CERIS Civil Engineering Research and Innovation for Sustainability

Optimal shape for precast ultra-thin shells in eco-efficient UHPC

Summary

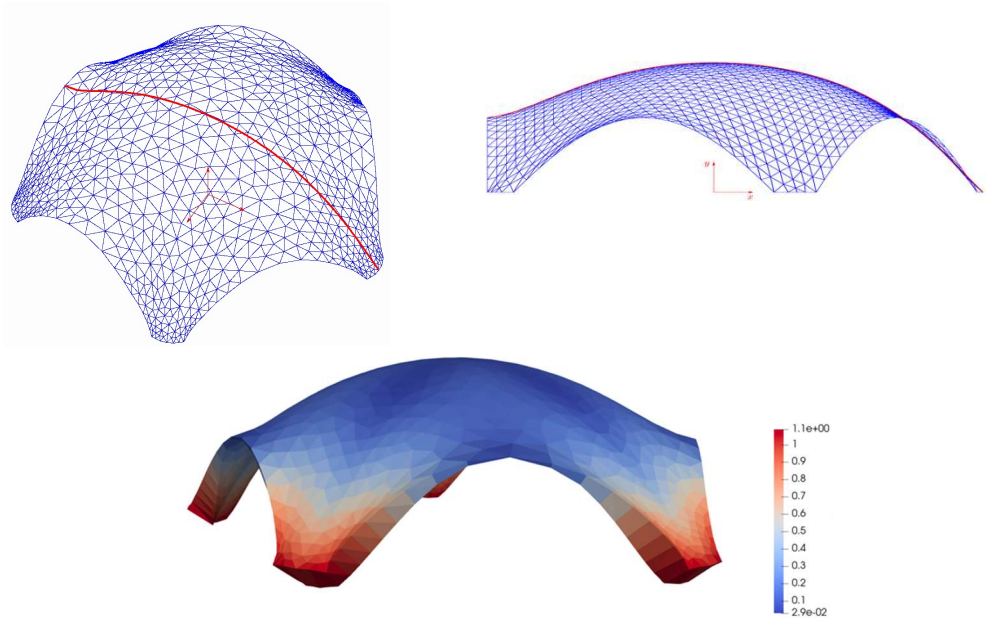
The scope of this thesis is to define double curvature lightweight structures focusing on the optimization of precast ultra-thin shells in eco-efficient UHPC. The first approach consists in developing innovative computational tools for form finding, through the hanging model approach. Discrete models replace the continuum approach in order to find the optimal structural shape, *e.g.* the shape with the most suitable stress distribution. This method is described by conventional non-linear finite element analysis of elastic bodies with respect to large displacements and small deformations.

Once the optimal shape is defined, the process of thickness optimization is implemented. The main goal is to optimize the thickness distribution so that the stresses within the shell are as close as possible to the maximum admissible stress for the material. Consequently, less material consumption is required. This optimization has to take into account the main existing constrains: irregular boundary domain and minimum feasible thickness for concrete. As the form finding process depends on the loading conditions, namely the self-weight, the new form finding procedure has to be repeated with the new thickness distribution.

Finally, structural behaviour and analysis is performed regarding static and dynamic actions, such as snow and seismic and wind actions. Double curvature shells, with different types of support conditions, are analysed regarding different construction stages/phases and the final global stability.

Keywords

Lattice mesh generation, irregular boundary domain, double curvature shells, non-linear structural analysis, precast modules, structural optimization, eco-efficient UHPC, non-linear constitutive-laws.



Form finding of shells and membranes. .Thickness optimization.

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