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NASA TECH BRIEF

Ames Research Center

Lift Distribution in a Rectangular Jet

The problem:

There is an apparent need for VSTOL aircraft to relieve air traffic congestion. One of the most promising methods of reducing take-off and landing distances is to use propellers or ducted fans to augment the airflow over the wing at low speeds. It is necessary to be able to predict the effect of slipstream-wing flow interaction on the aerodynamic characteristics of deflected slipstream and tilt aircraft.

The solution:

Two programs have been developed for the prediction of slipstream-wing flow interaction. The first of these calculates the lift distribution, lift and drag of a wing in a wide slipstream, such as might be produced by several propellers.

How it's done:

To restrict the complexity of the calculations, it is desirable to use the simplest possible analytical models. Two models of a wide slipstream have been found to be amenable to analysis: a rectangular jet and an elliptic jet. The rectangular jet is particularly suitable for an analysis of the static case, when the aircraft is in a hovering condition. The situation of the blown part of the wing is then similar to that of a wing in an open wind tunnel, making it possible to draw upon existing theories of wind tunnel interference. The distinguishing features of the present case are that the wing may span the entire jet and that the aspect ratio of that part of the wing which is in the jet may be small. These features make it desirable to allow for both the spanwise and the chordwise variation of the interference downwash. With a rectangular jet it is possible to satisfy the boundary condition for the static case at every point of the jet surface throughout its length by introducing images, so that a lifting surface theory can be readily developed.

Unfortunately, this theory is exact only for the static case, since it is no longer possible to satisfy the boundary conditions at the surface of a rectangular jet by introducing images when the aircraft has forward speed. Using an elliptic jet as a model of the slipstream, it is possible, however, to develop a simple lifting line theory which is valid throughout the speed range. From the results of this analysis, it is then possible to determine a correction factor for the effect of forward speed on the rectangular jet. In this way, an approximate lifting surface theory is obtained for the whole speed range. By using the results of calculations for a square jet to estimate the chordwise variation of the interference downwash, it is also possible to develop a simplified lifting surface theory for a circular jet.

Notes:

1. This program was written in FORTRAN IV for use on either the IBM-360 or IBM-1130 computer.
2. Inquiries concerning this innovation may be directed to:
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   Barrow Hall
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   Reference: B71-10030

Patent status:

No patent action is contemplated by NASA.

Source: Antony Jameson of
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