

Abstract

Free vibration, acoustic response and supersonic flutter of periodic structures have been analysed in this thesis using a wave propagation method based on Floquet's principle.

Deflection functions formed by a judicious combination of the characteristic beam functions so as to include the effects of rotational restraints at the supports have been used wherever appropriate. Beam function modes have been chosen due to their inherent elegance and brevity.

Free vibration of rotationally restrained periodic beams and plates has been studied. Propagation constant curves and surfaces (i.e. the phase constant-natural frequency relationships) have been presented covering a large range of frequencies in different 'propagation bands'. The propagation surfaces have been conveniently identified by a pair of integers representing the bounding modes of the corresponding bands. Natural frequencies of finite periodic beams and plates for certain specified end-conditions have been obtained using the figures presented (Publications [1] and [2]).

Response of rotationally restrained and unrestrained beams and plates subjected to an acoustic pressure field have been determined using a superposition of beam modes. It has been shown that the critical conditions for the maximum response in any desired propagation band can be determined from resonant response-convection speed relationships (Publications [3] and [4]).

Wave propagation concepts have been applied to study the behaviour of periodic structures exposed to a supersonic flow. It has been found that flutter wave propagation occurs in frequency ranges which were pure attenuation zones of the in-vacuo case. Further, it has been found that while in the absence of a fluid flow the propagation constants of periodic beams on non-deflecting supports are either purely real (attenuation bands) or purely imaginary (propagation bands), they tend to be complex in general, (having attenuation and phase constants) if the periodic structure

is subjected to a fluid flow. A new and simple method is described by which the critical flutter conditions of a given finite number of panels may be read off from the curves presented. Extreme limits of flutter have been found to exist within a given frequency band. This is perhaps the first successful application of the wave propagation method for flutter prediction of multi-spanned plates, and forms the most significant contribution of this thesis (Publications [5] and [6]).

Results obtained in the present work have been compared with those presented in earlier literature wherever possible.