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Study on dynamic responses of planar multibody systems with dry revolute clearance joint: numerical and experimental approaches

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Abstract

The main purpose of this work is to present a comprehensive methodology to study the dynamic responses of multibody dynamics with revolute clearance joint, which is based on an improved nonlinear impact force model and a modified friction force model. A planer slider-crank mechanism with clearance joint between connecting rods and slider is used as an example. Firstly, the simulation models are presented which can take into account the influence of different clearance size, crank speed and material on dynamic responses of planar multibody systems. Secondly, an experimental test rig is designed, which can monitor the dynamic responses of the slider-crank mechanism by using a linear voltage differential transducer (LVDT) and an accelerometer. Then, the experimental tests are conducted, which have the same working conditions with numerical simulations, and the slider acceleration and FFT analysis of slider acceleration are presented as two measurements. Finally, the experimental and numerical results are compared and discussed, which validate the nonlinear impact force model in clearance joint, and the numerical results of dynamic responses of mechanism with clearance joint.

Keywords: Multibody system; Dynamic responses; Nonlinear impact force model; Slider-Crank mechanism; Experimental test rig

1 Introduction

In dynamic analysis of planar mechanism, the joints which are used to connect two adjacent parts are usually assumed as ideal or perfect ones, and it means that there is no clearance between the journal and bearing [1-2]. However, because of the demand of relative motion, the errors due to manufacture and assemblage, and the influence of wear and material deformation, all the mechanical systems do not have perfect kinematic joints. Furthermore, clearance joints may cause a lot of harmful influences, such as impact reaction force and friction between journal and bearing,