

Architectural ceramics influenced by structured materials

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Abstract

Current Digital Fabrication techniques allow fast and affordable prototyping of customized solutions for specific design requirements. It has a great industrial potential since it enables material and formal experimentation, as well as alternative morphological and structural capabilities.

The possibility of using digital processes to develop and deploy individual, prototypical and shape-optimized structures motivates more and more architects to explore the use of Additive Manufacturing (AM) and its possibilities. However, some materials used traditionally in construction like ceramics were not extensively explored in combination with these techniques. Although the AM with materials like polymers and concrete have been intensively explored, these results cannot be directly transferred to the use of ceramics because of a different physical behaviour due to the sintering process [1].

One of the special characteristic of ceramics is its expansion rate which is highly influenced by the design-shape ($d_1 > d_2, d_3$) and fabrication (liquid-base material or plastic-base material) [1]. This special feature influences the structure in such a way that it is exposed to multi-axial forced stresses and deformations depending, among others, on the manufacturing process.

With the integration of Computational Models and AM techniques this paper propose to explore formal and mechanical properties of ceramics in order to improve its structural performance for an innovative application in architecture.

Further more, structurally efficient cellular configurations are investigated due to its efficiency consuming less resources [2]. Case-studies in nature are presented in order to re-interpret them in analog 3D-printed structures, so called 'structured materials' in nature (namely honeycomb-like, foam-like, sandwich panels, etc).

This paper explores the interaction between the bionic-inspired-design of cellular structures [3] and AM in the context of architectural ceramics.

After the analysis of the case-studies in nature, the methodology involves computational models in order to achieve a family of customized possible design solutions. With the digital workflow this research attempts to optimize the final designs by reducing material and weight, while increasing structural integrity.

References

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