Numerical investigation of crushing behavior of conventional and reinforced honeycomb structure against in plane loading

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1. INTRODUCTION:

Energy absorption is the most important aspect in the modern light weighted automobile and aerospace structures. Safety for occupants has become one of the major considerations in design of a mobile body along with performance and efficiency. Many energy absorbing structures like metallic and composite pipes, Metallic and Polymeric Foams, Sandwich structures with foams, Honeycomb and Lattice cores were studied against impact and quasi-static loads to obtain an efficient energy absorbing structure. Honeycomb core was analyzed in in-plane direction to evaluate the properties of honeycomb in this direction and different modes of failure. Theoretical model for estimating properties in in-plane direction was obtained by various methods and validated with experimentation [1-3]. Finite element simulations were used to obtain deformation pattern resulting from in-plane impact like crush band initiation and wave trapping. Hu et al. used finite element simulation to find the effect of cell topology in in-plane impact [4]. It was found that cell shape and arrangement plays an important role in dynamic analysis of honeycomb [5-6].

2. RESULTS AND HIGHLIGHTS:

Numerical analysis of Quasi-static compression test were performed on honeycomb sample (cell size 20 mm with different cell wall thickness 0.1 mm, 0.2 mm and 0.3 mm respectively) by applying load in the direction of its width (in-plane) to analyze the deformation behavior and parameters affecting the performance of honeycomb core in this direction. Force-displacement curve was obtained to analyze the performance of honeycomb core in in-plane direction. It was observed that force-displacement curve analysis was divided into the same three regions: (1) Linear region; (2) Plateau region; and (3) Densification region. It was evident that initially the honeycomb core deforms in an elastic manner and cells were deformed symmetrically along their centers about the vertical axes. Then afterwards first row cells start to localize into a narrow zone and changes their original shape. Then the cells start to collapse in a diagonal direction wave form from top to bottom and after that deformation again the cells start to deform in ordered form along a horizontal line until densification occurs which leads to increase in the stresses rapidly [1-4]. Reinforced honeycomb was also analyzed under the same boundary conditions. It was found that mid layer of cell influences the mode of deformation and changes its behavior. X-mode of deformation was not seen in the reinforced honeycomb which was seen in honeycomb and Force-displacement curve also shows that Reinforced honeycomb has high load carrying capacity in in-plane direction. In-plane properties in case of regular hexagonal honeycomb are isotropic [2] but in this study honeycombs were made up of hexagons having internal apex angle as 45^0 which has four plane moduli to be defined (E_1, E_2, G_{12} and γ_{12}).

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All the four properties has been obtained with numerical simulations and validated with mathematical models available in the literature. In-plane properties of Reinforced hexagonal honeycomb were derived in this paper and verified using numerical simulation.

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