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Test method

# Assessment of the stepped isostress method in the prediction of long term creep of thermoplastics

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ABSTRACT

To predict long term creep of thermoplastics, methods based on the time–temperature superposition principle (TTSP) or on the time–stress superposition principle (TSSP) are commonly used. These methods enable the construction of a creep master curve without a lengthy experimental program. Recently, a new accelerated creep testing method, termed the stepped isostress method (SSM), was proposed and used to predict long term creep of technical yarns. This paper focuses on the processing aspects of the SSM test data and its validity in the creep prediction of thick thermoplastic specimens. Excellent correlation is obtained between the master curves constructed by the classical TSSP method and those constructed by the SSM method. The variation of the SSM testing parameters has no significant effect on the obtained master curves, which constitutes proof of the SSM robustness. Further, the trend of the SSM shift factors in terms of the creep stress obeys the Eyring equation.



## 1. Introduction

Thermoplastics materials are widely used in structural components subjected to high load levels. Because of the weak cohesion between the molecules of the thermoplastic polymers, those materials allow sliding of the polymer segments and exhibit significant viscoelastic behavior, even at ambient temperatures and under moderate stress levels. Furthermore, an increase in the operating temperature or in the stress level quickly brings on nonlinear viscoelastic behavior.

A creep test is conducted in order to characterize the tendency of the material to deform permanently under constant loading. The rate of the creep deformation is a function of material properties, exposure time, exposure temperature and applied loads. The risk over time rises when the creep deformation becomes large enough to exceed the design limit for an in-service part. In order to predict the long-term material creep, the testing needed may require extensive laboratory time. The application of time–temperature or stress–temperature superposition principals provides the capability to predict the long-term material performance very much beyond the creep test period.

### 1.1. Time–temperature superposition principle

Leaderman [1] was among the first to emphasize that a portion of the creep curve obtained at temperature $T_r$ is identical to a creep curve obtained at temperature $T_i$, if all the time values at $T_i$ are multiplied by a constant factor. This means that the creep curves plotted versus log time at $T_i$ temperatures are identical to a corresponding portion of a

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