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Flutter of Systems with Many Freedoms

-by-

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SUMMARY

Experience has shown that it is often necessary to retain many degrees of freedom in order to calculate critical flutter speeds reliably, but this entails much labour. Part I discusses the choice of a minimum set of freedoms and suggests that this should be based on the equation of energy and the use of the Lagrangian dynamical equation corresponding to any proposed additional freedom. The methods for conducting flutter calculations so as to minimise labour are treated in Part II.

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1. Introduction

The aim of this paper is to discuss methods for calculating the critical flutter speeds and the nature of the motion at these speeds for systems with a large number of degrees of freedom. This problem is becoming increasingly important since it is now recognised that reliable estimates of critical speeds can, in many instances, only be made when many independent kinds of motion of the structure are admitted. However, the labour in the calculations increases exceedingly rapidly as the number of degrees of freedom is increased. Hence two principal problems arise:-

(a) The choice of a minimum set of dynamical coordinates or degrees of freedom which leads to calculated results of adequate accuracy.

(b) The choice of the method of conducting the calculations after the dynamical coordinates have been chosen.

These problems are separately considered in Parts I and II of the paper.

It is concluded that a particular freedom F must be retained when the balance of energy at a critical flutter speed is sensitive to its inclusion, unless it can be shown that the amplitude of F is very small. This amplitude will be very small when one or both of the following conditions is satisfied:-

(a) The coupling terms in the Lagrangian dynamical equation corresponding to F are all very small.

(b) The impedance for F at the critical flutter speed and for the flutter frequency is very large.

As regards the energy balance, it is shown that large skew-symmetric components in the aerodynamic stiffnesses are of particular importance. Inverse methods appear to be the most advantageous for the calculation of critical flutter speeds when there are many freedoms.

There are a few known special cases where 'exact' calculations of critical flutter speeds can be made for elastic continuous systems having infinitely many degrees of freedom. Such systems throw much light on the general problem of the choice of freedoms and they are briefly considered in the following section.

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