Numeric modeling of cable structures: geometric regulation

Summary

This research work deals with the numerical modeling of cable structures, especially their geometric regulation for permanent loads. It was born out of the need to know the corresponding geometric configuration of the structure with precision.

In this context, geometric regulation is understood as the imposition of certain geometric conditions on the structure, which satisfy the desired aesthetic and functional requirements, without ever ceasing to obtain a viable geometric configuration, in equilibrium with the permanent loads.

Geometric configurations are obtained by means of a form-finding process, often numerically solved through an optimization algorithm, also known as non-linear programming. The existing methods of form-finding found in the literature are presented, pointing out individually its advantages and disadvantages, with special emphasis given to the Force Density Method.

An analytical study of cables, including classical mathematical formulations, is also presented. The different types of cable finite element found in the literature are also object of study, comparing its advantages and disadvantages.

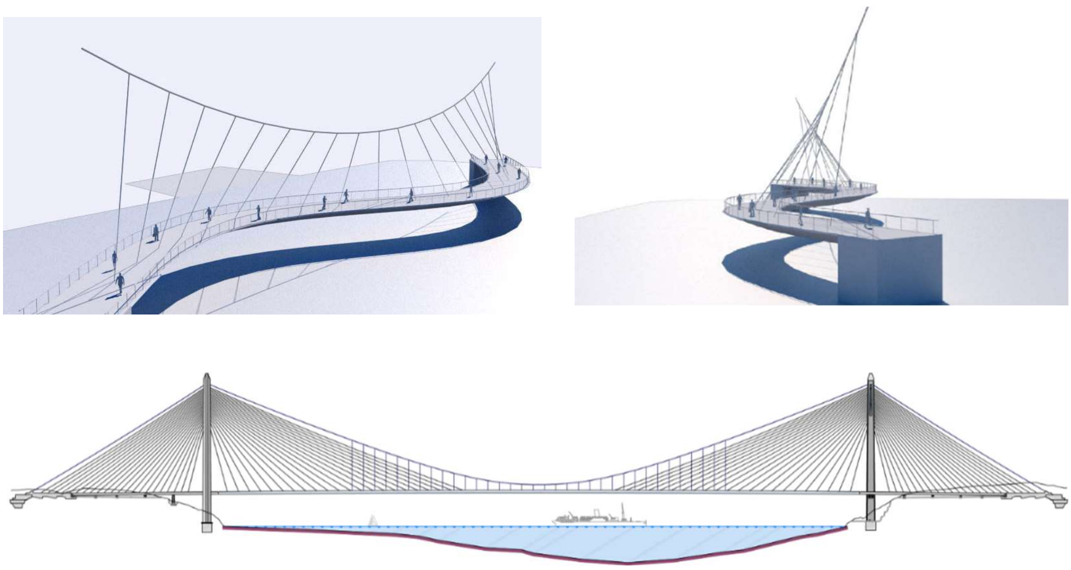
A methodology was developed that allows the geometric regulation of cable structures, with a level of detail and precision that attest to their validity, utility and potential. It was also shown ways of calculating other results, from the coordinate values obtained by the proposed methodology, such as the axial forces and the initial and final lengths of the cables.

Since a mathematical optimization algorithm was used in the numerical resolution of the proposed methodology, a small theoretical introduction is presented, explaining the concepts of objective function and constraints, along with the solving strategies and ways to model an optimization problem.

Finally, the proposed methodology was applied to a set of suspension bridges with complex geometry, presenting the relevant results.

Keywords

Cable, form-finding, bridge, geometric configuration, geometric regulation.



Examples of cable bridges studied using the proposed methodology.

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