TensiNews

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Newsletter of the European based Network for the Design and Realisation of Tensile Structures

RESEARCH

BELTS IN TEXTILE ARCHITECTURE

BENDING-ACTIVE MEMBRANE STRUCTURE

PROJECTS

BC Place Stadium

AN ICONIC LANDMARK

ART meets HIGHTECH

"LEVIATHAN" FOR MONUMENTA 2011

TensiNewsINFO

Editorial Board
John Chilton, Evi Corne, Peter Gosling, Marijke Mollaert, Javier Tejera

Coordination
Marijke Mollaert,
phone: +32 2 629 28 45,
marijke.mollaert@vub.ac.be

Address
Vrije Universiteit Brussel (VUB),
Dept. of Architectural Engineering,
Pleinlaan 2, 1050 Brussels, Belgium
fax: +32 2 629 28 41

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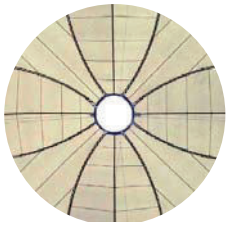


REPORT

MISC

Edito

Looking forward to future TensiNet activities we are happy to launch the next TensiNet Symposium 2013 which will be held in Istanbul (TR) from Wednesday the 8th till Friday the 10th of May 2013. The Symposium with the title [RE]THINKING lightweight structures will cover different topics such as Recent Projects; [RE]Thinking Analysis and Materials; ETFE Applications; Pneumatic Structures and [Closing the Loop] Life Cycle Assessment for Membrane Materials and Structures. The keynote speakers Werner Sobek (DE), Alar Ruutopold (USA) and Jan Cremers (DE) have already confirmed to give a lecture at the event. The call for abstracts will be distributed soon.

The next TensiNet Partner meeting will be organised at Buro Happold on Wednesday 27th of June just before the start of the 2nd International Conference on Flexible Formwork (www.icff2012.co.uk) in Bath (UK). Matthew Birchall (WG Pneumatic Structures) and Jan Cremer (WG Life Cycle Assessment) will have their first Working Group meeting, while Peter Gosling (WG Analysis and Materials) and Marijke Mollaert (WG Specifications Eurocode) will report about the recent progress in their WG discussions. With the Working Group activities we try to establish state of the art documents and hence disseminate progress in material development, technology and calculation methods.

In the current TensiNews issue the mentioned projects range from small canopies or inflatable event covers up to the large sport facilities. The renewal of the membrane to extend the lifespan of a construction has been done in several cases, while the application of inflatable membrane structures is growing.

In the academic institutions interesting research was done. At the Institute of Building Structures and Structural Design (University of Stuttgart, DE) a new type of bending-active membrane structure was developed and realized in collaboration with students from the Hochschule für Technik in Stuttgart. At the Karlsruhe Institute of Technology (DE) a research on "Belts in textile architecture" was finalised. The TensiNet Association is establishing an overview of recently or currently conducted research in the domain of Fabric Architecture performed in Europe, which could be a basis for more active networking in research activities.

The number of members of the TensiNet Association is only slightly varying. We welcome Sefar AG, who is taking over the technical textiles activities from Gore, as a TensiNet Partner! The fact that workshops like Textile Roofs in Berlin (www.textile-roofs.com) and master classes like the Master of Engineering in Membrane Structures in Dessau (www.membranestructures.de), the Postgraduate MEng program Membrane Lightweight Structures in Vienna (cec.tuwien.ac.at/engineering_school/membrane_lightweight_structures) and the first Tensile Architecture Master in Madrid (www.structuralia.com/artx) gain success confirms the increasing interest from architects and engineers in Tensile Surface Structures. Still building on a lightweight future.

Forthcoming Meetings

TensiNet meetings in Bath, UK
Wednesday 27/06/2012

09:00 - 10:00	Partner Meeting (1/2012)
10:00 - 12:00	Working Group Meetings
	Pneumatic Structures - *Matthew Birchall*
	Analysis & Materials - *Peter Gosling*
	Life Cycle Assessment - *Jan Cremers*
	Specifications EUROCODE - *Marijke Mollaert*
12:00 - 12:30	Tour of Offices
12:30	Transport to Bath University icff 2012

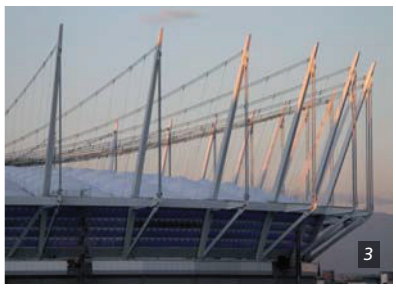
Location: Buro Happold Ltd ,
Camden Mill, 230 Lower Bristol Road, Bath

Forthcoming Events

Textile Roofs 2012 TU Berlin, Germany *14-16/05/2012* **http://textile-roofs.com/** ● *2012 IASS Annual Symposium:* **IASS-APCS 2012** Seoul, Korea *21-24/05/2012* **http://iass2012.org/** ● **ROOF INDIA 2012** Chennai Trade Centre, Chennai, India *25-27/05/2012* **http://www.roofindia.com/** ● *2nd International Conference on Flexible Formwork* **icff 2012** Bath, UK *27- 29/06/2012* **http://people.bath. ac.uk/jjo20/icff/ICFF2012/ Homepage.html** ● **International Textile Conference** Dresden, Germany *29-30/11/2012* **www.aachen-dresden-itc.de** ● **TensiNet Symposium 2013** Istanbul, Turkey *8-10/05/2013* ● *2nd International Conference on Structures and Architecture* **ICSA 2013** Guimarães, Portugal *24-26/07/2013* **http://www.icsa2013.arquitectura.uminho.pt** ● *Annual Symposium: Beyond the Limit of Man* **2013 IASS** Wroclaw, Poland *23-27/09/2013*

CALL for participants for TensiNet Working Group on Life Cycle Assessment

Following an initiative of Prof. Jan Cremers from Hightex, a new working group has been founded which will focus on the subject of Life Cycle Assessment (LCA). The aim of this group is to review the current status on materials and typical membrane structures with regard to LCA issues. As building certification becomes more and more standard this subject will also touch our part of the building sector. The status reached so far is very heterogeneous and inconsistent for the typical materials we use. On the level of structure types, there is hardly any information available so far. The LCA Working Group will identify and describe steps that could be taken within the TensiNet association to achieve a coherent data base to work with. It should also be as open and transparent as possible to gain a maximum of credibility. The idea is to present a kind of road map how to proceed at the next meeting. During the setup in Barcelona (November 2011) and afterwards, there was great interest to cooperate in this working group from different sides. But of course we still invite others to join us. If you are interested, please send an email to Jan Cremers from Hightex: **jan.cremers@hightexworld.com.**



HIGHTEX

BC Place Stadium

Vancouver, British Columbia, Canada

AN ICONIC LANDMARK

Context

"BC Place" in Vancouver Canada was first opened in 1983 as part of the World Expo 1986. The original roof was one of the largest air inflated domes and has become one of Vancouver landmarks. However, after a significant tear in the fabric skin and consequential deflation early January 2007, it became apparent the roof system has approached the end of its life cycle. At this stage it was decided to initiate a major rejuvenation project, which included beside major renovation of all stadium facilities also a new roof and a highly translucent facade.

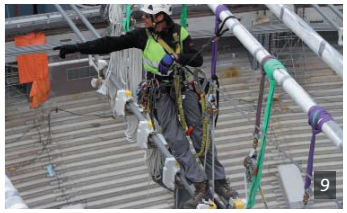
Project

In contrary to most other stadium facilities BC Place hosts throughout the year not only sporting events but also trade fairs and concerts. Therefore the use is predominately a closed facility. One of the design criteria for the roof was that it must be able to carry all the snow loads.

The structural principal of the new roof system was introduced by Schlaich Bergermann and Partners from Stuttgart in Germany and is based on the spoke wheel system. At the perimeter 36 steel masts are placed onto the existing concrete structure. An upper steel compression ring and a secondary lower tension ring of a bundle of endless cables stabilize 36 cable trusses that run into the centre node (Fig. 2 and Fig. 3).

About two third of the roof is a fixed fabric roof of PTFE/Glass membrane with 36 bays spanning between the cable trusses and rest on concentric series of 9 arches. The fixed roof also has a lower mesh fabric membrane.

The centre third of the roof is a retractable fabric roof of 36 inflatable cushions made of PTFE fabric. The cushion design became necessary for the retractable portion of the roof of BC Place to take on the wind and snow loads. At fair weather, the roof can be opened up to 7.500m² of sky.



To retract the roof, large deflation units installed in the centre node extract the air from the cushions. The deflated membrane quilt of 36 cushions, attached to 9 sliding carriages each running along the 36 lower radial cables, is pulled towards the centre. The folded membrane is then parked inside a vertical moving garage. The centre node is 60m above the playing field (Fig. 4 and 5).

To deploy the retractable roof, the membrane quilt is pulled over the glazing skirt at the transition to the fixed roof. The inflation of the cushions to 500Pa then stabilizes the whole roof structure. An additional inflated closure ring at the perimeter of the retractable roof presses against the glazing skirt to seal the fabric roof structure against wind and rain. 72 load sensors on the hanger cables track the snow load on the roof and, at higher loads, trigger increased air pressures of 1000Pa and 2000Pa.

At the perimeter of the stadium between the existing concrete structure and the steel compression ring, a single layered ETFE facade was installed. 4 horizontal frames, each about 20m long and 2m high with 13 vertical arches span between the 36 steel masts. These facade elements are spanned with fritted ETFE foil. All facade elements are fitted with LED light elements between the arches, which can be electronically controlled to the whole spectrum of colours, so the whole facade can be illuminated with astounding light effects.

BC Place Stadium with its prominent steel columns, the retractable roof, and illuminated facade is in many ways the first and very unique of its kind. Since the opening ceremony in September 2011 it has become an iconic landmark for Vancouver and British Columbia.

Seethaler Markus
markus.seethaler@hightexworld.com
Gregor Grunwald
gregor.grunwald@hightexworld.com
www.hightexworld.com

Figure 1-2. BC Place at night
© Grant Mattice
Figure 3. Façade and roof structure
© Grant Mattice
Figure 4. Stadium center node
Figure 5. Retractable roof
Figure 6-9. Installation work
© Hightex GmbH

Name of the project:	BC Place Stadium
Location:	Vancouver, British Columbia, Canada
Year of construction:	2011
Client:	Pavillion Corporation
Architect:	Stantec Architecture Ltd.
Design concept for membrane roof:	Schlaich Bergermann und Partner
Engineer of Record:	Geiger Engineers
Membrane Analysis:	Tensys
Detailed design:	Tony Hogg Design
General Contractor:	PCL Contractors Westcoast
Contractor for the retractable roof membrane and facade:	Hightex Tensile Structures Ltd.
Contractor for the fixed roof:	FabricTec Structures Inc.
Membrane material:	Sefar Tenara
Covered area of retractable roof:	7500m² (double layer)
Membrane material for the fixed roof:	Saint Gobain Sheerfill I
Façade:	Saint Gobain ETFE
Area:	5750m² (single layer)