SPACE EXPLORATION SYMPOSIUM (A3)
Poster Session (P)

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LATERAL BENDING VIBRATION AND EXPERIMENTAL INVESTIGATION OF THE LUNAR SOIL SAMPLING DRILL PIPE

Abstract

The coordinate system of the drill pipes is established according to the actual slant angle of the drilling process. In the provided coordinate, the geometric nonlinear dynamics equations of lateral bending vibration under simply supported are derived in consideration of lunar gravity and the axial force. The damp force and the axial force of the system are discussed, taking account of the centrifugal force, the cutting force and lunar gravity. The main resonance and non-main resonance approximate steady-state solutions are obtained through the multiple-scale method. And the influence of the friction damp and the axial force on the steady-state solutions are analyzed in theory and tested by experiments. Compared with the general rotor, the revolving speed of the drill pipe is lower (less than 500rpm). However, due to the complex load case, including the axial force, the longitudinal periodic impact and the lateral cutting force, the natural frequency of the slender drill pipe is reduced. Furthermore, the amplitude-frequency response curves are achieved by simulations and experiments. The curves reveal that the bending amplitude could reach 10-15mm in practice. And the amplitude jumps remarkably once the revolving speed ascends or descends, which is known as nonlinear bifurcation. The result is coincident with multi-scale amplitude-frequency analysis. Since the thin-walled slender drill pipe possesses the property of strong nonlinear, an auxiliary supported structure in the middle of the drill pipe is proposed to reduce the amplitude in order to avoid the resonance damage of the drill pipe.