Proposal for a deceleration pulse for AECD sled testing

Matthias Seidl
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Full-scale impact tests and sled test

- What is the relationship between the full-scale impact tests, UN R94 and UN R95, and the component-based sled test?

- The full-scale tests provide an assessment of the whole AECS in a front and a side collision:
  1. Taking into account vehicle deformations and vehicle-specific installation; and
  2. Testing the triggering.

- The sled test of the AECD in-vehicle system adds value by:
  1. Providing a vehicle-independent and installation-independent assessment that avoids repeated full-scale tests after re-designs of AECD components; and
  2. Covering real-world collision configurations that are more challenging to AECD than the full-scale tests UN R94 and UN R95, in order to ensure that AECS deliver high societal benefits to those casualties who need it most.

Why is a pulse similar to UN R94 tests not suitable for component-based sled tests?
Decelerations in UN R94 full-scale test

**UN R94**
- 56 km/h
- 40% overlap
- Deformable barrier

**Deceleration pulse**
- Small family car (MY 2008)
- Peak deceleration: 28g
- Duration: ca. 130 ms
How was the UN R94 test defined?

- What accident severity was considered appropriate? What was technically feasible?
- The consensus at the time was to choose a $\Delta v$-level (change in velocity) that covered about $^{1}$:
  - 1/3 of all fatalities; and
  - 1/2 of those severely injured (MAIS3+).

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How was the UN R94 test defined?

- Casualties at every given $\Delta v$-level result from a wide variety of different collision configurations.

- Which configuration should be simulated?
  - Purpose of the UN R94 test was an assessment of the protection of occupants, which includes structural crashworthiness and compartment strength.
  - Hence, a test configuration was chosen to represent a worst case for occupant protection$^1$:
    - Offset test (engaging only one longitudinal member) to encourage vehicle design changes towards a structure that performs well under a wide range of conditions; and
    - Deformable barrier to simulate interactions in car-to-car impact.

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Different peak decelerations at identical $\Delta v$

Different cars:
- Small car
- Medium car
- Large car

Different collision configurations:

- UN R94 test
- Full-width, rigid barrier test

Cumulative percent of severity vs. Delta-v (mph)

UN R44 corridor

High overlap
Rigid barrier
What does this mean for AECD testing?

- The UN R94 test configuration is challenging for structural crashworthiness but not the most challenging for restraint systems or AECD survivability:
  - AECD components are mounted directly onto the vehicle structure, i.e. not protected by restraint systems.
  - The most harmful mechanism to these components is likely to be forces experienced due to **high peak deceleration levels**.

- At the same $\Delta v$-level, the configuration with the highest peak deceleration levels is: Full-width impact into rigid barrier.

- UN R94 represents a configuration of fairly moderate peak deceleration levels compared with full-width impact into rigid barrier.
Deceleration pulse of a full-width test

**Full-width test**
- 56 km/h
- 100% overlap (full-width)
- Rigid barrier

**Deceleration pulse**
- Supermini (MY 2012)
- Peak deceleration: 77g
- Duration: ca. 60 ms
Defining a deceleration corridor

A corridor can be defined based on a sample of full-scale crash test results of superminis, MYs 2012 and 2013 (56 km/h, rigid barrier, full-width):

[Graph showing deceleration over time for different tests]
Deceleration corridor based on full-width tests

- 77g, 22 ms
- 65g, 4 ms
- 60 ms
Deceleration corridor based on full-width tests (detailed description)

Deceleration corridor based on full-width tests

Based on 56 km/h, rigid barrier, full-width impact tests

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Is this corridor enough to ensure real-world safety?

- This deceleration corridor is to be considered a **minimum approach** because these levels already occur in crash tests at a $\Delta v$-level chosen to represent only 1/3 of fatals and 1/2 of severely injured.

- From a safety and product assurance perspective, it seems advisable to exceed these levels, in order to ensure high societal benefits among fatal and serious injuries.

- Applying a **safety factor of 1.3** is proposed to represent cases at a higher severity level and to cover potentially higher peak decelerations at an installation location further towards front of the vehicle.
Proposed Deceleration Corridor

- $100g$, 22 ms
- $85g$, 4 ms
- 60 ms
Proposed Deceleration Corridor

Based on 56 km/h, rigid barrier, full-width impact tests and safety factor 1.3

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Conclusions

- The UN R44 pulse corridor, which is similar to UN R94 decelerations, is not suitable for AECD testing: UN R94 was designed to challenge the structural crashworthiness of vehicles, not to test the resistance of on-board equipment.

- A more challenging real-world configuration (at the same Δv-level) is a full-width, rigid barrier impact.

- To cover a greater proportion of casualties a deceleration pulse corridor was proposed based on crash test data and an additional safety factor:
  - Peak deceleration: 85-100g
  - Peak duration: ≥4 ms
  - Total duration: ≤60 ms

- The nature of the sled test is vehicle- and installation-independent. This makes a distinction between front/side impacts obsolete because the in-vehicle orientation is not known.

  → The proposed pulse should be applied in various directions.
Thank you

Proposal for a deceleration pulse for AECD sled testing

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Matthias Seidl
Tel: +44 1344 770549
Email: mseidl@trl.co.uk
Independent Transport Research, Consultancy & Testing

Creating the future of transport