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

Juan BESSINI*a, Carlos LÁZAROa, Paul SHEPHERDb

*a Departamento de Mecánica de los Medios Continuos y Teoría de Estructuras
Universitat Politècnica de València, Camino de Vera s/n, 46022 Valencia, Spain
juabesmu@mes.upv.es

b Department of Architecture & Civil Engineering
University of Bath

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.

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