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Flow Structure on a Rotating Wing: Effect of Rossby Number
MAXWELL WOLFINGER, DONALD ROCKWELL, Lehigh University — The flow structure on a rotating wing is determined via stereoscopic particle image velocimetry. Sectional and three-dimensional, volumetric reconstructions define the flow patterns as a function of Rossby number Ro. An aspect ratio $AR = 1$ rectangular, flat plate is rotated at a geometric angle of attack $\alpha = 45°$. The flow structure is determined at various angles of rotation, in order to characterize both the initial development and the fully evolved state of the flow structure. The Rossby number $Ro = r_g/C$ is varied via alteration of the radius of gyration r_g of the wing, to give values from $Ro = 1.2$ to $Ro = 5.1$. Large changes of the flow structure are represented by images of of spanwise vorticity, Q-criterion; spanwise velocity; and downwash velocity. At the lowest Rossby number $Ro = 1.2$, a vortex is attached to the leading edge of the wing; it is present along most of the span. At higher Rossby numbers $Ro = 2.1$ and $Ro = 5.1$, this leading-edge vortex becomes less organized and deflects away from the surface of the wing. At a Rossby number $Ro = 5.1$ the structure of the flow in the vicinity of the leading edge resembles a separated shear layer. The nature of other elements of the three-dimensional flow, such as the root and tip vortices and the downwash velocity, are closely related to the degree of coherence of the leading-edge vortex.

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