How to fulfil increasingly demanding technical specifications for membrane structures

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Abstract

When tensile structures became more and more popular in the 90th, designers and proof engineers had just limited knowhow about verifiable calculations and comparative structural analysis of textile structures. Until today no design code for membrane structures and relevant materials is existing in its entirety. However, over the past 20 years several designers and specialized consulting engineers have gained lots of theoretical knowhow about membrane structures, materials and testing procedures which they incorporate in the design and technical specifications. Further, at the same time membrane applications became more sophisticated and demanding.

Without any doubt the developments in the past years lead to many fantastic architectures textile applications. Nevertheless, on the one hand it is architecturally a significant positive evolution for building-owners and users with better technical transparency and risk minimization for high tensile structures. On the other hand the realization of such structures becomes more and more critical for construction companies as specified technical demands are extremely difficult to be fulfilled in reality.

Until today several design guides for membrane structures have been developed in various countries, in particular in Europe, North America and Japan. In Europe the most widely used guide is the “European Design Guide for Tensile Surface Structures”, which is a comprehensive guide on how to test and proof membrane structures. However, this guide in several design and testing aspects only gives recommendations and therefore leaves room for interpretation.

Sophisticated membrane structures are challenging architects, designers and constructors to go to the limits of membrane material properties. More and more often well-known standard materials do not fulfil desired properties and new materials have to be developed. Especially when it comes to new or non-standard membrane materials, which may result from material modifications or completely new material developments, material properties and behaviours are not sufficiently available. As a consequence more material tests, more stringent material production control and higher factors of safety are required. Combining all those parameters and considering that design guides preferentially give design recommendations, it is understandable that in such cases a relatively broad range of design approach is possible. This may lead to opposed discussions between designers and construction companies in order to find a reasonable and realistic project realisation process.

Taking the world highest membrane façade of Thyssenkrupp’s Test Tower in Rottweil and the new material developments for the Al Bayt Stadium in Qatar as an example, we will illustrate the limits and challenges for both, designers and executive construction companies likewise.

References

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