Abstract

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Measurement of Dynamic Properties of Viscoelastic Materials, Experimental Mechanics

An improved method to measure the dynamic viscoelastic properties of elastomers is proposed. The method is based on the analysis of forced oscillation of a cylindrical sample loaded with an inertial mass. No special equipment instrumentation other than the ordinary vibration measurement apparatus is required. Upper and lower surfaces of the viscoelastic material sample were bonded to a load disc and a rigid base plate, respectively. The rigid base plate was subject to forced oscillations driven by a vibration exciter. Two accelerometers were attached to monitor the displacement of the base plate and the load disc. The recorded magnitude ratio and the phase difference between the load disc and the base plate vibrations represent the axial, dynamic deformation of the sample. The data are sufficient to obtain the dynamic properties of the sample, oscillation properties of vibration exciter, whereas the sensitivity of gauges having no effect on the calculation results. For accurate calculation of the properties, a two-dimensional numerical model of cylindrical sample deformation was used. Therefore, a form factor, which takes into account the sample sizes in one-dimensional models, is not required in this method. Typical measurement of the viscoelastic properties of a silicone rubber Silastic® S2 were measured over the frequency range from 10 Hz to 3 kHz under deformations (ratio of vibration magnitude to sample thickness) from 10?4% to 5%. It was shown that the modulus of elasticity and the loss tangent fall on a single curve when the ratio of load mass to sample mass changed from 1 to 20. When the sample diameter was varied from 8 to 40 mm, the modulus of elasticity fall on the same curve, but the loss tangent curves showed some degree of scatter. Studied temperature dependence and nonlinear behavior of viscoelastic properties is found not to be associated with this effect.