Journal of Engineering Mechanics
Volume 125, Issue 8, 1999, Pages 956-963

Dynamics of SDOF systems with nonlinear viscous damping

Terenzi, G.
Dept. of Civ. Engrg, Facu. of Engrg, Florence Univ., 50139 Florence, Italy

Abstract

The effects of nonlinear viscous damping on the dynamic response of single-degree-of-freedom (SDOF) structural systems are analyzed. This kind of damping characterizes a special class of fluid viscous dampers recently utilized in the field of vibration control as base-isolation devices or viscoelastic elements included in steel braces of framed structures. The analytical relationship adopted to reproduce the mechanical behavior of the fluid viscous dampers is a fractional power-law of the velocity, the exponent of which ranges between 0.1 and 0.2. This function had been previously calibrated on the results of a special experimental survey carried out at the University of Florence. The dynamics of the classical linear-viscous SDOF oscillator is herein reformulated on the basis of the above-mentioned fractional viscous damping (FrVD) relationship. In particular, the transient and steady-state responses are examined in both free and forced vibration conditions. The magnification and transmissibility factors are analytically determined for different damping levels. Moreover, the relation between the viscous damping coefficient and the frequency ratio (i.e., the ratio of the dynamic load to the oscillator frequencies) is defined. The diagrams describing these functions provide direct correlations between the damping as well as the elastic properties of the system and the frequency content of the dynamic action. © ASCE.