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PERFORMANCE ANALYSIS OF A PLUNGING WING AT LOW REYNOLDS NUMBER

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The unsteady aerodynamics of plunging wings has received much attention due to numerous applications including, micro air vehicles and civil transport aircraft wing loading during gusts, turbulence or low speed manoeuvres [1]. Key components of the computational process are considered for two test cases. Firstly, the unsteady computation of a periodically plunging wing is considered. An investigation is made on the sensitivity of unsteady aerodynamic loads and flow structures, more especially the development of the vortical structures and their influence on the aerodynamic loads. In addition, the effects of the geometrical angle of attack and frequency on the velocity field around the airfoil, particularly the pressure side are discussed. The flow fields are computed using a large eddy simulation (LES) approach. Calculations are performed for a NACA-0012 airfoil, modified to include a sharp tailing edge at a chord-based Reynolds number of Re = 2 x 10^4.

Secondly, a plunging finite wing is investigated. The set-up matches experimental water tunnel conditions [2]. Particular attention is placed on the design of the computational grid due to the complexity of the flow. The results are validated against the experimental water tunnel data to provide a baseline simulation. Insight is then given into significant features of dynamic stall, including stall delay and the development of the leading and trailing edge vortices. Aerodynamic loads as well as wing tip vortex effects are also assessed by comparing the results to a quasi two-dimensional case. Overall the results showed the LES approach to be promising for the present flow, where transition is mainly dominated by geometrical and dynamical effects.

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