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Contribution of fin to sideforce, yawing moment and rolling moment derivatives due to rate of yaw, $(Y_r)_F$, $(N_r)_F$, $(L_r)_F$

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THE PREPARATION OF THIS DATA ITEM

The work on this particular Data Item which supersedes Item No. 70006, was monitored and guided by the Aerodynamics Committee. This Committee first met in 1942 and now has the following membership:

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CONTRIBUTION OF FIN TO SIDEFORCE, YAWING MOMENT AND ROLLING MOMENT DERIVATIVES DUE TO RATE OF YAW, $(Y_r)_F$, $(N_r)_F$, $(L_r)_F$

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CONTRIBUTION OF FIN TO SIDEFORCE, YAWING MOMENT AND ROLLING MOMENT DERIVATIVES DUE TO RATE OF YAW, $(Y_r)_F$, $(N_r)_F$, $(L_r)_F$

1. NOTATION AND UNITS (see Sketch 1.1)

The derivative notation used is that proposed in ARC R&M 3562 (Hopkin, 1970) and described in Item No. 86021. Coefficients and aerodynamical 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 derivatives Y_r , N_r and L_r are often written as C_{Yr} , C_{Nr} and C_{Lr} in other systems of notation, but attention must be paid to the reference dimensions used. In particular, in forming C_{Yr} , C_{Nr} and C_{Lr} differentiation of C_Y , C_n and C_l 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
b	wing span	m	ft
$(C_{L\alpha})_F$	lift-curve slope of fin, evaluated from Item No. 82010 (Derivation 19)	radian ⁻¹	radian ⁻¹
C_l	rolling moment coefficient, $\mathcal{L}/\frac{1}{2}\rho V^2 S_w b$		
C_n	yawing moment coefficient $\mathcal{N}/\frac{1}{2}\rho V^2 S_w b$		
C_Y	sideforce coefficient, $Y/\frac{1}{2}\rho V^2 S_w$		
c_{rF}	fin root chord, see also Item No. 82010 (Derivation 19)	m	ft
c_{tF}	fin tip chord, see also Item No. 82010 (Derivation 19)	m	ft
h_{BW}	body height at wing root quarter-chord station	m	ft
h_F	height of fin, measured from fin root chord in direction normal to longitudinal body axis, see also Item No. 82010 (Derivation 19)	m	ft
J_B	fin sideforce correction factor allowing for presence of body, evaluated from Item No. 82010 (Derivation 19)		
J_T	fin sideforce correction factor allowing for presence of tailplane, evaluated from Item No. 82010 (Derivation 19)		
J_W	fin sideforce correction factor allowing for presence of wing, evaluated from Item No. 82010 (Derivation 19) as a function of z_W/h_{BW} when estimating fin contribution to lateral derivatives due to sideslip, set equal to unity when estimating fin contribution to lateral derivatives due to rate of yaw		
$\mathcal{L}$	rolling moment	N m	lbf ft

L_r	rolling moment derivative due to rate of yaw $L_r = (\partial \mathcal{L} / \partial r) / \frac{1}{2} \rho V S_W b^2$		
$(L_r)_F$	fin contribution to L_r in presence of body, wing and tailplane		
L_v	rolling moment derivation due to sideslip, $L_v = (\partial \mathcal{L} / \partial v) / \frac{1}{2} \rho V S_W b$		
$(L_v)_F$	fin contribution to L_v in presence of body, wing and tailplane		
$\bar{l}'_F$	distance of centre of pressure position of fin sideforce, measured aft from centre of gravity position and parallel to longitudinal body axis; from Item No. 82010 (Derivation 19) $\bar{l}'_F = m_F + 0.7 \bar{z}_F \tan \Lambda_{1/4F}$	m	ft
m_F	distance of fin root quarter-chord station aft of centre of gravity position, measured parallel to longitudinal body axis, see also Item No. 82010 (Derivation 19)	m	ft
$\mathcal{N}$	yawing moment	N m	lbf ft
N_r	yawing moment derivative due to rate of yaw, $N_r = (\partial \mathcal{N} / \partial r) / \frac{1}{2} \rho V S_W b^2$		
$(N_r)_F$	fin contribution to N_r in presence of body, wing and tailplane		
N_v	yawing moment derivative due to sideslip, $N_v = (\partial \mathcal{N} / \partial v) / \frac{1}{2} \rho V S_W b$		
$(N_v)_F$	fin contribution to N_v in presence of body, wing and tailplane		
r	rate of yaw	rad/s	rad/s
S_F	fin area, $h_F(c_{rF} + c_{tF})/2$, see also Item No. 82010 (Derivation 19)	m ²	ft ²
S_W	wing (reference) area	m ²	ft ²
V	velocity of aircraft relative to air	m/s	ft/s
v	slipside velocity	m/s	ft/s
Y	sideforce	N	lbf
Y_r	sideforce derivative due to rate of yaw, $Y_r = (\partial Y / \partial r) / \frac{1}{2} \rho V S_W b$		
$(Y_r)_F$	fin contribution to Y_r in presence of body, wing and tailplane		

Y_v	sideforce derivative due to sideslip, $Y_v = (\partial Y / \partial v) / \frac{1}{2} \rho V S_W$		
$(Y_v)_F$	fin contribution to Y_v in presence of body, wing and tailplane		
$[(Y_v)_F]_{J_W = 1}$	value of $(Y_v)_F$ with no interference between wing and fin ($J_W = 1$) evaluated from Item No. 82010 (Derivation 19)		
z_{crF}	height of fin root chord, measured from longitudinal body axis in direction normal to longitudinal body axis, see also Item No. 82010 (Derivation 19)	m	ft
$\bar{z}_F$	height of centre of pressure position of load distribution on fin, measured from fin root chord in direction normal to longitudinal body axis, evaluated from Item No. 82010 (Derivation 19) as function of z_T / h_F	m	ft
$\bar{z}'_F$	distance of centre of pressure position of fin sideforce, measured above and normal to longitudinal body axis; from Item No. 82010 (Derivation 19) $\bar{z}'_F = z_{crF} + 0.85 \bar{z}_F$	m	ft
z_T	height of intersection of fin-mounted tailplane with fin, measured from fin root chord in direction normal to longitudinal body axis, see also Item No. 82010 (Derivation 19)	m	ft
z_W	height of wing root quarter-chord point above local body centre-line, positive for low wings	m	ft
α	angle of attack	radian	radian
β	angle of sideslip	radian	radian
$\Lambda_{1/4F}$	fin quarter-chord sweep angle	degree	degree
ρ	density of air	kg/m ³	slug/ft ³