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Analytical vibroacoustic modeling of an elastic Rayleigh beam using Green's function

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Abstract

The purpose of this article is to provide an analytical model of the vibroacoustic for an elastic beam submerged in low subsonic flows with mean velocities. In general, vibroacoustic modeling refers to the combined effects of sound propagation and mechanical vibration of the structure. Sound radiations from submerged structures are coupled with physical phenomena because the sound pressures acting on structure surfaces and the dynamic responses of structures will impact each other. The Rayleigh Theory has been used to derive the beam vibration equations, and Green's functions are used to find the response of vibrations and the propagation of sound waves from the elastic beam. Initially, we solve the differential equation governing the Rayleigh beam under harmonic load. Then, the sound wave propagation equation around the beam is solved. The solution of the vibration and sound propagation differential equations must be done in the form of couplings so that at first distinct Green's function is obtained for each of the differential equations, and then by combining these two Green's functions, a coupled response function is found to solve the problem. Further, the vibroacoustic response of the beam was obtained by applying the boundary conditions at the interface between the beam and the fluid. In order to evaluate the process of analysis and validation, the results are compared with the results of other researchers and a good match between the results is observed; then, the effects of fluid velocity and useful parameters on the sound field have been investigated.

Keywords: Rayleigh beam, Wave propagation, Vibroacoustic, Green's function.

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