Hybridating vertex and face normals to design torsion-free gridshells: application to the X-Mesh pavilion.

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Abstract

The fabrication of a freeform structural envelope is usually a highly complex task. The most costly aspect is often the fabrication of connections between the constitutive parts. X-Mesh is a pavilion that demonstrates a new rationalization strategy. Its structure is a hexagonal gridshell braced by panels.

A novel geometrical configuration, based on [1], allows for a significant simplification of connections at multiple levels. Firstly, the contact between panels and beams top surface is perfect and the angle between beam webs and panels is 90°. Thanks to these properties, standard low-cost connections can be used to structurally connect beams to panels. Secondly each node is torsion-free: medial axes of beams meet on a common axis. As a result, structural depth can easily be given to the grid. Thirdly, one half of the nodes are planar, and for the other half, beam planes intersect at 120°, thus allowing a standardization of all beam connections. These geometrical properties are obtained by optimization with the Rhinoceros™ plugin Kangaroo2, based on the projective algorithm developed in [2].

This pavilion shows another way of rationalizing a gridshell beyond the popular planar-quad meshes and circular/conical meshes. Also, hexagonal gridshell projects are usually restricted to convex shapes, because covering them with planar faces requires the panels to have a bow-tie shape in negatively curved areas. The proposed geometry is intended at being covered with folded panels, so the hexagons need not be planar: our geometry therefore does not suffer from this convexity limitation.

References

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