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EFFECT OF TRAILING-EDGE FLAPS ON SIDEFORCE AND YAWING MOMENT DERIVATIVES DUE TO SIDESLIP, $(Y_v)_f$ AND $(N_v)_f$

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EFFECT OF TRAILING-EDGE FLAPS ON SIDEFORCE AND YAWING MOMENT DERIVATIVES DUE TO SIDESLIP, $(Y_v)_f$ AND $(N_v)_f$

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 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 derivatives N_v and Y_v are often written as $\partial C_n / \partial \beta$ and $\partial C_Y / \partial \beta$ or $C_{n\beta}$ and $C_{Y\beta}$ in other systems of notation, but attention must be paid to the reference dimensions used and it is to be noted that a constant datum value of V is employed in the Hopkin system.

		SI	British
A	wing aspect ratio, b^2/S		
b	wing span	m	ft
b_T	tailplane span	m	ft
C_D	drag coefficient, $D/1/2\rho V^2 S$		
C'_D	viscous drag coefficient, <i>i.e.</i> total drag coefficient less drag coefficient due to vortices trailing from wing, see Section 3.1		
$\Delta C'_{Df}$	increment in viscous drag coefficient due to deployment of trailing-edge flaps		
C_L	lift coefficient, $L/1/2\rho V^2 S$		
ΔC_{Lf}	increment in lift coefficient due to deployment of trailing-edge flaps		
C_n	yawing moment coefficient, $\mathcal{N}/1/2\rho V^2 S b$		
C_Y	sideforce coefficient $Y/1/2\rho V^2 S$		
c	wing chord	m	ft
c_{rF}	fin root-chord, taken parallel to longitudinal body axis and passing through intersection of fin quarter-chord line with body, see Sketch 1.1	m	ft
D	drag	N	lbf
F	function allowing for effects on Y_v of wing height and wing-span to body-width ratio, evaluated using Item No. 79006 (Derivation 5)		
F_W	factor for applying corrections for wing planform to function F , evaluated using Item No. 79006 (Derivation 5)		

F_1	function allowing for effects of wing-body interference on $(Y_v)_f$		
F_2	function allowing for effectiveness of tail in contributing to $(Y_v)_f$ and $(N_v)_f$	radian	radian
G	ratio of experimental increments in C_D' associated with inner and outer flapped sections of wing, see Section 3.2		
h	body height at wing root quarter-chord station, see Sketch 1.1	m	ft
h_F	height of fin measured from fin root chord in direction normal to longitudinal body axis, see Sketch 1.1	m	ft
K	function allowing for increment in vortex drag coefficient due to deployment of trailing-edge flaps, evaluated using Item No. Aero F.02.01.08 (Derivation 1)		
L	lift	N	lbf
l_h	longitudinal distance from centre of gravity position to intersection of extended flap hinge line with wing centre-line chord, positive aft	m	ft
$\bar{m}$	spanwise distance from wing centre-line to centre of pressure position of incremental vortex drag coefficient on half-wing		
$\mathcal{N}$	yawing moment	N m	lbf ft
N_v	aeronormalised yawing moment derivative due to sideslip, $N_v = (\partial \mathcal{N} / \partial v) / \frac{1}{2} \rho V S b$		
$(N_v)_F$	fin contribution to yawing moment derivative due to sideslip in presence of body, tailplane and wing with trailing-edge flaps retracted, evaluated using Item No. 82010 (Derivation 6)		
$(N_v)_f$	increment in N_v due to deployment of trailing-edge flaps		
S	wing reference area	m ²	ft ²
s	wing semi-span	m	ft
V	velocity of aircraft relative to air	m/s	ft/s
v	sideslip velocity	m/s	ft/s
Y	sideforce	N	lbf
Y_v	aeronormalised sideforce derivative due to sideslip, $Y_v = (\partial Y / \partial v) / \frac{1}{2} \rho V S$		
$(Y_v)_F$	fin contribution to sideforce derivative due to sideslip in presence of body, tailplane and wing with trailing-edge flaps retracted, evaluated using Item No. 82010 (Derivation 6)		

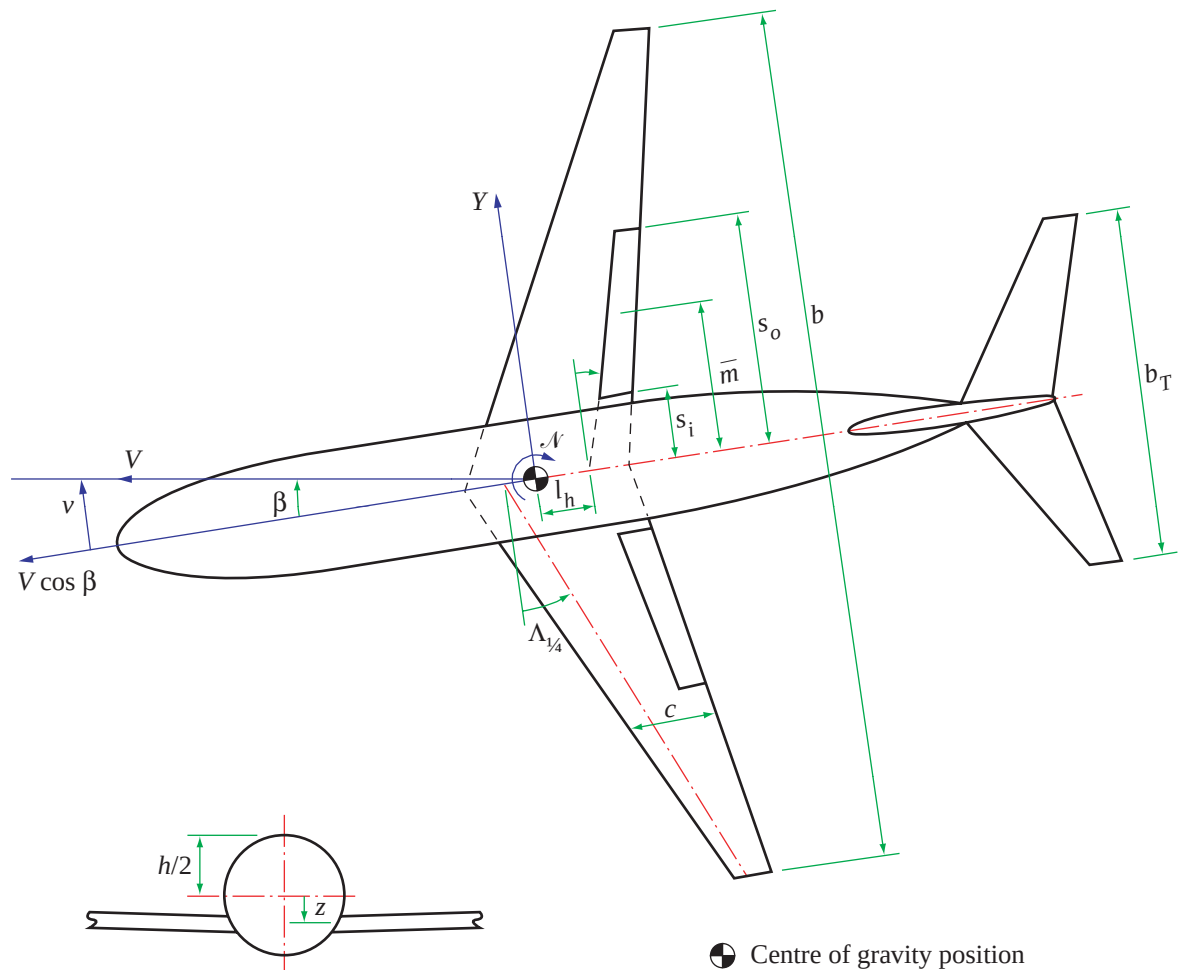
$(Y_v)_f$	increment in Y_v due to deployment of trailing-edge flaps		
z	vertical position of quarter-chord point of wing root-chord below longitudinal body axis, positive downwards, see Item No. 79006 (Derivation 5)	m	ft
z_T	height of intersection of fin-mounted tailplane with fin, measured from fin root chord in direction normal to longitudinal body axis, see Sketch 1.1	m	ft
α	angle of attack	degree	degree
β	angle of sideslip	radian	radian
$\Lambda_{1/4}$	sweepback of wing quarter-chord line	degree	degree
$\Lambda_{1/4F}$	sweepback of fin quarter-chord line	degree	degree
Λ_h	sweepback of flap hinge line	degree	degree
λ	ratio of wing tip-chord to wing centre-line chord		
ρ	density of air	kg/m ³	slug/ft ³

Subscripts

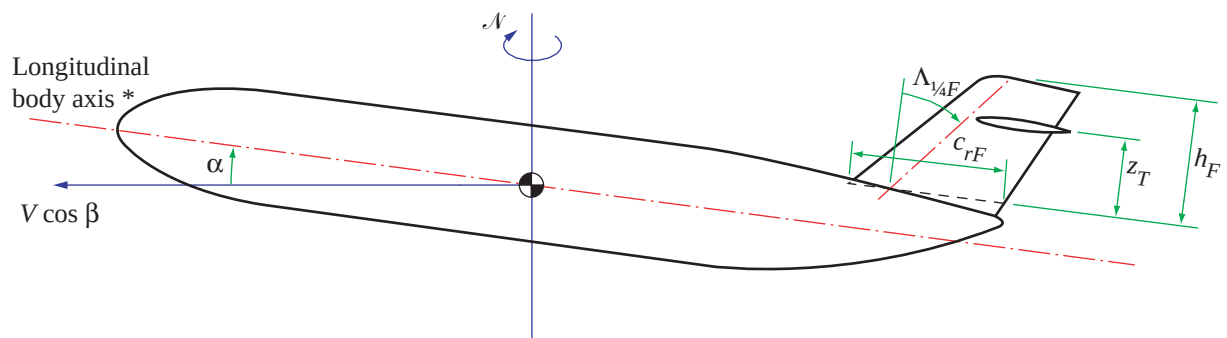
a, b	respectively denote inner and outer flapped sections of wing, see Sketch 3.1
i, o	respectively denote inboard and outboard ends of flapped section of wing, see Section 3.1

Additional symbols

$[]_A$	denotes aspect ratio component
$[]_{FT}$	denotes fin-tailplane component, including fin-tailplane interference and wing-body-tail interference
$[]_{WB}$	denotes wing-body interference component
$[]_\Lambda$	denotes sweepback component



Section through wing root quarter-chord point



Sketch 1.1

* The longitudinal body axis is a reference axis, fixed in the body in the plane of symmetry and passing through the centre of gravity position. The exact direction of the axis in the plane of symmetry is conventionally determined by considerations of mid-body geometry, the axis being taken parallel to some convenient 'horizontal' datum.