NHTSA Research on Improved Restraints in Rollovers

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SAE Government/Industry Meeting
9 May 2006
Session G3
Overview

Introduction

Testing

Measurements

Preliminary Results
Introduction

- Testing
- Measurements
- Preliminary Results
Introduction

- 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 of 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 Test Fixture

Test Platform

Adjustable Shock Tower

Framework

Drop Tower
Introduction

RRT Overview Video
Testing

Introduction

Testing

Measurements

Preliminary Results
Test Protocol

• Evaluate Restraint Performance in a Rollover Scenario
• Phase I uses 50\textsuperscript{th} male Hybrid III (instrumented head, neck and chest)
• Each Configuration repeated 3 times
• Use video analysis to evaluate occupant head excursion
## Phase I Test Matrix

<table>
<thead>
<tr>
<th>Integrated 3-Point:</th>
<th>Non-Integrated 3-point:</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Pretensioner A</td>
<td>Lower D-Ring (No Pretension) C</td>
</tr>
<tr>
<td>SWAP No Pretensioner B</td>
<td>Upper D-Ring (No Pretension) D</td>
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<table>
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<th>Other:</th>
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<tr>
<td>4-Point with two lower anchor Pretensioners J</td>
<td></td>
</tr>
<tr>
<td>Retractor &amp; Buckle Pretensioner G</td>
<td>Motorized &amp; Buckle Pretensioner I</td>
</tr>
<tr>
<td>Buckle Pretensioner F</td>
<td>Motorized Pretensioner H</td>
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Configuration A
Integrated 3 pt. Seat
Configuration C
Non Integrated 3 pt. Seat

Testing

PRE

POST
Configuration J
4 Point Belt

Testing

PRE

POST
Measurements

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
Excursion

Static Test
Pre and Post Test

Dynamic Test
Pre and Post Test

Video Analysis
Measure Dynamic Excursion
  2 On Board Cameras (Low speed, 33 fps)
  2 Off Board Cameras (High speed, 500 fps)
Measurements

Excursion

Pre Test
Measurements

Excursion

Post Test
Preliminary Results

- Introduction
- Testing
- Measurements

Preliminary Results
Results

Roll Angle

Roll Angle Vs. Time

Pre Impact

Post

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Results

Roll Rate

Roll Rate Vs. Time

Pre Impact

Post

0 1 2 3

0 50 100 150 200 250 300 350

Time (s)

Roll Rate (Deg/S)
### Results

**Impact Roll Rate**

**Average Impact Roll Rate (Deg/S) w/Std Deviation (RRT)**

- Impact Roll Rate (deg/s)
  - 255
  - 275
  - 295
  - 315
  - 335

Configuration:
- A
- B
- C
- D
- E
- F
- G
- H
- I
- J

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Excursion
Y-Direction

Results

Pre Impact

Post

Excursion (mm)

Time (s)

C

G
Excursion
Y-Direction

PRE IMPACT Y(IN) AND Y(OUT)

Configuration

Excursion (mm)

Results

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Excursion
Y-Direction

PRE IMPACT Y(IN) AND Y(OUT)

Results
Results

Video Comparison
Pre Impact

Test C  Test G
Results

Video Comparison
Pre Impact

Test C          Test G
Excursion
Z-Direction

PRE AND POST IMPACT Z

Excursion (mm)

A  B  C  D  E  F  G  H  I  J

Configuration

Results

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Excursion
Z-Direction

PRE AND POST IMPACT Z

Excursion (mm)

Configuration

A B C D E F G H I J

Results
Video Comparison
Post Impact

Test C
Test G
Summary

• The RRT tester can provide repeatable dynamics.
• Pretensioning appears to reduce head excursion during the tests of the 50th male.
• Future studies will include different occupant sizes, restraint technologies and dynamic parameters.
• Explore a way to include a partial cab to utilize other restraint devices (Rollover Bags)
Thank You

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