APPLICATION OF HIGH ORDER ACOUSTIC FINITE ELEMENTS TO TRANSMISSION LOSSES AND ENCLOSURE PROBLEMS

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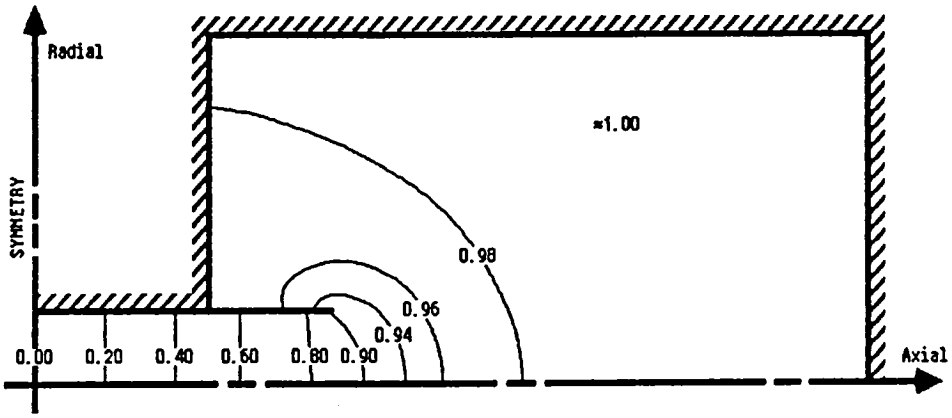
A family of acoustic finite elements has been developed based on C° continuity (acoustic pressure being the nodal variable) and the no–flow condition. The family includes triangular, quadrilateral and hexahedral isoparametric elements with linear, quadratic and cubic variation in modelling and distortion. Of greatest use in problems with irregular boundaries are the cubic isoparametric elements: the 32 node hexahedral element for three–dimensional systems; and the twelve node quadrilateral and ten node triangular elements for two–dimensional/axisymmetric applications. These elements have been applied to problems involving cavity resonances, transmission loss in silencers and the study of end effects, using a Floating Point Systems 164 attached array processor accessed through an Amdahl 5860 mainframe.

Accuracy of the cubic elements is quite good, requiring only two elements per standing wavelength in a rectangular room cavity resonance problem to produce eigenvalues with less than 0.5% error.

The elements are presently being used to study the end effects associated with duct terminations within finite enclosures. The model utilized in this study is essentially a helmholtz resonator which consists of two cavities connected by a duct, the overall enclosure being symmetric about the midpoint of the duct. By solving for the lowest non–zero eigenpair, the acoustic pressure contours can be plotted (see figure 1 for example) and the equivalent attached mass calculated. Through variations in the geometry of the duct termination and the location of the cavity walls, design criteria are being developed.

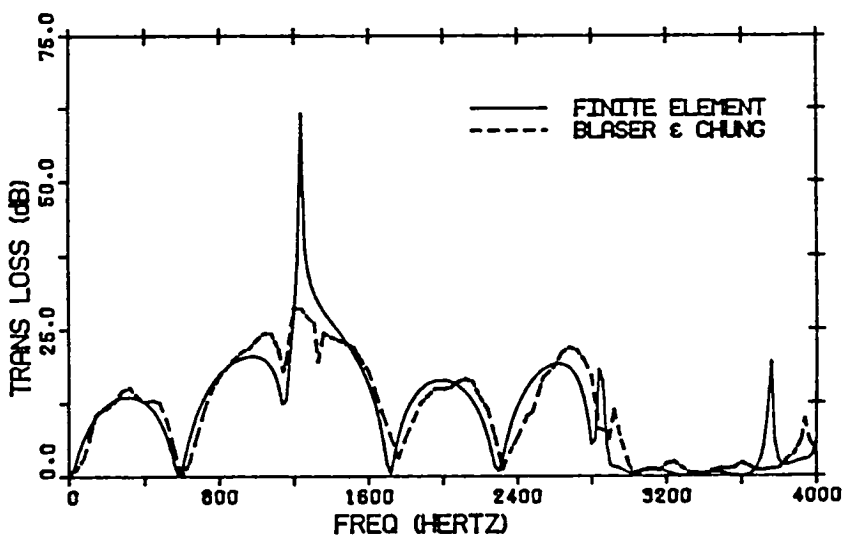
The transmission losses associated with various silencers and sidebranches in ducts is also being studied using the same elements. The inlet and outlet ducts are modelled as having infinite lengths and the inlet and outlet waves are forced to be plane. Both the transmission loss spectrum for a particular frequency range and the pressure profile for a specific frequency can be generated. As a test of both the program and the elements, a comparison was done with experimental data gathered by Blaser and Chung (1) for an expansion chamber silencer. The model of the silencer was based on the use of two quadrilateral cubic elements per wavelength over the frequencies of interest, and the resulting transmission loss spectrum is very close to the experimental (see figure 2).

(1) D.A. Blaser and J.Y. Chung 1978 *Proceedings - International Conference on Noise Control Engineering: Inter-Noise '78.* A transfer function technique for determining the acoustic characteristics of duct systems with flow.



RELATIVE PRESSURE CONTOURS FOR A SHARP–EDGED CIRCULAR DUCT

Figure 1



COMPARISON TO EXPERIMENTAL DATA FOR SILENCER

Figure 2