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Combining 3D-printing and GA-based optimization for the design and manufacturing of UHPC spatial lattices

Computational architecture, Structural engineering

Philippe Morel
EZCT Architecture & Design Research / ENSA Paris-Malaquais

Romain Duballet
Ecole des Ponts ParisTech

Abstract

We present in this paper a computational method for the design of 3-dimensional spatial lattices made of ultra-high performance fibre-reinforced concrete (UHPC). It consists in a GA-based topological optimization, including multi-objective evaluation of the trusses to deal with mechanical performances, architectural constraints and construction issues simultaneously. The whole algorithm, from the direct stiffness method for mechanical analysis to the implementation of geometrical constraints, is written in *Mathematica*®. The optimized geometry is to be cast in 3D-printed sand and cement moulds according to a validated fabrication process that we first introduced in the exhibition Archilab 2013, held in Orléans (France). This integrated method of conducting the architectural project takes advantage of the efficiency and adaptability of coding in *Mathematica* that allows us to control many constructive issues by actually including them in the form-finding process. It also gives us the ability to freely handle communication between each software and machine involved in the project: from design to manufacturing.