

Unsteady aerodynamic performance improvement and flow mechanism of bending morphing wing

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Abstract

This presentation involves the aerodynamic enhancement and vortex structures evolution by dynamic spanwise bending morphing of a wingtip. First, the lift-to-drag ratio (L/D) improvement on a three-dimensional wing through morphing is presented. Some critical parameters, such as reduced frequency (k) and morphing amplitude (A) of the bending motion, are analyzed to enhance the L/D ratio. Then, for the three-dimensional wing with the moving boundary, the framework of partitions forces into components due to motion, vortex dynamics, and friction is introduced, offering a quantitative analysis of the mechanism behind performance enhancement. The relationship between the wingtip vortex structures evolution and the substantial L/D is revealed. Afterwards, the wingtip bending is applied to alleviate the gust-induced aerodynamics in the wind tunnel test. At last, some opening issues and applications of unsteady aerodynamic control via wingtip's morphing are presented.

Keywords: Bending Morphing, Unsteady Aerodynamics, Lift-to-drag ratio, Partitioned forces

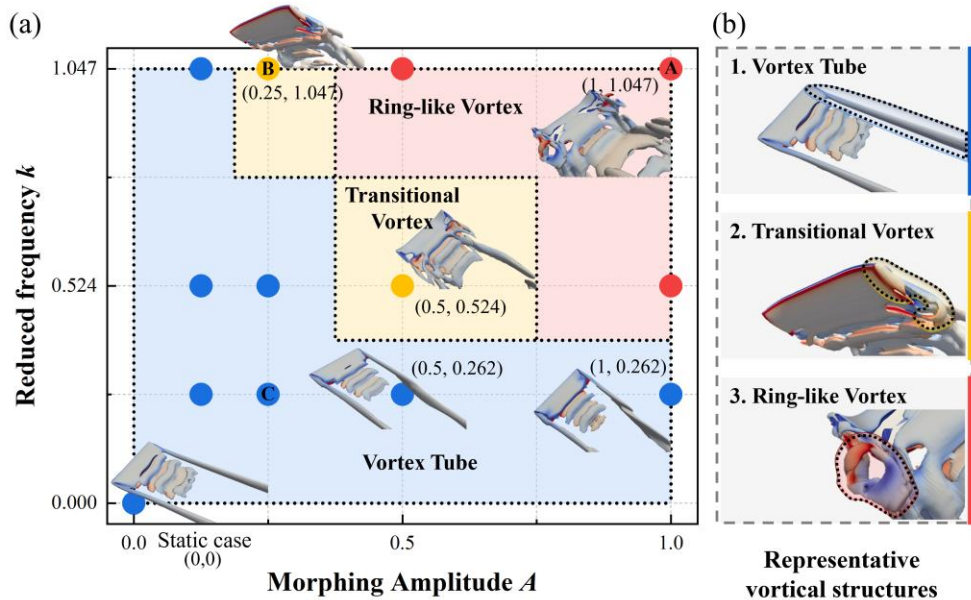


Figure 1. (a) Pattern diagrams of vortex in morphing region. The dashed lines delineate the boundaries among the vortex tube (blue circles ●), transitional vortex (yellow circles ●), and ring-like vortex (red circles ●). The values in the parentheses (A, k) denote the morphing amplitude and reduced frequency for the shown snapshots. (b) Representative vortical structures visualized by $Q=1$, with essential features highlighted by dashed black curves.

Acknowledgments

We sincerely thank the Asian Fluid Mechanics Committee (AFMC) for their exceptional efforts in organizing the 18th Asian Congress of Fluid Mechanics (ACFM) scheduled to be held in Seoul, Korea, from September 10 to 13, 2025. Support from grant ### is gratefully acknowledged.