Investigation on Deformation Process of Cellular Structures with Gradient Topology Manufactured Additively

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INTRODUCTION

Contemporary, a progress in the area of material science and a growing potential of additive manufacturing methods cause an increasing development of advanced engineering and functional cellular structure materials [1]. One of their significant features is its high crashworthiness with low relevant density. This group of materials is in the area of interest of automotive, aviation, railway, chemical and civil engineering. Moreover, regular cellular structures could be potentially implemented in many military applications, especially in development of passive protective systems [2].

The main aim of this paper is to present results of investigation on deformation process of 2D regular cellular structures with gradient topologies manufactured additively under quasi-static loading conditions.

RESEARCH METHODOLOGY

The main idea of the performed investigations is presented in Fig.1. Authors decided to determine the relation between a structure topology, relative density versus energy absorption capacity. A typical honeycomb and its modifications with gradient unit cell size (Fig.2) were manufactured from Polyamide PA12 by SLS (*Selective Laser Sintering*). Additionally, material specimens were built to determine mechanical properties of Polyamide PA12 under quasi-static (uniaxial tensile and compression tests) loading conditions. Experimental investigations of structures specimens were carried out with the use of universal tensile machine MTS Criterion C45. Simultaneously, numerical approach was performed thanks to Finite Element Method implemented in LS-Dyna code. The initial boundary conditions in the performed computations were adopted from experimental tests. Numerical models of structures were developed using solid elements. Additionally, the interaction between the non-deformable moving plane and tested cellular structures were defined using contact definition (penalty method). The loading conditions associated with the moving rigid plane were also transferred from experimental tests. The outcomes obtained from compression tests as well as from computations were compared to validate numerical models. Finally, such approach it gives the opportunity to optimize a structure topology referring to crashworthiness.

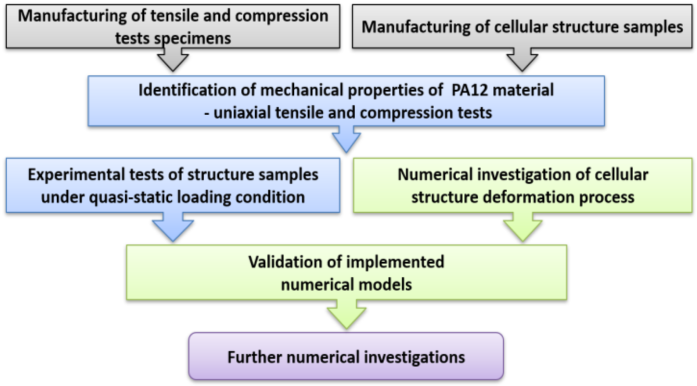

FIGURE 1. Scheme of main stages of conducted investigations

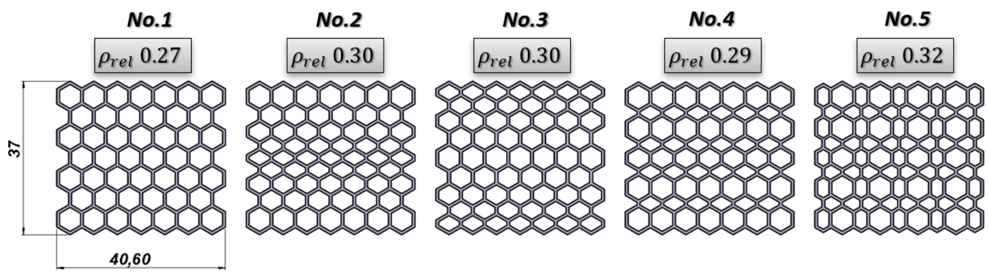

FIGURE 2. Specimens of gradient cellular structures developed based on honeycomb topology

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