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Tile Vault 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 limits 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 is built gradually via additional structural material application. This paper—part 1 in the series—uses FDM to produce bendable panels that can form highly curved scaffolds for thin-tile vaulting. The feasibility of the novel assembly process is demonstrated with the construction of a large-scale pavilion measuring seven metres in diameter: the project assembled seven overlapping flexible panels that were robotically additive manufactured in polylactic acid to create a load-bearing scaffold for thin-tile applications. 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 of complexly curved thin-tile vault construction without intensive labour and formwork requirements.

Figure 1: Images of finished tiled vault