Buckling of actively bent barrel-vaulted timber gridshells

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Abstract

Timber elastic gridshells represent a promising solution for medium and long span lightweight roofs featuring free or modular geometries. This technique enables the construction of large simple or double curved shells by bending standard timber elements on site, incorporating potential for a high degree of industrialization and standardization.

Double curved gridshells with complex geometries require great efforts in the design, analysis and construction phases (e.g. Downland and Savill gridshells). In contrast to that, gridshells with simple curvature such as barrel-vaulted gridshells (e.g. Turnhalle Grundschule Hausdorf and Reithalle Trappenfelde), feature advantages such as simplicity of geometric definition procedures, flexibility in erection and quick and easy covering systems.

The design of gridshells is governed by their sensitivity to buckling. Although this phenomenon has been deeply studied for steel gridshells, there are very few works related to buckling focused on elastic gridshells and those that exist are not specific for timber or barrel vaulted shapes.

Timber elastic gridshells show particular constructive and structural characteristics. In this paper, the influence of these characteristics on the critical buckling load of barrel-vaulted gridshells is analysed. A parametric study by linear and non-linear buckling analysis is presented. The influence of different factors such as the initial bending stresses, the connection stiffness, connection eccentricities and the global geometric imperfections are discussed. The results show that the mentioned factors should not be neglected in the stability verification of elastic timber gridshells.

References

[1] B. Lefevre, C. Douthe and O. Baverel, "Buckling of elastic gridshells", *Journal of the International Association for Shell and Spatial Structures*, vol. 56, pp. 153-171, 2015.

[2] B. D'Amico, A. Kermani, H. Zhang, P. Shepherd and C.J.K. Williams, "Optimization of cross-section of actively bent grid shells with strength and geometric compatibility constraints", *Computers and Structures*, vol. 154, pp. 163-176, 2015.

[3] J. Natterer, N. Burger, A. Müller and J. Natterer, "Holzrippendächer in Brettstapelbauweise Raumerlebnis durch filigrane Tragwerke", *Bautechnik*, vol. 77, pp 783-792, 2000.