

Airy Stress-based Approach for Assessment and Design of Compressed Shells

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Tentative date: March-April 2025

Bio

Carlo Olivieri is Assistant Professor with expertise in civil and structural engineering, currently associated with the Faculty of Engineering and Computer Science of the Telematic University Pegaso. His work focuses on structural analysis and design, particularly in the context of historical masonry and complex geometrical structures. Olivieri has contributed to research on the equilibrium and stability of vaulted structures, applying modern computational techniques like finite element methods (FEM) and stress analysis to assess historical buildings and optimize new structural forms.

He has authored multiple studies that blend engineering and architectural principles, addressing the behavior of cloister vaults, cross vaults, and masonry domes. His research uses both experimental data and advanced modeling to understand the structural integrity of these complex forms, contributing to preservation efforts of historical monuments.

Abstract

The seminar addresses critical challenges and innovative solutions in the analysis and design of block-based shells. It will showcase work conducted by myself and various research groups I have collaborated with, focusing on the development of new analytical methods for accurately analyzing such structures and their application to design and construct architecturally ambitious shells in various competitions and exhibitions. Furthermore, digital innovations in the construction process utilise technologies such as Augmented Reality to streamline the accurate assembly of these shells, which have very small construction tolerances.

The key topic is Membrane Equilibrium Analysis (MEA), a method based on the use of the Airy stress function to provide an equilibrium solution that is wholly in compression under combined vertical and horizontal loading. The last developments of this methods provide more accurate equilibrium solutions for the assessment of historic masonry vaulted structures as well as the design of new block-based shells.

Additionally, case studies of notable structures that have been designed and assessed using these methods will be discussed. Among these, the Angelus Novus Vault built in occasion of the 2023 Venice Architectural Biennale, the SOM pavilion for COP28 in Dubai, the Shenzhen pavilion "I live with nature", and the pavilion for IMI Workshop will be highlighted, demonstrating the practical implications of the research and the potential for integrating traditional masonry techniques with modern engineering principles to create resilient, efficient, sustainable, and aesthetically pleasing structures.