Design requirements for maximum compactness in Deployable Structures

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Abstract

This paper is part of the research that is being developed and compiled in the doctoral thesis *Parametric Design and Digital Fabrication of Deployable Structures based on Scissors-like-Elements and Quadrangular Patterns* by the author of this manuscript. The main aim of the work is to develop a geometric method to transform any type of surface into a deployable grid based in two families of scissors-like-elements chains oriented in two directions.

The main design conditions to achieve a maximum compactness in the final closed stage of the grid are presented. The graphic method of the ellipsoid is established and is applied for the generation of deployable chains based in any planar or spatial generic curve. The geometric process to make three different types of scissors-like-elements chains is explained: with parallel axes; with axes perpendicular to the directrix; with radial axes.

This research continues and automates the studies developed by professor Félix Escrig and José Sánchez, from the University of Seville, in quadrangular deployable structures. Foldable grids based on straight rods have been broadly studied by several researchers. However, there is not a general or standardized method that allows to transform any shape into a deployable one. The work that comes closest to achieving this goal is the one developed by professor Luis Sánchez-Cuenca, from the University of Girona, who generates translational foldable surfaces based in two planar perpendicular generic curves. He uses scissors-like-elements chains with parallel axes, in which the dimension of the axes remains constant along the grid. He established the method of the ellipse.

The graphic method of the ellipse offers great possibilities in the creation of new foldable geometries, and it cannot stay limited to translational surfaces with constant thickness. In this research is used as one of the starting points, and it is generalized establishing the graphic method of the ellipsoid, and automatized using Grasshopper, allowing to create new types of deployable chains and grids.

References

[1] F. Escrig, *Modular, Ligero, Transformable. Un paseo por la Arquitectura Ligera Móvil*. Sevilla, 2012.

[2] L. Sánchez-Cuenca, “Geometry for ‘X’ Expandable Structures,” in *Conceptual Design of Structures. Proceedings of the IASS Symposium*, vol. 2, pp. 937–944, 1996.

[3] N. De Temmerman, *Design and Analysis of Deployable Bars Structures for Mobile Architectural Applications*. Vrije Universiteit Brussel. PhD thesis, 2007.