The Variation of C_d with Reynolds number Re.

∴ Basic viscous flow theory and experiments show that the local skin-friction co-efficient C_f on a surface,

for a flat plate, varies as $C_f \propto \frac{1}{\sqrt{Re}}$ for laminar flow.

$C_f \propto \frac{1}{(Re)^{0.2}}$ turbulent flow.

∴ $(C_d)_{min}$ is sensitive to Reynolds number and is larger at lower Reynolds number

∴ Reynolds number influences the extent and characteristic of separated flow region ∴

C_d at larger value of α is also sensitive to Re.

∴ Aerodynamic co-efficient as a function of (M)

recall: $C_m = C_D = C_L = f(\alpha, Re, M_\infty)$

∴ How Aerodynamic Co-efficient Varies with free stream Mach number (M_∞) from subsonic speed to supersonic regime?

∴ For conventional airfoil, C_l, C_d with M_∞

@ "Subsonic Compressibility effects". increasing $M_\infty \rightarrow$ increase in C_l (subsonic)

"Prandtl-Glauert rule" $\Rightarrow$ Compressibility correction

C_l inversely proportional to $\sqrt{1-M_\infty^2}$

Assuming an incompressible value of

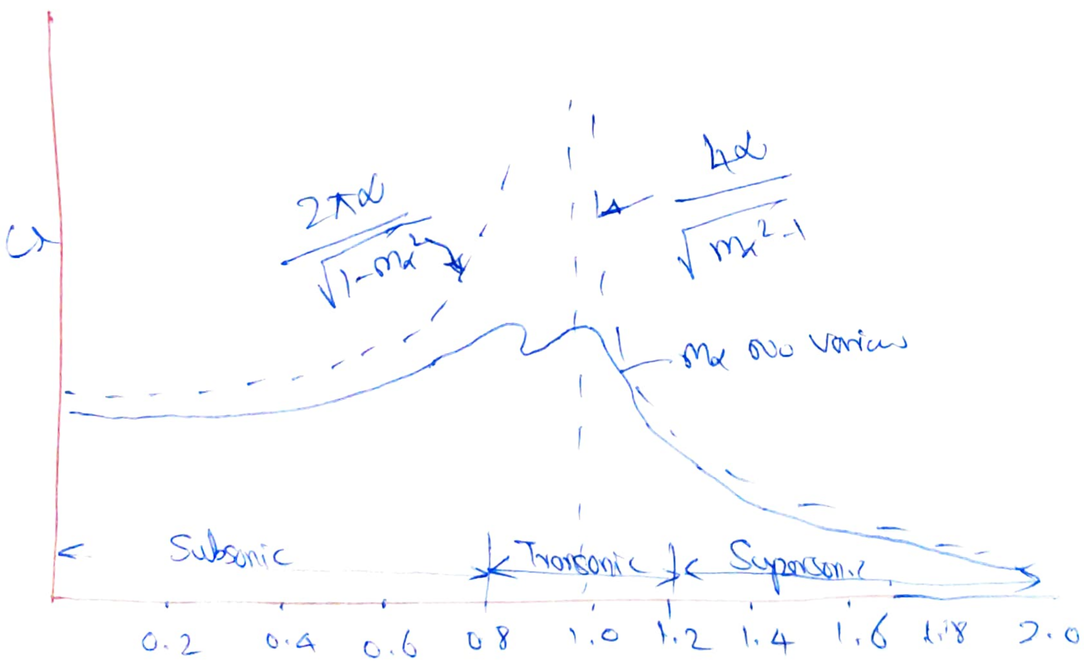
$$C_l = 2\pi\alpha$$

$$\therefore C_l = 2\pi\alpha \times \frac{1}{\sqrt{1-M_\alpha^2}}$$

$$C_l = \frac{2\pi\alpha}{\sqrt{1-M_\alpha^2}}$$

$\therefore$ for supersonic Variation for a thin airfoil,

$$C_l = \frac{4\alpha}{\sqrt{M_\alpha^2-1}}.$$



The solid curve → Variation of C_l versus M_α for both the subsonic and supersonic region.

where, $a, a_0 \Rightarrow$ lift slop per radian

e_1 is a factor depends on geometric shap of the wing, including aspect ratio and taper ratio.

$\therefore$ lift slope for a finite wing decreases as the aspect ratio decreases.

Prandtl's lifting line theory does not apply to low-aspect ratio wings.

Now. Mach number 0.3 and higher - Compressibility Correction, Prandtl - Glauert rule.

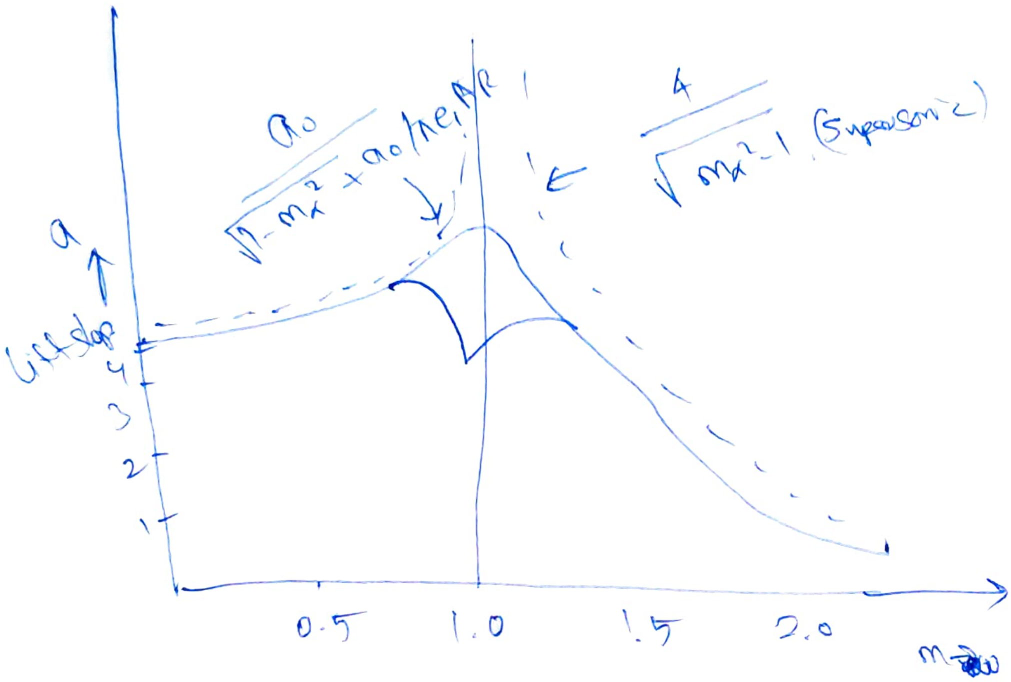
$$a_{0,\,comp} = \frac{a_0}{\sqrt{1 - M_\infty^2}}$$

$\therefore$ so prandtl's lifting line theory for subsonic Compressible flow

$$a_{comp} = \frac{a_{0.comp}}{1 + a_{0comp}/\pi e_1 AR}$$

$$\therefore \quad a_{comp} = \frac{a_0/\sqrt{1-M_\infty^2}}{1 + a_0/\left[\pi e_1 AR \sqrt{1-M_\infty^2}\right]}$$

$$\therefore \quad a_{comp} = \frac{a_0}{\sqrt{1-M_\alpha^2} + a_0/\pi e_1 AR} \quad \text{(Compressible)}$$



$$a_{comp} = \frac{4}{\sqrt{M_\alpha^2 - 1}}.$$