A novel concept of shape-adaptable sandwich panel with shape memory alloy based actuators

Oleg Testoni*, Andrea Bergamini†, Sampada Bodkhe+ and Paolo Ermanni+

*+ Laboratory of Composite Materials and Adaptive Structures (CMASLab)
Eidgenössische Technische Hochschule Zürich
ETH Zurich, 8092, Zurich Switzerland
e-mail: testonio@ethz.ch, web page: http://www.structures.ethz.ch
† Laboratory Acoustics / Noise Control
Eidgenössische Materialprüfungs- und Forschungsanstalt
Empa, 8600, Dubendorf, Switzerland
e-mail: Andrea.Bergamini@empa.ch, web page: https://www.empa.ch/web/s509

ABSTRACT

Shape memory alloys (SMA) that generate high stresses and simultaneously achieve large deformations, have already been widely used as actuators in shape adaptable structures. Nonetheless, most of these structures have been designed for a specific purpose and, therefore, to accomplish only a single type of deformation. In order to widen the scope of applications, we have conceived a polyhedric structural concept realizing different types of deformation.

This novel concept consists of a shape adaptable sandwich panel with SMA-based actuators with a truss core. The modular arrangement of its face sheets, composed of a specific pattern of rigid unit cells interconnected through the actuators, enables us to selectively control the distance between the cells on both the face sheets further resulting in complex shape changes.

In this paper, we present the characteristics of the proposed concept and its actuation system in detail. The latter consists of SMA wires with a 3D printed compliant impedance matching structure in the shape of a leaf spring, which acts both as amplifying mechanism and as a bias spring. Further, we show how, starting from a flat panel, the proper actuation of specifically selected actuators can induce various changes in the shape of the panel, including a double curvature configuration. Finally, we present experimental evidence of the function of this shape adaptable sandwich panel showing deformations with single and double curvature as well as a saddle configuration.