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ANALYSIS ON PARAMETRIC EXCITATION VIBRATION OF DRILL PIPE OF LUNAR SOIL SAMPLER

Abstract

The lunar soil sampler can drill to 2 m under the soil. The slender drill pipe with the outer screw wing is designed as a hollow structure and its internal part is hollow. The impact rotary drilling mode is used. The high-density lunar soil particle contains a certain amount of lunar rocks. When the slender drill pipe contacts the hard stratum in the drilling test of experiment, the parametric excitation of lateral vibration will be generated due to the periodic loading of the pulsating axial force under the axial drilling pressure and impact pulsating force. The parametric excitation vibration makes impact energy fail to be transferred to the drilling bit effectively and crash the rock, even the thin-wall drill pipe generates the buckling failure. The unstable domain of the parametric excitation is determined by the kinetic parameters of the action system. The kinetic equation of the lateral vibration of the axial excitation of the Bernoulli-Euler action system is established. The axial excitation is decomposed into joint action of the constant drilling pressure and pulsating periodic force. The axial constant force affects the natural frequency of the pipe system. The pulsating force is processed as the periodic excitation load. The impact mechanism is used as the harmonic function excitation. The action of the small damping on the linear excitation system is considered. The kinetic equation of the undamped and damped parametric excitation is established. The separate variant method is used in the kinetic equation. The kinetic equation of the linear parameter vibration is transformed to the Mathieu equation to get the resonance area of the stable area and unstable area. The domain boundary is determined by the excitation frequency, system structure and kinetic parameters. For the vibration equation of damped parameters, the small parameter and multi-scale perturbation method is used to solve the one asymptotic steady state solution of the lateral amplitude in the time domain. The axial drilling pressure reduces system natural frequency and increases the unstable domain. The small damping reduces unstable domain. The analysis indicates that the reasonable excitation frequency, pulsating axial force, material of slender thin-wall drill pipe, flexural modulus and natural frequency should be matched to make the drill pipe operate away from the unstable domain generating parametric excitation vibration, ensures secure drilling of the lunar soil, impact broken rock effectively and get samples reliably.