NHTSA’s Child Side Impact Protection Research Program

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Research

- Initial Validation of Sled Concept
- Evaluation of “Door” Padding Stiffness
- Initial Testing of Rear-facing Restraints and Seat Cushion Foams
- Evaluation of Q3s Dummy
Initial Validation of Sled Concept

- Conducted sled tests
  - Based on Takata’s sliding seat with “intruding door” procedure
  - NHTSA made some modifications to test set-up
  - Phase I – Tests at 0° and 10° impact angle; 5 different CRS models
  - Phase II – Tests at 15° and 20° impact angle; selected 3 of previous 5 CRS models tested

- Conducted four (4) side impact crash tests
  - Based on FMVSS No. 214 procedure
Summary of Initial Testing

- Sled provides good replication of side impact crash
  - Sled and crashed vehicle responses comparable
- Dummy and CRS kinematics in sled tests similar to those in crash tests
  - Armrest issue needs further investigation
  - Additional evaluation of results required to refine side impact sled test parameters
- Previously presented at 2008 and 2009 SAE Government Industry meetings
Research

- Initial Validation of Sled Concept
- **Evaluation of “Door” Padding Stiffness**
  - Three different stiffnesses of padding
  - Potential armrest design
- Initial Testing of Rear-facing Restraints and Seat Cushion Foams
- Evaluation of Q3s Dummy
Free Motion Headform (FMH) Tests

- Used pedestrian GTR 3.5 kg child headform at 24 kph
- 8 vehicles tested
  - Nissan Sentra, Nissan Versa, Volvo XC90, Chevy Trailblazer, Toyota Highlander, Infiniti FX35, Nissan Pathfinder, Dodge Caravan
    - Door padding
    - Armrest
- Side impact sled buck (i.e. rigid wall)
  - Foams with varying stiffness and thickness
**FMH Door Testing**

**Energy Displacement**

**FMH Door Stiffness Tests 15 Mph Overlays**

Dashed colored curves – vehicle interior door results

Solid colored curves – foam materials selected for use in sled tests
Sled Tests to Evaluate ‘‘Door’’ Padding Effect

- Angle of 10° selected for test buck
  - Based on crash test results and accident data analyses
- Evaluated “stiff”, “average” and “soft” foams at 5 cm (2”) thickness
  - Tested with CRS models used during crash tests
    - Graco SafeSeat Step 2
      (renamed to Graco Cozy Cline in 2009)
    - Maxi-Cosi Priori
Sled without Armrest
SafeSeat Step 2 (Cozy Cline)
Frontal Videos
Armrest Design

**Armrest**

5 cm (2.5”’) thickness over lower portion of “door” – used “average” foam material
Initial Sled Tests to Investigate "Armrest"

- Conducted 2 tests of each dummy / CRS configuration
  - Forward facing with Q3s dummy
    - tested 3 CRS models used in previous series
  - Rear-facing with CRABI 12 month dummy
    - 1 convertible (Maxi-Cosi Priori)
    - 2 infant only with detachable base
      (Graco SnugRide and Chicco KeyFit30)
Sentra Crash vs Sled with Armrest
Graco SafeSeat Step 2 (Cozy Cline)
Frontal Videos
Research

- Initial Validation of Sled Concept
- Evaluation of “Door” Padding Stiffness
- Initial Testing of Rear-facing Restraints and Seat Cushion Foams
  - 1 convertible CRS
  - 2 infant only CRS
  - FMVSS 213 and ECE R44 seat foams
- Evaluation of Q3s Dummy
Rear-facing CRS Tests

Maxi-Cosi Priori

Graco SnugRide

Chicco KeyFit30
RF Convertible vs RF Infant Only
Frontal and Overhead Videos

Graco SnugRide Infant with Base on Right

Maxi-Cosi Priori Convertible on Left
FMVSS 213 and ECE R44
Seat Cushion Comparison

- FMVSS 213 seat cushion is soft compared to ECE R44 seat cushion
- Forward facing with Q3s dummy
  - 3 CRS models used in previous series
- Rear-facing with CRABI 12 month dummy
  - 1 infant only with detachable base (Graco SnugRide)
Comparison of FMVSS 213 & ECE R44 Cushions with Q3s in FF CRS

Frontal Videos

Sentra Crash Test

FMVSS 213 Seat Cushion

ECE R44 Seat Cushion
Summary of Results

- Buck angle of 10° provides good replication of dummy / CRS kinematics observed in crash tests
- Based on dummy head and neck injury responses
  - Stiffness of “door” padding does not appear to have pronounced effect (based on limited # of tests)
- More research required to assess
  - need for armrest
  - effect of sliding seat cushion stiffness on results (including NPACS proposed seat foam)
- Conduct fleet tests using majority of CRS models sold in U.S.
Research

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- Initial Testing of Rear-facing Restraints and Seat Cushion Foams
- Evaluation of Q3s Dummy
Evaluation of Q3s Dummy

- During the preliminary evaluation of the Q3s dummy, VRTC identified three primary issues:
  - Thorax Durability
  - Neck Biofidelity
  - Pelvis/Femur Design
Thorax Failures
Neck Biofidelity

Head and Neck Sled Tests
Lateral Response of Q3s and 3Cs Necks

- Q3s 8.0 g pulse
- Q3s 9.5 g pulse
- Q3s 14.2 g pulse
- 3Cs 8.0 g pulse
- 3Cs 9.5 g pulse
- 3Cs 14.2 g pulse

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Pelvis/Femur Issues

Femur fill material was incompatible with vinyl skin and would not fully cure.

Femur ball could dislodge from hip socket resulting in leg separation from torso.
Q3s Design Revisions
Thorax Modifications

Nitinol insert

FE Stress Analysis

Images courtesy of FTSS

Reinforced Nitinol design
Filleted corner design

25% max stress reduction
baseline
Evaluation of Nitinol Rib Vers.3

- **100 “Standard” Thorax Impacts**
  - 3.8 kg probe
  - 3.3 m/s impact speed
  - Bench seat
  - Impact to lateral thorax at IR-Tracc mounting location
  - Impact-side arm removed

- **10 High Severity Impacts**
  - Same as above except 3.8 m/s impact speed
IR-Tracc Bracket Contact

FTSS plans to modify bracket
Micro-cracking in Urethane

- First observed after test # 67
- Minor propagation after initial observation
- Final crack length ~ 1.2 mm
- FTSS proposes to introduce an edge radius to eliminate stress riser in the urethane
Summary of Rib Modifications

- Durability improved significantly
- Repeatability of responses was excellent
- Minor design issues to be addressed
  - Modify IR-Tracc bracket
  - Add edge radius to urethane
- Minimal permanent deformation observed
- Additional pendulum and sled testing planned to assess durability and biofidelity
Neck Revision

- New Q3s neck based on 3Cs design, which VRTC developed with Denton ATD
- Preliminary results are encouraging
- Continuing to refine the design
Pelvis/Femur Revisions

- New upper leg filler material is compatible with vinyl flesh
- Aluminum hip cup and hardened femoral ball improve femur retention
For additional inquiries, please contact

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