High-Performance Corrugated Concrete Shell Construction on Bending-actuated Robotically 3D-printed Formworks

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Abstract

Additive manufacturing (AM) has expanded possibilities for materialising structures that achieve strength through intelligent, but complex geometries. However, conventional AM techniques, such as thermoplastic fused deposition modelling (FDM), also rely on material with low strength and stiffness, which limit their full-scale building construction applications. This paper articulates one of several design-fabrication strategies jointly developed by MIT, ETHZ and Tongji researchers in a workshop to respond to this challenge: FDM is optimised for producing self-supporting scaffold that can be printed flat and bent in-place on site—scaffolds whose strength are built gradually via additional structural material application. Inspired by principles of shallow arching action and structural corrugation, this paper—part 2 in the series—develops an AM-enabled multi-phased construction method for creating a walkable full-span structure capable of accommodating live structural loads. The feasibility of the novel assembly process is demonstrated with the construction of a bridge measuring approximately 5-metre in span. The produced prototype illustrates one alternative design-fabrication strategy leveraging force-explicit equilibrium design methods to synthesise the advantages of vernacular and digital manufacturing techniques—resulting in new possibilities for the materialisation geometrically complex, live-load-bearing and moderate-span concrete structures with minimal form-work.

Figure 1 Images of completed bridge