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

$$\lim_{\substack{thickness\to 0\\ camber\to 0}} \underbrace{\left\{\lim_{N\to\infty} \text{vortex panel}\right\}}_{\frac{1}{2\pi}\sum_{j=1}^{N}\gamma_j K_{ij}=\vec{V}_\infty\bullet\vec{n}_i} = \underbrace{\text{thin airfoil theory}}_{\frac{1}{2\pi}\int_0^c \frac{\gamma(\xi)d\xi}{x-\xi}=V_\infty\left(\alpha-\frac{dz}{dx}\right)}$$

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 $\frac{dz}{dx} = 0$ {i.e. symmetric airfoils}
- thickness does not affect C_l to 1st order

3. Moment at $\frac{c}{4}$ is constant with respect to α according to thin airfoil theory

$\Rightarrow \frac{c}{4} =$ 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 α
- Small $\tau_{\max}/c$
- Small $z_{\max}/c$

$* \Rightarrow D' = 0$