Vortex-Induced Vibration Structural Response Under Parametric Excitation

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ABSTRACT

A model for calculating response associated with vortex-induced vibrations of a cylinder is proposed. The model considers the periodic wake as a nonlinear oscillator interacting nonlinearly with the body oscillator. For studying structural response, parametric excitation is taken as the driving mechanism. The nonlinear stiffness considered in the model arises out of the vortex-structure interaction and the nonlinear fluid damping is due to higher-order fluctuations. This model represents the mechanism of vortex-induced vibration that includes lock-in motion over a bandwidth, zones of instability for various frequency ratios, phase jump and hysteresis in structural response.

Mathematical analysis of the model shows that there are two distinct levels of response. A significant phase jump during the mode transition is also observed. The study for structural response shows a hysteretic behavior at both ends of the lock-in zone due to parametric excitation and high amplitude nonlinear damping resembling experimentally observed free vortex-induced vibrations of cylinders. This study suggests that the structural response due to vortex-induced vibration is nonlinear and parametric.