the expression

$$\omega_N = (\omega_0^2 + K_N)^{1/2} \; (K_N > 0) \quad (8)$$

The sideslip sensitivity increases for large ω_N/ω_{sp} which implicate large negative values of $M_{\beta\beta}$. Similar considerations exist for the influence of the frequency ratio ω_N/ω_d on the sideslip sensitivity of the dutch roll branch, where the minimum sensitivity is obtained for $\omega_N/\omega_d \simeq 1$. In addition, the paths of the root loci are not unique as can be seen from the transition effect between the curves b and c.

Conclusions

It is the purpose of this Note to give the stability and control analyst some feel of and a simple procedure for determining aerodynamic coupling effects due to steady sideslip. On the basis of the feedback analogy, it is shown that the root locus technique is a powerful tool for inspecting and predicting the single contributions of the aerodynamic coupling derivatives on the characteristic roots for a wide variety of aircraft classes.

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Pitot Inlet Additive Drag

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SIBULKIN[1] derived the explicit analytical expression for Pitot inlet additive drag based on flow continuity and momentum considerations. However, it is difficult to apply manually at prescribed values of capture area ratio. This Note presents a unique additive drag approximation defined in simpler terms of capture area ratio, together with static pressure coefficient and total pressure coefficient ahead of the inlet.

Consider the Pitot inlet depicted in Fig. 1. The terms P_s and P_t are the upstream static and total pressures, respectively, when freestream Mach number M_0 is less than 1.0, and those pressures directly behind the normal shock when M_0 is 1.0 and greater. For a fixed M_0 and upstream capture area A_0 an approximate expression for additive drag coefficient C_{D_a} (derived intuitively) is

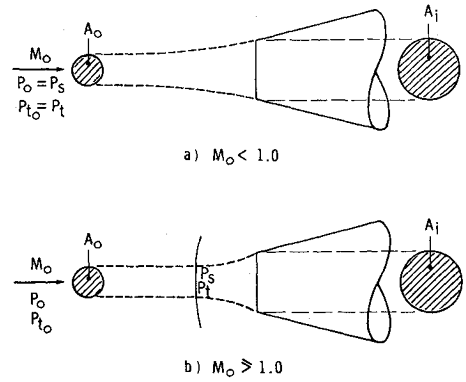

Fig. 1 Pitot inlet nomenclature.

$$C_{D_a} = C_{P_s}(1 - A_0/A_i)A_0/A_i + C_{P_t}(1 - A_0/A_i)^{(2+C_{P_s})/C_P} \quad (1)$$

where C_{D_a} = (additive drag)$/0.7P_0M_0^2A_i$, $C_{P_s} = (P_s - P_0)/0.7P_0M_0^2$, and $C_{P_t} = (P_t - P_0)/0.7P_0M_0^2$.

At $M_0 < 1.0$ (i.e., with no bow shock), $C_{P_s} = 0$ and C_{P_t} is the upstream stagnation pressure coefficient, which may be determined from the value of P_{t_0}/P_0 in standard isentropic flow tables at $M = M_0$. At $M_0 \geqslant 1.0$, C_{P_s} and C_{P_t} correspond to properties behind the normal shock and may also be determined from shock tables at $M = M_0$. Alternatively, the appropriate analytical expressions are

$$C_{P_s} = 0 \text{ at } M < 1.0 \quad (2)$$

$$C_{P_s} = \tfrac{5}{3}(M_0^2 - 1)/M_0^2 \quad \text{at} \quad M_0 \geqslant 1.0 \quad (3)$$

$$C_{P_t} = [(1 + M_0^2/5)^{3.5} - 1]/0.7M_0^2 \quad \text{at} \quad M_0 < 1.0 \quad (4)$$

$$C_{P_t} = [1.84/(1 - 1/7M_0^2)^{2.5}] - 1/0.7M_0^2 \quad \text{at} \quad M_0 \geqslant 1.0 \quad (5)$$

Numerical values from Eqs. (2–5) are shown in Fig. 2, together with values of the exponent contained in Eq. (1). At limit conditions of M_0 and capture area ratio, Eq. (1) itself has the following noteworthy properties:

$$C_{D_a} = (1 - A_0/A_i)^2 \quad \text{at} \quad M_0 = 0 \quad (6)$$

$$C_{D_a} = C_{P_t} \quad \text{at} \quad A_0/A_i = 0 \quad (7)$$

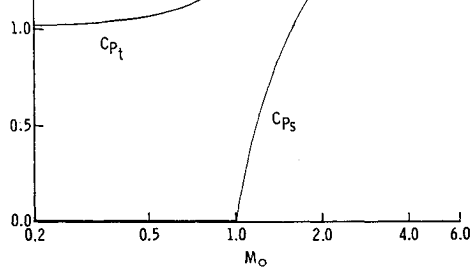

Fig. 2 Static and total pressure coefficients.

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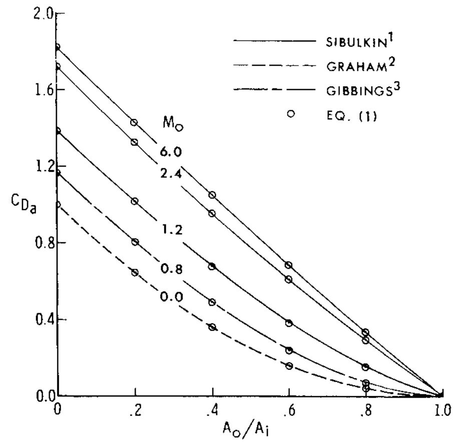

Fig. 3 Comparison of C_{D_a} by present method and other analytical sources.

$$C_{D_a} = C_{P_s}(1 - A_0/A_i) \quad \text{at} \quad A_0/A_i = 1.0 \tag{8}$$

$$dC_{D_a}/d(A_0/A_i) = -2 \quad \text{at} \quad A_0/A_i = 0 \tag{9}$$

$$dC_{D_a}/d(A_0/A_i) = -C_{P_s} \quad \text{at} \quad A_0/A_i = 1.0 \tag{10}$$

Equation (6) is identical to the incompressible form of C_{D_a} derived by Graham.[2] Equation (7) concurs with Sibulkin's[1] derivation when his equation is evaluated at zero capture area ratio. The properties defined by Eqs. (8–10), however, are not readily deducible from Sibulkin although curves based on his equations appear to be compatible in trend. In Fig. 3, values of C_{D_a} from Eqs. (1–5) are compared with analytical levels presented by Sibulkin and others.[3,4] The agreement is generally well within ± 0.003.

Experimental data presented in Refs. 1 and 5 substantiate theory at M_0 values of 1.42–1.87. Figure 4 presents further substantiating data[6] acquired at the General Dynamics/Convair High Speed Tunnel during tests with a series of sharp-lip and blunt-lip cowls. Additive drag was determined by means of pressure rake instrumentation at the inlet, metered duct flow, and application of flow continuity considerations. The results at M_0 values of 1.80, 1.20, and 0.86 are typical and agree well with C_{D_a} from Eq. (1).

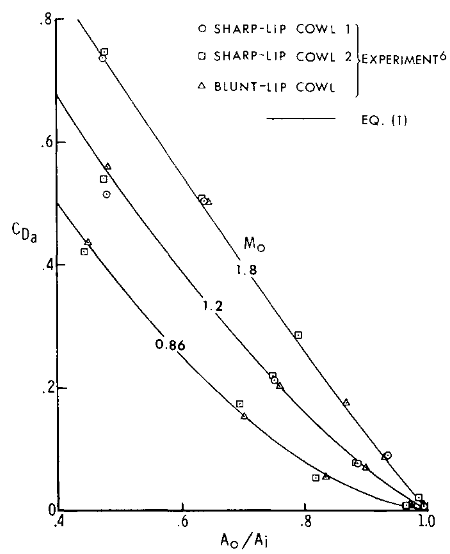

Fig. 4 Comparison of C_{D_a} by present method and experimental measurement.

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Solutions for Axially Symmetric Orthotropic Annular Plates

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Nomenclature

A,B,C,E	=	arbitrary constants
a	=	radius of plate
D_r,D_θ	=	plate constants in the radial and circumferential directions
k	=	$(D_r/D_\theta)^{1/2}$
M	=	bending moment
M_r,M_θ	=	radial bending moment and circumferential bending moment
P	=	point load
Q_r	=	transverse shearing force
q,q_0	=	lateral loading
r	=	radial coordinate
r_0,r_1	=	coordinate for starting function
w	=	lateral deflection
w_d,w_r,w_m w_Q,w_l	=	starting functions for unit deflection, unit slope, unit moment, unit shear, and unit lateral load, respectively
w_p	=	particular solution
$\alpha_{ij}(r)$	=	slope, or stress field for various starting functions as noted in Table 2
ν_r,ν_θ	=	Poissons ratio in radial and circumferential direction

Introduction

A SYSTEM of starting functions for solving annular orthotropic plate problems are presented. At a given radial coordinate, r_0, r_1, etc., a particular function will give a unit intensity for one field quantity and zero for all others. The technique of generating solutions to problems is indicated with an example.

Formulation of Starting Functions

The equilibrium equation for axisymmetric problems for classical plate theory is given by Eq. (1)

$$w'''' + (2/r)w'' + k^2[-(1/r^2)w'' + (1/r^3)w'] = q(r)/D_r \tag{1}$$

Table 1 Starting functions and stresses

w	(dw/dr)	M_r	M_θ	Q_r	q
w_d	0	0	0	0	0
w_r	α_{21}	α_{22}	α_{23}	0	0
w_m	α_{31}	α_{32}	α_{33}	0	0
w_Q	α_{41}	α_{42}	α_{43}	α_{44}	0
w_l	α_{51}	α_{52}	α_{53}	α_{54}	α_{55}

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