

Investigation of Human Kinematics and Risk of Injury during a Vertical Crash using Dummy and Human Finite Element Models

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Abstract

The first objective of this study was to validate a finite element (FE) model of the THOR crash dummy in a vertical impact scenario. The second objective was to compare the dummy model response to the corresponding response of a human model in the same impact conditions. The THUMS human FE model was used in this comparison.

A series of vertical drop tests were performed on a THOR crash dummy. Simulation impact conditions were replicated based on pre-impact velocities and crash pulse decelerations measured during testing. FE simulations were run with both dummy and human models using LS-Dyna software. The dummy model was evaluated relative to the test data in terms of kinematics (e.g. head acceleration) and kinetics (e.g. upper/lower neck and lumbar spine loading). Comparisons between kinematics and injury prediction of dummy and human models were also performed. Dummy injury criteria specific to vertical loading such as Head Injury Criterion, Lumbar Load Criterion, and Lower Neck Beam Criterion were calculated. A correlation matrix was developed based on the peak values of dummy injury criteria and human stress/strain in corresponding body regions. It is believed that this matrix will help to better evaluate the human injury risk based on the dummy measurements recorded during aerospace crash tests.

Preliminary results showed a reasonable correlation between the physical tests and FE dummy simulations. In addition the dummy and human models showed similar kinematics, though a greater compliance was observed in the human model. Promising overall results validate the use of the current THOR FE model in simulation, for evaluation of occupant safety in the aerospace field.