ABSTRACT

Viscoelastic materials (VEMs) are commonly used as passive vibration control devices in mechanical systems due to their inherent damping characteristics. These are commonly applied on the surface of the structure to enhance its damping characteristics. The dynamic properties of the viscoelastic layer considerably impact on the dynamic behaviour of such structures. These properties are highly sensitive to the loading time and frequency of the vibration. To quantify the precise damping of the viscoelastic structure, it is necessary to capture the experimental dynamic properties of VEMs using suitable mechanical models. Classical mechanical models (based on the integer-order derivative) are ineffective in replicating the experimental behaviour, both in the time-domain and in the frequency-domain. Therefore, it is difficult to quantify the accurate damping of the system using classical models. In other words, classical models are unable to capture their real-life behaviour. However, basic fractional mechanical models (based on fractional-order derivative) can effectively capture the experimental power-law behaviour over a wide range of frequencies using a few model parameters. The fractional models are used in the modelling of the basic viscoelastic structural elements like beams and plates. The excitation load is considered as the moving load to represent a broad range of real-life applications. The effects of the fractional order of derivative on the free and forced vibration results of such structures are analysed. It is seen that the integer-order derivative-based mechanical model overestimates the damping of the system and underestimates the dynamic deflection and associated stresses. Further, this thesis studies the dynamics of structure-viscoelastic foundation interaction subjected to moving load to understand the dynamics of the railway tracks, roadways, floating airport etc. The effects of the order of derivative, foundation parameters and speed of the moving load on the dynamic behaviour of the structures are quantified. Finally, an efficient identification technique is proposed to evaluate the fractional Kelvin-Voigt model parameters from experimental data of commercial VEMs. Transient responses of viscoelastic structures (modelled using the classical and fractional model parameters) are investigated and compared, to demonstrate the adverse consequences of unknowingly using the classical Kelvin-Voigt model.

***Keywords*:** Beam vibration, Plate vibration, Fractional viscoelastic models, Fractional damping, Moving load, Dynamic Amplification Factor.