

Tailored flexibility

A formwork and reinforcement system for bespoke concrete form.

by

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The tailored flexibility project seeks to develop a construction system that combines flexible formwork with robotic 3D plastic printing, resulting in novel approaches that expand the ranges of both techniques. This paper introduces an approach to combine this system's adaptability with robotically bent steel reinforcement, both alleviating the need for traditional scaffolding and realising complex concrete form.

Flexible formwork

Concrete is the most commonly used building material internationally (U.S. Geological Survey, 2018). Due to its liquid beginnings, concrete offers tremendous formal flexibility. However, common to concrete production is that the shapes realised are constrained much more by the limitations of the formwork than by the limitations of the concrete itself. These limitations have led to the dominance of flat forms created from rigid – often timber - formwork, and avoidance of curved geometries. Flexible formwork has been used to create a wide range of concrete structures and has produced exciting new structural and architectural possibilities and replacing rigid moulds with flexible materials thus offers many practical advantages as well as opportunities for improved structural efficiency (Hawkins et al., 2016).

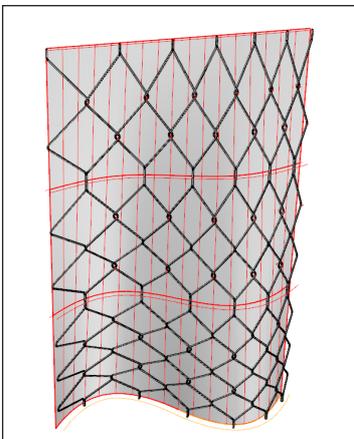
Additive manufacturing

The conventional approach to shape control with fabric is sewn tailoring and rigid edge fixation (West, 2006). This method is, however, not typically CNC controlled and therefore exhibits larger tolerances. While double-curvature is readily achievable, there thus remain significant limitations on the specific forms that are practically feasible, be they for ornament, or for the accurate incorporation of features such as rebar spacers and holes. The introduction of additive manufacturing via robotic plastic extrusion alleviates many of the complications associated with fabric formwork while increasing the variety of forms and surface qualities that can be produced. The strategic reinforcement of the membrane allows for a wider range of formwork materials, including highly flexible fabrics not previously employed in such processes.

Bespoke reinforcement

Combining flexible formwork with robotic 3D plastic printing benefits from strengths in both materials: The compound system is pliable yet rigid. This flexibility allows the formwork to adapt to a rigid framework and thus opens up for a unified bespoke design combining fabric formwork and steel reinforcement. Parallel to the printed shuttering, this paper thus presents a method for 3D steel rebar bending and describes initial prototyping that combines both formwork and reinforcement fabrication methods.

Select process images



References

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