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Flow Structure on a Flapping Wing: Quasi-Steady Limit[1] CEM OZEN, Air Products and Chemicals Inc., DONALD ROCKWELL, Lehigh University — The three-dimensional flow structure on a rotating wing is determined using stereoscopic particle image velocimetry. The wing is a rectangular flat plate with an aspect ratio $AR = 2$; the effective angle of attack is $\alpha_{eff} = 45^\circ$ and the Reynolds number $Re = 15{,}150$. Emphasis is on comparison of the early stages of rotation with the late stage corresponding to the steady-state. The flow structure in the early stage involves a stable leading-edge vortex, and root, tip, and shed vortices. Along the span of the wing, the leading-edge vortex has pronounced concentrations of chordwise-oriented vorticity. These concentrations arise from the large-magnitude spanwise flow along the surface of the wing. At large angles of rotation, there is loss of the tip vortex, which is accompanied by loss of the chordwise-oriented vorticity due to eruption of the spanwise flow from the wing surface. In addition, patterns of downwash, spanwise velocity and spanwise vorticity flux are correlated with the local scale and degree of concentration of spanwise vorticity of the leading-edge vortex.

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