On time- and temperature-dependent material behaviour of ethylene-tetrafluoroethylene foils in building construction

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ABSTRACT

Ethylene tetrafluoroethylene (ETFE) foils exhibit a non-linear viscoelastic material behaviour. For the dimensioning of safe and durable structures made of ETFE foils it is necessary to take this material response into account regarding single-layer, mechanically prestressed and multi-layer, pneumatically prestressed constructions.

Systematic and comprehensive investigations with respect to the time-dependent material behaviour have not been published to date. For individual, more project-specific data, please refer to [2], [3], [4].

In order to investigate the time-dependent material behaviour of ETFE foils under permanent loads (retardation, creep), permanent load and load repetition tests were carried out in the form of uniaxial tensile tests. The non-linear influence of the load on the time-dependent material behaviour was investigated by performing tests under four different stress levels, each combined with the influence of a constant temperature by means of three test temperatures. The experimental investigations aiming at the long-term behaviour of the ETFE foils with test durations between 1200 h and 4000 h were supplemented and completed by tests under anisothermal, natural climate. These continuous load tests were performed for approximately 8 years.

For the description of the material response, a rheological model is proposed. This model is based on Burgers' model, which, for the purpose of this study, was enhanced by additional model parameters to take into account the stress level and the temperature. The comparison of the experimental and the projected strain-time-curves proves the model's applicability for describing isothermal continuous load tests.

All of the model's parameters can be derived directly on ETFE foils via isothermal short-time tensile and continuous load testing, which makes for the practical applicability of the model. Moreover, using a modified superposition principle, the proposed material model serves to describe continuous, non-constant stress curves under constant temperatures. Modelling of strains determined in isothermal load repetition tests is successful qualitatively and, for practical use, sufficient in terms of quantity.

The influence of non-isothermal natural climatic conditions on time-dependent material behaviour was investigated in multiannual continuous load tests for Ethylene tetrafluoroethylene (ETFE) foils. The equivalent temperature derived from these tests can be used as a basis for the determination of component temperatures in static analysis.

REFERENCES

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