F1a. Before touchdown:

After touchdown:

Airfoil sheds a vortex which contains all the airfoil's initial circulation. Airfoil is left with zero circulation.

F1b. Since initial circulation is zero, must have \( \Gamma_v = -\Gamma \)

Velocity seen by airfoil:

\[
\omega = \frac{\Gamma}{2\pi d}, \quad |\mathbf{V}|^2 = V_\infty^2 + \left(\frac{\Gamma}{2\pi d}\right)^2 \ll V_\infty^2 \quad \text{if} \quad \omega \ll V_\infty
\]

Net lift force/span is perpendicular to apparent velocity:

\[
F' = \rho |\mathbf{V}| \Gamma \times \rho V_\infty \Gamma
\]

Take components \( L \) and \( D \) to \( V_\infty \):

\[
L' = \frac{F' V_\infty}{|\mathbf{V}|} \times \frac{F' \mathbf{V}}{V_\infty} = \rho V_\infty \Gamma \rightarrow C_L = \frac{L'}{2\rho V_\infty^2} = \frac{2\Gamma}{c V_\infty}
\]

\[
D' = \frac{F' \omega}{|\mathbf{V}|} = \rho w \Gamma \rightarrow C_D = \frac{D'}{2\rho V_\infty^2 c} = \frac{2\Gamma w}{c V_\infty V_\infty} = C_L \frac{w}{V_\infty}
\]

since \( w \sim \frac{1}{d} \sim \frac{1}{\text{time}} \)

\( C_d \) decreases as \( \frac{1}{\text{time}} \)

\[ C_d \rightarrow t \]