



Pitching moment of low aspect ratio wing-body combinations up to high angles of attack at supersonic speeds

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PITCHING MOMENT OF LOW ASPECT RATIO WING-BODY COMBINATIONS UP TO HIGH ANGLES OF ATTACK AT SUPERSONIC SPEEDS

CONTENTS

	Page
1. NOTATION AND UNITS	1
2. INTRODUCTION	3
3. METHOD	4
4. APPLICABILITY AND ACCURACY	5
5. DERIVATION	7
6. EXAMPLE	9

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PITCHING MOMENT OF LOW ASPECT RATIO WING-BODY COMBINATIONS UP TO HIGH ANGLES OF ATTACK AT SUPERSONIC SPEEDS

1. NOTATION AND UNITS

		SI	British
A	aspect ratio of net wing, $4(s-r)/(c_r + c_t)$		
C_{mC}	pitching moment coefficient of wing-body combination about moment reference point, based on q , S_B and D , positive nose up, see Sketch 1.1		
$(C_m)_{0B}$	body-alone pitching moment coefficient about tip of nose ($x_m = 0$), based on q , S_B and D , positive nose up		
$(C_m)_{0C}$	pitching moment coefficient of wing-body combination about tip of nose ($x_m = 0$), based on q , S_B and D , positive nose up		
C_{NC}	normal force coefficient of wing-body combination, based on q and S_B		
C_{NW}	net wing-alone normal force coefficient, based on q and S_W		
c_r	wing root chord, see Sketch 1.1	m	ft
c_t	wing tip chord, see Sketch 1.1	m	ft
D	maximum diameter of body, $2r$, see Sketch 1.1	m	ft
$K_{B(W)}$	linear normal force interference factor due to effect of wing on body (from Item No. 91007)		
$K_{W(B)}$	linear normal force interference factor due to effect of body on wing (from Item No. 91007)		
$K_{W(V)}$	normal force interference factor due to effect of body vortices on wing (from Item No. 91042)		
k	compressibility factor from Item No. 91042, see Equation (3.1)		
L	total length of body, see Sketch 1.1	m	ft
M	free-stream Mach number		
p	free-stream static pressure	N/m ²	lbf/ft ²
q	free-stream kinetic pressure, $\frac{1}{2}\rho V^2$ or $\frac{1}{2}\gamma p M^2$	N/m ²	lbf/ft ²
r	maximum radius of body, $D/2$, see Sketch 1.1	m	ft

S_B	body maximum cross-sectional area, πr^2	m ²	ft ²
S_W	net wing area, $(s-r)(c_r + c_t)$	m ²	ft ²
s	gross wing semi-span, see Sketch 1.1	m	ft
V	free-stream velocity	m/s	ft/s
x_m	axial distance from tip of nose to moment reference point, see Sketch 1.1	m	ft
x_{rl}	axial distance from tip of nose to wing root leading-edge, see Sketch 1.1	m	ft
$(x_{ac})_C$	axial distance from tip of nose to aerodynamic centre of wing-body combination at zero angle of attack	m	ft
$(x'_{ac})_{B(W)}$	axial distance aft of wing-root leading edge of aerodynamic centre of carry-over load on body due to presence of wing at zero angle of attack (from Item No. 92024)	m	ft
$(x'_{ac})_W$	axial distance aft of wing-root leading edge of aerodynamic centre of wing alone at zero angle of attack	m	ft
$(x'_{ac})_{W(B)}$	axial distance aft of wing-root leading edge of aerodynamic centre of interference load on wing due to presence of body at zero angle of attack (from Item No. 92024)	m	ft
$(x_{cp})_C$	axial distance from tip of nose to centre of pressure position of wing-body combination	m	ft
$(x'_{cp})_{B(W)}$	axial distance aft of wing-root leading edge of centre of pressure position of carry-over load on body due to presence of wing	m	ft
$(x'_{cp})_W$	axial distance aft of wing-root leading edge of centre of pressure position of net wing alone	m	ft
$(x'_{cp})_{W(B)}$	axial distance of centre of pressure position aft of wing-root leading edge of interference load on wing due to presence of body	m	ft
α	angle of attack	degree	degree
γ	ratio of specific heat capacity at constant pressure to specific heat capacity at constant volume		
λ	taper ratio of net wing, c_t/c_r		
ρ	free-stream density	kg/m ³	slug/ft ³



This Item presents a method for estimating the pitching moment coefficient for delta, cropped delta and rectangular wings mounted at mid-height on an axisymmetric body. The method is applicable, within the Mach number range 1.2 to 5.0, to configurations having thin, sharp-edged, planar wings of aspect ratio in the range 0.2 to 4.0 at angles of attack up to 60 degrees; it must be used in combination with Item Nos 91007 (Derivation 24), 91042 (Derivation 25) and 92024 (Derivation 26). The method is for the condition of zero roll and can therefore also be applied to cruciform wings at this condition.

The method is outlined in Section 3 and is illustrated by means of a worked example in Section 6. A guide to the accuracy and applicability of the method may be found in Section 4.