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Influence of the vortex shedding on the time evolution of instantaneous pressure fields and forces in rotating airfoils ARTURO VILLEGAS, FRANCISCO J. DIEZ, Rutgers University — Time-resolved measurements of instantaneous pressure fields and aerodynamic loads are obtained for rotating airfoils. These allowed evaluating temporal variations in the flow field and were able to capture the evolution of vortex shedding in the wake of the rotating blade. The results show the influence of vortex shedding in the instantaneous loads. These measurements involve obtaining first the velocity field from TR-PIV. This is used to calculate the pressure field from the Poisson pressure equation, and later the forces from the integral momentum equation. The robustness of the measurements is analyzed by calculating the PIV uncertainty, and the independence of the calculated forces. Experimental mean aerodynamic forces are compared to theoretical predictions from the Blade Element Momentum theory (BEM) showing good agreement. The instantaneous pressure varied with time only in the wake due to vortex shedding. This is the first time the evolution of the instantaneous pressure field has been resolved for a rotating airfoil. The contribution to the instantaneous forces from each term in the integral momentum equation is evaluated. The analysis shows that the larger contributions to the normal force coefficient are from the unsteady and the pressure terms while the larger contribution to the tangential force coefficient is from the convective term. The method can be used to measure unsteady forces in rotating airfoils, providing useful information not just for computational studies, but also for aerodynamics, material and structural optimization and safety purposes.

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