Engineering Risk Analysis Group
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MSc thesis

# Statistical Methods for Parameter Identification of Temperature Dependent Viscoelastic Models

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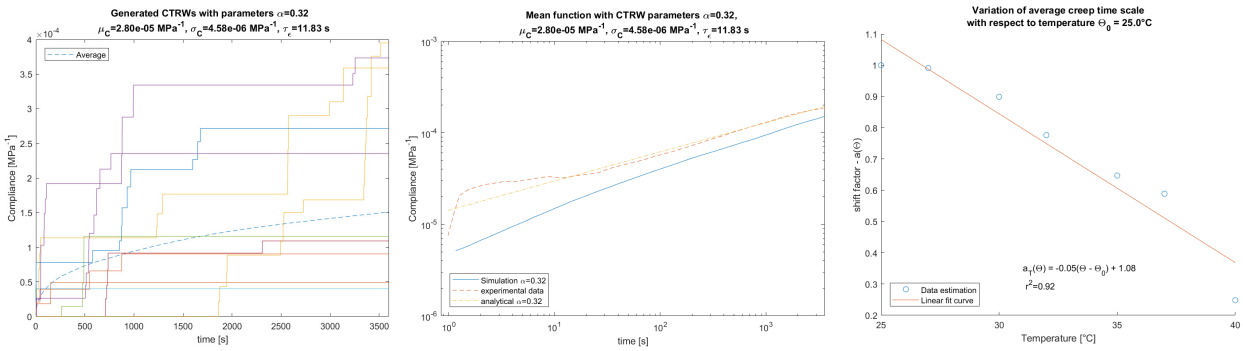
## Background

Modelling linear viscoelastic materials in the time domain requires to consider creep and relaxation processes. Both can be modelled by fractional constitutive equations, which have the advantage of representing complex idealizations of springs and dashpots with few parameters, and the response is described by power-law functions. Additionally, fractional operators describe Continuous Time Random Walks (CTRW) with long waiting times, which also present a power-law mean function. As consequence, CTRW parameters can describe the interactions between material fibers and entanglements, as well as thermal effects.




*Left: Realizations of CTRWs and their average function. Middle: Simulated average function compared with experimental data. Right: Dependency between creep time scale and temperature.*

*CTRW Parameters: α: stability parameter. $\mu_C$ : mean jump compliance. $\sigma_C$: compliance jump variance. $\tau_\varepsilon$: creep time scale*

## Methodology

A creep test was simulated in MATLAB by averaging realizations of a CTRW with alpha-stable waiting time distribution. The sample of realizations was generated by Monte Carlo Simulation. Validation was performed by estimating parameters (time scale, jump compliance mean and standard deviation) from experimental creep-recovery tests applied to specimens of epoxy resin (SX8 EVO) at different temperatures between 25℃ and 40℃.

## Results

Simulated results approach asymptotically to experimental data, both following a power-law increase during the creep phase. Average parameter values decrease with higher temperatures, meaning that changes of mechanical properties at microscopic scale occur more often. Additionally, it was observed that standard deviations of parameters estimators increase when temperature rises and approaches to the glass transition point.

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