MODELING THE STRUCTURAL CRASH RESPONSE OF A VEHICLE TORQUE BOX AND RELATED CRASH DYNAMICS OF THE VEHICLE OCCUPANT

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ABSTRACT

Torque boxes are the main structural components in ground vehicles, trains etc. They are mainly curved box beams that dissipate energy of impact so that a majority of impact energy as a result of a crash is dissipated before reaching the occupants. Analysis and design of torque boxes have been a subject of intense research for a long time. In this research, a flexible multibody dynamics approach, as well as nonlinear contact forces and plastic hinges are used to simulate the dynamic behavior of a torque box under barrier impact load. The flexibility is included in the analysis using the finite element method incorporating beam elements. Contact forces used are based on the Hertzian contact force law. A hysteresis damping term is included to represent the energy dissipation at the localized contact point. For the representation of large deformations, plastic hinges are introduced by revolute joints between two bodies loaded with elasto-plastic torsional spring-dampers. The data for springs is adopted from an experimental data bank.

Different materials are considered in this approach. The structural behavior and energy absorption capacity of different materials are compared and the material with a better energy absorption capacity is identified. The response of the torque box in a crash is used as an input to a vehicle occupant simulation. The obtained occupant injury parameters have been found to be well below the injury threshold values. The relationships between the injury parameters of occupants and structural stiffness are determined and further improvement of the structure is obtained such that the injury parameters reach less values.