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Longitudinal dynamic characteristics of steel wire rope in a friction hoisting system and its coupling effect with friction transmission

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Abstract: The longitudinal rope dynamics in a friction hoisting system and its coupling effect with friction transmission are investigated. The tension and longitudinal vibration characteristics of the rope are obtained through experiments. The dynamics of rope and friction transmission are obtained by a validated simulation model. The results show that the rope tension is divided into the dynamic tension regime and inertial tension regime due to the multi-frequency cross-linking. The longitudinal rope vibration is embodied as random perturbation. The reduction of the friction coefficient will increase the sliding between the rope and lining, and it will be beneficial to narrowing the dynamic tension regime. The increase in the longitudinal rope vibration will reduce the friction force between the rope and lining.

Keywords:； Longitudinal rope dynamics; Dynamic tension regime; Friction transmission; Coupling effect

1. Introduction

In the field of friction transmission, such as mining hoist, construction elevator, belt conveyor and automobile transmission, etc., the slender flexible rod is usually used as the transport carrier, and the friction force between the flexible rod and a rotating body is used as the power to carry out various operations. Multi-rope friction hoists, driven by the friction force between steel wire ropes and grooves on the surface of a pulley, have wide applications in deep mine hoists [1] and building elevators [2]. Compared to winding wire rope lifting system [3], multi-rope friction hoists have many advantages. The lifting height is not limited by the rope capacity of the drum. The load is shared by a number of wire ropes, which greatly improves the safety of the lifting work. The size and quality of the rope and hoisting equipment are significantly reduced. The quality of the multi-rope friction hoist is 20%-25% that of the winding type under the same load. The bending times of the wire rope are greatly reduced and the bending fatigue is weakened [4]. An assembly of a multi-rope friction hoist system is shown in Fig. 1, which is comprised of a friction pulley, a guide pulley, several steel wire ropes, several tail ropes, and two conveyances.

In recent years, the market for ultrahigh-speed elevators has continued to grow due to the expanding demand for skyscrapers worldwide. And with the development of deep mining, the requirements for safe and efficient production are increasingly urgent and strict. The high speed and long length of wire rope have more complicated dynamic characteristics, including dynamic rope tension, rope sway, rope resonance, external excitation (wind and earthquake) and transverse-longitudinal coupled vibrations [5-9]. The longitudinal dynamics of the wire rope includes rope tension and longitudinal vibration. In addition to the rope properties and the motion parameters,

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