Multi-objective optimisation-based design for bending-active tied arches

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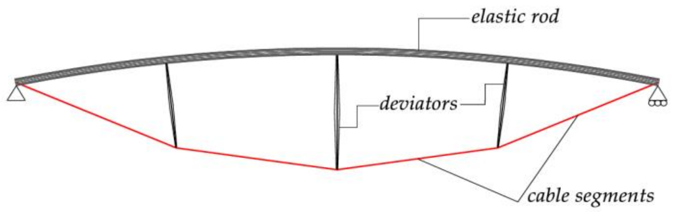
Abstract

In the design of bending-active structures, a compromise between stiffness and flexibility must be achieved: curved members must be slender enough to keep activation stresses low; however, designing with very slender members may lead to structures with low stiffness. Indeed, many bending-active gridshells take advantage of double curvature to limit their deformability. For structures that need to support heavier loads, such as footbridges, the design space may be very limited [1], and this explains why there are very few examples.

In a previous contribution [2], we analysed the structural performance and practicality of planar *bending-active tied arches with bracing* as individual modules for the design of lightweight footbridges. We carried out a series of simulations using specific sized members and material properties, for a certain proportion of length between deviators. However, the results obtained from this study are not directly applicable to bending-active tied arches with different geometries, since it would be necessary to replicate the numerical experiments for every potential structural configuration. Due to the large number of form-finding parameters, and the tight limitations posed by codes, the determination of the best structural configuration may become a challenging process.



Bending-active tied arch

In this paper, we propose a methodology to obtain efficient structural configurations for braced bending-active tied arches using multi-objective optimisation strategies. Initially, plausible random configurations are simulated using non-linear analysis software. In a second step, a genetic algorithm classifies the solutions and establishes the new structural configuration according to best performance. Results are given in terms of non-dimensional parameter, which makes them applicable to a wide variety of scales and cross-sectional sizes.

References

[1] J. Bessini, R. Piñol, C. Lázaro and S. Monleón, "Design of an experimental lightweight footbridge based on the active bending principle", *Proceedings of the IASS Symposium 2018*, International Association for Shell and Spatial Structures, 2018.

[2] C. Lázaro, J. Bessini and S. Monleón, "Shape and performance of bending-active tied arches", *Proceedings of the IASS Symposium 2018*, International Association for Shell and Spatial Structures, 2018.