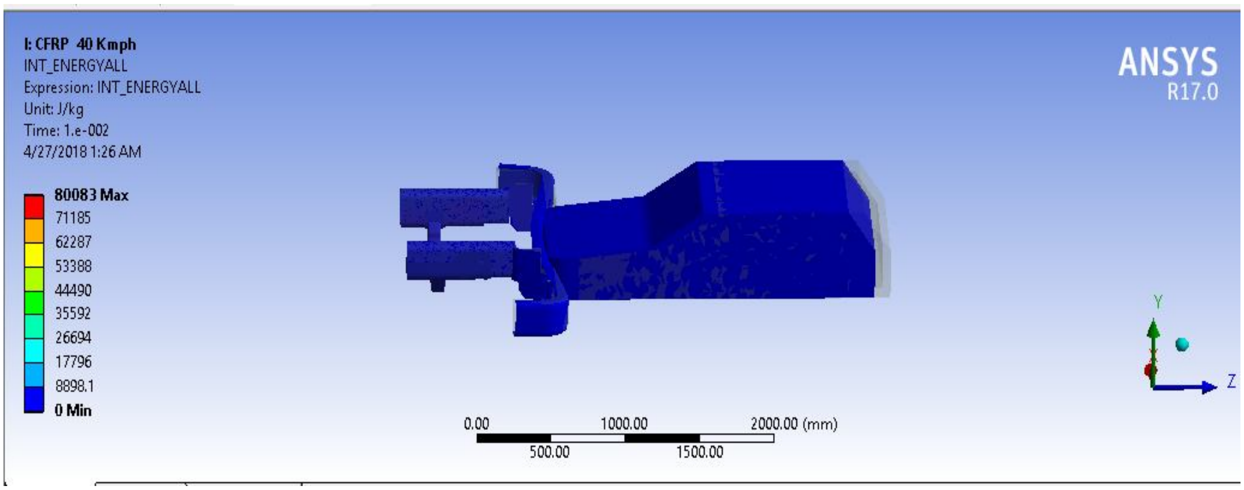

Fig. 12 Internal energy absorption of CFRP bumper when a rigid body of mass 2500 kg strikes at 40 km/hr

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VI. RESULTS AND DISCUSSION

1) The graph for total deformation of steel bumper when a rigid body of mass 2500 kg strikes at various Speed

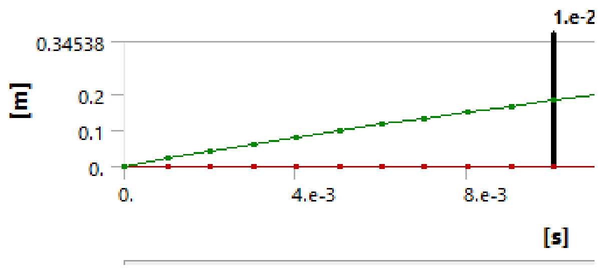

Fig. 13 Deformation at 80km/hr

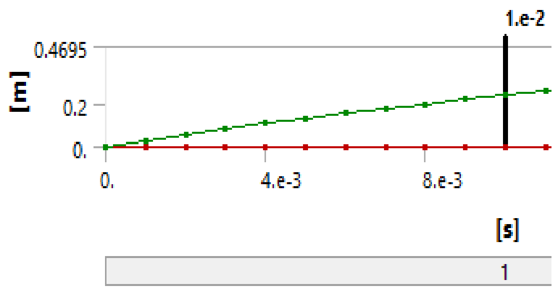

Fig. 14 Deformation at 60 km/hr

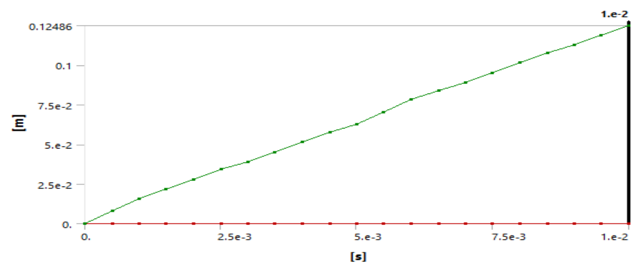

Fig. 15 Deformation at 40 km/hr

2) The graph for total deformation of CFRP bumper when a rigid body of mass 2500 kg strikes at various speed

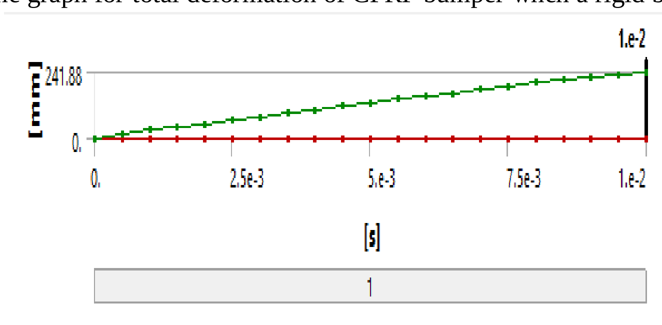

Fig. 16 Deformation aT 80 km/hr

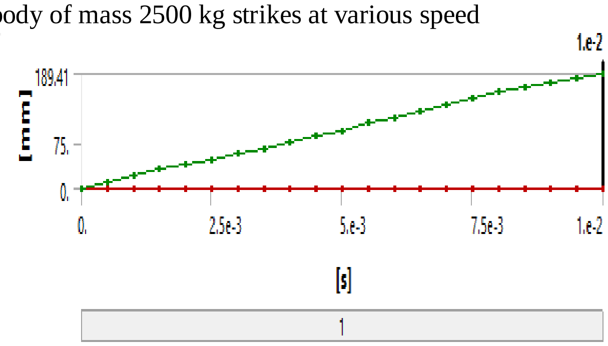

Fig. 17 Deformation at 60 km/hr

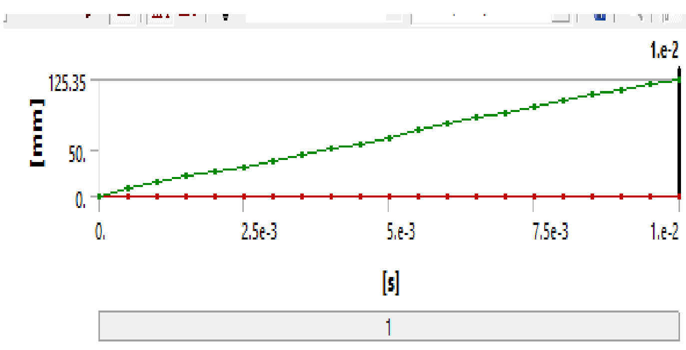

Fig. 18 Deformation at 40 km/hr

From the case of steel and CFRP bumper when a rigid body of mass strikes at 80 km/hr, 60 km/hr, 40 km/hr and result for 10 millisecond is taken. From the result the deformation is minimum for CFRP bumper compared to steel bumper at various speed. For good bumper material less deformstion is needed. Less deformation means less damage to body of vehicle .

3) The graph for internal energy absorption of steel bumper when a rigid body of mass 2500 kg strikes at various Speed

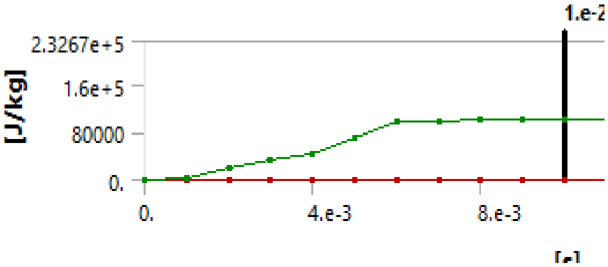

Fig. 19 Internal energy absorption at 80 km/hr

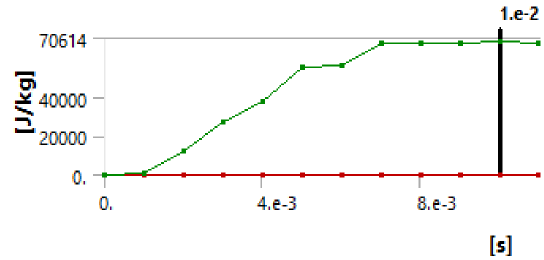

Fig. 20 Internal energy absorption at 60 km/hr

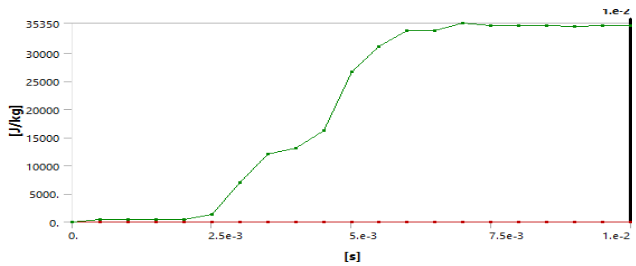

Fig. 20 Internal energy absorption at 40 km/hr

4) The graph for internal energy absorption of CFRP bumper when a rigid body of mass 2500 kg strikes at various speed

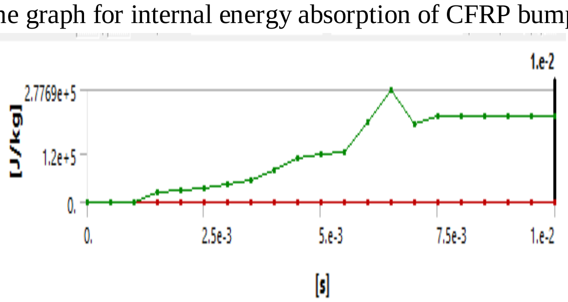

Fig. 21 Internal energy absorption at 80 km/hr

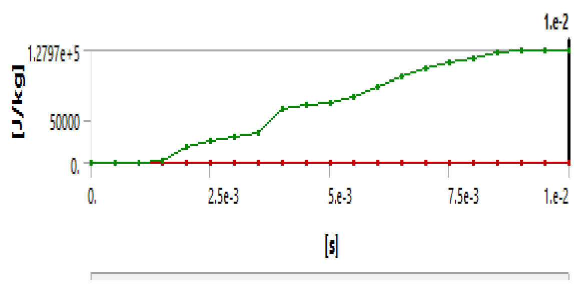

Fig. 22 Internal energy absorption at 60 km/hrZ

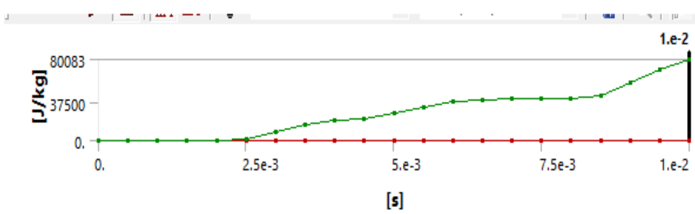

Fig. 23 Internal energy absorption at 40 km/hr

From the case of steel and CFRP bumper when a rigid body of mass strikes at 80 km/hr, 60 km/hr, 40 km/hr and result for 10 millisecond is taken. From the result the internal energy absorption is maximum for CFRP bumper compared to steel bumper at various speed. For good bumper material more internal energy absoption is needed. More internal energy absorption means less damage to body of vehicle.

VII. CONCLUSION

The comparison analysis of steel and CFRP bumper is obtained using Ansys at various speed of 80 km/hr , 60 km/hr , 40 km/hr
At a fraction of 10 milli second result is obtained. In the first case, total deformation properties of steel and CFRP bumper is obtained at various speed. From the result the total deformation of CFRP bumper is less compared to steel bumper. Thus CFRP material has less deformation properties. In second case, the internal energy absorption properties of steel and CFRP bumpers are obtained at various speeds. From the result the internal energy absorption of CFRP material is more compared to steel bumper. Thus CFRP material has high internal energy absorption properties.

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