3D-Printed Formwork for Integrated Funicular Concrete Slabs

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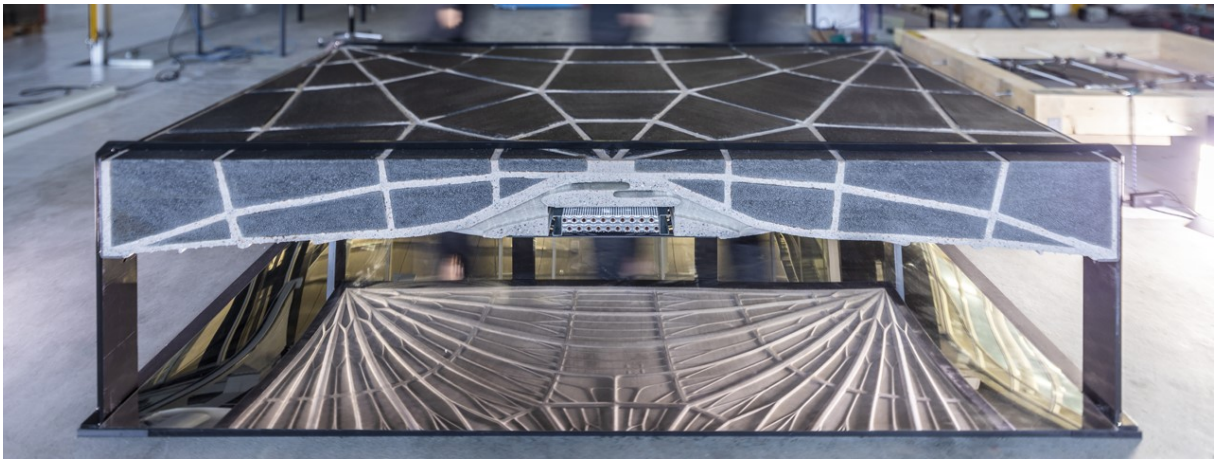

Abstract

The paper describes how 3D-printed formwork can be used to integrate functional features in structurally optimised concrete slabs.

The weight of concrete slabs represents up to 80% of the dead load of a building. Despite this significant share, slabs are usually designed as monolithic, oversized boxes due to various construction constraints. Optimised design alternatives, featuring funicular shapes, structural ribs, profiled soffits and hollow sections use significantly less material [1]. Moreover, the resulting internal voids can be used to integrate building services within the thickness of the slab, such as heating, cooling and ventilation provisions.

Nevertheless, both the optimized external geometry and the internal network of functional voids present very complex fabrication challenges for concrete. This is because standard commercial formwork systems are not suitable for bespoke designs. To address this limitation, different 3D printing technologies have been proposed already for the fabrication of formwork [2, 3].

This research builds up on the state-of-the-art to demonstrate how fused deposition 3D printing can be used for the fabrication of custom formwork with fully recyclable materials for a functional concrete slab. The resulting demonstrator is structurally efficient, weighing only 30% of a conventional solid slab. It further showcases the integration of a complex chilled beam ventilation system within the 30 cm structural depth of the slab. All these intricate geometric features are achieved with an ultra-lightweight 3D-printed formwork, weighing less than 10 Kg for the entire 600 Kg concrete slab.

References

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