



SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE-35

DEPARTMENT OF AEROSPACE ENGINEERING



The Variation of C_d with Reynolds number Re .

∴ Basic viscous flow theory and experiments show that the local skin-friction coefficient 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_∞)

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

* 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 effect" - 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

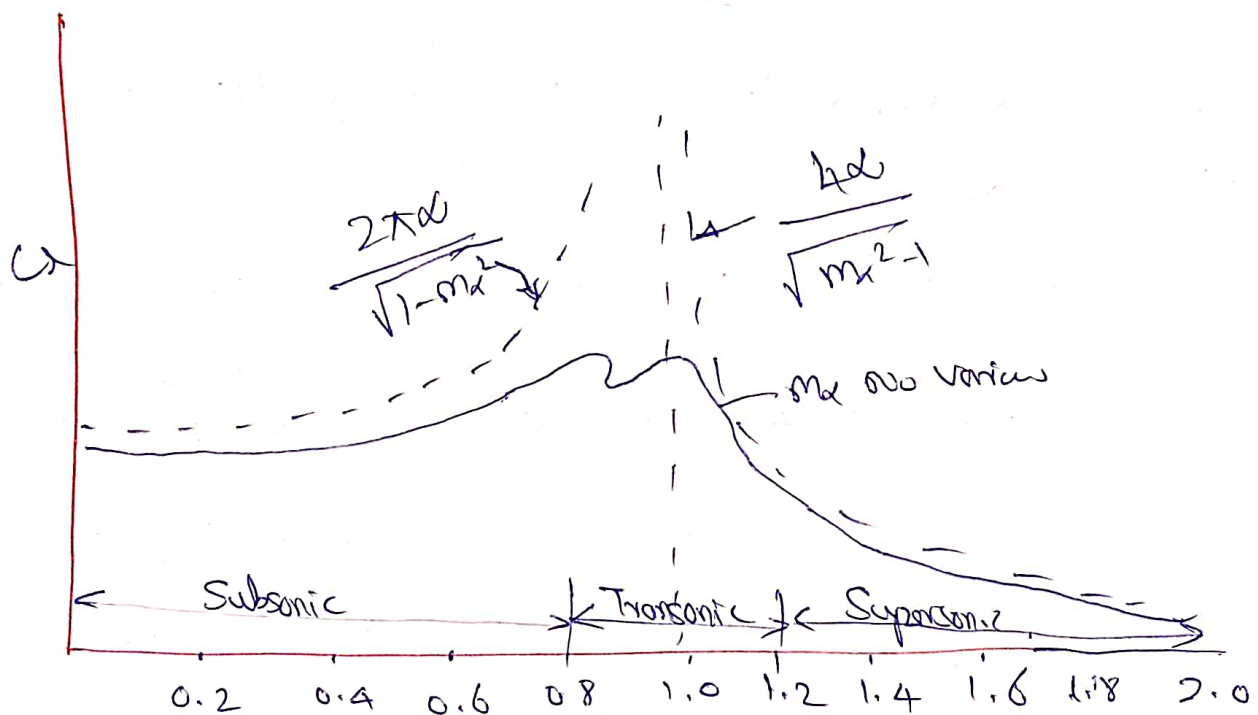
$$C_L = 2\pi\alpha$$

$$\therefore C_L = 2\pi\alpha \times \frac{1}{\sqrt{1-m_\alpha^2}}$$

$$C_L = \frac{2\pi\alpha}{\sqrt{1-m_\alpha^2}}$$

\therefore for supersonic variation for a thin airfoil,

$$C_L = \frac{4\alpha}{\sqrt{m_\alpha^2 - 1}}$$



The solid curve \rightarrow Variation of C_L versus M_α for both the subsonic and supersonic region,



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where, $a, a_0 \Rightarrow$ lift slope per radian.

e_i is a factor depends on geometric shape 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.

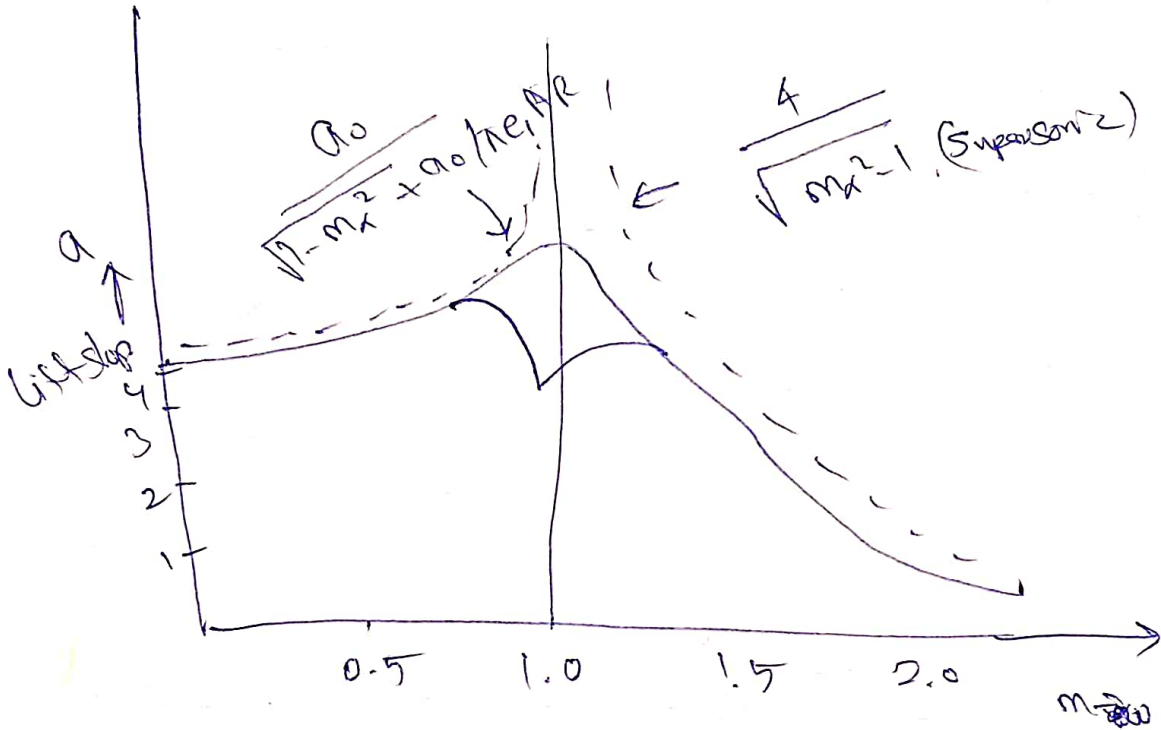
$$a_{0, \text{comp}} = \frac{a_0}{\sqrt{1 - M_\infty^2}}$$

\therefore so Prandtl's lifting line theory for subsonic compressible flow

$$a_{\text{comp}} = \frac{a_{0, \text{comp}}}{1 + a_{0, \text{comp}} / \pi e_i AR}$$

$$\therefore a_{\text{comp}} = \frac{a_0 / \sqrt{1 - M_\infty^2}}{1 + a_0 / [\pi e_i AR \sqrt{1 - M_\infty^2}]}$$

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



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