
Mechanics of ribbon gridshells

Joo-Won Hong¹, Daniel Castro , José Bico^{*†2}, Etienne Reyssat , Hillel Aharoni , and
Benoît Roman

¹Laboratoire PMMH (CNRS - UMR 7636) – PMMH, CNRS, ESPCI Paris, Université PSL, Sorbonne
Université, Université Paris Cité – France

²pmmh – PMMH, CNRS, ESPCI Paris, Université PSL, Sorbonne Université, Université Paris Cité –
France

Abstract

Bending a sheet of paper into a doubly curved surface such as a dome or a saddle is a challenging operation generally leading to crumples or tears. More generally, changing the local Gaussian curvature of surfaces – the product of the main curvatures – imposes in-plane distortions. Geometrical strategies such as folding (origami) or cutting (kirigami) can be deployed to transform a poorly stretchable sheet into a complex 3D shape. Sheets obtained by weaving inextensible rods bring another degree of freedom as they are free to shear. Such gridshells structures can adopt doubly curved shapes that have been widely studied since the seminal works from Chebyshev and Shukhov motivated by applications ranging from clothing to architecture. We are interested in gridshells formed by crossed ribbons. We first present structures where the ribbons are originally assembled into a regular array with their normal direction perpendicular to the array. We will illustrate how the bending rigidity of the individual ribbons combined with the finite stiffness on their cross-sections dictate in-plane mechanical properties of such arrays. As the deformations of the ribbons are limited to bending in a single direction and twisting, the out-of-plane deflections of the array are geometrically constrained to shapes of negative Gaussian curvature. Can other type of shapes be programmed by adjusting the initial direction of the ribbons at each cross-section?

*Speaker

†Corresponding author: jose.bico@espci.fr