NHTSA’s Initial Evaluation of Child Side Impact Test Procedures

GRSP – 43rd Session
Mary Versailles
Outline

★ Background
★ Test Conditions
★ Test Series
★ Future Work
Children Involved in Side Impacts

Children represent more than 50% of the rear seat occupants in motor vehicle crashes

  • 42% involved 0-3 years old
  • 36% involved 4-8 year olds
  • 22% involved 9-12 year olds
Children Involved in Side Impacts

- Side impacts with $\Delta V \geq 30$ kph produced 104 injuries in 28 children ages 1-3 yrs. (unweighted due to paucity of data, NASS-CDS)
  - PDOF of side impact crashes is approx. 30° off lateral
  - Near-side and center occupants suffered more severe injuries (AIS2+) than far-side occupants
  - Direct contact with vehicle interior responsible for 45% (47) of injuries
    - Head - 57% of injuries
    - Torso - 21% of injuries
    - Neck, upper and lower extremities - 6%-9% of injuries
Children Involved in Side Impacts

★ For kids 0-8 years old (FARS 1991-2000)
– 276 fatalities (front passenger or 2nd row seats) per year in side impacts
  • Near side - 170 fatalities/year (43 known CRS use)
  • Far side - 56 fatalities/year (13 known CRS use)
  • Middle - 50 fatalities/year (12 known CRS use)
Test Conditions
Side Impact Sled Variables

- Sliding seat acceleration
- “Door” velocity
- Sled pulse
- Honeycomb stiffness
- “Door” padding stiffness
- Seat cushion foam
- Impact angle
- Locked vs. sliding seat
Sled Test Pulse Inputs

- Sliding seat acceleration ~ 20 g’s
  - based on right rear sill accelerometers from 10 FMVSS 214 tests of small vehicles
- Sled (Door) velocity ~ 20 mph
  - based on door accelerometers from 4 FMVSS 214 tests of small vehicles
- Sled pulse – ½ sine
  - shape not critical; reach velocity in 250 mm
- Resultant sled pulse:
  - ½ sine wave with peak of 28 g’s and velocity of ~20 mph with a duration of ~50 ms
Sliding Seat Acceleration Pulse

10 MDB Tests Combined
Right Rear Sill Y-axis Acceleration
Average with Upper and Lower Boundaries

Acceleration [g]

TIME [ms]

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Sled Test Pulse Inputs

- Sliding seat acceleration ~ 20 g’s
  - based on right rear sill accelerometers from 10 FMVSS 214 tests of small vehicles
- Sled (Door) velocity ~ 20 mph
  - based on door accelerometers from 4 FMVSS 214 tests of small vehicles
- Sled pulse – ½ sine
  - shape not critical; reach velocity in 250 mm
- Resultant sled pulse:
  - ½ sine wave with peak of 28 g’s and velocity of ~20 mph with a duration of ~50 ms
Sled and Sliding Seat Velocity
Sled Test Pulse Inputs

★ Sliding seat acceleration ~ 20 g’s
   – based on right rear sill accelerometers from 10 FMVSS 214 tests of small vehicles

★ Sled (Door) velocity ~ 20 mph
   – based on door accelerometers from 4 FMVSS 214 tests of small vehicles

★ Sled pulse – \( \frac{1}{2} \) sine
   – shape not critical; reach velocity in 250 mm

★ Resultant sled pulse:
   – \( \frac{1}{2} \) sine wave with peak of 28 g’s and velocity of ~20 mph with a duration of ~50 ms
## CRS Tested

<table>
<thead>
<tr>
<th>U.S. Models</th>
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<tbody>
<tr>
<td>Graco SafeSeat Step 2 Toddler</td>
<td><img src="image1.png" alt="Image" /></td>
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<tr>
<td>Evenflo Triumph Advance DLX</td>
<td><img src="image2.png" alt="Image" /></td>
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<tr>
<td>Safety 1st All-in-One Convertible</td>
<td><img src="image3.png" alt="Image" /></td>
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<table>
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<tr>
<th>European Models</th>
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<tbody>
<tr>
<td>Maxi-Cosi Priori (SIP)</td>
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<tr>
<td>Graco Logico M (SIP) (does not meet FMVSS 213)</td>
<td><img src="image4.png" alt="Image" /></td>
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Test Series
CRS SI Sled Test Series

★ Series #1:
  – Sliding seat
  – Q3s dummy
  – 0° and 10° impact angles

★ Series #2:
  – Locked seat
  – Q3s dummy
  – 0° and 10° impact angles
Series #1: Sliding Seat, 0° vs. 10° Impact Angle

- Q3s dummy
- Original sliding seat fixture
- 0° and 10° impact angles
  - 10° based on FMVSS 214 crash data
  - Performed repeat tests with 5 CRS models at 0°
- Door padding - 2” foam thickness
  - Takata’s foam (stiffer)
  - Ethafoam type (softer) – 0° tests only
    - no apparent differences observed between Takata and Ethafoam in 0° series
Safety 1st All-in-One, \(0^\circ\) vs. \(10^\circ\) Impact

0\(^\circ\) impact

10\(^\circ\) impact

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Safety 1st All-in-One, 0° vs. 10° Impact

0° impact

10° impact

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**Sliding Seat, 0° vs 10° Impact Angle Summary**

- Takata sled exhibited good repeatability
- Able to distinguish between car seat models using injury levels
  - No significant differences between European (2 models) and U.S. seats (3 models) tested
- Two “door” foams used did not appear to affect results
- Minimal differences observed between 0° and 10° impact angles for 5 CRS models tested
  - Significantly higher neck tensions during 10° test for 2 CRS
CRS SI Sled Test Series

✿ Series #1:
  – Sliding seat
  – Q3s dummy
  – 0° and 10° impact angles

✿ Series #2:
  – Locked seat
  – Q3s dummy
  – 0° and 10° impact angles
Series # 2: Sliding vs. Locked Seat

★ Q3s Dummy
★ Locked seat fixture
  – initial position dependent on width of CRS tested (approximately 2” from edge of CRS to padded wall)
★ 0° and 10° Impact angles
Sliding vs. Locked Seat

Evenflo Triumph

Graco SafeSeat

Maxi Cosi Priori

Safety 1st All-in-One
Method to Lock Seat

Rigid bar with removable shims
Sliding vs. Locked Seat
10° impact

Sliding seat

Locked seat
Sliding vs. Locked Seat
10° impact

Sliding seat

Locked seat

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Sliding vs. Locked Seat Summary

★ Sliding Seat Configuration
  – better real-world simulation
  – sliding seat configuration repeatable

★ Locked Seat Configuration
  – simpler to fabricate
  – have not conducted repeatability tests
  – generally resulted in higher injury values
    • reducing velocity could compensate for difference in values

★ Unknown if both sled configurations will produce same outcome/countermeasures
  – Mixed outcomes of observed trends
Future Work
NHTSA’s Future CRS Side Impact Research

★ Continue test procedure development and evaluation
  – Wall padding stiffness
  – Buck angle
  – Seat cushion stiffness
  – CRS fleet performance
  – Other CRS types and child size dummies
★ Continue Q3s development and evaluation
★ Continue development of viable IARV’s
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Thank You