Fabrication of Topology Optimized Concrete Components Utilizing 3D Printed Clay Mould

In the past two decades, the use of cementitious materials in Additive Manufacturing (AM) technologies has grown substantially within the Architecture, Engineering, and Construction (AEC). One of these techniques includes the use of clay and robotic technology to fabricate clay moulds via AM extrusion, for the casting of freeform concrete components using Self-Compacting Concrete (SCC) (Wang et al., 2017). Once the concrete cures, the clay is demoulded and can be recycled for subsequent prints. Thus, this method takes the advantage of AM to enable the production of freeform geometries without depending on extensive one-off formworks. The use of clay as a mould, further sidesteps such problems of additive manufacturing as the printed material's performance is not equivalent to that of the final product.

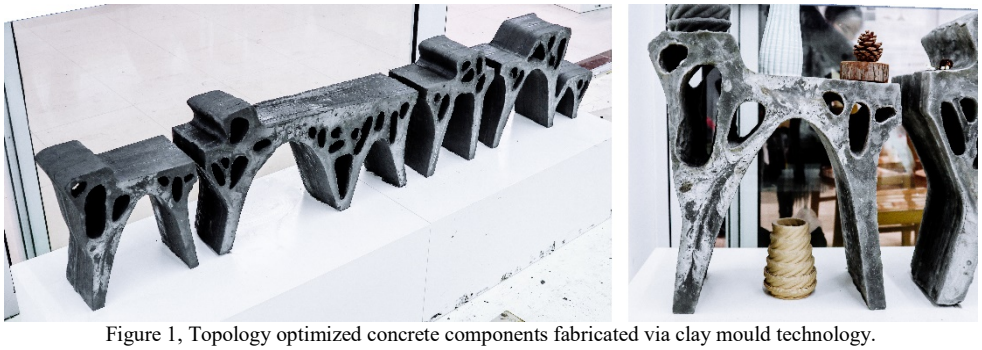

Figure 1, Topology optimized concrete components fabricated via clay mould technology.

In this paper, we utilize the AM clay technique to fabricate the mould for the casting of freeform topology optimized concrete components. Our main research objective is to develop a fabrication process which is suitable for designated geometry that improves the fabrication efficiency without losing the accuracy. In this scenario, our study focuses on the following fabrication procedures: 1. Design and AM extrusion of single-piece clay mould; 2. Planning and assembling of monolithic clay mould; 3. Reinforcing the mould; 4. Concrete casting and demoulding. In addition to the overall fabrication procedures, we have also studied the fabrication of hollows with various cross-section topologies as shown in figure 2. This further contributes to the expansion of achievable geometry range which offers the flexibilities in terms of AM clay with more geometrical varieties.

In the end, we discuss the pro and contra of such fabrication method with the comparison to other contemporary freeform concrete fabrication techniques. Furthermore, we propose the development of AM clay mould towards more formability and geometrical complexities.

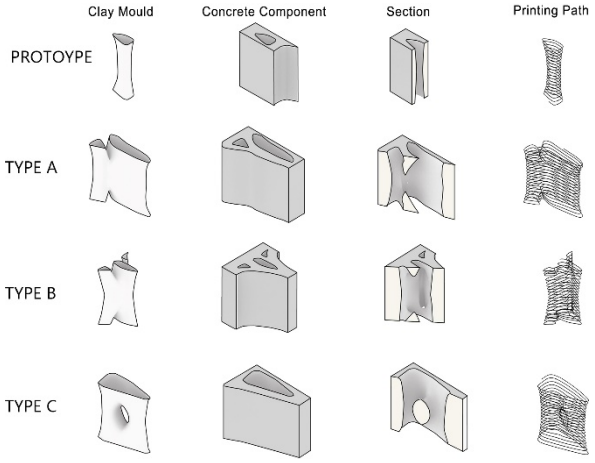

Figure 2, Various topologies of the clay moulds for hollows.

References

Wang, S., Morel, P., Ho, K. and Dritsas, S.: "Clay robotics: A hybrid 3D printing casting process," Proceedings of the International Conference on Sustainable Smart Manufacturing (S2M), Lisbon, pp.83-88, 2016.