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Rolling and twisting of finite foil[1] ANDHINI NOVRITA ZURMAN NASUTION, BHARATHRAM GANAPATHISUBRAMANI, GABRIEL D. WEYMOUTH, University of Southampton — Strip theory in flapping foils, i.e. reconstructing a 3-dimensional (3D) behavior from a spanwise sequence of 2D strips, has a potential to give fast predictions but the modeling errors are poorly understood. In this work, finite foils with an elliptic tip are simulated with a sinusoidal motion of pure rolling and combined rolling-twisting. Their spanwise cross-sections are compared with 2D simulations of the same kinematics. The 3D pressure distributions are strongly correlated with the 2D, but have very different amplitudes. The spanwise velocity of the cross-sections also increases with the local velocity caused by the kinematic. The pure rolling motion indicates that maximum lift coefficient (C_L) at each cross-section augments linearly with local velocity square except at the tip. It is discovered that the slope of C_L along the span declines as the aspect ratio is reduced with the same scaling as Prandt'l finite-wing theory. Similar behavior is found by Green and Smits [2008] to scale the thrust coefficients of pitching panel for different aspect ratios. With these discoveries, the 2D C_Ls can be corrected with the scaling to find their corresponding 3D cross-sections at different aspect ratios, enabling quantitative strip theory predictions of 3D flapping flight.

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