Miura-Ori based folding cell structure: Structural evaluation and beyond

Anastasia IOANNIDI*, Katherine LIAPI[a], George KOMINEAS[b]

*National Technical University of Athens, Greece, School of Architecture
42 Patision, 10682, Athens, Greece
E-mail: aioannidi@gmail.com

[a] University of Patras, Greece, Dept of Architecture, University Campus, Rio, 26500, Greece
[b] University of Patras, Department of Mechanical Engineering and Aeronautics, Patras, 26500, Greece

Abstract

This paper presents an advanced level of investigation of a novel concept of a 3D cell structure based on the Miura–Ori crease pattern already developed by the authors. This structure can be easily deployed, collapsed and transported, and can be utilized for habitation in emergency or temporary situations.

The developed Miura-Ori based cell structure consists of two identical parallel surfaces connected to each other with transverse linear rigid members. Each surface is divided into slightly slanted square shaped surface elements connected to each other that fold according to the Miura crease pattern. The so defined cell structure presents one degree of freedom, and both the folding and unfolding process is completed in one continuous motion. In the fully folded configuration, all the elements of the structure, are parallel to each other (flat folding). Once the cell structure acquires its deployed configuration, it locks up and becomes rigid and self-supported.

The present study explores constructability considerations related to full-scale architectural applications of the cell structure. To this end, a structural evaluation of the proposed structure is carried out, and two separate studies are conducted: The first one assesses the dynamic behavior of the different types of joints that the structure incorporates. The second one evaluates the kinematic behavior of the cell assembly.

Intrigued by the mostly forgotten work of Margharita Beloch on finding real roots of cubic equations via paper folding (1936), and Edward Lill's geometric method (1867) for solving polynomials of any order, the current study explores the potential of utilizing origami and paper folding in linear algebra matrices, in other words to introduce paper folding (with the aid of dynamic geometry softwares) to the analytical methods used to assess the static and dynamic performance of a structure.

References

[1] Thomas C Hull, *Solving Cubics With Creases: The Work of Beloch and Lill* The American Mathematical Monthly, April 2011.

[2] A. Ioannidi and K. Liapi, Miura-Ori based folding cell structure: *Proceedings of the IASS Annual Symposium 2016*, Tokyo, Japan, September 26-30, 2016