Studies of energy absorption of TPMS structures manufactured via EBM from Ti6Al4V

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Cellular structures are the subject of many research works due to their high capacity to absorption mechanical energy. These meta-materials have been classified into two main groups: 2D and 3D [1]. One of the example of spatial 3D structures is Triply Periodic Minimal Surface (TPMS), which has been widely studied over last years with the most well-known architectures like diamond and gyroid structures [2].

In the present paper, the EBM method was used to produce specimens of TPMS structures, which were subsequently subjected to uniaxial compression tests under quasi-static loading conditions in order to characterize their deformation behavior and energy absorption capacity. Moreover, the material model calibration was performed in the LS-DYNA numerical environment based on the results of quasi-static uniaxial tensile tests conducted on dog-bone specimens. The purpose of this paper is to present the results of experimental and numerical studies of TPMS structures manufactured using EBM technology from Ti6Al4V titanium alloy and tested under quasi-static compression conditions for different wall thicknesses. The obtained results constitute a starting point for assessing the potential use of this type of structure as an element of a ballistic panel.

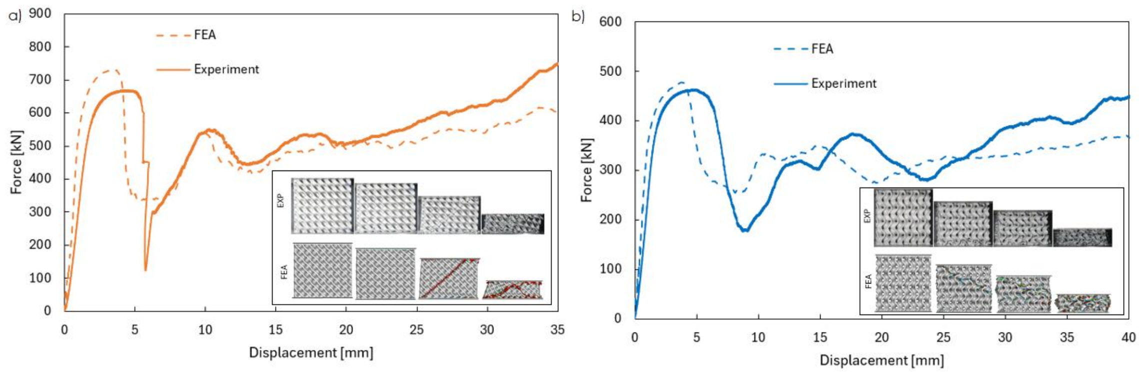

Figure 1. Deformation force vs. displacement curves from experimental test and simulations: a) Diamond structure, b) Gyroid structure.

The developed LS-DYNA numerical model accurately reproduced experimental behavior, with an overall discrepancy between numerical predictions and experiments within 6–10% for SEA. From the conducted studies it was demonstrated that gyroid structures shows progressive folding and stable plateau behavior, while diamond structures exhibits higher stiffness and peak force associated with shear-band dominated collapse. Furthermore, diamond architectures gave approximately 8% higher SEA than gyroid structures at comparable relative densities.

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