Effect of wing deformation on the aerodynamic performance of flapping wings: fluid-structure interaction approach

ABSTRACT

Wing stiffness is very crucial in augmenting aerodynamic forces in flapping wing flyers. In this work, the effect of wing deformation was studied using three-dimensional numerical analysis (two-way fluid structure interaction), coupling the flow solver (*FLUENT*) and the structural (*ABAQUS*) solver via the *MpCCI* platform. Three different degrees of bending stiffness corresponding to rigid, flexible, and highly flexible case wings were investigated. Moreover, the wings were tested for both low Reynolds number (R=9,000) and high Reynolds number (R=40,000), at a flapping frequency of 9 Hz corresponding to an angle of attack (AoA) ranging from α=0 to 50°. The results of mean aerodynamic lift and drag coefficients showed good agreement between numerical and experimental findings. Also, the time-averaged lift-to-drag ratio reveals that the highly flexible wing exhibited the best overall aerodynamic performance when compared to the rigid and flexible wing.

Keyword: Wing deformation; Aerodynamic performance; Flapping wings; Fluid-structure interaction approach