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## Human Response to a Frontal Sled Deceleration Test for the Validation of a Car Occupant Mathematical Model

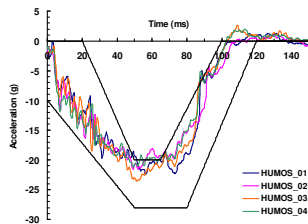
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### Introduction

The general objective of the HUMOS (HUMan MOdel for Safety) European research program is the development of a new finite element model of a seated car occupant, validated for car crash conditions and aiming at the optimization of vehicle design. The information presented here show the response of the Post Mortem Human Subject in a frontal sled deceleration test which is used for the validation of the model.

### Methodology

The experimental protocol was set up according to the needs expressed by the HUMOS consortium. For the mathematical modeling purpose, the boundary conditions were simplified. No steering wheel, no knee bolster and no airbag were mounted. The subject seated on a rigid seat was restrained by a 3-point belt with two types of load limiter (4 and 6kN) . A catapult simulated the impact. The main measurements consist of a 3D head acceleration (12 channels), torso 3D acceleration (T1, T8) and sacrum acceleration.



**Deceleration pulse  
(UN/ECE/R44 regulation)**

Test	Velocity (km/h)	Max. Decel. (g)	Load limiter (kN)
HUMOS_01	48.8	-21.92	6
HUMOS_02	48.1	-21.26	6
HUMOS_03	49.8	-23.56	4
HUMOS_04	48.1	-21.21	4

**Deceleration conditions**



**Test set up**

### Results

Four tests have been carried out. The results consist of the kinematics of the PMHS obtained from the analysis of the high-speed films and the dynamics coming from the sensors.

Test	X accel. (g)	Z accel. (g)	Resultant Accel. (g)	AIS
HUMOS_01	-33.63	*	*	5
HUMOS_02	-38.75	-17.22	40.65	5
HUMOS_03	-20.30	-11.95	25.00	5
HUMOS_04	23.30	-16.67	24.78	4

**Maximal thorax (T8) acceleration  
and AIS thorax**

\* channel not available

Test	X accel. (g)	Z accel. (g)	Resultant Accel. (g)	HIC
HUMOS_01	-69.82	87.01	96.48	919
HUMOS_02	-46.56	43.03	75.36	402
HUMOS_03	-35.03	43.64	55.71	173
HUMOS_04	-25.92	31.76	38.93	176

**Maximal head acceleration  
and Head Injury Criterion**

### Discussion

For the first two tests, a 6kN shoulder belt load limiter was used and the subjects were massively injured. The results are however in accordance with known injury risk curves. The last two tests were carried out with a 4kN shoulder belt load limiter and the number of rib fractures reduced, as expected.

### Conclusions

The situation tested is representative of accidents with occupant restrained by a safety belt. For further validation of the model we need to increase the knowledge of the human thorax/shoulder response during loading in frontal impact with airbags. Such an action is planned within the FID (Improved Frontal Impact Protection through a World Frontal Impact Dummy) European research program.

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