



Third Training School
**Technological aspects of the engineering of
 lightweight structures**

25 – 26 – 27 – 28 September 2023

Room 422, UCL – Department of Mechanical Engineering, Roberts Engineering building, WC1E 7JE London or [Zoom](#)

Registrations requests should be sent to: lighten.project@ucl.ac.uk

Time (BST)	Monday 25/9/23	Tuesday 26/9/23	Wednesday 27/9/23	Thursday 28/9/23
9.00 – 10.00	Standard codes & Best practice (A. Bown – Tensys)	Structural design under impact loading (J. Marr – Tensys)	Travel from London Paddington to Chepstow D : 0930 A : 1153	Official project and SB meeting (hybrid - Tensys office Bath and MS Teams) – only for LIGHTEN members
10.00 – 10.30	Coffee break			
10.30 – 12.00	Design & Analysis of building skins (A. Cabello – Tensys)	Innovative and unconventional membrane structures (C. Paech - SBP)		
12.00 – 13.30	Lunch break		Lunch at ALM	Free afternoon to visit Bath and return to London
13.30 – 14.30	Lifecycle Assessment (C. Siepiora – Serge Ferrari)	Lifecycle assessment (C. Monticelli – POLIMI)	ALM site tour & ETFE talk	
14.30 – 15.00	Coffee break			
15.00 – 16.30	Stability problems in lightweight buildings (F. Dal Corso – University of Trento)	Management & Financial aspects (C. Rowell – ALM)	Travel from Chepstow to Bath	
16.30 – 17.30		Tour of UCL labs, UCL East and social dinner (F. Bosi – UCL)	Social evening Bath	

Organised by:



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Monday 25/9/23 | 09.00 – 10.00 BST

Standard codes and best practice

by *Adam Bown* – Tensys

The discussion aims to give a review of the standard process flow for the design and construction of a typical tension structure, with particular emphasis on the use of design codes and current best practice

The following topics will be covered:

- Short refresher on the key aspects of each stage of the process
- Brief review of the historical codes, standards and best practice
- The introduction and prospects for the new Eurocode for the design of tension structures
- Consequences of the alignment to EN1990 Basis of design (ULS requirements)
- SLS requirements
- Overview of design figures for ETFE design



Adam Bown, a Director of Tensys Ltd, has over twenty years of experience in the design, form-finding, static and transient analysis and provision of fabrication data for a variety of tensile structures from around the world. Working in the fields of architecture, aerospace, and artistic installations. Notable projects and experience being: *Architecture*: BC Place Stadium, Vancouver; Suvarnabhumi Airport, Bangkok; M11 Monument, Madrid; Munich Olympic Swimming Pool; Waldstadion Frankfurt. *Aerospace* 'lighter than air' craft: Project Loon communication balloons and the NASA high altitude super pressure balloon program. *Artistic installations* by artist Anish Kapoor: Sectional Body preparing for Monadic Singularity, Palace of Versailles, France; 'Ark Nova' – Japan; 'Leviathan' – Grand Palais, Paris; 'Marsyas' Tate Modern, London.

Monday 25/9/23 | 10.30 – 12.00 BST

Design and analysis of building skins

by *Adrián Cabello* – Tensys

Practical implementation of a thermo-visco elastic material model for the design and analysis of ETFE structures

The presentation will cover how the valuable tools and modelling approach developed by the LIGHTEN Program can effectively be applied in the design of ETFE structures, whilst remaining within the design framework of the new Eurocode for membrane structures. It will be discussed the challenges in attempting to reconcile the 'snapshot' approach of the Eurocode with the time and loading rate dependence inherent to visco-elastic models. It will be stressed the recommendation to use material non-linear modelling to implement the limit states verifications required by the code.

- Reference: Using a nonlinear thermo-viscoelastic constitutive model for the design and analysis of ETFE structures (2019). IASS Annual Symposium, proceedings.



Adrián Cabello is a structural engineer at Tensys. He has vast experience in design and analysis of tension structures, developing his professional career in Spain, Germany and United Kingdom. He graduated as Civil Engineer (2009) by the Polytechnic University of Madrid and holds a master's degree in Concrete Engineering (2011) by the Polytechnic University of Valencia. He has been involved in the design of stadia, membrane roofs, lighter than air vehicles and balloons. He has also kept a link with the academic world by publishing technical papers and attending conferences.



Monday 25/9/23 | 13.30 – 14.30 BST (online)

Lifecycle assessment

by *Catherine Siepiora* – Serge Ferrari

The lectures will give an overview of the environmental product declaration (EPD): An instrument to communicate sustainability performance.

The lecture will cover key topics such as:

- Overview of the environmental challenges, processes and results
- Definition and scope
- Process
- Examples in tensile architecture and solar protection products
- Case study of the Chrifia Gold resort, Morocco



Catherine first joined Serge Ferrari in 1990. In her time at Serge Ferrari, Catherine has held the roles of the Communication Manager, Specification Manager France,

Marketing and Communication Manager Europe before taking on her current role as the Specification Manager Europe. Serge Ferrari Group's mission is to act now to build a better tomorrow. For nearly 50 years, Serge Ferrari has been designing, developing and manufacturing innovative composite fabrics for light architectural and exterior landscaping applications. Aimed primarily at four strategic and global markets linked to the building and industrial sectors - solar protection, taut architecture, modular structures, furniture / marine - our high-end solutions combine durability, safety, design, comfort and eco-responsibility.

Monday 25/9/23 | 15.00 – 16.30 BST (online)

Stability problems in lightweight buildings

by *Francesco Dal Corso* – University of Trento

An overview will be given on the main theoretical aspects of stability problems of lightweight structures, with particular reference to flutter instability and wrinkling.

References:

- *Bigoni, D. Noselli, G. "Experimental evidence of flutter and divergence instabilities induced by dry friction." Journal of the Mechanics and Physics of Solids (2011), 59, 2208-2226.*
- *Liu, Z. G., Yang Liu, and Jian Lu. "Fluid-structure interaction of single flexible cylinder in axial flow." Computers & Fluids 56 (2012): 143-151.*
- *Hiroaki, Keiichi, Yutaka Hayashi, and Masahiro Watanabe. "Numerical simulation on a limit cycle oscillation of a rectangular sheet in three-dimensional flow: influence of vortex element model on post-critical behavior." Nonlinear Dynamics 106 (2021): 2893-2917.*
- *Wang, Ting, Chenbo Fu, Fan Xu, Yongzhong Huo, and Michel Potier-Ferry. "On the wrinkling and restabilization of highly stretched sheets." International Journal of Engineering Science 136 (2019): 1-16.*
- *Fu, Chenbo, Hui-Hui Dai, and Fan Xu. "Computing wrinkling and restabilization of stretched sheets based on a consistent finite-strain plate theory." Computer Methods in Applied Mechanics and Engineering 384 (2021): 113986.*



After earning a PhD in Materials and Structural Engineering at the University of Trento, Italy, he had a postdoctoral fellowship at the Department of

Applied Mathematics and Theoretical Physics, University of Cambridge, UK. Francesco Dal Corso is currently an Associate Professor of Solid and Structural Mechanics at Department of Civil, Environmental and Mechanical Engineering of the University of Trento, Italy. His research activity is devoted to the Mechanical behavior of Solid and Structures. In particular, he dealt with problems related to the localization of deformation, plasticity, large deformations, homogenization, higher-order continua, stress concentrations and singularities, contact mechanics, configurational mechanics and stability. He has co-authored more than 50 journal papers. He has co-guest edited a Special Issue of the Journal of the Mechanics and Physics of Solids in 2020 and he is Associate Editor of Frontiers in Mechanical Engineering -Solid and Structural Mechanics section since 2021.



Tuesday 26/9/23 | 09.00 – 10.00 BST (online)

Structural design under impact loading

by *James Marr* – Tensys

With particular reference to a variety of recently competed case studies, this lecture will introduce the methodology, techniques and factors relating to modelling of impact loads onto tensile structures.



Director of Tensys with 15 years experience in structural design of lightweight structures. Successfully delivered unique

complex geometric structures as part of stadium, building facade, artwork, zoological enclosure and fall protection barrier projects internationally. Skilled in form finding, analysis and design of wide variety of materials including;

- Tensioned fabrics (Glass/PTFE, PES/PVC)
- Air supported films (ETFE)
- Tensioned Cables/Ropes (steel, fibre)
- Meshes (woven, ferruled)
- Aluminium (extrusions, expanded, composite)

Has also completed a number of retractable/operable structures. Member of the Institution of Engineers Australia with Chartered Status, on the NER and has presented at a number of the Lightweight Structures Association of Australasia conferences.



Tuesday 26/9/23 | 10.30 – 12.00 BST (online)

Innovative & Unconventional membrane structures

by *Christoph Paech* – Schlaich Bergermann Partner

This lecture will be about: Innovative and unconventional membrane structures

Christoph Paech, Managing Director at schlaich bergermann partner- sbp will showcase in his lecture several projects that have been designed by sbp over the last years given an emphasis on latest developments and trends in lightweight architecture. One of the trends are for sure convertible membrane roofs and facades that find its application in both large scale but also small-scale projects.

He will give an overview of possible solutions and highlight the most important advantages of these kinds of structures. The presented works range from the implementation of a new lightweight roof for the BC Place stadium in Vancouver in Canada, the retractable roof for a FIFA world cup Stadium to recently commissioned retractable courtyard covers of an existing wine castle. Beside their advantages in functionality, permanent membrane structures can furthermore add an iconic shape to the architectural appearance, like the roof for the Schierker Feuerstein Arena in Germany. To round off the spectrum the latest developments in the field of temporary pavilion architecture with textile membranes will also be presented.



Managing Director at schlaich bergermann partner, sbp se.

Christoph Paech, born in 1978, studied civil engineering at the University of Stuttgart between 1999-2004. Christoph Paech has been part of schlaich bergermann partner's team for 19 years. Immediately after graduating, he started his career at sbp in Stuttgart and then moved internally to the New York office for several years. Back in Stuttgart, he became Head of Middle East Projects in 2013, Director at sbp in 2015 and Managing Director in 2023.

Christoph's international experience includes prestigious and innovative international projects. He has designed and successfully managed numerous large scale projects where textile membranes and foils play a major role in the design, as for example the Al Bayt Stadium and the retractable roof of Al Janoub Stadium for the FIFA Worldcup 2022 in Qatar or the BC Place stadium in Vancouver.



Tuesday 26/9/23 | 13.30 – 14.30 BST

Lifecycle assessment

by Carol Monticelli – POLIMI

This lecture will cover the key topics of environmental impacts of ultra-lightweight structures used in architecture, from raw materials, production, transport, use and disposal and sustainable strategies .

- Advantages and limits of Membranes as construction system and their Lightness
- Less matter, material and energy saving?
- The life cycle of membranes: from cradle to cradle/reuse/recycling
- Some updates on PFAS restriction of fluoropolymers
- Tendencias, challenges, the sustainability and life cycle of Contemporary Tensile Structures in Europe will also exposed

References:

- 2023 *Life Cycle Design for Lightweight Skin. In Lightweight Energy Membrane Architecture Exploiting Natural Renewable Resources - ISBN: 978-3-031-08153-8. In RESEARCH FOR DEVELOPMENT vol. 1 Monticelli, C.*
- 2023 *Lightweight Energy. Membrane Architecture Exploiting Natural Renewable Resources. DOI: 10.1007/978-3-031-08154-5 - ISBN: 978-3-031-08154-5. In RESEARCH FOR DEVELOPMENT Zanelli, Alessandra; Monticelli, Carol; Jakica, Nebojsa; Fan, Zhengyu*
- 2021 *Sustainable innovation in Minimal Mass Structures and Lightweight Architectures. DOI: 10.1080/17452007.2021.1938458. In ARCHITECTURAL ENGINEERING AND DESIGN MANAGEMENT vol. 17 (3-4) Zanelli, A.; Monticelli, C.; Mollaert, M.*
- 2020 *Material saving and building component efficiency as main eco-design principles for membrane architecture: case - studies of ETFE enclosures. DOI:10.1080/17452007.2020.1768507. In ARCHITECTURAL ENGINEERING AND DESIGN MANAGEMENT vol. TAEM20 Monticelli, C.; Zanelli, A.*



Carol Monticelli is an Associate Professor in the Department of Architecture Built Environment and Construction Engineering at

POLIMI for the discipline of the Architectural Technology, architect and PhD in Technology and design for environmental quality on a building and urban scale. She carries out research activities with the POLIMI Textile Architecture Network, within the interdepartmental Textiles Hub laboratory.

Her research activity is devoted to investigating the issues of eco-sustainable design of buildings and the environmental impact in construction, with particular attention to the assessment of the environmental impacts of materials and technologies in the various phases of building process. She took part to many research projects at the national and international scale. She is Quality Manager of the biaxial mechanical testing rig at the accredited Textiles Hub at PoliMi. She is a member of the WG membrane structures CEN / TC250 WG5 and of the mirror group UNI / CT 046 / subcommittee 01 relating to textile and textile products CEN / TC248. Since 2016 she is coordinator of the WG Sustainability & Comfort of the European Tensinet network for the development of membrane constructions in the activity of the European Tensinet network Author of more than 120 publications, with mentions and acknowledgments, has co-guest edited Special Issues of International Ranked Journals. She is co-inventor of an Italian and a European patent.



Tuesday 26/9/23 | 15.00 – 16.30 BST (online)

Management and financial aspects

by *Christopher Rowell* – Architen Landrell

The lecture will introduce the management and financial aspects of a typical tensile structure project.



Christopher Rowell is Managing Director of Architen Landrell, one of the world's leading specialists in lightweight membrane architecture and the UK's only ETFE contractor. Christopher's father, Lance Rowell, founded Landrell Fabric Engineering in the mid-1980s and Christopher has been involved in every aspect of the industry through his childhood and career. His knowledge of the design, manufacture and installation of fabric membrane structures is unrivalled and his desire to pioneer more efficient, smarter, flexible and aesthetic systems is key to the success of the business.



| Wednesday 27/9/23 |

ETFE overview and Architen Landrell factory visit

by Architen Landrell Manufacturing – Chepstow

The visit to the Architen Landrell facilities will start with an informal presentation and Q&A session on the topic of ETFE structures. The presentation, by Amy Richardson, will cover topics such as:

- An overview of the typical ETFE system
- The benefits of ETFE
- Design considerations
- Case studies

Following the presentation, there'll be a tour of Architen Landrell's on-site manufacturing facility and ETFE production line.



Architen Landrell is a specialist tensile fabric company that designs, engineers, manufactures, installs, and maintains some of the world's most inspiring tensile fabric structures, ETFE systems, and fabric canopies.

With 30 years of experience in the industry, an impressive portfolio of award-winning projects, and a growing list of over 6,000 structures in 48 countries, our track record speaks for itself.

