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IMPACT ANALYSIS OF ALUMINUM HONEYCOMB SANDWICH PANEL BUMPER BEAM: A REVIEW

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ABSTRACT

Bumper is a energy absorbing protective element which absorb the energy in front collision and protect valuable parts like radiator etc. Bumper is act like protective shield generally made of steel material. As economic point of view and to reduce consumption of fuel manufacturing of light weight vehicle is requirement of current situation. Application of composite material in automobile sector is now day common thing. Aluminum honeycomb sandwich panel is basically material from aerospace industries and known for its high strength to weight ratio. Sandwich structure basically having its properties due to geometry. To determine various properties of sandwich structure conducting experiments is expensive, so generally FEA is used .However complex geometry is hurdle so there are various theories are available for simplification of model. These theories convert 3D model in to homogenous model .As far as concerning India manufacturing rate of sandwich structure is very less, so generally cost is more. Greatest giant manufacturer is china we can observe their bullet train and metro transport facility construction.
Recently in march 2014 largest selling Indian cars are failed in NCap test in 100% frontal crash test. So requirement of more energy absorbing material with economy consideration is important.

KEYWORDS: sandwich structure, Hexagonal cell, Impact analysis

INTRODUCTION

According to survey of national Crime Records Bureau Ministry of Home Affairs Government of India unnatural accidental death are the sever problem, because in accidental death mainly age group between 18 to 40 are more. In alone Maharashtra state you will find 62,160 accidental death in year 2013 June to 2014 June. So there is concern about crashworthiness of structure which are used as protection in automobile as well awareness of road safety rules and regulation in people. Bumper beam mainly absorb the energy in low velocity impact but as need their should be increment in crashworthiness of structure.
Consider following point

- Road accident in year 2009 is 4,21,600
- Road accident in year 2013 is 4,43,000.
- On average 1,50,000 people get killed in road accident .

A solution of above problem lies in either change in dimension, change in shape or change in material. Main objective of the study understands basic terminology regarding bumper system, behavior of sandwich structure and its basic properties, regarding impact analysis.

Bumper system mainly [26] contain

- A cover
- Bumper reinforcement.
- The mechanical and deformable energy absorber

Fig No.1: Bumper System [26]

A cover is outermost layer which basic purpose is aesthetic look and also little bit protection. Its aerodynamic shape is also important. The bumper reinforcement which is main energy absorbing element .It absorbs the shock and transfer remains amount of energy to a deformable energy absorber which is mainly crush box.

1) LITERATURE SURVEY ON HONEYCOMB SANDWICH STRUCTURE:

Sandwich composites primarily have two components namely, skin and core as shown in Fig.2 If an adhesive is used to bind skins with the core, the adhesive layer can also be considered as an additional component in the structure. The thickness of the adhesive layer is generally neglected because it is much smaller than the thickness of skins and the core. The properties of sandwich composites depend upon properties of the core and skins, their relative thickness and the bonding characteristics between them .

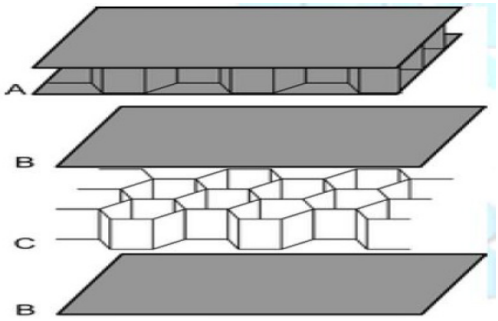

Fig No2: Honeycomb structure [12]

Jim Kindnger[1] has mentioned about lightweight structural cores. His paper describes brief about honeycomb material, cell configuration, application of honeycomb material. He also mentioned about manufacturing methods for honeycomb material, adhesive bonding and expansion, corrugation and adhesive bonding, corrugation and brazes welding, and extrusion. He mentioned cell configuration like hexagonal reinforced hexagonal, overexpanded (ox), square, flex core, double flex-core spirally wrapped (tube core), cross core, circular with its specific applications. Most honeycombs are anisotropic that is properties are directional .it is also includes selection parameter about the core such as material, size, density, and mechanical properties.

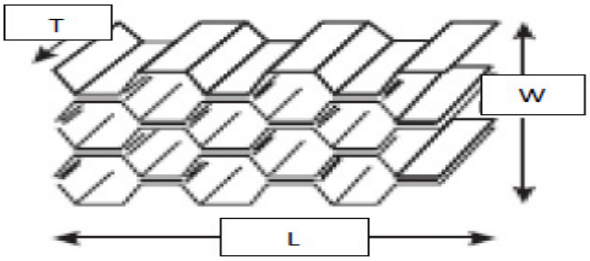

Fig no.3: Hexagonal structure

C. W. Schwingshack [2] examined several available analytic and experimental methods to determine the orthotropic material properties of honeycomb sandwich structure. Fifteen published sets of simple equations for the material properties were reviewed and their values calculated for a specific honeycomb aluminum core. The same core was tested with ASTM standard methods and the agreement between the theoretical material properties and the experimental results was considered

Harish R, Ramesh. [3] found out the effect of the core height on the fundamental natural frequency of aluminum honeycomb sandwich panels by both experimentally and by finite element method. Experimental modal testing was conducted on specimen by using traditional "strike method" for three boundary conditions.. it is proved that increase in core height increase natural frequency of sandwich panel. Sourabha S. Havaldar[4] have done remarkable work in investigation effect of parameter cell size on vibration characteristic .They manufactured FRP honeycomb sandwich panel with varying size from 8mm to 20mm maintaining face thickness constant at around 1mm with two different condition. The traditional strike hammer method is has been used vibration characteristic. Each specimen has been subjected to impulses through a hard tipped hammer which is provided with a force transducer and the response has been measured through the accelerometer. The impulse and the response are processed through a computer aided FFT Analyzing test system in order to extract the modal parameters with the aid of software. Finite Element modeling has been done treating the facing as an orthotropic laminate and Core as orthotropic with different elastic constants as recommended in the literature. Now variation of cell size shows that as cell size increase the natural frequency of panel decreases. Dimitrios Garinis [5] have performed modal analysis on modified Gazelle helicopter blade. The construction of the blade is fully composite with the honeycomb core. The approach to determining structure mode shapes and natural frequencies is presented. Modified blade consists of core material, 3D unidirectional composite spar and thin carbon composite face sheets as blade skin. To determine the stiffness of the honeycomb core, the equivalent mass approach was used. Several methods of Eigen value extraction have been investigated in order to find optimal method which can be used in dynamic analysis of composite structures containing honeycomb cores. Among all extraction methods investigated, it was found that combined Lanczos method is most effective in terms of accuracy.Ganesh J G, G.Venkata Ramana [6] have done investigation, design and analysis of honeycomb sandwich structures. Their primary goal is to develop an equivalent orthotropic material model that is a good substitute for the actual honeycomb sandwich structure. To figure out the best equivalent model among the approximate analytical models that can be found in the literature, a comparison is made. Free vibration analysis (natural frequency) is done on all models to determine the best material for making honeycomb sandwich structures. The results are compared to find out the best performing equivalent model. After three major analysis loops with different material combinations, decision on the equivalent model is made. However, the equivalent model can be used reliably for deflection analysis, forced vibration analysis, stiffness determination and aero-elastic analysis. An analysis shows that core made of fiber reinforced plastic or e- glass and face sheet made of stainless steel (SS316) shows better performance in dynamic approach

JeomKeePaika [7] has find the strength characteristics of aluminum sandwich panels with aluminum honeycomb core theoretically and experimentally. A series of strength tests are carried out on aluminum honeycomb-cored sandwich panel specimen in three point bending, axial compression and lateral crushing loads. Simplified theories are applied to analyze bending deformation, buckling/ultimate strength and crushing strength of honeycomb sandwich panels subject to the corresponding load component. The structural failure characteristics of aluminum sandwich panels are discussed. It was observed that with an increase in the thickness of honeycomb core cell, the start of plastic deformation could be delayed, resulting in increase of ultimate strength. The equivalent single skin panel approach, together with either equal rigidity or equal weight, may possibly be used for predicting the ultimate strength of honeycomb sandwich panels under axial compression. The equal weight based method may be available only for the honeycomb sandwich panels with smaller value of core height to facing layer thickness ratio, while the equal rigidity based method may provide more reasonable results for the panels with a larger value of core height to facing layer thickness ratio.

LITERATURE SURVEY ON DIFFERENT TYPES MATERIALS, MODELING AND ANALYSIS OF BUMPER BEAM

Alen John [8] in his paper compared carbon fiber composite and chromium coated steel with aluminium B390 alloy .The result shows that carbon fiber composite having material density 1640 kg/m3 and Youngs Modulus 85 GPa, in dynamic test shows higher stress but lower deformation .It also have high strength to weight ratio. so it is also better

option for manufacturing of car part .The Methodology used is EuroNcap .Speed of vehicle is 10m/s (36 km/hr) and mass with occupant is considered 1550kg.Impact time is considered is 0.1 second. A.Calienciug [20] in his paper investigated the bumper made of material composite Epoxy resin & fiber glass fabric and it is compared with another composite material Epoxy resin & Nylon 6/10 .Simulation is carried out in Abaqus software .The methodology used is a bumper impacted with steel ball of weight 0.5 kg at speed of 45 km/hr. Stress and deflection is observed as result. In present days, the most of all materials that are used on bumpers is ABS because of its properties like rigidity, elasticity, corrosion resistance. This material is compared with Epoxy resin reinforced with fiberglass fabric made properties like high tensile, resistance toheat, are resistant to chemical agents and good resistance to radiation. Q. H. Ma in his paper [21] focused on mainly safety consideration rather than weight reduction .A bumper beam made of low carbon steel material having density 7.9 gm/cm3 is used and tested according to100% NCAP head on collision test at speed 45km/hr. 87% increase in weight caused 34.4% safety.

M. M. Davoodi [22] in his research mainly focused on hybrid natural fiber epoxy composite as automotive bumper beam material and got excellent success in improvement of impact strength .In this research, epoxy is considered as a matrix. Five plies have been used to fulfill the common desired bumper beam thickness. The modified sheet-molding compound (SMC) selected as a fabricating method to enhance the required mechanical properties. Since the long fibres present, more strength and kenaffibres are twisted naturally, so a fixture is made to stretch the fibers. A thin frame was located on the top of the fixture to keep the fibers in the stretched condition. Sample is made from two kenaffibre and three glass fiber layers. In SMC method the fibers disperse over the slurry resin then pass through sequential roller to make it denser and more stable, but in this method resin spray onto the different directions stretched fibers Next, the stacked layers put into the mould and mount into the controlled temperature and pressure hot press for forming the desired shape.

V.MohanSrikanth [23] has did research on Carbon Fiber Reinforced Poly Ether Imide and S2 Glass Epoxy Materials as bumper material . The majority of modern plastic car bumper system fascias are made of thermoplastic olefins (TPOs), polycarbonates, polyesters, polypropylene, polyurethanes, polyamides, or blends of these with, for instance, glass fibers, for strength and structural rigidity. At Present the material used for car bumper is steel. Steel is replacing with S2 Glass epoxy and Carbon fiber -Reinforced Poly-Ether-Imide PEI. Present used material for car bumper is steel. By using steel the weight of the car bumper is more but by using composites the weight of the bumper is reduced since densities are very less compared with steel. By using S2 Glass Epoxy, the weight is almost reduced by 4Kgs and by using PEI it is almost reduced by 5Kgs. The density of S2 Glass epoxy and PEI is less than that of steel, thereby the overall weight of car bumper is reduced.