JAPAN Accident Analyses for Application and Height on Head Restraints GTR

Rev.1 January ‘06
September ’05

JAPAN MLIT
Part 1
Study of Application
Vehicles of 3.5 t or less account for 92% of the whole fleet.

Vehicles of 3.5 to 4.5 t account for only 1.1% of the fleet, but many vehicles of the same type are found among larger vehicles. When the scope of application is extended, it will place a large burden on them.
Order of accident analyses

1. Number of Road Accidents in Japan in 2004
2. Number of Rear Impacts in 2004
3. Number of Injuries and Deaths in Rear Impacts
4. Number of Vehicles and Occupants Sustaining Neck Injuries by Vehicle Class
5. Number and Proportion of Occupants Sustaining Neck Injuries by Gender and Age
6. Conclusion
In Japan, rear impacts account for 30% of accidents resulting in bodily injury. Among them, 90% of the injuries of impacted vehicle occupants are minor neck injuries.
Proportion of Rear-Impacting and -Impacted Vehicles by Vehicle Weight

90% of accidents occur between cars with GVW up to 3.5 t.

Breakdown of Impacting and Impacted Vehicles in Rear Impacts in 2003
(Based on the number of accidents, except multi-collisions, resulting in bodily injury of impacting or impacted vehicle occupant(s.).)

<table>
<thead>
<tr>
<th>Rear-Impacted Vehicle</th>
<th>GVW up to 3.5 t</th>
<th>GVW over 3.5 t</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Passenger Car</td>
<td>Mini-car</td>
<td>Truck (up to 3.5 t)</td>
<td>Mini-sized Truck</td>
</tr>
<tr>
<td>GVW up to 3.5 t</td>
<td>88,464</td>
<td>20,424</td>
<td>10,027</td>
<td>8,792</td>
</tr>
<tr>
<td>Mini-car</td>
<td>24,368</td>
<td>8,119</td>
<td>2,509</td>
<td>3,133</td>
</tr>
<tr>
<td>Truck (up to 3.5 t)</td>
<td>6,772</td>
<td>1,390</td>
<td>1,221</td>
<td>837</td>
</tr>
<tr>
<td>Mini-sized Truck</td>
<td>9,827</td>
<td>2,815</td>
<td>1,388</td>
<td>1,524</td>
</tr>
<tr>
<td>GVW over 3.5 t</td>
<td>2,120</td>
<td>446</td>
<td>490</td>
<td>283</td>
</tr>
<tr>
<td>Truck (Over 3.5 t)</td>
<td>198</td>
<td>52</td>
<td>35</td>
<td>18</td>
</tr>
<tr>
<td>Bus</td>
<td>504</td>
<td>103</td>
<td>107</td>
<td>68</td>
</tr>
<tr>
<td>Others</td>
<td>Special Purpose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>132,253</td>
<td>33,349</td>
<td>15,777</td>
<td>14,835</td>
</tr>
</tbody>
</table>

Number of rear impacts between vehicles with GVW up to 3.5 t, resulting in bodily injury: 191,790 (89.4%)

Number of rear impacts between vehicles with GVW over 3.5 t, resulting in bodily injury: 1,540 (0.7%)
Vehicles with GVW up to 3.5t account for 97.5% of rear-impacted vehicles which occupant(s) sustained neck injury.

<table>
<thead>
<tr>
<th>GVW</th>
<th>Vehicle Class</th>
<th>Number of Occupants</th>
<th>Subtotal by GVW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 3.5 t</td>
<td>Passenger car</td>
<td>200,666</td>
<td>302,157 (97.5%)</td>
</tr>
<tr>
<td></td>
<td>Mini-car</td>
<td>63,664</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Truck (up to 3.5 t)</td>
<td>15,451</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mini-sized truck</td>
<td>22,376</td>
<td></td>
</tr>
<tr>
<td>Over 3.5 t</td>
<td>Truck (Over 3.5 t)</td>
<td>6,636</td>
<td>7,173 (2.3%)</td>
</tr>
<tr>
<td></td>
<td>Bus</td>
<td>537</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>Special-purpose</td>
<td>609</td>
<td>609(0.2%)</td>
</tr>
</tbody>
</table>

Number of occupants sustaining minor neck injury in rear-impacted vehicles: 309,939
1. Application

In Japan, there is no need for expanding the application beyond Category 1-1 and 2 with GVW up to 3.5t, because the number of neck injuries in the rear-impacted vehicles with GVW over 3.5t is quite small.
Part 2
Study of Height
Drivers in their 30s make up the majority of the occupants sustaining neck injuries.
Number of Occupants Sustaining Neck Injuries in Rear-Impacted Vehicles by Gender and Age

Among rear-impacts resulting in bodily injury, 81.7% of male and 88% of female drivers of the impacted vehicles sustained minor neck injuries.

Minor Neck Injury Ratio = Minor Neck Injuries / (Deaths + Serious injuries + Minor Injuries + Not injured)

Subject: Rear impact resulting in bodily injury

“Not injured” means the number of drivers who were not injured in the accident in which any passenger of rear-impacted vehicle was injured.
Example of Consideration in Europe

A DETAILED ANALYSIS OF THE CHARACTERISTICS OF EUROPEAN REAR IMPACTS
Volker Eis, Raimondo Sferco, Paul Fay/Ford Motor Company, Germany and UK  #19ESV 05-0385

Female front seat occupants are at higher risk of receiving an STNI (Soft tissue neck injuries).

STNI risk of front seat occupants in single rear impacts by gender and seating position

The taller the women are, the higher is their risk of receiving a soft tissue neck injury.

STNI risk of front seat occupants in single rear impacts by gender and body height
Comparison of Seated Height of Japanese, Netherlanders, and Americans

Since the seated heights of Japanese females and males are shorter than those of Americans in all age groups, head restraints with a height of 800 mm will cover all occupants.

Source: (Netherlands) NL Calculation of needed head restraint height (informal group 3rd meeting)
(Japan) Human Body Dimensions Data for Designs (1994) by Life Engineering and Industrial Technology Research Institute, Agency of Industrial Science and Technology
Straightening and Ramping-up of the test subject in the past

< Points of Examination >

1) Straightening
   Amount of change due to the straightening of the vertebrae
   Amount of change in distance between T1-IC

2) Ramping-up
   Amount of elevation of the trunk
   Displacement of IC along the seat back

Standard seat: 22.5

The above points were examined until just before the trunk rebounds from the seat back
Check them at the moment T1 is closest to the seat back

Seat used: Standard seat
Test subjects: 4 to 5 males
Straightening and Ramping-up at the moment T1 is closest to the seatback

**Straightening**: About 38 mm in average (up to 6 km/h)

**Ramping-up**: About 10 mm in average (8 km/h)

**Orbit of T1·IC**

Sled speed: 8 km/h

**Straightening**

Change in the distance between PN·IC

**Ramping-up**

Displacement of IC along the seatback
Measuring Seating Height and Seating Position
At CEASAR and in Japan, the seating height is measured with the subject sitting up straight and includes extension due to the straightening of the vertebrae that occurs at the moment the occupant sustains a rear impact.

CEASAR: Sitting Height
Same method used in Japan

Example of the sitting position

Mini sled test
UMTRI method
Summary

• Upward move during a mini-sled test simulating a rear impact
  Ramping-up: About 10 mm (8 km/h)
  Straightening: About 38 mm (6 km/h)

• Of the above amount, the “Straightening” is included in the sitting height measured.

  The factors we have to consider in determining the head restraint height are only
  “the straight sitting height + Ramping-up”.
2. Height

- It was found that females are more susceptible to neck injury than males in Japan. However, there is no data supporting the relationship between seated height and susceptibility.

- According to the research in Europe, females with high seated height are the most susceptible.

- Head restraints with a height of 800 mm can cover the body of Japanese occupants. Head restraints with a height of 850 mm may cause a concern about rear field of view. Therefore, Japan recommends 800 mm.
2. Study of Possible Effects on Mini Cars

(1) On direct rearward and rearward oblique visibility

Affected by the head restraint width, but hardly affected by its increased height.

(2) On indirect rearward visibility

At the maximum head restraint height, visibility through the inner mirror greatly affected due to a limited vehicle width.

- Height-adjustable head restraints are likely to be required.