In Preparation for *Enable New Occupant Seating Positions*: the ENOP Project

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I. INTRODUCTION

The consortium *Enable New Occupant Seating Positions* (ENOP) aims to understand the implications of non-conventional seating positions, involving several seat pan and seatback angles, on the occupant kinematics and potential new injury patterns. ENOP consists of eight partners: Laboratory of Accidentology, Biomechanics and Human Behavior (LAB), Université Gustave Eiffel, European Center for Safety Studies and Risk Analysis, Toyota, Bundesanstalt fur strassenwesen, Cellbond, Faurecia Automotive Seating, Autoliv Development AB and ICAI-Comillas Pontifical University. ENOP is fully funded by its partners and is coordinated by LAB. The work, started in 2019, will go on until 2023.

Human Body Models (HBMs) and Anthropometric Test Devices (ATDs) have been insufficiently verified to allow for assessment of injury risk in other than conventional seating positions (20 - 25° seatback), partially due to the scarcity of experimental data. To enable the kinematic and injury prediction capabilities of HBMs and ATDs, they need to be benchmarked against Post-Mortem Human Subject (PMHS) tests to assess their biofidelity. Thus, the global objective of the ENOP project is to generate reference data that can be used in the validation of HBMs and ATDs in non-conventional seating positions, such as reclined postures, and to investigate new injury types that might be occurring in those. To this end, 15 PMHS sled tests of 15 mid-sized males in five different seating positions will be performed (three PMHS tests per condition, no repeat tests on the same PMHS). These seating positions will include various degrees of reclined seatback and seat pan inclination angles.

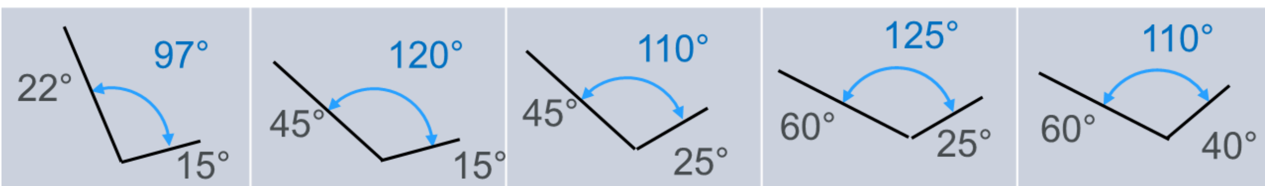
The specific objective of this paper is to introduce the selected seating positions and test protocol and to provide preliminary results obtained in tests with the Hybrid III 50th percentile (HIII-50M) dummy assessing the functionality and the repeatability characteristics of the proposed setup.

II. METHODS

Sled tests with the HIII-50M were performed on a hydraulic-type sled catapult using a 30 g peak and a 50 km/h delta-v generic crash pulse [1]. A semi-rigid seat, designed by Uriot et al. [1] and then reproduced in several PMHS and ATD test campaigns was used [1-5]. Five different seating positions (SP) with varying seat pan and seat back angles were evaluated (see Figure 1). Note that SP1 corresponds to a conventional seating position and is used as baseline to compare the influence of seatback and seat pan changes in the response of the occupants.

A backrest composed of a rigid plane covered with foam (but incorporating a central window capable of accommodating VICON markers clusters attached to the spine of the human surrogate) was used to support the ATD before the test. The backrest was retracted at time 0 of the deceleration pulse by a belt pretensioner.

Upright	Reclined		Relaxed	



SP1	SP2	SP3	SP4	SP5

Fig. 1. Seating positions (SP) to be tested in the ENOP project.

The HIII-50M was restrained by an advanced seat-integrated 3-point belt system consisting of a shoulder-belt retractor with 2 kN pretensioner and 4 kN load limiter, 2 kN lap-belt pretensioners and approximately 5 kN load limiters at each side of the pelvis (although with different magnitudes at each side, to ensure that the pelvic forward displacement is even at both sides) [6]. The double lap-belt pretensioners and load limiters are enabled by a prototype belt system with two retractors: one at the outer anchorage, and one at the inner anchorage (buckle side). Where the inner retractor includes a buckle sewed to the webbing of a retractor. Additionally, the

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buckle was equipped with a crash locking tongue, preventing webbing slippage from the shoulder belt to the lap belt, or vice versa. The retractor anchorage points were fixed at the seat fixture and therefore moved jointly with the seat pan and seatback for the different SP. The feet were free to move along the horizontal plane for SP (1) and (2) and on a lower leg support for SP (3) - (5). Figure 2 shows two side views of the test setup including the HIII-50M in SP2, without foot support (left) and SP5, with a lower leg support (right).

The test setup was equipped with sensors allowing the characterization of the kinematics of the restraint systems (retractor webbing pay-in and pay-out, seat deflection) and the measurement of forces between the occupant and its environment (seat, leg support, belt webbing and belt anchorage points).

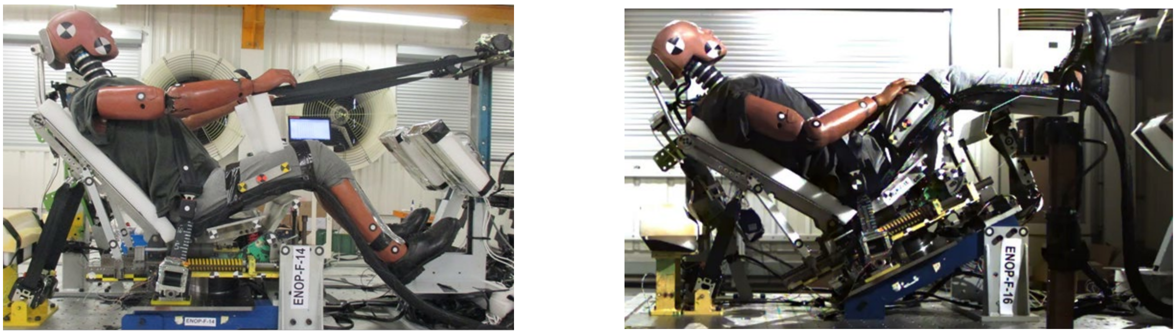

Fig. 2. Left: sled test with HIII-50M positioned in SP2. Right: sled test with HIII-50M positioned in SP5.

III. INITIAL FINDINGS

Sled tests with the HIII-50M were performed to ensure the correct functioning of the test setup and the restraint system at all the intended test configurations. The test fixture exhibited the expected behaviour and no damage to either the fixture components or the ATD was observed, achieving the first goal of the ATD testing series.

Out of the five SPs intended to be tested within ENOP, the data traces shown in Figure 3 correspond to SP1 (black, baseline), SP2 (red) and SP5 (blue). Two tests were run per condition to assess the repeatability of the test fixture. In particular, the time history plots in Figure 3 show the repeatability of the test setup for the seat belt pay-out at the shoulder retractor (Figure 3, left), the upper shoulder belt force (Figure 3, centre) and the seat reaction forces (Figure 3, right). Other sensor data in the test fixture confirmed the repeatability of the test setup.

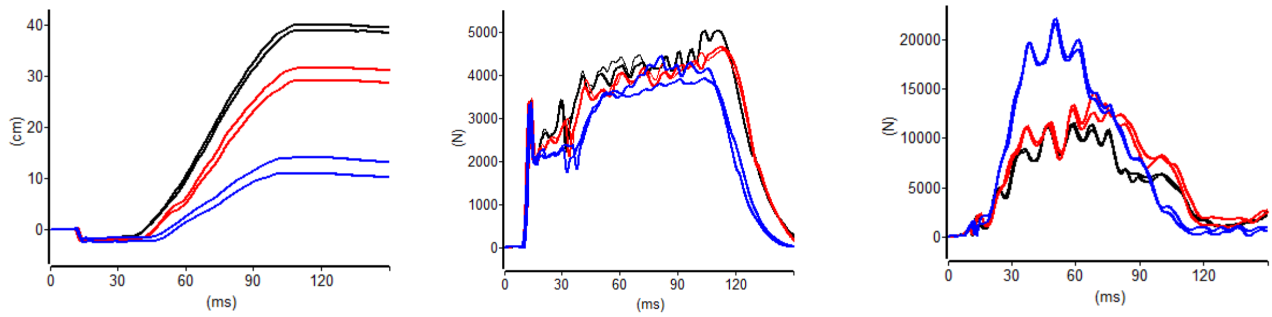

Fig. 3. Time history plots of (black: SP1; red: SP2; blue: SP5): shoulder belt pay-out (Left), shoulder-belt forces (Center) and seat reaction resultant (Right). Two tests per SP.

IV. DISCUSSION

Based on the preliminary tests performed with the HIII-50M, the test fixture and restraint system performed as expected in all the five seating positions. Thus, this test fixture will be further used in the planned PMHS tests to obtain information to benchmark ATDs and HBMs. In addition to PMHS, the ENOP project will also continue testing 50th percentile male ATD designs (HIII-50M, THOR-50M and modifications of THOR for reclined positions) to compare the response of these ATDs to the one of the PMHS tests.

REFERENCES

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