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Experimental Investigation of Beams Having Spring Mass Resonators

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Abstract : A flexural beam carrying elastically mounted concentrated masses, such as engines, motors, oscillators, or vibration absorbers, is often encountered in mechanical, civil, and aeronautical engineering domains. To prevent resonance conditions, the designers must predict the natural frequencies of such a constrained beam system. This paper investigates experimental and analytical studies on vibration suppression in a cantilever beam with a tip mass with the help of spring-mass to achieve local resonance conditions. The system consists of a 3D printed polylactic acid (PLA) beam screwed at the base plate of the shaker system. The top of the free end is connected by an accelerometer which also acts as a tip mass. A spring and a mass are attached at the bottom to replicate the mechanism of the spring-mass resonator. The Fast Fourier Transform (FFT) algorithm converts time acceleration plots into frequency amplitude plots from which transmittance is calculated as a function of the excitation frequency. The mathematical formulation is based on the transfer matrix method, and the governing differential equations are based on Euler Bernoulli's beam theory. The experimental results are successfully validated with the analytical results, providing us essential confidence in our proposed methodology. The beam spring-mass system is then converted to an equivalent two-degree of freedom system, from which frequency response function is obtained. The H2 optimization technique is also used to obtain the closed-form expression of optimum spring stiffness, which shows the influence of spring stiffness on the system's natural frequency and vibration response.

Keywords : euler bernoulli beam theory, fast fourier transform, natural frequencies, polylactic acid, transmittance, vibration absorbers
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