Vrije Universiteit Brussel

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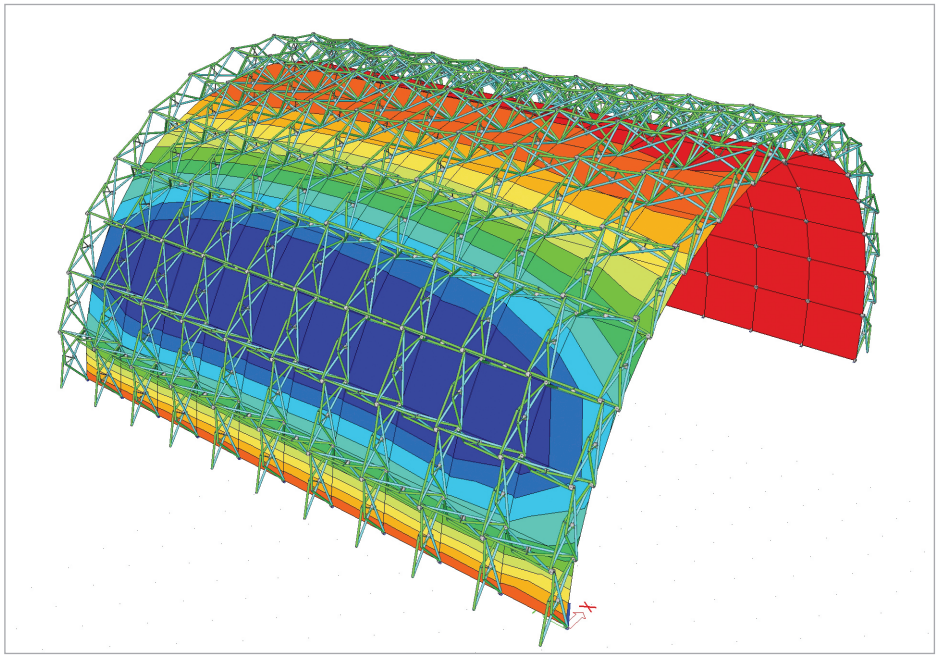
The Vrije Universiteit Brussel is a dynamic and modern university with two parkland campuses in the Brussels Capital Region.
We offer a quality education to more than 9.000 students. Brussels Faculty of Engineering (in short "Bruface") is an initiative of the two universities in the centre of Brussels.
Starting from the academic year 2011-2012, the 'Université Libre de Bruxelles' and the 'Vrije Universiteit Brussel' jointly organise English taught 'Master of Science (MSc)' programmes, among which Civil Engineering and Architectural Engineering.

In the Department of Architectural Engineering (ARCH), the research is focused on "the use of engineering tools to create architecture". This approach is applied on three topics that ask for interdisciplinary studies: the design of lightweight structures, the issue of re-use, and the incorporation of 4D design.



Software: Scia Engineer

Universal Scissor Component - Brussels, Belgium

Information on the project

Deployable scissor structures consist of beam elements connected by hinges, allowing them to be folded into a compact bundle for storage or transport. Subsequently, they are deployed, demonstrating a huge volume expansion. This process can be reversed, allowing re-use.

The purpose of the research aimed at designing and analyzing a new multi-configurational Universal Scissor Component. While current designs of scissor systems give an 'ad hoc' solution, this research provides a methodology for designing a scissor component resulting in generic structures: different geometrical domes and barrel vaults with varying spans. The Universal Scissor Component is a single and unique element in all the proposed configurations, the only difference is the position of the pivot hinge. This concept makes re-use and adaptability possible: it is well equipped to meet changing requirements.

A structural study is conducted to investigate the feasibility of the new concept.

Project approach

During deployment no additional stresses are induced in the proposed foldable structures and the imposed loads and span are usually less than those for the fully deployed state. Therefore, the structural study concentrated on the analysis in the fully deployed configuration.
In a larger construction the loads increase and the global instability becomes significant due to the scale-effect. Hence, a total detailed calculation of the largest barrel vault structure is assumed to result in a scissor component that satisfies the structural requirements in all system configurations.
The study includes the geometric modelling of the structure, the determination of the symmetrical and asymmetrical load cases and the dimensioning of the Universal Scissor Component.

Structural concept

The semi-cylindrical shape of the barrel vault consists of 11 arches formed by the USC composed in a polar configuration, which are linked together with translation USC's creating a deployable structure.

The geometry is based on a semicircle with a radius of 8.6 m. It has a span of approximate 17 m and the structural thickness is less than 1 m. The barrel vault is an open structure in steel with neither back nor front and encloses a quite large architectural area of 308 m^2.

Generally, mobile deployable structures consist of a weather protecting membrane. This dissertation however focused on the feasibility of the designed steel scissor structure, without details regarding a more accurate load transfer with a pre-tensioned membrane. Therefore 2D plate elements are introduced in the structure to form a 3D shell. The 2D elements are modelled as thin aluminium plates with an adjusted self weight to approach the self weight of a membrane in case of mobile structures.

Loading scheme

Eurocode 1 determines the permanent loads:
- Self weight of the steel scissor structure
- Self weight of the membrane (plates)

Eurocode 1 was used to determine the variable loads:
- Snow
- Transverse wind
- Longitudinal wind

The complete analysis is carried out according to the actual European standards: Eurocodes EN1990, EN1991 and EN1993.

Universal Scissor Component

Brussels, Belgium

Project information

Owner	Master Thesis of Lara Alegria Mira
Architect	Promotor: Prof. dr. ir. arch. Niels De Temmerman (Dept. ARCH)
Construction Period	From 2010 to 2011
Location	Brussels, Belgium

Short project description

This project is about a student dissertation, more specifically a three dimensional computational structural analysis is carried out on a deployable barrel scissor structure. The study includes the geometric modelling of the structure, the determination of the symmetrical and asymmetrical load cases and the dimensioning of the Universal Scissor Component. The complete analysis is carried out according to the actual European standards: Eurocodes EN1990, EN1991 and EN1993. This structural calculation is executed to investigate the feasibility of the designed innovative scissor concept.