Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Streamwise Oscillations of Freely Vibrating Circular Cylinder in the Vicinity of a Stationary Wall RAJEEV JAIMAN, DANIEL THAM, LI ZHONG, PARDHA GURUGUBELLI, National University of Singapore — We present a numerical study on vortex-induced vibration (VIV) of a freely vibrating two degree-of-freedom circular cylinder in close proximity to a stationary plane wall. Fully implicit combined field scheme based on Petrov-Galerkin formulation has been employed to analyze the nonlinear effects of wall proximity on the vibrational amplitudes and hydrodynamic forces. Two-dimensional simulations are performed as function of decreasing gap to cylinder diameter ratio $e/D \in [0.5, 10]$ for reduced velocities $U^* \in [2, 10]$ at $Re_D = 100$ and $Re_L = 2900$, where Re_D and Re_L denote the Reynolds numbers based on the cylinder diameter and the upstream distance, respectively. We investigate the origin of enhanced streamwise oscillation of freely vibrating near-wall cylinder as compared to the isolated cylinder counterpart. For that purpose, detailed analysis of the amplitudes, frequency characteristics and the phase relations has been performed for the isolated and near-wall configurations. Initial and lower branches in the amplitude response are found from the gap ratios of 0.75 to 10, similar in nature to the isolated cylinder laminar VIV. For near-wall cases, phase relation between drag force and streamwise displacement varies from close to 0° to 180°. Effects of mass-ratio, thickness of wall boundary layer and cylinder depth from the top surface are further investigated. Finally, we introduce new correlations for characterizing peak amplitudes and forces as a function of the gap ratio for a cylinder vibrating in the vicinity of a stationary plane wall.

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Date submitted: 20 Jul 2015 Electronic form version 1.4