MODELING CONTACT FORCES AND ENERGY DISSIPATION DURING IMPACT IN MECHANICAL SYSTEMS

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Spring 1997

ABSTRACT

Analysis of response of mechanical systems subjected to impact is an important aspect of engineering design. The members involved in impact experience contact forces of high magnitude lasting only for a small duration. At the end of impact there will be a loss in the kinetic energy of the members involved. Many theoretical models have been previously proposed trying to explain this energy loss in the form of internal damping of the vibration of the system. These do not account for the loss of energy due to localized plastic deformations at the impact site and also it's combined effect with hysteresis damping. In this research, these phenomena were explained and modeled. The modeling of impact in stiff systems, flexible systems and multibody mechanical systems has been carried out. Experiments were conducted to investigate the nature of contact forces and to verify the theoretical models. An extension of the proposed models of impact between two bodies was made to impact in multibody mechanical systems. As an application of interest to the automobile and aircraft industries, a discussion on the modeling of head impact and selection of a proper padding material to reduce head injury levels of the occupants has been presented.

The results from this study showed that in stiff systems, the energy dissipation is mainly in the form of localized plastic deformation. In flexible members, at low impact velocities, hysteresis damping was found to be the prime factor for energy dissipation. Also, it was found that with a proper padding material and panel, it is possible to reduce head injury levels effectively.