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Lift generation of an impulsively started flat wing from the perspective of a diagnostic vorticity force theory CHENG-TA HSIEH, Division of Mechanics, Research Center for Applied Sciences, Academia Sinica, JIAN-JHIH LEE, Institute of Applied Mechanics, National Taiwan University, CHIH-YU KAO, Division of Mechanics, Research Center for Applied Sciences, Academia Sinica, CHIEN-CHENG CHANG, CHIN-CHOU CHU, Institute of Applied Mechanics, National Taiwan University — In this study, we consider various force contributions to an impulsively started wing plate from the perspective of a diagnostic vorticity force theory. A wing plate has the aspect ratio between 1 and 3 and is placed at different angles of attack (α) 30° , 45° and 60° , while the Reynolds number is varied between 100 and 300. The force theory enables us to examine forces exerted on the wing plate credited to the individual flow structures, such as the leading-edge vortex (LEV), trailing edge vortex (TEV), tip vortices as well the contribution from the surface vorticity. Given a force direction (in particular lift and drag), each fluid element with nonzero vorticity in the flow is associated with a vorticity force element which gives the intensity contributed by that element. The contour plots of the force elements help us visualize where the fluid elements play more significant roles than elements elsewhere. The relative importance of the various contributions to the hydrodynamic forces is analyzed in terms of the aspect ratio, angle of attack and the Reynolds number.

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