矩形弹性壳液耦合系统中的重力波分析

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摘要　　根据非线性动力学理论，建立了矩形壳液耦合系统的非线性振动方程组，通过数值求解，发现当激振频率为壳体固有频率与重力波频率之和，且激振力足够大时，会产生大幅低频重力波．通过实验验证，发现了壳液耦合系统中存在的大幅低频重力波现象，实验结果与理论结果基本吻合．

关键词　　壳液耦合系统,矩形壳,重力波,组合共振,非线性振动
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The analyses of gravity waves in a rectangular elastic fluid-shell coupled system

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Abstract

  The theory and experiment about gravity waves in a rectangular elastic fluid-shell coupled system are presented in this paper. A set of equations are constructed according to fluid and vibration theory. Based on the boundary and initial conditions of the system, the velocity potential of the fluid and the surface wave function of the first gravity wave are obtained. Through the numerical calculation for the equations, the time response curves and response spectrum are given to the first gravity wave. The results show that when gravity wave appears, the shell acts as pendulum and the gravity wave's motion is harmonic. Furthermore, the effects of exciting force and the frequency to the system are also discussed. Only when the force is large enough to conquer the viscid resistance and the frequency is near a certain constant, gravity waves are engendered, which is the result of resonance vibration. At the same time, the experimental study is processed. The phenomena observed are resonance without gravity wave if the system is excited on the shell with a horizontal force and the force is large enough but the frequency out of the scope. When all the conditions are met, large-amplitude and low-frequency gravity waves are observed. All the experimental results show good qualitative agreement with the theoretical results.

Key words　 fluid-shell coupled system　 rectangular shell　 gravity waves　 coupled resonance　 nonlinear vibration

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