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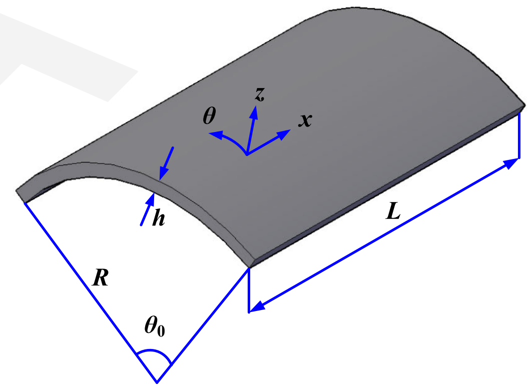
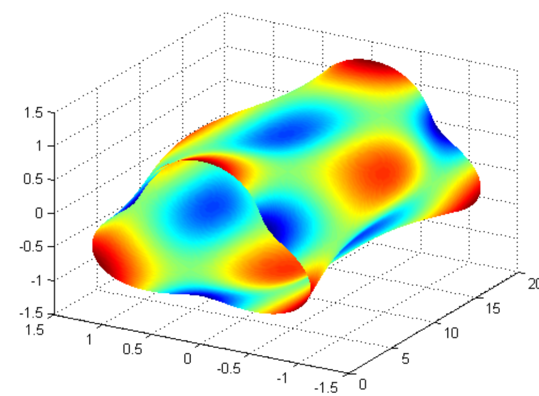
Exact free vibration analysis of open circular cylindrical shells by the method of reverberation-ray matrix

Key words:

Open circular cylindrical shell, Method of reverberation ray matrix, Free vibration analysis, Donnell-Mushtari-Vlasov thin shell theory, Analytical wave form solution

- Thin shells are extensively used in naval architecture and ocean engineering, as well as in civil, mechanical, and aeronautical engineering. Open circular cylindrical shells are often used as structural components of pressure vessels, roof structures, open space buildings, and marine structures.
- It is of great significance for engineers to be familiar with the vibration behaviors of such shell structures in practical design.
- Many pioneering scholars have developed numerous approximate analytical models for thin shells. Most thin shell theories developed before 1973 were formulated by (Leissa, 1973).
- The method of reverberation ray matrix is suitable for determining the natural frequencies and steady-state response of multi-span structures and space frame structures with complex geometry.





In the present work, the research field of the method of reverberation ray matrix is extended to but not restricted to dynamic analysis of open circular cylindrical shells. The effects of shell length, shell radius, shell thickness, and the included angle as well as the boundary conditions for the remaining two edges on the natural frequencies are investigated.

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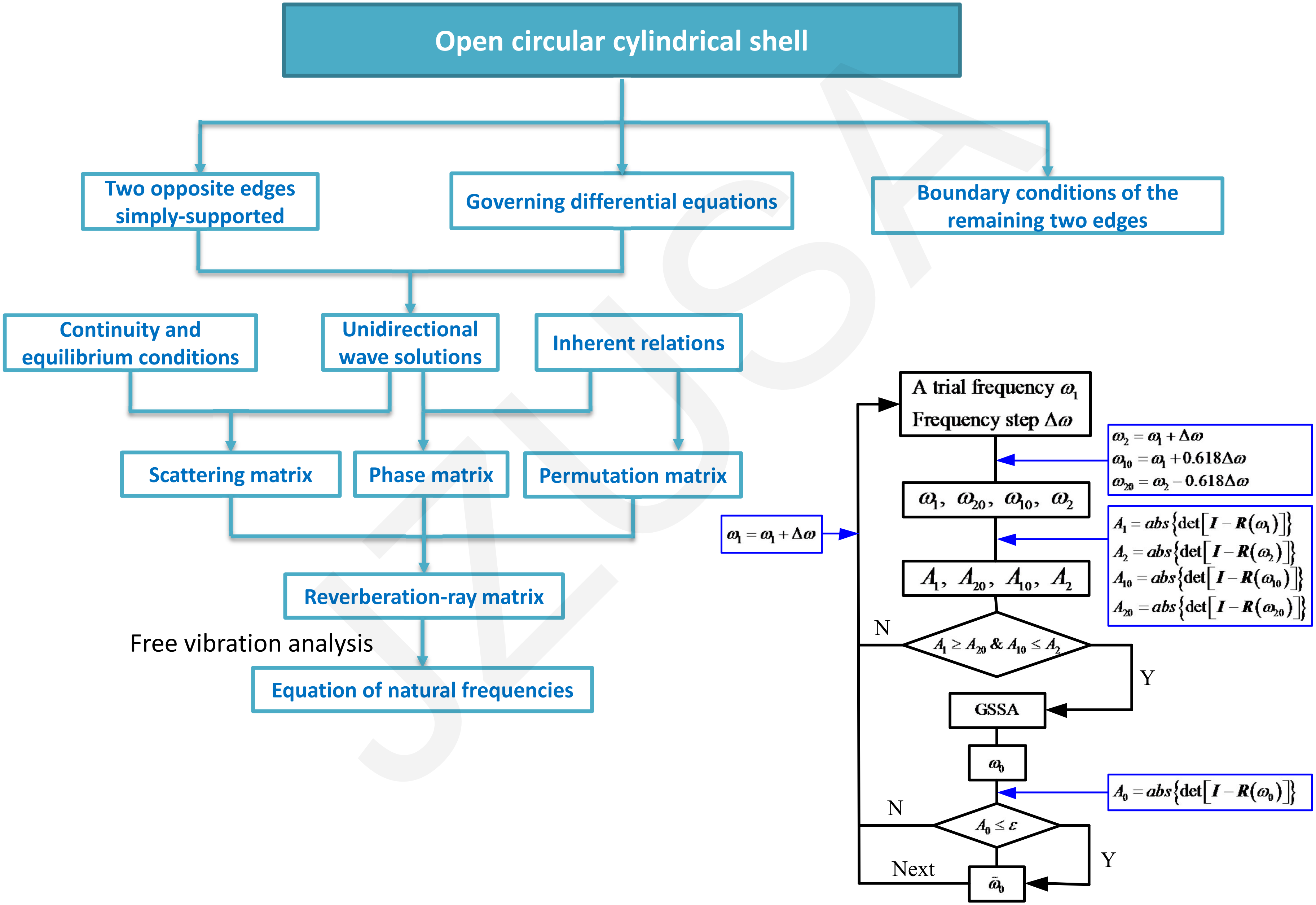
METHOD



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RESULTS AND CONLUSIONS

- The method of reverberation-ray matrix is validated and of high precision for vibration analysis of open circular cylindrical shells.
- The natural frequencies of the open circular cylindrical shell decrease with the increase of the shell length.
- The natural frequencies of the open circular cylindrical shell decrease with the increase of the shell radius for most mode numbers.
- The natural frequencies of the open circular cylindrical shell increase with the increase of the shell thickness. The natural frequencies corresponding to different shell thickness are very close to each other for mode numbers n=1 and 2, while they vary linearly with the shell thickness for mode numbers n≥7.
- The natural frequencies of the open circular cylindrical shell decrease rapidly as the included angle increases for most mode numbers.
- As the two curved edges are simply supported, the natural frequencies corresponding to the three kinds of boundary conditions of the remaining two edges decrease in the order of CEs, SSEs, and FEs for most of the mode numbers.
- As the two straight edges are simply supported, the boundary conditions of the remaining two edges have little effect on the natural frequencies of the open circular cylindrical shell .
- The exact natural frequencies of the open circular cylindrical shell for various parameters and different boundary conditions are presented in tabular form for easy reference as benchmark values for researchers to verify their numerical methods and for convenient consulting for engineers in practical design.

RELATED ARTICLES

- Tang D., Pang F., Wang Q., Yao X. Research on transmission loss of power flow through a finite Vshaped plate. Journal of Vibration Engineering, Vol. 29, Issue 1, 2016, p.1-11.
- Tang D., Wu G., Yao X., Wang C. Free vibration analysis of circular cylindrical shells with arbitrary boundary conditions by the method of reverberation-ray matrix. Shock and Vibration, Vol. 2016, 2016 p.1-18.
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