Deployable Elastic Rod Pavilion

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Abstract

We propose the construction, deployment, and exhibition of a lightweight pavilion structure composed of elastic beam elements fastened together in a special layout that allows easy on-site deployment. The structure's undeployed configuration lies mostly flat and is easy to build, consisting of GRP rods joined with mechanical fasteners made of aluminum and steel. The structure is deployed simply by either stretching the flat layout or by driving open the angles between bars at the joints. As the structure expands, the constraints imposed by the joints force its beams to bend, and the whole structure buckles into a predetermined shape. A lightweight fabric covering provides shelter from the sun.

Unlike traditional gridshell structures, our structure does not require boundary supports to maintain its shape. Instead, the structure's shape is directly encoded in the layout of its beams and the choice of their cross-section geometry. Importantly, the structure can be locked in its deployed configuration just by fixing the angles at a few joints. Apart from simplifying deployment, this feature offers several advantages. For instance, it allows the beam ends touching the ground to be mounted on castor wheels without the structure collapsing back into its flat state.

Our pavilion design is transported as pre-assembled modules, requiring minimal joining on site. Once the structure is assembled, it can be deployed (opened) with minimal effort by driving open one or a few of the joint angles, either mechanically or by hand. The rain cover attaches to the elastic beam elements with velcro straps or clips.

The pavilion was designed using a state-of-the-art simulation and optimal design tool developed by our lab. The design tool seeks a deployed structure close to a user's desired target shape while guaranteeing that the deployed configuration can be reached by expanding a flat layout. Furthermore, the optimization seeks to minimize stresses in both the deployed and flat configurations.

The final result of our design framework is a pavilion that is lightweight, easy to stow away, easy to transport, and easy to deploy into its final shape. This method also enriches architectural expression by opening up a new class of gridshell designs to explore.