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Multi-frequency lift forces from vortex shedding behind an oscillating cylinder JASON DAHL, FRANZ HOVER, MICHAEL TRIANTAFYLLOU, MIT — Vortex shedding in the wake of a flexibly mounted circular cylinder results in hydrodynamic forces that affect the fatigue life of long cylindrical structures such as cables, risers, and pipelines. Restricting the cylinder to cross-flow vibrations results in forces typically modeled as single frequency sinusoids. We show that this model does not hold when the cylinder is allowed to vibrate in two degrees of freedom (in-line and transverse to the flow). Free vibration motions are replicated in a small towing tank by forcing a cylinder to move in two degrees of freedom with equivalent kinematics to measured free vibrations. Through quantitative flow visualizations and force measurements, we show that over one cycle of transverse free vibration, the relative motion of shed vortices with respect to the cylinder results in large amplitude, multi-frequency harmonic lift forces. The higher harmonics in lift are shown to be enhanced by the in-line motions of the cylinder combined with the phasing between cross-flow and in-line oscillations. A coarse matrix of forced vibration tests is performed with varying in-line amplitude, cross-flow amplitude, phase between in-line and cross-flow motions, and reduced velocity. The database of tests provides a basis for introducing higher harmonic forces into lift coefficient predictions, while showing how in-line motions change the existing coefficients for single frequency sinusoids.

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