

Rigid-Foldable Thick Origami

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Rigid-foldable origami or rigid origami is a piecewise linear origami that is continuously transformable without the deformation of each facet. Therefore, rigid origami realizes a deployment mechanism with stiff panels and hinges, which has advantages for various engineering purposes, especially for designs of kinetic architecture. When we utilize the stiffness of panels for building kinetic structures, it is necessary to properly treat the thickness of origami. Hoberman [1] proposed a thick origami structure, whose rigid-foldability relies on the symmetry of vertex shape. However, no method that enables the thickening of freely designed rigid origami was proposed; such a freeform rigid origami can be designed as a triangular mesh origami or a generalized rigid-foldable quadrilateral mesh origami [2].

This paper proposes a novel geometric method to implement a general rigid-foldable origami as a structure composed of tapered or non-tapered (constant-thickness) thick plates and hinges without changing the mechanical behavior from that of the ideal rigid origami. The panels are designed to enable the dihedral rotation around shared edges within the range between given minimum and maximum fold angles. If the thickness-width ratio of each panel is small enough compared to the incident minimum dihedral angles, the structure can be further built up from two-ply constant thickness panels, which can be easily manufactured via a 2-axis cutting machine (Figure 1). The proposed thickening method is implemented as a parametric design system using *Grasshopper*.

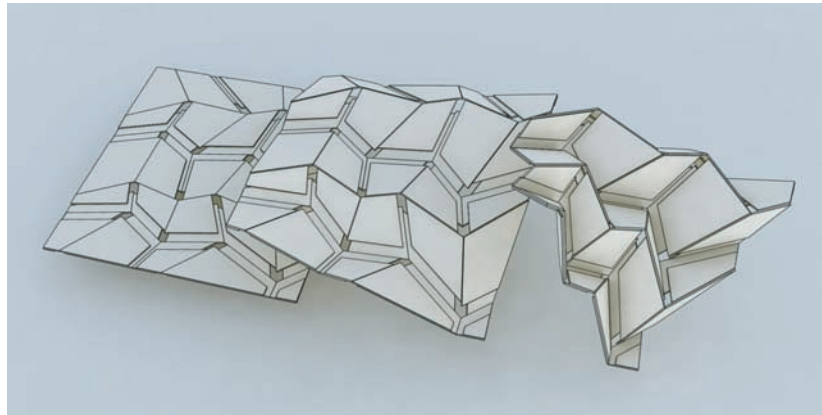


Figure 1: Rigid-foldable origami with constant thickness panels.

References

- [1] Charles Hoberman. Reversibly expandable three-dimensional structure. United States Patent No. 4,780,344, 1988.
- [2] Tomohiro Tachi. Generalization of rigid foldable quadrilateral mesh origami. In *Proceedings of the IASS Symposium 2009*, pages 2287–2294, 2009.

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