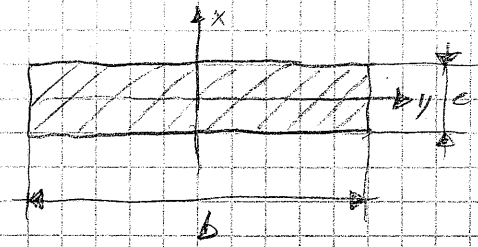
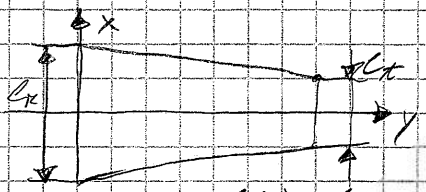
CAPITOLO 2 | CORDA MEDIA AERODINAMICA

ESEMPIO ALA RETTANGOLARE



$$\bar{c} = \frac{2}{b \cdot c}\int_0^{b/2} c^2\,dy = \frac{2c^2}{b}\,\frac{b}{2} = c \qquad \bar{c} = c \;\; \begin{matrix}\text{CORDA}\\ \text{MEDIA}\\ \text{AERODINAMICA}\end{matrix} \equiv \begin{matrix}\text{CORDA}\\ \text{GEOMETRICA}\end{matrix}$$

PROBLEMA 2.1



$$\frac{S}{2} = \frac{(c_t + c_r)}{2}\,b/2$$

$$c(y) = c_r + y\,\frac{(c_t - c_r)}{b/2} \qquad c(0) = c_r \qquad c\left(\frac{b}{2}\right) = c_r + \frac{b}{2}\,\frac{(c_t - c_r)}{b/2} = c_t$$

$$\int_0^{b/2}\left(c_r + \frac{c_t - c_r}{b/2}\,y\right)^2 dy = \left[\frac{1}{3}\left(c_r + \frac{c_t - c_r}{b/2}\,y\right)^3 \frac{b/2}{c_t - c_r}\right]_0^{b/2} = \frac{1}{3}\,\frac{b/2}{c_t - c_r}\,\left(c_t^3 - c_r^3\right)$$

↑ CAMBIO DI SEGNO

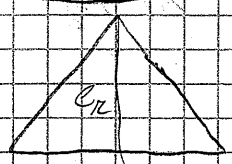
$$\bar{c} = \frac{2}{(c_t + c_r)\,b/2}\,\frac{b/2\,(c_t^3 - c_r^3)}{3(c_r - c_t)} = \frac{2}{3}\,\frac{c_t^3 - c_r^3}{(c_t + c_r)(c_r - c_t)} = \frac{2}{3}\,\frac{c_r^3 - c_t^3}{c_r^2 - c_t^2}$$

DIFFERENZA CUBI DIVISO DIFFERENZA QUADRATI.

COSTRUZIONE GEOMETRICA PER ALA CON RASTREMAZIONE SEMPLICE



ESERCIZIO ALA A DELTA

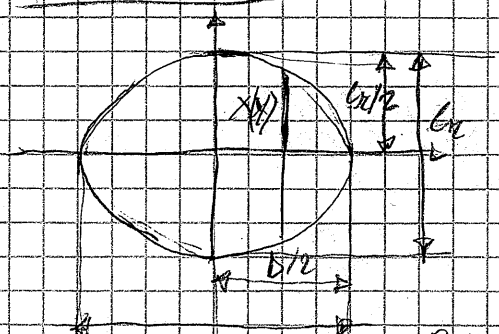


POICHÉ $c_t = 0$

$$\bar{c} = \frac{2}{3}\,\frac{c_r^3}{c_r^2} = \frac{2}{3}\,c_r$$

66% CORDA ALLA RADICE

PROBLEMA 2.2 ALA CON FORMA IN PIANTA ELLITTICA



$$\frac{x^2}{(c_r/2)^2} + \frac{y^2}{(b/2)^2} = 1 \quad \text{EQ ELLISSE}$$

$$S = \pi\,\frac{b}{2}\,\frac{c_r}{2} = \frac{\pi}{4}\,b\,c_r \qquad \left(\pi \text{ PER SEMIASSE MAGGIORE PER SEMIASSE MINORE}\right)$$

L'ALA È SIMMETRICA RISPETTO A X E Y

QUINDI $x(y) = \frac{c_r}{2}\sqrt{1 - \frac{y^2}{(b/2)^2}}$ DA CUI PER AVERE LA CORDA:

$$c(y) = 2x(y) = c_r\sqrt{1-\frac{y^2}{(b/2)^2}}$$

$$\bar{c} = \frac{8}{\pi b c_r}\int_0^{b/2} c_r^2\left(1-\frac{y^2}{(b/2)^2}\right)dy = \frac{8c_r}{\pi b}\int_0^{b/2}\left(1-\frac{y^2}{(b/2)^2}\right)dy$$

$$\left[y - \frac{y^3}{3(b/2)^2}\right]_0^{b/2} = \frac{b}{2} - \frac{(b/2)^3}{3(b/2)^2} - 0 = \frac{b}{2}\left(1-\frac{1}{3}\right) = \frac{b}{3}$$

85% CORDA ALLA RADICE

$$\bar{c} = \frac{8}{3\pi}c_r$$

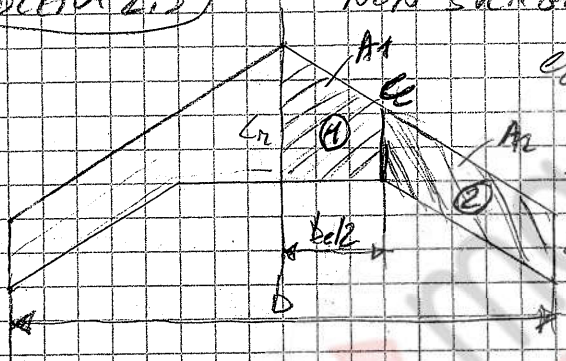
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PROBLEMA 2.3

DOPPIA RASTREMAZIONE NON SVERGOLATA

c_c = KINK

CONSIDERO L'ALA A DOPPIA RASTREMAZIONE COME LA SOMMA DI 2 ALI A SEMPLICE RASTREMAZIONE



CALCOLO LA CORDA MEDIA AERODINAMICA PER ENTRAMBI GLI ALI



$$\bar{c}_{①} = \frac{1}{A_1}\left[\int_0^{b_c/2} c_1^2(y)\,dy\right] = \frac{2}{3}\,\frac{c_r^3 - c_c^3}{c_r^2 - c_c^2}$$

POICHÉ $\frac{S}{2} = A_1 + A_2$

$$\bar{c}_{②} = \frac{1}{A_2}\left[\int_0^{\frac{b-b_c}{2}} c_2^2(y)\,dy\right] = \frac{2}{3}\,\frac{c_c^3 - c_t^3}{c_c^2 - c_t^2}$$

$$\bar{c} = \frac{1}{A_1+A_2}\left[\underbrace{\left(\int_0^{b_c/2} c^2(y)\,dy\right)}_{\bar{c}_1 A_1} + \underbrace{\left(\int_{b_c/2}^{b/2} c^2(y)\,dy\right)}_{\bar{c}_2 A_2}\right] = \frac{\bar{c}_1 A_1 + \bar{c}_2 A_2}{A_1 + A_2}$$

LA CORDA MEDIA AERODINAMICA DI UN ALA A DOPPIA RASTREMAZIONE È LA MEDIA PESATA DELLE CORDE MEDIE AERODINAMICHE DELLE SINGOLE ALI VIRTUALI

CON n = RASTREMAZIONE

$$\bar{c} = \frac{\sum_{i=1}^{n} \bar{c}_i A_i}{\sum_{i=1}^{n} A_i}$$

PROBLEMA 3,1

$h_1 = 10.000\ m$

$\frac{\rho}{\rho_0} = \left(1 - \frac{\lambda h}{\Theta_0}\right)^{g/R\lambda - 1}$

$\lambda = \frac{6,5}{10.000} =$

$g = 9,81\ m/s^2$ $\quad R = 287\ \frac{J}{kg\,K}$

$\Theta_0 = 288,15\ K$ DA TABELLA

$\frac{\rho}{\rho_0} = 0,336$ $\quad \frac{\Theta}{\Theta_0} = 0,94$ $\quad \frac{p}{p_0} = 0,26$

LA DENSITÀ SI RIDUCE DEL 66%

74% DI RIDUZIONE

$\frac{\Theta}{\Theta_0} = 0,88$

$h_2 = 12.000\ m$ RISPETTO LA QUOTA 0

$\frac{\rho}{\rho_0} = \frac{\rho}{\rho^*}\frac{\rho^*}{\rho_0} = \exp\left(-\frac{g}{R\Theta^*}(h - h^*)\right)\left(1 - \frac{\lambda h^*}{\Theta_0}\right)^{\frac{g}{R\lambda}-1} = 0,256$

$\Theta^* = 216,6\ K$

$\frac{p}{p_0} = 0,19$ $\quad \frac{\Theta}{\Theta^*} = 0,45$ $\quad \frac{\rho}{\rho_0} = 0,86$

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PROBLEMA 4.1 $h = 3000\ ft$ DEVO DETERMINARE Q E p

ANGOLO FLAPS ZERO $V_{TAS} = ?$ VELOCITÀ VERA

$V_{IAS} = 110\ Kts$ (VELOCITÀ LETTA DAL PILOTA)

DALLE TABELLE DEL TESTO

$V_{CAS} = 108\ Kts$

$$\Delta P = \frac{p_0}{2116}\left\{\left[1 + 0{,}2\left(\frac{108}{661{,}47}\right)^2\right]^{3{,}5} - 1\right\} = 39{,}8\ lb/ft^2$$

$$\frac{\Delta P}{p} = \left(1 + 0{,}2M^2\right)^{3{,}5} - 1 \rightarrow M = \sqrt{\left[\left(\frac{\Delta P}{p} + 1\right)^{1/3{,}5} - 1\right]/0{,}2} = 0{,}1725 \ (<1)$$

$p_{3000ft} = 1896{,}7\ lb/ft^2$ $\quad \rho_{3000ft} = 1{,}106\ ft/s = 654\ Kts$ (MACH < 1 ↳ FLUSSO COMPRI.)

$M = 0{,}1725$ $\quad$ $1\ Kts = 1{,}688\ ft/s$

$V_{TAS} = M \cdot a = 0{,}1725 \times 654 = 112{,}85\ Kts$ (NODI)

$$V_{EAS} = V\sqrt{\frac{\rho}{\rho_0}} \quad \text{(VELOCITÀ EQUIVALENTE)} \qquad V_{EAS} = 112{,}85\sqrt{\frac{2{,}17 \cdot 10^{-3}}{2{,}3765 \cdot 10^{-3}}}$$

$V_{EAS} = 107{,}9\ Kts$

IN CASO DI MACH < 1 IL $V_{CAS} \simeq V_{EAS}$ PER L'IPOTESI DI INCOMPRIMIBILITÀ DELL'ARIA

$V \rightarrow V_{EAS}$ AUMENTA 1,6% OGNI 1000 ft $\quad V = (1 + h \cdot 0{,}016)V_{EAS}$

$V = V_{EAS}(1 + 3 \cdot 0{,}016) \simeq 113\ Kts$

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