PARAMETRIC STUDY OF NECK LOADS DURING AUTOMOBILE REAR-END IMPACTS

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Spring 2003

ABSTRACT

Recent research in the field of computer-aided engineering has focused on the development of safer automobiles in order to meet increasingly stringent requirement on the part of the customer and government agencies. One of the areas where research is currently being conducted, in order to meet these requirements, is in the area of neck injuries caused by low speed rear-end impacts. This is particularly important considering that one third of all the automobile accidents are rear-end impacts. Usually, the occupant in a rear-end collision experiences severe pain in the neck region and headache. This is due to the occupant experiencing whiplash. The occupant's orientation like the seatback angle of the seat, position of the headrest with respect to head, etc plays an important role in the nature and severity of injuries sustained.

This thesis will attempt to study the occupant responses during a low speed rear-end collision for three different speeds. The acceleration pulses (g) experienced at the driver's seat were obtained from a LS-DYNA simulation using a Ford Taurus model in a rear-end collision scenario against a full width deformable barrier. The results obtained from these simulations however, were found to vary significantly from the expected values. This may be due the result of FE model being very coarsely meshed at rear end. Consequently, compatible acceleration pulse (g) levels of 8g, 15g, and 20g were utilized for the simulation of occupant response and injury prediction.

The occupant responses for these pulses were then analyzed using the Mathematical Dynamical Model (MADYMO) code. The car interior, which includes the seat, steering and floor of the Ford Taurus, were modeled in MADYMO. A Hybrid III 50^{th} percentile dummy was used to study the responses. A TRID (TNO Rear Impact Dummy) model was used to study the responses at 20g acceleration pulse. The seat was modeled with three different seatback angles 9 deg., 22 deg., and 35 deg. The seat was also modeled without a headrest as well as with a headrest both above and below the C.G of the head. Neck loads were recorded and plotted for different acceleration pulses and headrest positions. While the focus of the study was primarily on low speed impacts with pulses up to 20g, in order to obtain a greater understanding of the general phenomenon of neck injuries due to rear-end impacts, simulations were also carried out at 40g with both articulated and rigid seatbacks.

The results from the study indicate that the dummy experiences lower neck loads if the headrest is at or above the C.G of the head. It was observed that the gap (backset) between the head and the headrest should be less than 5 cm to ensure lower load on the soft tissues. Seatback with angles between 9 deg. and 22deg. provides a good orientation of the occupant in the compartment. The neck loads of the Hybrid III dummy and TRID

model, when compared, indicates that the Hybrid III has a stiffer neck when compared with the TRID model. Under high severity condition at 40g, and a seat with a rigid seatback, the occupant sustains high neck loads as compared to a seat with articulated seatback. Finally, a methodology has been developed for reducing the neck loads during rear-end collision.