Important Concepts in Thin Airfoil Theory

1. This airfoil theory can be viewed as a panel method with vortex solutions taking the limits of infinite number of panels & zero thickness & zero camber

\[
\lim_{\text{thickness}\to 0, \text{camber}\to 0} \left( \lim_{N\to\infty} \text{vortex panel} \right) = \text{thin airfoil theory}
\]

\[
\frac{1}{2\pi} \sum_{i=1}^{N} K_i \tilde{f}_{x_i} \tilde{h}_{z_i} = \frac{1}{2\pi} \int_{-\infty}^{\infty} f(x) \left( \frac{d\alpha}{dx} \right) dx
\]

2. \( C_l = 2\pi (\alpha - \alpha_{LO}) \)

\[
\alpha_{LO} = \frac{1}{\pi} \int_{0}^{\pi} \frac{dz}{dx} (1 - \cos \theta_o) d\theta_o
\]

\[
x = \frac{c}{2} (1 - \cos \theta_o)
\]

- \( \alpha_{LC} = 0 \) for \( \frac{dz}{dx} = 0 \) \( \{\text{i.e. symmetric airfoils}\} \)
- thickness does not affect \( C_l \) to 1st order

3. Moment at \( \frac{c}{4} \) is constant with respect to \( \alpha \) according to thin airfoil theory

\[
\Rightarrow \frac{c}{4} = \text{aerodynamic center}
\]

- \( M_{\frac{c}{4}} \) only depends on camber!
- \( M_{\frac{c}{4}} = 0 \) for symmetric airfoil

4. Thin airfoil theory assumes:

- 2-dimensions
- Inviscid*
- Incompressible*
- Irrotational*
- Small \( \alpha \)
- Small \( \tau_{max}/c \)
- Small \( z_{max}/c \)

* \( \Rightarrow D' = 0 \)