

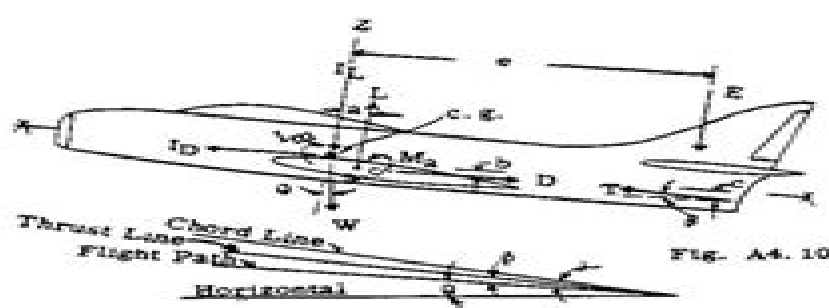


Fig. A4.10

- T = engine thrust.
 L = total wing lift plus fuselage lift.
 D = total airplane drag.
 L_a = moment of L and D with reference to wing a.c. (aerodynamic center)
 W = weight of airplane.
 I_L = inertia force normal to flight path.
 I_D = inertia force parallel to flight path.
 I_m = rotation inertia moment.
 E = tail load normal to flight path.

For a horizontal constant velocity flight condition, the inertia forces I_L , I_D , and I_m would be zero. For an accelerated flight condition involving translation but not angular acceleration about its own c.g. axis, the inertia moment I_m would be zero, but I_L and I_D would have values.

Equations of Equilibrium For Steady Flight.

From Fig. A4.10 we can write:-

$$\begin{aligned}
 \Sigma F_x &= 0, & D + W \sin \theta - T \cos \beta &= 0 \\
 \Sigma F_z &= 0, & L - W \cos \theta + T \sin \beta - E &= 0 \\
 \Sigma M_y &= 0, & -M_a - L_a - Db + Tc \cos \beta + Ea &= 0
 \end{aligned}$$

Equations of Equilibrium in Accelerated Flight.

$$\begin{aligned}
 \Sigma F_x &= 0, & D + W \sin \theta - T \cos \beta - I_D &= 0 \\
 \Sigma F_z &= 0, & L - W \cos \theta + T \sin \beta - I_L - E &= 0 \\
 \Sigma M_y &= 0, & -M_a - L_a - Db + Tc \cos \beta + Ea + I_m &= 0
 \end{aligned}$$

Signs used: { Forces - Plus is up and toward tail.
 Moment - Clockwise is positive.
 Distances from c.g. to force - Plus is up and toward tail.

A4.7 Load Factors.

The term load factor normally given the symbol (n) can be defined as the numerical multiplier. The bar through letter Z has no significance. Same meaning without bar.

multiplying factor by which the forces on the airplane in steady flight are multiplied to obtain a static system of forces equivalent to the dynamic force system acting during the acceleration of the airplane. Fig. A4.11 illustrates

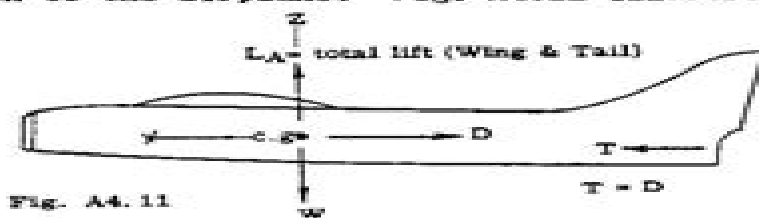


Fig. A4.11

forces in steady horizontal flight. L represents the total airplane lift (wing plus tail). Therefore $L = W$. Now assume the airplane is accelerated upward along the Z axis. Fig. A4.12 shows the additional inertia force $W a_z/g$ acting downward, or opposite to the direction of acceleration. The total airplane lift L for the



Fig. A4.12

unaccelerated condition in Fig. A4.11 must be multiplied by a load factor n_z to produce static equilibrium in the Z direction.

$$\text{Thus, } n_z L - W - \frac{W}{g} a_z = 0$$

Since $L = W$

$$\text{Hence } n_z = 1 + \frac{a_z}{g}$$

An airplane can of course be accelerated along the X axis as well as the Z axis. Thus in Fig. A4.13 the magnitude of the engine thrust T is greater than the airplane Drag D , which



Fig. A4.13

causes the airplane to accelerate forward. It is convenient to express the inertia force in the direction in terms of the load factor n_x and the

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N Noddings



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Virtual Principles in Aircraft Structures M. Gatewood, 2012-12-06 The basic partial differential equations for the stresses and displacements in classical three dimensional elasticity theory can be set up in three ways 1 to solve for the displacements first and then the stresses 2 to solve for the stresses first and then the displacements and 3 to solve for both stresses and displacements simultaneously These three methods are identified in the literature as 1 the displacement method 2 the stress or force method and 3 the combined or mixed method Closed form solutions of the partial differential equations with their complicated boundary conditions for any of these three methods have been obtained only in special cases In order to obtain solutions various special methods have been developed to determine the stresses and displacements in structures The equations have been reduced to two and one dimensional forms for plates beams and trusses By neglecting the local effects at the edges and ends satisfactory solutions can be obtained for many cases The procedures for reducing the three dimensional equations to two and one dimensional equations are described in Chapter 1 Volume 1 where the various approximations are pointed out

8th PhD Symposium in Copenhagen Denmark FIB - International Federation for Structural Concrete, 2010-06-01

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Analytical Design Methods for Aircraft Structural Joints W. F. McCombs, J. C. McQueen, J. L. Perry, 1968 An engineering procedure for determining the distribution of loads in the mechanically fastened joints of splice and doubler installations has been developed Methods for both hand analyses and computer analyses are presented Routines for solution by digital computer are provided The methods are generally limited to the cases of a single lap arrangement and a single sandwich arrangement but the cases of multiple stacked members is discussed The members may have any form of taper or steps and the effects of fastener hole clearance or slop and plasticity can be accounted for

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Aeronautical Engineering, 1991

High-performance Sustainable Materials and Structures Prince Lazar, I. A. Palani, Manish Kumar, 2024-10-31 This book underscores the idea of harnessing the sustainable designs and materials in nature and integrating them into the field of engineering to design innovative materials and structures with multifunctional properties targeting defense automotive aerospace electronics nuclear healthcare energy sports packaging etc to offer improved safety reliability performance durability sustainability and functionality The concept of sustainability involves the understanding of how nature has evolved solutions to various challenges over millions of years and applying these principles to design innovative materials and structures with multifunctional properties This book provides a thorough examination of the methods and techniques used in developing sustainable materials and structures highlighting their potential for multifunctional applications The book delves into the expansion of our understanding in this field which is accompanied by novel synthesis and processing methods These methods and techniques incorporate sustainable strategies to create

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