NHTSA Research on Improved Restraints in Rollovers

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SAE Government/Industry Meeting
13 May 2008
Session G13: Rollover
Presentation Overview

- Introduction
- 2007/08 Testing
- Inflatable Belts
- 4-Point Belts
- Summary
Introduction

2007/08 Testing

Inflatable Belts

4-Point Belts

Summary
• Reducing Roof Crush alone will not eliminate occupant contact with roof.

• Previous NHTSA (mid-1990’s) research found reduced occupant excursion with improved restraint systems in rollover conditions.

• Few studies looking at improved restraint system effectiveness for rollover accident conditions exist.
Objective

• Evaluate the current state-of-the-art restraint systems in a rollover condition.
• Examine *Occupant Head Excursion* of various restraint configurations.
• Build research data for aiding in the potential test procedure development for assessing restraint effectiveness.
Introduction

RRT Overview Video
Fixture Dynamics

• Roll Rate  (Goal: 315 deg/s at impact)
• Impact Force (~100000 N)
• Shock Deflection  (up to 25 cm)
• Acceleration Under Seat  (~50 g)
• Lap Belt Force
• Shoulder Belt Force
# Base Configurations

## Non-Integrated 3-point:
- **Baseline** *(No Pretension)*
  - Lower D-Ring **C**
  - Upper D-Ring **D**

## Pretensioners
- Retractor Pretensioner **E**
- Buckle Pretensioner **F**
- Retractor & Buckle Pretensioner **G**
- Motorized Pretensioner **H**
- Motorized & Buckle Pretensioner **I**

## Integrated 3-Point:
- No Pretensioner **A**
- SWAP No Pretensioner **B**

## 4-Point Belts:
- 4-Point w/Pretensioners **J**
- 4-Point redesign w/Pretensioners **M**

## Inflatable Belts:
- Inflatable Belt w/Pretensioner **K**
- Inflatable Belt (No Pretension) **L**
2007/08 Testing

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Summary
## Base Configurations

### Non-Integrated 3-point:  
**Baseline** *(No Pretension)*  
- Lower D-Ring **C**  
- Upper D-Ring **D**  

**Pretensioners**  
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### Inflatable Belts:  
- Inflatable Belt w/Pretensioner **K**  
- Inflatable Belt (No Pretension) **L**
## 95th Test Matrix

### Non-Integrated 3-point:
- **Baseline (No Pretension)**
  - Upper D- Ring D
- **Pretensioners**
  - Retractor & Buckle Pretensioner G
  - Motorized & Buckle Pretensioner I

### Integrated 3-Point:
- No Pretensioner A
- SWAP No Pretensioner B

### 4-Point Belts:
- 4-Point redesign w/Preten M

### Inflatable Belts:
- Inflatable Belt w/Pretensioner K
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95th Male Average Plots

Y-Excursion

Time (s)

Excursion (mm)

Pre Impact

Post Impact

-D-  -G-  -I-  -K-  -M-
95th Male Average Y-Excursion

Testing
95th Male Average

Z-Excursion

Configuration

C  D  E  F  G  H  I  A  B  K  L  J  M

3 PT CONFIG
Non-Integrated

INTEGRATED
INFLATABLE
4 PT CONFIG
5th, 50th, & 95th Comparison
Baseline (D)

No Pretensioning
Y-Direction

Testing
Testing

5th, 50th, & 95th Comparison
Baseline (D)

No Pretensioning
Z-Direction

![Graph showing excursion over time with labels for 5th, 50th, and 95th percentiles in Z-direction. Pre Impact and Post Impact areas are highlighted.]
5th, 50th, & 95th Comparison
Configuration G
Retractor and Buckle Pyrotechnic Pretensioners

Y-Direction

Z-Direction

Excursion (mm)

Time (s)
Testing

5th, 50th, & 95th Comparison
Configuration I

Motorized Retractor and Pyrotechnic Buckle Pretensioners

Y-Direction

Z-Direction

Excursion (mm)

Pre Impact

Post Impact

-5TH Female - 50TH Male - 95TH Male

Excursion (mm)

Pre Impact

Post Impact

-5TH Female - 50TH Male - 95TH Male

Time (s)

Time (s)
50th, 5th, 95th Comparison
Y-Excursion
Testing

50th, 5th, 95th Comparison

Z-Excursion

Configuration

Z-Excursion [mm]
Inflatable Belts

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- 2007/08 Testing
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- Summary
95th Male
Configuration K

95th Male directly prior to inflation

95th Male directly after inflation
5th, 50th, & 95th
Configuration K

50th Male

5th Female

95th Male
5th Female
Configuration K vs C

5th Female Inflatable Belt (K)  
5th Female Baseline (C)
95th Male vs 5th Female
Configuration K

5th Female
Inflatable Belt (K)

95th Male
Inflatable Belt (K)
50th, 5th, 95th Comparison
Configuration K

Y-Direction

Excursion (mm)

Pre Impact
Post Impact

-5TH Female -50TH Male -95TH Male

Time (s)

-1.5 -1 -0.5 0 0.5

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4-Point

5th Female

50th Male

95th Male
4-Point

5th Female vs. 95th Male
Configuration M

5th Female Video

95th Male Video
4-Point

50th Male
Configuration M

50th Male
5th Female Configuration M vs. C

M
4-point
W/Pretensioning

C
Baseline
No Pretensioner

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5th Female
Configuration M vs. I

I
Motorized Retractor
W/Buckle Pretensioner

M
4-point
W/Pretensioning
50th, 5th, 95th Comparison
Configuration M
Y-Direction

4-Point

Excursion (mm)

Pre Impact

Post Impact

50TH Female - 50TH Male - 95TH Male

Time (s)
50th, 5th, 95th Comparison
Configuration M

Z-Direction

Excursion (mm)

-5TH Female - 50TH Male - 95TH Male

Time (s)
Summary

- Pretensioning appears to reduce head excursion in both the Y and Z directions of all size dummies
- 95th male testing followed trends similar to prior testing
- 5th female appear to demonstrate more excursion when compared to equivalent 50th male tests
Summary

• Inflatable belts were effective in reducing dummy excursion when compared to baseline.

• 4-point belts were effective in reducing Z-direction for excursion but less effective in Y-direction compared to baseline.
Summary

Future Work

- Future testing to include incorporation of a reaction surface to replicate the roof interior
- Full Scale Dynamic Rollovers to evaluate advanced restraints (J211 Dolly)
- Work with OEMs, suppliers and test labs to explore other rollover test devices or restraint evaluation
Thank You

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