NONLINEAR FINITE ELEMENT ANALYSIS CRASHWORTHINESS OF A VEHICLE TORQUE BOX

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ABSTRACT

Torque boxes are the main components in ground vehicles, cars, trains etc. They are curved box extrusions that dissipate energy of impact so that a majority of impact energy as a result of a crash is dissipated before reaching the occupants. Design and analysis of torque boxes have been a subject of intense research for a long time. In this thesis, a nonlinear explicit finite element method is used to simulate the dynamic behavior of a torque box under different barrier impact load and/or speed. A node to surface search algorithm is employed to model the contact between the barrier and torque box. A sticker sliding interface is assumed based on the fact that the structure experiences large plastic deformations to absorb the imparted kinetic energy. As one side of the torque box experiences the crushing behavior, the other end of torque box is fixed. Both parts are modeled using four-node Belytschko-Tsay shell elements. An artificial large material density is calculated for barrier to simulate a heavy rigid barrier mass depicting the condition for the Federal Motor Vehicle Safety Standard Test. Two different elastic - plastic metal materials are considered for the torque box in the simulations. The effect of strain rate is taken into account for strain sensitive A36 steel. The results of the study indicated local buckling and swelling phenomenon around the two curvature corners. The simulations were compared with some of the earlier experimental results in the literature. The structural behavior and energy absorption capacity of different materials are compared and the structural material with a better energy absorption capacity is identified.