Variable-Order Fractional Dynamic Behavior of Viscoelastic Damping Material

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Abstract

Viscoelastic damping material has been widely used in engineering machinery to absorb vibration and noise. In engineering, the dynamic behavior of the viscoelastic material is mainly affected by temperature and frequency. Classical dynamic behavior equations of the viscoelastic damping material have complex structures with multiple and ambiguous parameters. So a novel variable-order fractional constitutive model (VOFC) is established based on the variable-order fractional operator. Then the viscoelastic dynamic equations are derived by the Laplace transform of the VOFC model. The DMA test by the three-point bending mode is carried out at variable temperatures and frequencies and the frequency spectrum of the dynamic behaviors, i.e., the loss modulus, the storage modulus and the loss factor are obtained. Against the test data ,the VOFC model is compared with classical models such as the integer-order Maxwell model (IOM), the constant fractional-order Kelvin-Voigt model (CFK), the constant fractional-order Maxwell model (CFM) and the constant fractional-order standard linear solid model (CFS). Through the comparison , it can be found that the VOFC model can describe dynamic behaviors of the viscoelastic damping material at different temperatures and frequencies more accurately. Furthermore, the VOFC model has simpler structure and only two parameters with clearly-physical meanings.

Full Text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures

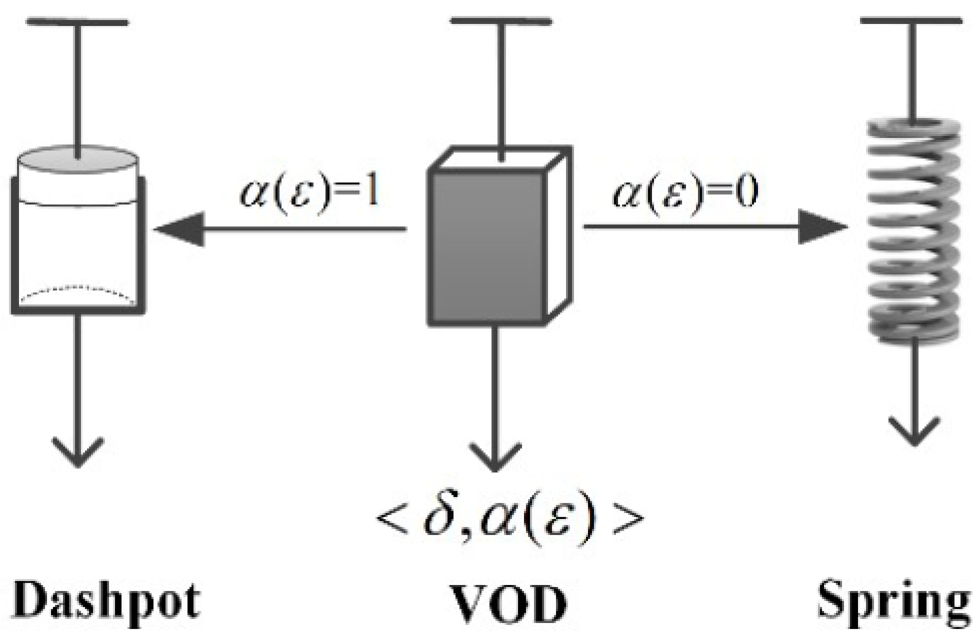

Figure 1

VOFC model

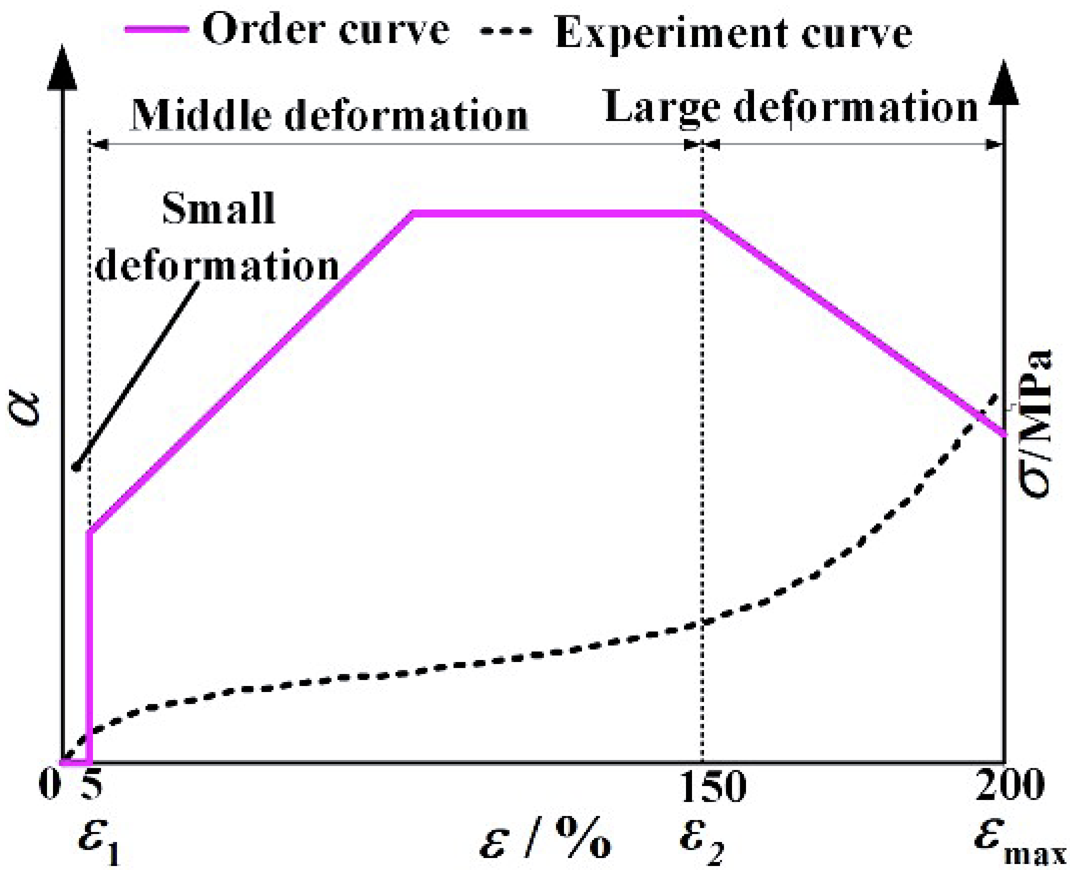

Figure 2

Constitutive behavior

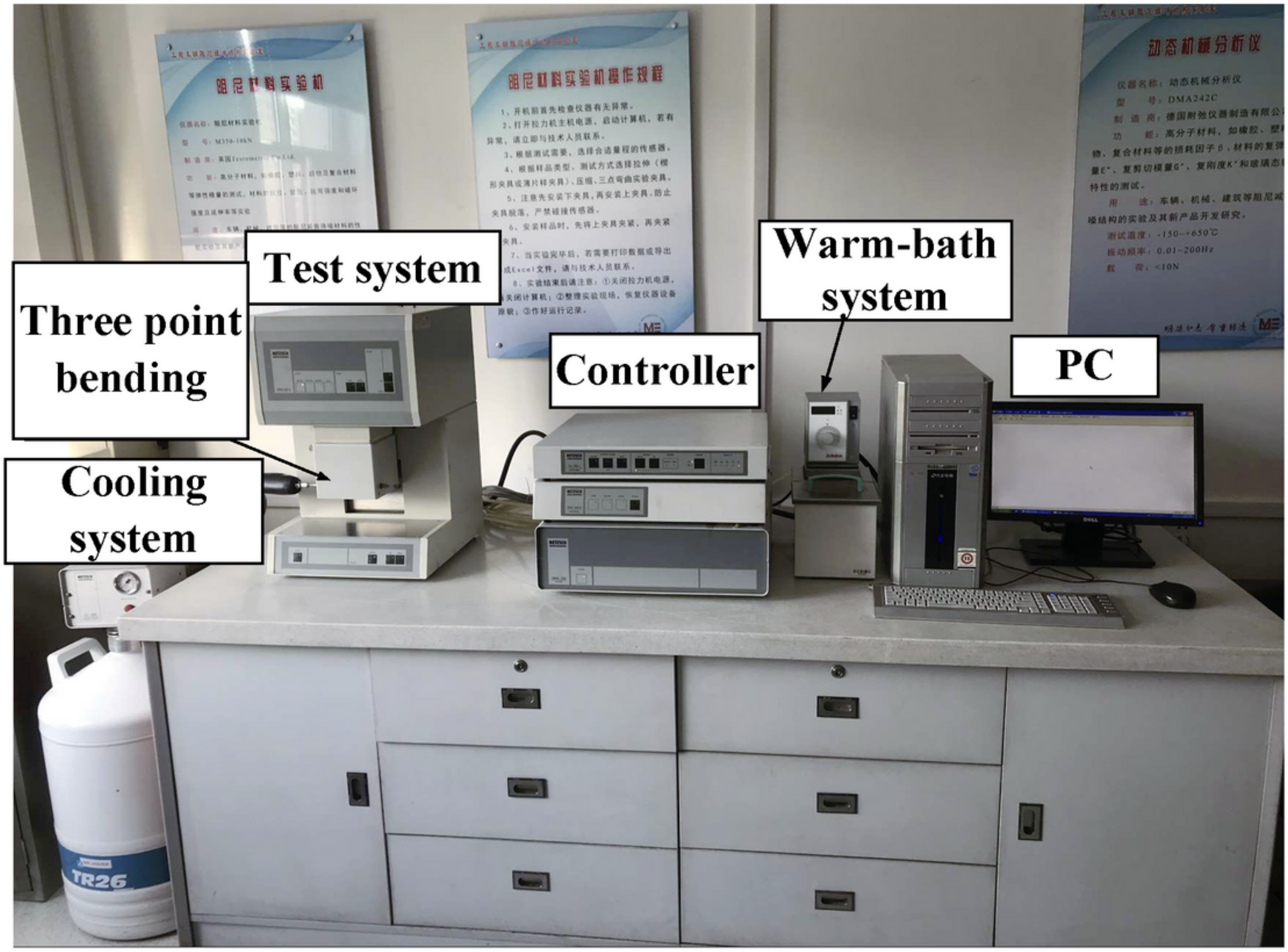

Figure 3

DMA 242C

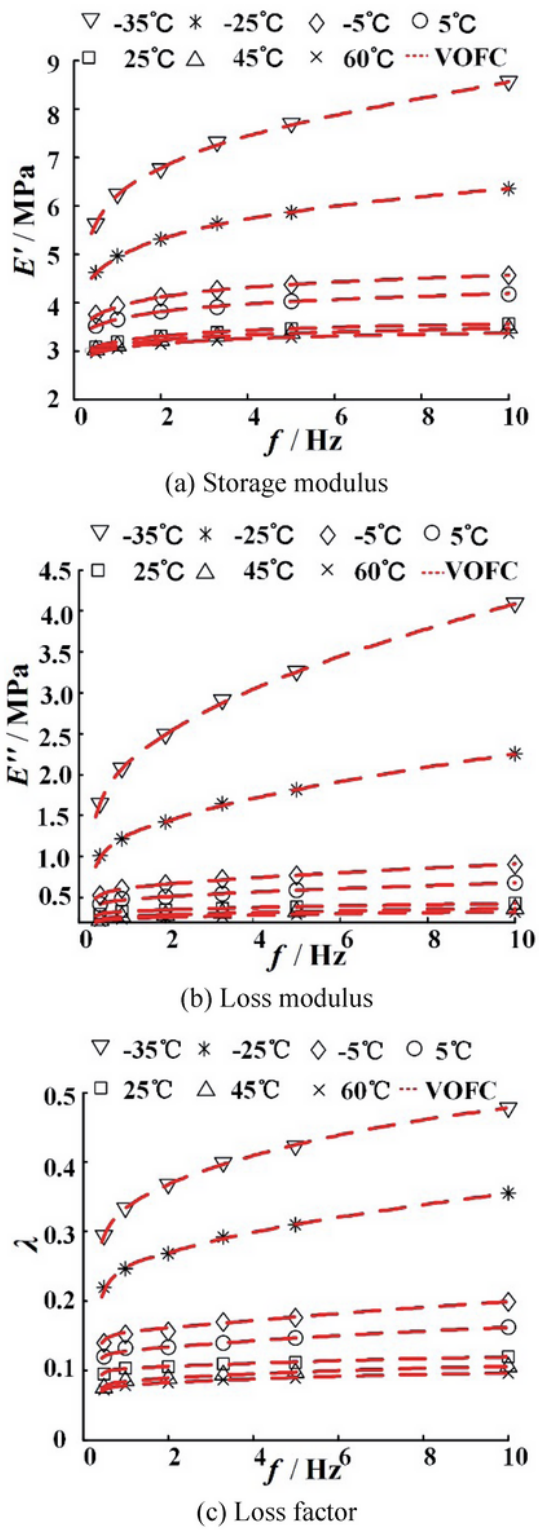

Figure 4

Frequency spectrum

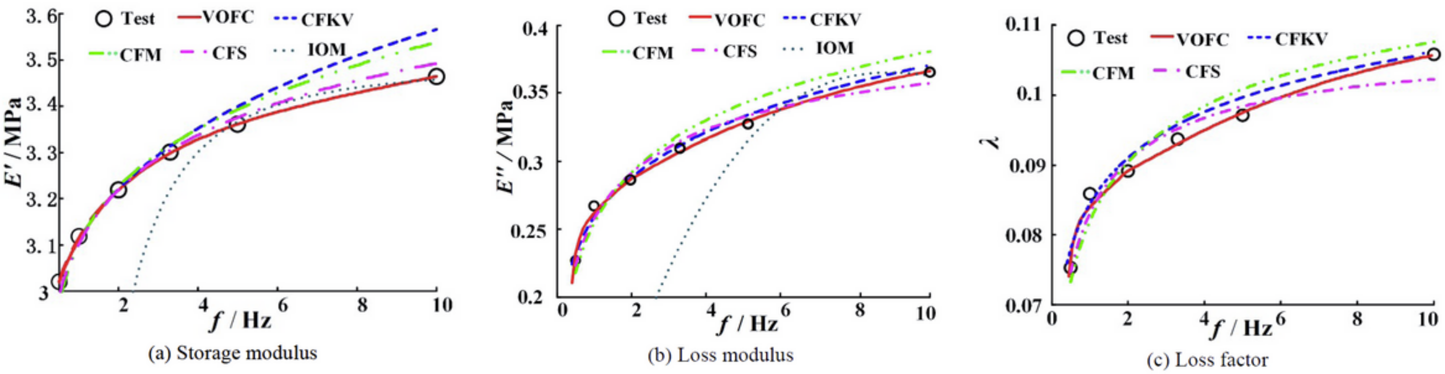

Figure 5

Comparisons of the theoretical models