CRASHWORTHINESS OF AUTOMOTIVE BUMPER USING BAMBOO FIBER REINFORCED EPOXY COMPOSITE

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Abstract: An automobile bumper is the structural part, which front-most or rear-most part, designed to allow the car to sustain an impact without damage to the vehicle's safety systems. They are not capable for reducing injury to vehicle occupants in high-speed impact. This research work describes the design a car bumper using Bamboo material, which is protection device for light utility vehicle .The work describes the development of front protective device for Light vehicle and protection under run situation of bicyclists, pedestrians, two wheeler riders, which happen to be major part of road accidents in urban area .In this paper we mainly focused on weight reduction, material selection and geometry to improve crashworthiness. This Project model built using the Solid works Software and while the simulation of crash done in Numerical study carried by simulation via the Dynamic Analysis in RADIOSS 14.0 software. To determine the impact energy absorbing member and also investigate the weight reduction of the panel, to determine the stiffness on the crash behavior.

Keywords: Bamboo fiber, Epoxy, composites, Bumper panel, Structural analysis, Displacement, Stress and weight.

1. Introduction

Occupants of car vehicles are killed in several crash events in frontal, rear and side etc. The crashes which makes the occupants to sudden death or injuries to risk .In crash report which taken in India the frontal impact has huge effect on the accidents when compared to others. The frontal impact has 40% accidents occurring in the India. And we have carried out a wide range of studies and analysis on impact. The following graph indicates the accidents happened in India. Mainly due to frontal impact the occupants has sitting inn the front seats has huge effects when compared to others . Many design and optimization material changes had made inorder to reduce the injuries and in order to improve the absorption of kinetic energy of the panel. More over nearly 1 lakh people were die every year in frontal impact in that more than 50% of deaths due to head injuries .

In this paper, the most important design parameter like thickness is studied for design and analysis of an automotive front bumper beam to improve the crashworthiness design in low-velocity impact. with increase in thickness, load carrying capacity of the bumper has increases due to increased stiffness. This has resulted in reduced Bumper deformation which in turn resulted into reduced plastic strain[1]. The passengers safety can be increased by using good materials at the same time we should not increase the weigth of the component. In this carbon composite material is used for this application due to high strength and weight reduction [2].Composite materials are characterised by high specific strength, both in static and impact loading conditions, and high specific stiffness; they could be an interesting candidate material for this type of component, posing as targets the lightweight together with the maintenance of at least the same level of safety performance in comparison with the present steel solution. When designing with composite material, it is always needed not only to choose the appropriate material but to think composite (i.e. to not simply replace the metallic material with the new one, but to redesign the part) and to select the type of production technology that will be used in manufacturing, as this choice will affect deeply both the structural performance, the cost and the production rate [3**].** In this research an analytic bumper model is developed and fixed wall is created . Then we made the analytic model with low speed velocity of 10m/s and obtaining the results [4**].** Hosseinzadeh et al. studied the structure, shape, and impact condition of glass mat thermoplastic (GMT) bumper by using LS-DYNA pre solver and the results are compared with conventional metals like steel and aluminium. GMT showed very good impact behavior compared with steel and aluminium, which all failed and showed manufacturing difficulties due to strengthening ribs or weight increase due to usage of more dense materials[5]. In this paper the performance of crash can be increased by using new technique and methods. The new technique which we are using can absorb more energy. The kinetic energy absorbing mainly depends upon geomentry and material selection. The chosen material should have high strength, less weight and easy avaliability [6].

1.1 Background

There are several conventional materials occur's such as steel, aluminium, titanium and other composite materials. Composite materials has high modulus to weight ratio and strength to weight ratio, it has good fatigue properties and non corroding properties. Traditionally the bamboo material is used in many parts of the vehicle like seat belts , seat covers , side doors and in cycle chassis system etc. With composite materials the design can vary with geometry and material property by changing the fiber orientation and fiber content. Thus the property of this material creates the positive environment in automobile and aeronautical industries , since they provide required strength for less weight when compared to other materials.

1.2 Methodology

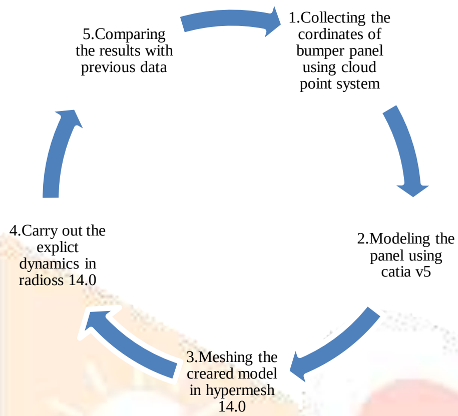


Fig 1: Methodology of designing

2. Material selection

As we have seen from different literatures bamboo fiber has better mechanical properties as compared with other natural fibers. Therefore, using this plant fiber as reinforcement in composite materials for different structural components by replacing the currently used conventional materials will have a competence advantages. In this analysis the bamboo fiber/epoxy composite materials with a considerable composition are used as the materials of bumper panel of an automotive.

2.1 Bamboo Fiber

From the fact that, the availability of large amount of bamboo plant resources in India attracts for the relying on this plant for different studies in the past. Especially the highland bamboo species is given more focus from the researchers and it is suitable for different applications.

2.2 Epoxy Resin

The resins were mainly used for composite structure in components and characteristic. The commonly used resins are epoxy, vinyl ester, polyester and phenolic. Among this materials were widely used in many composites due to their advantages such as performance based on elevated temperature, good mechanical and electrical properties. The epoxy based materials are extensive and include coating, adhesive and composites materials such those using carbon fiber and fiber glass reinforcement. Moreover, epoxies generally out-perform most other thermosetting resins in terms of mechanical properties and resistance to environmental degradation, (has superior tensile strength, bond strength, adhesive characteristics, fatigue resistance and resistance to water degradation).

Table: 2.1 mechanical properties of Bamboo fiber reinforced epoxy composite

Material property	Values
Density (ρ)	1120kg/m^3
Tensile Strength	187.73MPa
Flexural Strength	190.32MPa
Compressive Strength	114.13MPa
Shear Strength	81.18MPa
Young's Modulus	3852
Shear Modulus	1580

3. Modeling and analysis

3.1 Modeling

Fig 2: 3D model using catia

3.2 Finite element modeling

The finite element model of extendable and retractable mechanism is created in Hypermesh 14.0. The finite element model of the bumper panel is created by using shell element with an element size of 4. The finite element of the bumper used in this mechanism is carried out in CAD Soft wares like Catia V5. Mechanism is modeled in Catia V5 R20 and meshed in Hypermesh 14.0 only for the ease of meshing and maintaining the connectivity between the elements.

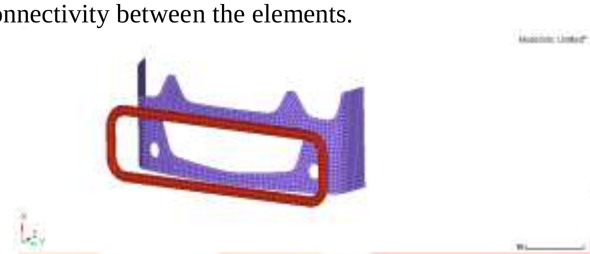


Fig 3: Geometric Meshing of the model on Hypermesh.

Table 1: no of nodes and elements

	Bumper panel	Rigid tube
Number of nodes	1414	1308
Number of elements	1235	1308

Application of boundary conditions and external loads

Applying the velocity of bumper panel as 30m/s and fixing the tube panel as constrain region.

Fig 4: Applying boundary and velocity of the bumper

4. Analysis

The panel model and analysis is performed using finite element method with the software RADIOSS 14.0 that consists of a transient structural. From this we can obtain stress and displacement of bumper panel. From this Explicit Dynamics analysis we can determine the characteristic of the stress and displacement of the panel by applying load and boundary conditions. The following typical transient structural analysis system of RADIOSS 14.0 could be performed one by one to complete the analysis and get appropriate solutions of the problem.

The equivalent (Von Mises) stress and total displacement values of bumper panel are shown in the following figures.

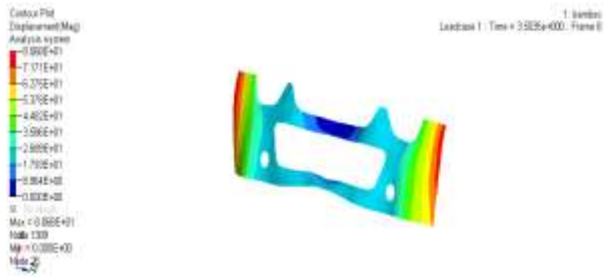
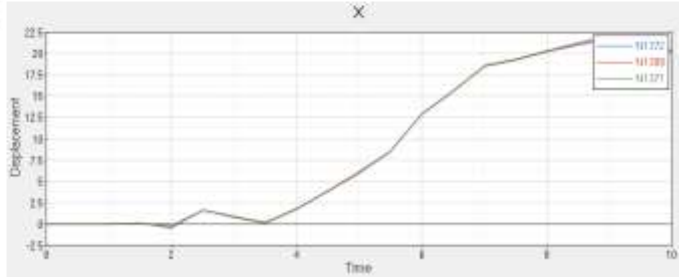


Fig 5: displacement of bamboo



Graph 1: displacement (vs.) time of bamboo

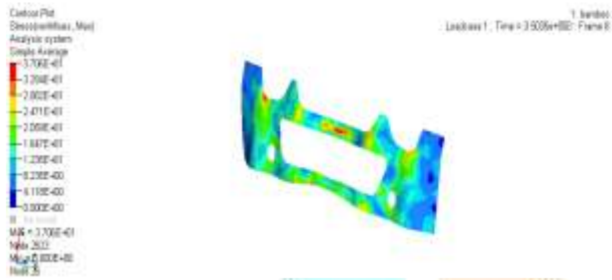
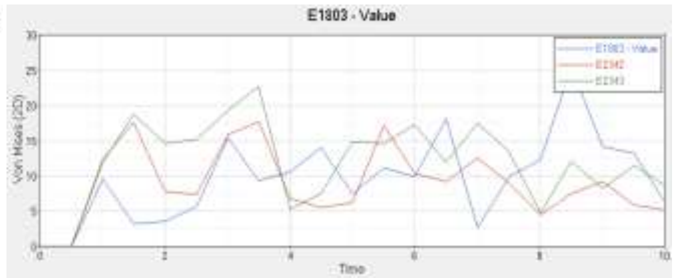


Fig 6: stress of bamboo



Graph 2: stress (vs.) time of bamboo

Other tested materials

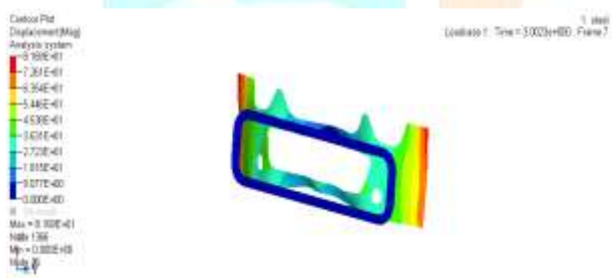
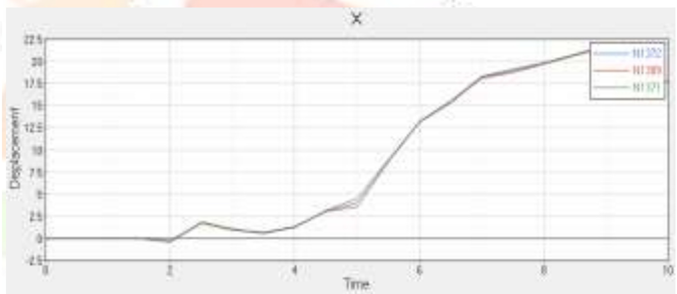


Fig 7: Displacement of steel



Graph 3: displacement (vs.) time of steel

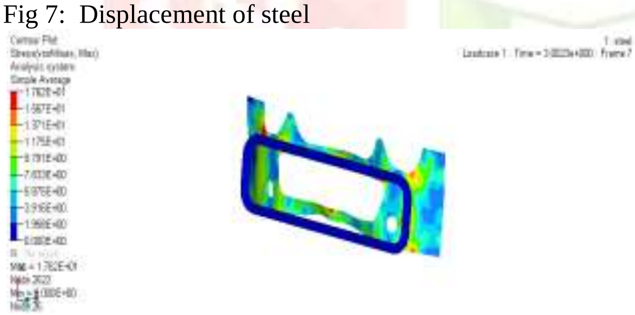
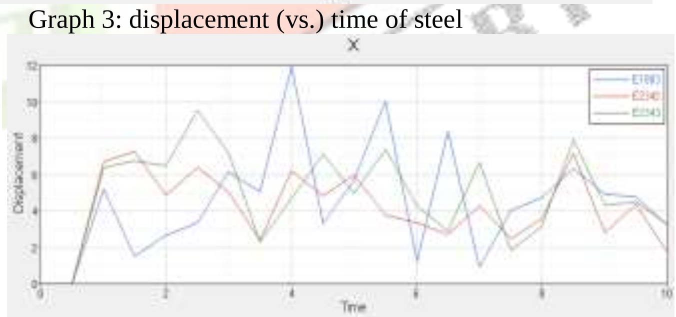


Fig 8: Stress of steel



Graph 4: stress (vs.) time of steel

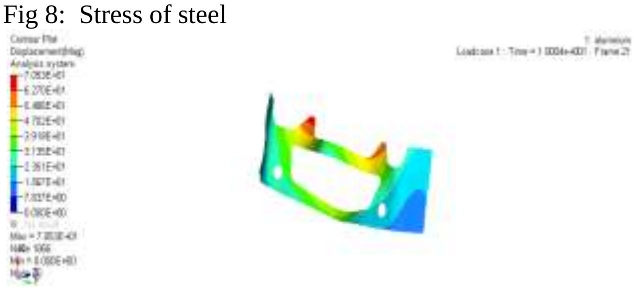
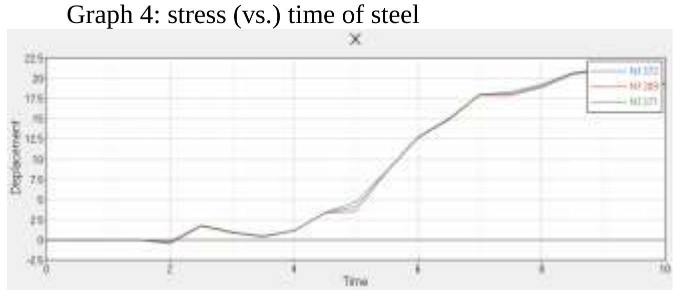


Fig 9: Displacement of aluminium



Graph 5: displacement (vs.) time of aluminium

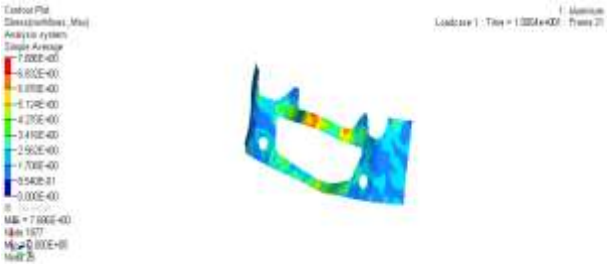
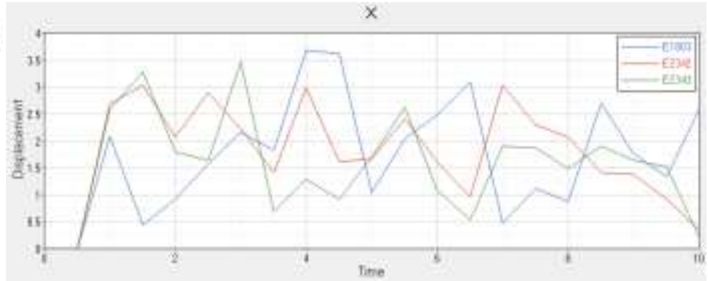
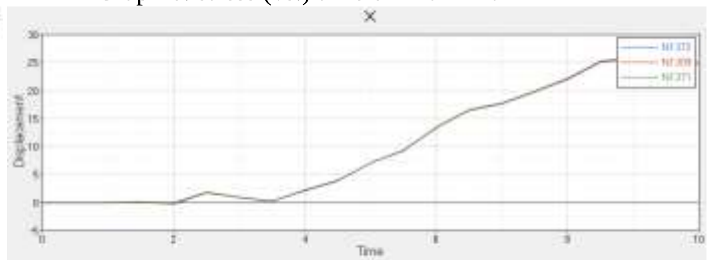


Fig 10: Stress of Aluminium



Graph 6: stress (vs.) time of Aluminium

Fig 11: Displacement of carbon composite



Graph 7: displacement (vs.) time of carbon composite

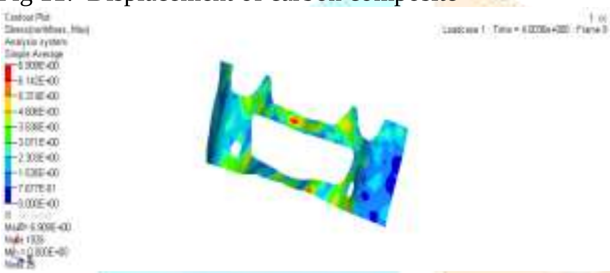
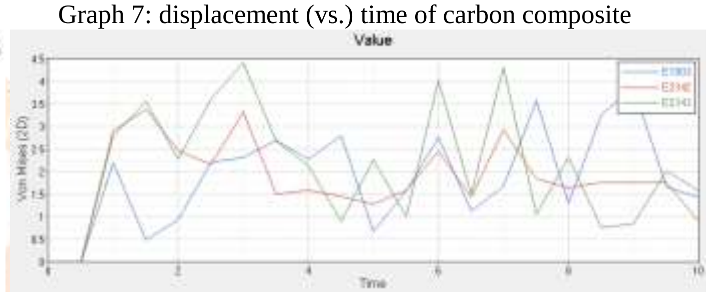


Fig 12: Stress of carbon composite



Graph 8: stress (vs.) time of carbon composite

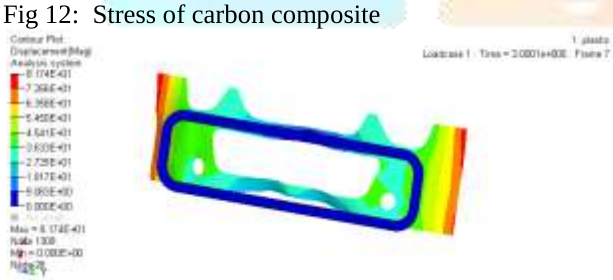
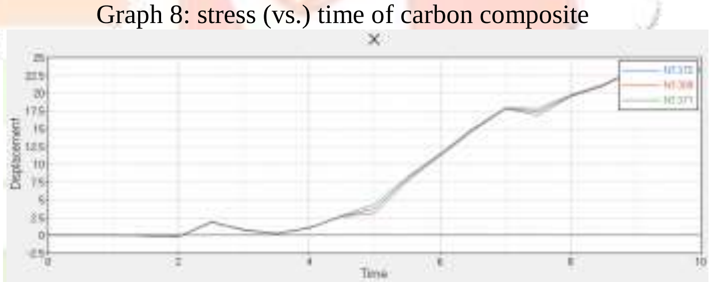


Fig 13: Displacement of plastic



Graph 9: displacement (vs.) time of plastic

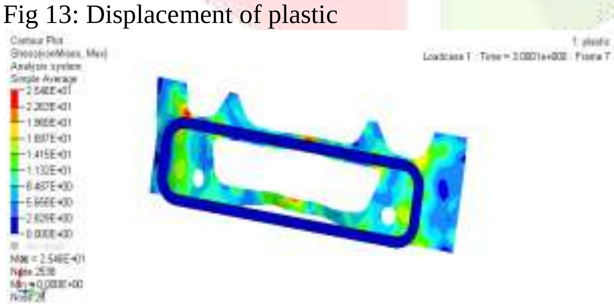
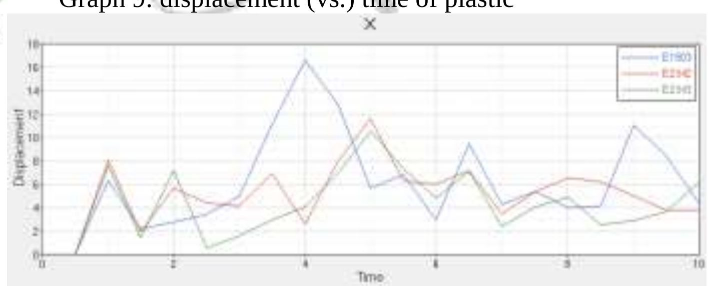


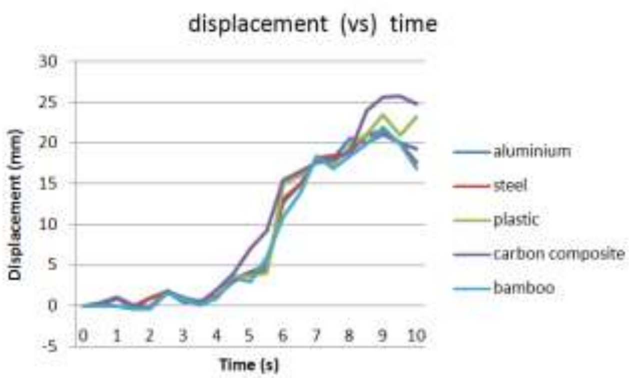
Fig 14: Stress of plastic



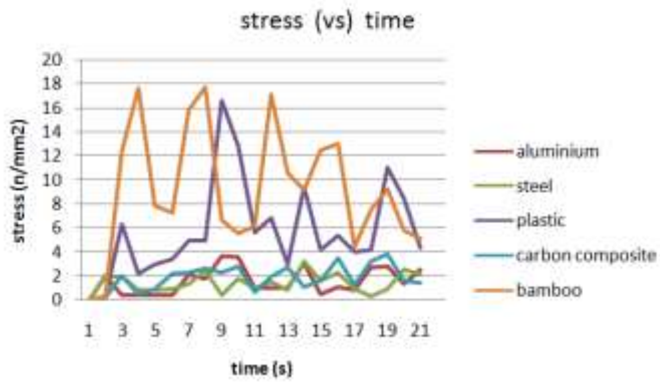
Graph 10: stress (vs.) time of plastic

5. Results and discussion

Providing the Bumper panel with the velocity of 30m/s and then results are obtained from the RADIOSS 14.0 Explicit Dynamic solver. The results are comparing bamboo materials with other materials. This describes results obtained from the transient structural dynamic analysis of the bumper panel during the present study. After completion of the transient structural dynamic analysis in RADIOSS 14.0, results were reviewed by result report. Basically, the two significant types of results were recorded from this analysis of the imported model. The results which we presented are von Mises stress and total displacement. The most important step in FEA is physical interpolation of the result by analysis. Since finite element analysis procedures are invariably accompanied by an extensive output of data, it is extremely important that we interpret the results correctly.



Graph 11: Displacement (vs.) time of all material



Graph 12: Stress (vs.) time of all material

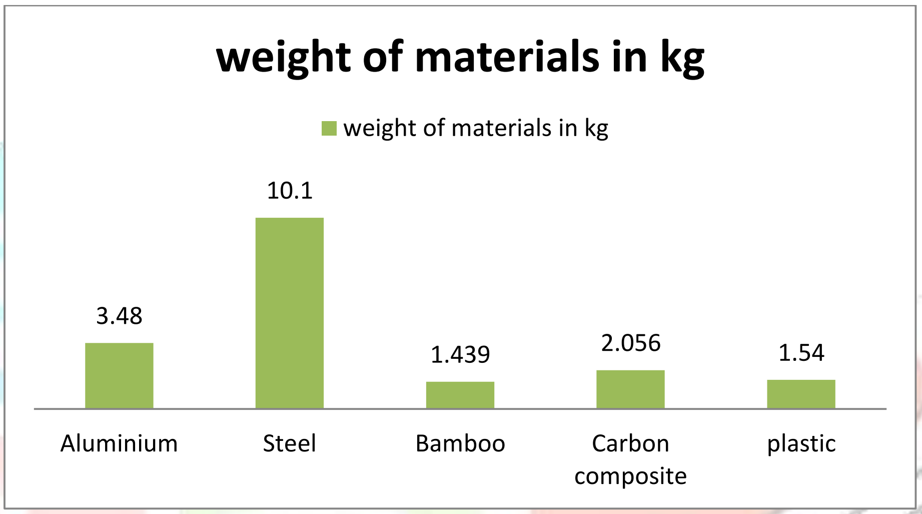


Fig 15: weight distribution of different materials

5. Conclusion

In this work RADIOSS 14.0 Explicit Dynamics solver has been used to find the displacement, stress and weight of the material. The results are improved when compared with existing materials used and required modifications were made in the design. The total paper presents the overall comparison of materials used in the past. Results can be obtained from the graphs and figure provided. Finally the bamboo material has less displacement, weight reduction and cost when compared with other material and drastic. Finally it is found that the bamboo fiber reinforced composite material is selected in impact point of view and weight reduction.

6. Reference

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