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Aspects of the Material Performance of ETFE in Tensile Membrane Structures

Abstract

Due to damage caused by a massive hailstorm the foil cushions of the first roof that has ever been built by applying ETFE film technology for a building cladding system had to be exchanged. Samples taken from the foil cushions of that roof for the first time allowed for a comparison of ETFE samples that have been exposed to environmental stress, mechanical stress in particular, for more than 25 years with samples from the archive as well as with samples from current production [1].

The analysis of the chemical structure of new and aged ETFE film samples by means of Raman Spectroscopy did not allow to identify any difference regarding the chemical structure.

Mono-axial tests did show an enhanced stiffness at 10% elongation for ETFE samples that have been exposed to outside weathering under mechanical stress also. In order to better understand the ageing behaviour a procedure for the accelerated simulation of mechanical ageing by means of cyclic bi-axial tensile tests has been developed. This procedure has been applied on new ETFE foil samples as well as on the aged samples from two projects. The enhanced stiffness of the samples from the projects could be verified. The artificial simulation of the ageing performance by application of the hysteresis test procedure allowed for perfect accelerated replication of the mechanical ageing performance of ETFE foils. Over and above, the rate of elastic and plastic deformation could be derived as well as the E-modulus under bi-axial load distribution between 15 MPa and 26 MPa.

The analysis of the mechanical performance of ETFE foils even under planar bi-axial loads allow for characterisation of the basic mechanical properties of ETFE foils. Thus, the long-term performance of ETFE systems can be predicted.

[1] Maywald, Carl; Mißfeld, M., Zum Alterungsverhalten von ETFE-Konstruktionen in der Architektur, Wiley Press / Ernst & Sohn., Stahlbau 87 Vol. 7, Berlin, July 2018