The influence of 3D printed polymer structures on mechanical properties of lightweight protective systems

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Abstract

Nowadays, ballistic threats have caused increasing development lightweight and more effective solutions in the field of passive protective systems. Application of new types of composite materials with gradually changed mechanical properties is one possible development which enables improvement of protective structures. Moreover, the progress in the area of additive manufacturing and the design freedom it enables has brought an additional increase of interests in lightweight passive protective systems.
The main goal of the paper is to present the results of experimental investigations related to ballistic resistance of composite structure subjected to impact of 9 mm bullets. Proposed by the authors panels consisted of two aluminum plates and 3D printed regular cellular inserts made from ABS polymer material. Typical honeycomb and so-called re-entrant honeycomb topologies with two elementary unit cell sizes were used during these tests.

Additional aspect of performed investigations is related to adopted non-destructive, laser-ultrasonic method for the damage assessment of the structure to determine the efficiency of composite materials used. To verify the results of the examination by laser ultrasonic structuroscopy, the items were investigated by optical observations and tomography..
Results point out that application of additional 3D printed polymer inserts significantly improve the ballistic resistance of proposed composite structures.

Keywords: additive manufacturing, ballistic resistance, lightweight protective systems, laser ultrasonic structuroscopy, composite structures.

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