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The Development of the Vorticity Field Downstream of a NACA0012 Airfoil Undergoing Small Amplitude Sinusoidal Oscillation
COLIN STUTZ, Clarkson University, PATRICK HAMMER, Michigan State University, DOUGLAS BOHL, Clarkson University, MANOOCHEHR KOOCHESFAHANI, Michigan State University — Symmetric small amplitude oscillation of an airfoil produces a semi-infinite array of alternating sign vortices. Under some conditions single vortices of alternating sign are produced for each cycle, whereas under other conditions multiple vortices of each sign are produced. This work investigates a reduced frequency range, k=3.5-5.1, for which at low k (3.5-4.5) two vortices of each sign are produced, at higher k (5.0) the two vortices pair, and finally at the highest k (5.1) a single vortex of each sign is produced. The work utilizes highly resolved (spatially and temporally) computations for $\alpha_{\max}$ =2° and Re=12000. For low k's the second vortex has the higher vorticity of the two and the two vortices spread vertically away from each other. As the reduced frequency increases the magnitude of the peak vorticity equalizes between the two structures and they move towards each other as the downsteam distance is increased. At the highest reduced frequencies these two structures merge downstream for form a single structure in the more typical von Karman vortex array. The range of reduced frequencies over which the flow transitions from multi-structure, and spreading in nature, to that of single structures is narrow, k≈4.5 to 5.1.

Douglas Bohl
Clarkson University

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