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Sandwich hybrid structural component for tilt rotor aircraft

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Abstract

Tilt rotors are hybrid aircraft capable of shifting between vertical take-off and landing (VTOL), hovering, and efficient forward flight thanks to their rotors which can rotate around the pitch aircraft axis and assume a vertical or a horizontal position. In recent years, a slow and gradual interest and development of these aircraft have arisen as a potential solution for urban air mobility. Indeed, the ability to take off and land vertically in tight spaces, combined with forward flight, makes tilt rotors well-suited for flying around urban areas while reducing air traffic and busy airport runway congestion [1].
One of the major challenges for engineers and designers is creating lightweight aircraft while maintaining structural integrity and safety. For this reason, new light-weighted structures are constantly sought in the aviation sector to reduce fuel consumption and increase efficiency. Sandwich structures, multi-layered structures formed by high-strength outer layers (faces) separated by a thick low-density inner layer (core) [2], have been increasingly used due to their high strength-to-weight ratio and their bending and buckling resistance [3].
In this paper, a sandwich lattice structure is designed for the control surface of a new generation of civil transportation tilt rotors. Lattice is a topologically ordered three-dimensional structure characterised by a unit cell repeated along a given pattern to achieve specific mechanical properties while maintaining a high strength-to-weight ratio [4]. The lattice core structure is realised through additive manufacturing technologies, allowing free design freedom and greater flexibility in the creation of complex and unique geometries compared to traditional manufacturing methods.
At first, the experimental tests performed to assess the mechanical properties of the hybrid lattice structure are presented and used to validate the numerical Finite Element Analyses. Therefore, a 2D model and a simplified homogenised one are compared with a full 3D analysis to have reliable design and verification tools while keeping the computational costs low. Moreover, the aim of the project is a numerical comparison between the proposed design, a classical composite laminate structure, and a honeycomb sandwich structure.

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