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Topic:

Crash Dynamics – Human Injury Criteria

Title: Comparison of the Hybrid II, FAA Hybrid III and THOR-NT in Vertical Impacts

Abstract

To support the National Aeronautics and Space Administration (NASA) occupant protection research, the Civil Aerospace Medical Institute compared the vertical response of typical civil aviation Anthropomorphic Test Dummies (ATDs) with the Test Device for Human Occupant Restraint (THOR). The performance of the THOR in the vertical direction has not been established and no lumbar injury criteria limit has been established. Compared to the Hybrid II and FAA Hybrid III, the THOR ATD has a different shaped lumbar spine element and has a load cell at the T-12 location instead of the sacro-lumbar location.

Impact sled tests were conducted using a rigid seat fixture pitched up at 60° off horizontal exposed to triangular pulses of 9 G, 14 G, and 19 G. A 1-inch very firm, rate sensitive cushion was chosen to distribute load on the pelvis while minimizing spinal load amplification. The National Highway Traffic Safety Institute Administration loaned the FAA an NT version of the THOR for this test series. Test setup techniques were employed to closely control the pre-test

position by reproducing the pelvic location and orientation in relation to the 1 G seating positions for each dummy. The FAA Hybrid III was instrumented with a T-12 load cell to allow for direct comparisons to be made between the Hybrid II-FAA Hybrid III and the THOR-FAA Hybrid III. Occupant kinematics as well as seat pan loads and floor loads were also gathered.

As expected, the lumbar load recorded by the Hybrid II and FAA Hybrid III closely matched for all three loading conditions. The change in load was not linear, suggesting that the rubber spine element is rate sensitive at these loading rates. The FAA Hybrid III T-12 and lumbar loads demonstrated a pure linear relationship ($r^2=0.999$) with the T-12 loads being approximately 85% of the lumbar load. Compared to the FAA Hybrid III, the THOR T-12 load was higher for the 9 G and 14 G tests and approximately equal at the 19 G condition. Based on the tests run in this series, the THOR-NT would not be considered an equivalent ATD to the Hybrid II for vertical testing and additional research is needed to determine appropriate lower thoracic spine injury metrics.