Waves and finite elements

Brian Mace

Acoustics Research Centre
Department of Mechanical Engineering
University of Auckland, New Zealand
b.mace@auckland.ac.nz

Abstract

A wave and finite element (WFE) method for the analysis of the wave behaviour of uniform and periodic 1- and 2-dimensional structures is described.

Wave methods are an appealing approach to acoustics and vibration at higher frequencies, when the size of the structure, or component substructure, is large compared to the wavelength. They require knowledge of the characteristics of wave propagation, reflection and transmission. Determining these is not difficult for simple cases such as isotropic beams and plates, but for more complex structures – e.g. composites, laminates, cylinders, tyres – analysis becomes difficult at best and a numerical approach is valuable.

The WFE method involves conventional finite element (FE) analysis of just a small segment of the structure, using conventional methods and commercial codes, followed by application of periodic structure theory. The method is overviewed, a hybrid FE/WFE method for the analysis of reflection and transmission at joints or boundaries of arbitrary complexity described, and some recent developments outlined. Applications are presented, including laminated fibre-reinforced panels, fluid-filled cylinders, a tyre, an extruded truss-cored aluminium panel and sound transmission. The WFE approach allows predictions to be made over a wide frequency range at a very small computational cost.

Brief bio

Brian's general research interests concern structural dynamics, vibrations, acoustics, active noise and vibration control, smart structures and dynamics. More specifically they include structural dynamics, uncertainty modelling, wave-based approaches, smart structures and active noise and vibration control, with the particular emphasis being on the noise and vibration behaviour of structures at higher frequencies. He has worked mostly at the Institute of Sound and Vibration Research, University of Southampton and the University of Auckland, New Zealand. He is currently Professor of Mechatronics at the University of Auckland.