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Three-Dimensional Vibration Characteristics of Piezoelectric Semi-Spherical Shell

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Abstract : Piezoelectric circular plates can provide out-of-plane vibrational displacements on low frequency and in-plane vibrational displacements on high frequency. Piezoelectric semi-spherical shell, which is double-curvature structure, can induce three-dimensional vibrational displacements over a large frequency range. In this study, three-dimensional vibrational characteristics of piezoelectric semi-spherical shells with free boundary conditions are investigated using three experimental methods and finite element numerical modeling. For the experimental measurements, amplitude-fluctuation electronic speckle pattern interferometry (AF-ESPI) is used to obtain resonant frequencies and radial and azimuthal mode shapes. This optical technique utilizes a full-field and non-contact optical system that measures both the natural frequency and corresponding vibration mode shape simultaneously in real time. The second experimental technique used, laser displacement meter is a point-wise displacement measurement method that determines the resonant frequencies of the piezoelectric shell. An impedance analyzer is used to determine the in-plane resonant frequencies of the piezoelectric semi-spherical shell. The experimental results of the resonant frequencies and mode shapes for the piezoelectric shell are verified with the result from finite element analysis. Excellent agreement between the experimental measurements and numerical calculation is presented on the three-dimensional vibrational characteristics of the piezoelectric semi-spherical shell.

Keywords : piezoelectric semi-spherical shell, mode shape, resonant frequency, electronic speckle pattern interferometry, radial vibration, azimuthal vibration
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