STUDY CASE: DESIGN & CONSTRUCTION OF A SPHERICAL ACTIVELY-BENT CHEBYCHEV NET TRIANGULAR GRIDSHELL COVERED BY A STRETCHABLE MEMBRANE

Self-bracing gridshell based on Chebyshev net with conical singularity of valence 3

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Abstract

The aim of this study is to design and build a 6 m diameter spherical elastic gridshell covered by a stretchable membrane. Using the previously published work in Chebychev Net gridshells [1] and the introduction of singularity points in the grid design, dividing the surface into 'patches' [2], we analyze the behavior of the structure on different configurations; focusing specially on the area where a patch meets another. We exploit the special case when introducing a single *valence 3* singularity on the center of the chebychev net: the bracing of each patch follows the same direction as the rods of its neighboring patches, leading to the assumption that structure and bracing could effectively be the same element. With this assumption, a number of new constructive problems arise when trying to erect the structure. In order to achieve a "flat-to-form" assembly with this configuration, the joints connecting the bracing elements must be allowed to slide freely until the gridshell has been fully erected. Finally, a membrane cover was designed to protect the structure using a recently developed stretchable architectural membrane. Finally, once the structure had been erected, different load tests were performed in both analytical model and physical model in order to compare their behavior under different conditions and to check the reliability of the parametric structural analysis tools used during the project's design phase.

Figure 1: Flat to form assembly process

Figure 2: Rendered analytical model (left) & final physical 6m dome (right)

References

[1] B. Lefevre, C.Douthe, and O. Baverel. *"Buckling of elastic gridshells".* Journal of IASS, 2015.

[2] Masson, Yannick. "*Existence and construction of Chebyshev nets with singularities and application to gridshells"*. École des Ponts Paris Tech, 2017.