

Strength values of ETFE-foils correlated to limited residual strains

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Abstract

In uniaxial tensile tests, ETFE foils exhibit two yield points where the stiffness changes. They are correlated to different residual strains after unloading. But as unloading is usually not carried out in uniaxial tensile tests, the residual strain after unloading is usually unknown. However, ensuring an appropriate limitation of residual strain after unloading is crucial for the design of utilizable structures to avoid plastifications in the material. Nowadays, the various existing design concepts used in practice are based on different definitions of the yield points. Herein, the residual strain after unloading is not considered at all. Moreover, in biaxial tensile tests, ETFE foils show a different stress-strain behaviour with only one yield point. Considering that ETFE foil structures usually exhibit biaxial stress states, the design is highly recommended to be based on the biaxial mechanical behaviour of the material.

In this contribution, experimental investigations into the uni- and biaxial tensile behaviour of ETFE-foils are presented considering load ratios of 1:1 and 2:1 for the biaxial tensile tests. The tests have been carried out up to certain load levels with subsequent unloading and measuring of the resulting residual strains. The objective was to determine load levels and thus strength and stiffness values which correlate to a limited spontaneous residual strain, e. g. 0.2 % as an oftentimes recommended value, see e. g. [1, 2]. A statistical evaluation considering the scatter has been carried out and compared to those achieved for other typical design properties, e. g. 10 %-strain-stress. Because of the viscoelastic material behaviour of ETFE-foils, the spontaneous 0.2 % residual strain decreases as time elapses. Thus, it can be shown that with stressless time passing, the actual residual strain decreases to values below 0.2 %. The achieved knowledge will strengthen the fundament for defining an appropriate design concept for ETFE-foil structures as an objective of the current development of the Technical Specification for Membrane Structures.

References

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