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Magnolia: a glass-fibre reinforced polymer gridshell with a novel pattern and deployment concept

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Abstract

This paper details the design, engineering and construction of a 9.5 by 9.5 m, 2.8 m high, glass-fibre reinforced polymer (GFRP) gridshell. This temporary pavilion, erected in November 2016 by the authors, together with staff and students of Sheffield Hallam University, stood for a period of five weeks at Hallam Square, Sheffield, United Kingdom. The structure was built over the course of four days as part of a larger event on gridshells, which included lectures and an exhibition. The gridshell was constructed using 8 mm thick GFRP tubes, 2 mm steel cables, plastic cable-ties and gaffer tape, supported on sand-filled timber bases.

Two novel concepts for deployable gridshells emerged from the design process. First, the flat mat was constructed to wrap in on itself, forming a cylinder, then pulling one open edge to the center. Second, the deployed gridshell had a central funnel support with a reduced mesh density, from a 45 x 45 cm to 90 x 90 cm grid. Both the central support and the varying density were a product of the initial design intent, to refer to the magnolia flower, through the shape and pattern of its leaves.

The form was found and structurally optimized using parametric modelling in Grasshopper. Initially a surface was manually generated. A grid was mapped onto it using the compass method [1]. This approach helped to define a flat mat, but the resulting gridshell had irregularities in the corners. In a second stage the flat mat was used as a starting point, and bent into shape using physical simulation, prior to structural analysis. The parametrically generated form proved to be very close to the final built result.

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Keywords

gridshell, elastic, deployable, form finding, glass-fibre reinforced polymer, GFRP

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