

Design of kit of parts reticular structures for reuse

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Abstract

This paper highlights the key features of the design, manufacturing and construction process of the IASS 2019 expo pavilion realized by the Structural Xploration Lab (SXL). The SXL conducts research at the interface of architecture and structural engineering with the aim of tackling global environmental problems caused by the building sector. To address these problems, our research focuses on the integration of circular economy principles into structural design. One circular strategy is *reuse*, which aims at reducing raw material use, energy consumption and waste by keeping products as close as possible to their original form over multiple service-lives.

Generally, reusing structural elements entails reversing the conventional structural design process: the available elements determine the topology and geometry of a structure. To facilitate the design of reticular structures from reused elements, we have recently developed custom structural optimization methods, which take into account the geometric and mechanical properties of an available stock of elements [1]. In addition, these methods are applicable to the inverse problem of synthesizing a trans-topological kit of parts whose elements can be reused to construct multiple different structures.

Through the pavilion design and construction, we apply the developed computational methods to a real case study. The pavilion proposal consists of multiple structural designs, which, during the symposium, will be built consecutively from one kit of parts. Figure 1(a) shows preliminary designs of two of these systems, where the color mapping corresponds to equal length elements and indicates which elements are shared between the two structures.

The reticular pavilion structures will be realized with linear elements. To comply with the expo guidelines, the designs are restricted by weight and dimensions of parts. The developed computational framework takes into account these constraints. To connect members under different angles at nodes with changing valences, digital fabrication techniques are employed to manufacture bespoke joints. In the paper, all crucial steps of the digital design process as well as the manufacturing and construction will be presented. This includes in particular the fabrication of all kit of parts elements such as linear members and joints.

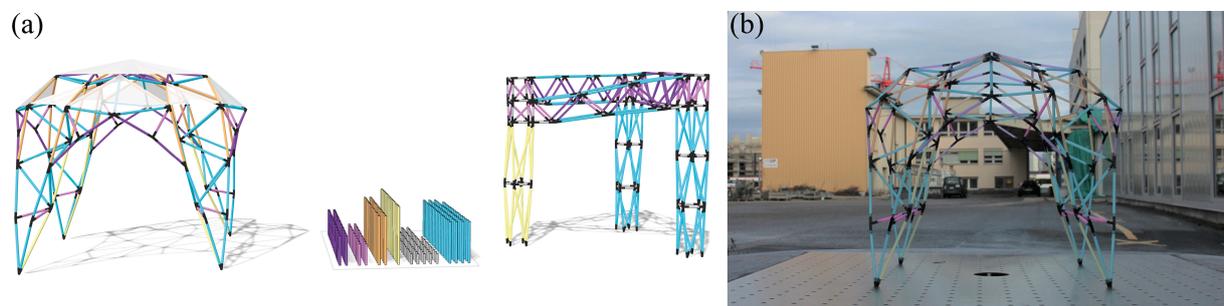


Figure 1. Pavilion concept. (a) Two structures that can be built from the same kit of parts. (b) A mockup of one of the structures (scale 1:10, photomontage)

References

- [1] J. Brütting, J. Desruelle, G. Senatore, and C. Fivet, “Design of Truss Structures Through Reuse,” *Structures*, 2018. doi: 10.1016/j.istruc.2018.11.006.