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Aero-normalised stability derivatives: effect of wing on yawing moment due to yawing

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THE PREPARATION OF THIS DATA ITEM

The work on this particular Data Item which supersedes Item No. Aero A.07.01.02, was monitored and guided by the Aerodynamics Committee. This Committee first met in 1942 and now has the following membership:

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AERO-NORMALISED STABILITY DERIVATIVES: EFFECT OF WING ON YAWING MOMENT DUE TO YAWING

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AERO-NORMALISED STABILITY DERIVATIVES: EFFECT OF WING ON YAWING MOMENT DUE TO YAWING

1. NOTATION AND UNITS

The derivative notation used is that proposed in ARC R&M 3562 (Hopkin, 1970) and described in Item No. 86021. Coefficients and aeronormalised derivatives are evaluated in aerodynamic body axes with origin at the aircraft centre of gravity and with the wing span as the characteristic length. The derivative N_r is often written as C_{nr} in other systems of notation, but attention must be paid to the reference dimensions used. In particular, in forming C_{nr} differentiation C_n may be carried out with respect to $rb/2V$ not rb/V as implied in the Hopkin system. It is also to be noted that a constant datum value of V is employed by Hopkin.

		SI	British
A	aspect ratio, b^2/S		
b	wing span	m	ft
b_f	flap span	m	ft
C_{D0}	wing drag coefficient at zero lift		
C_L	wing lift coefficient		
C_n	yawing moment coefficient, $\mathcal{N}^{1/2}\rho V^2 S b$		
c_r	root chord	m	ft
c_t	tip chord	m	ft
f	function of b_f/b and λ , see Equation (3.1)		
M	Mach number		
$\mathcal{N}$	yawing moment about the origin	N m	lbf ft
N_r	aero-normalised yawing moment derivative due to yawing, ($\partial \mathcal{N} / \partial r$)/ $\frac{1}{2}\rho V S b^2$		
r	angular velocity in yaw	rad/s	rad/s
S	gross wing area	m ²	ft ²
V	aircraft velocity relative to air	m/s	ft/s
ΔC_{D0}	increment in C_{D0} due to deflection of trailing-edge flaps		
ΔN_{r0}	increment in N_{r0} due to deflection of trailing-edge flaps		
$\Lambda_{1/4}$	sweepback of 1/4-chord line	degree	degree

λ taper ratio, c_t / c_r

ρ density of air kg/m³ slug/ft³

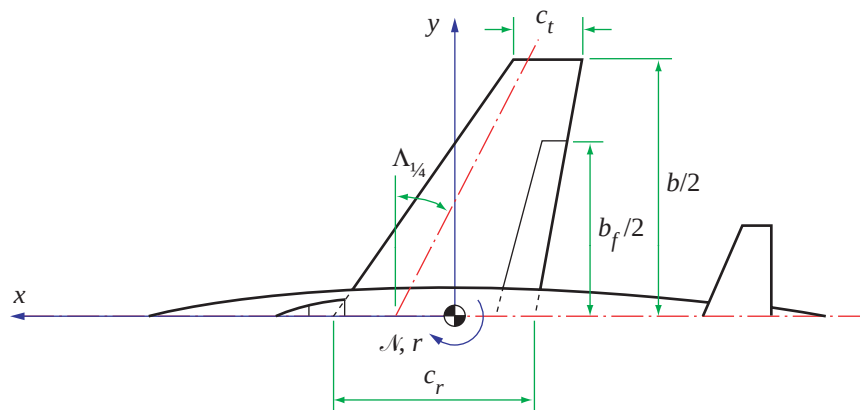
Suffixes

v denotes quantity arising from lift-dependent drag due to trailing vortices

w denotes wing total quantity

λ denotes quality relating to wing of taper ratio λ

0 denotes quantity arising from wing drag at zero lift.



2. PLAIN WINGS

Figures 1 and 2 present data for the contribution of a straight-tapered swept wing to the aero-normalised yawing moment derivative due to yawing in low-speed flow at lift coefficients for which the flow remains fully attached (see Item No. 66033 for wings with symmetrical sections).

Figures 1a and 1b present data for N_{r0} , the component of N_{rw} derived by consideration of the asymmetric distribution of the profile drag (Derivations 1 and 2). Data are presented to cover useful ranges of aspect ratio and sweepback of the $1/4$ -chord line.

Figures 2a to 2d present data for N_{rv} , the component of N_{rw} derived by consideration of the asymmetric distribution of the lift-dependent drag due to the trailing vortex system (Derivation 2) for taper ratios $\lambda = 0, 0.25, 0.5$ and 1.0 respectively over the same ranges of values for aspect ratio and sweepback as those of Figure 1a. The data given in these Figures strictly apply only to the case when the centre of gravity of the aircraft (assumed to be the centre of rotation) coincides with the wing aerodynamic centre. The effect of there being a finite distance between the centre of gravity and aerodynamic centre is small over the range likely to be experienced in practice. For further information see Derivation 2.