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free grid

A BENCHMARK ON

DESIGN AND OPTIMIZATION OF

FREE-EDGE GRIDSHELLS

under the umbrella of | with the support of | industrial partner

international association for shell and spatial structures

C T A — COLLEGIO DEI TECNICI DELL'ACCIAIO

ArcelorMittal

First Announcement

July 2023

Further Information

For further and updated information, please refer to the web page
https://sites.google.com/view/freegrid

or contact the Steering Committee
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free**grid**

a benchmark on design and optimization
of free-edge gridshells

AIMS AND GOALS

The FreeGrid benchmark moves from seven general problem statements, and towards related goals.

- The activity in Structural Engineering in general, and about gridshell as well, is increasingly polarized between mechanical modelling and analysis versus design practice and applications. FreeGrid is intended to bridge these two approaches.
- The design and optimization of gridshells as form-resistant discrete structures is intrinsically a multidisciplinary activity. FreeGrid aims at gathering competences and input from different fields around a common design problem.
- Artificial Intelligence (AI) is among the most recent generalized trends in contemporary science. FreeGrid is meant to offer a common benchmark to comparatively test the readiness of different approaches to the conceptual design of form-resistant structures, from the classical man-based heuristic design, to the optimization approach, to the AI-assisted design.
- Perfect infinitely rigid external constraints only seldom occur in built gridshells, while the structural performances of free-edge gridshells and their design proposals are scarcely treated in scientific systematic studies. FreeGrid aims at filling the gap between the design practice and the scientific literature by adopting free-edge gridshells as case studies.
- Design is a holistic activity accounting for multiple goals. FreeGrid calls for the holistic improvement of structural, buildability, and sustainability performances.
- Benchmarking best practices require that studies and related results are reproducible. FreeGrid adopts an Open Data policy and sets mandatory requirements to participants intended to secure the full description of the design solutions and their performances.
- An international scientific community needs opportunities for sharing, possibly collaborative, eventually truly competitive studies. FreeGrid precisely and analytically adopts objective, purely quantitative performance metrics to compare design solutions.

PROBLEM STATEMENT

FreeGrid sets as design baseline problems three quad gridshells with simple (barrel vault), double gaussian positive (parabolic dome) and double gaussian negative (hyperbolic paraboloid) curvature, with their spring line partially not constrained (free-edge), subjected to symmetric and asymmetric load conditions.
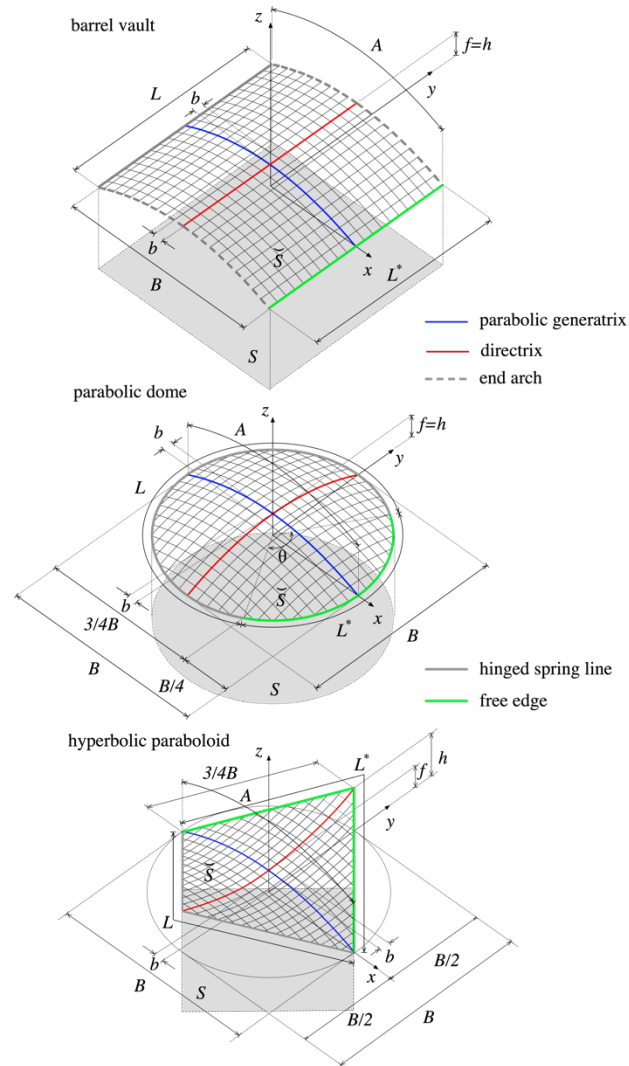
Participants are called to modify the baseline gridshell(s) above in order to improve their structural performances, their buildability, and their sustainability all weighted in a single, synthetic quantitative metric. Structural performances account for stability and stiffness at Ultimate and Serviceability Limit States, respectively. Buildability is achieved by reducing the face out-of-planarity and the structural joint number, and by increasing the uniformity of the structural joints and members. Sustainability is achieved by reducing the carbon dioxide equivalent to the steel weight of the structural members, that depends on the steel grade and type of cross sections. Participants shall comply with a limited number of design constraints, while any other design solution is allowed.

Baseline setups, performance metrics and design constraints are fully detailed in technical specifications made available at FreeGrid web site.

ARCELORMITTAL STELIGENCE AWARD

The *ArcelorMittal Steligence Award for scientific studies on holistic design and optimization of steel free-edge gridshells* will be remitted to the Authors(s) younger than 35 years old who will obtain the highest value of the synthetic performance metric for each type of baseline gridshell. An additional award will be remitted to the Author(s) who will deal with all the three baseline structures and obtain the highest performances in average. The full regulation of the ArcelorMittal Steligence Award is available at the Freegrid web site.

ORGANISATION AND TIME FRAME

- 2023

  FreeGrid is announced during the IASS Annual Symposium 2023 July, 10th-14th in Melbourne (AUS).

  FreeGrid is announced through publication in scientific journals.

- 2024 – 2025

  Dissemination of the in-progress activities possibly arranged within the Conference organized by IASS and CTA.

- 2026

  FreeGrid main milestone and prize-giving at IASSS Annual Symposium 2026.

  Set-up of a special issue of an international journal in the field to collect studies devoted to the benchmark.