IASS Annual Symposium 2019 – Structural Membranes 2019
Form and Force
7 – 10 October 2019, Barcelona, Spain

Casting ultra-thin concrete gridshells using bending-active formwork

Simon SCHLEICHER*, Yasaman YAVARIBAJESTANI, Konstantinos MOUSTAKAS, Michael HERRMANN[a]

*University of California, Berkeley
College of Environmental Design
232 Wurster Hall, #1800, Berkeley, CA 94720-1800
simon_s@berkeley.edu
[a]str.ucture GmbH, Stuttgart and University of California, Berkeley

Abstract

In recent years, bending-active structures have fascinated engineers and architects alike. This novel construction principle is based on using large elastic deformations of initially straight or planar building elements to generate complex forms and/or self-stabilize a structural system through the elastic energy stored in the deflected members [1]. While this concept has opened a promising new research trajectory and was applied to various prototypical structures and pavilions, one fundamental question still remains unresolved: How do bending-active structures perform when exposed to additional loads? To further explore this question, the authors investigated the potential of using bending-active structures as minimal, lost-formwork for ultra-thin concrete shells. Based on previous research on flexible formwork technologies [2], the authors conceptualized a lightweight substructure made from millimeter-thin strips of carbon fiber reinforced polymers (CFRP). 2 cm thick concrete strips were then sequentially cast on top to form a hybrid gridshell. The resulting hybrid gridshell has a multiple times higher stiffness and load bearing capacity compared to the initial carbon gridshell enabling the shell to be used as permanent structural system with capacity for additional live loads under small deflections. The potentials of this novel approach, as well as the effects on construction process and the resulting geometry will be studied in more detail and discussed by using both digital simulations and physical experimentation.

References

[1] J. Lienhard, H. Alpermann, C. Gengnagel, and J. Knippers, "Active bending, a review on structures where bending is used as a self-formation process," *International Journal of Space Structures*, vol. 28, no. 3–4, pp. 187–196, 2013.

[2] W. J. Hawkins *et al.*, "Flexible formwork technologies–a state of the art review," *Structural Concrete*, vol. 17, no. 6, pp. 911–935, 2016.