Al-becular: an aluminum spatial structure assembled with 3D-printed ESO node

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Abstract

The proposed work is to present the pavilion for the Competition and Exhibition of innovative lightweight structures organized by the IASS Working Group 21 "Advanced Manufacturing and Materials". The pavilion to be realized by the authors is a 3-support standing spatial trabecular structure realized in aluminum, designed to maximize the exploitation of the material used and partially manufactured by means of metal 3D printing.

The manufacturing processes adopted to realize the structure are based on pre-cast thin sheets to be shaped and folded in order to ensure rigid cross-sections of the linear members, to be formed and assembled on site. As far as the nodes are concerned, they are realized by an innovative 3D printing technique based on welding metal wires through a robotic arm. This technology, referred to as Wire-and-Arc Additive Manufacturing, has been first developed by the pioneering company MX3D, which realized the first metal 3D-printed footbridge to be held in Amsterdam by 2020.

The design has been realized based on the whole concept of stiffness maximization while reducing the material usage and weight. In details, the trabecular structure is composed by a series of triangular-hollow cross-sectional linear elements assembled on site and connected through organic 3D printed nodes. It aims at displaying the complexity revealed across scales with an economy of means: minimizing structural volume to maximize spatial occupation, useofa polyhedra-based spatial structure to exhibit an intricate 3-dimensional pattern minimizing the number of required elements (nodes and beams), use of hollow closed-section surfaces for nodes and triangular beams to exploit stiffness by form factor. Lightweightness is used as operating structural principle without sacrificing architectural complexity and embedding production and logistic constraints: the partition in nodes and beams facilitates transportability, as well as the beam design, from flat aluminium sheets. The beams themselves are shaped as two interconnected prismatic halves whose extremities have a relative rotation of 90 degrees; a logistic limit (elements longer than 1 meter should be made of parts because of transportation constraints) becomes a design opportunity. Nodes are designed with fabrication technology in mind as well: each volumetric node is fabricated in parts whose shape is compatible with the constraints of the adopted 3D-printing technology.