Analysis of Bumper Beam in Frontal Collision

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ABSTRACT: Aluminium Honeycomb sandwich panel is a structure which has very slight to weight ratio. Its main application in past observed in aerospace, marine and high end automobile sector. This structure can effectively be used to eliminate one major drawback in Indian passenger car which is Pedestrian damage. By reference of test conducted by Euro NCAP we are having data the major passenger car which is today part of life have fail in safety measure of European countries.

KEYWORDS: Sandwich structure, Impact Analysis.

I. INTRODUCTION

Honeycomb sandwich structure basically consist of a core, which is basically sandwiched between the two face sheet upper and lower face sheet. In this structure we have option to select material for upper face sheet, lower face sheet and for core material. This structure’s property depend upon the geometry of the core such as cell shape, which is basic unit of core, height of core, thickness of foil from which cell is prepared. Face sheet thickness also major contribute in properties. We can obtain desired effect by changing any one parameter. For pedestrian damage we have to focus on front side bumper of car. In Indian low cost car the material used for bumper is steel. Bumper is part which come most in deformation zone, so crashworthiness of bumper should increase.

The objective of this work is to identify the best material for bumper reinforcement which will ensure passenger safety, with high strength to weight ratio through static impact analysis. Using different engineering material like aluminium honeycomb sandwich and fly ash aluminium.

II LITERATURE REVIEW

First three paper in reference focuses on honeycomb structure Hexel is big bull in composite market and large shre in honeycomb manufacturing. Paper no second focuses about how material properties of honeycomb by different theories can be calculated. Third paper is most important as describes honeycomb equivalent plate theory. the three layer structure can be converted in to one layer and treated as isotropic. Author v.Kleisner and R Zerik in his paper (4) Analyses the car bumper reinforcement made of composite (EHKF420-UD24K-400). In methodology section they described RCAR test. The test vehicle speed is 15km/h within 1 meter distance from the barrier. The barrier offset of the vehicle is 40%. In paper no. (5) brief description regarding FMVSS215 is mentioned. It also shows that speed for
low velocity impact is 5 Km/hr. In paper no.6 design and manufacturing of car bumper is by hand layup method is described .material used is glass fibre reinforced polymer Charpy impact test is used to validate the result for energy absorption capacity of material. by studying paper no.7 we know just addition hexagonal honeycomb structure made cardboard increases energy absorption capacity by 260% in paper no .8 we can see comparison of composite GMT( Glass material Thermoplastics) and steel .They suggest to used GMT as backbone behind steel as energy absorber.

II. METHODOLOGY

The 3D model of bumper reinforcement is made in creo.2 After this the same model is imported in to ANSYS workbench for impact analysis and total deformation is observed. We are applied here condition for impact is low velocity condition which 8 km/hr (2.2m/s) [5] and mass 1000 kg. In100% frontal impact force component is perpendicular to the bumper beam. This test is conducted to check pedestrian safety purpose .Now by using Newtons second law, we calculated force value which is 2200 N. This point force applied centrally on Bumper beam. The Fixed support Applied at the end portion which is attached to the chassis in real condition. This condition is according to NCAP.

IV MATERIAL SELECTION

Three types of material is selected for bumper mainly following specification:

Table No.1 Material properties

<table>
<thead>
<tr>
<th>Material Name</th>
<th>Young’s Modulus</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>207 Gpa</td>
<td>7800 kg/m3</td>
</tr>
<tr>
<td>Fly Ash Aluminum (FAA)</td>
<td>70 Gpa</td>
<td>2611 kg/m3</td>
</tr>
</tbody>
</table>

As Aluminium honeycomb sandwich is anisotropic material having different properties in different crystal direction. We assumed it as orthotropic and applied The equivalent plate theory and make it as homogenous plate having only one young’s modulus. As these are assumption for fast analysis results are approximate and should be verified by practical impact test. [3]

Table No.2 Material properties of Aluminium honeycomb sandwich structure

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Real sandwich panel</th>
<th>Equivalent Homogenous Plate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Thickness</td>
<td>20mm</td>
<td>33mm</td>
</tr>
<tr>
<td>Young’s Modulus</td>
<td>Three different values in x,y,z direction</td>
<td>4253 kg/m²</td>
</tr>
<tr>
<td>Density Of Face-sheet</td>
<td>2700 kg/m3</td>
<td>210 kg/m³</td>
</tr>
<tr>
<td>Density Of Core</td>
<td>83 kg/m3</td>
<td></td>
</tr>
</tbody>
</table>
RESULT AND DISCUSSION

Fig. no. 2 Deformation of steel bumper Reinforcement

Figure No. 2 shows the deformation value for steel bumper beam which is we have considered as solid but in real practice it is hollow bumper beam. Maximum deformation we can observe is 0.17 mm. Here we have provided end support as well as central support.

Fig. no. 3 Deformation of AHCS bumper Reinforcement

Figure No. 3 shows the deformation value for Aluminium Honeycomb sandwich composite bumper beam which is we have considered as isotopic solid material but in real practice it is anisotropic layered material. Maximum deformation we can observe is 0.15 mm. Here we have provided end support as well as central support.
Figure No. 4 shows the deformation value for Fly Ash Aluminium bumper beam. Maximum deformation we can observe is 3.5 mm. Here we have provided end support as well as central support.

Table no.2 Material Deformation After Impact

<table>
<thead>
<tr>
<th>Material Name</th>
<th>Steel Deformation (mm)</th>
<th>Fly Ash Aluminium Deformation</th>
<th>Aluminium honeycomb sandwich structure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.17</td>
<td>3.5</td>
<td>0.15561</td>
</tr>
</tbody>
</table>

By observing the above result we can predict that we can replace steel by other two materials. By seeing the space required for other accessories behind reinforcement, we can increase the thickness of bumper reinforcement.

REFERENCES

4) “Kleisner, R. Zemcik”, “Analysis of composite car bumper reinforcement.” Faculty of applied sciences, University Of West Bohemia, Czech Republic, 2009.