Suppression of the Sommerfed Effect on a cantilever beam through a viscoelastic dynamic neutralizer

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Abstract. Passive vibration control is extremely useful when it is necessary to reduce the vibration levels of mechanical systemsFor this purpose, the use of Viscoelastic Dynamic Neutralizers (DVN) is efficient, even for the broadband control of vibrations, due to their high damping factors. The Sommerfeld effect was observed during experiments on a cantilever beam excited by an unbalanced DC motor. The phenomenon was characterized both in the time domain, through the system responses, and in the Wavelet domain, through the Wavelet synchrosqueezed transform. This paper proposes the use of an optimal VDN to suppress the occurrence of the Sommerfeld effect. The experimental results obtained with the VDN coupled to the system show that the phenomenon has been controlled.

Introduction

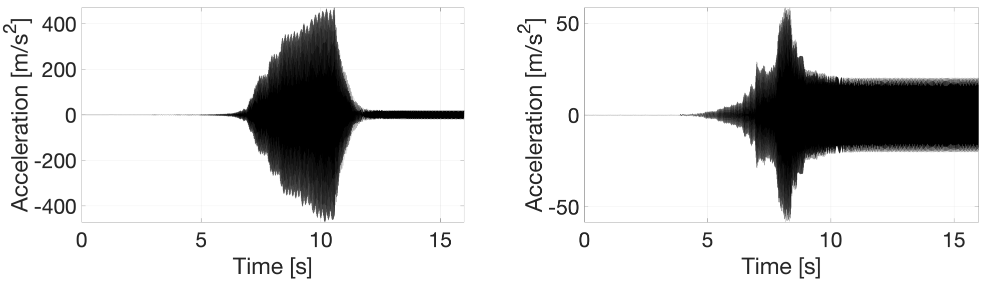
Several efforts are made in order to generate more efficient methods for vibration control. In this sense, several studies have addressed the use of viscoelastic materials for viscoelastic dynamic neutralizers (VDN), whichhave presented excellent results in broadband passive control of vibrations [1].

The Sommerfeld effect occurs in non-stationary operations, when a power source does not have enough energy to overcome the natural frequencies of the system. This phenomenon can be identified experimentally due to sudden reductions in the vibration amplitude of the system or through the Wavelet Transform techniques [2].

The design of one or more VDNs can be easily accomplished, as long as the primary system and the material to be used are fully known. In [1] was presented a methodology for the optimal design of VDNs for systems with multiple degrees of freedom, based only on their modal parameters: modal matrix, modal damping and spectral matrix.

Results and discussion

Experiments were carried out on a cantilever beam with a DC motor coupled to its free end. The motor was manually controlled using a DC power supply and was designed an optimum pendulum type VDN to control the Sommerfeld Effect. The results obtained with and without the VDN coupled to the primary system are shown in Figure 1.



(a) (b)

Figure 1: Experimental results: 1a Acceleration response of the system without passive control and 1b Acceleration response of the system with passive control.

Figure 1a shows the high amplitude of the system's response and the Sommerfeld Effect can be clearly seen due to the abrupt amplitude reduction. In Figure 1b, with the VDN coupled to the system, a lower response amplitude is observed in addition to no sudden amplitude changes.

The results show that VDN's are excellent devices for the passive control of large amplitudes of vibrations.In the proposed approach, it is shown that the Sommerfeld Effect is completely supressed through the proposed technique.

References

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[2] Varanis, M., Balthazar, J. M., Silva, A., Mereles, A. G., Pederiva, R. (2019). Remarks on the Sommerfeld effect characterization in the wavelet domain. Journal of Vibration and Control, 25(1), 98–108.