Additive Formwork for Shell Constructions

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Abstract

In complex concrete constructions, the design and production of formworks impact for more than half on the economy of the overall construction cost. This highlights the gap lying between the advances in digital design and the manufacturing processes in the realm of constructions, but also the distance that exists between the capacity of fluid concrete to be shaped in endless forms and the limitations of conventional formwork production technologies. Hence, the work here presented exploits the potential of additive manufacturing technologies in the attempt of improving the manufacturing process of formwork to unlock the full potential of concrete.

State-of-the-art research in the realm of digital fabrication applied to concrete is highly involved in the quest for novel approaches of manufacturing of such geometrical complexity. In fact, striving for the automation of the production chain as much as an increased precision and formal flexibility, a broad spectrum of approaches can be outlined in literature, each carrying advantages and limitations. In this light, the proposed method aims at combining the design freedom and complexity achievable through FDM additive manufacturing processes and the compressive and tensile mechanical resistance of Ultra-High Performance Fibre-Reinforced Concrete (UHPFRC) to expand the vocabulary of formal possibilities in concrete constructions through a feasible yet highly flexible manufacturing process.

The presented research focuses on the manufacturing of lightweight concrete shells to test and illustrate the potential of the proposed approach. An iterative approach of experiments has been performed to optimise the design-to-fabrication workflow, which comprises three main phases: design optimisation, where the designed is produced and iteratively optimised through a series of feedbacks on fabrication and performance-related attributes; formwork fabrication, where the digital design is transformed into machining code and manufactured by an FDM large scale 3D printer using a biopolymer; concrete casting, when the fluid mix of UHPFRC is poured into the formwork and then demoulded.

The work showcase a novel manufacturing approach to complex lightweight constructions with concrete, through the use of 3D printed formworks for the production of highly performative precast concrete shell panels.

References

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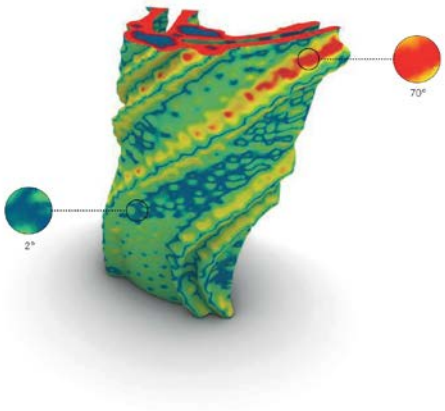
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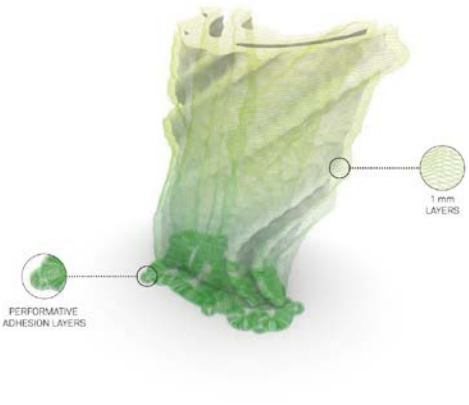
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