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## STIFFENED HANGERS: AN OFTEN OVERLOOKED TOOL FOR CONCEPTUAL DESIGN OF TIED-ARCH FOOTBRIDGES.

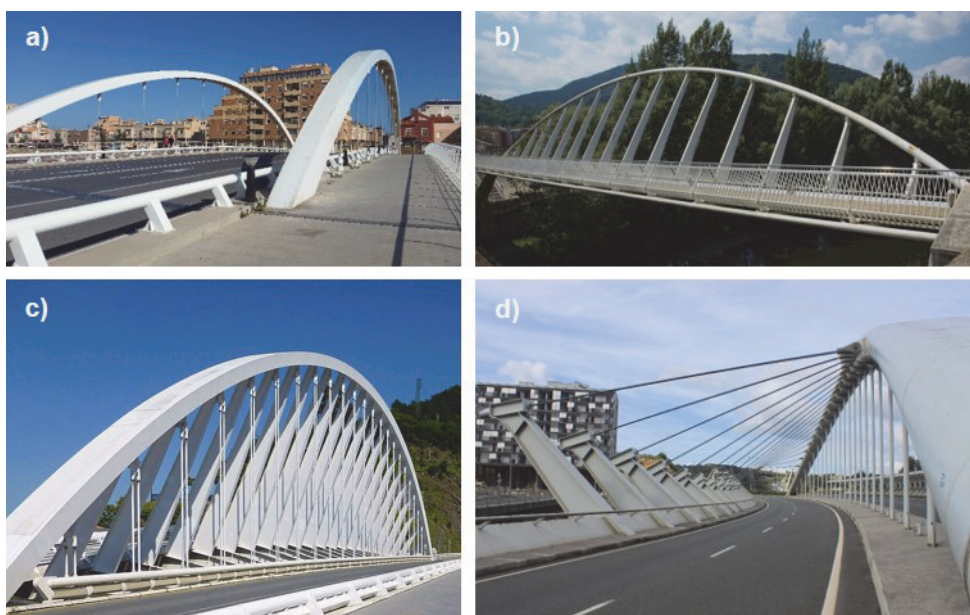
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In tied-arch bridges, the way the arch and the deck are connected may become crucial. The deck is usually suspended from hangers made out of steel pinned cables capable of resisting axial forces only. However, a proper structural response, (both in-plane and out-of-plane) may be ensured by fixing and stiffening the hangers in order to resist, additionally, shear forces and bending moments. This paper studies the effect of different pinned and stiffened hanger arrangements on the structural behavior of the tied-arch footbridges, with the intention of providing designers with useful tools at the early steps of design.

As a major conclusion, regarding the in-plane behavior, hangers composed of cables (either with vertical, Nielsen-Löhse or network arrangements) are recommended due to its low cost and ease of erection. Alternatively, longitudinally stiffened hangers, fixed at both ends, can be used. Regarding the out-of-plane behavior, and in addition to three-dimensional arrangements of cables, of limited effectiveness, transversally stiffened hangers fixed at both ends are the most efficient arrangement. A configuration almost as efficient can be achieved by locating a hinge at the end corresponding to the most flexible structural element (normally the arch). Its efficiency is further improved if the cross-section tapers from the fixed end to the pinned end.



*Fig. 1. Examples of hangers' arrangements: (a) Pinned hangers. (b) Stiffened hangers (c) Pinned and stiffened hangers combined (d) Three-dimensional pinned hangers arrangement.*