

CHALMERS

Welcome to

DESIGN-OGH KONSTRUKTIONSDAGEN 2016

The Structural Design Day, November 21, 2016, Gothenburg



Photo: Karin Holmgren

Shell Structures

Arranged by
Structural Engineering Centre at Chalmers
A joint event between Chalmers,
Samhällsbyggarna and Brosamverkan



Photo: Karin Lundgren

Design- och konstruktionsdagen (The Structural Design Day) is an annual activity that aims at providing inspiration and incentives for design and engineering, reflecting the needs of modern societies for sound and sustainable development. The theme of 2016 is “Shell Structures”.

How sustainable are shell structures? Pros and cons in a nutshell

Holger Wallbaum

The presentation will elaborate on the strength and challenges of shell structures as an advanced building construction. A holistic scan will be presented addressing the various dimensions of sustainability as well as judging the capabilities from a life cycle engineering standpoint

Holger Wallbaum is a Full Professor in sustainable building at the Division of Building Technology, research group Sustainable Building, and in the Area of advance Built environment. Holger works within sustainable building on concepts, tools and strategies to enhance the sustainability performance of construction materials, building products, buildings as well as entire cities.

His main research interests are related to ecological and economic life cycle assessment of construction materials, buildings and infra-



structures, sustainability assessment tools for buildings, social-cultural and climate adapted design concepts, the refurbishment of the building stock as well as dynamic building stock modeling and its visualization.

The equilibrium equations: How do shell structures stand up?

Chris Williams

Shell structures carry load through an interaction of their curvature with internal forces. The lecture will use the concept of statical determinacy to explain what is necessary in the shape of a shell and the way it is supported in order for it to carry load efficiently.

Chris J K Williams, Chalmers University and Bath University. Chris worked with Ted Happold and Ian Liddell at Ove Arup & Partners on the Frei Otto gridshells in Mannheim. This led to his research interest in the relationship between geometry and structural action, and collaboration on a number of projects including the British Museum Great Court Roof (Buro Happold and Foster + Partners), the Savill Building (Buro Happold and Glenn Howells



Architects), Gardens by the Bay glasshouses (Atelier One, Wilkinson Eyre and Grant Associates) and the Netherlands Maritime Museum (Ney + Partners).

Novel Shell Structures: Learning from the Master Builders.

Philippe Bloch

This lecture will present new computational form-finding and optimisation approaches for exploring three-dimensional equilibrium shell structures based on the stability analysis of Gothic masonry vaults. Thanks to intuitive graphical methods, the designer gains control over the exploration of form, which allows for the design of vaults with little or low-quality material or the design of efficient and expressive surface structures.

Several projects will demonstrate the power of these innovative methods for the safety assessment of historic masonry vaults with complex geometries and for the design, engineering and fabrication of novel masonry shells, which range from sustainable construction solutions for developing countries to unique, unreinforced vaults in tile or cut stone.

The last part of the lecture will demonstrate how we can learn from the Master Builders to design better – well beyond masonry.

Philippe Bloch is Associate Professor at the Institute of Technology in Architecture at ETH Zurich, where he directs the Block Research Group (BRG) together with Dr. Tom Van Mele. The BRG focuses on equilibrium analysis, computational form finding, optimisation and fabrication of curved



surface structures, specialising in unreinforced masonry vaults and thin concrete shells. Within the Swiss National Centre of Competence in Research (NCCR) - Digital Fabrication, the BRG develops innovative structural design strategies using bespoke prefabrication. Bloch studied architecture and structural engineering at the VUB, Belgium, and MIT, where he earned his PhD in 2009. With the BRG and as partner of Ochsendorf DeJong & Bloch (ODB Engineering), he applies his research into practice on the structural assessment of historic monuments and the design and engineering of novel compression structures. He has won numerous awards for his research, has lectured at top universities and leading engineering and architecture offices worldwide, and is regularly invited as an expert consultant.

Foster + Partner's design of the New Mexico City Airport

Andy Coward, Jens Olsson and Martha Tsigkari

Shell design has long been an area of interest at Foster + Partners. The use of in-plane strength and stiffness has allowed efficient and beautiful structures to be built, such as the Great Court roof at the British Museum. The design for the new Mexico City Airport continues this long running theme, posing an array of interesting challenges in terms of scale, complexity, site conditions, structure and planning requirements. Martha Tsigkari, Jens Olsson and Andy Coward from Foster + Partners will talk about the project's background and showcase how specific project challenges were tackled by the use of computational methods. The focus will be on the process of generating the roof geometry, which involves the application of methods such as dynamic relaxation, mesh smoothing and various bespoke geometry-manipulation techniques, all tied together in an parametric workflow. With an 0.5 million square meters footprint, the new international airport in Mexico city is going to be amongst the largest airports in the world, and the roof, the largest continuous roof to date.

Andy Coward

Andy graduated from Cambridge University in 2006, having been sponsored by Faber Maunsell (now AECOM). Spending the subsequent five years with AECOM in UK was considered to be very good training for a career in structural engineering, with exposure to some great projects and innovative designs, e.g. the new Spartak Moscow football stadium. Unusually, every project he worked on went on to be built. He also spent nine months on secondment as a site engineer with Kier London. This was valuable experience which helped him become chartered with ICE in 2010. In 2011, Andy moved to join the new engineering team at Foster + Partners, where he is now an Associate Partner. He describes this as an exciting and challenging role, with a relentless focus on design quality and further exposure to a host of fascinating projects, such as the new Mexico City Airport and the redevelopment of Marseille Vieux Port.



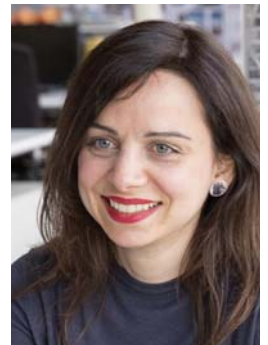
Jens Olsson

Jens is a member of the Applied research and development team at Foster + Partners. He graduated from Chalmers in 2014 with a double degree from the Architecture and Engineering program. He has previously been working with the computational research group at Buro Happold, and specialises in structural analysis, optimisation and complex geometries in the context of architecture and design. He's work ranges from design orientated project work to development of software and workflow automation, the main contribution being the new airport for Mexico city.



Martha Tsigkari

Martha Tsigkari is a Partner and a member of the Applied Research and Development (ARD) group at Foster + Partners. She is a specialist in a wide range of areas including Performance-driven Design and Optimisation, Interfaces & Interaction, Design-to-production and Fast Feedback & Integration. Her work incorporates the development of simulation tools, the introduction of integrated processes and the creation of physical interfaces. She has provided solutions for hundreds of diverse projects such as the new airport for Mexico City, Lusail Iconic Stadium for the 2022 FIFA World Cup, the new metro stations for Jeddah, UAE's 2015 Expo Pavilion, the Sheikh Zayed Museum and YachtPlus Boat Fleet. She is a member of the Royal Institute of British Architects, a tutor at UCL and a juror at AA. She has taught, lectured and published on the subjects of BIM, parametric and algorithmic design internationally.





Beyond-Bending, ArmadilloVault. Photo: Iwan-Baan

Shell Structures

The Structural Design Day, November 21, 2016, Gothenburg

PROGRAMME

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|-------|----------------------------------------------------------------------|------------------------------------------------------------------------------|
| 13:00 | Introduction and welcome | <i>Henriette Söderberg, Chalmers</i> |
| 13:10 | How sustainable are shell structures?
Pros and cons in a nutshell | <i>Holger Wallbaum, Chalmers</i> |
| 13:30 | The equilibrium equations:
How do shell structures stand up? | <i>Dr Chris Williams, Chalmers & University of Bath</i> |
| 14:15 | Novel Shell Structures:
Learning from the Master Builders | <i>Philippe Block, ETH Zurich</i> |
| 15:00 | Coffee | |
| 15:30 | Foster + Partner's design
of the New Mexico City Airport | <i>Andy Coward, Jens Olsson & Martha Tsigkari,
Foster + Partners</i> |
| 16:30 | Questions and conversion | <i>Morten Lund, Chalmers</i> |
| 17:00 | Mingle, light snacks | |



Konstruktionscentrum

The Structural Engineering Centre at Chalmers “Konstruktionscentrum” is the main organizer of the event. The Structural Engineering Centre is a collaboration body that aims at providing a platform for effective and broad interaction between research and education activities performed at the university and industry, primarily in the construction sector. The purpose is to develop and strengthen the theme of structural design. Members of the Structural Engineering Centre are actors in the construction sector and representatives of major stakeholders who, together with Chalmers, share the objectives of developing, supporting and promoting knowledge and skills in this area. This is done by targeted training, research and seminars where participant persons and entities are actively involved in both planning and implementation of the activities in the center.

Program committee

Mohammad Al-Emrani, Civil and Environmental Engineering, Chalmers

Mohammed Hoseini, Public Roads Administration - Norway

Martin Laninge, Brosamverkan

Sören Lindgren, Civil and Environmental Engineering, Chalmers

Morten Lund, Architecture, Chalmers

Karl-Gunnar Olsson, Architecture, Chalmers

Roland Olsson, WSP

Mario Plos, Civil and Environmental Engineering, Chalmers

The seminar will take place at:

RunAn, Chalmersplatsen 1, Kårhuset (Student Union Building). Chalmers, Gothenburg.

Documentation

Available for members after completion of the seminar, www.konstruktionscentrum.chalmers.se

Information

Further information can be obtained from:

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Members of the Structural Engineering Centre:

