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The Blast Resistance of Sandwich Beam with an Auxetic Core

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ABSTRACT

Auxetics are mechanical meta-materials which exhibits negative Poisson's ratio [1]. In here, we focus on sandwich beams with an auxetic core made using re-entrant honey-comb structure.To study the blast resistance of sandwich beam with an auxetic core. We adopted the Fleck and Deshpande [2] momentum transfer based sandwich beam model to estimate the structural response. In this analysis, the shock wave from the blast loading is idealized as a planar wave. And the structural response of sandwich beam is split into three sequential stages.In stage I the impulse from the primary shock wave accelerates the front face sheet of the sandwich beam to a velocity v_o by fluid-structure interaction. In stage II momentum is transferred from face sheet to core due to which core undergoes crushing. Finally in stage III the entire sandwich beam deflects through plastic bending and stretching in response to the shockwave.The mechanical behavior of auxetic core such as normal compressive strength σ_{ny} and the longitudinal strength σ_{ly} are required for the above mentioned three stage modelling of sandwich beams [2]. Obtaining relation of normal compressive strength σ_{ny} and longitudinal strength σ_{ly} withthe uniaxial yield strength σ_y of parent material experimentally for auxetic core is highly cumbersome. Hence the objective of our study is to investigate the mechanical behavior of auxetic material for various geometric configuration using finite element simulations. We obtained the mechanical properties by modeling each cell as representative unit volume and estimated the normal compressive strength using homogenized equivalent stress approach. Monte Carlo based FE simulations for various geometric configurations are carried out using ABAQUS 6.9 and relation between the density and the mechanical behavior of auxetic core is obtained.Then usingFleck and Deshpande [2] model, the transverse displacement and longitudinal tensile strain accumulated in anauxetic sandwich beam is calculated as a function of blast loading magnitude and the performance charts are obtained.

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