ASSESSMENT OF THE WAKE PATTERNS AND UNSTEADY LOADS FOR A NACA0012 AIRFOIL UNDER HEAVING AND PITCHING MOTION

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Abstract
The present study presents numerical simulations of a NACA0012 airfoil under unsteady heaving and pitching motion. We employ a computational fluid dynamics tool which features low dispersion and dissipation characteristics. The current simulations are able to resolve unsteady flow features which may occur in the flight of insects, maneuvering aircraft and other biological and engineering systems. The current study also provides a brief investigation of the Knoller-Betz effect for thrust and its correlation to flapping flight dynamics. Aspects of airfoils under heaving and pitching movements are studied analyzing the momentum variations and the flow patterns along the vortex wake.

Key words: Oscillating airfoils, dynamic stall, unsteady flows

Introduction
Unsteady flows such as wind gusts or airfoils under heaving and pitching motion have always been an interesting topic for scientists and engineers, since many critical phenomena may occur under these conditions. Studies of wake patterns and unsteady loads find application in several problems of biological and engineering interest, for instance, the flight of insects and maneuvering aircraft.

In the present work we perform numerical simulations of a NACA0012 airfoil submitted to unsteady flows. The computational fluid dynamics tool employed in the current analyses features low dispersion and dissipation characteristics and, therefore, the simulations are able to resolve the unsteady flow features of interest.

Results and Discussion
The aerodynamic response of an airfoil accelerated from rest to Mach number 0.2 and, then, decelerated again to rest was studied of an example of a wind gust. As depicted in image 1, the body experiences peaks of drag and lift which may be much greater than the steady flow values, and such variation is linked to the boundary layer development, shown in image 2.

Conclusions
The main goal of this work is to investigate different effects and phenomena related to dynamic stall and thrust generation and to prove the feasibility of using computational fluid dynamics to perform simulations of unsteady flows in non-inertial frames.

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References