



Session: 2

Paper Number: 24

Traumatic Injury Potential to Seat-Belted Operator During a Rearward Overturn of A ROPS-Equipped Farm Tractor

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Each year, an average of 120 American farm tractor vehicle operators die from tractor overturns. The use of rollover protective structure (ROPS), together with a seat belt, has been found to be the single most effective method of preventing overturn-related fatalities. However, non-fatal traumatic injuries may still occur during these events when a ROPS and seatbelt are appropriately used. Preliminary NIOSH anthropometric analyses indicate that the current operator protective volume, as defined in the ANSI/SAE Standard J2194, may be too small to prevent average-to-large sized people from being injured in a rollover incident. The present study examined the injury potential to a seat-belted operator during a rearward overturn in a ROPS-equipped farm tractor.

Three rearward overturn tests were conducted at the field test site of the NIOSH Pittsburgh Research Laboratory. These tests involved a Ford 4600 farm tractor running up a 60 deg ramp at an average speed of about 5 mph, as per ANSI/SAE Standard J2194. An instrumented crash-test manikin (Advanced Dynamic Anthropomorphic Manikin or ADAM; equivalent to a 95th %tile male) was restrained to the tractor seat by a seat belt. Data collection included the manikin's head movement, upper neck load, and head injury criterion (HIC) measurements.

The results showed that the manikin's head moved outside the inclined plain (G1 G2 I2 I1 as defined in ANSI/SAE J2194) of the operator protective volume and impacted the ground during each rearward overturn test. The time history analysis of axial neck loading ranged from 514 lbs to 925 lbs, which suggested injury modes ranging from neck pain to neck fracture with quadriplegia. The HIC measurements were below the level of brain damage or skull fracture.

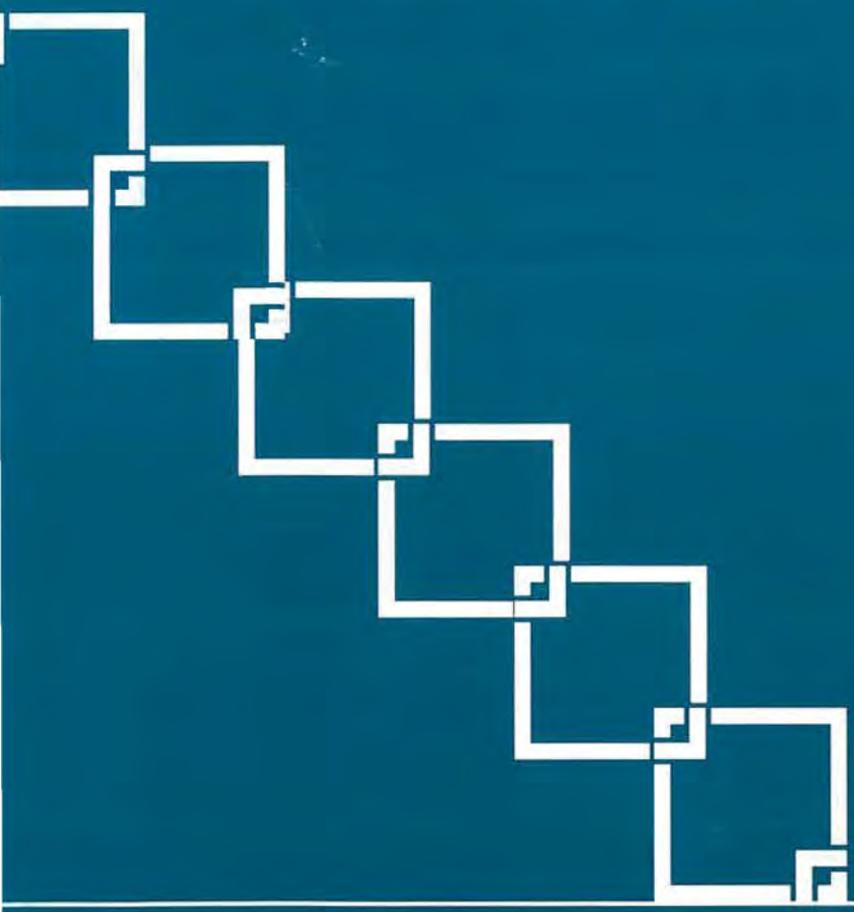
To reduce the likelihood of severe injuries to the upper neck, modifications could be made to the protective components of the farm tractor. First, the back rest of the tractor seat may be raised so that the head movement will be kept within the operator protective volume during a rearward overturn. Second, a mesh structure may be installed on the roll bar to prevent the operator's head from impacting the ground. Third, the operator protective volume may be redefined on the basis of the most recent anthropometric data, range of joint movement data, and the manikin's kinematic data obtained in this study. In the next phase of the study, the effectiveness of these modifications in reducing injury potential will be investigated.

20023576

NORA Symposium 2003



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June 23-24, 2003

Hilton Crystal City Hotel
Arlington, VA

