Proceedings of the Canadian Society for Mechanical Engineering International Congress 2022
CSME Congress 2022
June 5-8, 2022, Edmonton, AB, Canada

On association of wake topology and lift generation of oscillating foil in coupled motion

Suyash Verma[1], Muhammad Saif Ullah Khalid[1] and Arman Hemmati[1*]
[1] Department of Mechanical Engineering, University of Alberta, 9211-116 Street NW, Edmonton, AB, Canada T6G 1H9
*arman.hemmati@ualberta.ca

ABSTRACT

The association of wake mode and lift generation of an oscillating foil with coupled heaving and pitching motion is numerically evaluated at a range of reduced frequency ($0.16 \leq f^* \leq 0.48$) and phase offset ($0^o \leq \Phi \leq 315^o$), at a Reynolds number of 1000. The coinciding pitch dominated kinematics in the range of $\Phi \leq 120^o$ and $\Phi \geq 225^o$ revealed that the leading-edge vortices are suppressed while trailing edge vortices contributes entirely to the wake formation with increasing reduced frequency. This corresponds to a transition in wake mode from a 2P to a reverse Von Karman wake. Contrarily, heave dominated kinematics ($120^o < \Phi \leq 225^o$) did not exhibit any wake transition with increasing f*. The variation of instantaneous lift within one shedding cycle for cases corresponding to heave-dominated regime further revealed a symmetric temporal feature in terms of the time taken to attain peak lift generation. However, as kinematics transitioned from heave- to pitch-dominated regime, the temporal symmetry in lift variation was eventually lost. Assessment of changes in wake topology and lift features at quarter phase of an oscillation cycle revealed a vivid correspondence between the two processes during the heave- and pitch-dominated kinematics.