

# Apêndice A

## Erros

Nas folhas seguintes é apresentada a análise de erros,  $\Delta C_l$ ,  $\Delta C_d$  e o  $\Delta C_m$ .  
O erro efectivo de cada componente corresponde a fazer o seguinte cálculo:

$$C_l = \Delta C_l \pm C_l$$

$$C_d = \Delta C_d \pm C_d$$

$$C_m = \Delta C_m \pm C_m$$

$$\Delta C_l = \frac{dC_l}{dF_4} \Delta F_4 + \frac{dC_l}{dF_5} \Delta F_5 + \frac{dC_l}{dF_6} \Delta F_6 + \frac{dC_l}{dh} \Delta h + \frac{dC_l}{d\alpha} \Delta \alpha \frac{dC_l}{db} \Delta b + \frac{dC_l}{db} \Delta b + \frac{dC_l}{d\theta} \Delta \theta$$

$$\Delta C_D = \frac{dC_D}{dF_1} \Delta F_1 + \frac{dC_D}{dF_2} \Delta F_2 + \frac{dC_D}{dF_6} \Delta F_6 + \frac{dC_D}{d\theta} \Delta \theta + \frac{dC_D}{dL_1} \Delta L_1 \frac{dC_D}{dL_a} \Delta d_a + \frac{dC_D}{dh} \Delta h + \frac{dC_D}{d\alpha} \Delta \alpha$$

$$\Delta C_M = \frac{dC_M}{db} \Delta b + \frac{dC_M}{db} \Delta b + \frac{dC_M}{dF_6} \Delta F_6 + \frac{dC_M}{d\theta} \Delta \theta + \frac{dC_M}{dL_6} \Delta L_6 \frac{dC_M}{dL_a} \Delta d_a + \frac{dC_M}{dh} \Delta h + \frac{dC_M}{d\alpha} \Delta \alpha$$

$$C_L = \frac{L}{\frac{1}{2} \rho V^2 S}$$

$$S = cb$$

$$V = \sqrt{\frac{2\Delta p}{\rho}}$$

$$\Delta p = h\rho g$$

$$h = h' \sin \alpha$$

$$V^2 = 2h' \sin \alpha g$$

$$L = F_4 + F_5 + (F_6 \cos 11,5)$$

$$C_L = \frac{F_4 + F_5 + (F_6 \cos 11,5)}{\rho h' \sin \alpha gcb}$$

$$\frac{dC_L}{dF_4} = \frac{1}{\rho h' \sin \alpha gcb}$$

$$\frac{dC_L}{dF_5} = \frac{1}{\rho h' \sin \alpha gcb}$$

$$\frac{dC_L}{dF_6} = \frac{\cos 11,5}{\rho h' \sin \alpha gcb}$$

$$\frac{dC_L}{dh} = -\frac{F_4 + F_5 + (F_6 \cos 11,5)}{\rho h^2 \sin \alpha gcb}$$

$$\frac{dC_L}{d\alpha} = -\frac{F_4 + F_5 + (F_6 \cos 11,5) \cos \alpha}{\rho h' (\sin \alpha)^2 gcb}$$

$$\frac{dC_L}{db} = -\frac{F_4 + F_5 + (F_6 \cos 11,5)}{\rho h' \sin \alpha gcb^2}$$

$$\frac{dC_L}{dc} = -\frac{F_4 + F_5 + (F_6 \cos 11,5)}{\rho h' \sin \alpha gc^2 b}$$

$$\frac{dC_L}{d\theta} = -\frac{(F_6 \cos 11,5)}{\rho h' \sin \alpha gcb}$$

$$C_D = \frac{D}{\frac{1}{2} \rho V^2 S}$$

$$S = cb$$

$$V = \sqrt{\frac{2\Delta p}{\rho}}$$

$$\Delta p = h\rho g$$

$$h = h' \sin \alpha$$

$$V^2 = 2h' \sin \alpha g$$

$$D = (F_1 + F_2) \frac{L_1}{L_a} - F_6 \sin 11,5$$

$$C_D = \frac{(F_1 + F_2) \frac{L_1}{L_a} - F_6 \sin 11,5}{\rho h' \sin \alpha gcb}$$

$$\frac{dC_D}{dF_1} = \frac{\frac{L_1}{L_a}}{\rho h' \sin \alpha gcb}$$

$$\frac{dC_D}{dF_2} = \frac{\frac{L_1}{L_a}}{\rho h' \sin \alpha gcb}$$

$$\frac{dC_D}{dF_6} = \frac{-\sin 11,5}{\rho h' \sin \alpha gcb}$$

$$\frac{dC_D}{d\theta} = -\frac{(F_6 \cos 11,5)}{\rho h' \sin \alpha gcb}$$

$$\frac{dC_D}{dL_1} = \frac{(F_1 + F_2)/L_a}{\rho h' \sin \alpha gcb}$$

$$\frac{dC_D}{dL_a} = \frac{-\left(\frac{F_1 L_1}{L_a^2}\right) - \left(\frac{F_2 L_1}{L_a^2}\right)}{\rho h' \sin \alpha gcb}$$

$$\frac{dC_D}{dh} = \frac{-\left[\left(\frac{F_1 L_1}{L_a}\right) + \left(\frac{F_2 L_1}{L_a}\right) - F_6 \sin 11,5\right]}{\rho h^2 \sin \alpha gcb}$$

$$\frac{dC_D}{d\alpha} = \frac{-\left[(F_1 + F_2) \frac{L_1}{L_a} - F_6 \sin 11,5\right] \cos \alpha}{\rho h (\sin \alpha)^2 gcb}$$

$$C_M = \frac{M}{\frac{1}{2}\rho V^2 S}$$

$$S = cb$$

$$V = \sqrt{\frac{2\Delta p}{\rho}}$$

$$\Delta p = h\rho g$$

$$h = h' \sin \alpha$$

$$V^2 = 2h' \sin \alpha g$$

$$M = -(F_6 \cos 11,5)L_6$$

$$C_M = \frac{-(F_6 \cos 11,5)L_6}{\rho h' \sin \alpha gcb}$$

$$\frac{dC_M}{dF_6} = \frac{-\cos 11,5 \times L_6}{\rho h' \sin \alpha gcb}$$

$$\frac{dC_M}{dL_6} = \frac{-(F_6 \cos 11,5)}{\rho h' \sin \alpha gcb}$$

$$\frac{dC_M}{d\theta} = \frac{F_6 L_6 \sin 11,6}{\rho h' \sin \alpha gcb}$$

$$\frac{dC_M}{d\alpha} = \frac{F_6 L_6 \cos 11,6 \cos \alpha}{\rho h' (\sin \alpha)^2 gcb}$$

$$\frac{dC_M}{dh} = \frac{F_6 L_6 \cos 11,6}{\rho h^2 \sin \alpha gcb}$$

$$\frac{dC_M}{db} = \frac{F_6 L_6 \cos 11,6}{\rho h' \sin \alpha gcb^2}$$

$$\frac{dC_M}{dc} = \frac{F_6 L_6 \cos 11,6}{\rho h' \sin \alpha gc^2 b}$$



































