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Optimization studies on diagrid columns realized with Wire-and-Arc Additive Manufacturing process

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1 Abstract

The present work explores the possibilities of 3D printing applied to structural engineering field to create innovative design and optimized shapes. By means of Wire-and-Arc Additive Manufacturing, structural members are manufactured by placing layer upon layer of welded steel material in an automated process. Additive Manufacturing, thanks to the theoretical freedom in the geometrical shapes that can be obtained, open completely new possibilities for designers. On the other hand, specific aspects related to material properties and geometrical irregularities characteristics of such innovative manufacturing processes have to be properly considered in the design phase. Along with digital design tools recently developed and applied in architecture and construction for the realization of new shapes and forms through parametric design, the work presents a new structural shape for diagrid columns to obtain structurally optimized forms adapted to be efficiently realized by means of Wire-and-Arc Additive Manufacturing process taking into account the specific features of the printing process. The outcome of the study is the final realization of the column in a 1:2 scaled dimension. These first engineering evaluations are intended to pave the way towards the design of a new family of optimized structural elements to be efficiently 3D-printed, towards the fully-automated design and construction of novel 3D-printed building structures.

Keywords: Structural optimization; Additive Manufacturing; 3D printing; Parametric design.

2 Introduction

Along the centuries, the evolution in building construction has always been strictly linked to significant advancement in material science, technology, industrial processes and engineering.

Since the beginning of 21st century, automation has grown really fast and soon prevailed in almost all production domains with the exception of the building construction sector, in which the use of automation is still challenging and at its first applications due to some peculiar aspects of the construction industry (i.e. large-scale outcomes) [1]. Only in the last few years, the fast development in digital fabrication techniques is leading towards applications in structural engineering field as well, through Additive Manufacturing (AM)-based technologies, already commonly used in other sectors such as aerospace, automotive and biomedical engineering [2,3]. 3D printing applications in construction have gained much attention in the last years, providing prototypes for

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