Using creep models to assess structural behavior of flat-patterned ETFE cushion structures

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Abstract

ETFE buildings with excellent aesthetics, high light transmittance and active control have attracted considerable attention in Olympic Games and World EXPO as stadiums and exhibitions [1]. The form-finding and cutting pattern of conventional ETFE structures need complex theory and special techniques. The flat-patterned ETFE cushions can facilitate form-finding and structural analysis due to easy operations and hardening effects [2]. To address this topic and provide a convenient methodology for achieving these aims, an alternative approach is proposed in relation with time-temperature superposition effects of polymer materials [3]. This method in terms of small inner pressure but high temperature is relatively easy compared with available methods at room temperatures.

In this paper, creep experiments at high temperature (60 ^{o}C) for ETFE materials are carried out. A corresponding creep model based on modified time hardening theory is developed, where the parameters are fitted with true strain results. A piecewise creep function with a reduction factor for biaxial effects is then utilized to simulate structural behavior of flat-patterned ETFE cushions in the form-finding process. The related stress and strain are obtained under different pressures. In this case, the form and force characteristics of ETFE structures are revealed, which therefore contributes to understanding building and structural performance.

In the near future, a prototype in accordance with numerical simulations is under preparation and associated experiments will be carried out to validate the observations and findings.

References

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