EXPERIMENTAL ANALYSIS OF FRICTIONAL IMPACT IN OPEN-LOOP MULTIBODY MECHANICAL SYSTEMS

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ABSTRACT

Analysis of response of multibody mechanical systems subjected to impact is an important phenomenon in engineering design. The members involved in impact experience contact forces of high magnitude, which last only for a very short time. The presence of any tangential component of impact velocity requires a friction model capable of correct detection of the impact modes such as sliding, sticking, and reverse sliding. This work presents a formulation and methodology of experiment for the analysis of impact problems with friction in constrained multibody mechanical systems. The analysis is presented for open-loop multibody mechanical systems. The Poisson's hypothesis is used for the definition of the coefficient of restitution, and thus the energy gains inherent with the use of Newton's hypothesis are avoided. The formulation is developed by using a canonical form of the system equations of motion using joint coordinates and joint momenta. The joint coordinates reduce the equations of motion to a minimal set, and eliminate the complications arising from the kinematic constraint equations. The cases of impact are classified based on the pre-impact positions and velocities, and mass properties of the impacting systems. Analytical expressions for normal and tangential impulse are presented for each impact case. A system was setup to perform impact tests using a double pendulum impact with aluminum and steel plates at different heights. Experiments are conducted to investigate the nature of normal and frictional contact forces. The corresponding coefficients of restitution are found for each impact test. The post-impact velocities and the normal and tangential impulses obtained for each test, compare with the ones from the theoretical models. The experimental results verify that the methodology presented for the frictional impact analysis of multibody mechanical systems correctly recognizes the mode of impact; i.e., sliding, sticking and reverse sliding.