Modeling and characterization of suspension bushings using fractional derivatives

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Modeling of elastomers is necessary for vehicle dynamics. Classical elastomer models are high dimensional, have many parameters, and require extensive experimental characterization. Elastomers exhibit frequency-dependent material characteristics. To reduce the required number of model parameters while retaining a fair description of viscoelastic materials' frequency dependence a fractional order model was initially proposed by Bagley [1]. Moreover these elastomers exhibit constant phase over significant frequency ranges. The constant-phase aspect has recently gained popularity through fractional order models [2, 3]. Such models follow a power law behavior, often have good accuracy with few fitting parameters, and can be incorporated in commercial code like MD-Adams [4]. With this motivation, we have experimentally studied the frequency dependent behavior of four different commercially available suspension bushings (see Figure 1).

Figure 1: Suspension bushings used for experimental study.

A sinosuidally varying displacement amplitude was applied on these bushings using an MTS 370.10 elastomer test-rig[1] (see Figure 2 (left)). The frequency was varied from $\approx 1 - 30$ Hz.

The phase angle was found to be near-constant for all four bushings in the frequency range studied (see Figure 2 (right)), and a suitable fractional order model was thereby developed.

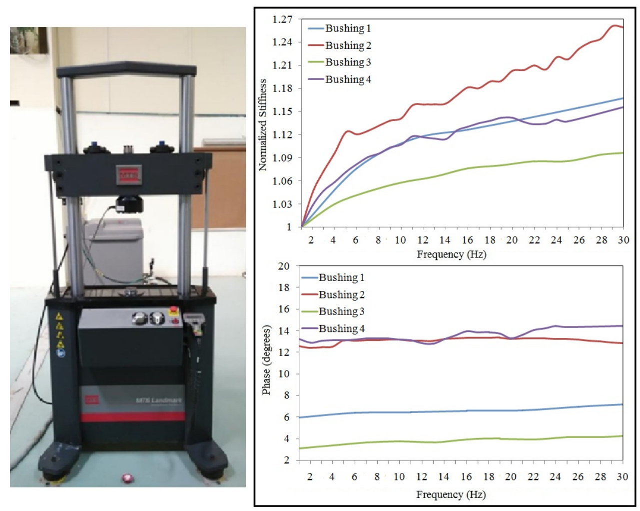

Figure 2: Left: MTS 370.10 elastomer test-rig (Image Source: NATRiP, Indore). Right: Normalized stiffness and phase versus frequency characteristics of four different suspension bushings.

References

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