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Dynamic Modeling and Swing Dynamics of Cable-Suspended Load Systems (Postprint)

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Abstract

For the analysis of swing patterns in under-constrained systems such as cable hoisting, a comprehensive approach combining theoretical modeling and visual simulation is employed to investigate the dynamic characteristics of cable hoisting systems. Using d'Alembert's principle, a dynamic model of the cable hoisting system is established, which not only considers the influence of horizontal and vertical motions on the system's motion state, but also incorporates the mass of the cable, thereby improving model accuracy. Reduced-order numerical solution of the model is performed using the Runge-Kutta method, and validation is conducted through dynamic simulation based on ADAMS software. Based on the dynamic model and numerical calculations, the influence patterns of horizontal motion, vertical motion, and system parameters on swinging are studied. The results show that: the established dynamic model and numerical calculations are accurate and can be used to study the motion patterns and control strategies of cable hoisting systems; during the motion of the hoisting point, the system's swing amplitude is significantly affected by the initial acceleration of the hoisting point, abrupt acceleration changes, and the vertical motion speed; excessive initial acceleration or abrupt acceleration changes, as well as greater vertical speed, result in larger swing amplitude, with vertical speed causing the swing amplitude to grow exponentially over time; after stopping, the swing amplitude is related to the velocity and acceleration of the load at the moment of stopping, as well as the system frequency; greater velocity leads to a larger base swing amplitude; greater acceleration and longer acceleration time result in larger increases in swing amplitude; cable length and load mass determine the system's natural frequency but do not affect the swing amplitude during system motion; research on the influence of hoisting point acceleration patterns on swinging can be used to guide the design and control of hoisting systems.

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Full Text

Preamble

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