Research Opportunities for Membrane Structures

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Abstract

After working over 50 years in the field of membrane structures, first at the University of Stuttgart and influenced widely by Frei Otto, and then as founder of the Labor Blum it is time to figure out what we are missing in the field of Membrane Structures and what the market will ask for.
We will start with the properties of materials: Here the failure modes and the long term strength of most common membrane materials as PVC coated polyester fabrics, PTFE-coated glass fiber fabrics, ETFE foils are presented and discussed. The test methods are shown and analyzed. From this we can establish development lines. The role of the elastic moduli and their determination will be mentioned. Microscopic pictures of the coating of materials after 20 years of use illustrate the importance of the coating and its behavior under the influence of the ambient. Thus the improvement of material starts with the improvement of the coating.
The building physics of membrane materials and membrane structures, especially the energy saving properties, will be discussed widely. The importance of radiation energy transfer will be shown, solutions are presented. A new developed air bubble film is presented, together with lab test and its application on a new sports hall in Bavaria. This material has a very high insulation value with respect to infrared radiation and is to some extent translucent for the visible light. The energy consumption over a defined time interval can be simulated by the software "Textile Climate". This software distinguishes between "cooling energy" and "heating energy".
The details of membrane structures are presented. The load introducing behavior of highly anisotropic materials will be shown, together with the consequences on the design of details as corner plates and cable edges. New designs of details are proposed.
In this context a method of welding a PVC-coated PES-Fabric to stainless steel is presented. The idea of continuous welding and its advantages arises here too.
At the end we will discuss design, analysis, confection, transport with packing and unpacking and erection. All these single steps will be analyzed together, since a smooth cooperation is the guaranty for a working structure. Here the integration of all information into the "formfinder" software is discussed.

References

/1/ H. D. Baehr, K. Stephan: *Wärme- und Stoffübertragung*, Berlin, Heidelberg, New York 2004

/2/ Blum, R., Bögner-Balz, H., Stegmaier, Th., Schneider, P., Vohrer, A., Planck: *Developing and testing textiles, coatings and connections for buildings and constructions, in: Textiles for Construction*, Woodhead, 2010

/3/ Bögner-Balz, H., Blum, R., Reimann, K.: *The Stress-Strain-Behaviour for Coated Orthotropic Fabrics and its Influence on the Analysis of prestressed Membranes*, an Approach, IASS 2011

/4/ R. Blum: *Zur Beschichtung von Materialien für das Textile Bauen*, Vortrag beim SKZ Würzburg 2012

/5/ Bögner-Balz, H., Blum, R., Köhnlein, J.: *Structural behaviour of fabrics and coatings for architectural fabric structures*, in: Fabric Structures in Architecture, Woodhead, 2015

/6/ Blum, R., Bögner-Balz, H., Köhnlein, J.: *On the mechanical behaviour of ETFE-films: Elastic range, yielding conditions, break determined by different test methods and the influence of the results on the analysis of ETFE-structures*, Tensinet Symposium Newcastle 2016

/7/ K. Reimann, R. Blum: *Handbook of the Software Package "Textile Climate" to simulate the energy transfer through thin films and the energy consumption for membrane buildings*, Stuttgart 2018

/8/ R. Blum: *Master Course for Membrane Structures, Module Building Physics*, Donau-Universität-Krems 2018