Sled Tests and Simulation Results with the Q10 Update Kit for Euro NCAP 2020

12th European LS-DYNA Conference
Dr. Hakan Ipek RD/KSF, Aranya Getta RD I/CCS, Koblenz, 14.05.2019
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1. Motivation and Current Status for 2020
2. Cellbond Shoulder Update Kit and Simulation Model Availability
3. Sled Test Comparisons with the Update Kit, Hardware and Simulation Results
4. Conclusions
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1. Motivation and Current Status for 2020
2. Cellbond Shoulder Update Kit and Simulation Model Availability
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Motivation

The assessment of the seat belt slip leads to unclear situations due to the partial penalty allocation for slipping into the shoulder joint gap. Moreover, this behavior is biomechanically questionable. => Request for an update.

- The first update prepared by Humanetics in 2017 was rejected by Euro NCAP due to extensive changes.
- A reduced shoulder update kit was introduced in 2018 by Cellbond ATD.
1. Motivation and Current Status for 2020

Current Status for Q10 Dummy in 2020

Euro NCAP Decision for 2020

- Implementation of Cellbond Shoulder Update Kit
- Implementation of Cellbond upper thighs with stiffer material
- Implementation of Cellbond lower leg with shortened foot

Decisions were communicated end of 2018 and are described in the draft Protocol:


3.2.3 Additions and modifications to the dummies

a) The Q6 dummy shall be standard build level A, and the Q10 standard build level C. See the relevant user manual for each dummy.

b) The Q10 dummy is used with the full arms for frontal impact testing. The Side Impact Kit including half arms on both sides of the dummy shall be used in the side impact test. The approved 2018 Q10 upgrade kit, consisting of shoulders, spine box, sacrum, femur flesh and short feet shall be used in both the front and side impact tests.
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2. Cellbond Shoulder Update Kit and Simulation Model Availability

Cellbond Shoulder Update Kit
Geometry – Overview

Current Q10 Design

Q10 with Cellbond Update Kit

Neck Connection Angle
Shoulder Cover, Scapulae
Spine Box (Density)
Sacrum (Density)
Cellbond Shoulder Update Kit
Geometry – All Affected Parts

2. Cellbond Shoulder Update Kit and Simulation Model Availability

Sled Tests and Simulation Results with the Q10 Update Kit Euro NCAP 2020 | Dr. Hakan Ipek | 14.05.2019
Cellbond Shoulder Update Kit

Geometry – Shoulder Cover

- A significant foam volume between the spine box and the sternum is omitted in the new design of the update kit.
- The thickness of the rubber covered foam block varies between 47mm to 55mm.
• Occupant simulations are essential for the restraint system set up. Usually these simulations are carried out in the early development phase.

➢ Therefore simulation models are necessary and should be provided with such modifications.

➢ Complicated development of simulation models based on two different hardware supplier parts.
Parallel Development of the Humanetics Euro NCAP 2020 Q10 Dummy

Humanetics Q.10 with the 2018 developed update kit for Euro NCAP 2020 (Light Beta Update Kit)

Will it be possible to use the Humanetics model to represent or validate the results of the combined Humanetics / Cellbond hardware in the simulation?
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3. Sled Test Comparisons with the Update Kit, Hardware and Simulation Results

Sled Test Comparisons with the Update Kit, **Hardware**

Test Series Specification and Goals

- All tests were carried out in a Mercedes-Benz family car sled set up. The sled pulses are based on the same family car crash test readings.
- The seat belt system is a separate configuration optimized for current rating and internal requirements. Pretensioner, force limiter and crash locking tongue were used in this basic study.

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- **ODB 64kph without shoulder belt slip.**
- **Kinematics and injury values.**

- **ODB 64kph with risk of shoulder belt slip.**
- **Kinematics (injury values).**

- **MPDB 50kph without shoulder belt slip.**
- **Kinematics and injury values.**
3. Sled Test Comparisons with the Update Kit, Hardware and Simulation Results

Sled Test Comparisons with the Update Kit, **Hardward**
Shoulder and Seatbelt Kinematics, Effect on Injury Values

- Q10 current Dummy and Q10 Dummy equipped with Cellbond Update Kit, ODB-Pulse 64kph ,
- 12.5° rotated sled

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ODB 64kph without shoulder belt slip. ➔ Kinematics and injury values.

ODB 64kph with risk of shoulder belt slip. ➔ Kinematics (injury values).

MPDB 50kph without shoulder belt slip. ➔ Kinematics and injury values.
Sled Test Comparisons with the Update Kit, **Hardware**
Shoulder and Seatbelt Kinematics, Effect on Injury Values

Q.10 cur. and Cellbond Update Kit, ODB 64kph, 12.5°
Sled Test Comparisons with the Update Kit, Hardware and Seatbelt Kinematics, Effect on Injury Values

Higher neck moment with update kit.

Higher chest deflection with update kit.

Higher chest deflection with update kit.
Sled Test Comparisons with the Update Kit, Hardware and Simulation Results

Test No. 2 and Test No. 3 Validations (ODB + 12p5 deg rotation)

- Compared to test the seatbelt on dummy in simulation moves closer to shoulder joint.
- The Hipshield stiffness is higher in simulations than tests. This influences belt behavior on pelvis and dummy upper body rotation.
3. Sled Test Comparisons with the Update Kit, Hardware and Simulation Results

Sled Test Comparisons with Current Q10, Hardware and Simulation

Test No. 2 Validations (ODB + 12.5 deg. rotation)

Significant difference in pelvis restraint and neck y moment.

Test No. 2 Humanetics Q10
Simulation – Q10 V1.6.2

Mercedes-Benz
Sled Test Comparisons with Current Q10, Hardware and Simulation Test No. 2 Validations (ODB + 12p5 deg. rotation)

Current Q.10 Dummy
➢ Deformation and folding of hip shields.

Q.10 Dummy Modell 1.6.2
➢ Almost no deformation of hip shields.
Sled Test Comparisons with the Update Kit, Hardware and Simulation Results

Test No. 3 Validations (ODB + 12p5 deg. rotation)

Sled Tests and Simulation Results with the Q10 Update Kit Euro NCAP 2020 | Dr. Hakan Ipek | 14.05.2019

Significant difference in pelvis restraint, neck y moment and neck shear forces.
Sled Test Comparisons with the Update Kit, **Hardware**

**Shoulder and Seatbelt Kinematics, Effect on Injury Values**

- Q10 current Dummy and Q10 Dummy equipped with Cellbond Update Kit, ODB-Pulse 64kph ,
- 30° rotated sled

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ODB 64kph without shoulder belt slip. → Kinematics and injury values.

ODB 64kph with risk of shoulder belt slip. → Kinematics (injury values).

MPDB 50kph without shoulder belt slip. → Kinematics and injury values.
Sled Test Comparisons with the Update Kit, **Hardware**
Shoulder and Seatbelt Kinematics, Effect on Injury Values

Q10 cur. and Cellbond Update Kit, ODB 64kph, 30°

4 point shoulder belt modifier  
8 point shoulder belt modifier
Sled Test Comparisons with the Update Kit, **Hardware and Simulation**

Test No. 6 / Test No. 7 Validations (ODB + 30 deg rotation)

• Kinematics of dummy matches to good extent with the test till 80ms.
• Belt slips away on the shoulder in simulation whereas it gets struck in the shoulder joint in the Test No. 6.
• Hipshield stiffness is higher in simulations than tests. This influences belt behavior on pelvis and dummy upper body rotation.
# Sled Test Comparisons with the Update Kit, **Hardware**

**Shoulder and Seatbelt Kinematics, Effect on Injury Values**

- Q10 current Dummy and Q10 Dummy equipped with Cellbond Update Kit, ODB-Pulse 64kph ,
- 12.5° rotated sled

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- ODB 64kph without shoulder belt slip.  
- ODB 64kph with risk of shoulder belt slip.  
- MPDB 50kph without shoulder belt slip.

Kinematics and injury values.

Kinematics and injury values.
Sled Test Comparisons with the Update Kit, **Hardware**
Shoulder and Seatbelt Kinematics, Effect on Injury Values

Q10 cur. and Cellbond Update Kit, MPDB 50kph, 12.5°

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<th>Test 10 Current</th>
<th>Test 12</th>
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<tr>
<td>Q10 Current</td>
<td>Q10 Cellbond Update Kit</td>
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**Mercedes-Benz**
3. Sled Test Comparisons with the Update Kit, Hardware and Simulation Results

Sled Test Comparisons with the Update Kit, **Hardware**
Shoulder and Seatbelt Kinematics, Effect on Injury Values

Q10 cur. - Q10 Cellbond Update Kit, MPDB, 12.5°

**Higher chest deflection with update kit.**

**Reduced neck moment with update kit.**

**Higher chest deflection with update kit.**

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Sled Tests and Simulation Results with the Q10 Update Kit Euro NCAP 2020 | Dr. Hakan Ipek | 14.05.2019
• Kinematics of dummy matches to good extent with the test
• Injury Values match in loading and unloading phase to good extent
• Hipshield stiffness is higher in simulations than tests. This influences belt behavior on pelvis and dummy upper body rotation
3. Sled Test Comparisons with the Update Kit, Hardware and Simulation Results

Sled Test Comparisons Current Q10, Hardware and Simulation Test No. 9 Validations (MPDB + 12p5 deg rotation)

Significant difference in pelvis restraint, neck y moment and chest acceleration.

Test No. 9 Humanetics Q10
Simulation – Q10 v1.6.2
Sled Test Comparisons Current Q10, Hardware and Simulation

Test No. 9 Validations (MPDB + 12p5 deg rotation)

Current Q10 Dummy
- Deformation and folding of hip shields.

Q.10 Dummy Light Update Kit
- Almost no deformation of hip shields.

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Sled Test Comparisons with the Update Kit, Hardware and Simulation

Test No. 11 Validations (MPDB + 12.5 deg. rotation)

Test No. 11 - Humanetics Q.10 Dummy with Cellbond Update Kit

Simulation – Q.10 Humanetics Light Beta Update Kit

Significant difference in pelvis restraint, neck shear forces and chest acceleration.
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1. Motivation and Current Status for 2020
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Q10 Dummy – Comparisons with Update Kit

Summary

- In general good correlation between Humanetics Euro NCAP 2020 simulation model and the Humanetics Q10 hardware dummy equipped with the Cellbond shoulder update kit.

- Clearer shoulder slip prognosis and correlation between hardware and simulation.

- Chest acceleration is lower calculated in the simulation result. It is especially noticeable in the MPDB tests.

- Pelvis, Abdomen and mainly the Hip Shield deformation should be improved in the simulation models.
Thank You For Your Kind Attention