AN ABSTRACT OF A THESIS

THE FREE VIBRATION OF INFINITELY LONG CYLINDRICAL SHELLS WITH BÉZIER CUBIC CROSS SECTIONS USING THE GRÖBNER BASIS METHOD

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Vibrations occur in buildings, bridges, aircraft, automobiles, and other structures when these structures are subjected to dynamic loading. At specific frequencies, namely natural frequencies, failure may be induced by a varying force with a frequency close or equal to the natural frequency of the structure. In this case, the vibration of the structure becomes violent, a phenomenon called resonance. For this reason, vibration analysis is of great significance, especially in determining natural frequencies, to avoid resonance. Vibration analysis can also provide some accuracy, reliability, and operation foresight for structural design which are desirable in various engineering industries.

The objective of the thesis study was to analyze the free vibration of infinitely long cylindrical shells with Bézier cubic cross sections using the finite element method. The Bézier cubic curve was of interest because of its flexible and controllable characteristics which allow it to model very complex geometry. For this study, the Bézier cubic curve was used to model a cross section similar to an airplane wing cross section. The cross section was created using the Gröbner basis method, one of the efficient mathematics tools to generate parallel curves. The shell was assumed to be infinitely long which made the vibration analysis a plane strain problem. A standalone FORTRAN program written by George Buchanan was used to calculate the natural frequencies and corresponding mode shapes. Assumed solutions for the displacement equations of motion were written in terms of the circular frequency which reduces the three-dimensional problem to a two-dimensional problem in the finite element model. However, a three-dimensional dependence was retained for the solution depending upon the choice of the axial wave number. Several example problems were investigated to determine the effects on the frequency of vibration and some of the results were validated with good agreement using the commercial finite element analysis software ANSYS.