DIRECT FORCING IMMERSED BOUNDARY MODELING FOR VORTEX-INDUCED VIBRATION WITH GROUND EFFECT

Ming-Jyh Chern[1] , Guan-Ting Lu[1], Yu-Hao Kuan[1] and Tzyy-Leng Horng[2]

[1] Department of Mechanical Engineering,
National Taiwan University of Science and Technology, Taipei 10607, Taiwan
mjchern@mail.ntust.edu.tw
[2] Department of Applied Mathematics,
Feng-Chia University, Taichung 40724, Taiwan
tlhorng@math.fcu.edu.tw

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The direct-forcing immersed boundary (DFIB) method incorporating the virtual force term is used to investigate a numerical simulation of the vortex-induced vibration (VIV) of a flexible supported circular cylinder. The proposed DFIB model has been simulated vortex induced vibration of a circular cylinder in a uniform flow successfully (Chern et al. [1]) . The effect of a plane boundary is taken into consideration on the VIV of two-degree-of-freedom vibrating circular cylinder in this study since the vibrating cylinder may be helpful for the drag reduction of the plane boundary (Igarashi [2]). Fig. 1 shows the schematic of the VIV problem.

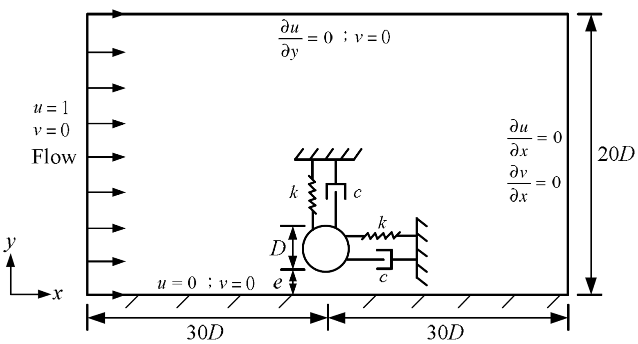

Figure 1: Problem description and boundary conditions for VIV of an elastically mounted circular cylinder in-line and transverse vibrations but near a plane boundary.

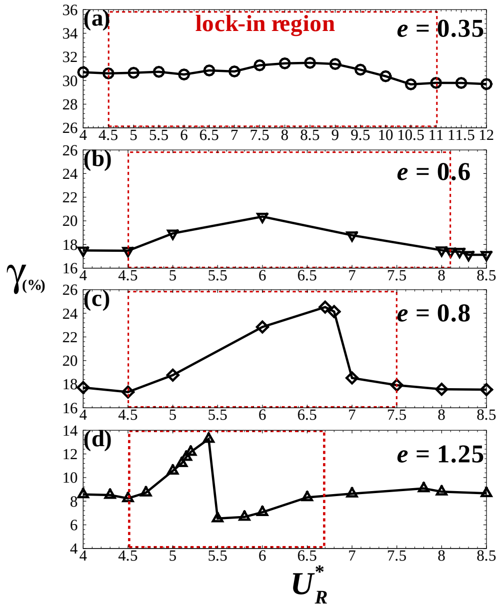

Figure 2: The skin-friction drag reduction percentage γ varies with the reduced velocity, U_R^* in various gap ratios, e.

The effects of reduced velocity and gap ratio on VIV are discussed. Hydrodynamic coefficients of a freely vibrating cylinder are analyzed in time and spectral domains. When the plane boundary is taken into account, the nearly round oval-shaped motion is observed only in the lock-in region. A cylinder is placed adjacent to the plane boundary, the skin-friction drag of the surface was measured. Results show that this mechanism can achieve the effect of drag reduction by controlling surface flow. Fig. 2 reveals the percentage of drag reduction of the plane boundary due to the vibrating cylinder. It is found that the lock-in phenomenon improves drag reduction. Also, the small gap can reduce more drag. The capability of the present DFIB model is proven by the verification with published experimental and numerical data. This proposed model can be useful for the investigation of VIV of the structures and its influence on drag reduction.

REFERENCES

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