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Flexural Response of Sandwiches with Micro Lattice Cores Manufactured via Selective Laser Sintering

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Abstract : The lightweight sandwiches obtained with the use of various core materials such as foams, honeycomb, lattice structures etc., which have high energy absorbing capacity and high strength to weight ratio, are suitable for several applications in transport industry (automotive, aerospace, shipbuilding industry) where saving of fuel consumption, load carrying capacity increase, safety of vehicles and decrease of emission of harmful gases are very important aspects. While the sandwich structures with foams and honeycombs have been applied for many years, there is a growing interest on a new generation sandwiches with micro lattice cores. In order to produce these core structures, various production methods were created with the development of the technology. One of these production technologies is an additive manufacturing technique called selective laser sintering/melting (SLS/SLM) which is very popular nowadays because of saving of production time and achieving the production of complex topologies. The static bending and the dynamic low velocity impact tests of the sandwiches with carbon fiber/epoxy skins and the micro lattice cores produced via SLS/SLM were already reported in just a few studies. The goal of this investigation was the analysis of the flexural response of the sandwiches consisting of glass fiber reinforced plastic (GFRP) skins and the micro lattice cores manufactured via SLS under thermo-mechanical loads in order to compare the results in terms of peak load and absorbed energy values respect to the effect of core cell size, temperature and support span length. The micro lattice cores were manufactured using SLS technology that creates the product drawn by a 3D computer aided design (CAD) software. The lattice cores which were designed as body centered cubic (BCC) model having two different cell sizes (d= 2 and 2.5 mm) with the strut diameter of 0.3 mm were produced using titanium alloy (Ti6Al4V) powder. During the production of all the core materials, the same production parameters such as laser power, laser beam diameter, building direction etc. were kept constant. Vacuum Infusion (VI) method was used to produce skin materials, made of [0°/90°] woven S-Glass prepreg laminates. The combination of the core and skins were implemented under VI. Three point bending tests were carried out by a servo-hydraulic test machine with different values of support span distances (L = 30, 45, and 60 mm) under various temperature values (T = 23, 40 and 60 °C) in order to analyze the influences of support span and temperature values. The failure mode of the collapsed sandwiches has been investigated using 3D computed tomography (CT) that allows a three-dimensional reconstruction of the analyzed object. The main results of the bending tests are: load-deflection curves, peak force and absorbed energy values. The results were compared according to the effect of cell size, support span and temperature values. The obtained results have particular importance for applications that require lightweight structures with a high capacity of energy dissipation, such as the transport industry, where problems of collision and crash have increased in the last years.

Keywords : light-weight sandwich structures, micro lattice cores, selective laser sintering, transport application
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